PROVINCE OF ALBERTA

RESEARCH COUNCIL OF ALBERTA

Bulletin 28
Volume 1

Lower Cretaceous Microfloras of the Peace River Area, Northwestern Alberta

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March, 1971

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Lower Cretaceous Microfloras of the Peace River Area, Northwestern Alberta

ABSTRACT

Eight sections of Lower Cretaceous rocks exposed along the Peace and Smoky Rivers in northwestern Alberta were sampled for palynological study. The rocks comprise a succession of interbedded shaly and arenaceous units of predominantly marine origin, encompassing the upper part of the Loon River Formation, the Peace River Formation (Notikewin, Harmon, Cadotte, and Paddy Members), and the lower part of the Shaftesbury Formation, dated as Albian on the basis of faunal content.

The microflora recovered from these strata contains 94 genera and 202 species of microspores and pollen, 7 genera and 13 species of megaspores, and 47 genera and 114 species of microplankton. Of these, 1 genus and 31 species of microspores and pollen, 1 genus and 1 species of megaspores, and 20 species of microplankton are new. The oldest microflora, from the upper part of the Loon River Formation, is essentially similar to the nonangiospermous upper Mannville microflora (middle Albian) of central Alberta. Angiosperm pollen make their main entrance in the Peace River Formation in the upper part of the Harmon Member, and show marked evolutionary diversification in the overlying beds. Many of these angiosperm species are known to make their entrance in strata of middle and late Albian age in other parts of North America. The microflora of the Harmon and Cadotte Members is dated as middle Albian and that of the overlying Paddy Member provisionally as late Albian. The lower part of the Shaftesbury Formation (from the base of the formation to just above the "Fish-scale" marker bed) contains microfloral species of late Albian age.

The microfloral evidence indicates that the Loon River Formation is correlative with the upper Mannville strata of central Alberta. The Harmon Member is older than the Joli Fou Formation and presumably correlative with part of the erosional interval between the Mannville Group and Joli Fou Formation in central Alberta. The Cadotte Member is partly correlative with the Joli Fou Formation. The microfloral evidence for correlation of the Paddy Member with the Viking Formation of central Alberta is inconclusive but the overlying Shaftesbury Formation is approximately correlative with the post-Viking shales in the lower part of the Colorado Group.

There is an increase in the representation of microplankton and a decline in that of megaspores in the shaly Loon River, Harmon, and Shaftesbury units, indicative of an offshore environment of deposition. This trend is reversed in the silty and sandy beds of the Cadotte and Paddy Members, which represent nearshore to continental depositional facies.

INTRODUCTION

Sedimentary rocks of Early Cretaceous age underlie much of northern Alberta, being exposed along the valleys of the Hay, Peace, and lower Athabasca Rivers and their tributary streams. The strata are of predominantly marine origin, having been deposited in or marginal to a series of shallow epicontinental seas that transgressed over what are now the Alberta Plains during Early Cretaceous time. Thus, they

consist of a succession of interbedded shaly and arenaceous rock units that in general represent the marine offshore facies and shoreline facies, respectively, of these seas.

Of considerable economic importance, these strata contain abundant heavy oil deposits, such as those exposed along the lower Athabasca River in northeastern Alberta, and moderate amounts of natural gas and oil in the subsurface to the west. Consequently, a detailed knowledge of the stratigraphy and correlation of these rocks is useful to the development of their mineral resources, in addition to providing the basic data for bedrock mapping in northern Alberta and adjacent areas.

The strata on which this study is based are exposed along the Peace River and its tributary streams, forming the near-surface bedrock throughout much of northwestern Alberta. The lithology of the beds has been described by McLearn (1918) and Wickenden (1951), and the age has been established, on the basis of ammonites and other diagnostic marine fossils, as middle to late Albian (Wickenden, *ibid.;* Stelck *et al.,* 1956). However, conflicting views have been expressed concerning correlations between the Lower Cretaceous rock units exposed along the Peace River and those on the Athabasca River to the east and in the subsurface of central Alberta (Wickenden, *ibid.;* Stelck, 1958; Workman, 1959; Oliver, 1960).

Because of the uncertainties in detailed correlations of these strata, an investigation of the microfloral content of the Lower Cretaceous rock units exposed along the Peace River was undertaken, the results of which are described in this report. The objective of the investigation was to describe the kinds and distributions of microfloral entities in beds which encompass the upper part of the Loon River Formation, the Peace River Formation, and the lower part of the Shaftesbury Formation. In addition, the entrance levels of stratigraphically significant species and the broad stratigraphic changes in major microfloral groups have been outlined within the framework of these rock units and compared with those established in correlative strata of central Alberta (Singh, 1964; Norris, 1967).

Previous Work

An initial description of the microflora in strata adjacent to the Jurassic-Cretaceous boundary in the Western Canadian Plains was published by Pocock (1962). Subsequently, Singh (1964) undertook a more detailed study of the microflora of the Mannville Group (Lower Cretaceous) in east-central Alberta. The pollen and spores of Chlamydospermidae and Schizaeaceae, and dispersed spores from the upper Mannville strata of Saskatchewan have been described by Pocock (1964) and Steeves and Wilkins (1967), respectively. However, all these microfloras are nonangiospermous and of middle Albian or older age. A younger microflora of

middle to late Albian age from the lower part of the Colorado Group in central Alberta containing tricolpate dicotyledonous pollen was first described by Norris (1967). The microflora of these and adjacent beds has been investigated further by Brideaux (1968).

Several important contributions to the study of mid-Cretaceous microfloras of the United States containing early tricolpate dicotyledonous pollen have been made. Groot and Penny (1960) initiated the study of plant microfossils from the nonmarine Potomac Group and Raritan Formation (Barremian to Cenomanian) of Maryland and Delaware, followed by more comprehensive studies of the same microflora by Brenner (1963, 1967). Pierce (1961) described spores and pollen of Cenomanian age from Minnesota, and Davis (1963) discussed the microflora of the Lower Cretaceous rocks of northern Wyoming. Pannella (1966) described the microflora and outlined the microfloral zones in the Dakota Group and Graneros Shale (middle Albian to early Cenomanian) of the Denver Basin. Hedlund (1966) made a comprehensive study of the microflora of the Woodbine Formation (Cenomanian) in southern Oklahoma; this work was followed by a report on the Albian microflora from beds in approximately the same region by Hedlund and Norris (1968).

Only minor studies of Lower Cretaceous microplankton have been published in North America: Pocock (1962) and Singh (1964) described some species of microplankton from the Mannville Group of Alberta, Manum and Cookson (1964) reported on a microplankton assemblage of early Late Cretaceous age from the Arctic Islands of Canada, and Tasch, McClure and Oftedahl (1964) published a paper on the microplankton of Albian age from Kansas.

Acknowledgments

The writer wishes to thank Dr. G. B. Mellon, Research Council of Alberta, for critically reading the manuscript and making many useful suggestions during all stages of the investigation. Sincere thanks are due to Dr. J. H. Wall, Research Council of Alberta, for accompanying the writer to the Peace River area during the initial phase of field work and contributing pertinent stratigraphic information. The writer also is indebted to Dr. Wall for reading and suggesting improvements to parts of the manuscript. Dr. L. A. Bayrock, Research Council of Alberta, kindly translated relevant portions from Russian publications.

The writer acknowledges the valuable information and advice received through correspondence with Professor T. M. Harris, Reading University; Mr. N. F. Hughes, Cambridge University; Dr. R. H. Tschudy, U. S. Geological Survey; Dr. G. Playford, University of Queensland; and Dr. J. Jansonius, Imperial Oil Limited, Calgary.

LOCATION OF SAMPLES AND LABORATORY TECHNIQUES

Location of Samples

The Lower Cretaceous strata on which this study is based are exposed over a large area in northwestern Alberta adjacent to the valleys of the Peace and Hay Rivers and tributary streams. The sampling localities extend from near the confluence of the Peace and Smoky Rivers, just south of the Town of Peace River, for approximately 60 miles northward along the Peace River valley (Fig. 1).

A total of 73 spot samples were collected from the shaly and silty portions of eight outcrop sections for microfloral analysis. The locations of the sampled sections, their lithologies, and the stratigraphic position of each sample are shown in figure 2. Sections 1, 2, and 3, near the confluence of the Smoky and Peace Rivers, expose most of the lower beds of the Shaftesbury Formation, from just above the "Fish-scale" marker bed to within a few feet of the base of the formation, an interval which is approximately 300 feet thick[1]. Sections 4 to 8 inclusive, situated downstream along the banks of the Peace River, expose a progressively older succession of strata including the basal beds of the Shaftesbury Formation, the Peace River Formation, and the upper part of the Loon River Formation. These last-named sections have been described in detail by Wickenden (1951), whose sections 1, 2, 3, 6, and 8 correspond with sections 4, 5, 6, 7, and 8, respectively of this report.

Sample Preparation

A standard preparation technique outlined by Singh (1964, p. 5) was followed. This involved the removal of silicates by 48 per cent hydrofluoric acid (more calcareous samples were first treated with 42 per cent orthophosphoric acid), followed by oxidation in Schultze's solution and a short treatment with 5 per cent potassium carbonate. The sample was wet-sieved through a 100-mesh screen, and the material remaining on the sieve was searched for megaspores. The material passing through the sieve was subjected to heavy liquid separation with zinc bromide (s.g. = 2.0), and the organic residue was collected for mounting. Slides were prepared using polyvinyl alcohol (Elvanol Grade 51-05) and Canada balsam as a permanent mounting medium. Many single grain slides also were prepared.

Counting Procedure

Generally, three slides per sample were examined by traversing each slide at a magnification of X125 lengthwise along lines 1 mm apart. The specimens of various species were counted and recorded as dominant (20 or more specimens), abundant (10 - 19 specimens), common (5 - 9 specimens), rare (2 - 4 specimens), or single (1 specimen).

[1] Based on data from logs of nearby oilwells.

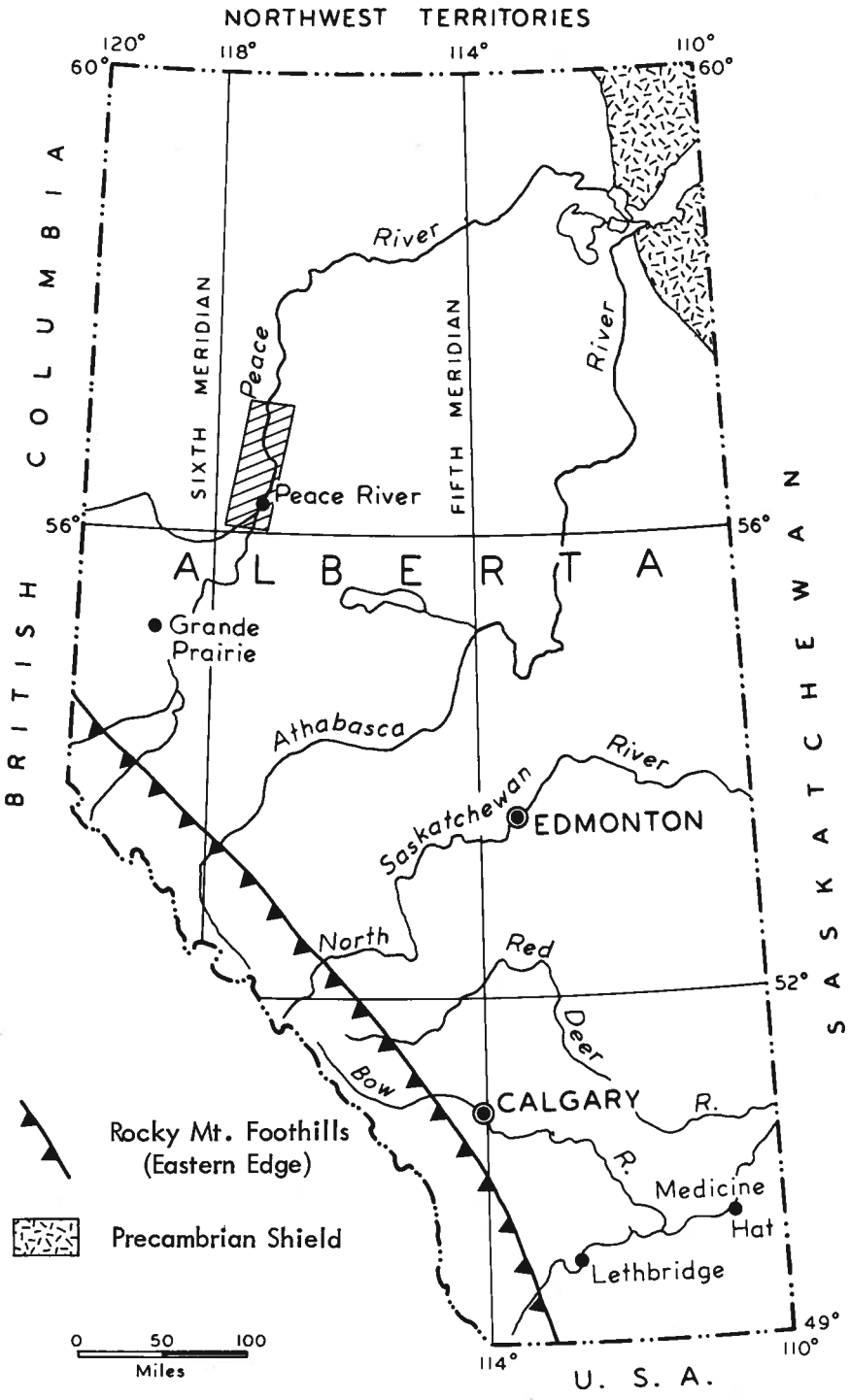

FIGURE 1. Index map of Alberta showing location of the study area (barred).

Photomicrography

A Carl Zeiss Polarizing Photomicroscope was used for taking the photomicrographs. The photographs were taken on Adox KB14 35mm film and printed on Kodak Polycontrast F single-weight paper. The microplankton photographs were printed on Kodak Kodabromide F-5 single-weight paper to produce sufficient contrast. A blue filter was used in taking the photographs. The photographs of the smaller specimens, especially the angiosperms, were taken with a X100 oil-immersion objective.

Most of the specimens are shown on the plates at a magnification of X500 to emphasize the relative size differences. The smaller specimens, especially the angiosperms, are illustrated at a magnification of X1000, whereas the megaspores are illustrated at magnifications ranging from X100 to X400.

Designation and Preservation of Type Specimens

The holotypes have been preserved on single grain and strew slides. They have been designated as follows:

(1) by type locality indicated by section numbers 1 to 8;

(2) by the code of the stratigraphic unit:

L = Loon River Formation
H = Harmon Member
C = Cadotte Member
P = Paddy Member
S = Shaftesbury Formation (lower)
US = Shaftesbury Formation (upper);

(3) by the number of the sample in the stratigraphic unit;

(4) by the number of the strew slide prepared from the sample;

(5) by the serial number of the slide in single grain slides, preceded either by Micro. (microspore or microplankton) or Mega. (megaspore) – e.g. Micro. 75;

(6) by the stage co-ordinates. The "vertical reading" is given first, and the "horizontal reading" next (e.g. co-ord. 3/36).

Thus, for example, the designation 8-L-9 (2) means that the type locality is section 8, the rock unit is the Loon River Formation, and 9 is the number of the sample in this section. The number in parenthesis indicates that the slide is the second from

that sample. In single grain slides the serial number of the slide instead of the number in parenthesis is given, e.g. 8-L-9-Micro. 50.

All holotypes and other figured specimens, slides, processed residues and unprocessed portions of the samples are deposited in the paleobotanical collection of the Research Council of Alberta.

STRATIGRAPHY

Introduction

McConnell (1893) briefly described the Lower Cretaceous strata of the Peace River area and introduced the names Loon River Formation and Peace River Sandstone for beds between the Devonian limestone and marine shales believed to be of Late Cretaceous age. McLearn and Henderson (1944) subsequently applied the name Shaftesbury Formation to the marine shales overlying the Peace River Sandstone, beneath the sandy beds of the Dunvegan Formation.

McLearn (1944) subdivided the Peace River Formation into lower sandstone, middle shale, and Cadotte Members, and used the name "McMurray" for beds between the base of his revised Loon River Formation and the underlying Paleozoic rocks. Wickenden (1951) studied the Lower Cretaceous sections on the Peace River below the Town of Peace River and described the beds from the basal portion of the Shaftesbury Formation, Peace River Formation, and the upper part of the Loon River Formation. He followed McLearn's (1944) division of the Peace River Formation but recognized that McLearn's Cadotte Member consisted of two units: a lower marine sandstone, to which he restricted the name Cadotte Member, overlain by a continental member.

Mainly on the basis of subsurface data, Workman *et al.* (1954) introduced the name Spirit River Formation for strata consisting essentially of the Loon River Formation and McLearn's (1944) lower sandstone member of the overlying Peace River Formation, the upper part of which they named the Notikewin Member. The Spirit River Formation consists of, in ascending order, Wilrich, Falher, and Notikewin Members. At the same time Workman *et al.* redefined the Peace River Formation, calling McLearn's (1944) middle shale member the Harmon Member, and Wickenden's (1951) continental member the Paddy Member. Thus, the Peace River Formation as defined by Workman *et al.* consists of, in ascending order, Harmon, Cadotte, and Paddy Members. Williams (1960) retained the name Loon River Formation for the strata assigned to the Wilrich and Falher Members by Workman *et al.* and included the Notikewin Member in the Peace River Formation. Williams' terminology is used in this report.

Loon River Formation

The Loon River Formation in the Peace River area consists of a basal unit of widespread glauconitic sandstone called the Bluesky Member (found only in the subsurface) and a succession of dark grey shales with minor sandstones and siltstones overlain by alternating, fine-grained, lime-cemented, often glauconitic, "salt-and-pepper" sandstones and shales. The top of the formation is marked by a gradational boundary with the basal sandstone (Notikewin Member) of the overlying Peace River Formation and the base is marked by the nonmarine sandstones, shales, and coals of the subsurface Gething Formation.

The Loon River Formation is entirely marine in origin, and is about 1000 feet thick in the vicinity of the Town of Peace River (Williams, 1960). It decreases in thickness towards the north, where it unconformably overlies Devonian beds. About 135 feet of the upper part of the Loon River Formation are exposed in section 8 (Fig. 2).

Peace River Formation

The Peace River Formation consists of a lower marine sandstone called the Notikewin Member, a middle marine shale known as the Harmon Member, overlain by another marine sandstone, the Cadotte Member, and an upper continental sandstone designated as the Paddy Member. The Peace River Formation is transitional with the underlying Loon River shales and disconformable with the overlying Shaftesbury Formation. Contacts between the four members of the Peace River Formation appear to be gradational, although Stelck (1958) and Oliver (1960) have suggested that a disconformity of fairly major proportions exists between the Cadotte and Paddy Members. The Peace River Formation thins and becomes more shaly and marine northward, and coarser and increasingly continental in aspect towards the south (Fig. 3).

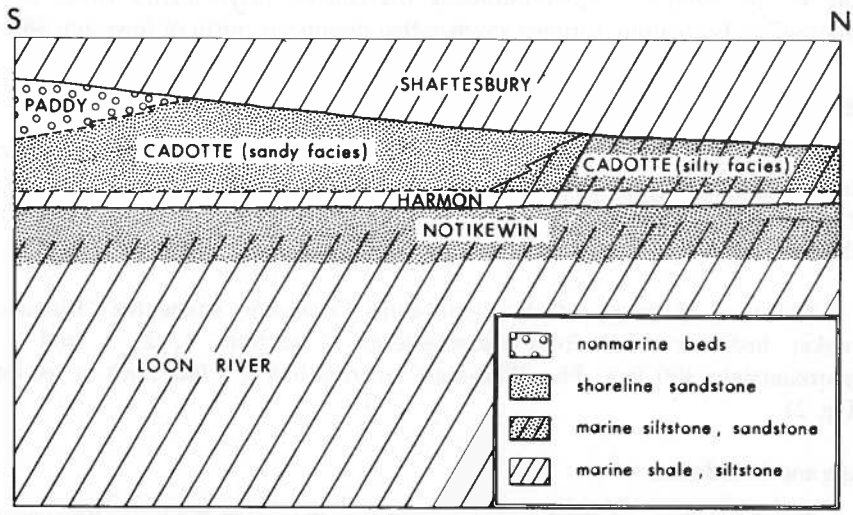

FIGURE 3. Schematic cross section through Lower Cretaceous strata of the Peace River area showing marine, shoreline, and nonmarine facies.

The Notikewin Member is 13 feet, 35 feet, and 21 feet thick in sections 6, 7, and 8, respectively. It consists of grey, fine- to medium-grained, somewhat clayey sandstones with interbeds of light to dark grey shales containing ironstone concretions. The sandstones usually contain some glauconite. The lower boundary of the member is less distinct than the upper and grades in many places imperceptibly into the underlying Loon River shales; however, the upper boundary with the Harmon Shale is fairly abrupt.

The Harmon Member is 31 feet and 26 feet thick in sections 6 and 7, respectively. It consists of dark grey, slightly silty, thinly bedded to fissile, marine shale with scattered interbeds of bentonitic shale and siltstone.

The Cadotte Member is 68 feet and 67 feet thick in sections 6 and 7, respectively. It is composed of grey to greenish grey, fine-grained, normally glauconitic, massive sandstone with minor shale interbeds in sections 5 and 6. It is represented by a silty and shaly facies towards the north, in section 7. The Cadotte Member is overlain by continental sandstones of the Paddy Member in sections 5 and 6. The Paddy Member pinches out towards the north so that in section 7 the Cadotte Member is disconformably overlain by shales of the Shaftesbury Formation (Fig. 2). The Cadotte Member thins, becomes more shaly towards the north and disappears altogether north of the township 93.

The Paddy Member is 58 feet thick in section 5. It consists of white to grey, poorly sorted, fine- to very coarse-grained, often crossbedded nonmarine sandstone with thin silty shale and lignitic coal beds. The base of the member grades into the underlying Cadotte Sandstone, and lithologic evidence of disconformity at the lower contact, as postulated by Stelck (1958) and Oliver (1960), is not discernible. The Paddy Member is disconformably overlain by black marine shales of the Shaftesbury Formation, forming a wedge that disappears north of township 88.

Shaftesbury Formation

The Shaftesbury Formation in the Peace River area consists of dark grey, slightly silty, marine shale with scattered rounded or banded ironstone concretions. It contains the widespread "Fish-scale" marker bed, which is mainly composed of siltstones carrying abundant fossil fish scales.

The total thickness of the Shaftesbury Formation below the "Fish-scale" marker bed, estimated from measurements of sections 1, 2, 3, and 4, is approximately 300 feet. The "Fish-scale" marker bed is 5 feet thick in section 1 (Fig. 2).

Age and Correlation

The relationship of the Lower Cretaceous rock units in the Peace River area to correlative strata in other parts of the Western Canada Sedimentary Basin is shown in table 1. Mellon (1967) discussed in detail the age and correlation of the Lower Cretaceous rock units of Alberta and northeastern British Columbia, and the new names proposed by him for some of them have been used in this report. The Gething Formation is correlative with the McMurray Formation of the northern and central Plains and the Gladstone Formation of the central and southern Foothills. The Loon River and Peace River Formations are correlative with the Clearwater-Grand Rapids and Fort Augustus Formations of the northern and central Plains, as well as the Moosebar-Commotion and Beaver Mines Formations of

the Foothills. The Shaftesbury Formation is equivalent to the Hasler, Goodrich, and Cruiser Formations of northeastern British Columbia and to the lower part of Blackstone Formation in the central and southern Foothills of Alberta. It is correlative with the lower part of La Biche Formation in the northeastern Plains and with the lower part of the Colorado Group lying above the Viking Formation in the central and southern Plains.

The Loon River Formation and correlative beds in the Foothills to the west (Moosebar Formation) are underlain conformably by nonmarine strata grouped under the term Gething Formation. The Gething Formation and correlative strata are of dominantly nonmarine origin, although a few marine invertebrates indicative of marine tongues within the formation have been reported by Stott (1963). The megafloral remains of the Gething Formation are nondicotyledonous (Bell, 1956; Mellon *et al.*, 1963; Stott, 1963) and essentially contain the elements of the "lower Blairmore" flora. The precise age of the Gething Formation remains uncertain due to the lack of diagnostic marine fossils, although Bell (1956, p. 19) assigned to it an Aptian age on the basis of megafloral evidence. McGregor dated the Gething microfloral assemblage as being Valanginian to Aptian and possibly younger than Barremian in age (*in* Stott, 1968, p. 39).

The Loon River Formation and equivalent strata are of marine origin. Stelck *et al.* (1956) reported *Cleoniceras* from the lower part of Loon River Formation, where it is associated with the *Rectobolivina* microfaunal zone (J. H. Wall, pers. comm.). *Cleoniceras* is early Albian in age. McLearn (1944) and Wickenden (1951) reported elements of the *Subarcthoplites – Beudanticeras* fauna of middle Albian age from the upper part of the Loon River Formation, where it is associated with the *Marginulinopsis collinsi* and *Verneuilina porta* microfaunal zones (Stelck *et al.*, 1956; Wall, 1969). The *Subarcthoplites – Beudanticeras* faunal zone encompasses also the lower part of the overlying Peace River Formation (Notikewin Member).

The Peace River Formation, with the exception of the continental Paddy Member at the top, is of marine origin. Wickenden (1951) and Stelck *et al.* (1956) reported elements of the *Gastroplites* fauna of late middle Albian age (see Jeletzky, 1968, p. 18) from the Cadotte Member, in which they are associated with the Cadotte microfaunal zone. The underlying Harmon Member carries the distinctive *Haplophragmoides multiplum* microfaunal zone (Stelck *et al.*, 1956). The Paddy Member does not contain diagnostic fauna or megaflora.

Although no identifiable megafloral remains have been reported from the Peace River Formation, the correlative Commotion Formation in the Foothills to the west has yielded a distinctive dicotyledon-bearing flora which contains the oldest angiosperm leaf impressions in Western Canada. Stott (1963, p. 13) listed the following species from the Gates (lower) Member of the Commotion Formation:

Sapindopsis belviderensis Berry
Araliaephyllum (?) sp.

Mellon *et al.* (1963, p. 70) reported the following dicotyledonous species from the Commotion section on Belcourt Ridge, in beds probably correlative with the upper part of the Gates Member:

Protophyllocladus subintegrifolius (Lesquereux)
Sapindopsis cf. *S. magnifolia* Fontaine
Fontainea cf. *F. grandiflora* Newberry
Cissites ?
Sassafras parvofilium Fontaine
Ficus ovatifolia Berry
Populites cf. *P. dawsoni* Bell
Aralia wellingtoniana Lesquereux

The upper beds (Boulder Creek Member) of the Commotion Formation also have yielded a dicotyledonous flora, originally described by Bell (1956, p. 37) who reported the following species from the top of the formation:

Ficus ? *fontainii* ? Berry
Menispermites reniformis Dawson
Menispermites potomacensis Berry
Fontainea grandiflora Newberry

This list subsequently was enlarged by Stott (1963, p. 16), who listed the following species from the Boulder Creek Member:

Cercidiphyllum sp.
Platanus sp.
Paliurus sp.
cf. *Cissites*
Magnolia sp. (=*Ficus fontainii* ? Berry)
Menispermites reniformis Dawson
cf. *Artocarpidium cretaceum* Ettingshausen
Rhamnus sp.

Bell (1956) tentatively assigned a late Albian age to the upper Commotion flora. However, Stott (1963) reports a late middle Albian *Gastroplites* fauna from the upper Commotion beds (Hulcross and Boulder Creek Members), in which case the upper Commotion flora is more likely of late middle Albian age.

The Shaftesbury Formation and equivalent strata are of marine origin. Wall (1969) reported elements of the *Verneuilina canadensis* (or *Miliammina manitobensis*) microfaunal zone of late Albian age from the lower part of the Shaftesbury Formation. This zone lies above the Viking (Pelican) Formation in the Alberta Plains (Stelck, 1958). No megafauna has been so far reported from the Shaftesbury Formation exposed near the Town of Peace River. However, the lower part of Cruiser Formation below the "Fish-scale" marker bed and the Goodrich Formation in northeastern British Columbia carry the *Neogastroplites* fauna of late Albian age (Stelck *et al.*, 1956). *Neogastroplites* has been collected by Stelck also from the

"Fish-scale" marker bed at Cadomin in the central Foothills (Jeletzky, 1968, p. 23). Thus, the lower part of Shaftesbury Formation below the "Fish-scale" marker bed near the Town of Peace River can be assumed to be of late Albian age.

The Joli Fou-Viking (Pelican) succession appears to be absent from the northwestern Plains and adjacent British Columbia. The *Inoceramus comancheanus* fauna and associated *Haplophragmoides gigas* microfauna (Wickenden, 1949; Stelck *et al.*, 1956; Stelck, 1958) found in the Joli Fou Formation have not been identified in the western Plains or Foothills. According to Mellon (1967, p. 82), the Joli Fou Formation and its fauna can be indirectly correlated with the upper part of the Blairmore Group in the southern Foothills containing the advanced Mill Creek flora ("upper Blairmore" flora) with a high representation of dicotyledonous elements. This correlation is supported by Norris (1967, p. 82), who reported several species of angiosperm pollen from the Joli Fou Formation.

The correlation of the Joli Fou and Viking Formations with the Harmon and Cadotte Members by Workman (1959) is contrary to the paleontological evidence. The Harmon and Cadotte Members contain a microfaunal assemblage which is distinct from that of the Joli Fou Formation (Wickenden, 1951; Stelck *et al.*, 1956; Stelck, 1958), showing a definite affinity with the Loon River - Clearwater assemblage (Mellon and Wall, 1963). The *Gastroplites* fauna found in the Cadotte Member is not only distinct from the Joli Fou megafauna but is associated with the upper Commotion flora (Stott, 1963) which is older than the Mill Creek flora mentioned above. Thus, the Joli Fou-Viking succession appears to be younger than the Harmon and Cadotte Members.

The Cadotte and Paddy Members probably interfinger with the nonmarine, upper parts of the Grand Rapids and Fort Augustus Formations in the subsurface to the east and southeast. These beds appear to be disconformably overlain by the Joli Fou Shale, which presumably wedges out towards the northwest because of the onlap onto the eroded surface of the Cadotte Sandstone (Stelck, 1958; Oliver, 1960).

Depositional Environment and Paleogeography

The Lower Cretaceous strata in the Peace River area can be related to two cycles of sedimentation separated by a break in deposition. The Loon River and Peace River Formations are associated with the transgression of the boreal Loon River - Clearwater Sea over northern and central Alberta and its subsequent withdrawal to the north. The Shaftesbury Formation, on the other hand, is related to the northward transgression of the Gulfian Sea over the Alberta Plains.

During early Albian *(Cleoniceras)* time, marine sedimentation was restricted to northernmost Alberta. The glauconitic sands of the Bluesky Member representing nearshore bar deposits and the shales in the lower part of the Loon River Formation indicative of deeper water conditions were deposited in the northern

sea. These marine beds interfinger to the southeast with shoreline or nonmarine beds in the upper part of the McMurray Formation.

The southward transgression of the boreal sea into central Alberta took place in early middle Albian (*Subarcthoplites* - *Beudanticeras*) time, during which the Loon River - Clearwater shales were deposited. The Notikewin Sandstone is associated with the gradual filling-in and shallowing of the boreal sea.

Late middle Albian (*Gastroplites*) time was marked by the withdrawal of the boreal sea towards northern Alberta in which the Harmon and Cadotte Members of the Peace River area were deposited. The Harmon Shale represents the deep water facies of a minor marine transgression, designated as the Hulcross Sea by Stott (1968, p. 118), which was gradually filled in by the sandy and silty beds of the Cadotte Member. The Paddy Member is probably a local lagoonal phase of the marine Cadotte Sandstone. The top of the Peace River Formation is marked by a regional disconformity caused by a widespread break in sedimentation.

At the beginning of late Albian (*Verneuilina canadensis* - *Neogastroplites*) time northern Alberta was inundated by the northward-advancing Gulfian Sea in which the Shaftesbury Shale and correlative strata were deposited.

SERIES	STAGES	AMMONITE ZONES	FORAMINIFERA ZONES	NORTHEAST BRITISH COLUMBIA	ALBERTA PLAINS: LOWER PEACE RIVER	ALBERTA PLAINS: LOWER ATHABASCA RIVER	ALBERTA PLAINS: CENTRAL	ALBERTA PLAINS: SOUTHERN	SOUTHERN FOOTHILLS	CENTRAL FOOTHILLS
UPPER CRETACEOUS	CENOMANIAN			CRUISER FORMATION	"FISH-SCALE" MARKER BED				BLACKSTONE FORMATION	BLACKSTONE FORMATION
LOWER CRETACEOUS	ALBIAN UPPER	*Neogastroplites*		GOODRICH FORMATION	SHAFTESBURY FORMATION	LA BICHE FORMATION	UPPER SHALE UNIT, COLORADO GROUP	COLORADO GROUP		
			Verneuilina canadensis	HASLER FORMATION						
					PADDY MEMBER	PELICAN FORMATION	VIKING FORMATION	BOW ISLAND FORMATION	CROWSNEST MEMBER	
			Haplophragmoides gigas		PEACE RIVER FORMATION	JOLI FOU FORMATION	JOLI FOU FORMATION		MILL CREEK FORMATION	
	ALBIAN MIDDLE	*Gastroplites*		BOULDER CREEK MEMBER, COMMOTION FORMATION	CADOTTE MEMBER					
			Haplophragmoides multiplum	HULCROSS MEMBER	HARMON MEMBER	GRAND RAPIDS FORMATION			GROUP	
		Beudanticeras and *Subarcthoplites*	*Verneuilina porta*	GATES MEMBER	NOTIKEWIN MEMBER		GRAND RAPIDS FACIES, FORT AUGUSTUS FORMATION, MANNVILLE GROUP	BLAIRMORE GROUP	BEAVER MINES FORMATION	MOUNTAIN PARK FACIES, BEAVER MINES FORMATION
			Marginulinopsis collinsi	MOOSEBAR FORMATION	LOON RIVER FORMATION	CLEARWATER FORMATION	CLEARWATER FACIES		BEAVER MINES FORMATION	LUSCAR FACIES
					BLUESKY MEMBER	WABISKAW MEMBER	WABISKAW MEMBER	"CALCAREOUS" MEMBER	"CALCAREOUS" MEMBER	MARINE TONGUE
			Rectobolivina				"CALCAREOUS" MEMBER			
	LOWER ALBIAN AND OLDER			GETHING FORMATION	GETHING FORMATION	McMURRAY FORMATION	McMURRAY FORMATION	SUNBURST FORMATION	GLADSTONE FORMATION	
				CADOMIN CGL.					CADOMIN CGL.	CADOMIN CGL.

Table 1. Chart Showing the Correlation of Lower Cretaceous Strata in Alberta and Northeastern British Columbia

STRATIGRAPHIC PALYNOLOGY

The Lower Cretaceous succession of the Peace River region contains a rich and varied microflora of which 329 species of microspores, pollen, megaspores, and microplankton are described in this report. The strata on which this study is based have been dated as middle to late Albian in age on the basis of ammonites and other diagnostic marine fossils (Wickenden, 1951; Stelck *et al.*, 1956). The composition of the microflora confirms this age range for the beds in question, although the succession contains many long-ranging microfloral species with pre-Albian entrance levels, which are of little value as criteria for refined dating and correlation at this level. Consequently, only those species with previously recorded Albian or younger entrance levels, or species found only in the Peace River sections are mentioned in the discussion below.

The stratigraphic distribution and relative abundances of microspores and pollen, microplankton, and megaspores are shown in tables 2, 3, and 4, respectively. The species are arranged in order of entrance levels, although some overlap exists in the vertical distribution of samples from the eight measured sections: for example, the two series of samples from the Harmon Member are from stratigraphically equivalent parts of the succession. The exact positions of the samples within each measured section and the relative stratigraphic positions of the sections are shown in figure 2.

Table 4. Distribution and Quantitative Estimates of Megaspore Species in Lower Cretaceous Strata of the Peace River Area

	LOWER CRETACEOUS																							
	LOON RIVER FORMATION	CADOTTE MEMBER		PADDY MEMBER						SHAFTESBURY FORMATION (LOWER)													
SECTION NUMBERS	8	7		4						5		4		3		1							
SAMPLE NUMBERS	8-L-11	7-C-3	7-C-2	4-P-8	4-P-7	4-P-6	4-P-5	4-P-4	4-P-3	5-S-3		4-S-3		3-S-2		1-S-11	1-S-5						
Arcellites reticulatus	1				2	1																	
Biharisporites sp.	1																						
Minerisporites marginatus	1	1																					
Minerisporites venustus	3				2	3																	
Erlansonisporites sparassis ?		1	3																				
Balmeisporites sp.			1				1	3															
Verrutriletes sp.			1																				
Arcellites disciformis				3	17	19	5																
Callistosporites graniferus				3	11	19	9	1	9														
Seed				1																			
Arcellites nudus						1																	
Lenticular bodies										47		12		1		1	4						
Verrutriletes sp. cf. V. compositipunctatus																	1						

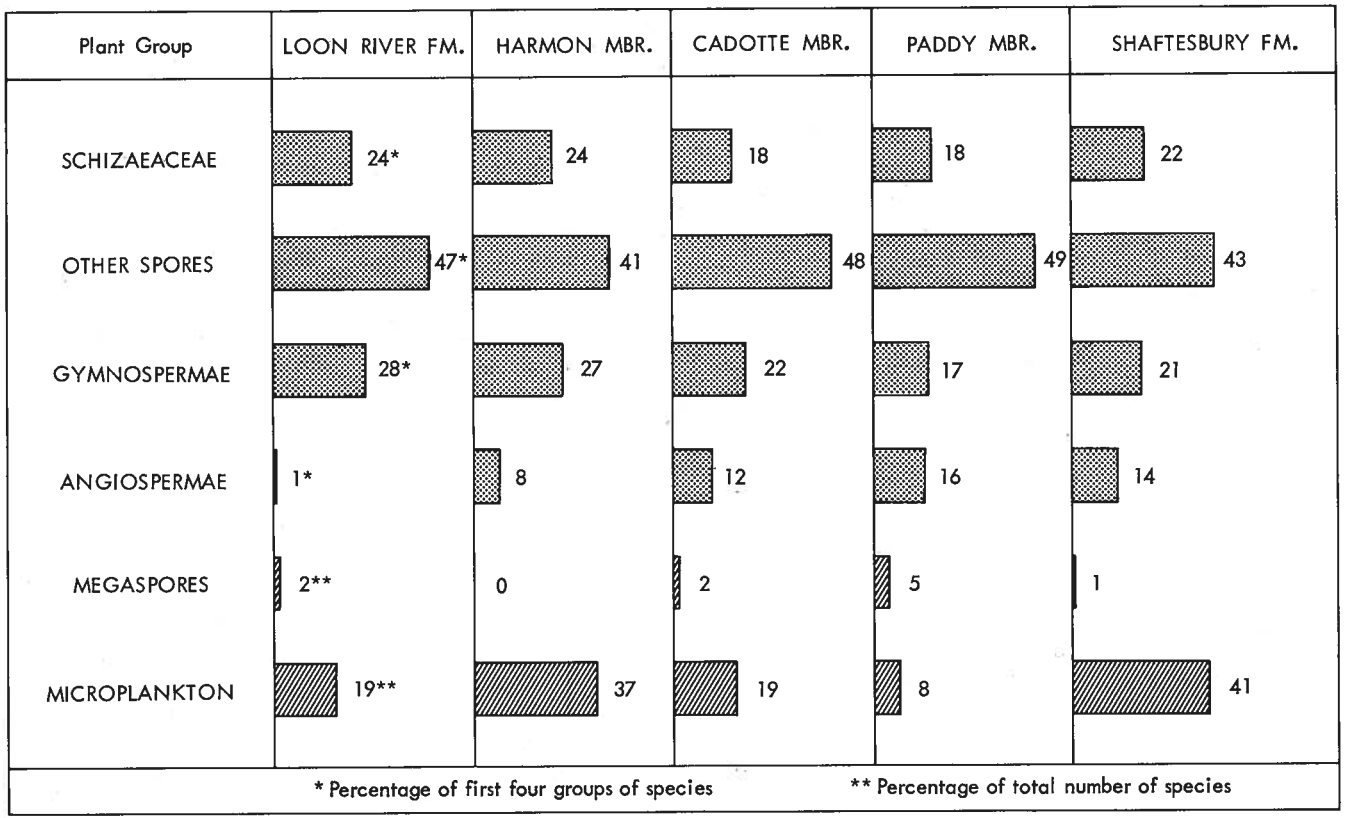

FIGURE 4. Percentage species-distribution of major microfloral groups in Lower Cretaceous strata of the Peace River area.

Table 5. Distribution of Microfloral Species by Entrance Levels in Lower Cretaceous Strata of the Peace River Area

	Species with Jurassic or older entrance levels	Species with pre-Albian Cretaceous entrance levels	Species with Albian entrance levels					Total Number of Species	Species continuing from below	Species making first appearance
			Continuing from below		First appearance		Total			
			A	B	A	B				
Shaftesbury Formation	43* (22)	36 (24)	26 (10)	21 (10)	5 (5)	0 (19)	52 (44)	131 (90)	126 (60)	5 (30)
Paddy Member	34 (4)	37 (3)	22 (1)	18 (1)	1 (1)	9 (1)	50 (4)	121 (11)	108 (8)	13 (3)
Cadotte Member	53 (15)	42 (12)	19 (2)	18 (3)	8 (0)	12 (4)	57 (9)	152 (36)	117 (31)	35 (5)
Harmon Member	47 (19)	32 (24)	16 (5)	17 (6)	9 (6)	3 (11)	45 (28)	124 (71)	109 (26)	15 (45)
Loon River Formation	50 (6)	41 (10)	- -	- -	17 (5)	26 (10)	43 (15)	134 (31)	- -	134 (31)

* Unbracketed numbers refer to microspores and pollen; bracketed numbers refer to microplankton.

A- species with previously known Albian or younger entrance levels.

B- species found only in the Peace River sections.

Microfloral Succession

The Lower Cretaceous strata sampled for this investigation, with the exception of the Paddy Member, are of marine origin, deposited in a series of shallow epicontinental seas that encroached over what are now the Interior Plains of North America during mid-Cretaceous time. In this light, the broad changes in the relative abundances of the major microfloral groups (grouped by species in Fig. 4) are understandable, reflecting changes in the positions of shorelines in the shallow interior seas. Thus, microplankton are most abundant in the shaly marine rock units (Loon River, Harmon, Shaftesbury), and megaspores in the sandy Cadotte and Paddy Members. However, in contrast to those groups the abundance of which is primarily a function of environmental conditions, angiosperms show marked evolutionary diversification in the upper part of the Harmon Member and overlying beds, corresponding with their appearance in strata of similar age in other parts of the world. No comparable change is observed in other groups of microspores and pollen, many of which are long-ranging forms that continue from older strata.

The microfloral succession in the Lower Cretaceous strata of the Peace River area is outlined below within the framework of the stratigraphic units. The interpretations concerning the age and correlation of these units are based mainly on the entrance levels of stratigraphically significant species, and on broad changes in major microfloral groups (Table 5; Fig. 4). The entrance of angiosperms in this succession is of considerable stratigraphic and evolutionary importance; consequently, the distribution of Lower Cretaceous angiosperm species common to the Peace River area and other parts of North America is summarized in table 6. The distribution of stratigraphically significant Lower Cretaceous microplankton species common to the Peace River area and other parts of the world is shown in table 7.

In the following discussion, only the names and the known stratigraphic ranges of species are given.

Loon River Formation

One hundred and thirty-four species of microspores and pollen, four species of megaspores, and thirty-one species of microplankton are present in the Loon River Formation[1]. Of these, 91 species of microspores and pollen, 1 species of megaspore, and 16 species of microplankton are long ranging and have been reported from strata older than Albian. The remaining 43 species of microspores and pollen, 3 species of megaspores, and 15 species of microplankton with Albian or younger entrance levels are listed below:

Species with previously known Albian or younger entrance levels

[1]Sampled interval includes only the upper 135 feet of the formation (Fig. 2).

	ALBERTA								NORTHERN WYOMING (Davis, 1963)								COLORADO and NEBRASKA DENVER BASIN (Pannella, 1966)									MINNESOTA (Pierce, 1961)	SOUTHERN OKLAHOMA (Hedlund and Norris, 1968)		(Hedlund, 1966)	MARYLAND (Brenner, 1963)			ATLANTIC COASTAL PLAIN (Groot, Penny and Groot, 1961) (Brenner, 1967)			CALIFORNIA (Drugg, 1967)	SOUTH DAKOTA (Stanley, 1965)	KNOWN STRATIGRAPHIC RANGE
	LOWER PEACE RIVER					CENTRAL PLAINS (Norris, 1967)			BLACK HILLS				BIG HORN BASIN				NORTHERN				SOUTHERN																	
	MIDDLE ALBIAN			UPPER ALBIAN		MIDDLE ALBIAN	UPPER ALBIAN		LOWER ALBIAN	MIDDLE ALBIAN	UPPER ALBIAN		MIDDLE ALBIAN	UPPER ALBIAN			MIDDLE ALBIAN	UPPER ALBIAN		CENOMANIAN	MIDDLE ALBIAN	UPPER ALBIAN	CENO-MANIAN	CENO-MANIAN	MIDDLE ?	ALBIAN	CENO-MANIAN	BARREMIAN	APTIAN	ALBIAN	CENO-MANIAN TURONIAN		CONI-ACIAN	MAES-TRICHTIAN DANIAN	PALEOCENE	
	LOON RIVER FM.	HARMON MBR.	CADOTTE MBR.	PADDY MBR.	SHAFTESBURY FM.	JOLI FOU FM.	VIKING FM.	UPPER SHALE UNIT	LAKOTA FM.	FALL RIVER FM.	SKULL CREEK SH.	NEWCASTLE FM.	RUSTY BEDS	THERMOPOLIS SH.	MUDDY SANDSTONE	SHELL CREEK SH.	FALL RIVER FM.	SKULL CREEK SH.	"J" SANDSTONE	HUNTSMAN SH.	"D" SANDSTONE	GRANEROS SH.	GLENCAIRN SH.	DAKOTA SANDSTONE	GRANEROS SH.	DAKOTA FM.	ANTLERS SANDSTONE	"WALNUT" CLAY	WOODBINE FM.	PATUXENT FM.	ARUNDEL FM.	PATAPSCO FM.	RARITAN FM.	TUSCALOOSA FM.	MAGOTHY FM.	MORENO FM. (upper)	LUDLOW MBR.	
Tricolpites micromunus	X	X	X	X													X		X	X			X	X	X		X	X				X	X	X	X		ALBIAN to DANIAN
Retitricolpites georgensis		X	X	X	X	X	X	X												X	X	X	X	X			X	X				X					ALBIAN and EARLY CENOMANIAN
Clavatipollenites hughesii		X	X	X	X		X	X									X	X	X	X	X	X	X	X	X					X	X	X					BARREMIAN to EARLY CENOMANIAN
Foveotricolpites concinnus		X	X		X																											X					MIDDLE ALBIAN to CENOMANIAN
Retitricolpites prosimilis		X	X	X	X	X	X	X																													MIDDLE and LATE ALBIAN
Retitricolpites vulgaris		X	X	X	X	X	X	X		X	X	X	X	X	X	X										X	X	X			X						MIDDLE ALBIAN to CENOMANIAN
Cupuliferoidaepollenites minutus		X				X	X	X									X	X	X	X	X	X		X	X						X						ALBIAN and EARLY CENOMANIAN
Retitricolpites virgeus		X	X	X	X												X		X				X	X			X	X					X	X	X			MIDDLE ALBIAN to CONIACIAN
Striatopollis paraneus		X	X	X	X	X	X	X																			X	X										MIDDLE and LATE ALBIAN
Liliacidites trichotomosulcatus			X	X																																		MIDDLE and LATE ALBIAN
Retitricolpites maximus			X	X	X																																	MIDDLE and LATE ALBIAN
Tricolpites sagax			X	X	X	X	X	X																														MIDDLE and LATE ALBIAN
Tricolpites parvus			X	X	X																																X	MIDDLE ALBIAN to EARLY PALEOCENE
Liliacidites reticulatus			X		X					X	X	X		X													X	X		X	X	X					BARREMIAN to ALBIAN
Tricolpites crassimurus			X	X	X												X	X	X	X	X	X	X	X	X						X	X	X	X			ALBIAN to CONIACIAN
Clavatipollenites minutus			X	X		X																					X	X		X	X	X					BARREMIAN to ALBIAN
Fraxinoipollenites venustus			X	X	X																																MIDDLE and LATE ALBIAN
Liliacidites dividuus			X	X	X				X	X	X	X		X		X	X	X.	X	X			X			X	X	X	X			X					ALBIAN and CENOMANIAN
Liliacidites peroreticulatus			X	X				X									X		X			X		X						X	X	X					BARREMIAN to EARLY CENOMANIAN
Liliacidites inaequalis				X	X																																	LATE ALBIAN
Liliacidites crassatus				X																																		LATE ALBIAN
Liliacidites clavatus				X																																		LATE ALBIAN
Psilatricolpites parvulus					X			X																								X	X	X	X			LATE ALBIAN to DANIAN
Liliacidites textus					X			X																														LATE ALBIAN
Nyssapollenites albertensis					X															X	X	X		X	X													LATE ALBIAN to EARLY CENOMANIAN

Table 6. Distribution of Angiosperm Species Common to the Peace River Area and Other Parts of North America

	CANADA									U.S.A.	ENGLAND												FRANCE	BELGIUM	GERMANY	POLAND				RUMANIA	BALTIC REGION (O. Wetzel, 1933)	MEDITERRANEAN REGION (Rossignol, 1964)	WEST PAKISTAN (Evitt, 1961)	AUSTRALIA								KNOWN STRATIGRAPHIC RANGE
	ALBERTA								ARCTIC ISLANDS (Manum and Cookson, 1964)	CALIFORNIA (Drugg, 1967)	CAMBRIDGE (Cookson and Hughes, 1964)			ISLE OF WIGHT (Clarke and Verdier, 1967)					(Davey et al., 1966) (Davey, 1969)	(White, 1842)	(Deflandre and Courteville, 1939) (Deflandre, 1937)	(Lejeune-Carpentier, 1940)	(Maier, 1959)	(Górka, 1963)				(Baltes, 1967b)							(Deflandre and Cookson, 1955; Cookson and Eisenack, 1958; Eisenack and Cookson, 1960; Cookson and Eisenack, 1962a; Cookson and Eisenack, 1962b; Cookson, 1965)								
	LOWER PEACE RIVER					CENTRAL PLAINS (Singh, 1964)																																		
	MIDDLE ALBIAN			UPPER ALBIAN		MIDDLE ALBIAN			LOWER UPPER CRETACEOUS	DANIAN	UPPER ALBIAN	BASAL CENOMANIAN	LOWER CENOMANIAN	CENOMANIAN	TURONIAN	CONIACIAN	SANTONIAN	CAMPANIAN																							
	LOON RIVER FM.	HARMON MBR.	CADOTTE MBR.	PADDY MBR.	SHAFTESBURY FM.	CLEARWATER FM.	GRAND RAPIDS FM.	HASSEL FM. and EQUIVALENT STRATA		MORENO FM. (upper)	UPPER GAULT	CAMBRIDGE GREENSAND	CHALK MARL	LOWER CHALK	MIDDLE CHALK	UPPER CHALK			CENOMANIAN	SENONIAN	SENONIAN	SENONIAN	MIDDLE OLIGOCENE and MIDDLE MIOCENE	CENOMANIAN	TURONIAN	CAMPANIAN	MAESTRICHTIAN	UPPER ALBIAN	SENONIAN	PLEISTOCENE	SENONIAN	ALBIAN	? UPPER ALBIAN	CENOMANIAN	LOWER TURONIAN	UPPER CRETACEOUS	EOCENE	OLIGOCENE	MIOCENE	
Baltisphaeridium multispinosum																																							MIDDLE and LATE ALBIAN
Hystrichosphaera cingulata																																							ALBIAN to PLEISTOCENE
Baltisphaeridium whitei																																							MIDDLE ALBIAN to SENONIAN
Hystrichosphaera scabrosa																																							MIDDLE ALBIAN to SANTONIAN
Diconodinium pusillum																																							MIDDLE and LATE ALBIAN
Hystrichosphaeridium stellatum																																							ALBIAN to MIDDLE MIOCENE
Pseudoceratium regium																																							MIDDLE and LATE ALBIAN
Hexagonifera chlamydata																																							ALBIAN to SANTONIAN
Oligosphaeridium prolixispinosum																																							MIDDLE ALBIAN to CENOMANIAN
Hystrichosphaera ramosa var. gracilis																																							MIDDLE ALBIAN to MIOCENE
Hystrichosphaeridium arundum																																							ALBIAN
Hystrichosphaera cingulata var. reticulata																																							MIDDLE ALBIAN to SANTONIAN
Odontochitina striatoperforata																																							ALBIAN to SENONIAN
Deflandrea limpida																																							MIDDLE and LATE ALBIAN
Lecaniella foveata																																							LATE ALBIAN
Schizocystia laevigata																																							LATE ALBIAN and CENOMANIAN
Apteodinium reticulatum																																							LATE ALBIAN
Crassosphaera bella																																							LATE ALBIAN
Gonyaulacysta edwardsi																																							ALBIAN to CAMPANIAN
Hystrichosphaeridium cooksoni																																							LATE ALBIAN
Oligosphaeridium diastema																																							LATE ALBIAN
Palambages Form A																																							ALBIAN and LATE CRETACEOUS
Scriniodinium eurypylum																																							LATE ALBIAN and EARLY LATE CRETACEOUS
Palaeostomocystis glabella																																							LATE ALBIAN
Ascodinium verrucosum																																							LATE ALBIAN and EARLY CENOMANIAN
Hystrichosphaeridium recurvatum																																							LATE ALBIAN to MAESTRICHTIAN

Table 7. Distribution of Stratigraphically Significant Microplankton Species Common to the Peace River Area and Other Parts of the World

Microspores and pollen

Appendicisporites unicus: middle Albian to Cenomanian
Cirratriradites teter: late Albian†
Distaltriangulisporites perplexus: middle and late Albian
Dyadosporites ellipsus: Late Cretaceous to early Pliocene †
Lycopodiumsporites crassimacerius: Cenomanian†
Reticulisporites elongatus: late Albian†
Tigrisporites scurrandus: middle and late Albian
Trilobosporites crassus: middle Albian to early Cenomanian
Appendicisporites spinosus: middle Albian
Cicatricosisporites imbricatus: Cenomanian†
Cicatricosisporites subrotundus: Albian
Cicatricosisporites minor: middle Albian to Late Cretaceous
Cicatricosisporites pseudotripartitus: Albian and Cenomanian
Taxodiaceaepollenites hiatus: Cenomanian to Miocene†
**Tricolpites micromunus:* Albian to Danian
Inaperturopollenites sp.: middle and late Albian
Polycingulatisporites radiatus: late Albian†

Megaspores

Arcellites reticulatus: Albian
Minerisporites venustus: middle and late Albian

Microplankton

Baltisphaeridium multispinosum: middle and late Albian
Hystrichosphaera cingulata: Albian to Pleistocene
Baltisphaeridium whitei: Cenomanian to Senonian†
Hystrichosphaera scabrosa: Cenomanian to Santonian†
Hystrichosphaeridium stellatum: Albian to middle Miocene

Species found only in the Peace River sections

Microspores and pollen

Appendicisporites bilateralis
Cicatricosisporites augustus
Cicatricosisporites sp. cf. *Anemia exilioides*
Cicatricososporites auritus
Distaltriangulisporites irregularis
Foveosporites labiosus

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†Range extended in this report to middle Albian.
*Angiospermae.

Klukisporites areolatus
Ornamentifera baculata
Undulatisporites fossulatus
Cicatricosisporites spiralis
Foveosporites sp. cf. *F. canalis*
Podocarpidites granulatus
Tigrisporites reticulatus
Distaltriangulisporites mutabilis
Lycopodiacidites canaliculatus
Distaltriangulisporites costatus
Distaltriangulisporites maximus
Cicatricosisporites sp. cf. *C. imbricatus*
Annulispora sp.
Dacrycarpites sp.
Vitreisporites sp.
Callialasporites sp.
Converrucosisporites exquisitus
Leptolepidites sp.
Aberrant *Pityosporites* pollen
Abiespollenites sp.

Megaspores

Biharisporites sp.

Microplankton

Chlamydophorella largissima
Gonyaulacysta sp. A
Precingular archeopyle operculum Type A
Precingular archeopyle operculum Type B
Baltisphaeridium sp. B
Chlamydophorella tabulata
Pareodinia sp. A
Cymatiosphaera sp. A
Prolixosphaeridium sp.
Diconodinium pusillum

Peace River Formation, Harmon Member

One hundred and twenty-four species of microspores and pollen and seventy-one species of microplankton are present in the Harmon Member. Of these, 79 species of microspores and pollen and 43 species of microplankton are long ranging and have been reported from strata older than Albian. Another 33 species of microspores and pollen and 11 species of microplankton with Albian entrance

levels continue from the Loon River Formation. The remaining 12 species of microspores and pollen and 17 species of microplankton with Albian or younger entrance levels which make their first appearance in the Harmon Member are listed below:

Species with previously known Albian or younger entrance levels

Microspores and pollen

Pluricellaesporites psilatus: Late Cretaceous to early Pliocene†
**Retitricolpites georgensis:* Albian and early Cenomanian
**Foveotricolpites concinnus:* Cenomanian†
**Retitricolpites prosimilis:* middle and late Albian
**Retitricolpites vulgaris:* middle Albian to Cenomanian
**Cupuliferoidaepollenites minutus:* Albian and early Cenomanian
**Retitricolpites virgeus:* middle Albian to Cenomanian
Phyllocladidites sp.: middle and late Albian
**Striatopollis paraneus:* middle and late Albian

Microplankton

Hexagonifera chlamydata: Albian to Santonian
Oligosphaeridium prolixispinosum: Cenomanian†
Hystrichosphaera ramosa var. *gracilis:* Cenomanian to Miocene†
Hystrichosphaeridium arundum: Albian
Hystrichosphaera cingulata var. *reticulata:* Cenomanian to Santonian†
Odontochitina striatoperforata: Albian to Senonian

Species found only in the Peace River sections

Microspores and pollen

Appendicisporites sp. cf. *A. cristatus*
Tigrisporites sp. A
Cicatricosisporites sp. cf. *C. potomacensis*

Microplankton

Baltisphaeridium crameri
Pseudoceratium regium
Cymatiosphaera sp. B
Exochosphaeridium scitulum
Gardodinium elongatum
Tanyosphaeridium sp.
Baltisphaeridium sp. A
Cordosphaeridium sp.
Pterodinium reticulatum
Gonyaulacysta sp. B
Cymatiosphaera sp. C

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†Range extended in this report to middle Albian.
*Angiospermae.

Peace River Formation, Cadotte Member

One hundred and fifty-two species of microspores and pollen, four species of megaspores, and thirty-six species of microplankton are present in the Cadotte Member. Of these, 95 species of microspores and pollen, 2 species of megaspores, and 27 species of microplankton are long ranging and have been reported from strata older than Albian. Another 37 species of microspores and pollen and 5 species of microplankton with Albian entrance levels continue from the underlying strata. The remaining 20 species of microspores and pollen, 2 species of megaspores, and 4 species of microplankton with Albian or younger entrance levels which make their first appearance in the Cadotte Member are listed below:

Species with previously known Albian or younger entrance levels

Microspores and pollen

Lophotriletes babsae: Albian
Phyllocladidites inchoatus: middle Albian to Cenomanian
Camarozonosporites insignis: Albian and Cenomanian
**Tricolpites sagax:* middle and late Albian
Rugubivesiculites reductus: middle Albian to Paleocene
**Tricolpites parvus:* early Paleocene†
**Tricolpites crassimurus:* Albian to Coniacian
**Liliacidites dividuus:* Albian and Cenomanian

Species found only in the Peace River sections

Microspores and pollen

* *Liliacidites trichotomosulcatus*
Lycopodiumsporites expansus
* *Retitricolpites maximus*
Appendicisporites sp. cf. *A. jansonii*
Concavissimisporites sp.
Kraeuselisporites sp.
Lycopodiumsporites crassatus
Podocarpidites sp. cf. *P. herbstii*
Trilobosporites sp.
Ischyosporites disjunctus
Appendicisporites sp. cf. *A. macrorhyza*
* *Fraxinoipollenites venustus*

Megaspores

Balmeisporites sp.
Verrutriletes sp.

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*Angiospermae.
†Range extended in this report to middle Albian.

Microplankton

Canningia aspera
Chytroeisphaeridia sp.
Deflandrea limpida
Veryhachium reductum forma 1

Peace River Formation, Paddy Member

One hundred and twenty-one species of microspores and pollen, seven species of megaspores, and eleven species of microplankton are present in the Paddy Member. Of these, 71 species of microspores and pollen, 1 species of megaspore, and 7 species of microplankton are long ranging and have been reported from strata older than Albian. Another 40 species of microspores and pollen, 3 species of megaspores, and 2 species of microplankton with Albian entrance levels continue from the underlying strata. The remaining 10 species of microspores and pollen, 3 species of megaspores and 2 species of microplankton with Albian entrance levels which make their first appearance in the Paddy Member are listed below:

Species with previously known Albian entrance levels

Microspores

Appendicisporites bifurcatus: middle and late Albian

Megaspores

Arcellites nudus: Albian

Microplankton

Schizocystia laevigata: late Albian and Cenomanian

Species found only in the Peace River sections

Microspores and pollen

Lycopodiacidites caperatus
Murospora truncata
Tigrisporites sp. B
* *Liliacidites inaequalis*
Fungal fruiting body (Microthyriaceae)
* *Liliacidites crassatus*
Rouseisporites sp. cf. *R. radiatus*
* *Liliacidites clavatus*
Undulatisporites sp.

Megaspores

Callistosporites graniferus
Seed

Microplankton

Lecaniella foveata

*Angiospermae.

Shaftesbury Formation

One hundred and thirty-one species of microspores and pollen, two species of megaspores, and ninety species of microplankton are present in the Shaftesbury Formation[1]. Of these, 79 species of microspores and pollen, 1 species of megaspore, and 46 species of microplankton are long ranging and have been reported from strata older than Albian. Another 47 species of microspores and pollen and 20 species of microplankton with Albian entrance levels continue from the underlying strata. The remaining 5 species of microspores and pollen, 1 species of megaspore, and 24 species of microplankton with Albian or younger entrance levels which make their first appearance in the Shaftesbury Formation are listed below:

Species with previously known Albian or younger entrance levels

Microspores and pollen

Rugubivesiculites rugosus: late Albian and Cenomanian
* *Psilatricolpites parvulus:* late Albian to Danian
* *Liliacidites textus:* late Albian
* *Nyssapollenites albertensis:* late Albian and early Cenomanian
Appendicisporites matesovae: Albian to Turonian

Microplankton

Gonyaulacysta edwardsi: Albian to Campanian
Palambages Form A: Albian and Late Cretaceous
Scriniodinium eurypylum: early Late Cretaceous†
Ascodinium verrucosum: late Albian and early Cenomanian
Hystrichosphaeridium recurvatum: Senonian†

Species found only in the Peace River sections

Megaspores

Lenticular bodies

Microplankton

Apteodinium reticulatum
Crassosphaera bella
Hystrichosphaeridium cooksoni
Micrhystridium sp.
Oligosphaeridium diastema

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[1]Sampled interval extends from the base of the formation to just above the "Fish-scale" marker bed (Fig. 2).

*Angiospermae.

†Range extended in this report to late Albian.

Polystephanephorus sp. cf. *P. urnaformis*
Ascostomocystis maxima
Crassosphaera ornata
Pterospermopsis sp. cf. *P. aureolata*
Pterospermopsis sp. A
Pterospermopsis sp. B
Pterospermopsis sp. C
Trichodinium spinosum
Chlamydophorella sp.
Leiosphaeridia sp.
Palaeostomocystis glabella
Broomea sp.
Oligosphaeridium sp.
Crassosphaera papillata

Age and Correlation of the Microflora

The entrance of tricolpate dicotyledonous pollen in Albian strata of North America has been well documented by Brenner (1963), Davis (1963), Pannella (1966), Norris (1967), and Hedlund and Norris (1968). In other parts of the world, the first definite dicotyledonous pollen have been reported from Albian strata of central Russia (Bolkhovitina, 1953), New Zealand (Couper, 1960), Portugal (Groot and Groot, 1962), Central America and Africa (Couper, 1964), Peru (Brenner, 1968), Australia (Dettmann and Playford, 1968), and England (Kemp, 1968). Thus, the entrance of tricolpate dicotyledonous pollen in the Lower Cretaceous succession of the Peace River area supports the middle to late Albian age assigned to these beds on faunal evidence (Wickenden, 1951; Stelck *et al.*, 1956).

The Loon River microflora is associated with the *Subarcthoplites - Beudanticeras* fauna of middle Albian age and contains 17 species of microspores and pollen, 2 species of megaspores, and 5 species of microplankton (listed above) with previously known Albian or younger entrance levels. Of these, *Appendicisporites unicus, Distaltriangulisporites perplexus, Appendicisporites spinosus, Cicatricosisporites minor, Arcellites reticulatus, Minerisporites venustus,* and *Baltisphaeridium multispinosum* are known also from the upper Mannville strata of central Alberta (Singh, 1964) or Saskatchewan (Pocock, 1964). Angiosperm pollen are sparsely represented in the Loon River Formation by only two specimens of *Tricolpites micromunus*, the main entrance level of the angiosperms being in the upper part of the Harmon Member (Table 2). These data indicate that the Loon River microflora is essentially similar to the nonangiospermous upper Mannville microflora of middle Albian age.

The stratigraphically significant microplankton species in the Loon River Formation are: *Baltisphaeridium multispinosum, Hystrichosphaera cingulata, Baltisphaeridium whitei, Hystrichosphaera scabrosa, Diconodinium pusillum, Hystrichosphaeridium stellatum* (Table 7).

The Harmon microflora is associated with the *Haplophragmoides multiplum* microfaunal zone of middle Albian age. Angiosperms make their entrance in the upper part of the member and diversify within a relatively short stratigraphic interval (Table 2). They constitute 8 per cent of the total number of microspore and pollen species in the Harmon Member (Fig. 4) and of the 15 microspore and pollen species which make their first appearance in this unit, 8 species are angiosperms. Of these, *Retitricolpites georgensis**, *Foveotricolpites concinnus*, *Retitricolpites prosimilis**, *Retitricolpites vulgaris**, *Cupuliferoidaepollenites minutus**, *Retitricolpites virgeus*, and *Striatopollis paraneus** make their entrance in strata of Albian age in other parts of North America (Table 6). The five species marked by asterisks above have been reported also from the Joli Fou Formation of central Alberta (Norris, 1967), a thin, transgressive marine shale unit that overlies disconformably the nonmarine (Grand Rapids) Mannville beds. Angiosperms, including some of the above species, make their first appearance at the base of the Joli Fou Formation but are absent from the underlying Mannville beds (Singh, 1964; Norris, *ibid.*). This strongly suggests that in central Alberta angiosperms made their entrance after deposition of the Mannville Group sediments but prior to the transgression of the Joli Fou sea, i.e. during the apparent hiatus in deposition between the two rock units. On the other hand, in the Peace River region angiosperms make their main entrance in the upper part of the Harmon Member, and are present in only one of the two Harmon sections examined (Fig. 2, section 7). Thus, the Harmon microflora appears to be older than the Joli Fou microflora, but younger than the nonangiospermous Mannville microflora of central Alberta. This interpretation is further supported by the fact that *Tricolpites sagax* and *Phyllocladidites inchoatus*, which make their first appearance in the Joli Fou Formation of central Alberta (Norris, 1967, Table 4), are absent from the Harmon, making their first appearance in the Peace River sections in the overlying Cadotte Member. Thus, the Harmon Member presumably correlates with part of the erosional interval between the Mannville Group and Joli Fou Formation of central Alberta (Table 1).

The microplankton species increase their representation to 37 per cent of the total number of microfloral species in the Harmon Member (Fig. 4), which is indicative of the offshore environment in which these beds were deposited. In addition, the Harmon microplankton assemblage is significantly different from that of the underlying Loon River Formation: of the 71 microplankton species present in the Harmon Member, 45 make their first appearance in this unit (Table 5). The stratigraphically significant Harmon microplankton species are: *Pseudoceratium regium*, *Hexagonifera chlamydata*, *Oligosphaeridium prolixispinosum*, *Hystrichosphaera ramosa* var. *gracilis*, *Hystrichosphaeridium arundum*, *Hystrichosphaera cingulata* var. *reticulata*, *Odontochitina striatoperforata* (Table 7).

The Cadotte microflora is associated with the *Gastroplites* fauna of late middle Albian age. Angiosperm species increase their representation to 12 per cent of the

total number of microspore and pollen species in the Cadotte Member (Fig. 4); of the 18 angiosperm species present, 10 make their first appearance in this unit. Of these, *Tricolpites sagax, Tricolpites crassimurus,* and *Liliacidites dividuus* make their entrance in strata of Albian age in other parts of North America (Table 6). Also present in the Cadotte Member is *Lophotriletes babsae,* which makes its entrance in the Patapsco Formation (Albian) of Maryland with the first tricolpate dicotyledonous pollen of that region (Brenner, 1963).

Of the 7 angiosperm species reported from the Joli Fou Formation of central Alberta (Norris, 1967), 6 are present in the Cadotte Member (Table 6). Besides these, the nonangiospermous species, *Phyllocladidites inchoatus, Camarozonosporites insignis,* and *Rugubivesiculites reductus,* which make their entrance in the Joli Fou and basal Viking beds (Norris, *ibid.,* Table 4) also make their first appearance in the Cadotte Member. This suggests that at least part of the Cadotte Member is correlative with the Joli Fou Formation.

The microplankton species *Deflandrea limpida* makes its entrance near the top of the Cadotte Member, and becomes abundant in the Shaftesbury Formation (Table 3).

The Paddy microflora is marked by a drastic decrease in numbers and species of microplankton and an increase in megaspores (Fig. 4), reflecting a near shore to continental environment of deposition. However, most of the microfloral species in the Paddy Member continue from the underlying beds (Table 5). Thus, although angiosperms increase their representation to 16 per cent of the total number of microspore and pollen species in the Paddy Member (Fig. 4), of the 19 angiosperm species present, only 3 make their entrance in this unit (Table 6). All three, moreover, are found only in the Peace River sections. Other stratigraphically significant new species in the Paddy Member are, *Murospora truncata, Callistosporites graniferus,* and *Lecaniella foveata.*

No precise conclusions concerning the age of the Paddy Member can be drawn on the basis of the microflora. Only three species, *Appendicisporites bifurcatus, Arcellites nudus,* and *Schizocystia laevigata* with previously known Albian entrance levels make their first appearance in the Paddy Member. Of these, *A. bifurcatus* and *A. nudus* make their entrance in the much older upper Mannville beds of central Alberta (Singh, 1964). However, the presence of *S. laevigata,* to date known only from strata of late Albian or younger age, and the high representation of the angiosperms in the Paddy Member suggest that this unit may be of late Albian age.

The microflora from the lower part of the Shaftesbury Formation (from the base of the formation to just above the "Fish-scale" marker bed – see Fig. 2) is characterized by an abundance in both numbers and species of microplankton, which constitute 41 per cent of the total number of microfloral species recorded in this interval (Fig. 4). This reflects an abrupt change in depositional facies, from

continental or shoreline arenaceous sediments of the older Paddy-Cadotte complex to the offshore silty shales of the Shaftesbury Formation.

The lower Shaftesbury microflora is associated with the *Verneuilina canadensis* microfaunal zone of late Albian age. Angiosperm species constitute 14 per cent of the total number of microspore and pollen species in the Shaftesbury Formation (Fig. 4); of the 18 angiosperm species present, 3 make their first appearance in this unit. These three species, *Psilatricolpites parvulus, Liliacidites textus,* and *Nyssapollenites albertensis* make their entrance in strata of late Albian age in other parts of North America (Table 6). Of these, *N. albertensis* is tricolporate and makes its entrance 115 feet below the "Fish-scale" marker bed in the Shaftesbury Formation. Pannella (1966) also has recorded the entrance of *N. albertensis* (=*Tricolporites dakotensis*) in the upper part of the Dakota Sandstone (late Albian) in Colorado (Table 6), but with these exceptions, earliest tricolporate pollen are known to make their entrance only in deposits of Cenomanian age (Pierce, 1961; Groot, Penny and Groot, 1961; Groot and Groot, 1962; Hedlund, 1966; Brenner, 1967). Thus, the rare presence of tricolporate pollen below the "Fish-scale" marker bed is presumably indicative of the latest Albian age of these beds. The late Albian age of the lower Shaftesbury Formation is further suggested by the entrance of *Rugubivesiculites rugosus,* known only from the strata of late Albian or younger age in North America (Pierce, 1961; Norris, 1967), at the base of this unit.

Psilatricolpites parvulus, Liliacidites textus, and *Appendicisporites matesovae* which make their entrance in the upper shale unit (late Albian) of the Colorado Group (Norris, 1967, Table 4), also make their first appearance in the lower part of the Shaftesbury Formation, indicating approximate correlation of the two units.

The microplankton assemblage in the lower part of the Shaftesbury Formation is significantly different from that of the underlying beds. Of the 90 microplankton species present in the Shaftesbury Formation, 30 make their first appearance in this unit (Table 5). The stratigraphically significant microplankton species in the Shaftesbury Formation are: *Apteodinium reticulatum, Crassosphaera bella, Gonyaulacysta edwardsi*, Hystrichosphaeridium cooksoni, Oligosphaeridium diastema, Palambages* Form A* , *Scriniodinium eurypylum*, Palaeostomocystis glabella, Ascodinium verrucosum*, Hystrichosphaeridium recurvatum** (Table 7). The 5 species marked by asterisks above are known also from strata of Albian or younger age in other parts of the world, and of these, *H. recurvatum* and *A. verrucosum* make their entrance in the "Fish-scale" marker bed and 40 feet below it, respectively. The presence of these species in the lower part of the Shaftesbury Formation suggests a late Albian age for these beds.

SUMMARY AND CONCLUSIONS

The Lower Cretaceous rocks exposed in the Peace River area consist of a succession of predominantly marine, interbedded shaly and arenaceous sediments that can be divided, in ascending order, into the Loon River, Peace River (Notikewin, Harmon, Cadotte, and Paddy Members) and Shaftesbury Formations. Eight outcrop sections of these rock units, exposed along the Smoky and Peace Rivers, were sampled for palynological study. The described microflora contains 202 species of microspores and pollen, 13 species of megaspores, and 114 species of microplankton.

The Loon River microflora is essentially similar to the nonangiospermous upper Mannville microflora (middle Albian) of central Alberta. Angiosperm pollen make their main entrance in the upper part of the Harmon Member, constituting 8 per cent of the total number of microspore and pollen species in this unit. Some of these angiosperm species are known to make their entrance in strata of middle Albian age in other parts of North America. Angiosperm species increase their representation to 12 per cent of the total number of microspore and pollen species in the Cadotte Member and are associated with the *Gastroplites* fauna of late middle Albian age. No precise conclusions concerning the age of the Paddy Member can be drawn on the basis of the microflora. However, the presence of *Schizocystia laevigata,* to date known only from strata of late Albian or younger age, and the high representation (16 per cent) of angiosperms in the Paddy Member suggest that this unit may be of late Albian age. The lower Shaftesbury microflora contains *Rugubivesiculites rugosus, Psilatricolpites parvulus, Liliacidites textus,* and *Nyssapollenites albertensis*, which make their entrance in strata of late Albian age in other parts of North America. Of these, *N. albertensis* is tricolporate and thus stratigraphically significant, for earliest tricolporate pollen are known to make their entrance only in deposits of latest Albian or Cenomanian age. The lower part of the Shaftesbury Formation also contains the microplankton species *Scriniodinium eurypylum* and *Ascodinium verrucosum,* to date known only from strata of late Albian or younger age. Thus, the Loon River Formation, and Harmon and Cadotte Members of the Peace River Formation are dated as middle Albian, the Paddy Member of the Peace River Formation is provisionally dated as late Albian, and the lower part of the Shaftesbury Formation (from the base of the formation to just above the "Fish-scale" marker bed) is dated as late Albian.

The paucity of angiosperm pollen and the presence of many upper Mannville index species in the Loon River Formation points to time equivalence of the two units. Angiosperms make their main entrance in the upper part of the Harmon Member, whereas they make their first appearance at the base of the Joli Fou Formation of central Alberta. Insofar as the Joli Fou Formation disconformably overlies the Mannville beds which are devoid of angiosperms, it can be inferred that in central Alberta angiosperms made their entrance after deposition of the Mannville Group sediments but before deposition of the Joli Fou beds, i.e. during

the apparent hiatus in deposition between the two rock units. Thus, the Harmon Member appears to be older than the Joli Fou Formation and presumably correlates with part of the erosional interval between the Mannville Group and the Joli Fou Formation. The Cadotte Member contains 6 out of 7 angiosperm and a few nonangiosperm index species reported from the Joli Fou Formation, which suggests that the two units are at least partly correlative. The microfloral evidence for correlation of the Paddy Member with the Viking Formation of central Alberta is inconclusive, but the overlying Shaftesbury Formation contains species which make their entrance in the upper shale unit of the Colorado Group, indicating approximate correlation of the two units.

The changes in the environment of deposition of sediments are reflected by the changes in the representation of the marine and continental elements of the microflora. Thus, microplankton are most abundant in the shaly offshore rock units (Loon River, Harmon, Shaftesbury) and megaspores in the sandy nearshore to continental rock units (Cadotte and Paddy).

TAXONOMIC APPROACH

Of the 329 microfloral entities described and figured in the section on Formal Descriptions, 202 are microspores and pollen, 13 are megaspores, and 114 are microplankton. Of these, 1 genus and 31 species of microspores and pollen, 1 genus and 1 species of megaspores, and 20 species of microplankton are new.

The microspore and pollen genera have been assigned to natural families or taxa of higher rank in the section on Formal Descriptions, following a systematic approach outlined by Singh (1964, p. 37). The principles of priority and type method as outlined in the International Code of Botanical Nomenclature (1961) have been used. Only the new species, emended species, and those appearing in obscure or foreign language publications have been fully described in the following chapter. However, these data have been supplemented by tabulated descriptions of all the microspore and pollen species (Appendix) for the convenience of the reader. In these tables morphologically similar species have been grouped within the suprageneric categories used by Potonié (1956, 1958, 1960, 1966) and Dettmann (1963).

The megaspore species have been treated as a distinct group and assigned to form-genera along the lines suggested by Singh (1964, p. 148). Only the new forms have been fully described.

The microplankton genera have been allocated to suprageneric categories outlined in the classifications proposed by Sarjeant and Downie (1966) and Downie, Evitt and Sarjeant (1963) for fossil dinoflagellate cysts and acritarchs, respectively. However, the term family instead of "cyst-family" introduced by Sarjeant and Downie (1966) has been used in this report in view of the fact that cysts which represent only parts of a life cycle cannot constitute a family. Genera of the family Tasmanaceae are now known to resemble strongly some members of the Chlorophyceae (Wall, 1962), and the Tasmanaceae are treated here as a family of the Chlorophyceae. The extensive changes proposed by Davey *et al.* (1966) in the classification of fossil dinoflagellate cysts have been adopted in the present study, and a complete description of all the microplankton species has been given.

FORMAL DESCRIPTIONS

Family **Sphagnaceae**

Genus **Cingutriletes** Pierce, 1961, emend. Dettmann, 1963

Type species **Cingutriletes congruens** Pierce, 1961

See Dettmann (1963, p. 69) for synonymy and emended generic diagnosis.

Remarks: Dettmann (1963) emended the genus *Cingutriletes* to include only cingulate, trilete spores with smooth exine and circular to subcircular amb. The interradially crassate forms with concave sides, and conforming with the genus *Gleicheniidites* Ross, 1949 ex Delcourt and Sprumont, 1955, have been excluded from *Cingutriletes* by Dettmann (1963).

Cingutriletes has been restricted to forms with circular to subcircular amb. It can be easily distinguished from *Cingulatisporites* Thomson, 1953, emend. Potonié 1956, which has a triangular amb with straight to convex sides. *Murospora* Somers, 1952, is distinct in having concave sides. The expansion of the generic circumscription of *Murospora* to include forms with subcircular amb by Potonié (1966, p. 81) appears to be unwarranted. His treatment of *Cingutriletes* as a junior synonym of *Murospora* also seems to be unjustified.

Many of the cingulate forms ascribed to the genus *Stereisporites* by Krutzsch (1963a) actually belong to *Cingutriletes*.

98[1] **Cingutriletes clavus** (Balme) Dettmann, 1963

Plate 1, figures 1-3

See Dettmann (1963, p.69) for synonymy and description.

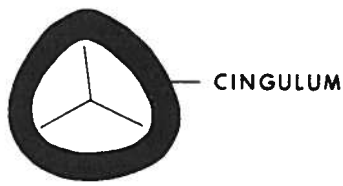

FIGURE 5. Cingutriletes clavus *(Balme) Dettmann. Proximal view.*

[1]Number refers to listing in Appendix - Tabulated descriptions of microspore and pollen species.

Distribution: Jurassic to Tertiary. Widespread in various parts of the world, including Western Canada.

Remarks: As reported by Norris (1967, p.97), the specimens assigned to *Sphagnumsporites psilatus* (Ross) Couper, 1958, by Pocock (1962) and Singh (1964), actually belong to *Cingutriletes clavus*.

A distal circular thickening, 14 to 18 microns in diameter, distinguishes *Cingutriletes clavus* from the type species *Cingutriletes congruens* Pierce, 1961.

Locality of figured specimens:

Pl. 1, fig. 1.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 1, fig. 2.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 1, fig. 3.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 1, fig. 1.	Slide No. 8-L-3 (1);	co-ord. 16/52.	
Pl. 1, fig. 2.	Slide No. 4-P-4-Micro. 42;	co-ord. 13.9/45.7.	
Pl. 1, fig. 3.	Slide No. 8-L-12 (1);	co-ord. 6/74.1.	

Genus **Stereisporites** Pflug, 1953

Type species **Stereisporites stereoides** (Potonié and Venitz) Pflug, 1953

See Dettmann (1963, p. 25) for synonymy.

Remarks: As noted by Manum (1962, p.26) and Dettmann (1963, p. 25), *Stereisporites* Pflug, 1953, has priority over *Sphagnumsporites* Raatz, 1937 ex Potonié, 1956, and *Sphagnites* Cookson, 1953.

Pflug (*in* Thomson and Pflug, 1953) proposed the genus *Stereisporites* to accommodate only acingulate and unsculptured spores. The subsequent assignment of distally sculptured species like *Stereisporites perforatus* Leschik to this genus by Leschik (1955), Playford and Dettmann (1965), and Playford (1965) is untenable. The assignment of many species with wide cingulum to the genus *Stereisporites* by Krutzsch (1963 a) is also unacceptable.

9 **Stereisporites antiquasporites** (Wilson and Webster) Dettmann, 1963

Plate 1, figures 4, 5

See Dettmann (1963, p. 25) for synonymy and description.

Distribution: Jurassic to Tertiary. Widespread in various parts of the world, including Western Canada.

Remarks: As noted by Singh (1964, p. 38), *Sphagnum punctaesporites* Rouse, 1959, is also conspecific with *S. antiquasporites*, besides the species listed by Dettmann (1963) in synonymy.

A distal polar thickening distinguishes *S. antiquasporites* from several other species of the genus, including the type species *S. stereoides*.

Locality of figured specimens:

Pl. 1, fig. 4.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 1, fig. 5.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 1, fig. 4.	Slide No. 8-L-11 (3);	co-ord. 13/57.5.	
Pl. 1, fig. 5.	Slide No. 8-L-12(3);	co-ord. 5.2/73.2.	

Class **Hepaticae**

Genus **Aequitriradites** Delcourt and Sprumont, 1955, emend. Cookson and Dettmann, 1961

Type species **Aequitriradites dubius** Delcourt and Sprumont, 1955

See Singh (1964, p. 88) for synonymy and generic diagnosis.

Remarks: As noted by Dettmann (1963, p. 91), *Selaginellidites* Krasnova, 1961, is a junior synonym of the genus *Aequitriradites*.

120 **Aequitriradites spinulosus** (Cookson and Dettmann) Cookson and Dettmann, 1961

Plate 1, figure 6

See Singh (1964, p. 88) for synonymy and description.

Distribution: Early Cretaceous to Danian. Cadotte and Paddy Members and lower Shaftesbury Formation of the Peace River area; Mannville Group (except Deville Member) of central Alberta (Singh, 1964); Lower Cretaceous of Saskatchewan, Canada (Steeves and Wilkins, 1967); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Lower Cretaceous of southeastern Australia (Cookson and Dettmann, 1958a; Dettmann, 1963); Hauterivian to Danian of U.S.S.R. (Bolkhovitina, 1959; Krašnova *in* Samoilovitch *et al.*, 1961); Albian of Rumania (Baltes, 1967a).

Locality of figured specimen:

Pl. 1, fig. 6.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 1, fig. 6.	Slide No. 4-P-6-Micro. 53;	co-ord. 12.2/45.1.	

Genus **Couperisporites** Pocock, 1962

Type species **Couperisporites complexus** (Couper) Pocock, 1962

See Singh (1964, p. 83) for synonymy and generic diagnosis.

121 **Couperisporites tabulatus** Dettmann, 1963

Plate 1, figure 7

See Dettmann (1963, p. 95) for description.

Distribution: Early Cretaceous. Loon River Formation of the Peace River area; Neocomian and Aptian of southeastern Australia (Dettmann, 1963).

Remarks: The distal surface of *Couperisporites tabulatus* is ornamented by low hexagonal verrucae, and lacks the spinose elements of *Couperisporites complexus.*

According to Dettmann (1963), this species resembles the spores of *Naiadita lanceolata* Buckman, 1850, which belong to the class Hepaticae.

Locality of figured specimen:

Pl. 1, fig. 7. Sample No. 8-L-9; Loon River Formation. Section 8.
Pl. 1, fig. 7. Slide No. 8-L-9-Micro.29; co-ord. 11/44.5.

Genus **Foraminisporis** Krutzsch, 1959

Type species **Foraminisporis foraminis** Krutzsch, 1959

See Krutzsch (1959a, p. 130) for generic diagnosis.

Remarks: Krutzsch (1959a) proposed the genus *Foraminisporis* to accommodate trilete spores, with circular amb, foraminate and verrucate exine ornamentation, and a cluster of verrucae on the central area of each contact face. Forms possessing a narrow, sculptured cingulum were subsequently assigned to *Foraminisporis* by Dettmann (1963) after a detailed examination of the specimens.

100 **Foraminisporis dailyi** (Cookson and Dettmann) Dettmann, 1963

Plate 1, figure 8

See Dettmann (1963, p. 72) for synonymy and description.

Distribution: Early Cretaceous. Loon River Formation, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Lower Cretaceous of southeastern Australia (Cookson and Dettmann, 1958a; Dettmann, 1963).

Remarks: *Foraminisporis dailyi* can be distinguished from *Foraminisporis wonthaggiensis* (Cookson and Dettmann) Dettmann, 1963, by the lack of spinulose ornamentation, and the presence of a cluster of clearly defined granules on the central area of each contact face.

According to Dettmann (1963), this species resembles the spores of the recent hepatic species *Phaeoceros bulbiculosus* (Brotero) and *Notothylas breutelii* Gottsche.

Locality of figured specimen:

Pl. 1, fig. 8.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 1, fig. 8.	Slide No. 7-C-8(2);	co-ord. 5.1/76.2.	

101 **Foraminisporis wonthaggiensis** (Cookson and Dettmann) Dettmann, 1963

Plate 1, figures 9, 10

See Dettmann (1963, p. 71) for synonymy and description.

Distribution: Valanginian to Turonian. Loon River Formation, Cadotte Member and lower Shaftesbury Formation of the Peace River area; Ellerslie Member (Singh, 1964), upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; Valanginian to Albian of southeastern Australia (Cookson and Dettmann, 1958a; Dettmann, 1963); Turonian of Siberia (Samoilovitch *et al.*, 1961).

Remarks: *Lycospora cretacea* Pocock, 1962, cited by Dettmann (1963) in synonymy, does not appear to be conspecific with *Foraminisporis wonthaggiensis* as its ornamentation is composed mainly of low verrucae and that of *F. wonthaggiensis* of spinulae. *Neoraistrickia*? sp. described by Singh (1964, p. 68) is conspecific with *F. wonthaggiensis.*

According to Dettmann (1963), *F. wonthaggiensis* is morphologically similar to the spores of the living hepatic species *Notothylas breutelii* Gottsche.

Locality of figured specimen:

Pl. 1, figs. 9, 10.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 1, figs. 9, 10.	Slide No. 8-L-12(2);	co-ord. 19/38.5.	

Genus **Rouseisporites** Pocock, 1962

Type species **Rouseisporites reticulatus** Pocock, 1962

See Dettmann (1963, p. 96) for restated generic diagnosis.

Remarks: After the examination of the transverse sections of the spore wall, Dettmann (1963) recognized that the genus *Rouseisporites* is characterized by a two-layered sclerine. The outer layer of the sclerine is membraneous and forms a

zona with invaginations in each radial region at the equator. It also forms the surface reticula and the distal hollow muroid ridges. These transverse sections of the spore wall further confirmed that *Rouseisporites* has a proximally inaperturate sclerine, although a faint tetrad mark is usually present.

Rouseisporites is distinct from *Zlivisporis* Pacltova, 1961, and *Seductisporites* Chlonova, 1961, in possessing invaginations in each equatorial radial region.

122 **Rouseisporites reticulatus** Pocock, 1962

Plate 1, figures 11, 12

See Dettmann (1963, p. 97) for synonymy and description.

Distribution: Barremian to Turonian. Loon River Formation and Paddy Member of the Peace River area; Mannville Group of central Alberta (Singh, 1964); Ellerslie and "calcareous" Members of Western Canada (Pocock, 1962); Albian of Oklahoma (Hedlund and Norris, 1968); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Aptian to Cenomanian ? of southeastern Australia (Cookson and Dettmann, 1958a; Dettmann, 1963); Aptian, Albian and Turonian of Siberia (Samoilovitch *et al.*, 1961); Albian of Rumania (Baltes, 1967a).

Remarks: According to Dettmann (1963), this species resembles the spores of *Riccia beyrichiana* Hampe, which belong to the class Hepaticae.

Locality of figured specimen:

Pl. 1, figs. 11, 12.	Sample No. 8-L-7;	Loon River Formation. Section 8.
Pl. 1, figs. 11, 12.	Slide No. 8-L-7-Micro. 36;	co-ord. 10.2/44.

124 **Rouseisporites** sp. cf. **R. radiatus** Dettmann, 1963

Plate 1, figure 13

See Dettmann (1963, p. 98) for description.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: The single specimen of this species recorded from the Paddy Member possesses distal muroid ridges which emanate from the pole and bifurcate towards the equator, as in *Rouseisporites radiatus* Dettmann. The wall of this specimen, however, is considerably thinner than that of *R. radiatus*, and the outer membraneous layer is missing in the equatorial regions.

Locality of figured specimen:

Pl. 1, fig. 13.	Sample No. 4-P-4;	Paddy Member. Section 4.
Pl. 1, fig. 13.	Slide No. 4-P-4(2);	co-ord. 4.1/59.1.

123 **Rouseisporites triangularis** Pocock, 1962

Plate 1, figure 14

See Singh (1964, p. 91) for synonymy and description.

Distribution: Aptian and Albian. Loon River Formation, Paddy Member and lower Shaftesbury Formation of the Peace River area; Ellerslie Member and Grand Rapids Formation of central Alberta (Singh, 1964); Mannville Group (except Deville Member) of Western Canada (Pocock, 1962).

Remarks: *Rouseisporites triangularis* Pocock differs from *Rouseisporites simplex* (Cookson and Dettmann) Dettmann, 1963, in having a more conspicuous tetrad mark, a triangular shape, and very wide invaginations in the equatorial, radial regions. Both species are, however, characterized by very distinct Y-shaped distal interradial muroid ridges.

Locality of figured specimen:

Pl. 1, fig. 14. Sample No. 8-L-7; Loon River Formation. Section 8.
Pl. 1, fig. 14. Slide No. 8-L-7-Micro. 44; co-ord. 15/44.2.

Family **Lycopodiaceae**

Genus **Lycopodiacidites** Couper, 1953, emend. Potonié, 1956

Type species **Lycopodiacidites bullerensis** Couper, 1953

See Potonié (1956, p. 39) for emended generic diagnosis.

Remarks: The genus *Lycopodiacidites* Couper, emend. Potonié has a rugulate distal sculpture, and can be distinguished from *Camarozonosporites* Pant, 1954 ex Potonié, 1956, emend. Klaus, 1960, by the lack of the interradial crassitudes. *Rugulatisporites* Thomson and Pflug, 1953, is distinct in having a sculpture composed of densely arranged, short, tortuous, and narrow muri or warts. The rugulate sculpture of *Lycopodiacidites* consists of narrow, long, branching or convolute grooves separated by wide, elongate ridges of uneven width, which give the surface of the body a wrinkled appearance. This ornamentation has a close resemblance to what has been described as 'hamulate' sculpture in the genus *Hamulatisporis* Krutzsch, 1959. *Hamulatisporis* is a junior synonym of *Lycopodiacidites* (see Klaus, 1960, p. 134).

50 **Lycopodiacidites canaliculatus** n. sp.

Plate 1, figure 15

Description: Trilete; laesurae simple slits, extending up to 2/3 of the spore radius; amb rounded-triangular; proximal surface ornamented by low, irregularly arranged rugulae; distal surface distinctly rugulate; sculpture composed of

flat-crested, 2-to 6-micron wide rugulae of uneven width; rugulae separated by 1-micron wide branching grooves following acute zigzag courses; amb slightly crenellated by the grooves; exine about 2 microns thick and of uniform thickness around the equator.

Size range: Equatorial diameter (10 specimens) 36 (46) 55 microns. Holotype 55 microns.

Distribution: Middle and late Albian. Loon River Formation, and Harmon, Cadotte, and Paddy Members of the Peace River area.

Remarks: *Lycopodiacidites canaliculatus* n. sp. can be distinguished from *Camarozonosporites cerniidites* (Ross) Krutzsch, 1963, by the lack of interradial crassitudes, the presence of ornamentation on the proximal surface, coarser sculptural elements on the distal surface, shorter laesurae and larger size. *Lycopodium vermiculaesporites* Rouse, 1957, is distinct in having a finer vermiculate ornamentation and longer laesurae. *Lycopodiacidites canaliculatus* is larger than *Hamulatisporis hamulatis* Krutzsch, 1959.

The specific name is derived from *"canaliculatus"* (channelled) and refers to the narrow grooves separating the wide rugulae.

Type locality:

Holotype: Pl. 1, fig. 15.	Sample No. 8-L-11;	Loon River Formation. Section 8.
Holotype: Pl. 1, fig. 15.	Slide No. 8-L-11(1);	co-ord. 12.1/53.1.

51 **Lycopodiacidites caperatus** n. sp.

Plate 1, figures 16, 17

Description: Trilete; laesurae simple slits, often gaping, extending up to 2/3 of the spore radius; amb rounded-triangular and markedly crenellated by grooves; proximal surface ornamented by low, radially oriented rugulae; distal surface convex and coarsely rugulate; distal rugulae randomly oriented; sculpture composed of round-crested, wide rugulae of uneven width; rugulae 4 to 10 microns wide, 3 to 4 microns high, and separated by about 3-micron wide branching grooves; exine about 4 microns thick, slightly thicker interradially.

Size range: Equatorial diameter (7 specimens) 48 (58.5) 63 microns. Holotype 63 microns.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: *Lycopodiacidites caperatus* n. sp. can be distinguished from *Hamulatisporis amplus* Stanley, 1965, by the presence of radially oriented proximal rugulae, coarser distal sculpture, and shorter laesurae. *Lycopodiacidites kuepperi* Klaus, 1960, is distinct in being proximally smooth, and having longer laesurae.

Lycopodiacidites caperatus n. sp. resembles *Camarozonosporites helenensis* Krutzsch, 1959, in having radially oriented proximal rugulae; however, the former is distinct in possessing a coarser distal sculpture. An undescribed species listed as *Lycopodiumsporites* sp. 2 by Stover (1964, pl. 2, fig. 6) from the Magothy Formation, Maryland, U.S.A. has proximal sculpture identical to that of *Lycopodiacidites caperatus* n. sp.

The specific name is derived from *"caperatus"* (wrinkled) and refers to the wrinkled appearance of the distal surface.

Type locality:

Holotype: Pl. 1, figs. 16, 17.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Holotype: Pl. 1, figs. 16, 17.	Slide No. 4-P-8(1);	co-ord.5.2/42.9.	

Genus **Lycopodiumsporites** Thiergart, 1938 ex Delcourt and Sprumont, 1955

Type species **Lycopodiumsporites agathoecus** (Potonié) Thiergart, 1938

See Singh (1964, p. 39) for synonymy and generic diagnosis.

Remarks: Krutzsch (1959a, p. 159, 164) has suggested the abandonment of the generic name *Lycopodiumsporites,* and in the course of a comprehensive revision of the genus (1963b, p. 8-18) proposed its replacement with the name *Retitriletes* van der Hammen, 1956 ex Pierce, 1961. His arguments for these taxonomic changes are, however, not convincing, and therefore, have been generally rejected (Manum, 1962, p. 25; Delcourt, Dettmann and Hughes, 1963, p. 286; Dettmann, 1963, p. 44; Potonié, 1966, p. 47, 49). In the present study, the genus *Lycopodiumsporites* has been used, in the sense it was originally circumscribed.

34 **Lycopodiumsporites austroclavatidites** (Cookson) Potonié, 1956

Plate 2, figure 1

See Dettmann (1963, p. 44) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Locality of figured specimen:

Pl. 2, fig. 1.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 2, fig. 1.	Slide No. 8-L-7-Micro. 49;	co-ord. 11.9/43.1.	

35 **Lycopodiumsporites crassatus** n. sp.

Plate 2, figures 2-4

Description: Trilete; laesurae almost reaching the equator and raised into 4- to 5-micron high lips; lips about 2 microns thick and widening toward the base; amb rounded-triangular; proximal surface reticulate, with raised, radially elongate muri enclosing rectilinear lumina; distal surface strongly convex and reticulate, with 4- to 5-micron high muri; muri thickening toward the base and producing an undulate spore wall margin; lumina 8 to 12 microns wide, polygonal in outline at the bases of muri but almost rounded at the top; raised muri forming a 4- to 5-micron wide margin of membraneous network around the spore body; spore wall 4 to 6 microns thick and dark brown in color.

Size range: Equatorial diameter (13 specimens) 48 (56) 65 microns. Holotype 60 microns.

Distribution: Middle and late Albian. Cadotte and Paddy Members of the Peace River area.

Remarks: *Lycopodiumsporites crassatus* n. sp. can be distinguished from *Lycopodiumsporites marginatus* Singh, 1964, by its characteristically thickened body wall, lower and thicker muri, and more elaborate reticulate sculpture on the proximal surface. *Woodsia reticulata* Bolkhovitina, 1953, is distinct in having larger lumina (20 to 25 microns) and an almost circular amb. Although *Reticulatisporites incomptus* Manum, 1962, bears a superficial resemblance to *L. crassatus* n. sp., it has shorter laesurae, thinner exine and lower muri.

The specific name is derived from *"crassatus"* (thickened) and refers to the characteristically thickened spore wall.

Type locality:

Holotype: Pl. 2, figs. 2, 3.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Paratype: Pl. 2, fig. 4.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Holotype: Pl. 2, figs. 2, 3.	Slide No. 4-P-3(1);	co-ord. 5.4/56.8.	
Paratype: Pl. 2, fig. 4.	Slide No. 7-C-7(1);	co-ord. 6.7/70.9.	

32 **Lycopodiumsporites crassimacerius** Hedlund, 1966

Plate 2, figures 5-8

1966 *Lycopodiumsporites crassimacerius* Hedlund, Oklahoma Geol. Surv., Bull. 112, p. 19, pl. 3, figs. 1 a-c.

Description: Trilete; laesurae extending up to 3/4 of the spore radius; commissures slightly raised; amb rounded-triangular; proximal surface almost smooth with reticulate sculpture near the equatorial margin; distal surface convex

and coarsely reticulate; muri about 2 microns high and 2 to 3 microns wide; lumina polygonal and 6 to 7 microns in diameter; exine 2 to 3 microns thick.

Size range: Equatorial diameter (19 specimens) 39 (45) 53 microns.

Distribution: Middle Albian to Cenomanian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Cenomanian of Oklahoma, U.S.A. (Hedlund, 1966).

Remarks: The Alberta specimens of *Lycopodiumsporites crassimacerius* are slightly smaller than Hedlund's (1966) specimens, which range from 45 to 67.5 microns in size. *L. crassimacerius* can be distinguished from *Lycopodiumsporites triarcuatus* Delcourt and Sprumont, 1955, by its rounded-triangular amb. According to Delcourt and Sprumont (1955, p. 32), *L. triarcuatus* has slightly concave sides. Its poorly preserved holotype fits into their original description. However, one of the specimens subsequently assigned to *L. triarcuatus* by Delcourt, Dettmann and Hughes (1963, pl. 43, fig. 5) has a rounded-triangular amb and closely resembles *L. crassimacerius* Hedlund.

Lycopodiumsporites sp. A described by Singh (1964) is distinct in having 5-micron wide thickened lips bordering the commissures.

Locality of figured specimens:

Pl. 2, figs. 5-8.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 2, figs. 5, 6.	Slide No. 7-C-7(1);	co-ord. 12.2/69.2.	
Pl. 2, figs. 7, 8.	Slide No. 7-C-7(1);	co-ord. 17.8/72.2.	

37 **Lycopodiumsporites expansus** n. sp.

Plate 2, figures 9-11

Description: Trilete; laesurae almost reaching the equator; commissures slightly raised; amb subcircular, spore body rounded-triangular; proximal surface almost smooth with reticulate sculpture near the equatorial margin; distal surface convex with broadly reticulate sculpture; lumina 10 to 16 microns wide, pentagonal or hexagonal in outline at the bases of muri but almost rounded at the top; muri membraneous, about 8 microns high; muri thickening toward the base and producing an undulate spore wall margin; raised muri forming a 6- to 8-micron wide margin of membraneous network around the spore body; exine about 2 microns thick.

Size range: Equatorial diameter (11 specimens) 36 (41) 46 microns. Holotype 44 microns.

Distribution: Middle and late Albian. Cadotte and Paddy Members and lower Shaftesbury Formation of the Peace River area.

Remarks: *Lycopodiumsporites expansus* n. sp. can be distinguished from *Lycopodiumsporites marginatus* Singh, 1964, by its wider lumina, subcircular amb, and almost smooth proximal surface. *Woodsia reticulata* Bolkhovitina, 1953, is distinct in having a larger size (65 to 70 microns). *L. expansus* n. sp. closely resembles *Lycopodium parvum* (Naumova) Bolkhovitina, 1953, but differs in possessing higher muri.

The specific name is derived from *"expansus"* (widely spread) and refers to the broadly reticulate sculpture.

Type locality:

Holotype: Pl. 2, figs. 9, 10.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Paratype: Pl. 2, fig. 11.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Holotype: Pl. 2, figs. 9, 10.	Slide No. 7-C-8(2);	co-ord. 12.8/64.	
Paratype: Pl. 2, fig. 11.	Slide No. 7-C-10(2);	co-ord. 4.1/60.	

36 **Lycopodiumsporites marginatus** Singh, 1964

Plate 2, figures 12-14

See Norris (1967, p. 90) for synonymy and description.

Distribution: Aptian and Albian. Loon River Formation, Harmon, Cadotte and Paddy Members and lower Shaftesbury Formation of the Peace River area; Ellerslie and Wabiskaw Members and Grand Rapids Formation (Singh, 1964), and the lower part of the Colorado Group (Norris, 1967) of central Alberta; Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Locality of figured specimen:

Pl. 2, figs. 12-14.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 2, figs. 12-14.	Slide No. 7-C-10(1);	co-ord. 21.1/71.1.	

33 **Lycopodiumsporites reticulumsporites** (Rouse) Dettmann, 1963

Plate 3, figures 1, 2

See Dettmann (1963, p. 45) for synonymy and description.

Distribution: Bathonian to Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); Upper Jurassic of southeastern British Columbia (Rouse, 1959); Bathonian of England (Lantz, 1958); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: *Lycopodiumsporites reticulumsporites* is characterized by radially elongate, low muri, less than 1 micron high, enclosing rectilinear lumina on the proximal surface.

Locality of figured specimen:

Pl. 3, figs. 1, 2.	Sample No. 7-H-6;	Harmon Member.	Section 7.
Pl. 3, figs. 1, 2.	Slide No. 7-H-6(1);	co-ord. 2.5/61.3.	

Genus **Sestrosporites** Dettmann, 1963

Type species **Sestrosporites irregulatus** (Couper) Dettmann, 1963

See Dettmann (1963, p. 66) for generic diagnosis.

Remarks: Dettmann (1963) proposed the genus *Sestrosporites* to accommodate trilete spores with interradial crassitudes and foveolate to foveo-reticulate sculpture. It can be distinguished from *Foveosporites* Balme, 1957, and *Foveotriletes* van der Hammen, 1954 ex Potonié, 1956, by the presence of the interradial crassitudes.

Spores comparable to *Sestrosporites* have been found in the recent species *Lycopodium manii* (Selling, 1946) and *Lycopodium laterale* (Harris, 1955).

96 **Sestrosporites pseudoalveolatus** (Couper) Dettmann, 1963

Plate 3, figures 3-7

See Dettmann (1963, p. 66) for synonymy and description.

Distribution: Bajocian to early Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Grand Rapids Formation (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); early Cenomanian of Colorado, U.S.A. (Pannella, 1966); Bajocian to Aptian of England (Couper, 1958); Albian of Rumania (Baltes, 1967a); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: Dettmann (1963) showed that *Sestrosporites pseudoalveolatus* is actually not "zonate". The membraneous margin surrounding the body is induced on some specimens by compression or prolonged maceration, and results from rupture of the cavate interradial crassitudes.

Hymenozonotriletes pseudoalveolatus (Couper) described by Singh (1964, p. 83) is a junior synonym of *Sestrosporites pseudoalveolatus* (see Norris, 1967, p. 96).

Locality of figured specimens:

Pl. 3, figs. 3-6.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Pl. 3, fig. 7.	Sample No. 4-P-5;	Paddy Member.	Section 4.
Pl. 3, fig. 3.	Slide No. 4-P-8(1);	co-ord. 3.8/54.	
Pl. 3, figs. 4-6.	Slide No. 4-P-8(1);	co-ord. 16/72.	
Pl. 3, fig. 7.	Slide No. 4-P-5(2);	co-ord. 5.2/53.	

Family **Selaginellaceae**

Genus **Acanthotriletes** Naumova, 1937?, 1939 ex Potonié and Kremp, 1954

Type species **Acanthotriletes ciliatus** (Knox) Potonié and Kremp, 1954

See Singh (1964, p. 43) for synonymy and generic diagnosis.

30 **Acanthotriletes varispinosus** Pocock, 1962

Plate 3, figure 8

See Pocock (1962, p. 36) for description.

Distribution: Early Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Ellerslie Member and Grand Rapids Formation (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; Mannville Group of Western Canada (Pocock, 1962).

Locality of figured specimen:

Pl. 3, fig. 8.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 3, fig. 8.	Slide No. 7-C-8(2);	co-ord. 13.5/76.5.	

Genus **Densoisporites** Weyland and Krieger, 1953, emend. Dettmann, 1963

Type species **Densoisporites velatus** Weyland and Krieger, 1953

See Dettmann (1963, p. 83) for synonymy and emended generic diagnosis.

Remarks: As emended by Dettmann (1963), the genus *Densoisporites* refers to trilete spores with an outer loose, structured sculptine layer which is attached proximally to an inner smooth layer. The sculptine is equatorially thickened, and

finely patterned with structural elements. The inner smooth layer has three interradial thickenings near the proximal pole.

125 **Densoisporites velatus** Weyland and Krieger, 1953, emend. Krasnova, 1961

Plate 3, figures 9, 10

See Dettmann (1963, p. 84) for synonymy and description.

Distribution: Lias to Danian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Lias to Aptian of England (Couper, 1958); Senonian of Germany (Weyland and Krieger, 1953); Lower Cretaceous of southeastern Australia (Dettmann, 1963); Valanginian to Danian of Siberia (Krasnova *in* Samoilovitch *et al.*, 1961; Chlonova, 1961).

Remarks: The original measurements of *Densoisporites perinatus* Couper, 1958, are larger (43 to 68 microns) than *Densoisporites velatus* Weyland and Krieger, 1953, which ranges in size from 25 to 35 microns. However, the two species are morphologically identical, and their size ranges also seem to overlap. Brenner (1963, p. 61) has assigned specimens measuring from 34 to 58 microns to *D. perinatus.* It appears that there is no actual basis for distinguishing between *D. velatus* and *D. perinatus,* and therefore, the latter should be treated as a junior synonym.

Locality of figured specimen:

Pl. 3, figs. 9, 10.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 3, figs. 9, 10.	Slide No. 7-C-8(2);	co-ord. 10/77.4.	

126 **Densoisporites microrugulatus** Brenner, 1963

Plate 3, figures 11, 12

See Brenner (1963, p. 61) for description.

Distribution: Barremian to Albian. Loon River Formation, Cadotte Member, and lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963).

Remarks: *Densoisporites microrugulatus* Brenner can be distinguished from *Densoisporites velatus* Weyland and Krieger, 1953, by the fine reticulate pattern on

the cingulum, shorter laesurae, narrower cingulum, and a more loosely fitting sculptine layer.

The specimens assigned to *D. microrugulatus* by Burger (1966) are closer to *D. velatus* in appearance.

Locality of figured specimens:

Pl. 3, fig. 11.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 3, fig. 12.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 3, fig. 11.	Slide No. 7-C-8(1);	co-ord. 7.2/73.7.	
Pl. 3, fig. 12.	Slide No. 7-C-6(2);	co-ord. 17/36.8.	

Genus **Neoraistrickia** Potonié, 1956

Type species **Neoraistrickia truncata** (Cookson) Potonié, 1956

See Potonié (1956, p. 34) for generic diagnosis.

Remarks: Potonié (1956) proposed the genus *Neoraistrickia* to incorporate trilete baculate spores with a rounded-triangular amb. This genus can be distinguished from *Baculatisporites* Thomson and Pflug, 1953, by its rounded-triangular amb, and larger, more widely distributed bacula. *Raistrickia* Schopf, Wilson and Bentall, 1944, differs in also including forms with additional spinulae or coni, or both, between the bacula.

28 **Neoraistrickia truncata** (Cookson) Potonié, 1956

Plate 3, figure 13

See Dettmann (1963, p. 36) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: This species is morphologically similar to the recent spores of *Selaginella biformis*-group described by Knox (1950).

Locality of figured specimen:

Pl. 3, fig. 13.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 3, fig. 13.	Slide No. 7-C-2(1);	co-ord. 17/31.9.	

Family **Osmundaceae**

Genus **Baculatisporites** Thomson and Pflug, 1953

Type species **Baculatisporites primarius** (Wolff) Thomson and Pflug, 1953

See Thomson and Pflug (1953, p. 56) for generic diagnosis.

Remarks: The genus *Baculatisporites* is distinct from *Osmundacidites* Couper, 1953, in having a baculate sculpture. The latter possesses a granulate exine.

18 **Baculatisporites comaumensis** (Cookson) Potonié, 1956

Plate 3, figure 14

See Dettmann (1963, p. 35) for synonymy and description.

Distribution: Late Triassic to Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: According to Dettmann (1963), this species resembles the recent spores of *Osmunda cinnamomea.*

Locality of figured specimen:

Pl. 3, fig. 14.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 3, fig. 14.	Slide No. 8-L-11(1);	co-ord. 21/50.	

Genus **Biretisporites** Delcourt and Sprumont, 1955, emend. Delcourt, Dettmann and Hughes, 1963

Type species **Biretisporites potoniaei** Delcourt and Sprumont, 1955

See Delcourt, Dettmann and Hughes (1963, p. 283) for synonymy and emended generic diagnosis.

Remarks: As emended by Delcourt, Dettmann and Hughes (1963), the genus *Biretisporites* consists of smooth trilete spores with a triangular to subtriangular amb, and commissures enclosed within elevated lips. Contrary to the original description of the type species (Delcourt and Sprumont, 1955; Potonié, 1956), the exine is of uniform thickness.

Dictyophyllidites Couper, 1958, emend. Dettmann, 1963, can be distinguished from *Biretisporites* by the exinal thickenings about its laesurate margins. *Hymenophyllumsporites* Rouse, 1957, is a junior synonym of *Biretisporites.*

10 **Biretisporites potoniaei** Delcourt and Sprumont, 1955

Plate 3, figures 15, 16

See Delcourt, Dettmann and Hughes (1963, p. 284) for synonymy and description.

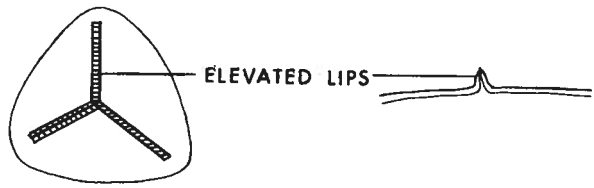

FIGURE 6. Biretisporites potoniaei *Delcourt and Sprumont. 1. Proximal view. 2. Vertical section showing the elevated lips.*

Distribution: Early Cretaceous. Loon River Formation, Harmon, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Ellerslie Member (Pocock, 1962), and lower part of the Colorado Group (Norris, 1967) of central Alberta; Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); Lower Cretaceous of Belgium and France (Delcourt and Sprumont, 1955, 1959), and southeastern Australia (Dettmann, 1963).

Remarks: This species can be distinguished from *Biretisporites deltoidus* (Rouse) Dettmann, 1963, by its longer laesurae, smaller size, and smooth exine.

Locality of figured specimens:

Pl. 3, fig. 15.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 3, fig. 16.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 3, fig. 15.	Slide No. 8-L-11(2);	co-ord. 6/32.	
Pl. 3, fig. 16.	Slide No. 8-L-9(3);	co-ord. 7.4/72.8.	

Genus **Osmundacidites** Couper, 1953

Type species **Osmundacidites wellmanii** Couper, 1953

See Singh (1964, p. 44) for synonymy and generic diagnosis.

Remarks: The genus *Osmundacidites* possesses a predominantly granulate exine and is distinct from *Baculatisporites* Thomson and Pflug, 1953, which has baculate sculpture, and *Rugulatisporites* Thomson and Pflug, 1953, which is characterized by a rugulate exine.

Many species assigned to *Baculatisporites* by Krutzsch (1959a, p. 138) and *Osmunda* by Klimko *in* Samoilovitch *et al.*(1961, p. 112) actually belong to *Osmundacidites*. *Conosmundacidites* Klaus, 1960, is a junior synonym of the genus *Osmundacidites* Couper, 1953.

17 **Osmundacidites wellmanii** Couper, 1953

Plate 4, figure 1

See Dettmann (1963, p. 32) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: Couper (1953, 1958, 1960) compared *Osmundacidites wellmanii* with spores of several fossil representatives of the family Osmundaceae.

Locality of figured specimen:

Pl. 4, fig. 1.	Sample No. 8-L-13;	Loon River Formation.	Section 8.
Pl. 4, fig. 1.	Slide No. 8-L-13(3);	co-ord. 8.2/37.1.	

Genus **Todisporites** Couper, 1958

Type species **Todisporites major** Couper, 1958

See Singh (1964, p. 45) for synonymy and generic diagnosis.

Remarks: This genus can be distinguished from *Biretisporites* Delcourt and Sprumont, 1955, emend. Delcourt, Dettmann and Hughes, 1963, by its circular amb and the lack of prominently raised lips enclosing the commissures.

16 **Todisporites minor** Couper, 1958

Plate 4, figure 2

See Singh (1964, p. 45) for synonymy and description.

Distribution: Bajocian to Cenomanian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), Viking Formation and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; Upper Jurassic

and Lower Cretaceous of Western Canada (Pocock, 1962); Bajocian of England (Couper, 1958); Cenomanian of Oklahoma (Hedlund, 1966).

Locality of figured specimen:

Pl. 4, fig. 2.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 4, fig. 2.	Slide No. 8-L-11(1);	co-ord. 20.9/53.3.	

Family **Schizaeaceae**

In the present study, the spore species belonging to the family Schizaeaceae have been distinguished from one another, using the criteria proposed by Delcourt and Sprumont (1955), Kedves (1961), Dettmann (1963), and Hughes and Moody-Stuart (1966). These criteria are based upon the following morphological features:

1. Proximal and distal rib patterns (Fig. 7 A-P).
2. Orientation of the ribs in relation to the sides and laesurae.
3. The pattern of junction of the ribs in the proximal and distal radial regions (Fig. 8 A-H).
4. The manner in which the appendices are formed and their size and shape (Fig. 8 C-H).
5. The spacing of the ribs i.e., the ribs are wider (canaliculate) or narrower (cicatricose) than the canals.
6. The width of the ribs and canals, the number of ribs in each proximal and distal interradial region or in each set of ribs, and the shape of the ribs.
7. The laesurae, contact areas, shape of amb, thickness of exine, and the equatorial diameter of the spore.

Considerable difficulties were encountered in delimiting the various species of the family Schizaeaceae described in the present study. This was mainly due to the significant degree of variation within the species and occasionally due to the subtle changes produced in the general appearance of the individual specimens as a result of mechanical distortions or varying preservational factors. As far as possible, all these variations have been taken into account before defining a species.

The schematic drawings in the figures 7 and 8 represent only the basic patterns of the sculptural configurations, which are usually common to more than one species. Therefore, these drawings resemble only broadly the sculptural patterns of the various species referred to them in the following descriptions.

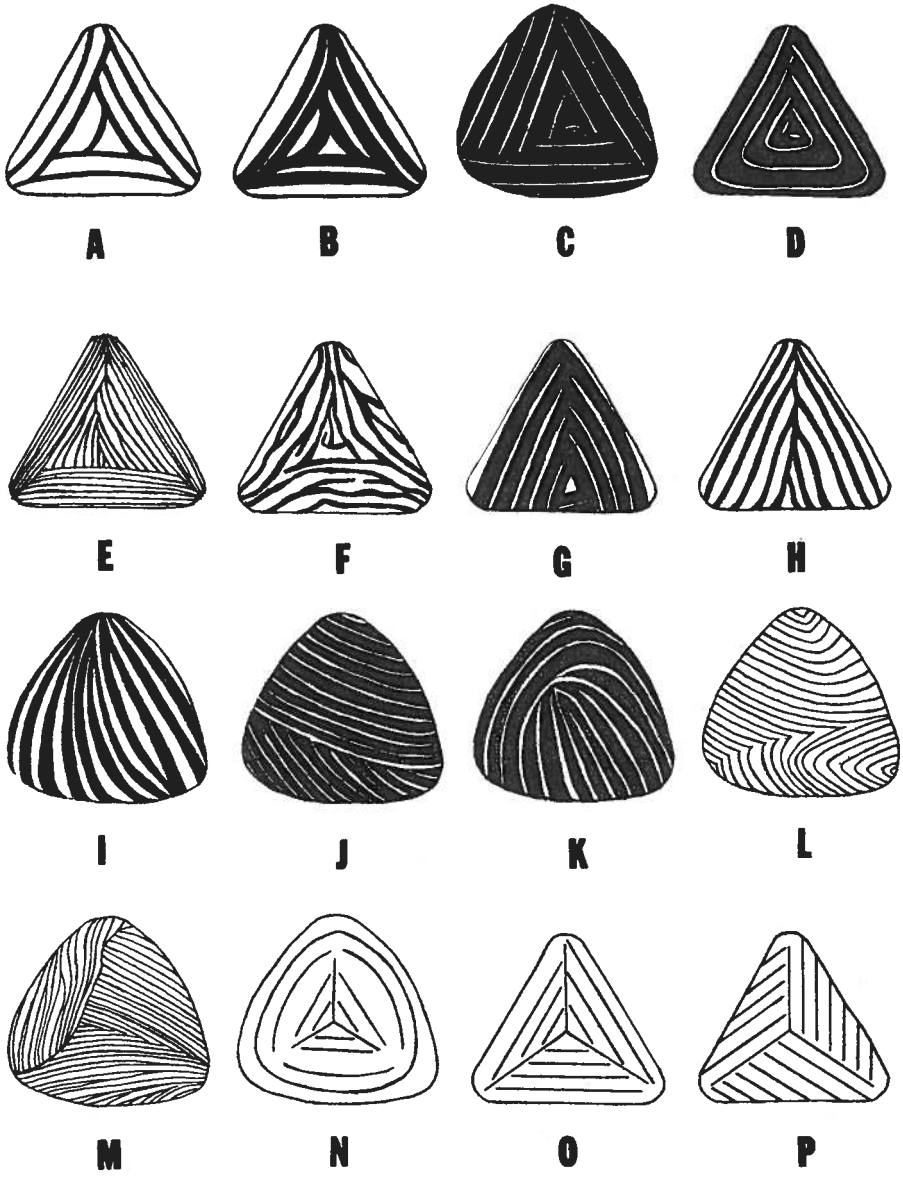

FIGURE 7. Schematic drawings illustrating the distal and proximal rib patterns of some of the schizaeaceous spores.

The distal rib pattern of the spores illustrated in figures A to F consists of ribs running parallel to each other and to their side of the spore in the equatorial region, and forming a triangular area centered on the distal pole. The ribs in the triangular area are parallel to subparallel to the two sides and oblique to the third side of the triangle. These distal rib patterns, however, differ from each other in the following manner:

A. *Sculpture cicatricose; alternate ribs of adjacent sides coalescing in radial regions e.g.* Cicatricosisporites hughesi *Dettmann, 1963.*

B. *Sculpture canaliculate; alternate ribs of adjacent sides coalescing in radial regions e.g.* Cicatricosisporites pseudotripartitus *(Bolkhovitina) Dettmann, 1963.*

C. *Sculpture canaliculate, with extremely thickened ribs and narrow, noncoalescent, interfingering canals; alternate ribs of adjacent sides coalescing in radial regions e.g.* Cicatricosisporites subrotundus *Brenner, 1963.*

D. *Sculpture canaliculate; rib pattern similar to C, but canals coalescing in two radial regions and producing a spiral rib pattern e.g.* Cicatricosisporites spiralis *n. sp.*

E. *Sculpture cicatricose or canaliculate; corresponding ribs of adjacent sides joining in equatorial radial regions. Alternate ribs from the two sides of the inner triangular area joining in a regular or irregular manner in the polar region e.g.* Cicatricosisporites australiensis *(Cookson) Potonié, 1956.*

F. *Sculpture canaliculate or cicatricose, with irregularly branching, often discontinuous and wavy ribs. The ribs of adjacent sides not coalescing in the distal radial regions and crossing over to the proximal surface without joining e.g.* Cicatricosisporites mohrioides *Delcourt and Sprumont, 1955.*

G. *The distal rib pattern consisting of ribs running parallel to two sides and obliquely to the third side of the spore, near which a triangular area is formed. Sculpture canaliculate; alternate ribs of the two sides coalescing along a median line perpendicular to the third side e.g.* Cicatricosisporites *sp. cf.* Anemia exilioides *(Maljavkina) Bolkhovitina, 1953.*

H. *The distal rib pattern consisting of ribs running parallel to two sides and obliquely to the third side of the spore. Sculpture cicatricose; alternate ribs of the two sides coalescing along a median line perpendicular to the third side e.g.* Cicatricosisporites imbricatus *(Markova) n. comb.*

I. *The distal rib pattern consisting of a single set of subparallel ribs starting from one apex and disposed obliquely to the opposite side. Ribs often showing a tendency to converge abruptly opposite two radial areas. Sculpture canaliculate; ribs coalescing near the apex e.g.* Cicatricosisporites *sp. cf.* C. potomacensis *Brenner, 1963.*

J. *The distal rib pattern consisting of two sets of ribs. The ribs of each set running parallel to one another and obliquely to the ribs of the other set. The line where the two sets of ribs meet clearly demarcated. Sculpture canaliculate; ribs oblique to the sides of the spore e.g.* Cicatricosisporites hallei *Delcourt and Sprumont, 1955.*

K. *The distal rib pattern consisting of two sets of ribs. The ribs of the outer set parallel to each other and to the amb, and continuous around the apices; the*

ribs of the inner set parallel to each other and oblique to the ribs of the outer set; the inner set of ribs running across the distal surface and obliquely to the amb. Sculpture canaliculate; the line where the two sets of ribs meet clearly demarcated e.g. Cicatricosisporites annulatus *Archangelsky and Gamerro, 1966.*

L. The distal rib pattern consisting of three sets of ribs. The ribs of each set running parallel to one another and obliquely to the ribs of the other sets, and coalescing to form a V-shaped pattern near the apices. Sculpture cicatricose; ribs oblique to the amb, and usually bifurcating after crossing over to the distal surface from the proximal surface e.g. Cicatricosisporites venustus *Deák, 1963.*

M. The distal rib pattern consisting of three sets of ribs. The ribs of each set running parallel to one another and obliquely to the ribs of the other sets, and forming a triangular area centered on the distal pole; the ribs in the triangular area parallel to the two sides and oblique to the third side of the triangle. Sculpture cicatricose; ribs oblique to the amb and usually bifurcating e.g. Cicatricosisporites augustus *n. sp.*

N. The proximal rib pattern consisting of three sets of interradial ribs. The ribs in each interradial region running parallel to the side and obliquely to the laesurae. The outer ribs are continuous around the apices; the inner ribs terminate at the laesurae e.g. Cicatricosisporites annulatus *Archangelsky and Gamerro, 1966.*

O. The proximal rib pattern consisting of three sets of interradial ribs. The ribs in each interradial region running parallel to the side and obliquely to the laesurae e.g. Cicatricosisporites spiralis *n. sp.*

P. The proximal rib pattern consisting of three sets of interradial ribs. The ribs in each interradial region running parallel to one another and to one laesura and obliquely to the side and the other laesura. Each set of interradial ribs running obliquely to the other two sets e.g. Cicatricosisporites hallei *Delcourt and Sprumont, 1955.*

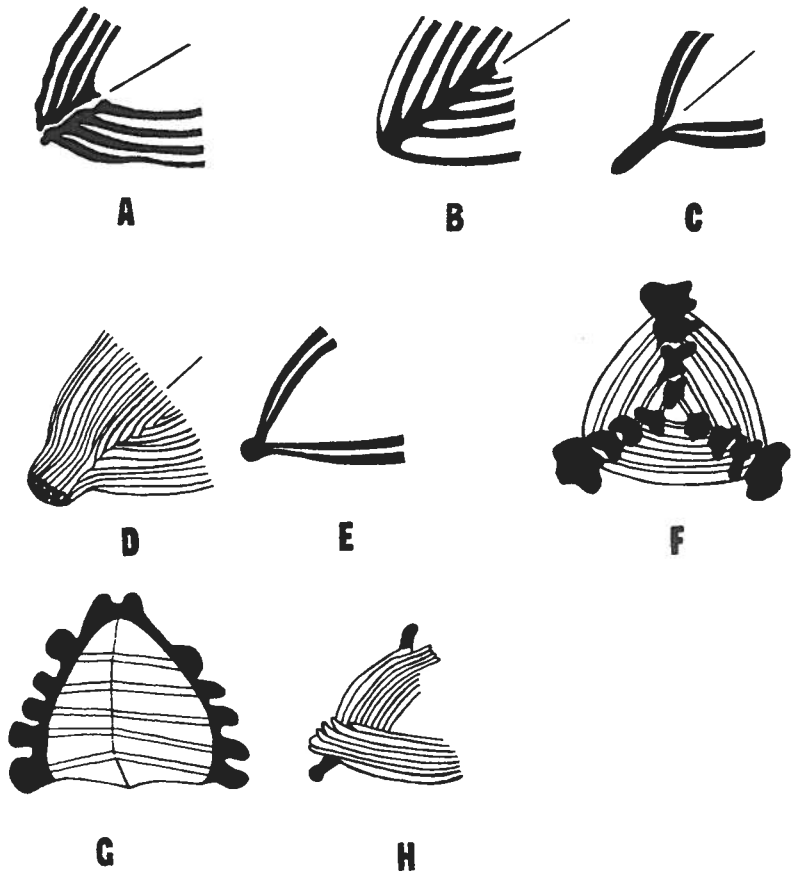

FIGURE 8. Schematic drawings illustrating the pattern of junction of the ribs in the radial region of some of the schizaeaceous spores.

A. Proximal radial region with equatorial ribs converging towards the apices and coalescing with the adjacent ribs of their own side e.g. Cicatricosisporites australiensis *(Cookson) Potonié, 1956.*

B. Proximal radial region with alternate ribs of the adjacent sides coalescing e.g. Cicatricosisporites hughesi *Dettmann, 1963.*

C. Radial region with equatorial ribs fusing one with another and forming one projecting appendix at the apex e.g. Appendicisporites unicus *(Markova) Singh, 1964.*

D. Radial region with equatorial ribs extending onto the appendix at the apex before coalescing with one another e.g. Appendicisporites bifurcatus *Singh, 1964.*

E. Radial region with equatorial ribs fusing one with another, and forming one short appendix at the apex e.g. Appendicisporites erdtmanii *Pocock, 1964.*

F, G. Distal and equatorial views of spores with comb-like, enlarged projections (appendices) at the junctions of the distal ribs along the radial lines e.g. Appendicisporites matesovae *(Bolkhovitina) Norris, 1967.*

H. Distal view of Appendicisporites *sp. cf.* A. cristatus *(Markova) Pocock, 1964, showing one large appendix at each apex, and short, comb-like projections along the radial lines, where the ribs from adjacent sides coalesce in pairs.*

Genus **Appendicisporites** Weyland and Krieger, 1953

Type species **Appendicisporites tricuspidatus** Weyland and Greifeld, 1953

See Singh (1964, p. 46) for synonymy and generic diagnosis.

Remarks: In the writer's opinion, the genus *Plicatella* Maljavkina, 1949, as defined at present, cannot be objectively distinguished from the genus *Appendicisporites*. There does not seem to be any taxonomic merit in Potonié's (1960, p. 50; 1966, p. 60, 74) suggestion that this distinction should be based upon the length of the appendices, since it would be entirely arbitrary. The circumscription of the genus *Plicatella* is ambiguous, and the various species originally assigned to it have been poorly described. The separation of this genus from *Appendicisporites* must await a general revision of this group on the basis of taxonomically significant features. Therefore, in the present study, the genus *Appendicisporites* has been provisionally used to accommodate all the forms which possess one or more appendices at the apices or along the radial lines (Fig. 8 C-H).

86 **Appendicisporites bifurcatus** Singh, 1964

Plate 4, figures 3-5

See Singh (1964, p. 54) for description.

Distribution: Middle and late Albian. Paddy Member of the Peace River area; Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964).

Remarks: The specimens of *A. bifurcatus* found during the present study have equatorial ribs which extend onto the appendices before coalescing with one another (Fig. 8 D). The terminations of the ribs and canals in the appendices give them a foveolate appearance.

Locality of figured specimen:

Pl. 4, figs. 3-5.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 4, figs. 3-5.	Slide No. 4-P-6-Micro. 2;	co-ord. 10.3/41.2.	

87 **Appendicisporites bilateralis** n. sp.

Plate 4, figures 6-8

Description: Trilete; laesurae about 2/3 of the spore radius; commissures raised, with membraneous lips; amb triangular; sides straight to slightly convex; proximal surface with 3 to 4 ribs in each interradial region running parallel to the side and coalescing with the ribs of adjacent side in the apical areas; surface near the laesurae smooth; distal surface with 5 to 7 ribs in two interradial regions, and about

3 ribs in the third interradial region; distal ribs running parallel to one another and to their side of the spore in the equatorial region; distal ribs in the polar region running parallel to sub-parallel to the two sides and obliquely to the 3 equatorial ribs of the third side (Fig. 9); alternate ribs from the two sides coalescing and forming a ridge running from the distal polar area to the appendix; appendices conical, 4 to 6 microns long and 3 to 6 microns wide (Fig. 8 E); sculpture canaliculate; ribs flat topped, 2 to 3 microns wide, separated by 1- to 2-micron wide canals; exine about 3 microns thick.

FIGURE 9. Appendicisporites bilateralis *n. sp. Distal view.*

Size range: Equatorial diameter including appendices (14 specimens) 42 (46.5) 60 microns. Holotype 60 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: This species is distinguishable from *Appendicisporites* sp. cf. *Anemia macrorhyza* (Maljavkina) Bolkhovitina, 1953, and *Appendicisporites erdtmanii* Pocock, 1964, by its different distal rib pattern. *Appendicisporites tricornitatus* Weyland and Greifeld, 1953, is distinguishable from *Appendicisporites bilateralis* n. sp. by its smaller size (35 microns). The sculptural features of *A. bilateralis* n. sp. resemble those of *Anemia trichacantha* (Maljavkina) Markova, 1961. The latter differs, however, in possessing longer (13 to 17 microns) appendices and laesurae which reach the equator. Moreover, the specimens originally assigned to *A. trichacantha* by Maljavkina (1949) are considerably larger (120 to 140 microns) in size.

The specific name is derived from *"bilateralis"* (bilateral) and refers to the distal rib pattern.

Type locality:

Holotype: Pl. 4, figs. 6, 7. Sample No. 8-L-6; Loon River Formation. Section 8.
Paratype: Pl. 4, fig. 8. Sample No. 8-L-9; Loon River Formation. Section 8.
Holotype: Pl. 4, figs. 6, 7. Slide No. 8-L-6 (1); co-ord. 18/59.
Paratype: Pl. 4, fig. 8. Slide No. 8-L-9 (1); co-ord. 21.1/74.5.

90 **Appendicisporites** sp. cf. **A. cristatus** (Markova) Pocock, 1964

Plate 4, figures 9, 10

1961 ?*Anemia cristata* Markova, *in* Samoilovitch *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., vol. 177, p. 78, pl. 20, figs. 1 a-b.

1964 ?*Appendicisporites cristatus* (Markova) Pocock, Grana Palynologica, vol. 5, p. 164, pl. 3, figs. 9, 10.

Description: Trilete; laesurae reaching the equator; amb rounded-triangular with several appendices at each apex; proximal surface with 6 to 8 ribs in each interradial region running parallel to the side and coalescing with the ribs of the adjacent side in the apical areas; distal surface with 6 to 8 ribs in each interradial region; distal ribs running parallel to their side and coalescing in pairs with the ribs of the adjacent side along the radial lines; ribs prolonged into short, comb-like projections along the radial lines and at the apices; comb-like projections consisting of numerous, tightly packed ribs, about 8 microns high; a separate and larger appendix, about 11 microns long and 3 to 4 microns wide, and with slightly swollen and rounded tips, present at each apex (Fig. 8 H); sculpture canaliculate; ribs flat-topped, 1.5 to 2 microns wide, separated by about 0.5-micron wide canals; exine about 2.5 microns thick.

Size range: Equatorial diameter including appendices (5 specimens) 45 (52) 60 microns.

Distribution: Middle and late Albian. Harmon, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Appendicisporites* sp. cf. *A. cristatus* differs from *Appendicisporites cristatus* (Markova) Pocock, 1964, in having one appendix at each apex, which is distinctly larger than the remaining comb-like projections.

Locality of figured specimen:

Pl. 4, figs. 9, 10.	Sample No. 7-H-6;	Harmon Member.	Section 7.
Pl. 4, figs. 9, 10.	Slide No. 7-H-6 (1);	co-ord. 2.2/33.5.	

82 **Appendicisporites erdtmanii** Pocock, 1964

Plate 4, figure 11

See Singh (1964, p. 48) for synonymy and description.

Distribution: Barremian to Cenomanian-Turonian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area; Mannville Group of central Alberta (Singh, 1964); upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Wealden and Aptian of England (Couper, 1958); Cenomanian-Turonian of northern Spain (van Amerom, 1965).

Remarks: This species is characterized by about 4 to 6 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 7 B). The triangular area, including the enclosing ribs, is from 15 to 20 microns in width. The alternate ribs of adjacent sides coalesce in the distal radial regions. The appendices are short (Fig. 8 E). The proximal sculpture consists of about 3 ribs in each interradial region, which are parallel to the side and coalesce with the corresponding ribs of the adjacent side near the apices. The sculpture is canaliculate. The contact areas are smooth.

Appendicisporites erdtmanii is distinct from *Appendicisporites* sp. cf. *Anemia macrorhyza* (Maljavkina) Bolkhovitina, 1953, which has knob-like appendices, smaller triangular area on the distal surface, narrower ribs, and a triangular amb. *Appendicisporites bilateralis* n. sp. is distinguishable from *A. erdtmanii* in having a different distal rib pattern, slightly narrower ribs, and a triangular amb. *Appendicisporites tricornitatus* Weyland and Greifeld, 1953, can be easily distinguished from *A. erdtmanii* by its smaller size (35 microns), smaller triangular area on the distal surface, and triangular shape.

Some of the specimens assigned to *A. tricornitatus* by Couper (1958, pl. 17, figs. 8, 9) are identical with *A. erdtmanii.*

Locality of figured specimen:

Pl. 4, fig. 11.	Sample No. 8-L-6;	Loon River Formation.	Section 8.
Pl. 4, fig. 11.	Slide No. 8-L-6(3);	co-ord. 5/68.	

84 **Appendicisporites jansonii** Pocock, 1962

Plate 5, figures 1, 2

See Pocock (1962, p. 37) for description.

Distribution: Barremian to Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area; Mannville Group of central Alberta (Singh, 1964); Ellerslie and "calcareous" Members of Western Canada (Pocock, 1962); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); uppermost Wealden of England (Lantz, 1958).

Remarks: This species is characterized by its triangular amb, straight sides, and wide, blunt apical thickenings which do not project beyond the general outline of the spore. The proximal sculpture consists of about 6 or more ribs in each interradial region, which are parallel to the side and coalesce with the corresponding ribs of the adjacent side near the apices. The sculpture is canaliculate.

The details of the distal rib pattern of *Appendicisporites jansonii* have not been given by Pocock (1962). The specimens assigned to *A. jansonii* in the present study are characterized by about 6 to 10 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Pl. 5, Fig. 2). The alternate ribs of adjacent sides coalesce in the distal radial regions. The equatorial ribs extend onto the appendices before coalescing with one another (Fig. 8 D).

Appendicisporites sp., figured by Lantz (1958, pl. 3, fig. 26) from the uppermost Wealden beds of England, is conspecific with *A. jansonii.*

Locality of figured specimen:

Pl. 5, figs. 1, 2.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 5, figs. 1, 2.	Slide No. 4-P-6 (1);	co-ord. 5/53.2.	

85 **Appendicisporites** sp. cf. **A. jansonii** Pocock, 1962

Plate 5, figures 3, 4

See Pocock (1962, p. 37) for description.

Distribution: Middle Albian. Cadotte Member of the Peace River area.

Remarks: Two specimens of *Appendicisporites* sp. cf. *A. jansonii* were found in the Cadotte Member. Their proximal and distal rib patterns and appendices resemble those of *Appendicisporites jansonii* Pocock, 1962. However, *A.* sp. cf. *A. jansonii* differs from *A. jansonii* in having wider and fewer ribs, very narrow, noncoalescent canals, and in being smaller (55 microns). The width of 4 ribs and canals is 16 microns.

Locality of figured specimen:

Pl. 5, figs. 3, 4.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 5, figs. 3, 4.	Slide No. 7-C-8 (1);	co-ord. 6.1/49.8.	

83 **Appendicisporites** sp. cf. **Anemia macrorhyza** (Maljavkina) Bolkhovitina, 1953

Plate 5, figures 5-8

1961 ? *Anemia macrorhyza* (Maljavkina) Bolkhovitina (part), Trudy Geol. Inst., Akad. Nauk SSSR, vol. 40, p. 54, pl. 15, figs. 7 a-e, pl. 17, fig. 9a only.

1961 ?*Anemia macrorhyza* (Maljavkina) Bolkhovitina–Markova *in* Samoilovitch *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., vol. 177, p. 71, pl. 18, figs. 1 a-b.

Description: Trilete; laesurae simple, extending to the base of the appendices; amb triangular; sides slightly convex to slightly concave; proximal surface with about 4 ribs in each interradial region running parallel to the side and coalescing with the ribs of the adjacent side in the apical areas; distal surface with 4 to 6 ribs in each interradial region; distal ribs running parallel to one another and to their side of the spore in the equatorial region, and forming a triangular area centered on the distal pole (Fig. 7B); the triangular area including the enclosing ribs about 8 microns in width; alternate ribs of the adjacent sides coalescing in the distal radial regions; appendices knob-shaped, 6 to 8 microns long and 5 to 8 microns wide (Fig. 8E); sculpture canaliculate; ribs flat-topped, 2 to 2.5 microns wide, separated by 1- to 1.5-micron wide canals; exine about 2.5 microns thick.

Size range: Equatorial diameter including appendices (4 specimens) 44 (55) 63 microns.

Distribution: Middle and late Albian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Appendicisporites* sp. cf. *Anemia macrorhyza* differs from the specimens assigned to *Anemia macrorhyza* by Bolkhovitina (1953, 1961) in having a smaller size and narrower ribs. The details of the proximal and distal rib patterns have not been given by Bolkhovitina. The specimens assigned to *A. macrorhyza* by Markova (*in* Samoilovitch *et al.*, 1961) are almost identical with *A.* sp. cf. *A. macrorhyza.*

This species is characterized by knob-like appendices. *Appendicisporites erdtmanii* Pocock, 1964, can be distinguished from *A.* sp. cf. *A. macrorhyza* by its larger triangular area on the distal surface, wider ribs, rounded-triangular amb, and smaller appendices. *Appendicisporites bilateralis* n. sp. is distinguishable from *A.* sp. cf. *A. macrorhyza* in possessing a different distal rib pattern, shorter laesurae, and conical appendices. *A.* sp. cf. *A. macrorhyza* is distinct from *Appendicisporites tricornitatus* Weyland and Greifeld, 1953, which has conical appendices and a smaller size (35 microns).

Locality of figured specimens:

Pl. 5, figs. 5, 6.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 5, figs. 7, 8.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 5, figs. 5, 6.	Slide No. 4-P-6(1);	co-ord. 17.8/54.2.	
Pl. 5, figs. 7, 8.	Slide No. 7-C-6(2);	co-ord. 4/54.1.	

89 **Appendicisporites matesovae** (Bolkhovitina) Norris, 1967

Plate 5, figure 9

See Norris (1967, p. 94) for synonymy and description.

Distribution: Albian to Turonian. Lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Cenomanian of Oklahoma, U.S.A. (Hedlund, 1966); Albian of Russia (Bolkhovitina, 1961); Cenomanian and Turonian of western Siberia, U.S.S.R. (Markova *in* Samoilovitch *et al.*, 1961).

Remarks: This species is characterized by several appendices at each apex, and along the radial lines of the spore. The proximal and distal ribs are parallel to the sides. The ribs from adjacent sides coalesce along the radial lines, where they are prolonged into comb-like projections (Fig. 8 F, G). The projections have enlarged rounded terminations. The proximal surface is almost smooth, with only one rib running parallel to the side in each equatorial interradial region.

Appendicisporites matesovae is distinct from *Appendicisporites cristatus* (Markova) Pocock, 1964, which has narrower appendices and is smaller. *Anemia insignis* Markova, 1961, can be easily distinguished from *A. matesovae* by its numerous, individually projecting, rod-like appendices, which are developed along the radial lines on the distal surface of the spore.

Appendicisporites undosus Hedlund, 1966, from the Cenomanian of Oklahoma, U.S.A. is conspecific with *A. matesovae.*

Locality of figured specimen:

Pl. 5, fig. 9.	Sample No. 1-S-9;	lower Shaftesbury Formation. Section 1.
Pl. 5, fig. 9.	Slide No. 1-S-9 (1);	co-ord. 7.9/75.9.

79 **Appendicisporites potomacensis** Brenner, 1963

Plate 5, figures 10-13

See Brenner (1963, p. 46) for description.

Distribution: Barremian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), Viking Formation and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian of Maryland, U.S.A. (Groot and Penny, 1960).

Remarks: This species is characterized by 4 to 6 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 7 A). The alternate ribs of adjacent sides coalesce in the distal radial regions. The proximal surface has about 3 ribs in each interradial region, which are parallel to the side and coalesce with the ribs of the adjacent side in the apical areas. The equatorial ribs fuse to form a projecting, rod-shaped appendix at each apex (Fig. 8 E). The sculpture is distinctly cicatricose. The contact areas are smooth.

Appendicisporites potomacensis is distinct from *Appendicisporites tricornitatus* Weyland and Greifeld, 1953, which has a canaliculate sculpture and thicker, conical appendices. Specimens assigned to *A. tricornitatus* by Singh (1964, pl. 2, fig. 1) and Groot and Penny (1960, pl. 1, fig. 4) actually belong to *A. potomacensis*. *Cicatricosisporites hughesi* Dettmann, 1963, differs from *A. potomacensis* in having sinuous ribs separated by wider intervening spaces, and in the absence of elongate, rod-shaped appendices. *Appendicisporites erdtmanii* Pocock, 1964, can be easily distinguished from *A. potomacensis* by its canaliculate sculpture, and the larger triangular area centered on the distal pole.

Locality of figured specimens:

Pl. 5, figs. 10, 11.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 5, fig. 12.	Sample No. 7-H-7;	Harmon Member.	Section 7.
Pl. 5, fig. 13.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 5, figs. 10, 11.	Slide No. 7-C-7(3);	co-ord. 12.3/53.2.	
Pl. 5, fig. 12.	Slide No. 7-H-7-Micro. 59;	co-ord. 12.4/42.5.	
Pl. 5, fig. 13.	Slide No. 8-L-3(3);	co-ord. 17.9/60.1.	

88 **Appendicisporites problematicus** (Burger) n. comb.

Plate 6, figures 1-6

1966 *Plicatella problematica* Burger, Leidse Geol. Mededel., Deel 35, p. 245, pl. 10, figs. 3 a-b.

See Burger (1966, p. 245) for description.

FIGURE 10. Appendicisporites problematicus *Burger. Distal view.*

Distribution: Berriasian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Berriasian and Valanginian of Holland (Burger, 1966).

Remarks: This species is characterized by 3 to 5 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 10). The alternate ribs of adjacent sides coalesce in the distal radial regions. The proximal surface has 1 to 2 ribs in each interradial equatorial region, which are parallel to the side and coalesce with the ribs of the adjacent side in the apical areas. The equatorial ribs fuse to form an appendix at each apex (Fig. 8E). The sculpture is cicatricose with very high and sharp-crested ribs. The contact areas are smooth.

The outermost equatorial ribs are invariably flattened horizontally, producing a flange-like effect. They are convex, hyaline, from 4 to 6 microns in width interradially, and narrower toward the apices. The inner ribs on the distal surface remain in vertical position and are from 4 to 6 microns in height, becoming lower toward the apices. These inner ribs form the straight sides of a triangle. The apices of the triangle project to form the appendices. The appendices of the Alberta specimens of *Appendicisporites problematicus* are variable in length. The inner ribs are normally high and narrow with wide intervening spaces between them (cicatricose). However, the intervening spaces become narrower than the ribs in those specimens whose ribs are flattened horizontally due to compression.

Appendicisporites problematicus is distinct from *Appendicisporites irregularis* Pocock, 1964, whose distal ribs are discontinuous, irregularly thickened, and appear like aligned, elongate verrucae. *Anemia bella* Markova, 1961, resembles *A. problematicus* in certain respects but is insufficiently described for detailed comparison. Moreover, Markova (*in* Samoilovitch *et al.*, 1961) has made no mention of the flange-like equatorial ribs, which characterize *A. problematicus*, in the description of *A. bella*. *A. problematicus* can be easily distinguished from *Cicatricosisporites hughesi* Dettmann, 1963, *Appendicisporites erdtmanii* Pocock, 1964, and *Appendicisporites potomacensis* Brenner, 1963, by its outer flange-like equatorial ribs.

Locality of figured specimens:

Pl. 6, figs. 1, 2.	Sample No. 8-L-6;	Loon River Formation.	Section 8.
Pl. 6, fig. 3.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 6, fig. 4.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 6, figs. 5, 6.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 6, figs. 1, 2.	Slide No. 8-L-6 (3);	co-ord. 8/36.5.	
Pl. 6, fig. 3.	Slide No. 8-L-9 (3);	co-ord. 7.2/47.2.	
Pl. 6, fig. 4.	Slide No. 7-C-7 (1);	co-ord. 16.2/49.1.	
Pl. 6, figs. 5, 6.	Slide No. 8-L-7-Micro. 35;	co-ord. 10.2/44.4.	

81 **Appendicisporites spinosus** Pocock, 1964

Plate 6, figures 7-9

See Pocock (1964, p. 169) for description.

Distribution: Middle Albian. Loon River Formation and Harmon Member of the Peace River area; upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); middle Albian of northern Wyoming, U.S.A. (Davis, 1963).

Remarks: This species is characterized by 3 to 5 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 7 A). The alternate ribs of the adjacent sides coalesce in the distal radial regions. The proximal surface has about 3 to 4 ribs in each interradial region, which are parallel to the side and coalesce with the ribs of the adjacent side in the apical areas. Minute appendices are developed on the apices of some specimens, but most specimens lack appendices. The sculpture is cicatricose. A series of round-topped clavate and spinose processes is developed along the crest of every rib.

Appendicisporites spinosus Pocock, 1964, is distinct from *Appendicisporites dentimarginatus* Brenner, 1963, in which the spines are borne on a hyaline, equatorial zona encircling the spore body. *A. dentimarginatus* differs also in having rod-shaped appendices at the apices and a smooth proximal surface.

Cicatricosisporites sp. C, described from the Fall River Formation of northern Wyoming, U.S.A. by Davis (1963, pl. 3, fig. 9), is conspecific with *A. spinosus.*

A. spinosus appears to be identical in all respects to the spores of the modern schizaeaceous fern *Anemia phyllitidis* (Linnaeus) Swartz.

Locality of figured specimens:

Pl. 6, fig. 7.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 6, figs. 8, 9.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 6, fig. 7.	Slide No. 8-L-4(1);	co-ord. 10.2/59.1.	
Pl. 6, figs. 8, 9.	Slide No. 8-L-9-Micro.37;	co-ord. 9/42.6.	

80 **Appendicisporites unicus** (Markova) Singh, 1964

Plate 6, figures 10-12

See Singh (1964, p. 53) for synonymy and description.

Distribution: Middle Albian to Cenomanian. Loon River Formation, Harmon,

Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Grand Rapids Formation (Singh, 1964), and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Cenomanian of western Siberia, U.S.S.R. (Markova *in* Samoilovitch *et al.*, 1961).

Remarks: This species is characterized by 3 to 5 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 7A). The alternate ribs of adjacent sides coalesce in the distal radial regions. The proximal surface has 3 to 4 ribs in each interradial region, which are parallel to the side and coalesce with the ribs of the adjacent side in the apical areas. The equatorial ribs fuse to form a rod-shaped appendix, about 15 microns long, at each apex (Fig. 8 C). The sculpture is cicatricose, with slightly sinuous ribs.

Appendicisporites unicus is distinct from *Appendicisporites tricuspidatus* Weyland and Greifeld, 1953, which is considerably larger in size, and whose appendices are equal to or longer than the diameter of the spore body. The appendices of *A. unicus* are usually less than or equal to the radius of the body.

Appendicisporites sp., described by Davis (1963, pl. 4, fig. 11) from the Thermopolis and Skull Creek shales of northern Wyoming, U.S.A., is conspecific with *A. unicus.*

Locality of figured specimens:

Pl. 6, fig. 10. Sample No. 2-S-10;	lower Shaftesbury Formation.	Section 2.
Pl. 6, fig. 11. Sample No. 6-H-2;	Harmon Member.	Section 6.
Pl. 6, fig. 12. Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 6, fig. 10. Slide No. 2-S-10-Micro. 38;	co-ord. 11.5/42.2.	
Pl. 6, fig. 11. Slide No. 6-H-2 (1);	co-ord. 14/76.5.	
Pl. 6, fig. 12. Slide No. 8-L-11 (1);	co-ord. 1.2/35.	

Genus **Cicatricosisporites** Potonié and Gelletich, 1933

Type species **Cicatricosisporites dorogensis** Potonié and Gelletich, 1933

See Dettmann (1963, p. 52) for synonymy and discussion.

Remarks: The various species assigned to the genus *Cicatricosisporites* in the present study lack distinct appendices. A few of these species have small radial exinal thickenings (e.g. *Cicatricosisporites hughesi* Dettmann, 1963) where the alternate ribs of the adjacent sides fuse in the radial regions (Fig. 8 B). However, this differs significantly from the manner in which the appendices are formed in the genus *Appendicisporites* Weyland and Krieger, 1953 (Fig. 8 C-H).

64 **Cicatricosisporites annulatus** Archangelsky and Gamerro, 1966

Plate 6, figures 13-15; plate 7, figures 1, 2

1964 *Cicatricosisporites* sp. B. Singh, Res. Coun. Alberta, Bull. 15, p. 60, pl. 7, figs. 4-6.

1966 b *Cicatricosisporites annulatus* Archangelsky and Gamerro, Ameghiniana, vol. 4, p. 368, pl. 2, figs. 6-8.

1967 *Cicatriosisporites* sp. Norris (part), Palaeontographica, Band 120, Abt.B, p. 93, pl. 12, figs. 4, 5 only.

Description: Trilete; laesurae 2/3 to 3/4 of the spore radius; commissures raised, bordered by 1-micron wide lips; lips up to 2 microns high; most of the contact area near laesurae smooth; amb subcircular; distal surface strongly convex; proximal surface with 3 ribs in each equatorial interradial region; ribs in each interradial region running parallel to the amb and obliquely to the laesurae; the outermost rib continuous around the apices; the inner ribs terminating at the laesurae (Fig. 7 N); distal rib pattern consisting of two sets of ribs; the outer set of ribs running parallel to the amb and continuous around the apices; the inner set of ribs running across the distal surface, and disposed obliquely to one side and the outer set of ribs (Fig. 7 K); the line where the two sets of ribs meet clearly demarcated; the outer and inner sets consisting of about 6 and 8 ribs respectively; sculpture canaliculate; ribs flat-topped, 2 to 3 microns wide, separated by about 1.5-micron wide canals; exine about 2.5 microns thick.

Size range: Equatorial diameter (4 specimens) 54 (55) 56 microns.

Distribution: Cretaceous. Paddy Member and lower Shaftesbury Formation of the Peace River area; Grand Rapids Formation (Singh, 1964), and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; Cretaceous of Argentina (Archangelsky and Gamerro, 1966b).

Remarks: *Cicatricosisporites annulatus* Archangelsky and Gamerro, 1966, resembles some of the specimens assigned to *Pelletieria mediostriata* by Bolkhovitina (1961, pl. 21, figs. 1 a-b), but is dissimilar to the other specimens (Bolkhovitina, 1961, pl. 19, figs. 3 a-b, pl. 21, fig. 1c). A detailed comparison of the two species is not possible, as the proximal and distal rib patterns have not been clearly described by Bolkhovitina (1961). *Cicatricosisporites hallei* Delcourt and Sprumont, 1955, can be distinguished from *C. annulatus* by its different proximal and distal rib patterns, slightly narrower ribs, and triangular amb. *C. annulatus* is distinct from *Cicatricosisporites subrotundus* Brenner, 1963, which has wider ribs and a different arrangement of proximal and distal ribs, and from *Cicatricosisporites spiralis* n. sp., which has a spiral rib pattern on the distal surface, and a triangular amb.

Locality of figured specimens:

Pl. 6, figs. 13-15.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 7, figs. 1, 2.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 6, figs. 13-15.	Slide No. 4-P-4(1);	co-ord. 14/62.9.	
Pl. 7, figs. 1, 2.	Slide No. 4-P-4-Micro. 54;	co-ord. 10.2/42.5.	

66 **Cicatricosisporites augustus** n. sp.

Plate 7, figures 3-11

Description: Trilete; laesurae about 3/4 of the spore radius; commissures raised, bordered by membraneous lips; amb triangular; sides slightly concave to slightly convex; apices broadly rounded; proximal ribs in each interradial region running parallel to one laesura and obliquely to the side and other laesura (Fig. 7P); proximal equatorial ribs usually coalescing with the adjacent ribs of their own side near the apices (Fig. 8A); each set of proximal interradial ribs running obliquely to the other two sets; distal rib pattern consisting of three sets of ribs; the ribs of each set running parallel to one another and obliquely to the ribs of the other two sets, and forming a triangular area centered on the distal pole (Fig. 7M); the ribs of the triangular area disposed parallel to the two sides and obliquely to the third side of the triangle; the remaining ribs oriented obliquely to the amb; each proximal and distal interradial region with 12 to 20 ribs; sculpture cicatricose with bifurcating, sharp-crested, and very narrow ribs; ribs 0.8 micron wide, separated by 1.5- to 2-micron wide canals; exine 1.5 microns thick; most specimens folded or twisted due to the thin wall.

Size range: Equatorial diameter (18 specimens) 39 (50) 58 microns. Holotype 55 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Pelletieria minutaestriata* Bolkhovitina, 1961, resembles *Cicatricosisporites augustus* n. sp. in having a cicatricose sculpture and very narrow ribs, but differs in having longer laesurae, which reach the equator, and in being smaller (34 (36) 38 microns). A detailed comparison of the two species is not possible as the proximal and distal rib patterns of *P. minutaestriata* have not been described by Bolkhovitina (1961). *Cicatricosisporites venustus* Deák, 1963, differs from *C. augustus* n. sp. in being smaller and having a different arrangement of the distal ribs (Fig. 7L). *Cicatricosisporites australiensis* (Cookson) Potonié, 1956, can be easily distinguished from *C. augustus* n. sp. by its ribs which are oriented parallel to the sides. *C. augustus* n. sp. is distinct from all other species of the genus *Cicatricosisporites* in possessing very narrow ribs, which are always less than 1 micron in width.

The specific name is derived from *"augustus"* (majestic).

Type locality:

Holotype: Pl. 7, figs. 3-5. Sample No. 8-L-11; Loon River Formation. Section 8.
Paratype: Pl. 7, figs. 6-11. Sample No. 8-L-11; Loon River Formation. Section 8.
Holotype: Pl. 7, figs. 3-5. Slide No. 8-L-11-Micro. 64; co-ord. 9.6/40.
Paratype: Pl. 7, figs. 6-8. Slide No. 8-L-11-Micro. 64; co-ord. 13.2/41.2.
Paratype: Pl. 7, figs. 9, 10. Slide No. 8-L-11-Micro. 64; co-ord. 10.4/42.
Paratype: Pl. 7, fig. 11. Slide No. 8-L-11-Micro. 39; co-ord. 15.8/40.9.

56 **Cicatricosisporites australiensis** (Cookson) Potonié, 1956

Plate 7, figures 12-15

See Dettmann (1963, p. 53) for synonymy and description.

Distribution: Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; Mannville and Colorado Groups of Western Canada (Pocock, 1962); upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); late Purbeckian of England (Lantz, 1958); Lower and Upper Cretaceous of southeastern Australia (Cookson, 1953, 1954; Baker and Cookson, 1955; Cookson and Dettmann, 1958a, 1959b; Dettmann, 1959, 1963); Lower Cretaceous of Western Australia (Balme, 1957), Queensland and New Guinea (Cookson and Dettmann, 1958a); Albian of Kazakhstan (Bolkhovitina, 1961); Albian of Peru (Brenner, 1968).

Remarks: This species is characterized by a cicatricose sculpture composed of a large number of narrow, bifurcating, distal ribs running parallel to each other and to their side of the spore in the equatorial region and leaving a triangular area centered on the distal pole, with ribs disposed subparallel to the two sides and obliquely to the third side of the triangle (Fig. 7 E). The distal equatorial ribs cross over to the proximal surface only at the apices where they coalesce with the adjacent ribs of their own side (Fig. 8 A). The contact areas on the proximal surface are smooth.

Cicatricosisporites dorogensis Potonié and Gelletich, 1933, is distinct from *Cicatricosisporites australiensis* in having ribs which are oblique to the sides, shorter laesurae and a subcircular amb. *Ruffordia goepperti* (Dunker) Seward, 1894 (spores) and *Cicatricosisporites mohrioides* Delcourt and Sprumont, 1955, differ from *C. australiensis* in having fewer, more widely spaced, often discontinuous, wavy, and subparallel ribs of uneven width, which occasionally join to form a partial reticulum on the distal surface.

Some of the specimens assigned to *C. dorogensis* by various authors (Bolkhovitina, 1961, pl. 20, figs. 3a-c, pl. 21, figs. 2d-e; Pocock, 1962, pl. 2, fig. 36;

1964, pl. 2, fig. 19; Singh, 1964, pl. 6, fig. 1) actually belong to *C. australiensis.* A few of the specimens identified as *C. mohrioides* by Lantz (1958, pl. 2, figs. 19, 20) also belong to *C. australiensis.*

Locality of figured specimens:

Pl. 7, fig. 12.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 7, figs. 13-15.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 7, fig. 12.	Slide No. 7-C-8 (1);	co-ord. 19.3/56.5.	
Pl. 7, fig. 13.	Slide No. 8-L-7 (2);	co-ord. 16.6/76.	
Pl. 7, figs. 14, 15.	Slide No. 8-L-7 (2);	co-ord. 7/63.9.	

58 **Cicatricosisporites** sp. cf. **Anemia exilioides** (Maljavkina) Bolkhovitina, 1953

Plate 8, figures 1-6

1961 ?*Anemia exilioides* (Maljavkina) Bolkhovitina (part), Trudy Geol. Inst., Akad. Nauk SSSR, vol. 40, p. 51, pl. 14, fig. 2b, pl. 17, figs. 1 a-d only.

1961 ?*Anemia exilioides* (Maljavkina) Bolkhovitina–Markova *in* Samoilovitch *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., vol. 177, p. 66, pl. 17, figs. 1 a-b.

Description: Trilete; laesurae indistinct, about 2/3 to 3/4 of the spore radius; amb triangular; sides convex; apices sharply rounded, with small thickenings usually not projecting beyond the amb; proximal ribs in each interradial region running parallel to the side and obliquely to the laesurae; the outer proximal ribs coalescing with the corresponding ribs of the adjacent side in the radial regions (Fig. 7 N); the inner proximal ribs terminating at the laesurae; distal ribs running parallel to each other and to their side of the spore in the equatorial region, and forming a triangular area centered on the distal pole (Pl. 8, Fig. 2); the triangular area sometimes closer to one side (Pl. 8, Fig. 4) or entirely replaced by subparallel ribs (Pl. 8, Fig. 6); alternate ribs of adjacent sides coalescing in the distal radial regions; each proximal and distal interradial region with 6 to 8 ribs; sculpture canaliculate with flat-topped, sharp-edged ribs; ribs 2.5 to 5 microns wide, separated by 1- to 1.5-micron wide canals; exine about 4 microns thick.

Size range: Equatorial diameter (11 specimens) 54 (65) 84 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Cicatricosisporites* sp. cf. *Anemia exilioides* resembles the specimens assigned to *Anemia exilioides* by Bolkhovitina (1961) and Markova (*in*

Samoilovitch *et al.*, 1961) in having the characteristic triangular arrangement of the proximal and distal ribs, which are parallel to the sides of the spore. The latter species differs, however, is possessing longer and distinct laesurae, which reach the equator. Moreover, the symmetry of the distal sculpture of *C.* sp. cf. *A. exilioides* varies from the extreme in which the triangle is centered on the distal pole (Pl. 8, Fig. 2), through the intermediate condition in which the triangle is closer to one side of the spore (Pl. 8, Fig. 4), to the other extreme in which subparallel ribs replace the triangle (Pl. 8, Fig. 6). The distal sculpture of *Anemia exilioides* does not appear to be so variable. The earlier description and illustrations of *Anemia exilioides* by Bolkhovitina (1953) are too sketchy for a detailed comparison.

Cicatricosisporites pseudotripartitus (Bolkhovitina) Dettmann, 1963, differs from *C.* sp. cf. *A. exilioides* in having fewer ribs in the interradial regions, longer and more distinct laesurae reaching the equator, and in being smaller. *Cicatricosisporites subrotundus* Brenner, 1963, is distinct from *C.* sp. cf. *A. exilioides* in having fewer and wider ribs, and a subcircular amb without apical thickenings.

The proximal and distal rib patterns of *C.* sp. cf. *A. exilioides* broadly resemble those of *Pelletieria valdensis* Seward, 1913 (spores) (see Hughes and Moody-Stuart, 1966, pl. 44, figs. 3, 4, pl. 45, figs. 3, 4). *Pelletieria valdensis* was originally described from the lower Wealden beds of England by Seward (1913).

Locality of figured specimens:

Pl. 8, figs. 1, 2.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 8, figs. 3, 4.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 8, figs. 5, 6.	Sample No. 7-H-7;	Harmon Member.	Section 7.
Pl. 8, figs. 1, 2.	Slide No. 8-L-4(1);	co-ord. 6/68.1.	
Pl. 8, figs. 3, 4.	Slide No. 8-L-12(3);	co-ord. 8.9/39.2.	
Pl. 8, figs. 5, 6.	Slide No. 7-H-7-Micro. 66;	co-ord. 11.5/41.6.	

63 **Cicatricosisporites hallei** Delcourt and Sprumont, 1955

Plate 8, figures 7-11

See Delcourt and Sprumont (1955, p. 17) for description.

Distribution: Early Cretaceous and Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Albian and Cenomanian of

Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1967); "Wealden" of Belgium and France (Delcourt and Sprumont, 1955, 1959).

Remarks: According to Delcourt and Sprumont (1955, p. 18), the distal rib pattern of *Cicatricosisporites hallei* consists of three zones, whereas Norris (1967, p. 93) states that it consists of ribs running in one direction across the distal face. Both of these observations are apparently inaccurate. The re-illustrated holotype of *C. hallei* (see Delcourt, Dettmann and Hughes, 1963, pl. 43, fig. 6) displays a distal rib pattern consisting of two distinct sets of ribs. The ribs of each set are parallel to one another and oblique to the ribs of the other set. The line where the two sets of ribs meet is clearly demarcated (Fig. 7 J). Both the sets of ribs are oblique to the sides of the spore. The proximal ribs in each interradial region are oblique to the side and one laesura and parallel to the other laesura (Fig. 7 P). The sculpture is canaliculate with flat-topped, sharp-edged, 1.5- to 2.5-micron wide ribs and about 0.8-micron wide canals. The average width of 4 ribs and canals is 11 microns.

C. hallei is distinct from *Cicatricosisporites venustus* Deák, 1963, which has a cicatricose sculpture with narrower ribs (less than 1 micron wide), three sets of distal ribs, and smaller size (25 to 36 microns). *Pelletieria minutaestriata* Bolkhovitina, 1961, differs from *C. hallei* in having a cicatricose sculpture with narrower ribs. *Pelletieria mediostriata* Bolkhovitina, 1961, resembles *C. hallei* in having a similar distal rib pattern (see Bolkhovitina, 1961, pl. 19, fig. 3a) but differs in having wider ribs (3 to 4 microns wide) and a circular to subcircular amb.

The specimens assigned to *Cicatricosisporites mediostriatus* (Bolkhovitina) Pocock, 1964, by Singh (1964, p. 59) and Pocock (1964, p. 157) actually belong to *C. hallei.*

Locality of figured specimens:

Pl. 8, figs. 7-9.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 8, figs. 10, 11.	Sample No. 8-L-6;	Loon River Formation.	Section 8.
Pl. 8, figs. 7-9.	Slide No. 8-L-3(1);	co-ord. 4.9/67.	
Pl. 8, figs. 10, 11.	Slide No. 8-L-6(1);	co-ord. 18.8/63.2.	

52 **Cicatricosisporites hughesi** Dettmann, 1963

Plate 8, figures 12, 13; plate 9, figures 1, 2

See Dettmann (1963, p. 55) for description.

Distribution: Aptian to Danian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); Cenomanian of

Alabama, U.S.A. (Groot, Penny and Groot, 1961); Maestrichtian and Danian of California, U.S.A. (Drugg, 1967); uppermost Wealden of England (Lantz, 1958); Aptian, Albian, and Cenomanian? of southeastern Australia (Dettmann, 1963).

Remarks: This species is characterized by 3 to 5 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 7 A). The sculpture is cicatricose with slightly sinuous ribs. Alternate ribs of the adjacent sides coalesce in the radial regions (Fig. 8 B). The contact areas are smooth.

Cicatricosisporites hughesi differs from *Anemia pseudomacrorhyza* Markova, 1961, which has wider ribs and narrower canals. *Appendicisporites punctatus* Pacltová, 1961, can be distinguished from *C. hughesi* by its wider ribs with punctate sculpture. *Cicatricosisporites pseudotripartitus* (Bolkhovitina) Dettmann, 1963, is distinct from *C. hughesi* in having a canaliculate sculpture.

Specimens assigned to *Appendicisporites tricornitatus* Weyland and Greifeld, 1953, by Lantz (1958, pl. 3, fig. 25) and Groot, Penny and Groot (1961, pl. 24, figs. 6, 7) actually belong to *C. hughesi*. Some specimens assigned to *Anemia caucasica* by Bolkhovitina (1961, pl. 17, figs. 4b-c) are also probably identical with *C. hughesi.*

Locality of figured specimens:

Pl. 8, figs. 12, 13.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 9, fig. 1.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 9, fig. 2.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 8, figs. 12, 13.	Slide No. 8-L-11(1);	co-ord. 19.9/80.5.	
Pl. 9, fig. 1.	Slide No. 8-L-4(3);	co-ord. 3.9/53.9.	
Pl. 9, fig. 2.	Slide No. 8-L-7(3);	co-ord. 21/45.2.	

59 **Cicatricosisporites imbricatus** (Markova) n. comb.

Plate 9, figures 3-5

1961 *Mohria imbricata* Markova, *in* Samoilovitch *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., vol. 177, p. 88, pl. 22, fig. 6.

Description: Trilete; laesurae reaching the equator; commissures raised, bordered by membraneous lips; amb rounded-triangular; one apex more pointed than the other two apices, the pointed apex with a small thickening; distal surface strongly convex; 5 to 7 proximal ribs in each interradial region running parallel to the side and obliquely to the laesurae (Fig. 7 O); about 18 to 20 distal ribs running parallel to two sides and obliquely to the third side of the spore; alternate ribs from

the two sides converging towards the pointed apex and coalescing along a median line perpendicular to the third side (Fig. 7 H); sculpture cicatricose; ribs sinuous, round-topped, bifurcating, 1.5 to 2 microns wide; canals becoming progressively wider from the median line of fusion of the ribs, 1 to 3 microns wide; exine 1.5 microns thick.

Size range: Equatorial diameter (7 specimens) 46 (54.5) 60 microns.

Distribution: Middle Albian to Cenomanian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Cenomanian of western Siberia (Markova *in* Samoilovitch *et al.*, 1961).

Locality of figured specimens:

Pl. 9, figs. 3-5.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 9, figs. 3, 4.	Slide No. 8-L-11(2);	co-ord. 18.8/75.9.	
Pl. 9, fig. 5.	Slide No. 8-L-11(3);	co-ord. 3.9/79.8.	

60 **Cicatricosisporites** sp. cf. **C. imbricatus** (Markova) n. comb.

Plate 9, figure 6

Size range: Equatorial diameter (2 specimens) 70 (71) 72 microns.

Distribution: Middle Albian. Loon River Formation and Harmon Member of the Peace River area.

Remarks: *Cicatricosisporites* sp. cf. *C. imbricatus* differs from *Cicatricosisporites imbricatus* (Markova) n. comb. in possessing fewer (12 to 14) and wider (4 microns) distal ribs, separated by wider (4 microns) canals. This species also is slightly larger than *C. imbricatus.* These two species are identical in all other respects.

Locality of figured specimen:

Pl. 9, fig. 6.	Sample No. 7-H-7;	Harmon Member.	Section 7.
Pl. 9, fig. 6.	Slide No. 7-H-7(2);	co-ord. 4.8/59.5.	

62 **Cicatricosisporites minor** (Bolkhovitina) Pocock, 1964

Plate 9, figures 7, 8

1959 *Mohria minor* Bolkhovitina, Trudy Geol. Inst., Akad. Nauk SSSR, vol. 24, p. 93, pl. 2, fig. 31.

1961 *Pelletieria minor* (Bolkhovitina) Bolkhovitina, Trudy Geol. Inst., Akad. Nauk SSSR, vol. 40, p. 68, pl. 19, fig. 8, pl. 22, figs. 3a-c.

1964 *Cicatricosisporites minor* (Bolkhovitina) Pocock, Grana Palynologica, vol. 5, p. 160, pl. 2, figs. 20-23.

Description: Trilete; laesurae reaching the equator; commissures raised, bordered by 1-micron wide, thickened lips; amb triangular; sides straight to slightly convex; apices sharply rounded; proximal ribs in each interradial region running parallel to one laesura and obliquely to the side and other laesura; distal ribs disposed obliquely to the amb, and running subparallel to each other across the distal face; sculpture cicatricose; ribs 0.8 micron wide, separated by 1.5-micron wide canals; exine 1.5 microns thick.

Size range: Equatorial diameter (3 specimens) 25 (26) 26.5 microns.

Distribution: Middle Albian to Late Cretaceous. Loon River Formation, and lower Shaftesbury Formation of the Peace River area; upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); Upper Cretaceous of Siberia (Bolkhovitina, 1961).

Remarks: *Cicatricosisporites minor* can be distinguished from *Cicatricosisporites venustus* Deák, 1963, by its smaller size and thickened laesurae reaching the equator.

Locality of figured specimen:

Pl. 9, figs. 7, 8.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 9, figs. 7, 8.	Slide No. 8-L-9(1);	co-ord. 12/40.	

57 **Cicatricosisporites mohrioides** Delcourt and Sprumont, 1955

Plate 9, figure 9

1949 *Mohria*–Typus Thiergart (part), Palaeontographica, Band 89, Abt. B, p. 22, pls. 4, 5, figs. 15, 16 only.

1955 *Cicatricosisporites mohrioides* Delcourt and Sprumont, Mém. Soc. Géol. Belgique, n. s., vol. 4, p. 20, pl. 1, fig. 2.

1958 *Cicatricosisporites mohrioides* Delcourt and Sprumont–Lantz (part), Rev. Inst. Franc. Pétrole, vol. 13, p. 923, pl. 2, figs. 21, 22 only.

1960 *Cicatricosisporites goepperti* auct. non Seward–Groot and Penny, Micropaleont., vol. 6, p. 230, pl. 2, figs. 20, 22.

1962 *Cicatricosisporites* cf. *C. mohrioides* Delcourt and Sprumont–Pocock, Palaeontographica, Band 111, Abt. B, p. 40, pl. 3, figs. 42, 43.

1963 *Cicatricosisporites aralica* auct. non Bolkhovitina–Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 47, pl. 7, figs. 4, 5.

1966 *Cicatricosisporites mohrioides* Delcourt and Sprumont–Burger, Leidse Geol. Mededel., Deel 35, p. 243, pl. 8, figs. 2, 3a-b.

See Burger (1966, p. 243) for description.

Distribution: Purbeckian to Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area; Deville and Ellerslie Members of Western Canada (Pocock, 1962); Lower Cretaceous of Maryland, U.S.A. (Groot and Penny, 1960; Brenner, 1963); late Purbeckian of England (Lantz, 1958); "Wealden" of Belgium (Delcourt and Sprumont, 1955) and Germany (Thiergart, 1949); uppermost Jurassic to Valanginian of Holland (Burger, 1966).

Remarks: This species is characterized by 4 to 5 distal ribs in each interradial region, which are subparallel to one another and to their side of the spore in the equatorial region, and form a triangular area centered on the distal pole (Fig. 7 F). The sculpture is canaliculate with slightly sinuous, irregularly branching, often discontinuous ribs of uneven width. The equatorial ribs of adjacent sides do not coalesce in the distal radial regions, but cross over to the proximal surface, where they converge towards the apices and coalesce with the adjacent ribs of their own side (Fig. 8 A). The contact areas are smooth. The average width of 4 ribs and canals is 18 microns.

Cicatricosisporites mohrioides is almost identical with the spores from the sporangia of *Ruffordia goepperti* (Dunker) Seward, 1894, which have been described in detail by Hughes and Moody-Stuart (1966, p. 276). The spores of *Ruffordia goepperti* were originally described from the lower Wealden beds of England by Seward (1913). The writer is in complete agreement with Hughes and Moody-Stuart, who consider the combining of the *in situ* spores of *Ruffordia goepperti* with the dispersed spore species by Groot and Penny (1960, p. 230) and Bolkhovitina (1961, p. 13) to be inadmissible. The synonymizing of *Ruffordia goepperti* with *Cicatricosisporites aralica* (Bolkhovitina) Brenner by Brenner (1963, p. 47) is also untenable.

C. mohrioides differs from *Ruffordia aralica* Bolkhovitina, 1961, which has fewer and more widely spaced ribs. *Cicatricosisporites ludbrooki* Dettmann, 1963, is distinct from *C. mohrioides* in having wider ribs, larger size (56 (73) 96 microns), and sculptured contact areas.

Locality of figured specimen:

Pl. 9, fig. 9.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 9, fig. 9.	Slide No. 4-P-4-Micro. 65;	co-ord. 12/43.8.	

61 **Cicatricosisporites** sp. cf. **C. potomacensis** Brenner, 1963

Plate 9, figures 10, 11

See Brenner (1963, p. 50) for description.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Remarks: The proximal and distal rib patterns of the two specimens of this species recorded from the Harmon Member resemble those of *Cicatricosisporites potomacensis* Brenner, 1963. However, these specimens differ significantly from *C. potomacensis* in having wider and fewer ribs.

The spores assigned here to *Cicatricosisporites* sp. cf. *C. potomacensis* are characterized by about 17 subparallel distal ribs, which start from one apex and are disposed obliquely to the opposite side, with a tendency to converge opposite two radial areas (Fig. 7 I). Each interradial region on the proximal surface has about 10 ribs, which are parallel to the side and oblique to the laesurae. Three of the outer ribs are continuous around the apices, and the remaining ribs terminate at the laesurae (Fig. 7 N). The sculpture is canaliculate, with 2-micron wide ribs separated by 0.5-micron wide canals.

The proximal and distal rib patterns of *C.* sp. cf. *C. potomacensis* broadly resemble those of *Schizaeopsis americana* Berry, 1911, (spores) (see Hughes and Moody-Stuart, 1966, pl. 47, figs. 1, 2). *S. americana* spores differ, however, in possessing more and narrower ribs. *Schizaeopsis amerieana* was originally described from the Patuxent Formation, Virginia, U.S.A. by Berry (1911).

Locality of figured specimen:

Pl. 9, figs. 10, 11.	Sample No. 6-H-5;	Harmon Member.	Section 6.
Pl. 9, figs. 10, 11.	Slide No. 6-H-5(2);	co-ord. 11.2/51.9.	

53 **Cicatricosisporites pseudotripartitus** (Bolkhovitina) Dettmann, 1963

Plate 9, figures 12-15

See Dettmann (1963, p. 54) for synonymy and description.

Distribution: Albian and Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); Albian of southeastern Australia (Dettmann, 1963); Cenomanian of Yakutsk (Bolkhovitina, 1961) and western Siberia, U.S.S.R. (Markova *in* Samoilovitch *et al.*, 1961).

Remarks: This species is characterized by 4 to 5 distal ribs in each interradial region, which are parallel to one another and to their side of the spore in the equatorial region and form a triangular area centered on the distal pole (Fig. 7 B). The sculpture is canaliculate. Alternate ribs of the adjacent sides coalesce in the radial regions. Proximal sculpture consists of 2 to 3 ribs in each interradial region which are parallel to the side.

Cicatricosisporites pseudotripartitus is distinct from *Anemia tripartita* Bolkhovitina, 1961, which has more widely spaced and narrower distal ribs projecting at

the apices. The specimens assigned to *Anemia tripartita* by Markova (*in* Samoilovitch *et al.*, 1961, pl. 17, fig. 4) actually belong to *C. pseudotripartitus. Cicatricosisporites hughesi* Dettmann, 1963, can be easily distinguished from *C. pseudotripartitus* by its cicatricose sculpture.

The Alberta specimens of *C. pseudotripartitus* are on an average larger (31 (45) 54 microns) than the specimens described by Bolkhovitina (1953), which range in diameter from 35 to 42 microns, averaging 38 microns.

Locality of figured specimens:

Pl. 9, figs. 12, 13.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 9, figs. 14, 15.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 9, figs. 12, 13.	Slide No. 8-L-4(3);	co-ord. 16/54.1.	
Pl. 9, figs. 14, 15.	Slide No. 8-L-11(2);	co-ord. 18/77.8.	

55 **Cicatricosisporites spiralis** n. sp.

Plate 10, figures 1-3

Description: Trilete; laesurae reaching or almost reaching the equator; commissures simple slits; amb triangular; sides straight to slightly convex; apices rounded; proximal surface with 4 to 5 ribs in each interradial region; ribs in each interradial region running parallel to the side and obliquely to the laesurae (Fig. 7 O); distal surface with 5 to 7 ribs in each interradial region; ribs running parallel to one another and to their side of the spore in the equatorial region, and forming a triangular area centered on the distal pole; alternate ribs of the adjacent sides coalescing in the radial regions; ribs wide, separated by narrow, noncoalescent, interfingering canals in one radial region; canals in the remaining two radial regions coalescing and producing a spiral rib pattern (Fig. 7 D); sculpture canaliculate; ribs flat topped, 2.5 to 4 microns wide, separated by 0.5- to 1-micron wide canals; exine about 2.5 microns thick.

Size range: Equatorial diameter (2 specimens) 46 (47) 48 microns. Holotype 48 microns.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: *Cicatricosisporites spiralis* n. sp. is distinct from *Cicatricosisporites subrotundus* Brenner, 1963, which possesses wider ribs, different proximal and distal rib patterns, and a subcircular amb.

The specific name is derived from *"spiralis"* (spiral) and refers to the spiral pattern of the distal ribs.

Type locality:

Holotype: Pl. 10, figs. 1, 2. Sample No. 8-L-11; Loon River Formation. Section 8.
Paratype: Pl. 10, fig. 3. Sample No. 8-L-12; Loon River Formation. Section 8.
Holotype: Pl. 10, figs. 1, 2. Slide No. 8-L-11(2); co-ord. 13.1/41.1.
Paratype: Pl. 10, fig. 3. Slide No. 8-L-12(1); co-ord. 13/37.1.

54 **Cicatricosisporites subrotundus** Brenner, 1963

Plate 10, figures 4, 5

See Brenner (1963, p. 51) for description.

Distribution: Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; upper Grand Rapids Formation, and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); late Albian of northern Wyoming, U.S.A. (Davis, 1963); Albian of Maryland, U.S.A. (Brenner, 1963); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species is characterized by 5 to 6, extremely wide, distal ribs in each interradial region, which are parallel to one another and to their side of the spore, and form a triangular area centered on the distal pole (Fig. 7 C). The symmetry of the distal sculpture, however, varies widely so that often the triangular area is closer to one side and the ribs are oblique to the amb. The sculpture is canaliculate with 5- to 6-micron wide ribs and about 1-micron wide, noncoalescent, interfingering canals. The alternate ribs of adjacent sides normally coalesce in the radial regions (see Brenner, 1963, plate 10, fig. 1b), but this arrangement is also subject to wide variation. The proximal sculpture consists of 3 to 5 ribs in each interradial region, which are parallel to one laesura and oblique to the side and other laesura (Fig. 7 P).

The Alberta specimens of *Cicatricosisporites subrotundus* are on an average larger (41 (54) 64 microns) than the specimens described by Brenner (1963), which range in diameter from 37 to 55 microns, averaging 46 microns. The ribs on Brenner's specimens are from 6 to 8 microns wide.

Cicatricosisporites subrotundus differs from *Cicatricosisporites pseudotripartitus* (Bolkhovitina) Dettmann, 1963, and *Anemia exilioides* (Maljavkina) Bolkhovitina, 1953, which have narrower ribs, and a more triangular amb. *Cicatricosisporites brevilaesuratus* Couper, 1958, can be easily distinguished from *C. subrotundus* by its larger size (70 (90) 120 microns) and short indistinct laesurae. The specimens assigned to *Cicatricosisporites* sp. cf. *C. brevilaesuratus* by Davis (1963, pl. 3, fig. 14) which have a maximum diameter of only 53.3 microns, are identical with *C. subrotundus.*

Locality of figured specimen:

Pl. 10, figs. 4, 5.	Sample No. 8-L-5;	Loon River Formation.	Section 8.
Pl. 10, figs. 4, 5.	Slide No. 8-L-5(1);	co-ord. 4.4/45.	

65 **Cicatricosisporites venustus** Deák, 1963

Plate 10, figures 6-10

See Deák (1963a, p. 252) for description.

Distribution: Barremian to Cenomanian-Turonian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); late Aptian of Hungary (Deák, 1963a); Cenomanian-Turonian of northern Spain (van Amerom, 1965).

Remarks: This species is characterized by three sets of distal ribs. The ribs of each set are parallel to one another and oblique to the ribs of the other two sets. The distal ribs coalesce to form a V-shaped pattern near the apices (Fig. 7 L). The sculpture is cicatricose with sharp-crested, less than 1-micron wide ribs which are oblique to the amb. The ribs bifurcate after reaching the distal surface from the proximal surface. Proximal ribs in each interradial region are parallel to one laesura and oblique to the side and the other laesura (Fig. 7 P). The laesurae are bordered by a 4-micron wide smooth area.

Cicatricosisporites venustus is distinct from *Cicatricosisporites hallei* Delcourt and Sprumont, 1955, which has a canaliculate sculpture, two sets of distal ribs, and is larger. *Pelletieria minutaestriata* Bolkhovitina, 1961, resembles *C. venustus* in having a cicatricose sculpture and very narrow ribs, but differs in having longer laesurae which reach the equator. A detailed comparison of the two species is not possible as the proximal and distal rib patterns of *P. minutaestriata* have not been described by Bolkhovitina (1961).

The specimens assigned to *C. hallei* by Brenner (1963, pl. 9, fig. 2) are identical with *C. venustus.* Conspecificity may exist between *C. venustus* and *Cicatricosisporites* sp. A of Davis (1963, pl. 3, figs. 10, 11).

Locality of figured specimens:

Pl. 10, figs. 6, 7.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 10, figs. 8-10.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 10, figs. 6, 7.	Slide No. 8-L-12-Micro. 1;	co-ord. 12.5/46.2.	
Pl. 10, figs. 8-10.	Slide No. 7-C-7(2);	co-ord. 4.4/40.2.	

Genus **Cicatricososporites** Thomson and Pflug, 1953 ex Krutzsch, 1959

1952 *Cicatricoso spor. pseudodorogensis* auct. non Potonié – Pflug, Paläont. Z., vol. 26, p. 136, pl. 7, fig. 1 (holotype designated by Krutzsch, 1959).
1953 *Cicatricososporites pseudodorogensis* auct. non Potonié – Thomson and Pflug, Palaeontographica, Band 94, Abt. B, p. 61, pl. 4, fig. 13.
1959a *Cicatricososporites pseudodorogensis* Thomson and Pflug ex Krutzsch – Krutzsch, Geologie, Jahrg. 8, p. 224 (type species, subsequent designation).
1966 *Cicatricososporites pseudodorogensis* Krutzsch – Potonié, Beih. Geol. Jahrb., Heft 72, p. 100, pl. 9, fig. 104.

See Potonié (1966, p. 100) for generic diagnosis.

Remarks: The genus *Cicatricososporites* consists of monolete spores with cicatricose to canaliculate sculpture.

According to Krutzsch (1959a, p. 222), the type species of the genus *Schizaeoisporites* Potonié, 1951, emend. Krutzsch, 1959, is alete and distinct from the monolete spores of the genus *Cicatricososporites.* The genus *Schizaeoisporites* has been restricted to alete forms only (see Krutzsch, 1959a, p. 226; Potonié, 1966, p. 153).

Potonié (1951) erroneously considered his new genus *Schizaeoisporites* to be monolete and treated *Cicatricososporites* Thomson and Pflug, 1953, as a junior synonym (Potonié, 1956, p. 81; 1960, p. 70). These two genera, as stated above, are actually distinct.

Schizaeoisporites pseudodorogensis Potonié, 1951, is alete and distinct from the monolete spores assigned to this species by Pflug (1952) and Thomson and Pflug (1953). Krutzsch (1959a) treated *Cicatricososporites pseudodorogensis,* which the latter authors had erroneously attributed to Potonié, as a new species, assigned a holotype to it, and designated it as the new type species of the genus *Cicatricososporites.*

Schizaeoisporites eocenicus (Selling) Potonié, 1956, and its junior synonym *Schizaeoisporites pseudodorogensis* Potonié, 1951, are alete and distinct from *Cicatricososporites pseudodorogensis* Krutzsch, 1959, which contains monolete spores.

130 **Cicatricososporites auritus** n. sp.

Plate 10, figures 11-15

Description: Monolete; laesura about 2/3 of total length of spore; commissures slightly raised on a narrow ridge; a rupture perpendicular to the laesura and cutting across the ribs frequently present; amb bean shaped; exine ornamented by 1- to

2-micron wide, usually branching ribs, running parallel to each other and to the laesura; spore body with a 6- to 9-micron long and 8- to 14-micron wide auriculate protrusion at the two longitudinal ends; ribs converging towards and continuing onto the auriculate protrusions to coalesce with one another at a point or along a short thickened ridge; canals about 0.5 micron wide; exine 2.5 microns thick.

Size range: Length (17 specimens)52 (63) 78 microns. Holotype 66 microns.
Breadth (17 specimens) 31 (38) 45 microns. Holotype 35 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Cicatricososporites auritus* n. sp. resembles some of the species assigned to *Welwitschiapites* Bolkhovitina, 1953 ex Potonié, 1958, by Deák (1963b) in having auriculate protrusions at the two longitudinal ends of the body. However, *C. auritus* n. sp. is distinct from *Welwitschiapites* in being monolete, and the protrusions at the two ends are probably due to the detachment of the inner supporting layer of endexine from the ektexine. No mention has been made concerning the presence of a laesura in the species of *Welwitschiapites* described by Deák (1963b).

Bolkhovitina (1961, p. 26) has invalidated the genus *Welwitschiapites* by transferring its type species *Welwitschiapites magniolobatus* to the genus *Schizaea* Smith, 1798. Most of the species originally considered to have gnetalean affinity by Bolkhovitina (1953) have proven to be schizaeaceous fern spores, and the same may be true for the species assigned to *Welwitschiapites* by Deák (1963b).

Schizaeoisporites sp. B, described by Baltes (1965, p. 8, pl. 1, fig. 28), is similar to *C. auritus* n. sp. in having protrusions at the two longitudinal ends of the body. However, Baltes did not observe a laesura on any of the specimens examined by him. *Appendicisporites* - type, illustrated by Baltes (1967a, pl. 1, fig. 3), appears to be identical with *C. auritus* n. sp.

The monolete spores, erroneously assigned by Pocock (1962, p. 41), Singh (1964, p. 62), and Norris (1967, p. 100) to *Schizaeoisporites eocenicus* (Selling) Potonié, 1956, which contains only alete forms, are probably identical with *C. auritus* n. sp.

C. auritus n. sp. can be distinguished from *Cicatricososporites pseudodorogensis* Krutzsch, 1959, by its more elongate body, ribs which converge and fuse on the auriculate protrusions at the two longitudinal ends of the spore body, and smaller size.

Cicatricososporites phaseolus (Delcourt and Sprumont) Krutzsch, 1959, is distinct from *C. auritus* n. sp. in lacking the auriculate protrusions. The ribs of *C. phaseolus* differ from those of *C. auritus* n. sp. in running obliquely to the laesura forming a "criss-cross" pattern, and in being continuous with the ribs on the opposite surface.

The specific name is derived from *"auritus"* (having ears) and refers to the auriculate protrusions at the two longitudinal ends of the body.

Type locality:

Holotype: Pl. 10, fig. 11.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Paratype: Pl. 10, fig. 12.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Paratype: Pl. 10, fig. 13.	Sample No. 7-H-1(A);	Harmon Member.	Section 7.
Paratype: Pl. 10, figs. 14, 15.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Holotype: Pl. 10, fig. 11.	Slide No. 7-C-8(2);	co-ord. 5.2/47.8.	
Paratype: Pl. 10, fig. 12.	Slide No. 7-C-7(1);	co-ord. 4/70.	
Paratype: Pl. 10, fig. 13.	Slide No. 7-H-1(A) (2);	co-ord. 5/51.	
Paratype: Pl. 10, figs. 14, 15.	Slide No. 8-L-12(2);	co-ord. 18.7/35.2.	

129 **Cicatricososporites phaseolus** (Delcourt and Sprumont) Krutzsch, 1959

Plate 10, figure 16

1955 *Schizaeoisporites phaseolus* Delcourt and Sprumont, Mem. Soc. Géol. Belgique, n.s., vol. 4, p. 46, fig. 13.

1959a *Cicatricososporites phaseolus* (Delcourt and Sprumont) Krutzsch, Geologie, Jahrg. 8, p. 223.

See Singh (1964, p. 63) for description.

Distribution: Early Cretaceous and Cenomanian. Loon River Formation of the Peace River area; Mannville Group of central Alberta (Singh, 1964); McMurray Formation of Western Canada (Pocock, 1962); upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Cenomanian of Oklahoma, U.S.A.(Hedlund, 1966); "Wealden" of Belgium (Delcourt and Sprumont, 1955).

Remarks: This species is characterized by its surface ornamentation consisting of about 2-micron wide parallel ridges, running obliquely to the laesura forming a "criss-cross" pattern.

As the genus *Schizaeoisporites* Potonié, 1951, includes only alete forms, the monolete specimens erroneously assigned to *Schizaeoisporites phaseolus* by Delcourt and Sprumont (1955) and subsequent authors (Pocock, 1962, p. 41,

1964, p. 154; Singh, 1964, p. 63; Delcourt, Dettmann and Hughes, 1963, p. 291; Hedlund, 1966, p. 21, etc.) should be transferred to *Cicatricososporites phaseolus* (Delcourt and Sprumont) Krutzsch, 1959.

Locality of figured specimen:

Pl. 10, fig. 16.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 10, fig. 16.	Slide No. 8-L-3(2);	co-ord. 16.6/33.3.	

Genus **Contignisporites** Dettmann, 1963

Type species **Contignisporites glebulentus** Dettmann, 1963

See Dettmann (1963, p. 73) for generic diagnosis.

Remarks: Dettmann (1963) proposed the genus *Contignisporites* to incorporate cingulate trilete spores with a bilaterally symmetrical distal sculpture composed of parallel ribs running across the distal surface, and a radially symmetrical proximal sculpture composed of one tangentially disposed rib in the equatorial region of each contact face. These generic characters distinguish *Contignisporites* from *Cicatricosisporites* Potonié and Gelletich, 1933, and *Appendicisporites* Weyland and Krieger, 1953.

115 **Contignisporites glebulentus** Dettmann, 1963

Plate 11, figures 1-4

1964 *Cicatricosisporites dorsostriatus* auct. non Bolkhovitina – Singh, Res. Coun. Alberta, Bull. 15, p. 57, pl. 6, figs. 2-4.

See Dettmann (1963, p. 74) for description.

Distribution: Aptian and Albian. Loon River Formation, Harmon and Cadotte Members of the Peace River area; Ellerslie Member and Clearwater Formation of central Alberta (Singh, 1964); late Aptian and Albian of southeastern Australia (Dettmann, 1963).

Remarks: This species can be distinguished from *Contignisporites dorsostriatus* (Bolkhovitina) Dettmann, 1963, by its elongate verrucae in the proximal polar interradial regions, wider cingulum, and more numerous and narrower ribs.

The specimens assigned to *Cicatricosisporites dorsostriatus* by Singh (1964) have confluent elongate verrucae with corrugated margin in the proximal polar interradial regions, which were interpreted as representing an inner, second set of ribs. As *C. dorsostriatus* does not possess a proximal polar sculpture, these specimens have been transferred here to *Contignisporites glebulentus* Dettmann, 1963.

Locality of figured specimens:

Pl. 11, figs. 1, 2.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 11, fig. 3.	Sample No. 8-L-1;	Loon River Formation.	Section 8.
Pl. 11, fig. 4.	Sample No. 8-L-8;	Loon River Formation.	Section 8.
Pl. 11, figs. 1, 2.	Slide No. 8-L-12-Micro.32;	co-ord. 12.3/45.8.	
Pl. 11, fig. 3.	Slide No. 8-L-1(1);	co-ord. 21.1/63.8.	
Pl. 11, fig. 4.	Slide No. 8-L-8(2);	co-ord. 14.2/47.5.	

116 **Contignisporites cooksonii** (Balme) Dettmann, 1963

Plate 11, figures 5, 6

See Dettmann (1963, p. 75) for synonymy and description.

Distribution: Callovian to Albian. Loon River Formation, and Harmon Member of the Peace River area; Deville and Ellerslie Members of central Alberta (Singh, 1964); upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); Callovian to Albian of Western Australia and Queensland (Balme, 1957); Berriasian to Aptian of southeastern Australia (Dettmann, 1963); Barremian and Aptian of U.S.S.R. (Bolkhovitina, 1961); Cretaceous of Argentina (Archangelsky and Gamerro, 1966a); Lower Cretaceous of India (Singh and Kumar, 1966).

Remarks: This species is distinct from *Contignisporites fornicatus* Dettmann, 1963, which has hemispherical verrucae in the proximal polar regions, subcircular amb, and wider distal ribs. *Contignisporites cooksonii* can be distinguished from *Contignisporites glebulentus* Dettmann, 1963, which has wider cingulum, larger size, and elongate verrucae in the proximal polar interradial regions. According to Dettmann (1963), *C. cooksonii* is distinct from *Contignisporites mitriforminus* (Korgenevskaja) Dettmann, 1963, which is larger and has proximal polar sculpture. *Contignisporites dorsostriatus* (Bolkhovitina) Dettmann, 1963, differs from *C. cooksonii* in having wider distal ribs (6 to 9 microns).

Locality of figured specimen:

Pl. 11, figs. 5, 6.	Sample No. 7-H-3;	Harmon Member.	Section 7.
Pl. 11, figs. 5, 6.	Slide No. 7-H-3(2);	co-ord. 8.9/49.3.	

117 **Contignisporites multimuratus** Dettmann, 1963

Plate 11, figures 7, 8

See Dettmann (1963, p. 76) for description.

Distribution: Early Cretaceous. Loon River Formation, and Harmon Member of the Peace River area; Valanginian to Aptian of southeastern Australia (Dettmann, 1963).

Remarks: *Contignisporites multimuratus* differs from other species of the genus *Contignisporites* in having a large number (11 to 16) of bifurcating narrow (2 to 3 microns wide) ribs, and a strongly arched distal surface.

Locality of figured specimen:

Pl. 11, figs. 7, 8.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 11, figs. 7, 8.	Slide No. 8-L-9(1);	co-ord. 21.3/52.9.	

Genus **Costatoperforosporites** Deák, 1962

1962 *Costatoperforosporites fistulosus* Deák, Földtani Közlöny (Budapest), vol. 92 p. 230, pl. 27, figs. 1-3 (type species).

Diagnosis: Trilete spores; laesurae reaching or not reaching the equator; amb triangular; apices rounded, sometimes with appendices; proximal and distal surfaces ornamented by ribs; ribs wider than canals (canaliculate) and perforated with small holes; holes up to or slightly more than 1 micron in diameter, equally spaced and arranged in straight or sinuous rows; exine thick.

Remarks: The genus *Costatoperforosporites* is distinct from *Cicatricosisporites* Potonié and Gelletich, 1933, and *Appendicisporites* Weyland and Krieger, 1953, in having an exclusively canaliculate ornamentation with wide ribs, and rows of small perforations on the ribs.

68 **Costatoperforosporites fistulosus** Deák, 1962

Plate 11, figures 9, 10

(Synonymy as for genus)

Description: Trilete; laesurae simple, reaching the equator; amb rounded-triangular; apices broadly rounded, without thickenings; proximal and distal surfaces ornamented by ribs; ribs 4 to 6 microns wide; canals about 0.5 micron in width; a single row of less than 1-micron wide holes, spaced 2 to 3 microns apart, and arranged in a straight or sinuous line present on each rib; proximal surface ornamented by 3 to 4 ribs in each interradial region; ribs running parallel to each other and to their side of the spore; distal surface ornamented by 8 to 10 ribs disposed obliquely to one side of the spore from the opposite apex; exine 2 to 3 microns thick.

Size range: Equatorial diameter (2 specimens) 36 (39.5) 43 microns.

Distribution: Late Aptian and Albian. Cadotte and Paddy Members of the Peace River area; late Aptian of Hungary (Deák, 1962).

Remarks: *Costatoperforosporites fistulosus* Deák, 1962, is distinct from the specimens assigned by Singh (1964, p. 58) to *Cicatricosisporites perforatus* (Baranov, Nemkova and Kondratiev) Singh, 1964, which are larger (48 to 58 microns), have a less rounded amb and possess raised commissures with thickened lips.

Conspecificity may exist between *C. fistulosus* and *C. perforatus*. However, the holotype of *C. perforatus* has not been properly described and illustrated. The specimens subsequently assigned to this species by Bolkhovitina (1961, pl. 14, fig. 8), Markova (*in* Samoilovitch *et al.*, 1961, pl. 22, figs. 3a-b), and Singh (1964, pl. 6, figs. 5-7) probably belong to distinct species. It is obvious that the original specimens assigned to *C. perforatus* by Baranov, Nemkova and Kondratiev (1957) shall have to be described and illustrated in detail in order to circumscribe this species accurately.

The specimens of *C. fistulosus* described by Deák (1962) are larger (45 to 50 microns) than those described in the present study.

Locality of figured specimen:

Pl. 11, figs. 9, 10.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 11, figs. 9, 10.	Slide No. 7-C-6(2);	co-ord. 2.9/61.8.	

67 **Costatoperforosporites foveolatus** Deák, 1962

Plate 11, figures 11-15

1962 *Costatoperforosporites foveolatus* Deák, Földtani Közlöny (Budapest), vol. 92, p. 231, pl. 27, figs. 4-6.

Description: Trilete; laesurae usually gaping, reaching the equator; amb triangular; sides slightly convex; apices rounded to sharply rounded, occasionally slightly thickened at the junction of ribs; proximal and distal surfaces ornamented by ribs; ribs 4 to 6 microns wide; canals about 0.5 micron in width; a single row of 1- to 2-micron wide holes, spaced 2 to 3 microns apart, and arranged in a straight line present on each rib; proximal surface ornamented by 3 to 4 ribs in each interradial region; ribs running parallel to each other and to their side of spore; distal surface ornamented by 3 to 4 ribs in each interradial region running parallel to each other and to their side of spore; alternate ribs of adjacent sides fusing in pairs along the radius and surrounding a 10- to 15-micron wide triangular fused area over the distal pole; exine 2 to 3 microns thick.

Size range: Equatorial diameter (4 specimens) 41 (46) 53 microns.

Distribution: Late Aptian and Albian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; late Aptian of Hungary (Deák, 1962).

Remarks: This species can be distinguished from *Costatoperforosporites fistulosus* Deák, 1962, by its different distal rib pattern, triangular amb, larger holes on the ribs, and occasionally slightly thickened apices. *Costatoperforosporites triangulatus* Deák, 1962, and *Anemia perforata* Markova, 1961, differ from *C. foveolatus* in having distinct appendices at the apices, more numerous and narrower ribs, and in being larger.

The specimens of *C. foveolatus* described by Deák (1962) are smaller (39 to 42 microns) than those described in the present study.

Locality of figured specimens:

Pl. 11, figs. 11-15.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 11, figs. 11, 12.	Slide No. 7-C-2-Micro. 61;	co-ord. 11/44.9.	
Pl. 11, figs. 13-15.	Slide No. 7-C-2(1);	co-ord. 8/75.1.	

Genus **Distaltriangulisporites** n. gen.

1964 *Appendicisporites perplexus* Singh, Res. Coun. Alberta, Bull. 15, p. 55, fig. 7, pl. 5, figs. 6-9.
1964 *Appendicisporites degeneratus* auct. non Thiergart–Pocock, Grana Palynologica, vol. 5, p. 172, pl. 4, figs. 16-18.
1967 *Contignisporites perplexus* (Singh) Norris, Palaeontographica, Band 120, Abt. B, p. 98, pl. 14, figs. 1-4.

Type species **Distaltriangulisporites perplexus** (Singh) n. comb.

Diagnosis: Trilete spores; cingulate; amb triangular; laesurae reaching the inner margin of the cingulum and usually with a thickened margo; proximal surface smooth; distal surface with a radially symmetrical sculpture, and largely occupied by a thickened triangular shield; the shield almost smooth or with an imprecisely defined ribbed, foveolate, foveo-reticulate, verrucate or rugulate sculpture; apices of the distal triangular shield thickened (appendices); apical thickenings not projecting beyond the amb.

Remarks: The most diagnostic features of *Distaltriangulisporites* n. gen. are its sculptured distal triangular shield, cingulum, radially symmetrical distal sculpture and smooth proximal surface.

Distaltriangulisporites n. gen. is distinct from *Polypodiaceoisporites* Potonié, 1956, which lacks the distal triangular shield with thickened apices and incorporates spores with a reticulate sculpture only. *Polypodiaceoisporites* differs also in having a proximal sculpture. *Distaltriangulisporites* n. gen. can be distinguished from *Muricingulisporis* Krutzsch, 1959, which has proximal muri and lacks the distal triangular shield. *Contignisporites* Dettmann, 1963, differs from *Distaltriangulisporites* n. gen. in having a bilaterally symmetrical distal sculpture. *Distaltriangulisporites* n. gen. is readily distinguishable from *Appendicisporites* Weyland and Krieger, 1953, and *Corrugatisporites* Thomson and Pflug, 1953 ex Weyland and Greifeld, 1953, which are acingulate and lack the distal triangular shield. *Corrugatisporites* differs also in possessing distal tuberculate ridges running parallel to the amb.

110 **Distaltriangulisporites perplexus** (Singh) n. comb.

Plate 12, figures 1-6

(Synonymy as for genus)

See Singh (1964, p. 55) for description.

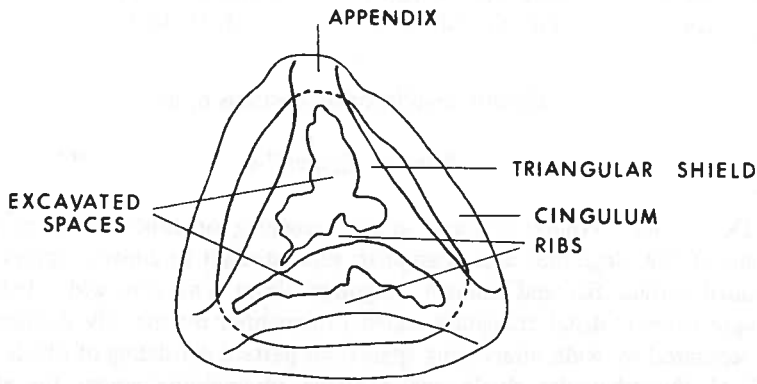

FIGURE 11. Distaltriangulisporites perplexus *(Singh) n. comb. Distal view.*

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Clearwater and Grand Rapids Formations (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964).

Remarks: The morphology of this species has been discussed in detail by Singh (1964, p. 55). The structure referred to as the equatorial girdle by Singh (*op. cit.*) is now interpreted as a cingulum. The species has been transferred here from

Appendicisporites to *Distaltriangulisporites* n. gen. because the former incorporates acingulate spores only. The transfer of this species by Norris (1967, p. 98) to *Contignisporites* Dettmann, 1963, which contains spores with a bilaterally symmetrical distal sculpture only, is untenable.

The distinction between *Distaltriangulisporites perplexus* (Singh) n. comb. and *Appendicisporites degeneratus* Thiergart, 1953, has been given in detail by Singh (1964, p. 56). *D. perplexus* can be readily distinguished from *A. degeneratus,* which lacks the cingulum and the distal triangular shield, and is considerably larger (80 microns). The specimens assigned to *A. degeneratus* by Pocock (1964, pl. 4, figs. 16-18) are identical with *D. perplexus. Appendicisporites ingens* Weyland and Krieger, 1953, resembles *D. perplexus* in possessing a wide cingulum, but a detailed comparison of the two species is not possible, as the distal sculpture of *A. ingens* has not been described or clearly illustrated.

Locality of figured specimens:

Pl. 12, figs. 1, 2.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 12, figs. 3, 4.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 12, figs. 5, 6.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 12, figs. 1, 2.	Slide No. 8-L-3(3);	co-ord. 4.8/63.	
Pl. 12, figs. 3, 4.	Slide No. 8-L-12(2);	co-ord. 21.7/46.1.	
Pl. 12, figs. 5, 6.	Slide No. 7-C-6(1);	co-ord. 19/51.2.	

111 **Distaltriangulisporites costatus** n. sp.

Plate 12, figures 7-9

Description: Trilete; laesurae simple, reaching or almost reaching the inner margin of the cingulum; amb triangular; sides straight to convex; apices rounded; proximal surface flat and smooth; cingulum about 4 microns wide; distal surface strongly convex; distal triangular shield ornamented by sparsely distributed ribs; ribs separated by wide intervening spaces; rib pattern consisting of ribs forming the sides of the triangular shield and a single rib running across the shield and bifurcating before joining the opposite side; ribs flat topped, straight, and about 4 microns wide; apices of the triangular shield very slightly thickened; exine about 3.5 microns thick.

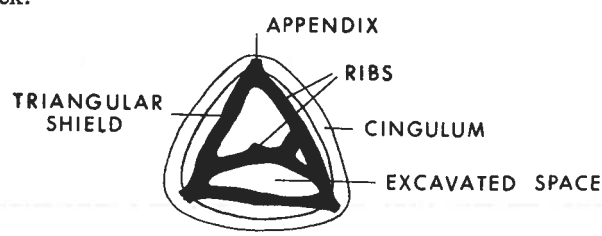

FIGURE 12. Distaltriangulisporites costatus *n. sp. Distal view.*

Size range: Equatorial diameter (5 specimens) 31 (37) 42 microns. Holotype 42 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: This species differs from *Distaltriangulisporites perplexus* (Singh) n. comb. in having a regular, distinct distal rib pattern, strongly convex distal surface, thick exine, and in lacking a margo. *Distaltriangulisporites costatus* n. sp. resembles the spores misidentified as *Appendicisporites degeneratus* Thiergart, 1953, by Pocock (1962, pl. 1, fig.21), but differs in having a smaller size and lacking the margo and proximal polar bosses.

The specific name is derived from "*costatus*" (ribbed) and refers to the distal rib pattern.

Type locality:

Holotype: Pl. 12, figs. 7, 8. Sample No. 8-L-2; Loon River Formation. Section 8.
Paratype: Pl. 12, fig. 9. Sample No. 8-L-2; Loon River Formation. Section 8.
Holotype: Pl. 12, figs. 7, 8. Slide No. 8-L-2(1); co-ord. 0.8/54.
Paratype: Pl. 12, fig. 9. Slide No. 8-L-2(3); co-ord. 14.9/44.

112 **Distaltriangulisporites irregularis** n. sp.

Plate 12, figures 10-13

Description: Trilete; laesurae simple slits, reaching the inner margin of the cingulum; commissures bordered by a 5-micron wide, thickened margo; margo narrowing towards the extremity of the laesurae; amb triangular; sides convex; apices rounded; proximal surface smooth; cingulum about 4 microns wide, usually with an undulate margin; distal surface ornamented by a thickened triangular shield with an undulate margin; the shield sculptured in a very irregular and variable manner; sculpture consisting of irregularly formed wavy ribs and wide intervening spaces; ribs occasionally joining to form an imperfect reticulate pattern; apices of the triangular shield very slightly thickened, occasionally with two small, rounded thickenings; exine about 2.5 microns thick.

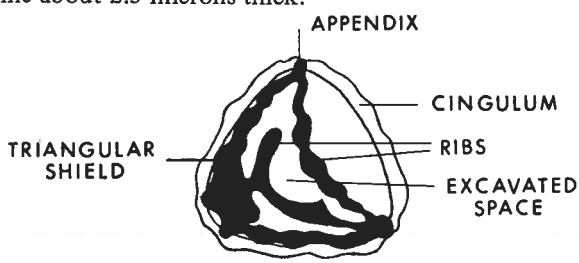

FIGURE 13. Distaltriangulisporites irregularis *n. sp. Distal view.*

Size range: Equatorial diameter (9 specimens) 36 (41) 48 microns. Holotype 45 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: This species differs from *Distaltriangulisporites perplexus* (Singh) n. comb. in having an undulate outline, and an extremely variable and irregular distal sculpture with wavy ribs. *Distaltriangulisporites irregularis* n. sp. is distinct from *Cingulatisporites problematicus* Couper, 1958, which has regularly arranged, wide, distal ridges, and lacks the distal triangular shield and margo.

The specific name is derived from *"irregularis"* (irregular) and refers to the irregular distal sculpture.

Type locality:

Holotype: Pl. 12, figs. 10, 11. Sample No. 8-L-10; Loon River Formation. Section 8.
Paratypes: Pl. 12, figs. 12, 13. Sample No. 8-L-12; Loon River Formation. Section 8.
Holotype: Pl. 12, figs. 10, 11. Slide No. 8-L-10(3); co-ord. 17.5/60.2.
Paratype: Pl. 12, fig. 12. Slide No. 8-L-12(3); co-ord. 13/72.3.
Paratype: Pl. 12, fig. 13. Slide No. 8-L-12(2); co-ord. 16/46.8.

114 **Distaltriangulisporites maximus** n. sp.

Plate 12, figures 14-16

Description: Trilete; laesurae simple slits, occasionally gaping; commissures reaching the inner margin of the cingulum and bordered by a thickened margo; margo 6 to 10 microns wide, with a wavy outer margin, and narrowing towards the extremity of the laesurae; amb triangular; sides straight; apices rounded; proximal surface smooth; cingulum 8 microns wide; width of cingulum uniform; distal surface with a thickened triangular shield; sides of the shield almost straight and usually overlapping the inner part of the cingulum; the shield ornamented by closely spaced, anastomosing, elongate verrucae and coarse rugulae; corroded specimens occasionally simulating a foveo-reticulate sculpture; apices of the distal triangular shield strongly thickened at the points of contact with the cingulum; thickenings (appendices) 6 to 8 microns long, 6 to 12 microns wide, and not projecting beyond the amb; exine about 4 microns thick.

Size range: Equatorial diameter (3 specimens) 57 (58) 60 microns. Holotype 58 microns.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: This species differs from *Distaltriangulisporites mutabilis* n. sp. which is smaller and has a sculpture consisting of coalescent foveolae.

The specific name is derived from *"maximus"* (greatest, largest) and refers to the large size of this species.

Type locality:

Holotype: Pl. 12, figs. 14, 15. Sample No. 8-L-9; Loon River Formation. Section 8.
Paratype: Pl. 12, fig. 16. Sample No. 8-L-8; Loon River Formation. Section 8.
Holotype: Pl. 12, figs. 14, 15. Slide No. 8-L-9(3); co-ord. 9.8/35.1.
Paratype: Pl. 12, fig. 16. Slide No. 8-L-8(2); co-ord. 2/34.

113 **Distaltriangulisporites mutabilis** n. sp.

Plate 13, figures 1-3

Description: Trilete; laesurae simple slits, reaching the inner margin of the cingulum; commissures bordered by a 3- to 6-micron wide, thickened margo; margo narrowing towards the extremity of the laesurae; amb triangular; sides straight to convex; apices broadly rounded; proximal surface smooth; cingulum about 4 microns wide; distal surface with a thickened triangular shield; sides of the shield almost straight and usually overlapping the inner part of the cingulum; the shield ornamented by closely spaced coalescent foveolae, forming short channels and irregular-shaped lumina; corroded specimens with badly dissected shields usually simulating a verrucate to rugulate sculpture; some specimens with an almost smooth distal shield, ornamented by a few sparsely distributed foveolae; apices of the triangular shield slightly thickened; exine about 2.5 microns thick.

Size range: Equatorial diameter (6 specimens) 31 (40) 48 microns. Holotype 46 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: This species resembles *Cingulatisporites foveolatus* Couper, 1958, which differs from it, however, in having noncoalescent foveolae, a wider cingulum narrowing toward the apices, a sculptured proximal surface, and in being larger (45 (53) 60 microns). *Distaltriangulisporites mutabilis* n. sp. can be distinguished from *Foveosporites labiosus* n. sp. which possesses a distal as well as a proximal sculpture and a narrower equatorial rim, and lacks the distal triangular shield.

The specific name is derived from *"mutabilis"* (inconstant, variable) and refers to the variable distal sculpture.

Type locality:

Holotype: Pl. 13, fig. 1. Sample No. 8-L-3; Loon River Formation. Section 8.
Paratype: Pl. 13, figs. 2, 3. Sample No. 8-L-3; Loon River Formation. Section 8.
Holotype: Pl. 13, fig. 1. Slide No. 8-L-3(1); co-ord. 16.2/56.9.
Paratype: Pl. 13, figs. 2, 3. Slide No. 8-L-3(1); co-ord. 10.8/59.9.

Genus **Klukisporites** Couper, 1958

Type species **Klukisporites variegatus** Couper, 1958

See Singh (1964, p. 64) for synonymy and generic diagnosis.

Remarks: The genus *Klukisporites* was proposed by Couper (1958) to incorporate trilete, foveolate to foveo-reticulate spores, which are morphologically similar to the spores of Jurassic schizaeaceous ferns *Klukia exilis* (Phillips) Raciborski and *Stachypteris hallei* Thomas.

There is some overlap between the generic circumscriptions of *Klukisporites* Couper, 1958, *Dictyotriletes* Naumova, 1937 ex Potonié and Kremp, 1955, and *Lycopodiumsporites* Thiergart, 1938 ex Delcourt and Sprumont, 1955, and a detailed revision of these and other morphologically related genera seems to be necessary. The type species *Klukisporites variegatus* Couper, 1958, is, however, morphologically distinct from all these genera in having a coarse foveolate to foveo-reticulate distal sculpture, irregular-shaped lumina, and a granulate to verrucate proximal sculpture.

Ischyosporites Balme, 1957, differs from *Klukisporites* in having exinal thickenings at the apices (valvae).

46 **Klukisporites areolatus** n. sp.

Plate 13, figures 4-7

Description: Trilete; laesurae reaching the equator; commissures raised; amb rounded-triangular; proximal surface smooth with slight encroachment by the distal sculpture near the apices; distal surface with foveo-reticulate sculpture; muri 2 microns wide, increasing to 5 microns at the junctions, and gradually sloping into and merging with the lumina; lumina pentagonal or hexagonal in outline, 6 to 12 microns in diameter, and usually larger at the distal pole; exine about 2.5 microns thick.

Size range: Equatorial diameter (10 specimens) 41 (50) 55 microns. Holotype 55 microns.

Distribution: Middle Albian. Loon River Formation and Harmon Member of the Peace River area.

Remarks: *Dictyotriletes granulatus* Pocock, 1962, can be distinguished from *Klukisporites areolatus* n. sp. by the granulate sculpture of its proximal surface and muri. *Klukisporites variegatus* Couper, 1958, is distinct in having a granulate to verrucate proximal sculpture and wider spaces between its irregular-shaped lumina.

The specimen illustrated as *Klukisporites* sp. 1 from the Arundel Formation of Maryland, U.S.A. by Stover (1964, pl. 1, figs. 18, 19) appears to be identical with *K. areolatus* n. sp.

The specific name is derived from *"areolatus"* (angular spaces) and refers to the angular lumina.

Type locality:

Holotype: Pl. 13, figs. 4, 5. Sample No. 8-L-12; Loon River Formation. Section 8.
Paratype: Pl. 13, figs. 6, 7. Sample No. 8-L-6; Loon River Formation. Section 8.
Holotype: Pl. 13, figs. 4, 5. Slide No. 8-L-12(1); co-ord. 4.3/73.
Paratype: Pl. 13, figs. 6, 7. Slide No. 8-L-6(1); co-ord. 5/33.9.

45 **Klukisporites foveolatus** Pocock, 1964

Plate 13,figures 8-11

1963 *Klukisporites pseudoreticulatus* auct. non Couper — Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 51, pl. 10, fig. 5.

1964 *Klukisporites foveolatus* Pocock, Grana Palynologica, vol. 5, p. 194, pl. 7, figs. 5, 6.

See Pocock (1964, p. 194) for description.

Distribution: Barremian to Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963).

Remarks: *Klukisporites foveolatus* Pocock is characterized by a dense foveo-reticulate distal sculpture, circular lumina of uniform size, convex sides, and raised commissures reaching the equator.

Locality of figured specimens:

Pl. 13, figs. 8-11.	Sample No. 8-L-6;	Loon River Formation.	Section 8.
Pl. 13, figs. 8, 9.	Slide No. 8-L-6(3);	co-ord. 2/70.2.	
Pl. 13, figs. 10, 11.	Slide No. 8-L-6(1);	co-ord. 2.8/75.	

44 **Klukisporites pseudoreticulatus** Couper, 1958

Plate 13, figures 12-15

See Couper (1958, p. 138) for description.

Distribution: Late Jurassic to early Cenomanian. Loon River Formation and Cadotte Member of the Peace River area; Mannville Group (Singh, 1964), Viking Formation, and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; upper part of the Vanguard Formation of Western Canada (Pocock, 1962); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Purbeckian to Barremian of England (Couper, 1958).

Remarks: Couper's (1958, pl. 19, figs. 8-10) specimens of *Klukisporites pseudoreticulatus* have unequal, angular lumina and straight to concave sides. His forms seem to be quite distinct from the ones assigned to *K. pseudoreticulatus* by Brenner (1963, pl. 10, fig. 5), which have circular lumina of uniform size and strongly convex sides. The latter seem to be identical with *Klukisporites foveolatus* Pocock, 1964.

Lycopodiumsporites elongatus Delcourt and Sprumont, 1955, has some resemblance to *K. pseudoreticulatus* but differs in having very wide (14 microns) lumina, and strongly concave sides.

The specimens transferred to *Dictyotriletes pseudoreticulatus* (Couper) Pocock, 1962, by Pocock (1962, p. 41) and Singh (1964, p. 64) have been restored here to *K. pseudoreticulatus* Couper, 1958.

Locality of figured specimens:

Pl. 13, figs. 12-15.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 13, figs. 12, 13.	Slide No. 8-L-9(3);	co-ord. 12.4/51.8.	
Pl. 13, figs. 14, 15.	Slide No. 8-L-9(3);	co-ord. 19/67.1.	

Family **Gleicheniaceae**

Genus **Gleicheniidites** Ross, 1949 ex Delcourt and Sprumont, 1955, emend. Dettmann, 1963

Type species **Gleicheniidites senonicus** Ross, 1949

See Dettmann (1963, p. 64) for synonymy and emended generic diagnosis.

Remarks: The genus *Gleicheniidites* as emended by Dettmann (1963), consists of only smooth trilete spores with exinal thickening (crassitudes) in each equatorial interradial region. Bolkhovitina (1966) has excluded morphologically similar spores with punctate, granulate, verrucate, tuberculate, baculate or spinose sculpture, belonging to the genus *Ornamentifera* Bolkhovitina, 1966, from the genus *Gleicheniidites.*

Triremisporites Delcourt and Sprumont, 1957, is a junior synonym of *Gleicheniidites.*

91 **Gleicheniidites senonicus** Ross, 1949

Plate 14, figure 1

See Singh (1964, p. 69) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Locality of figured specimen:

Pl. 14, fig. 1.	Sample No. 8-L-6;	Loon River Formation.	Section 8.
Pl. 14, fig. 1.	Slide No. 8-L-6(3);	co-ord. 3/56.2.	

92 **Gleicheniidites** sp. cf. **G. circinidites** (Cookson) Dettmann, 1963

Plate 14, figures 2, 3

See Dettmann (1963, p. 65) for synonymy and description.

Distribution: Late Jurassic and Early Cretaceous. Loon River Formation, Harmon, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964); Upper Jurassic to Valanginian of Holland (Burger, 1966); Upper Jurassic and Lower Cretaceous of Western Australia (Balme, 1957); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: *Gleicheniidites* sp. cf. *G. circinidites* (Cookson) Dettmann, 1963, can be distinguished from *Gleicheniidites senonicus* Ross, 1949, by its more pointed apices and thicker interradial crassitudes, and from *G. circinidites* (Cookson) Dettmann, 1963, by its smaller size.

This species resembles the spores of the recent species *Gleichenia circinata.*

Locality of figured specimens:

Pl. 14, fig. 2.	Sample No. 8-L-13;	Loon River Formation.	Section 8.
Pl. 14, fig. 3.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 14, fig. 2.	Slide No. 8-L-13(2);	co-ord. 8/56.5.	
Pl. 14, fig. 3.	Slide No. 8-L-4(3);	co-ord. 5.1/33.	

Genus **Ornamentifera** Bolkhovitina, 1966

Type species **Ornamentifera echinata** (Bolkhovitina) Bolkhovitina, 1966

See Dettmann and Playford (1968, p. 77) for synonymy and discussion.

Remarks: The genus *Ornamentifera* was proposed by Bolkhovitina (1966) to accommodate trilete spores of presumed gleicheniaceous affinity having interradial thickenings (crassitudes) at the equator and a punctate, granulate, verrucate, tuberculate, baculate or echinate sculpture.

The previous taxa proposed to accommodate morphologically similar spores include *Peregrinisporis* Krutzsch, 1959, which has subgeneric status, and *Gleicheniidites* Grigorjeva, 1961, which is a later homonym of *Gleicheniidites* Ross, 1949 ex Delcourt and Sprumont, 1955.

The genus *Ornamentifera* can be easily distinguished from *Anemiidites* Ross, 1949, *Pilosisporites* Delcourt and Sprumont, 1955, and *Neoraistrickia* Potonié, 1956, which lack the interradial crassitudes.

93 **Ornamentifera echinata** (Bolkhovitina) Bolkhovitina, 1966

Plate 14, figures 6, 7

1953 *Gleichenia echinata* Bolkhovitina, Trudy Inst. Geol. Nauk, Akad. Nauk SSSR, vol. 145, p. 55, pl. 8, fig. 17.

1959a *Gleicheniidites (Peregrinisporis) echinatus* (Bolkhovitina) Krutzsch, Geologie, Jahrg. 8, p. 114.

1961 *Gleicheniidites echinatus* (Bolkhovitina) Grigorjeva, *in* Samoilovitch *et al.*, Trudy Vses. Neft. Nauch.-Issled. Geol.-Razv. Inst., vol. 177, p. 61, pl. 16, figs. 1 a-b, 2 a-c, 3.

1963 *Pilosisporites brevipapillosus* auct. non Couper–Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 67, pl. 20, fig. 2.

1966 *Ornamentifera echinata* (Bolkhovitina) Bolkhovitina, *in* Nejshtadt (Ed.), The importance of palynological analysis for stratigraphic and palaeofloristic investigations, Nauka (Moscow), p. 69.

1967 *Pilosisporites* sp. Norris, Palaeontographica, Band 120, Abt. B, p. 89, pl. 10, fig. 23.

Description: Trilete; laesurae reaching the equator; commissures raised; amb triangular; sides slightly concave; interradial crassitudes 3 to 4 microns wide, dark and flat, present on most specimens; proximal and distal surfaces echinate; spines more sparse on the proximal surface; area close to the laesurae smooth; spines 0.5 to 2.5 microns long, up to 1 micron in basal diameter, and spaced 2 to 3 microns apart; exine 1 micron thick, increasing to 2 microns in thickness in the interradial regions.

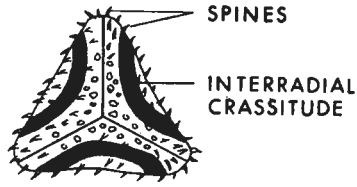

FIGURE 14. Ornamentifera echinata *(Bolkhovitina) Bolkhovitina. Proximal view.*

Size range: Equatorial diameter including spines (13 specimens) 27 (36) 40 microns.

Distribution: Hauterivian to Senonian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Viking Formation and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); late Albian of Maryland, U.S.A. (Brenner, 1963), western Kazakhstan, and southern Urals, U.S.S.R. (Bolkhovitina, 1953); Hauterivian to Barremian of northern Urals; Aptian to Senonian of western Siberia; Upper Cretaceous of Kazakhstan, U.S.S.R. (Grigorjeva *in* Samoilovitch *et al.*, 1961).

Remarks: The specimens described by Brenner (1963) as *Pilosisporites brevipapillosus* Couper, 1958, have an echinate sculpture and distinct interradial crassitudes, which are characteristic of *Ornamentifera echinata* (Bolkhovitina) Bolkhovitina, 1966. *P. brevipapillosus* is characterized by entirely papillate ornament, and lacks the interradial crassitudes.

As noted by Norris (1967), the interradial crassitudes are not present in all the specimens. However, this is almost certainly due to the poor preservation or overmaceration of the specimens.

The specimens assigned here to *Ornamentifera echinata* (Bolkhovitina) Bolkhovitina, 1966, have exclusively echinate sculpture.

O. echinata has so far not been reported from strata older than late Albian from North America.

Locality of figured specimens:

Pl. 14, figs. 6, 7.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 14, fig. 6.	Slide No. 7-C-8(1);	co-ord. 18.2/75.	
Pl. 14, fig. 7.	Slide No. 7-C-8(1);	co-ord. 10.4/34.7.	

94 **Ornamentifera baculata** n. sp.

Plate 14, figures 4, 5

Description: Trilete; laesurae reaching the equator; commissures raised; amb triangular; sides straight to slightly concave; interradial crassitudes 3 to 4 microns wide, dark and flat, present on most specimens; proximal and distal surfaces baculate; bacula more sparse on the proximal surface; area close to the laesurae smooth; bacula 2 to 4 microns long, up to 2 microns in width and slightly expanded at the tips; bacula spaced 2 to 3 microns apart; exine 1.5 microns thick, increasing to 3 microns in thickness in the interradial regions.

Size range: Equatorial diameter including bacula (15 specimens) 33 (42) 52 microns. Holotype 45 microns.

Distribution: Middle and late Albian. Loon River Formation, and Harmon, Cadotte, and Paddy Members of the Peace River area.

Remarks: *Ornamentifera baculata* n. sp. is characterized by a baculate sculpture. *Ornamentifera peregrina* (Bolkhovitina) Bolkhovitina, 1966, and *Ornamentifera tuberculata* (Grigorjeva) Bolkhovitina, 1966, can be distinguished from *O. baculata* n. sp. by their short tuberculate sculpture. *Ornamentifera sentosa* Dettmann and Playford, 1968, is distinct in having coalescent sculptural elements which occur in the proximal contact area and are confined to a triangular area on the distal surface of the body.

The specific name is derived from *"baculum"* (stick-like) and refers to the baculate sculpture.

Type locality:

Holotype: Pl. 14, fig. 4.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Paratype: Pl. 14, fig. 5.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Holotype: Pl. 14, fig. 4.	Slide No. 8-L-12-Micro. 40;	co-ord. 12.1/44.	
Paratype: Pl. 14, fig. 5.	Slide No. 8-L-7(2);	co-ord. 14/63.1.	

Family **Cyatheaceae** or **Dicksoniaceae**

Genus **Cyathidites** Couper, 1953

Type species **Cyathidites australis** Couper, 1953

See Singh (1964, p. 70) for synonymy and generic diagnosis.

1 **Cyathidites australis** Couper, 1953

Plate 14, figure 8

See Singh (1964, p. 70) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Locality of figured specimen:

Pl. 14, fig. 8.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 14, fig. 8.	Slide No. 8-L-11(1);	co-ord. 0.9/40.2.	

2 **Cyathidites minor** Couper, 1953

Plate 14, figure 9

See Singh (1964, p. 71) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Locality of figured specimen:

Pl. 14, fig. 9.	Sample No. 8-L-1;	Loon River Formation.	Section 8.
Pl. 14, fig. 9.	Slide No. 8-L-1(1);	co-ord. 20.8/60.9.	

Genus **Kuylisporites** Potonié, 1956

Type species **Kuylisporites waterbolki** Potonié, 1956

See Potonié (1956, p. 38) for generic diagnosis.

Remarks: Potonié (1956) proposed the genus *Kuylisporites* to accommodate trilete spores with three large lenticular elevations (scutula) partially enclosing circular to elliptical lumina in the interradial equatorial regions. This genus differs from *Dulhuntyispora* Potonié, 1956, in the form of its lumina, and the lenticular shape of its scutula. *Camursporis* Chlonova, 1961, has been treated as a junior synonym of *Kuylisporites* by Potonié (1966, p. 43).

The modern genus *Hemitelia,* belonging to the family Cyatheaceae, produces spores which are comparable to those assigned to *Kuylisporites* Potonié, 1956.

27 **Kuylisporites lunaris** Cookson and Dettmann, 1958

Plate 14, figures 10, 11

See Dettmann (1963, p. 39) for description.

Distribution: Early Cretaceous. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Aptian of Maryland, U.S.A. (Brenner, 1963); Lower Cretaceous of southeastern Australia (Cookson and Dettmann, 1958a; Dettmann, 1963).

Remarks: *Kuylisporites lunaris* Cookson and Dettmann, 1958, is not strictly conformable with *Kuylisporites* as defined by Potonié (1956). This species is characterized by numerous crescent-shaped scutula which are confined to the distal surface, whereas, according to Potonié (1956), the genus *Kuylisporites* has one large scutulum in each interradial equatorial region. *K. lunaris* is also weakly thickened equatorially. It would be desirable to transfer *K. lunaris* and morphologically similar forms to a new genus when more examples become available.

According to Dettmann (1963), *K. lunaris* slightly resembles the spores of the modern cyatheaceous fern *Alsophila blechnoides.*

Locality of figured specimens:

Pl. 14, fig. 10.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 14, fig. 11.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 14, fig. 10.	Slide No. 7-C-7(1);	co-ord. 17.9/31.5.	
Pl. 14, fig. 11.	Slide No. 8-L-3(3);	co-ord. 19.1/57.1.	

Family **Matoniaceae**

Genus **Matonisporites** Couper, 1958, emend. Dettmann, 1963

Type species **Matonisporites phlebopteroides** Couper, 1958

See Dettmann (1963, p. 58) for synonymy and emended generic diagnosis.

Remarks: Dettmann (1963) restricted the genus *Matonisporites* to include only smooth-walled, trilete spores with membraneous, raised commissures, and exinal thickenings (valvae) in the three radial regions at the equator.

Matonisporites is distinct from *Triquitrites* Wilson and Coe, 1940, which lacks the membraneous, raised commissures, and from *Trilobozonosporites* Pant, 1954 ex Potonié, 1956, which is cingulate.

Boseisporites Dev, 1961, is a junior synonym of *Matonisporites* Couper, 1958, emend. Dettmann, 1963.

69 **Matonisporites crassiangulatus** (Balme) Dettmann, 1963

Plate 14, figure 12

1957 *Cyathidites crassiangulatus* Balme, Australia, C.S.I.R.O., Coal Res. Sect., Ref. T.C. 25, p. 22, pl. 3, figs. 39-41.

1963 *Cyathidites crassiangulatus* Balme–Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 60, pl. 15, fig. 4.

1963 *Matonisporites crassiangulatus* (Balme) Dettmann, Proc. Roy. Soc. Victoria, vol. 77, pt. 1, p. 58.

Description: Trilete; commissures almost reaching the base of the valvae and enclosed within membraneous, raised lips; 4- to 8-micron wide exinal thickening surrounding the laesurae on either side; amb triangular; apices rounded; about 4-micron wide exinal thickenings (valvae) present in the three radial regions at the equator; exine smooth, up to 2 microns thick in the unthickened portions of the spore body.

1. 2.

FIGURE 15. Matonisporites crassiangulatus *(Balme) Dettmann. 1. Proximal view. 2. Vertical section showing the membraneous raised lips.*

Size range: Equatorial diameter (2 specimens) 48 (49.5) 51 microns.

Distribution: Oxfordian to Albian. Cadotte and Paddy Members of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Oxfordian to Aptian of Western Australia (Balme, 1957).

Remarks: This species has distinct exinal thickenings (valvae) at the apices, and therefore, its assignment to the genus *Cyathidites* Couper, 1953, which is composed of nonvalvate spores, by Balme (1957) is not justified.

The Mesozoic fossil genus *Phlebopteris,* belonging to the family Matoniaceae, and many modern dicksoniaceous ferns produce spores which are comparable to those assigned to *Matonisporites crassiangulatus* (Balme) Dettmann, 1963.

Locality of figured specimen:

Pl. 14, fig. 12.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 14, fig. 12.	Slide No. 7-C-6(1);	co-ord. 15/31.9.	

Family **Cheiropleuriaceae**

Genus **Dictyophyllidites** Couper, 1958, emend. Dettmann, 1963

Type species **Dictyophyllidites harrisii** Couper, 1958

See Dettmann (1963, p. 27) for synonymy and emended generic diagnosis.

Remarks: Dettmann (1963) emended the genus *Dictyophyllidites* to include both thin and thick-walled, smooth to faintly patterned trilete spores with membraneous, raised commissures bordered by a thickened margo.

Dictyophyllidites is distinct from *Biretisporites* Delcourt and Sprumont, 1955, which does not have a margo bordering its commissures, and from *Matonisporites* Couper, 1958, emend. Dettmann, 1963, which is valvate.

The Mesozoic fossil genera *Dictyophyllum* and *Phlebopteris,* and some modern matoniaceous ferns produce spores which are similar to those assigned to the genus *Dictyophyllidites.*

8 **Dictyophyllidites** sp.

Plate 14, figure 13

1963 *Dictyophyllidites* sp. Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 55, pl. 12, fig. 4.

See Brenner (1963, p. 55) for description.

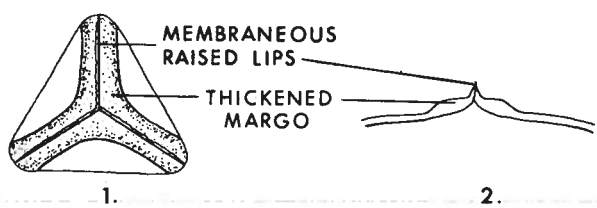

FIGURE 16. Dictyophyllidites *sp. 1. Proximal view. 2. Vertical section showing the thickened margo and membraneous raised lips.*

Distribution: Aptian and Albian. Loon River Formation, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Aptian of Maryland, U.S.A. (Brenner, 1963).

Locality of figured specimen:

Pl. 14, fig. 13.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 14, fig. 13.	Slide No. 8-L-3(2);	co-ord. 20.2/59.9.	

Family **Polypodiaceae** or **Dennstaedtiaceae**

Genus **Laevigatosporites** Ibrahim, 1933, emend. Schopf, Wilson and Bentall, 1944

Type species **Laevigatosporites vulgaris** (Ibrahim) Ibrahim, 1933

See Singh (1964, p. 98) for synonymy and generic diagnosis.

127 **Laevigatosporites ovatus** Wilson and Webster, 1946

Plate 14, figure 14

See Singh (1964, p. 99) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Locality of figured specimen:

Pl. 14, fig. 14.	Sample No. 8-L-2;	Loon River Formation.	Section 8.
Pl. 14, fig. 14.	Slide No. 8-L-2(1);	co-ord. 18/46.2.	

Family **Marattiaceae**

Genus **Punctatosporites** Ibrahim, 1933

Type species **Punctatosporites minutus** Ibrahim, 1933

See Playford and Dettmann (1965, p. 149) for synonymy.

Remarks: Ibrahim (1933) proposed the genus *Punctatosporites* for the reception of granulate-scabrate, monolete spores. As noted by Playford and Dettmann (1965), the genus *Marattisporites* Couper, 1958, is morphologically indistinguishable from *Punctatosporites* and is a junior synonym of this genus. *Extrapunctosporis* Krutzsch, 1959, has been treated as a junior synonym of the genus *Punctatosporites* by Potonié (1966, p. 104).

128 **Punctatosporites scabratus** (Couper) n. comb.

Plate 14, figure 15

1958 *Marattisporites scabratus* Couper, Palaeontographica, Band 103, Abt. B, p. 133, pl. 15, figs. 20-23.

See Couper (1958, p. 133) for description.

Distribution: Late Triassic to Albian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area; Upper Triassic of Arctic Islands, Canada (McGregor, 1965); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Lias to Aptian of England (Couper, 1958); Lias of Sweden (Nilsson, 1958).

Remarks: The granulate-scabrate, monolete spores assigned to *Punctatosporites scabratus* (Couper) n. comb. are comparable to those produced by the fossil and living members of the family Marattiaceae.

Locality of figured specimen:

Pl. 14, fig. 15.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 14, fig. 15.	Slide No. 8-L-4(1);	co-ord. 5.2/63.	

Division **Pteridophyta – Incertae Sedis**

Genus **Annulispora** de Jersey, 1959

Type species **Annulispora folliculosa** (Rogalska) de Jersey, 1959

See de Jersey (1959, p. 358) for synonymy and generic diagnosis.

Remarks: The genus *Annulispora* was proposed by de Jersey (1959) to incorporate circular to subcircular, smooth trilete spores with a single ring-like, circumpolar distal thickening. This ring-like thickening has a sharp inner boundary and a more gradual demarcation from the outer portion of the spore body. According to Playford (1965, p. 187), *Annulispora* is cingulate.

Distalanulisporites Klaus, 1960, differs from *Annulispora* in having longer laesurae with a thickening at their extremities and granulate, scabrate or verrucate sculpture. *Polycingulatisporites* Simoncsics and Kedves, 1961, emend. Playford and Dettmann, 1965, *Staplinisporites* Pocock, 1962, and *Taurocusporites* Stover, 1962, emend. Playford and Dettmann, 1965, are distinct in possessing an essentially trizonate distal ornamentation composed of a polar or subpolar thickening, which is encircled by a circumpolar ridge.

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Annulispora sp.

Plate 14, figures 16-18

Description: Trilete; laesurae simple slits, extending up to 2/3 of the spore radius, and with a weakly thickened margo; amb subcircular; proximal surface smooth; distal circumpolar thickening with an entire inner and a lobate outer margin, surrounded by 25 to 30 radially disposed canals; canals 0.5 micron wide, spaced 3 to 4 microns apart, and reaching the equator; circumpolar ridge about 5 microns wide, surrounding unthickened distal polar area, 14 microns in diameter; cingulum 2 microns wide; exine about 1.5 microns thick.

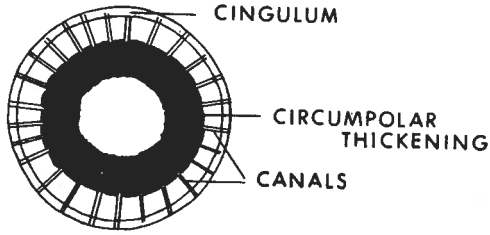


FIGURE 17. Annulispora *sp. Distal view.*

Size range: Equatorial diameter (2 specimens) 32 (34) 36 microns.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: The radially disposed canals surrounding the distal ring-like circumpolar ridge, give *Annulispora* sp. a superficial resemblance to *Rogalskaisporites cicatricosus* (Rogalska) Danzé-Corsin and Laveine, 1963. The latter, however, is distinct in having a disk-like polar thickening. *Annulispora* sp. also closely resembles *Polycingulatisporites radiatus* n. sp., which differs from it in having a distal polar thickening surrounded by the circumpolar ridge.

This species has not been formally named as only two specimens were found.

Locality of figured specimen:

Pl. 14, figs. 16-18.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 14, figs. 16-18.	Slide No. 8-L-7(3);	co-ord. 13.2/63.4.	

Genus **Antulsporites** Archangelsky and Gamerro, 1966

1966a *Heliosporites baculatus* Archangelsky and Gamerro, Ameghiniana, vol. 4, p. 203, pl. 1, figs. 12-15.

1966b *Antulsporites baculatus* (Archangelsky and Gamerro) Archangelsky and Gamerro, Ameghiniana, vol. 4, p. 369 (type species).

Diagnosis: Trilete spores; cingulate; amb subtriangular; sides convex; laesurae reaching the cingulum or extending onto it; cingulum radially striped, striated or segmented; proximal surface smooth or finely sculptured; distal surface strongly baculate, spinose or verrucate.

Remarks: Archangelsky and Gamerro (1966a, p. 203) proposed *Heliosporites* as a new genus. However, the name *Heliosporites* Archangelsky and Gamerro, 1966, is a later homonym of *Heliosporites* Schulz, 1962, and therefore, invalid under Article 64 of the International Code of Botanical Nomenclature (1961). A new generic name *Antulsporites* has been subsequently proposed by Archangelsky and Gamerro (1966b, p. 369) to accommodate the species originally assigned to *Heliosporites* Archangelsky and Gamerro, 1966.

Cingulatisporites saevus Balme, 1957, *Cingulatisporites distaverrucosus* Brenner, 1963, and *Cingulatisporites granulatus* de Jersey, 1960, belong to the genus *Antulsporites.*

The genus *Antulsporites* can be distinguished from *Kraeuselisporites* Leschik, 1955, emend. Jansonius, 1962, which is zonate, and has shorter laesurae not extending onto the cingulum. *Cingulatisporites* Thomson, 1953, emend. Potonié, 1956, and *Cingutriletes* Pierce, 1961, emend. Dettmann, 1963, differ from *Antulsporites* in being either faintly ornamented or smooth.

102 **Antulsporites baculatus** (Archangelsky and Gamerro) Archangelsky and Gamerro, 1966
Plate 15, figures 1-5

(Synonymy as for genus)

Description: Trilete; laesurae slightly raised, extending onto the cingulum and usually reaching the equator; commissures lined by a conspicuous and smooth margo; margo 3 microns wide near the pole, narrowing toward the equator and slightly widening again at the extremity of the laesurae; amb triangular; sides convex; apices rounded; cingulum 4 to 5 microns wide, radially striped, and of uniform width; proximal surface smooth in a circular area near the pole and laesurae; area outside the circle with short spinules or fused granules producing a crenellated circular margin; distal surface strongly convex with a prominent baculate sculpture; bacula near the pole almost equidimensional, about 3 to 4 microns long with jagged edges and arranged vertically; bacula near the equator elongate, spinose, oriented horizontally, and overlapping the inner margin of cingulum; cingulum without bacula; exine 2 to 4 microns thick.

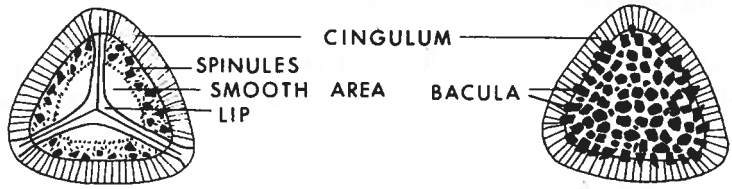


FIGURE 18. Antulsporites baculatus *(Archangelsky and Gamerro) Archangelsky and Gamerro. 1. Proximal view. 2. Distal view.*

Size range: Equatorial diameter (12 specimens) 33 (39) 45 microns.

Distribution: Cretaceous. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Cretaceous of Argentina (Archangelsky and Gamerro, 1966a).

Remarks: *Antulsporites baculatus* (Archangelsky and Gamerro) Archangelsky and Gamerro, 1966, can be distinguished from *Cingulatisporites saevus* Balme, 1957, by its narrower cingulum, longer laesurae reaching the equator, prominent and wide margo, characteristic proximal sculpture, and more equidimensional distal processes.

This species is morphologically similar to the recent spores of *Selaginella scandens*-group described by Knox (1950, p. 254).

Locality of figured specimens:

Pl. 15, figs. 1-3.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 15, figs. 4, 5.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 15, figs. 1, 2.	Slide No. 8-L-3(3);	co-ord. 19.1/73.8.	
Pl. 15, fig. 3.	Slide No. 8-L-3(1);	co-ord. 3.2/72.1.	
Pl. 15, figs. 4, 5.	Slide No. 8-L-4(2);	co-ord. 4.5/68.	

103 **Antulsporites distaverrucosus** (Brenner)
Archangelsky and Gamerro, 1966
Plate 15, figures 6, 7

1963 *Cingulatisporites distaverrucosus* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 58, pl. 13, figs. 6, 7, pl. 14, fig. 1.

1966a *Heliosporites distaverrucosus* (Brenner) Archangelsky and Gamerro, Ameghiniana, vol. 4, p. 203.

1966b *Antulsporites distaverrucosus* (Brenner) Archangelsky and Gamerro, Ameghiniana, vol. 4, p. 369.

See Brenner (1963, p. 58) for description.

Distribution: Late Jurassic to Albian. Cadotte Member of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Upper Jurassic of Holland (Burger, 1966).

Remarks: The genus *Cingulatisporites* Thomson, 1953, emend. Potonié, 1956, consists of unornamented to faintly ornamented spores possessing a smooth cingulum. As *Cingulatisporites distaverrucosus* Brenner, 1963, is distally verrucate, and has a radially segmented cingulum, it has been transferred to the genus *Antulsporites.*

Antulsporites distaverrucosus (Brenner) Archangelsky and Gamerro, 1966, can be distinguished from *Cingulatisporites saevus* Balme, 1957, and *Antulsporites baculatus* (Archangelsky and Gamerro) Archangelsky and Gamerro, 1966, by its verrucate distal surface and radially segmented cingulum.

Locality of figured specimen:

Pl. 15, figs. 6, 7.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 15, figs. 6, 7.	Slide No. 7-C-7(3);	co-ord. 19.8/61.9.	

Genus **Camarozonosporites** Pant, 1954 ex Potonié, 1956, emend. Klaus, 1960

Type species **Camarozonosporites cretaceus** (Weyland and Krieger) Potonié, 1956

See Klaus (1960, p. 135) for emended generic diagnosis.

Remarks: The genus *Camarozonosporites,* as emended by Klaus (1960), consists of trilete spores with a rugulate distal sculpture and prominent interradial equatorial thickenings (crassitudes).

According to Krutzsch (1963b, p. 22), the type species *C. cretaceus* has a fine rugulate sculpture, and is not smooth as stated by Potonié (1956, p. 65).

Rotaspora Schemel, 1950, differs from *Camarozonosporites* in having a smooth to infragranulate surface and wider cingulum which is thickened around the periphery to form a narrow rim. *Lycopodiacidites* Couper, 1953, emend. Potonié, 1956, resembles *Camarozonosporites* in having a rugulate sculpture, but lacks the interradial equatorial thickenings.

95 **Camarozonosporites insignis** Norris, 1967

Plate 15, figures 8-13

See Norris (1967, p. 96) for synonymy and description.

Distribution: Albian and Cenomanian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Viking Formation and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Albian of Maryland, U.S.A. (Brenner, 1963); Albian and Cenomanian of Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1967); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: *Camarozonosporites insignis* Norris, 1967, differs from *Camarozonosporites rudis* (Leschik) Klaus, 1960, in having simple laesurae which do not reach the equator, and relatively finer distal sculptural elements. Hedlund (1967) has transferred to *C. insignis* the specimens he previously assigned to *C. rudis* (see Hedlund, 1966, p. 17, pl. 3, figs. 3a-b) by mistake.

Camarozonosporites hammenii van Amerom, 1965, has relatively finer distal rugulae than *C. insignis* and lacks the proximal sculpture. *Camarozonosporites cerniidites* (Ross) Krutzsch, 1963, is distinct in having a laevigate proximal surface, and finer sculptural elements on the distal surface. The specimens assigned to *Lycopodiacidites cerniidites* by Brenner (1963, p. 43) and Pannella (1966, p. 62) actually belong to *C. insignis* Norris, 1967.

Locality of figured specimens:

Pl. 15, figs. 8-10.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Pl. 15, figs. 11-13.	Sample No. 7-C-9;	Cadotte Member.	Section 7.
Pl. 15, figs. 8-10.	Slide No. 4-P-8(2);	co-ord. 8.2/70.8.	
Pl. 15, figs. 11-13.	Slide No. 7-C-9-Micro. 60;	co-ord. 12.4/41.2.	

Genus **Cirratriradites** Wilson and Coe, 1940

Type species **Cirratriradites saturni** (Ibrahim) Schopf, Wilson and Bentall, 1944

See Potonié and Kremp (1956, p. 125) for synonymy and generic diagnosis.

Remarks: The genus *Cirratriradites* was proposed by Wilson and Coe (1940) to incorporate trilete, zonate spores with laesurae often reaching the outer edge of the broad membraneous flange. The flange is often radially striated.

118 **Cirratriradites teter** Norris, 1967

Plate 15, figures 14, 15

See Norris (1967, p. 98) for description.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Viking Formation, and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: This species appears to have a wider stratigraphic distribution than originally established by Norris (1967).

Locality of figured specimens:

Pl. 15, fig. 14.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 15, fig. 15.	Sample No. 7-H-1(A);	Harmon Member.	Section 7.
Pl. 15, fig. 14.	Slide No. 7-C-6(1);	co-ord. 13.8/46.5.	
Pl. 15, fig. 15.	Slide No. 7-H-1(A)(1);	co-ord. 20/77.1.	

Genus **Concavisporites** Pflug, 1953, emend. Delcourt and Sprumont, 1955

Type species **Concavisporites rugulatus** Pflug, 1953

See Potonié (1956, p. 15) for generic diagnosis.

Remarks: The genus *Concavisporites* Pflug, 1953, emend. Delcourt and Sprumont, 1955, consists of smooth to lightly ornamented trilete spores with kyrtomes (tori) and concave sides. The kyrtomes are formed by an abruptly convex exine area surrounding the laesurae which is reduced to three arcuate folds in the proximal interradial regions on compressed spores.

3 **Concavisporites jurienensis** Balme, 1957

Plate 15, figures 16, 17

See Burger (1966, p. 237) for synonymy and description.

Distribution: Late Jurassic and Early Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: *Concavisporites jurienensis* is distinct from *Deltoidospora juncta* (Kara-Murza) Singh, 1964, in having arcuate folds in the proximal interradial regions, and concave sides.

Locality of figured specimen:

Pl. 15, figs. 16, 17.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 15, figs. 16, 17.	Slide No. 8-L-7(2);	co-ord. 11.8/49.7.	

Genus **Concavissimisporites** Delcourt and Sprumont, 1955, emend.

Delcourt, Dettmann and Hughes, 1963

Type species **Concavissimisporites verrucosus** Delcourt and Sprumont, 1955, emend. Delcourt, Dettmann and Hughes, 1963

See Singh (1964, p. 76) for synonymy and generic diagnosis.

Remarks: This genus, as emended by Delcourt, Dettmann and Hughes (1963), includes trilete spores with a uniformly developed and evenly distributed verrucose sculpture, and concave to almost straight sides. The generic diagnosis has been slightly altered by Singh (1964) to also include spores with subgranulose to granulose sculpture.

20 **Concavissimisporites minor** (Pocock) Delcourt, Dettmann and Hughes, 1963

Plate 15, figure 18

1962 *Concavisporites verrucosus* var. *minor* Pocock, Palaeontographica, Band 111, Abt. B, p. 47, pl. 5, figs. 75, 76.

1963 *Concavissimisporites minor* (Pocock) Delcourt, Dettmann and Hughes, Palaeont., vol. 6, p. 286.

Description: Trilete; laesurae about 3/4 of the spore radius; margo weakly developed; amb triangular; sides concave; apices well rounded; proximal and distal surfaces ornamented by very small and widely spaced distinct verrucae; verrucae less than 1 micron in diameter; exine 2.5 microns thick.

Size range: Equatorial diameter (3 specimens) 73 (76) 78 microns.

Distribution: Late Jurassic to Albian. Loon River Formation, Cadotte Member, and lower Shaftesbury Formation of the Peace River area; upper part of Vanguard Formation, and McMurray Formation of Western Canada (Pocock, 1962); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species can be distinguished from *Concavissimisporites verrucosus* Delcourt and Sprumont, 1955, emend. Delcourt, Dettmann and Hughes, 1963, and *Concavissimisporites variverrucatus* (Couper) Brenner, 1963, by its

smaller and more widely spaced verrucae. *Concavissimisporites punctatus* (Delcourt and Sprumont) Brenner, 1963, differs from *Concavissimisporites minor* in having an indistinct subgranulose ornamentation.

Locality of figured specimen:

Pl. 15, fig. 18.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 15, fig. 18.	Slide No. 8-L-12-Micro. 45;	co-ord. 13/43.5.	

19 **Concavissimisporites punctatus** (Delcourt and Sprumont) Brenner, 1963

Plate 15, figure 19

1963 *Concavissimisporites punctatus* (Delcourt and Sprumont) Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 59, pl. 14, fig. 6.

See Singh (1964, p. 77) for additional synonymy and description.

Distribution: Berriasian to Albian. Loon River Formation, Harmon and Paddy Members of the Peace River area; Mannville Group of central Alberta (Singh, 1964); McMurray Formation of Western Canada (Pocock, 1962); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Berriasian to Aptian of England (Couper, 1958); "Wealden" of Belgium (Delcourt and Sprumont, 1955); Valanginian to Albian of southeastern Australia (Dettmann, 1963); Barremian and Aptian of U.S.S.R. (Bolkhovitina, 1961); Albian of Rumania (Baltes, 1967a).

Remarks: This species is characterized by its indistinct subgranulose ornamentation.

Locality of figured specimen:

Pl. 15, fig. 19.	Sample No. 8-L-13;	Loon River Formation.	Section 8.
Pl. 15, fig. 19.	Slide No. 8-L-13(2);	co-ord. 11.7/38.2.	

22 **Concavissimisporites variverrucatus** (Couper) Brenner, 1963

Plate 16, figure 1

1963 *Concavissimisporites variverrucatus* (Couper) Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 59, pl. 14, fig. 4.

See Singh (1964, p. 78) for additional synonymy and description.

Distribution: Bajocian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area;

Mannville Group of central Alberta (Singh, 1964); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian of northern Wyoming (Davis, 1963); Bajocian to Barremian of England (Couper, 1958).

Remarks: This species can be distinguished from *Concavissimisporites verrucosus* Delcourt and Sprumont, 1955, emend. Delcourt, Dettmann and Hughes, 1963, by its smaller size, less concave sides, and variable size, shape and spacing of the verrucae. *Concavissimisporites crassatus* (Delcourt and Sprumont) Delcourt, Dettmann and Hughes, 1963, differs from *Concavissimisporites variverrucatus* in having more widely spaced verrucae and longer laesurae.

Locality of figured specimen:

Pl. 16, fig. 1.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 16, fig. 1.	Slide No. 8-L-12-Micro. 10;	co-ord. 10.6/45.9.	

21 **Concavissimisporites** sp.

Plate 16, figures 2, 3

Description: Trilete; laesurae 3/4 of the spore radius; commissures bordered by linearly arranged confluent verrucae; amb triangular; sides straight; apices broadly rounded; proximal and distal surfaces verrucate; verrucae flat, confluent, elongate, and irregular-shaped; verrucae about 3 microns long and 1 to 2 microns wide; exine double-layered and about 3 microns thick; ektexine detached from the endexine.

Size range: Equatorial diameter (1 specimen) 48 microns.

Distribution: Middle Albian. Cadotte Member of the Peace River area.

Remarks: *Concavissimisporites penolaensis* Dettmann, 1963, resembles *Concavissimisporites* sp. but differs in having polygonal to circular-based verrucae, and slightly larger size (52 (64) 81 microns). *Concavissimisporites variverrucatus* Couper, 1958, is distinct from *Concavissimisporites* sp. in having bigger, hemispherical verrucae projecting up to 2 microns above the general surface, and in being larger.

This species has not been formally named as only two specimens were found.

Locality of figured specimen:

Pl. 16, figs. 2, 3.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 16, figs. 2, 3.	Slide No. 7-C-8(2);	co-ord. 12.2/75.	

Genus **Converrucosisporites** Potonié and Kremp, 1954

Type species **Converrucosisporites triquetrus** (Ibrahim) Potonié and Kremp, 1954

See Potonié and Kremp (1955, p. 63) for generic diagnosis.

Remarks: The genus *Converrucosisporites* consists of triangular to subtriangular trilete spores with densely verrucate sculpture. It differs from *Verrucosisporites* Ibrahim, 1933, emend. Potonié and Kremp, 1955, in not having a circular to subcircular outline.

The treatment of the genus *Converrucosisporites* Potonié and Kremp, 1954, as a junior synonym of *Trilites* Erdtman, 1947 ex Couper, 1953, emend. Dettmann, 1963, by Potonié (1966, p. 31) is not justified. The genus *Trilites* contains valvate spores whose sculptural elements consist of anastomosing, elongate verrucae or rugulae (see Dettmann, 1963, p. 62).

24 **Converrucosisporites exquisitus** n. sp.

Plate 16, figures 4, 5

Description: Trilete; laesurae about 2/3 of the spore radius; commissures inconspicuous simple slits; amb triangular; sides straight to slightly convex; apices broadly rounded; proximal and distal surfaces ornamented by large, evenly distributed, and closely spaced verrucae of uniform size; verrucae hemispherical, 6 to 10 microns in diameter, 4 to 7 microns high, and spaced 1 to 4 microns apart; exine thick.

Size range: Equatorial diameter (4 specimens) 68 (71) 84 microns. Holotype 68 microns.

Distribution: Middle and late Albian. Loon River Formation, and Cadotte and Paddy Members of the Peace River area.

Remarks: *Lygodioisporites perverrucatus* Couper, 1958, can be distinguished from *Converrucosisporites exquisitus* n. sp. by its circular amb and longer laesurae flanked by a wide margo.

The specific name is derived from *"exquisitus"* (excellent).

Type locality:

Holotype: Pl. 16, figs. 4, 5. Sample No. 7-C-10; Cadotte Member. Section 7.
Holotype: Pl. 16, figs. 4, 5. Slide No. 7-C-10(1); co-ord. 9.8/54.2.

Genus **Coronatispora** Dettmann, 1963

Type species **Coronatispora perforata** Dettmann, 1963

See Dettmann (1963, p. 67) for generic diagnosis.

Remarks: Dettmann (1963) proposed the genus *Coronatispora* to accommodate trilete, foveolate to reticulate, interradially thickened spores with a distal ornamentation composed of a circumpolar ridge which encircles a polar thickening. The polar, circumpolar and interradial thickenings (crassitudes) are often connected by radially disposed elevations.

The genus *Coronatispora* Dettmann, 1963, resembles *Staplinisporites* Pocock, 1962, *Polycingulatisporites* Simoncsics and Kedves, 1961, emend. Playford and Dettmann, 1965, and *Taurocusporites* Stover, 1962, emend. Playford and Dettmann, 1965, in having concentric trizonate distal ornamentation, but differs in possessing interradial equatorial thickenings (crassitudes).

97 **Coronatispora valdensis** (Couper) Dettmann, 1963

Plate 16, figures 6, 7

See Norris (1967, p. 96) for synonymy.

Description: Trilete; laesurae reaching the equator; commissures raised on a 2-micron high narrow ridge; amb rounded-triangular; interradial equatorial regions slightly thickened; proximal surface minutely rugulate; distal surface ornamented by a 2-micron wide circumpolar ridge, encircling a polar thickening about 14 microns in diameter; polar thickening granulate; circumpolar ridge surrounding an area about 28 microns in diameter; space between the equator and circumpolar ridge about 8 microns in width; polar, circumpolar, and interradial equatorial thickenings connected by radially disposed coarse rugulae; rugulae up to 1 micron wide; exine about 2 microns thick.

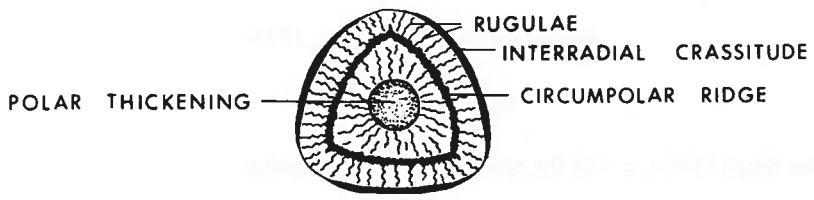


FIGURE 19. Coronatispora valdensis *(Couper) Dettmann. Distal view.*

Size range: Equatorial diameter (6 specimens) 41 (45) 52 microns.

Distribution: Late Jurassic to Albian. Loon River Formation, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Deville and Ellerslie Members, Grand Rapids Formation (Singh, 1964), and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; upper part of Fernie Group, Vanguard Formation, and Mannville Group of Western Canada (Pocock, 1962); Albian of Maryland, U.S.A. (Brenner, 1963); middle and late Albian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Berriasian to Aptian (Couper, 1958) and Upper Jurassic (Lantz, 1958; Norris, 1963) of England; Upper Jurassic to Valanginian of Holland (Burger, 1966); Aptian of Hungary (Deák, 1964).

Remarks: The specimens described as *Cingulatisporites caminus* by Balme (1957) differ from *Coronatispora valdensis* (Couper) Dettmann, 1963, in the absence of interradial thickenings and radially disposed rugulae within the area enclosed by the circumpolar ridge. The specimens from North America and Europe, which have been assigned to Balme's species described from Australia by various authors (Lantz, 1958, p. 924; Pocock, 1962, p. 49; Brenner, 1963, p. 57; Singh, 1964, p. 85; Pannella, 1966, p. 66; Burger, 1966, p. 246), actually belong to *C. valdensis* (Couper) Dettmann, 1963.

Spinaecoronatisporites valdensis (Couper) Deák, 1964, is a junior synonym of *C. valdensis.*

Locality of figured specimen:

Pl. 16, figs. 6, 7.	Sample No. 4-P-5;	Paddy Member.	Section 4.
Pl. 16, figs. 6, 7.	Slide No. 4-P-5(1);	co-ord. 14.1/78.9.	

Genus **Deltoidospora** Miner, 1935, emend. Potonié, 1956

Type species **Deltoidospora hallii** Miner, 1935

See Singh (1964, p. 80) for synonymy and generic diagnosis.

4 **Deltoidospora hallii** Miner, 1935

Plate 16, figure 8

See Singh (1964, p. 80) for synonymy and description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of North America.

Locality of figured specimen:

Pl. 16, fig. 8.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 16, fig. 8.	Slide No. 7-C-8(1);	co-ord. 20.2/42.1.	

5 **Deltoidospora diaphana** Wilson and Webster, 1946

Plate 16, figure 9

See Wilson and Webster (1946, p. 273) for description.

Distribution: Late Jurassic to Tertiary. Widespread in various parts of North America.

Remarks: This species can be distinguished from *Deltoidospora psilostoma* Rouse, 1959, by its smooth exine and smaller size (42 to 46 microns). The latter has a smooth to weakly punctate surface, and is from 50 to 70 microns in size.

Locality of figured specimen:

Pl. 16, fig. 9.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 16, fig. 9.	Slide No. 8-L-7(1);	co-ord. 7/35.3.	

7 **Deltoidospora juncta** (Kara-Murza) Singh, 1964

Plate 16, figures 10, 11

See Singh (1964, p. 81) for synonymy and description.

Distribution: Late Jurassic and Early Cretaceous. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Deville and Ellerslie Members, and Grand Rapids Formation (Singh, 1964), Joli Fou Formation and upper shale unit of the lower part of the Colorado Group (Norris, 1967) of central Alberta; Upper Jurassic to Lower Cretaceous of U.S.S.R. (Bolkhovitina, 1956); Albian of Rumania (Baltes, 1967a).

Remarks: *Deltoidospora juncta* differs from *Concavisporites jurienensis* Balme, 1957, in the absence of the arcuate folds in the proximal interradial regions. It is characterized by a deltoid shape, and very prominent distal exinal folds below the apices, which are perpendicular to the radius of the spore body. The specimen assigned to *D. juncta* by McGregor (1965, p. 22) actually belongs to *Concavisporites jurienensis* Balme, 1957.

Locality of figured specimen:

Pl. 16, figs. 10, 11.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 16, figs. 10, 11.	Slide No. 4-P-4(1);	co-ord. 12.2/35.	

6 **Deltoidospora psilostoma** Rouse, 1959

Plate 16, figure 12

See Singh (1964, p. 80) for synonymy and description.

Distribution: Late Jurassic to Late Cretaceous. Widespread in Western Canada.

Locality of figured specimen:

Pl. 16, fig. 12.	Sample No. 8-L-5;	Loon River Formation.	Section 8.
Pl. 16, fig. 12.	Slide No. 8-L-5(1);	co-ord. 7.7/35.	

Genus **Foveosporites** Balme, 1957

Type species **Foveosporites canalis** Balme, 1957

See Balme (1957, p. 17) for generic diagnosis.

Remarks: Balme (1957) proposed the genus *Foveosporites* to accommodate trilete spores with circular to rounded-triangular amb, elongate laesurae reaching or almost reaching the equator, and a proximal and distal ornamentation of sparsely distributed, irregular-shaped foveolae, often coalescing to form short channels.

48 **Foveosporites** sp. cf. **F. canalis** Balme, 1957

Plate 16, figures 13, 14

See Balme (1957, p. 17) for description.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: The single specimen recorded from the Loon River Formation has an ornamentation of coalescent foveolae, as in *Foveosporites canalis* Balme. However, this specimen is larger (50 microns) than those described by Balme (1957), which have an equatorial diameter of 30 (34) 37 microns, and its proximal surface is almost smooth, with the exception of a few foveolae developed near the margin.

Locality of figured specimen:

Pl. 16, figs. 13, 14.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 16, figs. 13, 14.	Slide No. 8-L-12(2);	co-ord. 1.8/48.2.	

49 **Foveosporites labiosus** n. sp.

Plate 17, figures 1-3

Description: Trilete; laesurae almost reaching the equator; commissures often split and bordered by a prominent, 4-micron wide thickened margo on either side; amb rounded-triangular; proximal and distal surfaces ornamented by coalescent foveolae forming short channels and irregular-shaped lumina; foveolae 2 to 3 microns apart; channels about 0.5 micron in width; exine near the equator thickened in a 2-micron wide band; average thickness of exine about 1.5 microns.

Size range: Equatorial diameter (14 specimens) 32 (38) 46 microns. Holotype 42 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Foveosporites labiosus* n. sp. differs from *Foveosporites canalis* Balme, 1957, in possessing a wide thickened margo bordering the commissures, and a 2-micron wide thickened equatorial rim.

The specific name is derived from *"labiosus"* (full-lipped) and refers to the prominently thickened margo.

Type locality:

Holotype: Pl. 17, figs. 1, 2.	Sample No. 8-L-1;	Loon River Formation.	Section 8.
Paratype: Pl. 17, fig. 3.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Holotype: Pl. 17, figs. 1, 2.	Slide No. 8-L-1(1);	co-ord. 14/67.8.	
Paratype: Pl. 17, fig. 3.	Slide No. 7-C-6(2);	co-ord. 6/54.9.	

Genus **Foveotriletes** van der Hammen, 1954 ex Potonié, 1956

Type species **Foveotriletes scrobiculatus** (Ross) Potonié, 1956

See Potonié (1956, p. 43) for emended generic diagnosis.

Remarks: The genus *Foveotriletes* consists of trilete spores with triangular amb, slightly concave to slightly convex sides, rounded apices, proximally flat and

distally convex surface, elongate laesurae reaching or almost reaching the equator, and densely foveolate exine, ornamented by evenly distributed, small, rounded lumina of equal size.

Foveotriletes is distinct from *Foveosporites* Balme, 1957, which has a circular to rounded-triangular amb, and a surface ornamentation of sparsely distributed, irregular-shaped foveolae or short channels. *Microreticulatisporites* Knox, 1950, emend. Bharadwaj, 1955, can be distinguished from *Foveotriletes* by its extrareticulate sculpture consisting of muri which are narrower than the width of lumina.

47 **Foveotriletes subtriangularis** Brenner, 1963

Plate 17, figures 4, 5

See Brenner (1963, p. 62) for description.

Distribution: Berriasian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Berriasian to Valanginian of Holland (Burger, 1966).

Remarks: The Alberta specimens of *Foveotriletes subtriangularis* are on an average slightly larger (36 (48) 54 microns) than those described by Brenner (1963), which have an equatorial diameter of 29 (38) 47 microns.

Foveosporites canalis Balme, 1957, differs from *Foveotriletes subtriangularis* in having an ornamentation of sparsely distributed, coalescent foveolae, which form short channels.

Locality of figured specimen:

Pl. 17, figs. 4, 5. Sample No. 8-L-9; Loon River Formation. Section 8.
Pl. 17, figs. 4, 5. Slide No. 8-L-9-Micro. 48; co-ord. 8.8/43.

Genus **Ischyosporites** Balme, 1957

Type species **Ischyosporites crateris** Balme, 1957

See Balme (1957, p. 23) for generic diagnosis.

Remarks: Balme (1957) proposed the genus *Ischyosporites* to incorporate trilete spores with triangular amb, elongate laesurae reaching or almost reaching the equator, a strongly convex distal surface ornamented by heavy ridges anastomosing to form an irregular reticulate pattern, and exinal thickenings at the apices (valvae).

Ischyosporites is distinct from *Trilobosporites* Pant, 1954 ex Potonié, 1956, which is characterized by granulate to verrucate sculpture in the polar regions of its exine, and *Klukisporites* Couper, 1958, which lacks the exinal thickenings at the apices (nonvalvate).

71 **Ischyosporites disjunctus** n. sp.

Plate 17, figures 6, 7

Description: Trilete; laesurae almost reaching the equator; commissures slightly raised; amb triangular; sides straight to slightly convex; apices rounded; proximal surface with imperfect foveo-reticulate sculpture at the apices; remaining proximal surface smooth; distal surface with imperfect foveo-reticulate sculpture; muri discontinuous and 4 to 6 microns wide; lumina intercommunicating, 6 to 10 microns in diameter; exine about 3 microns thick, increasing in thickness at the apices.

Size range: Equatorial diameter (6 specimens) 54 (64) 75 microns. Holotype 66 microns.

Distribution: Middle and late Albian. Cadotte Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Ischyosporites disjunctus* n. sp. differs from other species of the genus *Ischyosporites* Balme, 1957, in having discontinuous muri and an imperfect foveo-reticulate sculpture.

The specific name is derived from *"disjunctus"* (separated) and refers to the discontinuous muri.

Type locality:

Holotype: Pl. 17, figs. 6, 7.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Holotype: Pl. 17, figs. 6, 7.	Slide No. 7-C-7(1);	co-ord. 14.8/74.9.	

70 **Ischyosporites punctatus** Cookson and Dettmann, 1958

Plate 17, figures 8, 9

See Dettmann (1963, p. 63) for description.

Distribution: Late Jurassic to Albian. Cadotte Member of the Peace River area; Upper Jurassic to Aptian of Western Australia (Cookson and Dettmann, 1958a); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: *Ischyosporites punctatus* differs from *Ischyosporites crateris* Balme, 1957, which has larger lumina, especially about the distal pole.

Locality of figured specimen:

Pl. 17, figs. 8, 9. Sample No. 7-C-6; Cadotte Member. Section 7.
Pl. 17, figs. 8, 9. Slide No. 7-C-6-Micro. 68; co-ord. 13.2/42.8.

Genus **Kraeuselisporites** Leschik, 1955, emend. Jansonius, 1962

Type species **Kraeuselisporites dentatus** Leschik, 1955

See Jansonius (1962, p. 46) for emended generic diagnosis.

Remarks: The genus *Kraeuselisporites* was originally proposed by Leschik (1955) for alete spores. Jansonius (1962) subsequently recognized that the type species of *Kraeuselisporites* is trilete, and the genus, as emended by him, consists of trilete, flanged spores with a flat and smooth proximal surface and a strongly convex distal surface which may be apiculate, spinose, punctate or indistinctly ornamented. The laesurae in *Kraeuselisporites* reach only up to the inner margin of the flange.

Dettmann (1963, p. 77) has treated *Styxisporites* Cookson and Dettmann, 1958, as a junior synonym of *Kraeuselisporites* Leschik, 1955, emend. Jansonius, 1962.

119 **Kraeuselisporites** sp.

Plate 17, figures 10, 11

Description: Trilete; laesurae reaching the inner margin of flange, gaping, occasionally the entire proximal polar area ruptured, leaving a triangular opening; amb rounded-triangular; proximal face flat with granulate sculpture; distal face strongly arched and covered sparsely with up to 6 microns long clavae; distal surface granulate; flange about 5 microns wide with granulate surface; compression causing secondary folding at the base of the flange; exine 2 microns thick on distal surface and thinner on the proximal surface and flange.

Size range: Equatorial diameter (4 specimens) 31 (34) 40 microns.

Distribution: Middle Albian. Cadotte Member of the Peace River area.

Remarks: *Kraeuselisporites* sp. resembles *Styxisporites reissingeri* Danzé-Corsin and Laveine, 1963. However, the four specimens recorded during the present study

cannot be positively identified since their proximal face is ruptured and the laesurae imperfectly preserved.

Locality of figured specimen:

Pl. 17, figs. 10, 11.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 17, figs. 10, 11.	Slide No. 7-C-8(1);	co-ord. 13.9/39.	

Genus **Leptolepidites** Couper, 1953

Type species **Leptolepidites verrucatus** Couper, 1953

See Couper (1953, p. 28) for generic diagnosis.

Remarks: Couper (1953) proposed the genus *Leptolepidites* to incorporate subtriangular trilete spores with convex to concave sides and large verrucate projections, equally developed on the proximal and distal surfaces.

According to Dettmann (1963, p. 29), however, the specimens of the type species *Leptolepidites verrucatus* from southeastern Australia are smooth proximally.

The genus *Leptolepidites* can be distinguished from *Verrucosisporites* Ibrahim, 1933, emend. Potonié and Kremp, 1954, and *Converrucosisporites* Potonié and Kremp, 1954, in having large dome-shaped verrucae of equal size and circular outline. The sculptural elements of the latter genera consist of verrucae of unequal size and irregular outline.

25 **Leptolepidites verrucatus** Couper, 1953

Plate 17, figures 12, 13

See Dettmann (1963, p. 29) for description.

Distribution: Jurassic and Cretaceous. Cadotte Member and lower Shaftesbury Formation of the Peace River area; Upper Jurassic of England (Lantz, 1958), and New Zealand (Couper, 1953); Lower Jurassic of Queensland (de Jersey, 1959); Berriasian to Upper Cretaceous of eastern Australia (Cookson and Dettmann, 1958a); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: The Alberta specimens of *Leptolepidites verrucatus* are identical with those described by Dettmann (1963) and are devoid of proximal sculpture. *Converrucosisporites proxigranulatus* Brenner, 1963, is distinct from *L. verrucatus* in having a proximal granulate sculpture.

Locality of figured specimen:

Pl. 17, figs. 12, 13.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 17, figs. 12, 13.	Slide No. 7-C-10(1);	co-ord. 19.5/65.9.	

26 **Leptolepidites** sp.

Plate 17, figures 14, 15

Description: Trilete; laesurae indistinct, almost reaching the equator; amb triangular; sides concave; apices rounded; proximal and distal surfaces verrucate; verrucae larger at the poles, closely spaced and clustered at the proximal and distal poles and around the equator; verrucae hemispherical in shape, 3 to 7 microns in basal diameter and 3 to 5 microns high.

Size range: Equatorial diameter (1 specimen) 36 microns.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: *Leptolepidites* sp. differs from other species of this genus in having concave sides and larger verrucae at the proximal and distal poles.

This species has not been formally named as only one specimen was found.

Locality of figured specimen:

Pl. 17, figs. 14, 15.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 17, figs. 14, 15.	Slide No. 8-L-4(3);	co-ord. 10.9/70.9.	

Genus **Lophotriletes** Naumova, 1937 ex Potonié and Kremp, 1954

Type species **Lophotriletes gibbosus** (Ibrahim) Potonié and Kremp, 1954

See Potonié and Kremp (1955, p. 72) for generic diagnosis.

Remarks: The genus *Lophotriletes* consists of subtriangular trilete spores, thickly covered with tapered cones whose basal diameter is equal to or less than their height. The tips of the cones are blunt and their bases may or may not touch one another.

Apiculatisporis Potonié and Kremp, 1956, has the same sculptural elements as *Lophotriletes*, but differs in having a circular amb. *Anapiculatisporites* Potonié and Kremp, 1954, is distinct in having a smooth proximal surface.

31 **Lophotriletes babsae** (Brenner) n. comb.

Plate 17, figure 16

1963 *Apiculatisporis babsae* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 56, pl. 13, figs. 2, 3.

See Brenner (1963, p. 56) for description.

Distribution: Albian. Cadotte Member of the Peace River area; Albian of Maryland, U.S.A. (Brenner, 1963).

Remarks: The genus *Apiculatisporis* Potonié and Kremp, 1956, contains spores with a circular amb only. The specimens described by Brenner (1963) as *Apiculatisporis babsae* have a triangular amb. Therefore, this species has been transferred here to the genus *Lophotriletes.*

According to Brenner (1963), *Lophotriletes babsae* (Brenner) n. comb. makes its entrance in the Patapsco Formation of Maryland, U.S.A. with the first tricolpate dicotyledonous pollen, and is a fairly reliable index species. In the Peace River region this species makes its entrance in the Cadotte Member with the early tricolpate dicotyledonous pollen.

Locality of figured specimen:

Pl. 17, fig. 16.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 17, fig. 16.	Slide No. 7-C-10(2);	co-ord. 8.7/58.	

Genus **Microreticulatisporites** Knox, 1950, emend. Bharadwaj, 1955

Type species **Microreticulatisporites lacunosus** (Ibrahim) Knox, 1950

See Singh (1964, p. 97) for synonymy and generic diagnosis.

Remarks: Bharadwaj (1955) restricted the generic circumscription of *Microreticulatisporites* to include only triangular trilete spores possessing an extrareticulate sculpture and lumina not exceeding 3 microns in diameter.

39 **Microreticulatisporites uniformis** Singh, 1964

Plate 17, figures 17-19

See Singh (1964, p. 97) for description.

Distribution: Aptian to early Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members of the Peace River area; Mannville Group (except Deville Member) of central Alberta (Singh, 1964); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Locality of figured specimens:

Pl. 17, figs. 17, 18.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 17, fig. 19.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 17, figs. 17, 18.	Slide No. 8-L-12(1);	co-ord. 14.4/62.9.	
Pl. 17, fig. 19.	Slide No. 8-L-9(1);	co-ord. 9/48.	

Genus **Murospora** Somers, 1952

Type species **Murospora kosankei** Somers, 1952

See Potonié (1958, p. 25) for generic diagnosis.

Remarks: Somers (1952) proposed the genus *Murospora* to accommodate trilete cingulate spores with concave sides, elongate laesurae reaching the inner margin of the cingulum, and smooth to granulate exine. The cingulum is sometimes narrower or truncated at the apices.

The genus *Murospora* can be distinguished from *Cingutriletes* Pierce, 1961, emend. Dettmann, 1963, and *Cingulatisporites* Thomson, 1953, emend. Potonié, 1956, by its concave sides. The expansion of the generic circumscription of *Murospora* to include forms with subcircular amb by Potonié (1966, p. 81) appears to be unwarranted.

99 **Murospora truncata** n. sp.

Plate 18, figures 1, 2

Description: Trilete; laesurae reaching the inner margin of the cingulum; commissures raised; amb triangular; sides slightly concave; apices flat, occasionally invaginated; sides of the spore cavity concave; body cingulate; cingulum 6 to 8 microns wide and distinctly truncated at the apices; truncated cingulum at the apices 2 to 4 microns wide; exine 3 microns thick in the polar regions and about 7 microns thick equatorially; surface smooth; corroded specimens with pitted polar exines and radially disposed corrosion channels on the cingulum.

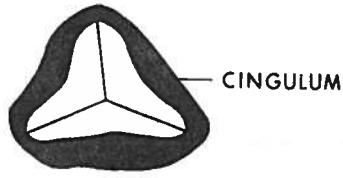


FIGURE 20. Murospora truncata *n. sp. Proximal view.*

Size range: Equatorial diameter (7 specimens) 44(51) 63 microns. Holotype 52 microns.

Distribution: Late Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Murospora truncata* n. sp. can be distinguished from *Murospora florida* Balme, 1957, by its smaller size and narrower cingulum which is truncated and thinner at the apices. *Murospora mesozoica* Pocock, 1961, is distinct in having smaller dimensions (37 microns), and a cingulum of uniform width.

Cingulatisporites sp. B, described and illustrated by Davis (1963, p. 78, pl. 5, fig. 4) from the Fall River Formation (middle Albian) of northern Wyoming, U.S.A., is probably conspecific with *M. truncata* n. sp.

The specific name is derived from *"truncatus"* (truncated) and refers to the truncated cingulum at the apices.

Type locality:

Holotype: Pl. 18, fig. 1.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Paratype: Pl. 18, fig. 2.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Holotype: Pl. 18, fig. 1.	Slide No. 4-P-6(1);	co-ord. 3.9/72.1.	
Paratype: Pl. 18, fig. 2.	Slide No. 4-P-3(2);	co-ord. 9.8/60.1.	

Genus **Pilosisporites** Delcourt and Sprumont, 1955

Type species **Pilosisporites trichopapillosus** (Thiergart) Delcourt and Sprumont, 1955

See Singh (1964, p. 74) for synonymy and generic diagnosis.

29 **Pilosisporites trichopapillosus** (Thiergart) Delcourt and Sprumont, 1955

Plate 18, figure 3

See Singh (1964, p. 75) for description.

Distribution: Purbeckian to Albian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area; Mannville Group of central Alberta (Singh, 1964); Lower Cretaceous of Saskatchewan, Canada (Steeves and Wilkins, 1967); middle Albian of northern Wyoming, U.S.A. (Davis, 1963); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Purbeckian to Wealden of England

(Couper, 1958); "Wealden" of Belgium (Delcourt and Sprumont, 1955) and Germany (Thiergart, 1949); Albian of Rumania (Baltes, 1967a).

Locality of figured specimen:

Pl. 18, fig. 3.	Sample No. 7-H-7;	Harmon Member.	Section 7.
Pl. 18, fig. 3.	Slide No. 7-H-7-Micro. 69;	co-ord. 12.1/43.5.	

Genus **Polycingulatisporites** Simoncsics and Kedves, 1961, emend.

Playford and Dettmann, 1965

Type species **Polycingulatisporites circulus** Simoncsics and Kedves, 1961

See Playford and Dettmann (1965, p. 143) for synonymy and emended generic diagnosis.

Remarks: Playford and Dettmann (1965) emended the genus *Polycingulatisporites* to incorporate trilete cingulate spores with smooth to scabrate exine, and a distal sculpture consisting of a circumpolar ridge concentrically encircling a polar or subpolar thickening.

Playford and Dettmann (1965, p. 146) restricted the genus *Taurocusporites* Stover, 1962, whose distal sculptural features are identical with those of *Polycingulatisporites,* to the proximally sculptured forms only. They transferred the smooth-walled species, earlier assigned to *Taurocusporites* by Stover (1962), to *Polycingulatisporites.*

Staplinisporites Pocock, 1962, differs from *Polycingulatisporites* in being acingulate and possessing radially disposed distal elevations. *Coronatispora* Dettmann, 1963, is distinct in possessing interradial equatorial thickenings (crassitudes), and a foveolate to reticulate exine. *Polycingulatisporites* can be easily distinguished from *Annulispora* de Jersey, 1959, and *Distalanulisporites* Klaus, 1960, whose distal sculptures consist of only one circumpolar ring-like thickening.

Neochomotriletes Reinhardt, 1962, is a junior synonym of the genus *Polycingulatisporites.*

108 **Polycingulatisporites radiatus** n. sp.

Plate 18, figures 4-7

1967 *Taurocusporites* sp. cf. *T. minor* Singh–Norris, Palaeontographica, Band 120, Abt. B, p. 91, pl. 11, fig. 9.

Description: Trilete; laesurae reaching the equator; commissures usually split, bordered by 2.5-micron wide thickened lips; amb rounded-triangular; body cingulate; cingulum 2 to 2.5 microns wide; proximal surface smooth; distal surface with a 4-micron wide circumpolar ridge concentrically encircling a 8-micron wide polar thickening; the unthickened space between the circumpolar ridge and polar thickening 2 to 3 microns wide; circumpolar ridge surrounded by 15 to 22 radially disposed ridges and canals; canals starting from the indentations on the outer margin of circumpolar ridge and usually reaching the equator; ridges 2 to 3 microns wide; canals about 0.5 micron wide; space between circumpolar ridge and cingulum 1 to 4 microns wide; exine smooth, about 2 microns thick.

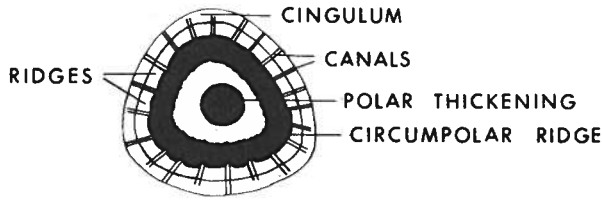


FIGURE 21. Polycingulatisporites radiatus *n. sp. Distal view.*

Size range: Equatorial diameter (7 specimens) 26 (30) 33 microns. Holotype 33 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: The specimen illustrated by Norris (1967) as *Taurocusporites* sp. cf. *T. minor* Singh, 1964, has a circumpolar ridge surrounding a distinct polar thickening, and is identical with *Polycingulatisporites radiatus* n. sp.

Taurocusporites minor Singh, 1964, has a polar cap-like distal thickening surrounded by numerous small crescent-shaped lumina, and is a junior synonym of *Rogalskaisporites cicatricosus* (Rogalska) var. *rotundus* Danzé-Corsin and Laveine, 1963.

The specimens assigned to *Annulispora* sp. in the present study have a superficial resemblance to *P. radiatus* n. sp., as both have radially disposed canals surrounding their distal circumpolar ridge. However, *Annulispora* sp. can be easily distinguished from *P. radiatus* n. sp., as it lacks the distal polar thickening inside the circumpolar ridge.

The specific name is derived from *"radiatus"* (rayed) and refers to the radially disposed ridges and canals surrounding the distal circumpolar ridge.

Type locality:

Holotype: Pl. 18, fig. 4.	Sample No. 7-C-5;	Cadotte Member.	Section 7.
Paratype: Pl. 18, fig. 5.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Paratype: Pl. 18, figs. 6,7.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Holotype: Pl. 18, fig. 4.	Slide No. 7-C-5 (1);	co-ord. 3.2/45.	
Paratype: Pl. 18, fig. 5.	Slide No. 7-C-2-Micro. 62;	co-ord. 10.8/44.9.	
Paratype: Pl. 18, figs. 6,7.	Slide No. 8-L-3 (2);	co-ord. 8.1/77.9.	

107 **Polycingulatisporites reduncus** (Bolkhovitina) Playford and Dettmann, 1965

Plate 18, figure 8

1953 *Chomotriletes reduncus* Bolkhovitina, Trudy Inst. Geol. Nauk, Akad. Nauk SSSR, vol. 145, p. 35, pl. 3, figs. 23, 24.

1962 *Taurocusporites reduncus* (Bolkhovitina) Stover, Micropaleont., vol. 8, p. 57, pl. 1, figs. 15-21.

1965 *Polycingulatisporites reduncus* (Bolkhovitina) Playford and Dettmann, Senckenbergiana Lethaea, Band 46, p. 144.

See Singh (1964, p. 86) for description.

Distribution: Middle Jurassic to Paleocene. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; McMurray and Grand Rapids Formations (Singh, 1964), and upper shale unit of the lower part of Colorado Group (Norris, 1967) of central Alberta; middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Cenomanian of Alabama, U.S.A. (Leopold and Pakiser, 1964); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Lower Cretaceous of Maryland, U.S.A. (Stover, 1962; Brenner, 1963); Upper Cretaceous to Paleocene of California, U.S.A. (Drugg, 1967); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); Middle Jurassic of Pakistan, Denmark and Yakutia region of U.S.S.R.; Lower Cretaceous (Aptian) and Upper Cretaceous (Senonian) of western Kazakhstan, U.S.S.R. (*fide* Stover, 1962, p. 57).

Remarks: The Alberta specimens of *Polycingulatisporites reduncus* are on an average smaller (30 (38) 48 microns) than the specimens described by Bolkhovitina (1953), which range in diameter from 42 to 55 microns, averaging 47 microns.

Taurocusporites segmentatus Stover, 1962, differs from *P. reduncus* in possessing a proximal ornamentation. *Polycingulatisporites triangularis* (Bolkhovitina) Playford and Dettmann, 1965, can be distinguished from *P. reduncus* by its distal sculpture composed of relatively wide unornamented areas separated by smooth, circular ridges. The distal sculpture of *P. reduncus* is distinct in having an imbricated arrangement of concentric, indented thickened ridges.

Locality of figured specimen:

Pl. 18, fig. 8.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 18, fig. 8.	Slide No. 8-L-12(1);	co-ord. 3.1/34.	

Genus **Psilatriletes** van der Hammen, 1954 ex Potonié, 1956

Type species **Psilatriletes detortus** (Weyland and Krieger) Potonié, 1956

See Potonié (1956, p. 18) for generic diagnosis.

Remarks: The genus *Psilatriletes* is used in the present study in the restricted sense of Potonié (1956). It consists of rounded-triangular trilete spores with long laesurae, closely spaced radial folds near the equatorial margin (usually caused by separation of the ektexine from endexine), and smooth to faintly ornamented exine.

11 **Psilatriletes radiatus** Brenner, 1963

Plate 18, figures 9, 10

See Brenner (1963, p. 68) for description.

Distribution: Barremian to early Cenomanian. Cadotte and Paddy Members of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: This species is characterized by fine, radial folds on the proximal surface near the equatorial margin, and elongate laesurae reaching the equator.

Locality of figured specimens:

Pl. 18, fig. 9.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 18, fig. 10.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 18, fig. 9.	Slide No. 7-C-8-Micro. 70;	co-ord. 12/43.2.	
Pl. 18, fig. 10.	Slide No. 7-C-10(2);	co-ord. 4/75.9.	

Genus **Reticulisporites** Potonié and Kremp, 1953

Type species **Reticulisporites parvogranulatus** Weyland and Krieger, 1953

See Potonié (1956, p. 44) for generic diagnosis.

Remarks: The genus *Reticulisporites* consists of reticulate trilete spores with low muri, elongate laesurae reaching or almost reaching the equator, concave sides and rounded apices. *Microreticulatisporites* Knox, 1950, emend. Bharadwaj, 1955, differs from *Reticulisporites* in having smaller lumina (less than 3 microns in diameter) and straight to convex sides. *Reticulisporites* can be easily distinguished from *Lycopodiumsporites* Thiergart, 1938 ex Delcourt and Sprumont, 1955, and *Reticulatisporites* Ibrahim, 1933, emend. Potonié and Kremp, 1954, which have higher muri and convex sides.

38 **Reticulisporites elongatus** n. sp.

Plate 18, figures 11, 12

1967 *Reticulisporites* sp. Norris, Palaeontographica, Band 120, Abt. B, p. 91, pl. 11, figs. 10, 11.

Description: Trilete; laesurae almost reaching equator; commissures slightly raised; amb triangular; sides slightly concave; apices rounded; proximal surface smooth to scabrate; distal surface with slightly imperfect reticulate sculpture; lumina polygonal, elongated, with no preferred orientation, 4 to 10 microns long and 2 to 3 microns wide; muri about 0.5 micron wide and 1 micron high; exine about 1.5 microns thick.

Size range: Equatorial diameter (7 specimens) 30 (33) 35 microns. Holotype 33 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Paddy Members, and lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: *Reticulisporites elongatus* n. sp. is characterized by a distal, imperfect reticulate sculpture composed of angular elongated lumina and low narrow muri. It can be easily distinguished from *Microreticulatisporites uniformis* Singh, 1964, by its larger lumina, concave sides, and smaller size.

This species appears to have a wider stratigraphic distribution than originally established by Norris (1967).

The specific name is derived from *"elongatus"* (elongate) and refers to the characteristic elongate angular lumina on the distal surface.

Type locality:

Holotype: Pl. 18, figs. 11, 12. Sample No. 8-L-7; Loon River Formation. Section 8.
Holotype: Pl. 18, figs. 11, 12. Slide No. 8-L-7 (2);co-ord. 19/77.5.

Genus **Rogalskaisporites** Danzé-Corsin and Laveine, 1963

1954 *Sporites cicatricosus* Rogalska, Instytut Geologiczny (Warsaw), Bull. 89, p. 26, pl. 12, fig. 11.

1955 *Stereisporites perforatus* Leschik, Schweiz. Paläont. Abhandl., Band 72, p. 10, pl. 1, figs. 3, 4.

1956 *Sporites cicatricosus* Rogalska, Instytut Geologiczny (Warsaw), Bull. 104, p. 41, pl. 29, fig. 7.

1963 *Rogalskaisporites cicatricosus* (Rogalska) Danzé-Corsin and Laveine, *in* Briche *et al.*, Mém. Soc. Géol. Nord, vol. 13, p. 80 (type species).

Diagnosis: Trilete spores; amb subcircular to subtriangular; laesurae relatively short, approximately 1/2 to 2/3 of spore radius, rarely up to 4/5 of radius; exine smooth or infrapunctate; central part of spore strongly convex, thickened and with a distinct trilete mark; central part surrounded by a circular zone of greater or lesser width with a variable number of radial cicatrices merging towards the central part; cingulum narrow, barely thicker than the central part, sometimes thinning opposite the ends of laesurae; size range 30 to 60 microns.

Remarks: Playford and Dettmann (1965, p. 134) claim that *Sporites cicatricosus* Rogalska, 1954, is illegitimate, because the species is not supported by a designated holotype. According to Playford (1965, p. 181), the genus *Rogalskaisporites* Danzé-Corsin and Laveine, 1963, is invalid because it is based on the illegitimate name *Sporites cicatricosus* Rogalska. However, Article 37 of the International Code of Botanical Nomenclature (1961) explicitly states that the designation of a nomenclatural type (a holotype in this case) for valid publication of a taxon is required only since 1 January, 1958. Moreover, Article 7, Note 2 of the Code states that "A holotype is the one specimen ..... used by the author". Since *Sporites cicatricosus* Rogalska, 1954, is illustrated by only one specimen, which automatically becomes the holotype, and insofar as it was published before 1 January, 1958, it is undoubtedly a validly published species. The genus *Rogalskaisporites* Danzé-Corsin and Laveine, which is based on this species, is also valid.

Rogalskaisporites can be distinguished from *Stereisporites* Pflug, 1953, by its distal ornamentation consisting of a polar disk-like thickening surrounded by numerous radially disposed ridges and canals. *Annulispora* de Jersey, 1959, and *Distalanulisporites* Klaus, 1960, are distinct in having a distal circumpolar ring-like thickening. *Staplinisporites* Pocock, 1962, *Polycingulatisporites* Simoncsics and Kedves, 1961, emend. Playford and Dettmann, 1965, and *Taurocusporites* Stover, 1962, emend. Playford and Dettmann, 1965, differ from *Rogalskaisporites* in having an essentially trizonate distal ornamentation composed of a ring-like circumpolar ridge surrounding a polar or subpolar thickening.

Rogalskaisporites multicicatricosus Danzé-Corsin and Laveine, 1963, probably belongs to the genus *Staplinisporites* Pocock.

As the holotype itself is only 29 microns in size, and many other smaller specimens have been found, the lower size limit of this genus is hereby reduced to 20 microns.

104 **Rogalskaisporites cicatricosus** (Rogalska) Danzé-Corsin and Laveine, 1963

Plate 18, figure 13

(Synonymy as for genus)

Description: Trilete; laesurae distinct, with slightly thickened lips, and extending up to 3/4 of the spore radius; amb subcircular to subtriangular; sides convex; proximal surface smooth; distal surface convex, with a polar disk-like thickening about 20 microns in diameter; polar thickening surrounded by 20 to 25 radially disposed ridges and canals; ridges up to 2 microns wide; canals about 0.5 micron wide; space between the outer margin of polar thickening and the equator about 5 microns wide; cingulum 1.5 to 2 microns wide; exine smooth, about 1 micron thick.

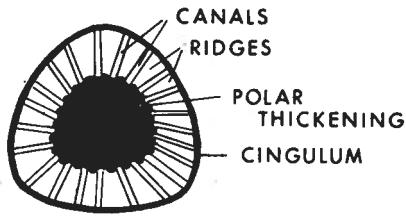


FIGURE 22. Rogalskaisporites cicatricosus *(Rogalska) Danzé-Corsin and Laveine. Distal view.*

Size range: Equatorial diameter (9 specimens) 24 (27) 36 microns.

Distribution: Keuper to Albian. Loon River Formation and Harmon Member of the Peace River area; Lower Jurassic of Arctic Islands, Canada (McGregor, 1965); Lias of Poland (Rogalska, 1954, 1956), and France (Levet-Carette, 1963); Keuper of Switzerland (Leschik, 1955); Rhaeto-Liassic of South Australia (Playford and Dettmann, 1965); Triassic of Tasmania (Playford, 1965).

Remarks: *Rogalskaisporites cicatricosus* resembles *Leiotriletes incertus* Bolkhovitina, 1956, with which it may be conspecific. *Leiotriletes bujargiensis* Bolkhovitina, 1956, is distinct from *R. cicatricosus* in being larger.

Locality of figured specimen:

Pl. 18, fig. 13.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 18, fig. 13.	Slide No. 8-L-11(3);	co-ord. 5.2/66.2.	

105 **Rogalskaisporites cicatricosus** (Rogalska) var. **rotundus** Danzé-Corsin and Laveine, 1963

Plate 18, figure 14

1956 cf. *Sporites cicatricosus* Rogalska, Instytut Geologiczny (Warsaw), Bull. 104, p. 41, pl. 29, figs. 8, 9.

1963 *Rogalskaisporites cicatricosus* (Rogalska) var. *rotundus* Danzé-Corsin and Laveine, *in* Briche *et al.*, Mém. Soc. Géol. Nord, vol. 13, p. 80, pl. 6, figs. 19-21.

1964 *Taurocusporites minor* Singh, Res. Coun. Alberta, Bull. 15, p. 87, pl. 11, figs. 7-11.

Description: Trilete; laesurae distinct, with thickened lips, and extending up to 4/5 of the spore radius; amb circular; proximal surface smooth; distal surface convex, with a polar disk-like thickening about 15 to 20 microns in diameter; polar thickening surrounded by 15 to 20 small crescent-shaped lumina; lumina separated by radially disposed ridges; ridges up to 2 microns wide; lumina 0.5 to 1 micron wide; distance between the outer margin of polar thickening and the equator 3 to 4 microns; cingulum 1 to 2 microns wide; exine smooth, about 1 micron thick.

Size range: Equatorial diameter (1 specimen) 21 microns.

Distribution: Lias to Albian. Cadotte Member of the Peace River area; Ellerslie and Wabiskaw Members of central Alberta (Singh, 1964); Upper Jurassic of Arctic Islands, Canada (McGregor, 1965); Lias of Poland (Rogalska, 1956), and France (Danzé-Corsin and Laveine *in* Briche *et al.*, 1963).

Remarks: *Taurocusporites minor* Singh, 1964, is a junior synonym of *Rogalskaisporites cicatricosus* (Rogalska) var. *rotundus* Danzé-Corsin and Laveine.

The specimens of this species described by Danzé-Corsin and Laveine (*in* Briche *et al.*, 1963) have a size range from 30 to 55 microns, whereas the Canadian specimens vary from 21 to 27 microns in size. They are, however, identical with the French specimens in all other respects.

Locality of figured specimen:

Pl. 18, fig. 14.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 18, fig. 14.	Slide No. 7-C-7(1);	co-ord. 13.5/58.2.	

Genus **Taurocusporites** Stover, 1962, emend. Playford and Dettmann, 1965

Type species **Taurocusporites segmentatus** Stover, 1962

See Playford and Dettmann (1965, p. 146) for synonymy and emended generic diagnosis.

Remarks: Playford and Dettmann (1965) restricted the genus *Taurocusporites* to include only proximally sculptured trilete cingulate spores which possess a distal sculpture consisting of a circumpolar ridge concentrically encircling a polar thickening. They transferred the smooth-walled species, earlier assigned to *Taurocusporites* by Stover (1962), to *Polycingulatisporites* Simoncsics and Kedves, 1961, emend. Playford and Dettmann, 1965.

The treatment of *Taurocusporites* as a junior synonym of *Polycingulatisporites* by Potonié (1966, p. 56) does not seem to be justified.

109 **Taurocusporites segmentatus** Stover, 1962

Plate 18, figures 15, 16

See Singh (1964, p. 86) for description.

Distribution: Early Cretaceous. Loon River Formation, and Harmon and Cadotte Members of the Peace River area; Ellerslie Member and Grand Rapids Formation of central Alberta (Singh, 1964); Lower Cretaceous of Saskatchewan, Canada (Steeves and Wilkins, 1967); Lower Cretaceous of Maryland, U.S.A. (Stover, 1962; Brenner, 1963); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species is characterized by a verrucate proximal sculpture and transversely segmented wide lips bordering the laesurae.

Locality of figured specimen:

Pl. 18, figs. 15, 16.	Sample No. 7-C-3;	Cadotte Member.	Section 7.
Pl. 18, figs. 15, 16.	Slide No. 7-C-3(2);	co-ord. 20.7/63.5.	

Genus **Tigrisporites** Klaus, 1960, emend.

1960 *Tigrisporites halleinis* Klaus, Jahrb. Geol. B.A. (Wien), Sonderband 5, p. 140, pl. 31, figs. 28, 30 (type species).

Emended diagnosis: Trilete spores; laesurae narrow, straight, and reaching the equator; amb triangular; proximal surface smooth or very finely sculptured; distal surface with a disk-like polar thickening; polar thickening smooth, granulate, punctate or diversely ornamented; remaining distal surface ornamented by short, prominent, undulate rugulae (sometimes radially oriented), perfect or imperfect reticulate sculpture or verrucae; spore margin notched or undulate due to the presence of rugulae or verrucae.

Remarks: The genus *Tigrisporites* is unique in possessing a distal polar disk-like thickening which is surrounded by a rugulate, reticulate or verrucate sculpture.

According to the original diagnosis by Klaus (1960), the genus *Tigrisporites* refers only to spores possessing a rugulate sculpture around the distal polar thickening. The generic circumscription of *Tigrisporites* has been expanded here to also include the spores having a reticulate or verrucate sculpture around the distal polar thickening.

40 **Tigrisporites reticulatus** n. sp.

Plate 18, figures 17-19

Description: Trilete; laesurae narrow, straight, and reaching the equator; commissures raised; amb triangular; sides slightly convex, straight or slightly concave; apices rounded; proximal surface almost smooth with reticulate sculpture near the equatorial margin; distal surface with a 10- to 12-micron wide, disk-like, smooth polar thickening; margin of polar thickening slightly undulate; polar thickening surrounded by a perfect reticulate sculpture; lumina 4 to 8 microns long, 2 to 4 microns wide, and usually radially elongated; muri 0.5 micron wide; exine about 1 micron thick.

FIGURE 23. Tigrisporites reticulatus *n. sp. Distal view.*

Size range: Equatorial diameter (18 specimens) 29 (35.5) 41 microns. Holotype 36 microns.

Distribution: Middle Albian to early Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: *Tigrisporites reticulatus* n. sp. differs from all other distally reticulate forms in possessing a distal polar disk-like thickening.

Lycopodiacidites reticulatus n. sp. described by Pannella (1966, p. 60), in his unpublished Ph.D. thesis, is conspecific with *T. reticulatus* n. sp.

The specific name is derived from *"reticulatus"* (net-like) and refers to the perfect reticulate sculpture surrounding the distal polar thickening.

Type locality:

Holotype: Pl. 18, figs. 17, 18. Sample No. 6-H-5; Harmon Member. Section 6.
Paratype: Pl. 18, fig. 19. Sample No. 8-L-12; Loon River Formation. Section 8.
Holotype: Pl. 18, figs. 17, 18. Slide No. 6-H-5(1); co-ord. 7.1/52.3.
Paratype: Pl. 18, fig. 19. Slide No. 8-L-12(1); co-ord. 21.4/73.2.

42 **Tigrisporites scurrandus** Norris, 1967

Plate 19, figures 1-4

See Norris (1967, p. 91) for description.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: This species differs from *Tigrisporites halleinis* Klaus, 1960, in having widely spaced, randomly distributed or tangentially elongated distal rugulae, proximal granules or radially arranged rugulae near the equator, and smaller dimensions.

Tigrisporites scurrandus displays a wide range of variation in the dimensions of the rugulae, and the distal polar thickening.

This species appears to have a wider stratigraphic distribution than originally established by Norris (1967).

Locality of figured specimens:

Pl. 19, figs. 1, 2.	Sample No. 8-L-10;	Loon River Formation.	Section 8.
Pl. 19, figs. 3, 4.	Sample No. 8-L-13;	Loon River Formation.	Section 8.
Pl. 19, figs. 1, 2.	Slide No. 8-L-10(1);	co-ord. 18/72.	
Pl. 19, fig. 3.	Slide No. 8-L-13(3);	co-ord. 8/59.1.	
Pl. 19, fig. 4.	Slide No. 8-L-13(2);	co-ord. 16.5/33.9.	

41 **Tigrisporites** sp. A

Plate 19, figure 5

Description: Trilete; laesurae narrow, simple, and reaching the equator; amb rounded-triangular; proximal surface almost smooth with reticulate sculpture near the equatorial margin; distal surface with a 10- to 12-micron wide, disk-like, smooth polar thickening; margin of the polar thickening slightly undulate; polar thickening surrounded by a perfect reticulate sculpture; lumina 2 to 4 microns long and 1 to 2 microns wide, usually radially elongated; muri 0.5 micron wide; exine about 1 micron thick.

Size range: Equatorial diameter (2 specimens) 33(34.5) 36 microns.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Remarks: *Tigrisporites* sp. A differs from *Tigrisporites reticulatus* n. sp. in having very small lumina.

This species has not been formally named as only three specimens were found.

Locality of figured specimen:

Pl. 19, fig. 5.	Sample No. 6-H-2;	Harmon Member.	Section 6.
Pl. 19, fig. 5.	Slide No. 6-H-2(1);	co-ord. 2.1/60.	

43 **Tigrisporites** sp. B

Plate 19, figure 6

Description: Trilete; laesurae narrow, simple, and reaching the equator; amb triangular; sides straight or slightly convex; apices broadly rounded; proximal surface smooth; distal surface with a 12- to 14-micron wide, disk-like, smooth polar thickening; margin of the polar thickening slightly irregular; polar thickening surrounded by a verrucate sculpture; verrucae 1 to 3 microns in diameter, spaced 0.5 to 1 micron apart, and slightly elongate to irregular in shape; exine about 1.5 microns thick.

Size range: Equatorial diameter (3 specimens) 30 (31.5) 33.5 microns.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: *Tigrisporites* sp. B differs from all other distally verrucate forms in possessing a distal polar disk-like thickening.

This species has not been formally named as only six damaged or poorly preserved specimens were found.

Locality of figured specimen:

Pl. 19, fig. 6.	Sample No. 4-P-7;	Paddy Member.	Section 4.
Pl. 19, fig. 6.	Slide No. 4-P-7(1);	co-ord. 14/35.9.	

Genus **Trilobosporites** Pant, 1954 ex Potonié, 1956

Type species **Trilobosporites hannonicus** (Delcourt and Sprumont) Potonié, 1956

See Delcourt, Dettmann and Hughes (1963, p. 288) for synonymy and restated generic diagnosis.

Remarks: The genus *Trilobosporites* consists of triangular trilete spores with sculptured valvae at the apices and granulate to verrucate exine.

Matonisporites Couper, 1958, emend. Dettmann, 1963, differs from *Trilobosporites* in having smooth exine and membraneous, raised commissures.

76 **Trilobosporites apiverrucatus** Couper, 1958

Plate 19, figures 7, 8

See Couper (1958, p. 142) for description.

Distribution: Late Jurassic to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group of central Alberta (Singh, 1964); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); middle and late Albian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Wealden of England (Couper, 1958); uppermost Jurassic to Valanginian of Holland (Burger, 1966); "Wealden" of France (Delcourt and Sprumont, 1959).

Remarks: This species differs from *Trilobosporites marylandensis* Brenner, 1963, in being larger (60(75)100 microns, *fide* Couper, 1958).

Lygodium multituberculatum Bolkhovitina, 1961, is probably conspecific with *Trilobosporites apiverrucatus.*

Locality of figured specimens:

Pl. 19, fig. 7.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 19, fig. 8.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 19, fig. 7.	Slide No. 8-L-12(1);	co-ord. 9.5/79.5.	
Pl. 19, fig. 8.	Slide No. 4-P-3(2);	co-ord. 18/57.2.	

74 **Trilobosporites crassus** Brenner, 1963

Plate 19, figure 9

See Brenner (1963, p. 70) for description.

Distribution: Middle Albian to early Cenomanian. Loon River Formation, and Harmon, Cadotte, and Paddy Members of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); late Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A.(Pannella, 1966).

Remarks: *Trilobosporites crassus* can be easily distinguished from the other species of *Trilobosporites* by its thickened, wide, smooth lips bordering the laesurae, and its sculptural elements consisting of low rugulae and irregular-shaped verrucae, which are more strongly developed in the apical areas and on the distal surface.

This species appears to have a wider stratigraphic distribution than established by Brenner (1963) and Norris (1967).

Locality of figured specimen:

Pl. 19, fig. 9.	Sample No. 8-L-13;	Loon River Formation.	Section 8.
Pl. 19, fig. 9.	Slide No. 8-L-13(1);	co-ord. 4.3/72.1.	

73 **Trilobosporites humilis** Delcourt and Sprumont, 1959

Plate 19, figures 10-14

See Brenner (1963, p. 71) for synonymy and description.

Distribution: Early Cretaceous. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); "Wealden" of France (Delcourt and Sprumont, 1959).

Remarks: This species is characterized by its triangular amb with straight sides, long laesurae reaching the equator, small valvae composed of two or three enlarged verrucae at the apices, large verrucae lining the laesurae, confluent, flat, irregular-shaped large verrucae at the distal pole, granulate sculpture in the interradial regions of the proximal and distal surfaces, and small size.

The Alberta specimens of *Trilobosporites humilis* are on an average slightly smaller (29 (32.5) 36 microns) than those described from France by Delcourt and Sprumont (1959), which range in size from 30 to 45 microns.

Trilobisporites minutis Levet-Carette, 1966, is probably identical with *T. humilis.*

Locality of figured specimens:

Pl. 19, figs. 10-12.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 19, figs. 13, 14.	Sample No. 7-C-3;	Cadotte Member.	Section 7.
Pl. 19, figs. 10-12.	Slide No. 7-C-8(1);	co-ord. 6.3/53.	
Pl. 19, figs. 13, 14.	Slide No. 7-C-3(2);	co-ord. 19.5/33.8.	

75 **Trilobosporites marylandensis** Brenner, 1963

Plate 19, figures 15, 16

See Brenner (1963, p. 71) for description.

Distribution: Early Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Ellerslie Member (Pocock, 1962), Wabiskaw Member (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Lower Cretaceous of Maryland, U.S.A. (Groot and Penny, 1960); Albian of northern Wyoming, U.S.A. (Davis, 1963).

Remarks: This species differs from *Trilobosporites apiverrucatus* Couper, 1958, in being smaller (33 (45) 54 microns, *fide* Brenner, 1963). The sculptural elements in the proximal and distal polar regions of *Trilobosporites marylandensis* are smaller than those of *T. apiverrucatus.*

The specimens assigned to *T. apiverrucatus* by Groot and Penny (1960) and *T.* sp. cf. *T. apiverrucatus* by Davis (1963) actually belong to *T. marylandensis.* The smaller specimens included within *T. apiverrucatus* by Pocock (1962, pl. 4, fig. 59) and Singh (1964, pl. 8, fig. 18) have been transferred to *T. marylandensis* by Norris (1967, p. 95).

Locality of figured specimens:

Pl. 19, fig. 15.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 19, fig. 16.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 19, fig. 15.	Slide No. 4-P-4-Micro.55;	co-ord. 11.9/47.	
Pl. 19, fig. 16.	Slide No. 4-P-3 (1);	co-ord. 2.5/63.8.	

78 **Trilobosporites tribotrys** Dettmann, 1963

Plate 20, figure 1

See Dettmann (1963, p. 61) for synonymy and description.

Distribution: Late Aptian to Cenomanian. Loon River Formation and Paddy Member of the Peace River area; late Aptian to Albian of southeastern Australia (Dettmann, 1963); Cenomanian of western Siberia (Samoilovitch *et al.*, 1961).

Remarks: This species is characterized by the presence of large spherical verrucae on the muri enclosing the polygonal lumina of its reticulate valvae, and its elongate laesurae bordered by conspicuous, 5-to 7-micron wide verrucate lips.

Trilobosporites tribotrys can be distinguished from *Trilobosporites trioreticulosus* Cookson and Dettmann, 1958, by the presence of large spherical verrucae on the muri of its reticulate valvae.

Locality of figured specimen:

Pl. 20, fig. 1.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 20, fig. 1.	Slide No. 8-L-12(2);	co-ord. 19.1/68.7.	

77 **Trilobosporites trioreticulosus** Cookson and Dettmann, 1958

Plate 20, figure 2

See Dettmann (1963, p. 60) for synonymy and description.

Distribution: Aptian and Albian. Loon River Formation, and Harmon, Cadotte, and Paddy Members of the Peace River area; Ellerslie Member and Grand Rapids Formation of central Alberta (Singh, 1964); upper Mannville equivalent strata of Saskatchewan, Canada (Pocock, 1964); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); middle and late Albian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Aptian to Albian of eastern Australia (Cookson and Dettmann, 1958a; Dettmann, 1963).

Remarks: *Trilobosporites trioreticulosus* is characterized by wide (7 to 9 microns), polygonal to subcircular, shallow lumina, and broad (3 to 5 microns), flat muri on its valvae.

Trilobosporites purverulentus (Verbitskaya) Dettmann, 1963, differs from *T. trioreticulosus* in having a larger number of lumina of smaller size (1.5 to 3 microns in diameter) on its valvae, and a more finely sculptured polar exine.

The Barremian-Cenomanian time range of *T. trioreticulosus* in U.S.S.R., given by Bolkhovitina (1961) and Samoilovitch *et al.* (1961), includes also that of *T. purverulentus*, as they have lumped these two species together.

Locality of figured specimen:

Pl. 20, fig. 2.	Sample No. 7-C-9;	Cadotte Member.	Section 7.
Pl. 20, fig. 2.	Slide No. 7-C-9-Micro. 63;	co-ord. 12.2/44.	

72 **Trilobosporites** sp.

Plate 20, figures 3, 4

Description: Trilete; laesurae 4/5 of the spore radius; commissures often split and bordered by a 2.5-micron wide margo; amb triangular; sides straight; valvae reduced to 2-micron wide thickenings at the apices; proximal surface uniformly granular; distal surface uniformly verrucate; verrucae confluent, flat, irregular-shaped, 2 microns or less in diameter; exine 1 micron thick.

Size range: Equatorial diameter (3 specimens) 25 (27) 29 microns.

Distribution: Middle Albian. Cadotte Member of the Peace River area.

Remarks: *Trilobosporites* sp. differs from *Trilobosporites humilis* Delcourt and Sprumont, 1959, in having smaller sculptural elements of uniform size. *Trilobosporites minor* Pocock, 1962, can be distinguished from *Trilobosporites* sp. by its sculpture consisting of apiculae concentrated at the apices and bordering the laesurae.

This species has not been formally named as only three specimens were found.

Locality of figured specimen:

Pl. 20, figs. 3, 4.	Sample No. 7-C-7;	Cadotte Member;	Section 7.
Pl. 20, figs. 3, 4.	Slide No. 7-C-7 (1);	co-ord. 2.8/77.	

Genus **Undulatisporites** Pflug, 1953

Type species **Undulatisporites microcutis** Pflug, 1953

See Potonié (1956, p. 19) for generic diagnosis.

Remarks: Pflug (*in* Thomson and Pflug, 1953) proposed the genus *Undulatisporites* to accommodate trilete spores with undulate, raised commissures, straight to convex sides, and smooth to slightly sculptured exine.

15 **Undulatisporites fossulatus** n. sp.

Plate 20, figures 5-8

Description: Trilete; laesurae reaching the equator; commissures raised, about 3 microns high, strongly undulate, and bordered by narrow, 1-micron wide lips; amb triangular; sides straight; apices sharply rounded; proximal surface smooth; distal

surface fossulate; fossulae interconnected and usually radially disposed, about 0.5 micron wide; exine about 2 microns thick.

Size range: Equatorial diameter (16 specimens) 27 (32.5) 38 microns. Holotype 33 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Undulatisporites fossulatus* n. sp. is distinct from *Undulatisporites pseudobrasiliensis* Krutzsch, 1959, which has fossulate sculpture on the proximal and distal surfaces, and from *Tripartina variabilis* Maljavkina, 1949, which has concave sides, and lacks the strongly undulate laesurae.

The specific name is derived from *"fossula"* (furrow) and refers to the distal fossulate sculpture.

Type locality:

Holotype: Pl. 20, figs. 5, 6. Sample No. 8-L-1; Loon River Formation. Section 8.
Paratype: Pl. 20, figs. 7, 8. Sample No. 8-L-4; Loon River Formation. Section 8.
Holotype: Pl. 20, figs. 5, 6. Slide No. 8-L-1(3); co-ord. 21.1/40.
Paratype: Pl. 20, figs. 7, 8. Slide No. 8-L-4(1); co-ord. 10/41.2.

14 **Undulatisporites pannuceus** (Brenner) n. comb.

Plate 20, figures 9, 10

1963 *Alsophilidites pannuceus* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 56, pl. 12, figs. 5, 6.

Description: Trilete; laesurae reaching the equator; commissures raised, moderately undulate, and bordered by thickened lips, 1.5 to 2 microns wide; amb triangular with indented outline; sides straight to slightly convex; apices acute; proximal and distal surfaces finely wrinkled; exine about 2 microns thick.

Size range: Equatorial diameter (3 specimens) 36 (38) 42 microns.

Distribution: Barremian to early Cenomanian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: The original assignment of this species to the genus *Alsophilidites* Cookson, 1947 ex Potonié, 1956, by Brenner (1963) appears to be inappropriate. *Alsophilidites* consists of spores with simple, straight laesurae, and smooth exine. *Undulatisporites pannuceus* (Brenner) n. comb. has moderately undulate, raised commissures bordered by thickened lips, and finely wrinkled surface. These are the characteristics of the genus *Undulatisporites*, to which this species has been transferred here.

The specimens of this species described by Brenner (1963) are smaller (11 (24) 34 microns) than the Canadian specimens. However, the two are identical in all other respects.

Locality of figured specimen:

Pl. 20, figs. 9, 10.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 20, figs. 9, 10.	Slide No. 7-C-2(1);	co-ord. 20/67.5.	

12 **Undulatisporites undulapolus** Brenner, 1963

Plate 20, figures 11, 12

See Brenner (1963, p. 72) for description.

Distribution: Barremian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: The width of the thickened lips bordering the raised commissures of the numerous specimens of *Undulatisporites undulapolus* examined during the present study is quite variable.

Undulatisporites sinuosis Groot and Groot, 1962, closely resembles *U. undulapolus*, and differs from it only in having a faintly scabrate exine.

Locality of figured specimens:

Pl. 20, fig. 11.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 20, fig. 12.	Sample No. 8-L-5;	Loon River Formation.	Section 8.
Pl. 20, fig. 11.	Slide No. 7-C-8(2);	co-ord. 21/36.7.	
Pl. 20, fig. 12.	Slide No. 8-L-5(1);	co-ord. 16.1/46.5.	

13 **Undulatisporites** sp.

Plate 20, figure 13

Description: Trilete; laesurae reaching the equator; commissures raised, about 1.5 microns high, undulate; lips 0.5 micron wide; amb rounded- triangular; sides convex; proximal and distal surfaces smooth; exine about 1 micron thick.

Size range: Equatorial diameter (1 specimen) 14 microns.

Distribution: Late Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area.

Remarks: This species has not been formally named as only three specimens were found.

Locality of figured specimen:

Pl. 20, fig. 13.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 20, fig. 13.	Slide No. 4-P-3(1);	co-ord. 2/64.	

Genus **Verrucosisporites** Ibrahim, 1933, emend. Potonié and Kremp, 1954

Type species **Verrucosisporites verrucosus** Ibrahim, 1933, emend. Potonié and Kremp, 1955

See Singh (1964, p. 95) for synonymy and generic diagnosis.

Remarks: The genus *Verrucosisporites* consists of circular to subcircular trilete spores with densely verrucate sculpture. It differs from *Converrucosisporites* Potonié and Kremp, 1954, in not having a triangular to subtriangular outline.

23 **Verrucosisporites rotundus** Singh, 1964

Plate 20, figure 14

See Singh (1964, p. 96) for description.

Distribution: Aptian and Albian. Loon River Formation and Cadotte Member of the Peace River area; Ellerslie Member of central Alberta (Singh, 1964); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Locality of figured specimen:

Pl. 20, fig. 14.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 20, fig. 14.	Slide No. 8-L-9(1);	co-ord. 20.1/50.1.	

Spores - Incertae Sedis

Genus **Inaperturopollenites** Pflug, 1952 ex Thomson and Pflug, 1953, emend. Potonié, 1958

Type species **Inaperturopollenites dubius** (Potonié and Venitz) Thomson and Pflug, 1953

See Potonié (1958, p. 77) for emended generic diagnosis.

Remarks: The genus *Inaperturopollenites* is distinct from *Spheripollenites* Couper, 1958, which possesses a poorly developed germinal pore or a weak exinal area in the polar region. *Laricoidites* Potonié, Thomson and Thiergart, 1950 ex Potonié, 1958, differs from *Inaperturopollenites* in being significantly larger.

133 **Inaperturopollenites** sp.

Plate 21, figure 1

1967 *Inaperturopollenites* sp. Norris, Palaeontographica, Band 120, Abt. B, p. 104, pl. 16, fig. 8.

See Norris (1967, p. 104) for description.

Distribution: Middle and late Albian. Loon River Formation and Harmon Member of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: This species is distinctive on account of its small size and relatively rigid, thick exine.

Locality of figured specimen:

Pl. 21, fig. 1.	Sample No. 8-L-8;	Loon River Formation.	Section 8.
Pl. 21, fig. 1.	Slide No. 8-L-8 (2);	co-ord. 0.6/43.1.	

Genus **Schizosporis** Cookson and Dettmann, 1959

Type species **Schizosporis reticulatus** Cookson and Dettmann, 1959

See Singh (1964, p. 100) for synonymy and generic diagnosis.

Remarks: The genus *Schizosporis* consists of biconvex and circular to elliptical forms which divide equatorially into two approximately equal parts.

131 **Schizosporis reticulatus** Cookson and Dettmann, 1959

Plate 21, figure 2

See Singh (1964, p. 100) for synonymy and description.

Distribution: Berriasian to Cenomanian. Loon River Formation, Cadotte Member and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964) and Viking Formation (Norris, 1967) of central Alberta; Ellerslie Member of Alberta (Pocock, 1962); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian and Cenomanian of Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1966); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Berriasian of England (Norris, 1963); Neocomian-Aptian to Cenomanian? of eastern Australia (Cookson and Dettmann, 1959a; Dettmann, 1963).

Locality of figured specimen:

Pl. 21, fig. 2.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 21, fig. 2.	Slide No. 8-L-3(3);	co-ord. 10/38.5.	

132 **Schizosporis parvus** Cookson and Dettmann, 1959

Plate 21, figures 3, 4

See Singh (1964, p. 101) for synonymy and description.

Distribution: Barremian to Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Deville Member and the Grand Rapids Formation of central Alberta (Singh, 1964); Ellerslie and "calcareous" Members of Alberta (Pocock, 1962); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Albian and Cenomanian of Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1966); Albian and Cenomanian? of eastern Australia (Cookson and Dettmann, 1959a; Dettmann, 1963).

Remarks: *Schizosporis parvus* is distinct from *Schizosporis spriggi* Cookson and Dettmann, 1959, which is circular in equatorial view and larger in size. It is distinct

also from *Schizosporis cooksoni* Pocock, 1962, which is smaller and has a thinner exine.

Locality of figured specimens:

Pl. 21, fig. 3.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 21, fig. 4.	Sample No. 4-S-4;	lower Shaftesbury Formation.	Section 4.
Pl. 21, fig. 3.	Slide No. 8-L-12-Micro. 11;	co-ord. 10.2/42.2.	
Pl. 21, fig. 4.	Slide No. 4-S-4(1);	co-ord. 2/68.	

Class **Basidiomycetes**

Genus **Dyadosporites** van der Hammen, 1954

Type species **Dyadosporites umirensis** van der Hammen, 1954

See Clarke (1965, p. 90) for generic diagnosis.

Remarks: The fungal spores assigned to this genus are bilocular (didymosporous) with a simple central septum and a pore at the apex of each cell. The shape of the spores is elliptical, and the body is smooth to finely punctate.

Dyadosporites ellipsus Clarke, 1965

Plate 21, figure 5

See Clarke (1965, p. 90) for description.

Distribution: Middle Albian to early Pliocene. Loon River Formation and Harmon Member of the Peace River area; late Miocene to early Pliocene of British Columbia, Canada (Martin and Rouse, 1966); Upper Cretaceous of central Colorado, U.S.A. (Clarke, 1965).

Remarks: Two specimens of this species were found. These specimens are bilocular (didymosporous) with a simple, 2-micron thick septum, and a 1.5-to 2-micron wide pore at the apex of each cell. The body is elliptical in shape, 40 microns long, and 19 microns wide. The surface is very finely punctate. These spores differ slightly from the specimens described by Clarke (1965), whose pores are 4 to 5 microns in diameter.

These specimens resemble the teliospores of a rust.

Locality of figured specimen:

Pl. 21, fig. 5.	Sample No. 8-L-13;	Loon River Formation.	Section 8.
Pl. 21, fig. 5.	Slide No. 8-L-13(2);	co-ord. 10/58.	

Genus **Pluricellaesporites** van der Hammen, 1954

Type species **Pluricellaesporites typicus** van der Hammen, 1954

See Clarke (1965, p. 90) for generic diagnosis.

Remarks: The fungal spores assigned to this genus are uniseriate with five or more cells separated by straight septa. The cells are interconnected by a slit-like opening through the septa and have convex sides. The cells in the middle are larger than those at either end of the body.

Pluricellaesporites psilatus Clarke, 1965

Plate 21, figures 6, 7

See Clarke (1965, p. 90) for description.

Distribution: Middle Albian to early Pliocene. Harmon and Paddy Members, and lower Shaftesbury Formation of the Peace River area; late Miocene to early Pliocene of British Columbia, Canada (Martin and Rouse, 1966); Upper Cretaceous of central Colorado (Clarke, 1965), and of western Alabama, U.S.A. (Leopold and Pakiser, 1964).

Remarks: Clarke (1965) assigned forms with almost cylindrical to fusiform shape to this species, which seem to intergrade into each other. The spores are uniseriate with five or more cells. The fusiform specimens usually have about eight cells, and the largest cells in the middle are about 11 microns long and 20 microns wide. These specimens have a total length of about 80 microns. The almost cylindrical specimens are slightly narrower at the two ends and the largest cells in the middle are about 12 microns long and 9 microns wide. The number of cells in these specimens varies according to the length of the body. The cells are interconnected in both types of specimens by a slit-like opening through the septa.

The specimen designated as the "fungal teleutospore of the Basidiomycetae" by Leopold and Pakiser (1964, pl. 9, fig. 1) belongs to *Pluricellaesporites psilatus*.

Locality of figured specimens:

Pl. 21, figs. 6, 7.	Sample No. 4-P-7;	Paddy Member.	Section 4.
Pl. 21, fig. 6.	Slide No. 4-P-7(1);	co-ord. 20/60.8.	
Pl. 21, fig. 7.	Slide No. 4-P-7(1);	co-ord. 9/78.2.	

Class **Ascomycetes**

Fungal fruiting body of the family **Microthyriaceae**

Plate 21, figure 8

Description: Fruiting body disk-like with radiating rows of cells; a simple hole present in the center of the disk due to the dissolution of the central cells; cells square to elongate, 5 to 8 microns long and 3 to 6 microns wide; body melanin-brown in color.

Size range: Total diameter of the fruiting body (1 specimen) 50 microns.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: A single specimen of this fungal fruiting body was found in the Paddy Member. It resembles some of the species of *Microthallites* Dilcher, 1965, and *Asterina* Léveillé, 1845, described by Dilcher (1965, p. 16-19).

Locality of figured specimen:

Pl. 21, fig. 8.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 21, fig. 8.	Slide No. 4-P-6(2);	co-ord. 4.9/64.9.	

Family **Caytoniaceae**

Genus **Vitreisporites** Leschik 1955, emend. Jansonius, 1962

Type species **Vitreisporites signatus** Leschik, 1955

See Singh (1964, p. 102) for synonymy and generic diagnosis.

159 **Vitreisporites pallidus** (Reissinger) Nilsson, 1958

Plate 22, figure 1

See Singh (1964, p. 102) for synonymy and description.

Distribution: Triassic to Cretaceous. Widespread in various parts of the world, including Western Canada.

Locality of figured specimen:

Pl. 22, fig. 1.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 22, fig. 1.	Slide No. 8-L-3(2);	co-ord. 14/79.1.	

160 **Vitreisporites** sp.

Plate 22, figure 2

Description: Bisaccate; central body oval in polar view and longer than broad; bladders finely reticulate and proximally attached at equator; distal sulcus wide, parallel-sided, and smooth; radially oriented muri present on either side of the distal sulcus; bladders wider in relation to central body; length of bladders equal to the length of the central body; exine about 1 micron thick.

Size range: Total breadth of grain (4 specimens) 50 (54.5) 58 microns.
Breadth of central body (4 specimens) 12(14) 15 microns.
Length of central body (4 specimens) 29(30) 31 microns.
Breadth of bladders (4 specimens) 18 (20) 22 microns.
Length of bladders (4 specimens) 28 (29) 30 microns.
Width of distal sulcus (4 specimens) 6 (7) 8 microns.

Distribution: Middle Albian. Loon River Formation and Cadotte Member of the Peace River area.

Remarks: This species differs from *Vitreisporites pallidus* (Reissinger) Nilsson, 1958, in having a distinctly larger size.

Locality of figured specimen:

Pl. 22, fig. 2.	Sample No. 7-C-5;	Cadotte Member.	Section 7.
Pl. 22, fig. 2.	Slide No. 7-C-5(1);	co-ord. 12/67.7.	

Order **Cycadales** or **Bennettitales** or **Ginkgoales**

Genus **Ginkgocycadophytus** Samoilovitch, 1953

Type species **Ginkgocycadophytus caperatus** (Luber) Samoilovitch, 1953

See Potonié (1958, p. 93) for generic diagnosis.

Remarks: The genus *Ginkgocycadophytus* differs from *Cycadopites* Wodehouse, 1933 ex Wilson and Webster, 1946, in having a sulcus which widens and merges with the outline of the body at both the longitudinal ends. It also differs in usually having a granulate to scabrate sculpture.

173 **Ginkgocycadophytus nitidus** (Balme) de Jersey, 1962

Plate 22, figure 3

See Dettmann (1963, p. 104) for synonymy and description.

Distribution: Triassic to Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: This species is distinct from *Cycadopites fragilis* Singh, 1964, which has an almost parallel-sided sulcus and a very thin and smooth exine.

Locality of figured specimen:

Pl. 22, fig. 3.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 22, fig. 3.	Slide No. 8-L-4(1);	co-ord. 4/62.3.	

Family **Araucariaceae**

Genus **Araucariacites** Cookson, 1947 ex Couper, 1953

Type species **Araucariacites australis** Cookson, 1947

See Potonié (1958, p. 81) for generic diagnosis.

Remarks: The genus *Araucariacites* was proposed by Cookson (1947) to incorporate spherical, nonaperturate pollen grains with granular exine.

138 **Araucariacites australis** Cookson, 1947

Plate 22, figure 4

See Couper (1958, p. 151) for synonymy and description.

Distribution: Jurassic to Tertiary. Widespread in various parts of the world, including Western Canada.

Remarks: According to Couper (1958), this species is comparable in all respects with the pollen of the Jurassic araucarian *Brachyphyllum mamillare* Brongniart, 1828.

Locality of figured specimen:

Pl. 22, fig. 4.	Sample No. 8-L-2;	Loon River Formation.	Section 8.
Pl. 22, fig. 4.	Slide No. 8-L-2(3);	co-ord. 18/67.5.	

Family **Taxodiaceae**

Genus **Perinopollenites** Couper, 1958

Type species **Perinopollenites elatoides** Couper, 1958

See Singh (1964, p. 107) for synonymy and generic diagnosis.

141 **Perinopollenites elatoides** Couper, 1958

Plate 22, figures 5, 6

See Singh (1964, p. 107) for synonymy and description.

Distribution: Early Jurassic to Cenomanian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area; Mannville Group (Singh, 1964) and lower part of the Colorado Group (Norris, 1967) of central Alberta; upper part of the Fernie Group, upper part of the Vanguard Formation, and Mannville Group of Western Canada (Pocock, 1962); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian and Cenomanian of Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1966); Jurassic and Lower Cretaceous of England (Couper, 1958); uppermost Jurassic to Valanginian of Holland (Burger, 1966); Lower and Middle Jurassic of Queensland, Australia (de Jersey and Paten, 1964); Lower Jurassic of Antarctica (Norris, 1965).

Locality of figured specimens:

Pl. 22, fig. 5.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 22, fig. 6.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 22, fig. 5.	Slide No. 8-L-9(1);	co-ord. 15.5/51.9.	
Pl. 22, fig. 6.	Slide No. 8-L-7(2);	co-ord. 13.9/46.2.	

Genus **Taxodiaceaepollenites** Kremp, 1949

Type species **Taxodiaceaepollenites hiatus** (Potonié) Kremp, 1949

See Potonié (1958, p. 78) for generic diagnosis.

Remarks: The genus *Taxodiaceaepollenites* consists of spherical pollen grains with weak flecking on the exine and a characteristic V-shaped rupture.

137 **Taxodiaceaepollenites hiatus** (Potonié) Kremp, 1949

Plate 22, figure 7

See Stanley (1965, p. 273) for synonymy and description.

Distribution: Middle Albian to Miocene. Widespread in various parts of the world, including Western Canada.

Remarks: This species has been described by Stanley (1965) under the name of *Thuja*? *hiatus* (Potonié) Stanley. Because of the uncertainty of the natural relationships, it appears preferable to retain this species in the organ-genus *Taxodiaceaepollenites.*

The oldest known occurrence of *Taxodiaceaepollenites hiatus* in other parts of North America is from Cenomanian to Coniacian of Alabama (Leopold and Pakiser, 1964) and Cenomanian of Oklahoma (Hedlund, 1966). This is in accord with the oldest known occurrences of the megafloral remains of *Thuja* and *Taxodium* (see Stanley, 1965, p. 282).

Locality of figured specimen:

Pl. 22, fig. 7.	Sample No. 8-L-2;	Loon River Formation.	Section 8.
Pl. 22, fig. 7.	Slide No. 8-L-2(1);	co-ord. 18.3/75.8.	

Family **Podocarpaceae**

Genus **Dacrycarpites** Cookson and Pike, 1953

Type species **Dacrycarpites australiensis** Cookson and Pike, 1953

See Potonié (1958, p. 72) for generic diagnosis.

Remarks: This genus was proposed by Cookson and Pike (1953) to accommodate trisaccate pollen grains with a similar construction to those of living species of *Podocarpus* (section *Dacrycarpus*). *Dacrycarpites* has a very wide, triangular distal furrow, a central body with a finely rugulate proximal surface, a thickened, coarsely rugulate marginal rim, and a crenate outer edge. The bladders are large, and have radial striations near the base. *Dacrycarpites* is distinct from *Microcachryidites* Cookson, 1947 ex Couper, 1953, whose bladders are smaller, and are attached closer to the distal pole so that they do not extend far beyond the margin of the central body.

169 **Dacrycarpites** sp.

Plate 22, figure 8

Description: Trisaccate; central body circular to triangular in polar view; proximal surface of the central body very finely rugulate; bladders distally pendant and attached close to the margin of the central body; length of bladders more than their breadth; bladders approximately equal in size to the central body; bladders with radially disposed muri near their bases and finely reticulate sculpture on the remaining surface; distal furrow very wide, triangular in shape, and smooth.

Size range: Maximum diameter of grain (4 specimens) 26 (30) 36 microns.
Maximum diameter of central body (3 specimens) 15 (19) 24 microns.
Breadth of bladders (3 specimens) 12 (14) 17 microns.
Length of bladders (3 specimens) 15 (23) 26 microns.

Distribution: Middle Albian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area.

Remarks: The central body of *Dacrycarpites* sp. lacks the thickened marginal rim and the coarsely crenate outer edge, which characterize some of the described species of this genus.

Locality of figured specimen:

Pl. 22, fig. 8.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 22, fig. 8.	Slide No. 7-C-8(2);	co-ord. 1.8/63.8.	

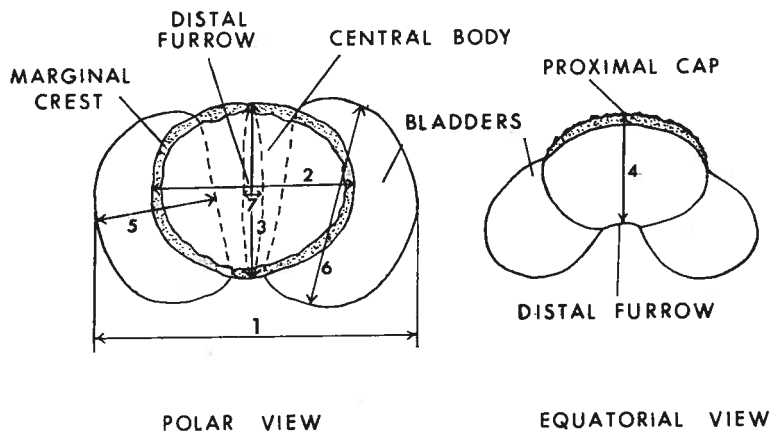


FIGURE 24. Measurements of a bisaccate pollen grain. 1. Total breadth of the grain. 2. Breadth of central body. 3. Length of central body. 4. Height of central body. 5. Breadth of bladders. 6. Length of bladders. 7. Width of distal furrow.

Genus **Parvisaccites** Couper, 1958

Type species **Parvisaccites radiatus** Couper, 1958

See Singh (1964, p. 112) for synonymy and generic diagnosis.

154 **Parvisaccites radiatus** Couper, 1958

Plate 22, figures 9, 10

See Singh (1964, p. 112) for synonymy and description.

Distribution: Late Jurassic to early Cenomanian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Ellerslie and Wabiskaw Members (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; McMurray and Clearwater Formations of Alberta (Pocock, 1962); Albian of the Arctic Islands, Canada (McGregor, 1965); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Wealden and Aptian of England (Couper, 1958); Barremian to Albian of Holland (Couper and Hughes, 1963); uppermost Jurassic to Valanginian of Holland (Burger, 1966); "Wealden" of France (Levet-Carette, 1966).

Locality of figured specimens:

Pl. 22, fig. 9.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 22, fig. 10.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 22, fig. 9.	Slide No. 7-C-2(1);	co-ord. 10/48.	
Pl. 22, fig. 10.	Slide No. 8-L-7(1);	co-ord. 18.3/57.8.	

Genus **Phyllocladidites** Cookson, 1947 ex Couper, 1953

Type species **Phyllocladidites mawsonii** Cookson, 1947

See Singh (1964, p. 113) for synonymy and generic diagnosis.

155 **Phyllocladidites inchoatus** (Pierce) Norris, 1967

Plate 22, figure 11

See Norris (1967, p. 103) for synonymy and description.

Distribution: Middle Albian to Cenomanian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); Cenomanian of Minnesota, U.S.A. (Pierce, 1961).

Remarks: The specimens assigned to *Granabivesiculites inchoatus* by Pierce (1961) were transferred to the genus *Phyllocladidites* Cookson, 1947 ex Couper, 1953, by Norris (1967). According to Norris, *Bacubivesiculites inchoatus* Pierce, 1961, and *Clavabivesiculites inchoatus* Pierce, 1961, may be synonymous with *Phyllocladidites inchoatus* (Pierce) Norris, 1967.

Locality of figured specimen:

Pl. 22, fig. 11.	Sample No. 7-C-6;	Cadotte Member.	Section 7.
Pl. 22, fig. 11.	Slide No. 7-C-6(2);	co-ord. 8/66.2.	

156 **Phyllocladidites** sp.

Plate 22, figure 12

1964 *Phyllocladidites* sp. Singh, Res. Coun. Alberta, Bull. 15, p. 114, pl. 15, fig. 10.

See Singh (1964, p. 114) for description.

Distribution: Middle and late Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area; Wabiskaw Member of central Alberta (Singh, 1964).

Remarks: *Phyllocladidites* sp. is characterized by very thick bladders.

Locality of figured specimen:

Pl. 22, fig. 12.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 22, fig. 12.	Slide No. 7-S-2(1);	co-ord. 8/75.7.	

Genus **Podocarpidites** Cookson, 1947 ex Couper, 1953

Type species **Podocarpidites ellipticus** Cookson, 1947

See Singh (1964, p. 115) for synonymy and generic diagnosis.

149 **Podocarpidites** sp. cf. **P. ellipticus** Cookson, 1947

Plate 22, figure 13

See Singh (1964, p. 115) for synonymy and description.

Distribution: Jurassic and Early Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964) and lower part of the Colorado Group (Norris, 1967) of central Alberta; Sinemurian and Berriasian of the Arctic Islands, Canada (McGregor, 1965); Jurassic and Lower Cretaceous of Western Australia (Balme, 1957); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: This species is characterized by a very wide distal furrow, and a central body which is usually longer than broad.

Locality of figured specimen:

Pl. 22, fig. 13.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 22, fig. 13.	Slide No. 8-L-9(3);	co-ord. 20.9/65.6.	

145 **Podocarpidites biformis** Rouse, 1957

Plate 23, figures 1, 2

See Rouse (1957, p. 367) for description.

Distribution: Late Jurassic to Campanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Oldman and Kootenay Formations of Western Canada (Rouse, 1957, 1959); late Berriasian of the Arctic Islands, Canada (McGregor, 1965); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963).

Remarks: This species is distinct from *Podocarpidites multesimus* (Bolkhovitina) Pocock, 1962, which is smaller (from 62 to 77 microns in total width, according to Bolkhovitina, 1956), and lacks the dense microreticulate sculpture on the central body.

Locality of figured specimen:

Pl. 23, figs. 1, 2.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 23, figs. 1, 2.	Slide No. 8-L-12(3);	co-ord. 4.4/45.9.	

146 **Podocarpidites canadensis** Pocock, 1962

Plate 23, figures 3, 4

See Singh (1964, p. 118) for synonymy and description.

Distribution: Hauterivian to middle Albian. Loon River Formation and Harmon Member of the Peace River area; Mannville Group (except Deville Member) of central Alberta (Singh, 1964); Deville and Ellerslie Members of Alberta (Pocock, 1962); Hauterivian and Aptian of the Arctic Islands, Canada (McGregor, 1965).

Remarks: This species is distinct from *Podocarpidites biformis* Rouse, 1957, which is smaller (from 75 to 90 microns in total width, according to Rouse, 1957), and has a dense microreticulate sculpture on the central body.

Locality of figured specimens:

Pl. 23, figs. 3, 4.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 23, fig. 3.	Slide No. 8-L-9-Micro. 31;	co-ord. 13.8/42.6.	
Pl. 23, fig. 4.	Slide No. 8-L-9-Micro. 31;	co-ord. 10.7/42.	

151 **Podocarpidites epistratus** Brenner, 1963

Plate 23, figure 5

See Brenner (1963, p. 81) for description.

Distribution: Late Jurassic to early Cenomanian. Loon River Formation, Harmon, and Cadotte Members of the Peace River area; late Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); uppermost Jurassic to Valanginian of Holland (Burger, 1966).

Remarks: This species is characterized by its small size, ranging from 25 to 35 microns in total width (Brenner, 1963), and its circular central body with a scabrate proximal and a smooth distal surface. The length of the bladders is approximately twice their width, and equal to the length of the central body. The bladders are constricted at the base, and have radially disposed muri in the region where they merge with the central body.

This species has been described as *Parvisaccites epistratus* by Pannella (1966, p. 101).

Locality of figured specimen:

Pl. 23, fig. 5.	Sample No. 8-L-1;	Loon River Formation.	Section 8.
Pl. 23, fig. 5.	Slide No. 8-L-1-Micro. 6;	co-ord. 12.2/41.2.	

150 **Podocarpidites granulatus** n. sp.

Plate 23, figures 6-9

Description: Bisaccate; breadth of central body greater than the length; marginal crest present; proximal surface of the central body granulate; granules 0.5 to 1.5 microns in diameter; bladders distally pendant; length of the bladders greater than their breadth, and slightly more than the length of the central body; bladders finely reticulate; distal furrow wide and smooth.

Size range: Total breadth of grain (11 specimens) 42 (48.5) 57 microns.
Holotype 55 microns.
Breadth of central body (6 specimens) 33 (36) 38 microns.
Holotype 36 microns.
Length of central body (3 specimens) 27 (29) 31 microns.
Holotype 31 microns.
Height of central body (3 specimens) 24 (26) 28 microns.
Breadth of bladders (6 specimens) 19 (21) 24 microns.
Holotype 24 microns.
Length of bladders (4 specimens) 31 (35) 36 microns.
Holotype 35 microns.
Width of distal sulcus (3 specimens) 8 (10) 12 microns.
Holotype 8 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: This species is characterized by the distinctly granulate proximal sculpture of its central body.

Podocarpidites granulatus n. sp. can be distinguished from *Podocarpidites epistratus* Brenner, 1963, by its larger size and wider central body. *Podocarpidites minisculus* Singh, 1964, is distinct from *P. granulatus* n. sp. in having a central body whose length is greater than the breadth. *P. granulatus* n. sp. is distinguishable from *Podocarpidites* sp. cf. *P. ellipticus* Cookson, 1947, which has a larger size, a central body whose length is greater than the breadth, and considerably larger bladders.

The specific name is derived from *"granulatus"* (granulate) and refers to the granulate proximal surface of the central body.

Type locality:

Holotype: Pl. 23, fig. 6.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Paratype: Pl. 23, figs. 7, 8.	Sample No. 8-L-5;	Loon River Formation.	Section 8.
Paratype: Pl. 23, fig. 9.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Holotype: Pl. 23, fig.6.	Slide No. 8-L-12 (1);	co-ord. 14/59.5.	
Paratype: Pl. 23, figs. 7, 8.	Slide No. 8-L-5 (2);	co-ord. 10.1/31.6.	
Paratype: Pl. 23, fig. 9.	Slide No. 8-L-11 (1);	co-ord. 3/51.1.	

153 **Podocarpidites** sp. cf. **P. herbstii** Burger, 1966

Plate 23, figure 10

See Burger (1966, p. 260) for description.

Distribution: Middle and late Albian. Cadotte Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Podocarpidites* sp. cf. *P. herbstii* Burger, 1966, closely resembles *Podocarpidites herbstii* Burger, 1966, described from the beds of Late Jurassic and Valanginian age of Holland, but differs in having a smaller central body and overall size (60 to 66 microns). The overall size of *P. herbstii* is from 75 to 85 microns (Burger, 1966).

This species is characterized by a central body whose width is approximately 1.4 times its length. The total width of the grain is normally twice its length. The bladders are small and widely separated from each other.

P. sp. cf. *P. herbstii* is considerably smaller than *Podocarpidites naumovai* Singh, 1964.

Locality of figured specimen:

Pl. 23, fig. 10.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 23, fig. 10.	Slide No. 7-C-8 (2);	co-ord. 18.8/76.2.	

152 **Podocarpidites minisculus** Singh, 1964

Plate 24, figure 1

See Singh (1964, p. 117) for description.

Distribution: Aptian and Albian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; Ellerslie Member, and Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964).

Locality of figured specimen:

Pl. 24, fig. 1.	Sample No. 7-H-1 (A);	Harmon Member.	Section 7.
Pl. 24, fig. 1.	Slide No. 7-H-1 (A) (2);	co-ord. 15/43.	

147 **Podocarpidites multesimus** (Bolkhovitina) Pocock, 1962

Plate 24, figure 2

See Singh (1964, p. 116) for synonymy and description.

Distribution: Jurassic and Cretaceous. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group of central Alberta (Pocock, 1962; Singh, 1964); Edmonton Formation of Alberta (Srivastava, 1966); Lower Jurassic of the Vilyui Basin, U.S.S.R. (Bolkhovitina, 1956); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Locality of figured specimen:

Pl. 24, fig. 2.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 24, fig. 2.	Slide No. 8-L-7 (1);	co-ord. 6/57.	

148 **Podocarpidites radiatus** Brenner, 1963

Plate 24, figure 3

See Brenner (1963, p. 82) for description.

Distribution: Late Jurassic to Albian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); uppermost Jurassic to Valanginian of Holland (Burger, 1966).

Remarks: This species is characterized by bladders which have radially disposed muri in the region where they merge with the central body.

Locality of figured specimen:

Pl. 24, fig. 3.	Sample No. 8-L-5;	Loon River Formation.	Section 8.
Pl. 24, fig. 3.	Slide No. 8-L-5 (3);	co-ord. 3/74.3.	

Genus **Rugubivesiculites** Pierce, 1961

Type species **Rugubivesiculites convolutus** Pierce, 1961

See Potonié (1966, p. 126) for generic diagnosis.

Remarks: Pierce (1961) proposed this genus to accommodate bisaccate pollen with rugulate sculpture on the proximal surface of the central body.

157 **Rugubivesiculites reductus** Pierce, 1961

Plate 24, figures 4, 5

See Pierce (1961, p. 41) for description.

Distribution: Middle Albian to Paleocene. Cadotte Member of the Peace River area; Viking Formation and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Cenomanian of Minnesota, U.S.A. (Pierce, 1961); late Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Senonian and Paleocene of Sarawak, Malaysia (Muller, 1968).

Remarks: This species is characterized by saccate marginal frills at the base of the bladders on the distal surface, and sparse, weakly developed rugulate ridges on the proximal surface of the central body.

The specimens assigned to *Rugubivesiculites reductus* by Burger (1966, pl. 31, fig. 2; pl. 32, figs. 1 a-b) probably belong to the genus *Podocarpidites.*

Locality of figured specimen:

Pl. 24, figs. 4, 5.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 24, figs. 4, 5.	Slide No. 7-C-2 (1);	co-ord. 11.8/60.8.	

158 **Rugubivesiculites rugosus** Pierce, 1961

Plate 24, figures 6, 7

See Pierce (1961, p. 40) for description.

Distribution: Late Albian and Cenomanian. Lower Shaftesbury Formation of the Peace River area; Viking Formation and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Cenomanian of Minnesota, U.S.A. (Pierce, 1961); late Albian of northern Wyoming, U.S.A. (Davis, 1963).

Remarks: This species is characterized by dense, broad, rugulate ridges with sharp angular bends on the proximal surface of the central body. The bladders are broadly attached to the central body.

Rugubivesiculites rugosus differs from *Rugubivesiculites reductus* Pierce, 1961, which has saccate marginal frills at the base of the bladders on the distal surface, and

sparse, weakly developed rugulate ridges on the proximal surface of the central body.

Rugubivesiculites sp. A, described and illustrated by Davis (1963, pl. 7, fig. 7) from the Newcastle Formation and Shell Creek Shale (late Albian) of northern Wyoming, U.S.A., is conspecific with *Rugubivesiculites rugosus.*

Locality of figured specimens:

Pl. 24, fig. 6.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 24, fig. 7.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 24, fig. 6.	Slide No. 7-S-2 (1);	co-ord. 4.9/76.8.	
Pl. 24, fig. 7.	Slide No. 2-S-3 (1);	co-ord. 19/50.	

Family **Pinaceae**

Genus **Abiespollenites** Thiergart, 1937, emend. Potonié, 1958

Type species **Abiespollenites absolutus** Thiergart, 1937

See Potonié (1958, p. 63) for generic diagnosis.

Remarks: This genus contains large (usually larger than 95 microns) bisaccate pollen with strongly distally pendant bladders, which are restricted to the area distal to the equator and are distinctly set off from the central body. The bladders are smaller than the central body and have an almost circular outline. The genus *Abiespollenites* is morphologically similar to pollen of the modern genus *Abies,* family Pinaceae.

168 **Abiespollenites** sp.

Plate 24, figure 8

Description: Bisaccate; bladders small in comparison to the central body and strongly distally pendant; base of bladders restricted to the area distal to the equator; bladders almost circular in outline, and distinctly set off from the central body; body and bladders with a finely reticulate sculpture; distal furrow wide.

Size range: Total breadth of grain (3 specimens) 135 (140) 150 microns.
Breadth of central body (1 specimen) 106 microns.
Breadth of bladders (1 specimen) 76 microns.
Height of central body (1 specimen) 82 microns.

Distribution: Middle Albian. Loon River Formation, and Harmon and Cadotte Members of the Peace River area.

Remarks: This species closely resembles the specimens assigned to *Abiespollenites* sp. by Manum (1962, pl. 6, figs. 1, 2), which are, however, slightly smaller (110 to 130 microns) in size.

Locality of figured specimens:

Pl. 24, fig. 8.	Sample No. 8-L-1;	Loon River Formation.	Section 8.
Pl. 24, fig. 8.	Slide No. 8-L-1 (2);	co-ord. 14.2/68.	

Genus **Alisporites** Daugherty, 1941, restr. Potonié and Kremp, 1956

Type species **Alisporites opii** Daugherty, 1941

See Singh (1964, p. 107) for synonymy and generic diagnosis.

162 **Alisporites bilateralis** Rouse, 1959

Plate 24, figure 9

1959 *Alisporites bilateralis* Rouse, Micropaleont., vol. 5, p. 316, pl. 1, figs. 10, 11.

1962 *Alisporites thomasii* (Couper) Pocock (part), Palaeontographica, Band 111, Abt. B, p. 62, pl. 9, fig. 143 only.

1964 *Alisporites thomasii* (Couper) Pocock–Singh, Res. Coun. Alberta, Bull. 15, p. 109, pl. 14, figs. 11, 12.

See Singh (1964, p. 109) for description.

Distribution: Late Jurassic to Cenomanian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and lower part of the Colorado Group (Norris, 1967) of central Alberta; Fernie and Vanguard Formations, and the Mannville Group of Western Canada (Pocock, 1962); Kootenay Formation of southeastern British Columbia (Rouse, 1959); early Hauterivian of the Arctic Islands, Canada (McGregor, 1965); Albian and Cenomanian of Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1966); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963).

Remarks: *Alisporites bilateralis* Rouse, 1959, is characterized by a wide, parallel-sided distal furrow. It is distinct from *Pteruchipollenites thomasii* Couper, 1958, which has a lenticular, sharply delimited distal furrow, and a markedly elongate central body (Couper, 1958, pl. 26, figs. 10-12; Norris, 1965, p. 253, fig. 3C; Norris, 1967, p. 101). The specimens erroneously assigned to *Alisporites thomasii* by Pocock (1962), Singh (1964) and McGregor (1965, p. 24) actually belong to *Alisporites bilateralis* Rouse, 1959.

Locality of figured specimen:

Pl. 24, fig. 9.	Sample No. 8-L-4;	Loon River Formation.	Section 8.
Pl. 24, fig. 9.	Slide No. 8-L-4 (3);	co-ord. 10/34.9.	

163 **Alisporites grandis** (Cookson) Dettmann, 1963

Plate 25, figures 1, 2

See Cookson (1953, p. 471) for description.

Distribution: Late Jurassic and Early Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Pocock, 1962; Singh, 1964), and the lower part of the Colorado Group (Norris, 1967) of central Alberta; Kootenay Formation of southeastern British Columbia (Rouse, 1959); early Hauterivian and Albian of the Arctic Islands, Canada (McGregor, 1965); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); Valanginian to Albian of Rumania (Baltes, 1965); pre-Tertiary strata of South Australia (Cookson, 1953); Oxfordian to Aptian of Western Australia (Balme, 1957); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Remarks: Dettmann (1963, p. 102) has treated *Alisporites rotundus* Rouse, 1959, as a junior synonym of *Alisporites grandis*. The specimens erroneously assigned to *Alisporites rotundus* by Rouse (1959, p. 316), Pocock (1962, p. 61), Singh (1964, p. 110) and Baltes (1965, p. 11), actually belong to *Alisporites grandis*. A detailed synonymy of this species has been listed by Norris (1967, p. 101).

Locality of figured specimen:

Pl. 25, figs. 1, 2.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 25, figs. 1, 2.	Slide No. 8-L-7-Micro. 21;	co-ord. 10.1/41.3.	

161 **Alisporites** sp. cf. **A. microsaccus** (Couper) Pocock, 1962

Plate 25, figure 3

See Singh (1964, p. 108) for synonymy and description.

Distribution: Late Jurassic and Early Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group of central Alberta (Singh, 1964); Fernie and Vanguard Formations, and Deville and Ellerslie Members of Western Canada (Pocock, 1962); early Hauterivian of the Arctic Islands, Canada (McGregor, 1965).

Locality of figured specimen:

Pl. 25, fig. 3.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 25, fig. 3.	Slide No. 7-C-7 (2);	co-ord. 20.4/65.6.	

Genus **Cedripites** Wodehouse, 1933

Type species **Cedripites eocenicus** Wodehouse, 1933

See Singh (1964, p. 111) for synonymy and generic diagnosis.

165 **Cedripites canadensis** Pocock, 1962

Plate 25, figures 4, 5

See Singh (1964, p. 112) for synonymy and description.

Distribution: Barremian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and the lower part of the Colorado Group (Norris, 1967) of central Alberta; Ellerslie Member of Alberta (Pocock, 1962).

Locality of figured specimens:

Pl. 25, fig. 4.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 25, fig. 5.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 25, fig. 4.	Slide No. 8-L-7 (1);	co-ord. 17/77.2.	
Pl. 25, fig. 5.	Slide No. 8-L-11 (1);	co-ord. 17/34.6.	

164 **Cedripites cretaceus** Pocock, 1962

Plate 25, figure 6

See Singh (1964, p. 111) for synonymy and description.

Distribution: Barremian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and the lower part of the Colorado Group (Norris, 1967) of central Alberta; McMurray Formation of Alberta (Pocock, 1962).

Locality of figured specimen:

Pl. 25, fig. 6.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 25, fig. 6.	Slide No. 8-L-7-Micro. 51;	co-ord. 12/42.2.	

Genus **Cerebropollenites** Nilsson, 1958

Type species **Cerebropollenites mesozoicus** (Couper) Nilsson, 1958

See Nilsson (1958, p. 72) for generic diagnosis.

Remarks: Nilsson (1958) proposed the genus *Cerebropollenites* to accommodate inaperturate, azonate pollen grains with a smooth, thin, circular area on the distal surface and numerous, small, saccate, corrugated protrusions of uniform size over the rest of the body.

Cerebropollenites differs from *Tsugaepollenites* Potonié and Venitz, 1934, emend. Potonié, 1958, which is zonate, and has a more or less prominent equatorial fringe (velum) formed by larger sacci (vesiculae).

Dettmann (1963, p. 99) has treated the genus *Cerebropollenites* as a junior synonym of *Tsugaepollenites*. However, in the writer's opinion, Dettmann has made the generic circumscription of *Tsugaepollenites* too wide by merging numerous morphologically distinct genera. Manum (1962, p. 45) and Potonié (1966, p. 117) have given a more acceptable definition of the genus *Tsugaepollenites*.

172 **Cerebropollenites mesozoicus** (Couper) Nilsson, 1958

Plate 25, figure 7

1958 *Tsugaepollenites mesozoicus* Couper, Palaeontographica, Band 103, Abt. B, p. 155, pl. 30, figs. 8-10.

1958 *Cerebropollenites mesozoicus* (Couper) Nilsson, Lunds Universitets Årsskrift, N.F., Avd. 2, Band 54, p. 72, pl. 6, figs. 10-12.

See Burger (1966, p. 261) for description.

Distribution: Jurassic and Cretaceous. Widespread in North America and Europe.

Locality of figured specimen:

Pl. 25, fig. 7.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 25, fig. 7.	Slide No. 8-L-7(2);	co-ord. 10.9/43.2.	

Genus **Laricoidites** Potonié, Thomson and Thiergart, 1950 ex Potonié, 1958

Type species **Laricoidites magnus** (Potonié) Potonié, Thomson and Thiergart, 1950

See Stanley (1965, p. 278) for synonymy and generic diagnosis.

Remarks: Manum (1962, p. 39) and Potonié (1966, p. 141) have treated the genus *Laricoidites* as a junior synonym of the genus *Inaperturopollenites* Pflug, 1952 ex Thomson and Pflug, 1953. However, in the writer's opinion, the inaperturate pollen grains, which are over 50 microns (occasionally about 150 microns) in diameter and resemble the pollen of the modern genus *Larix*, should be assigned to the distinct genus *Laricoidites*.

134 **Laricoidites magnus** (Potonié) Potonié, Thomson and Thiergart, 1950

Plate 25, figure 8

See Stanley (1965, p. 278) for synonymy and description.

Distribution: Cretaceous and Tertiary. Widespread in North America and Europe.

Locality of figured specimen:

Pl. 25, fig. 8. Sample No. 8-L-12; Loon River Formation. Section 8.
Pl. 25, fig. 8. Slide No. 8-L-12-Micro. 50; co-ord. 10.8/42.8.

Genus **Pityosporites** Seward, 1914, emend. Manum, 1960

Type species **Pityosporites antarcticus** Seward, 1914

See Singh (1964, p. 121) for synonymy and generic diagnosis.

166 **Pityosporites alatipollenites** (Rouse) Singh, 1964

Plate 25, figure 9

See Singh (1964, p. 123) for synonymy and description.

Distribution: Late Jurassic to Late Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Ellerslie Member, Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964); Kootenay and Brazeau Formations of Western Canada (Rouse, 1959).

Locality of figured specimen:

Pl. 25, fig. 9. Sample No. 8-L-7; Loon River Formation. Section 8.
Pl. 25, fig. 9. Slide No. 8-L-7-Micro. 52; co-ord. 9/45.6.

167 **Pityosporites constrictus** Singh, 1964

Plate 25, figure 10

See Singh (1964, p. 122) for description.

Distribution: Aptian and Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Ellerslie Member and Clearwater Formation of central Alberta (Singh, 1964).

Locality of figured specimen:

Pl. 25, fig. 10.	Sample No. 8-L-8;	Loon River Formation.	Section 8.
Pl. 25, fig. 10.	Slide No. 8-L-8 (1);	co-ord. 10/59.	

Aberrant **Pityosporites** pollen

Plate 26, figure 1

Description: Bisaccate; bladders distally pendant and constricted at the base; body consisting of two pollen grains grown together, separation having failed on the proximal side. Total breadth of grains 75 microns; breadth of the central body 50 microns.

Remarks: A single specimen was recorded from the Loon River Formation.

Locality of figured specimen:

Pl. 26, fig. 1.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 26, fig. 1.	Slide No. 8-L-3 (3);	co-ord. 9.4/43.6.	

Subclass **Coniferophyta – Incertae Sedis**

Genus **Callialasporites** Dev, 1961

Type species **Callialasporites trilobatus** (Balme) Dev, 1961

See Dev (1961, p. 48) for generic diagnosis.

Remarks: Dev (1961) proposed the genus *Callialasporites* to accommodate saccate pollen grains whose central body is encircled by an equatorial bladder. The equatorial bladder may be entire, intensely radially folded or separated into three distinct bladders. The proximal trilete mark, which consists of three radial ridges, is distinct or only faintly represented. The exine on the central body is infragranulate to microreticulate.

Callialasporites is distinct from *Tsugaepollenites* Potonié and Venitz, 1934, emend. Potonié, 1958, which has numerous, small, and distinct sacci (vesiculate).

Dettmann (1963, p. 99) has treated the genus *Callialasporites* as a junior synonym of *Tsugaepollenites*. However, in the writer's opinion, Dettmann has made the generic circumscription of *Tsugaepollenites* too wide by merging numerous morphologically distinct genera. A more acceptable definition of the genus *Callialasporites*, given by Potonié (1966, p. 127), has been followed in the present study.

Applanopsis Döring, 1961, *Triangulopsis* Döring, 1961, and *Pflugipollenites* Pocock, 1962, are junior synonyms of the genus *Callialasporites*.

170 **Callialasporites dampieri** (Balme) Dev, 1961

Plate 26, figure 2

1957 *Zonalapollenites dampieri* Balme, Australia, C.S.I.R.O., Coal Res. Sect., Ref. T.C. 25, p. 32, pl. 8, figs. 88-90.

1961 *Callialasporites dampieri* (Balme) Dev, The Palaeobotanist, vol. 8, p. 48, pl. 4, figs. 26, 27.

1961 *Applanopsis dampieri* (Balme) Döring, Geologie, Jahrg. 10, p. 113, pl. 16, figs. 11-15.

1962 *Pflugipollenites dampieri* (Balme) Pocock, Palaeontographica, Band 111, Abt. B, p. 72, pl. 12, figs. 183, 184.

1963 *Tsugaepollenites dampieri* (Balme) Dettmann, Proc. Roy. Soc. Victoria, vol.77, pt. 1, p. 100, pl. 24, figs. 1-5.

See Balme (1957, p. 32) for description.

Distribution: Jurassic to Eocene. Widespread in various parts of the world, including Western Canada.

Remarks: This species is characterized by an equatorial bladder, which is entire, of uniform width, and radially folded. A vestigial trilete mark is usually present, and the central body is finely granulate.

Callialasporites dampieri is distinguished from *Callialasporites segmentatus* (Balme) Dev, 1961, which has polar vesiculae, thicker ektexine, and more strongly folded, segmented, and narrow equatorial saccus. *Callialasporites trilobatus* (Balme) Dev, 1961, differs from *C. dampieri* in having small polar vesiculae, and a trilobate, radially folded saccus.

Tsugaepollenites and its junior synonym *Zonalapollenites* Pflug, 1953, are distinct from the genus *Callialasporites.* The specimens of this species, assigned to the former two genera by Balme (1957) and Dettmann (1963), actually belong to *C. dampieri. Applanopsis dampieri* (Balme) Doring, 1961, and *Pflugipollenites dampieri* (Balme) Pocock, 1962, are junior synonyms of *C. dampieri.*

Locality of figured specimen:

Pl. 26, fig. 2.	Sample No. 6-H-5;	Harmon Member.	Section 6.
Pl. 26, fig. 2.	Slide No. 6-H-5 (1);	co-ord. 5.2/39.2.	

171 **Callialasporites** sp.

Plate 26, figures 3, 4

Description: Saccate equatorially; vesiculate in polar regions; body biconvex; amb circular; laesurae inconspicuous; equatorial saccus 3 to 4 microns wide, with radial folds; polar vesiculae elongate, rugulate, anastomosing and up to 2 microns high; exine about 3 microns thick.

Size range: Total diameter of grain (1 specimen) 65 microns.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: *Callialasporites* sp. differs from *Callialasporites segmentatus* (Balme) Dev, 1961, in having a very narrow equatorial saccus.

Locality of figured specimen:

Pl. 26, figs. 3, 4.	Sample No. 8-L-6;	Loon River Formation.	Section 8.
Pl. 26, figs. 3, 4.	Slide No. 8-L-6 (1);	co-ord. 12.2/37.1.	

Genus **Classopollis** Pflug, 1953, emend. Pocock and Jansonius, 1961

Type species **Classopollis classoides** Pflug, 1953

See Singh (1964, p. 124) for synonymy and generic diagnosis.

140 **Classopollis classoides** Pflug, emend. Pocock and Jansonius, 1961

Plate 26, figures 5-7

See Singh (1964, p. 125) for synonymy and description.

Distribution: Rhaetic to Eocene. Widespread in various parts of the world,

including Western Canada. Particularly abundant in Jurassic rocks throughout the world.

Locality of figured specimens:

Pl. 26, fig. 5.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 26, fig. 6.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 26, fig. 7.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 26, fig. 5.	Slide No. 8-L-12 (3);	co-ord. 0/79.1.	
Pl. 26, fig. 6.	Slide No. 8-L-7 (1);	co-ord. 11.5/66.	
Pl. 26, fig. 7.	Slide No. 8-L-9 (1);	co-ord. 11/38.1.	

Genus **Eucommiidites** Erdtman, 1948, emend. Hughes, 1961

Type species **Eucommiidites troedssonii** Erdtman, 1948

See Singh (1964, p. 127) for synonymy and generic diagnosis.

142 **Eucommiidites troedssonii** Erdtman, 1948

Plate 26, figure 8

See Burger (1966, p. 267) for description.

Distribution: Jurassic and Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: This species is characterized by its ellipsoidal shape.

Locality of figured specimen:

Pl. 26, fig. 8.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 26, fig. 8.	Slide No. 8-L-9 (3);	co-ord. 4.1/51.2.	

143 **Eucommiidites minor** Groot and Penny, 1960

Plate 26, figures 9, 10

See Groot and Penny (1960, p. 234) for description.

Distribution: Late Jurassic to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and the lower part of the Colorado Group

(Norris, 1967) of central Alberta; upper part of Fernie Group, Vanguard Formation, and the Mannville Group of Western Canada (Pocock, 1962); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Barremian to Albian of Maryland, U.S.A. (Groot and Penny, 1960; Brenner, 1963); Upper Jurassic (Norris, 1963), and Hauterivian to Aptian (Hughes, 1961) of England; uppermost Jurassic to Valanginian of Holland (Burger, 1966); Aptian and Albian of Portugal (Groot and Groot, 1962).

Remarks: This species is characterized by its circular outline and spherical shape, which causes the grains to assume oblique and end view positions more frequently than in *Eucommiidites troedssonii* Erdtman, 1948. *Eucommiidites minor* is slightly smaller than *E. troedssonii. E. minor* in end view position (Pl. 26, Fig. 10) shows two ring-furrows, which are closer to each other and distant from the median furrow on the opposite face. In contrast, the colpi of a tricolpate angiosperm pollen are at an equal distance from each other.

The specimens assigned to *E. troedssonii* by Pocock (1962, p. 75), Brenner (1963, p. 85), and Singh (1964, p. 128) actually belong to *E. minor.*

Locality of figured specimens:

Pl. 26, fig. 9.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 26, fig. 10.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 26, fig. 9.	Slide No. 8-L-7-Micro. 47;	co-ord. 11.6/40.2.	
Pl. 26, fig. 10.	Slide No. 7-C-7 (1);	co-ord. 9/32.	

Genus **Exesipollenites** Balme, 1957

Type species **Exesipollenites tumulus** Balme, 1957

See Singh (1964, p. 126) for synonymy and generic diagnosis.

139 **Exesipollenites tumulus** Balme, 1957

Plate 26, figure 11

See Singh (1964, p. 126) for synonymy and description.

Distribution: Jurassic and Cretaceous. Loon River Formation, Harmon, and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Mannville Group (Singh, 1964), and the lower part of the Colorado Group (Norris, 1967) of central Alberta; Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); Lower Jurassic of Western Australia (Balme, 1957); Cenomanian and Turonian of Sarawak, Malaysia (Muller, 1968).

Remarks: Some of the Alberta specimens show a vestigial trilete mark, similar to those described by Brenner (1963, p. 87).

Locality of figured specimen:

Pl. 26, fig. 11. Sample No. 2-S-10; lower Shaftesbury Formation. Section 2.
Pl. 26, fig. 11. Slide No. 2-S-10 (2); co-ord. 13/47.8.

Genus **Spheripollenites** Couper, 1958

Type species **Spheripollenites scabratus** Couper, 1958

See Couper (1958, p. 158) for generic diagnosis.

Remarks: Couper (1958) proposed the genus *Spheripollenites* to accommodate spherical pollen grains, having a poorly developed pore, thin exine, and a diameter of less than 45 microns.

135 **Spheripollenites psilatus** Couper, 1958

Plate 26, figure 12

See Couper (1958, p. 159) for description.

Distribution: Late Jurassic to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Wealden and Aptian of England (Couper, 1958); "Wealden" of France (Delcourt and Sprumont, 1959); uppermost Jurassic to Valanginian of Holland (Burger, 1966); Lower Cretaceous of southeastern Australia (Dettmann, 1963).

Locality of figured specimen:

Pl. 26, fig. 12. Sample No. 8-L-3; Loon River Formation. Section 8.
Pl. 26, fig. 12. Slide No. 8-L-3 (2); co-ord. 4/68.

136 **Spheripollenites subgranulatus** Couper, 1958

Plate 26, figure 13

See Couper (1958, p. 158) for description.

Distribution: Middle Jurassic to middle Albian. Loon River Formation of the Peace River area; upper part of Fernie Group, Vanguard Formation, and Mannville Group of Western Canada (Pocock, 1962); Middle Jurassic to Lower Cretaceous of England (Couper, 1958); "Wealden" of France (Delcourt and Sprumont, 1959); uppermost Jurassic to Valanginian of Holland (Burger, 1966).

Locality of figured specimen:

Pl. 26, fig. 13.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 26, fig. 13.	Slide No. 8-L-12 (2);	co-ord. 15.1/57.6.	

Family **Ephedraceae**

Genus **Equisetosporites** Daugherty, 1941, emend. Singh, 1964

Type species **Equisetosporites chinleana** Daugherty, 1941

See Singh (1964, p. 129) for synonymy and emended generic diagnosis.

144 **Equisetosporites virginiaensis** (Brenner) n.comb.

Plate 26, figure 14

1963 *Ephedripites virginiaensis* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 90, pl. 38, fig. 3.

See Brenner (1963, p. 90) for description.

Distribution: Barremian to middle Albian. Loon River Formation and Harmon Member of the Peace River area; Barremian of Maryland, U.S.A. (Brenner, 1963).

Remarks: The genus *Ephedripites* Bolkhovitina, 1953, is invalid (Singh, 1964, p. 131), and its type species *Ephedripites mediolobatus* Bolkhovitina, 1953, has been transferred to *Schizaea certa* (Bolkhovitina) Bolkhovitina, 1961, (see Bolkhovitina, 1961, p. 26). Therefore, this species has been transferred here to the genus *Equisetosporites.*

Locality of figured specimen:

Pl. 26, fig. 14.	Sample No. 8-L-2;	Loon River Formation.	Section 8.
Pl. 26, fig. 14.	Slide No. 8-L-2 (1);	co-ord. 13.1/74.5.	

Subclass **Monocotyledoneae – Incertae Sedis**

Genus **Clavatipollenites** Couper, 1958

Type species **Clavatipollenites hughesii** Couper, 1958

See Couper (1958, p. 159) for generic diagnosis.

Remarks: Couper (1958) proposed the genus *Clavatipollenites* to accommodate monosulcate, elliptical to almost spherical pollen grains with double-layered exine. The exine consists of an unsculptured endexine from which arises the sculptured ektexine made up of closely spaced pila. The heads of pila are fused, producing a microreticulate surface and a tectate exine. The lumina are of uniform size and shape, and less than 1 micron in diameter. The sulcus is usually broad and extends along the whole length of the grain.

The genus *Liliacidites* Couper, 1953, differs from *Clavatipollenites* in having lumina which exceed 1 micron in diameter and are usually larger in the middle region of the grain. *Clavatipollenites* is distinctive on account of its double-layered tectate exine, microreticulate surface, and densely pilate ektexine.

174 **Clavatipollenites hughesii** Couper, 1958

Plate 27, figures 1-3

See Couper (1958, p. 159) for description.

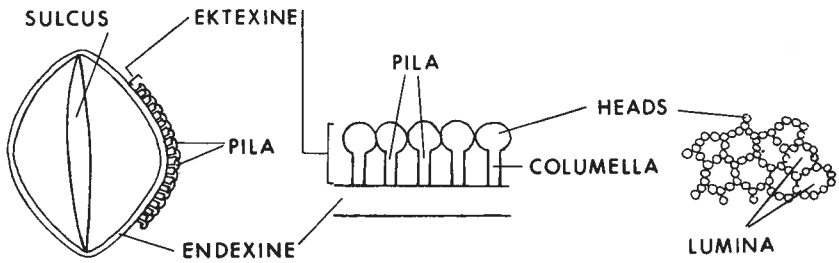


FIGURE 25. Clavatipollenites hughesii *Couper. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the microreticulate pattern.*

Distribution: Barremian to early Cenomanian. Harmon, Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Viking Formation and upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Barremian and Aptian of England (Couper, 1958).

Remarks: The sulcus of Alberta specimens of *Clavatipollenites hughesii* is not always fully developed.

Locality of figured specimens:

Pl. 27, figs. 1, 2.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Pl. 27, fig. 3.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 27, figs. 1,2.	Slide No. 4-P-8 (2);	co-ord. 10.1/59.	
Pl. 27, fig. 3.	Slide No. 4-P-3 (1);	co-ord. 10/42.1.	

175 **Clavatipollenites minutus** Brenner, 1963

Plate 27, figures 4-6

See Brenner (1963, p. 95) for description.

Distribution: Barremian to Albian. Cadotte and Paddy Members of the Peace River area; Joli Fou Formation of central Alberta (Norris, 1967); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species is distinguished from *Clavatipollenites hughesii* Couper, 1958, by its smaller size.

Many Alberta specimens of *Clavatipollenites minutus* are split along the sulcus.

Locality of figured specimens:

Pl. 27, figs. 4, 5.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 27, fig. 6.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 27, figs. 4, 5.	Slide No. 4-P-3 (1);	co-ord. 20.2/45.	
Pl. 27, fig. 6.	Slide No. 4-P-4 (2);	co-ord. 20/41.2.	

Genus **Liliacidites** Couper, 1953

Type species **Liliacidites kaitangataensis** Couper, 1953

See Couper (1953, p. 56) for generic diagnosis.

Remarks: Couper (1953) proposed the genus *Liliacidites* for the reception of fossil pollen grains of liliaceous affinities. This genus contains monosulcate or occasionally trichotomosulcate pollen grains with a reticulate surface pattern. The lumina generally exceed 1 micron in diameter and are usually larger in the middle region of the grain. The body is elliptical to spherical in shape. The endexine is unsculptured. The ektexine is reticulate. The muri are supported on and connected to the endexine by clavate, baculate or pilate processes.

179 **Liliacidites clavatus** n. sp.

Plate 27, figures 7-9

Description: Monosulcate; sulcus about 4.5 microns wide in the middle and narrowing towards the ends; sulcus extending along the long axis of grain on distal surface, and reaching or almost reaching the longitudinal ends of the body; amb elongate oval with acute to sharply rounded ends; distal surface flatter than the proximal surface; proximal and distal surfaces with reticulate sculpture; endexine unsculptured; ektexine reticulate; muri supported on and connected to the endexine by about 2-micron high clavae; clavae about 1 micron thick and spaced 1 to 2 microns apart; muri straight, about 1 micron thick; tops of clavae appearing as dark dots at the points of insertion on muri; lumina 2 to 4 microns in diameter, elongate to equidimensional, 4- to 6-sided, angular, and of uniform size and shape all over the body; exine about 3 microns thick.

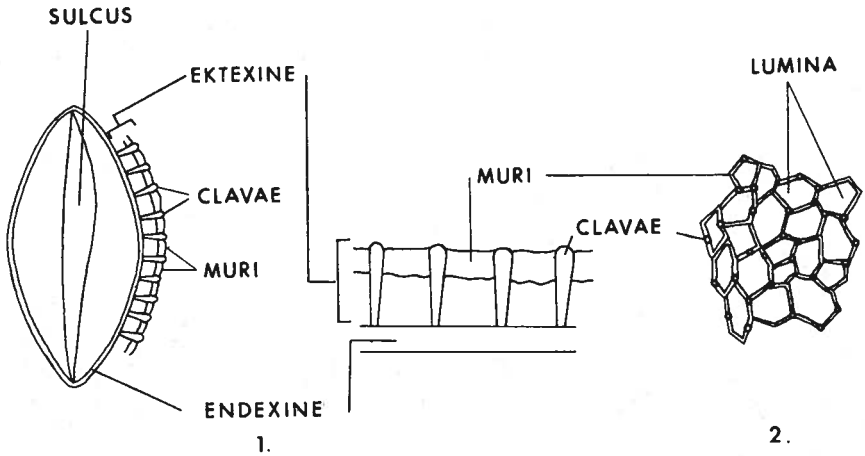


FIGURE 26. Liliacidites clavatus *n. sp. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Size range: Length (2 specimens) 40 (41) 42 microns. Holotype 40 microns.
Breadth (2 specimens) 22 (24.5) 27 microns. Holotype 22 microns.
Length to breadth ratio (2 specimens) 1.55 (1.7) 1.8. Holotype 1.8.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: *Liliacidites clavatus* n. sp. differs from *Liliacidites waitunaensis* Couper, 1960, described from the Oligocene of New Zealand, in having longer and thicker clavae, wider muri and sulcus, and a more elongate body.

The specific name is derived from *"clavatus"* (club-shaped) and refers to the large clavae of the ektexine.

Type locality:

Holotype: Pl. 27, figs. 7-9.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Holotype: Pl. 27, figs. 7-9.	Slide No. 4-P-3 (1);	co-ord. 19/62.5.	

177 **Liliacidites crassatus** n. sp.

Plate 27, figures 10-13

Description: Monosulcate; sulcus about 1.5 to 2 microns wide, extending along the long axis of grain on distal surface, and reaching or almost reaching the longitudinal ends of the body; sulcus wider in the middle; amb oval; distal surface flatter than the proximal surface; proximal and distal surfaces with reticulate sculpture; endexine smooth; ektexine reticulate; muri supported on and connected to the endexine by about 1.5-micron high clavae; clavae spaced about 1.5 microns apart; muri sinuous to convolute, 0.5 to 1 micron wide, and swollen at the points of insertion of clavae; lumina 1 to 2.5 microns in diameter, elongate to irregular-shaped, and of uniform size all over the body; exine about 2.5 microns thick.

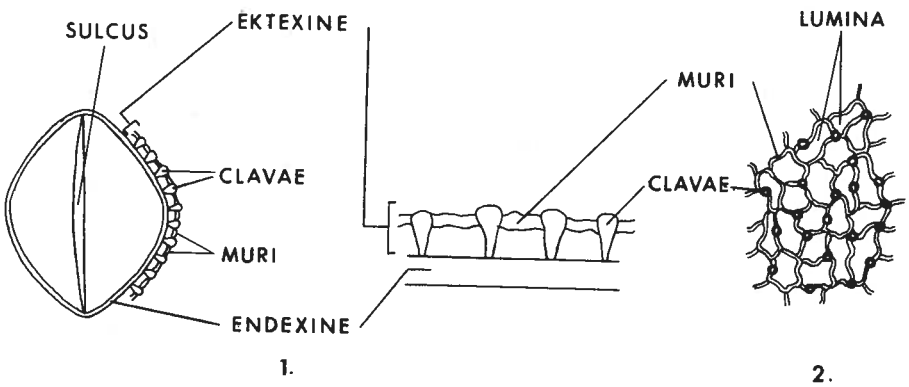


FIGURE 27. Liliacidites crassatus *n. sp. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Size range: Length (7 specimens) 22 (25.5) 27.5 microns. Holotype 27 microns.
Breadth (7 specimens) 16 (20) 24 microns. Holotype 20 microns.
Length to breadth ratio (7 specimens) 1 (1.26) 1.6.Holotype 1.35.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: *Liliacidites crassatus* n. sp. is distinct from *Liliacidites variegatus* Couper, 1953, which has smaller lumina near the longitudinal ends of the body, narrower muri, thinner exine, and is larger (26 (29) 36 microns long).

The specific name is derived from *"crassatus"* (thickened) and refers to the thick exine and muri.

Type locality:

Holotype: Pl. 27, figs. 10, 11.	Sample No. 4-P-5;	Paddy Member.	Section 4.
Paratype: Pl. 27, figs. 12, 13.	Sample No. 4-P-5;	Paddy Member.	Section 4.
Holotype: Pl. 27, figs. 10, 11.	Slide No. 4-P-5 (1);	co-ord. 13.1/51.8.	
Paratype: Pl. 27, figs. 12, 13.	Slide No. 4-P-5 (2);	co-ord. 6.2/54.6.	

176 **Liliacidites dividuus** (Pierce) Brenner, 1963

Plate 27, figures 14, 15; plate 28, figures 1, 2

1961 *Retimonocolpites dividuus* Pierce, Minnesota Geol. Surv., Bull. 42, p. 47, pl. 3, fig. 87.

1963 *Liliacidites dividuus* (Pierce) Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 93, pl. 40, figs. 7-10.

1968 *Clavatipollenites rotundus* Kemp, Palaeont., vol. 11, p. 424, pl. 79, figs. 1-19, pl. 80, figs. 1-8.

See Pierce (1961, p. 47) for description.

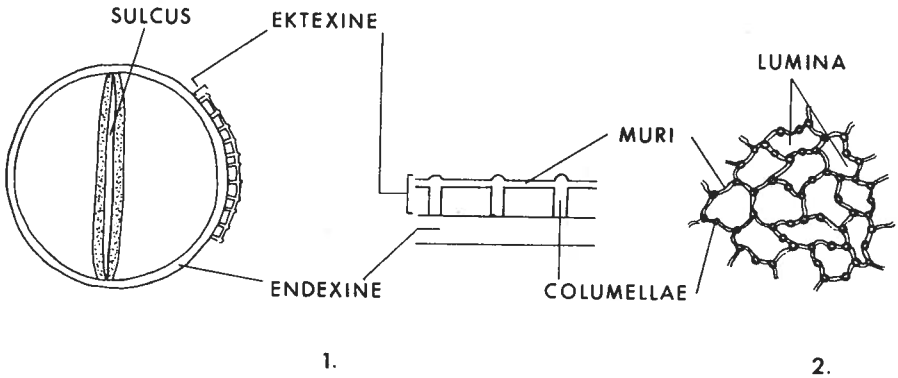


FIGURE 28. Liliacidites dividuus *(Pierce) Brenner. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Distribution: Albian and Cenomanian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Cenomanian of Minnesota, U.S.A. (Pierce, 1961); Albian of Maryland, U.S.A. (Brenner, 1963); Albian and Cenomanian of Oklahoma, U.S.A. (Hedlund and Norris, 1968; Hedlund, 1966); Albian of northern Wyoming, U.S.A. (Davis, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Albian of England (Kemp, 1968).

Remarks: This species consists of monosulcate, elliptical to spherical pollen grains with a reticulate surface pattern. The lumina are from 1 to 2 microns in diameter and of uniform size and shape. The endexine is unsculptured. The ektexine is reticulate. The muri are supported on and connected to the endexine by short columellae. The sulcus almost reaches the longitudinal ends of the grain and has a thickened border. The reticulate ektexine is usually separated from the smooth endexine.

Liliacidites dividuus differs from *Clavatipollenites hughesii* Couper, 1958, which has a double-layered tectate exine, microreticulate surface, and densely pilate ektexine. *L. dividuus* differs also in having a more distinct sulcus with thickened border, and in the tendency of the reticulate ektexine to separate from the endexine.

The specimens assigned to *Clavatipollenites* sp. cf. *C. hughesii* Couper, 1958, and *Clavatipollenites* sp. B by Davis (1963, pl. 9, figs. 1, 4) belong to *L.dividuus.*

Locality of figured specimens:

Pl. 27, figs. 14, 15.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 28, figs. 1, 2.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 27, figs. 14, 15.	Slide No. 4-P-6 (1);	co-ord. 21/75.9.	
Pl. 28, figs. 1, 2.	Slide No. 4-P-6 (1);	co-ord. 11.2/76.	

180 **Liliacidites inaequalis** n. sp.

Plate 28, figures 3-5

Description: Monosulcate; sulcus wide and indistinct, extending along the long axis of grain on distal surface, and reaching or almost reaching the longitudinal ends of the body; amb elongate oval; distal surface flatter than the proximal surface; proximal and distal surfaces with reticulate sculpture; endexine unsculptured; ektexine reticulate; muri supported on and connected to the endexine by about 1-micron high clavae; muri straight, 0.5 to 1 micron wide; clavae of the same width as muri, and appearing as dark dots at the points of insertion on muri; diameter of the lumina 3 to 6 microns in the middle region, diminishing to 1 micron near the longitudinal ends of the body; lumina distinct, mostly equidimensional and angular; exine about 2 microns thick.

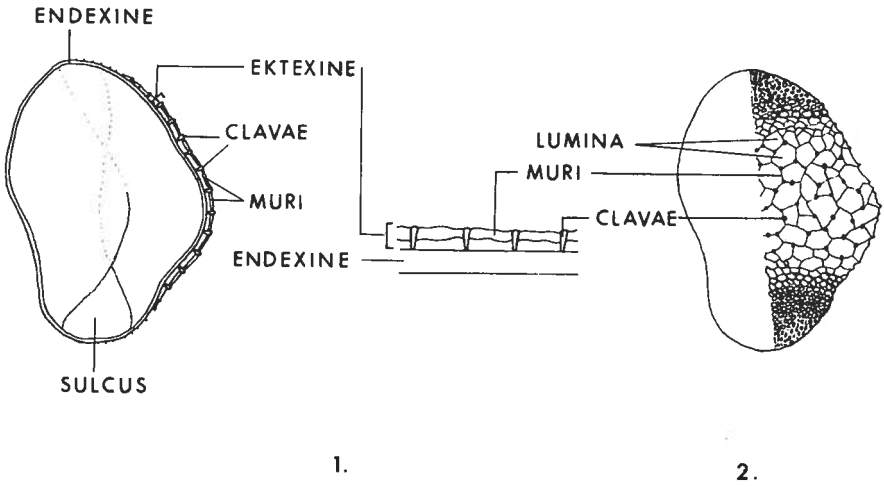


FIGURE 29. Liliacidites inaequalis *n. sp. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Size range: Length (7 specimens) 30 (40) 48 microns. Holotype 41 microns.
Breadth (7 specimens) 22 (29) 36 microns. Holotype 27 microns.
Length to breadth ratio (7 specimens) 1.25 (1.4) 1.6. Holotype 1.5.

Distribution: Late Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Liliacidites inaequalis* n. sp. can be distinguished from *Liliacidites intermedius* Couper, 1953, which has smaller lumina (2 to 3 microns wide), narrower muri, pilate ektexine, a distinct sulcus, and is slightly larger (44 to 53 microns long). *Liliacidites kaitangataensis* Couper, 1953, differs from *L. inaequalis* n. sp. in being distinctly larger (62 (66) 70 microns long).

The specific name is derived from *"inaequalis"* (unequal) and refers to the unequal size of the lumina.

Type locality:

Holotype: Pl. 28, fig. 3.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Paratype: Pl. 28, figs. 4, 5.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Holotype: Pl. 28, fig. 3.	Slide No. 4-P-4 (1);	co-ord. 15.2/77.	
Paratype: Pl. 28, figs. 4, 5.	Slide No. 4-P-4 (1);	co-ord. 18/49.1.	

182 **Liliacidites peroreticulatus** (Brenner) n. comb.

Plate 28, figures 6-11

1963 *Peromonolites peroreticulatus* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 94, pl. 41, figs. 1, 2.

See Brenner (1963, p. 94) for description.

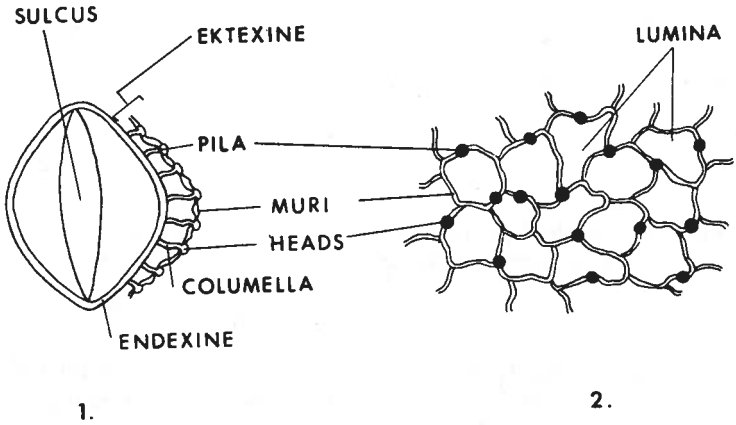


FIGURE 30. Liliacidites peroreticulatus *(Brenner) n. comb. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Distribution: Barremian to early Cenomanian. Cadotte and Paddy Members of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Albian of Peru (Brenner, 1968).

Remarks: This species consists of monosulcate, fusiform to almost circular pollen grains with a loosely attached reticulate ektexine. The lumina are from 3 to 7 microns wide, angular, elongate to equidimensional, and of uniform size all over the body. The endexine is unsculptured. The muri are supported on and connected to the endexine by 1- to 3-micron long pila, and are swollen at the points of insertion of pila. The pila are longest in the middle region of the grain producing a frill-like extension of the reticulate ektexine. The pila are about 1 micron wide and 2.5 to 4 microns apart. The sulcus is wide and reaches the longitudinal ends of the grain. The reticulate ektexine (the loosely attached outer layer) is interrupted at the position of the sulcus in most of the Alberta specimens of *Liliacidites peroreticulatus* (Brenner) n. comb. However, in certain cases the inner smooth endexinal body seems to have rotated so that the interruption in the ektexine does not coincide with the sulcus on the inner body (Pl. 28, Figs. 7, 8).

Brenner (1963, p. 94) interpreted the outer, loosely attached reticulate ektexine as perisporium, because in some specimens it passed over the sulcus without interruption. The present study, however, indicates that this outer layer is interrupted at the sulcus. Perhaps the rotation of the inner endexinal body in some of the specimens noticed by Brenner produced the effect mentioned by him. Moreover, the reticulate ektexine (outer layer) is supported on and connected to the endexine by long pila, which is contrary to the definition of a perispore (Fig. 30). Thus, the assignment of this species, described as monosulcate by Brenner (1963), to the genus *Peromonolites* Couper, 1953, which consists of monolete spores enclosed within a perispore, is entirely inappropriate. This species, with the exception of its longer pila, conforms with the generic circumscription of the genus *Liliacidites* Couper, 1953, and therefore, has been transferred to that genus here, pending detailed re-evaluation.

Liliacidites peroreticulatus (Brenner) n. comb. can be distinguished from *Liliacidites reticulatus* (Brenner) n. comb. by its smaller size, and larger lumina with thicker muri.

Locality of figured specimens:

Pl. 28, figs. 6-8.	Sample No. 7-C-3;	Cadotte Member.	Section 7.
Pl. 28, figs. 9-11.	Sample No. 7-C-1;	Cadotte Member.	Section 7.
Pl. 28, figs. 6-8.	Slide No. 7-C-3 (1);	co-ord. 1.9/39.1.	
Pl. 28, figs. 9-11.	Slide No. 7-C-1 (1);	co-ord. 20/48.8.	

183 **Liliacidites reticulatus** (Brenner) n. comb.

Plate 28, figures 12-14

1963 *Peromonolites reticulatus* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 94, pl. 41, figs. 3, 4.

See Brenner (1963, p. 94) for description.

Distribution: Barremian to Albian. Cadotte Member and lower Shaftesbury Formation of the Peace River area; middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Barremian to Albian of Maryland, U.S.A. (Brenner, 1963); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: *Liliacidites reticulatus* (Brenner) n. comb. is morphologically similar to *Liliacidites peroreticulatus* (Brenner) n. comb. but differs in being slightly larger and in having smaller lumina with narrower muri.

This species has been provisionally transferred to the genus *Liliacidites* Couper, 1953, for the same reasons as given for *L. peroreticulatus.*

The specimens assigned to *Clavatipollenites* sp. A by Davis (1963, pl. 9, figs. 2, 3) probably belong to *L. reticulatus.*

Locality of figured specimen:

Pl. 28, figs. 12-14.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 28, figs. 12-14.	Slide No. 7-C-7 (1);	co-ord. 18.2/64.2.	

178 **Liliacidites textus** Norris, 1967

Plate 29, figures 1-4

See Norris (1967, p. 106) for description.

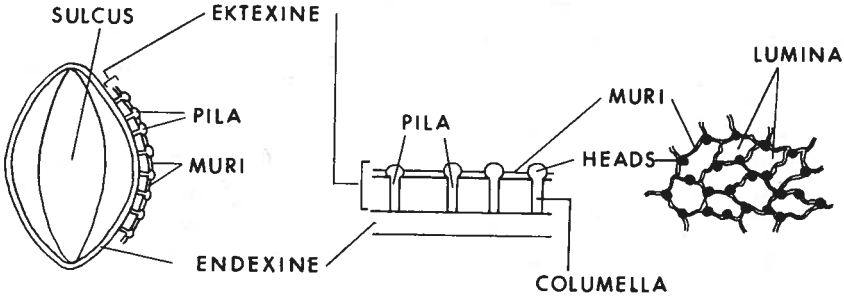


FIGURE 31. Liliacidites textus *Norris. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: This species consists of monosulcate, elongate oval pollen grains with a reticulate surface pattern. The lumina are from 1 to 4 microns in diameter, angular, elongate to equidimensional, and of uniform size all over the body. The endexine is unsculptured. The ektexine is reticulate. The muri are supported on and connected to the endexine by about 1-micron long pila. The muri are sinuous to convolute and swollen at the points of insertion of pila. The sulcus is smooth, about half the width of the body, and almost reaches the longitudinal ends of the grain.

Liliacidites textus differs from *Liliacidites reticulatus* (Brenner) n. comb., which has narrower sulcus, wider body, and longer pila in the middle region of the grain forming a frill-like extension of the reticulate ektexine.

Locality of figured specimens:

Pl. 29, figs. 1, 2.	Sample No. 2-S-8;	lower Shaftesbury Formation.	Section 2.
Pl. 29, figs. 3, 4.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 29, figs. 1, 2.	Slide No. 2-S-8(1);	co-ord. 15.8/52.	
Pl. 29, figs. 3, 4.	Slide No. 2-S-3(1);	co-ord. 1/74.9.	

181 **Liliacidites trichotomosulcatus** n. sp.
Plate 29, figures 5-7

Description: Trichotomosulcate; sulcus about 6 microns wide at the distal pole and narrowing towards the extremities; sulcus reaching or almost reaching the equator; amb circular; proximal and distal surfaces with reticulate sculpture; endexine unsculptured, about 1 micron thick; ektexine reticulate; muri supported on and connected to the endexine by about 0.8-micron high columellae; columellae about 0.5 micron thick and spaced 0.5 to 1 micron apart; muri sinuous to convolute, about 0.5 micron thick; the tops of columellae appearing as dark dots at the points of insertion on muri; lumina about 1 micron in diameter, circular to irregular-shaped, and of uniform size all over the body; exine about 2 microns thick.

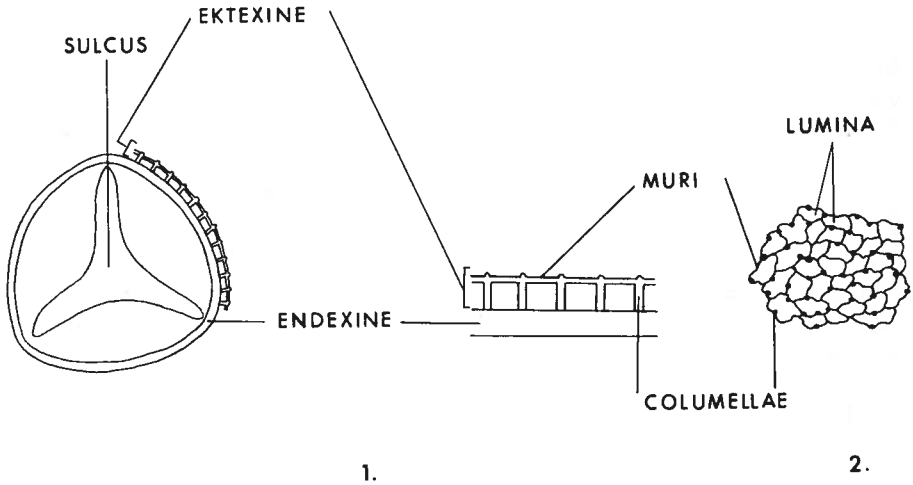


FIGURE 32. Liliacidites trichotomosulcatus *n. sp. 1. Optical section showing the details of endexine and ektexine. 2. Surface view showing the reticulate pattern.*

Size range: Equatorial diameter (3 specimens) 23 (24.5) 26 microns. Holotype 24 microns.

Distribution: Middle and late Albian. Cadotte and Paddy Members of the Peace River area.

Remarks: *Liliacidites trichotomosulcatus* n. sp. is characterized by its trichotomosulcate (triradiate) germinal furrow.

Type locality:

Holotype: Pl. 29, figs. 5-7.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Holotype: Pl. 29, figs. 5-7.	Slide No. 4-P-3 (1);	co-ord. 17/49.	

Subclass **Dicotyledoneae – Incertae Sedis**

The present classification of the tricolpate pollen grains is entirely unsatisfactory. A comprehensive revision of this group at the generic level is necessary. Some of the most commonly used genera are either too widely circumscribed to have any taxonomic meaning or of insecure validity. Couper (1953, 1960) used the genus *Tricolpites* Cookson, 1947 ex Couper, 1953, to accommodate tricolpate pollen grains with varied ornamentation. Potonié (1960) and Belsky, Boltenhagen and Potonié (1965) subsequently restricted the use of this genus to oblate, reticulate, tricolpate pollen grains. But it still remains too large a group to be assigned to a single genus. Some splitting of the rather diversified entities that have accumulated under the genus *Tricolpites* is clearly desirable. The generic circumscription of *Retitricolpites* van der Hammen, 1956 ex Pierce, 1961, is also very wide. All the reticulate, tricolpate pollen grains can be referred to it. The distinction between *Tricolpites* and *Retitricolpites* is not clear. Moreover, the genus *Retitricolpites* is of insecure validity because its type species is based on the pollen grain of a modern plant. The genus *Tricolpopollenites* Thomson and Pflug, 1953, has been commonly used to accommodate a wide variety of tricolpate pollen grains. It is not possible to distinguish this genus from the two tricolpate genera mentioned earlier. According to Krutzsch (1959b, p. 143), the type species of the genus *Tricolpopollenites* is actually tricolporate. *Tricolpopollenites* and its junior synonym *Cornaceoipollenites* Potonié, 1951 ex Potonié, 1960, have been reclassified as tricolporate genera (Ptychotriporines) by Potonié (1966,p. 168). The taxonomic position of the various tricolpate species assigned to the genus *Tricolpopollenites* is, therefore, quite ambiguous.

Sufficient attention has not been paid so far to many genetically significant features of the angiosperm pollen grains due to their small size and the difficulty in observing these minute features under an ordinary microscope. A detailed examination of the exine structure, ektexinal elements, surface ornamentation, and other morphological features of genetic significance by a scanning electron microscope is necessary for a more natural and meaningful classification of the tricolpate pollen grains. Such a detailed revision of the tricolpate genera is beyond the scope of the present study. Therefore, the tricolpate species have been tentatively assigned here to the existing genera. Most of these species belong to the reticulate tricolpate group of pollen grains. The criteria used for the generic and specific distinctions are based upon the following morphological features:

1. The position, dimensions, structure, and number of the colpi.

2. The outline of the pollen grain in polar and equatorial views.

3. The thickness and structure of the endexine, thickness and structure of the ektexine, ektexinal elements, structure of the tegillum and area covered by it.

4. The type of surface ornamentation, thickness of the muri and its relation to the ektexinal elements, size and shape of the lumina, lumina decreasing in size toward the poles or of uniform size.

5. The polar diameter (P), equatorial diameter in equatorial view (E1), equatorial diameter in polar view (E2), and P/E1 ratio (Fig. 33).

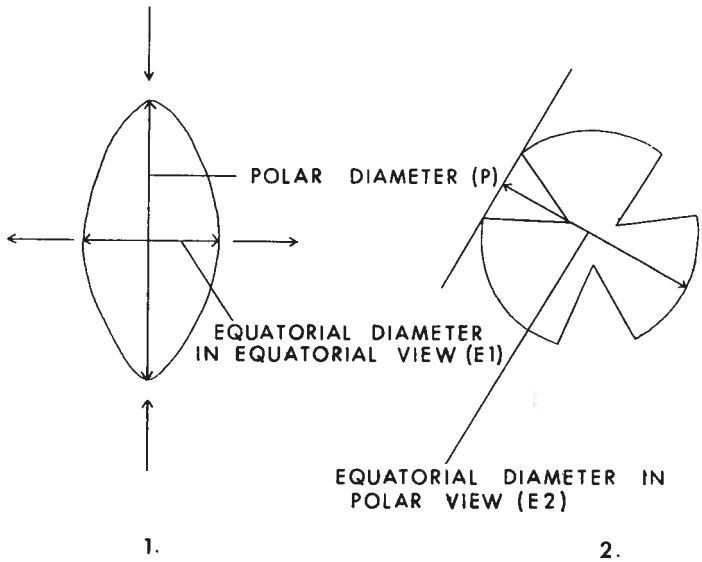


FIGURE 33. Measurements of a tricolpate pollen grain. 1. Equatorial view. 2. Polar view.

Genus **Cupuliferoidaepollenites** Potonié, Thomson and Thiergart, 1950

Type species **Cupuliferoidaepollenites liblarensis** Thomson, 1950

See Potonié (1960, p. 92) for generic diagnosis.

Remarks: The genus *Cupuliferoidaepollenites* contains prolate to subprolate, occasionally cylindrical, tricolpate pollen grains with rounded poles. The exine is hyaline, double-layered, and almost smooth to infratextured. This genus contains only small pollen grains whose polar diameter is usually 20 microns or less. The infratexture is most probably produced by baculate elements in the ektexine.

The genus *Cupuliferoidaepollenites* is used here as a form-genus, and no botanical affinities are implied.

189 **Cupuliferoidaepollenites minutus** (Brenner) n. comb.

Plate 29, figures 8, 9

1963 *Tricolpopollenites minutus* Brenner, Maryland Dept. Geol. Mines Water Resources, Bull. 27, p. 93, pl. 40, figs. 5, 6.
1967 *Cornaceoipollenites minutus* (Brenner) Norris, Palaeontographica, Band 120, Abt. B, p. 107, pl. 17, figs. 7-11.

See Brenner (1963, p. 93) for description.

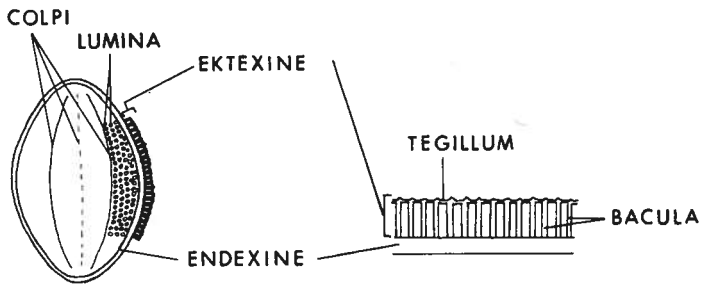


FIGURE 34. Cupuliferoidaepollenites minutus *(Brenner) n. comb. Equatorial view showing the details of exine structure and surface ornamentation.*

Distribution: Albian and early Cenomanian. Harmon Member of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); Albian of Maryland and Delaware, U.S.A. (Brenner, 1963, 1967); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: *Cupuliferoidaepollenites minutus* (Brenner) n. comb. contains subprolate to prolate tricolpate pollen grains with narrow, simple colpi almost extending to the poles. The exine is 1 micron thick and double-layered. The endexine is smooth. The ektexine is baculate. The tips of the bacula are joined together (tegillate) to produce a microreticulate surface. The lumina are about 0.2 micron in diameter and barely visible under oil immersion. The tegillum covers most of the surface (tectate) of the pollen grain.

The assignment of this species to *Tricolpopollenites* Thomson and Pflug, 1953, by Brenner (1963) and *Cornaceoipollenites* Potonié, 1951 ex Potonié, 1960, by Norris (1967) is untenable. According to Krutzsch (1959b, p. 143), the type species of the genus *Tricolpopollenites* is actually tricolporate. *Tricolpopollenites* and its

junior synonym *Cornaceoipollenites* have been reclassified as tricolporate genera (Ptychotriporines) by Potonié (1966, p. 168). Insofar as this species is distinctly tricolpate, and broadly conforms to the generic circumscription of *Cupuliferoidaepollenites* Potonié, Thomson and Thiergart, 1950, it has been placed in that genus here.

Locality of figured specimen:

Pl. 29, figs. 8, 9.	Sample No. 7-H-1;	Harmon Member.	Section 7.
Pl. 29, figs. 8, 9.	Slide No. 7-H-1(1);	co-ord. 20/44.	

Genus **Foveotricolpites** Pierce, 1961

Type species **Foveotricolpites sphaeroides** Pierce, 1961

See Pierce (1961, p. 49) for generic diagnosis.

Remarks: Pierce (1961) proposed the genus *Foveotricolpites* to accommodate foveolate, tricolpate pollen grains.

196 **Foveotricolpites concinnus** n. sp.

Plate 29, figures 10, 11

1967 *Foveotricolpites* cf. *rhombohedralis* Pierce–Brenner, Rev. Palaeobot. Palynol., vol. 1, p. 224, pl. 3, figs. 2a-b.

Description: Tricolpate; colpi wide, with thickened margin, and reaching or almost reaching the poles; polar outline subprolate to prolate, rhomboidal; endexine smooth, about 0.5 micron thick; ektexine foveolate, about 1.5 microns thick; muri supported on and connected to the endexine by 1- to 1.5-micron high, densely packed bacula; muri 1 to 3 microns wide, forming a smooth and flat-topped tegillum; tegillum covering more than half of the body surface; lumina 1 to 2 microns in diameter, angular, equidimensional to occasionally elongate, and of uniform size all over the body; exine tegillate, 2 microns thick.

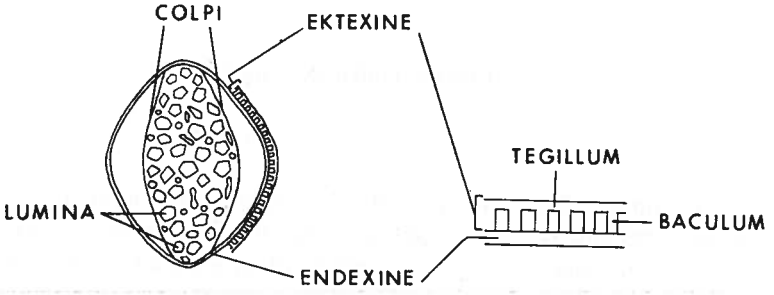


FIGURE 35. Foveotricolpites concinnus *n. sp. Equatorial view showing the details of exine structure and surface ornamentation.*

Size range: Polar diameter (P)(4 specimens) 25 (28) 33 microns. Holotype 33 microns.
Equatorial diameter in equatorial view (E1) (4 specimens) 14 (19) 25 microns. Holotype 25 microns.
P/E1 (4 specimens) 1.3 (1.5) 1.8. Holotype 1.3.

Distribution: Middle Albian to Cenomanian. Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Cenomanian of Delaware, U.S.A. (Brenner, 1967).

Remarks: This species is distinct from *Foveotricolporites rhombohedralis* Pierce, 1961, which is tricolporate. *Foveotricolpites sphaeroides* Pierce, 1961, differs from *Foveotricolpites concinnus* n. sp. in having a smaller size, smaller and more closely spaced lumina, and a more spherical shape.

The specific name is derived from *"concinnus"* (beautiful, neat).

Type locality:

Holotype: Pl. 29, figs. 10, 11. Sample No. 7-H-1(A); Harmon Member. Section 7.
Holotype: Pl. 29, figs. 10, 11. Slide No. 7-H-1(A)(1); co-ord. 2.6/38.

Genus **Fraxinoipollenites** Potonié, 1951 ex Potonié, 1960

Type species **Fraxinoipollenites pudicus** (Potonié) Potonié, 1951

See Stanley (1965, p. 305) for synonymy and generic diagnosis.

Remarks: Potonié (1951) proposed the genus *Fraxinoipollenites* to accommodate prolate, tricolpate pollen grains with long, distinct colpi and scabrate to reticulate sculpture.

The genus *Fraxinoipollenites* is used here as a form-genus, and no botanical affinities are implied.

190 **Fraxinoipollenites venustus** n. sp.

Plate 29, figures 12-14

Description: Tricolpate; colpi narrow, almost reaching the poles; polar outline prolate; endexine smooth, about 0.3 micron thick; ektexine microreticulate to pitted, about 1-micron thick; muri supported on and connected to the endexine by about 1-micron high, densely packed clavae; muri 0.5 to 1 micron wide, forming a smooth and flat-topped tegillum; tegillum covering more than 2/3 of the body

surface; lumina 0.2 to 0.4 micron in diameter, increasing to 0.8 micron in the polar regions; lumina in the polar regions widely spaced producing a pitted effect; lumina circular to elongate, and usually widely spaced; exine tegillate, about 1.3 microns thick.

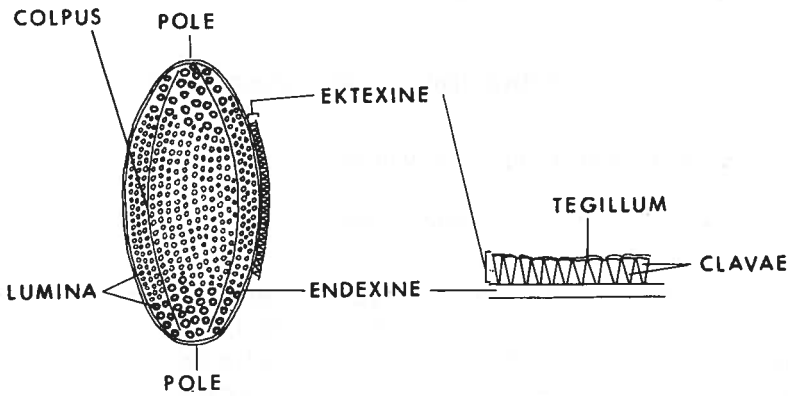


FIGURE 36. Fraxinoipollenites venustus *n. sp. Equatorial view showing the details of exine structure and surface ornamentation.*

Size range: Polar diameter (P) (18 specimens) 22(29) 41 microns. Holotype 30 microns.
Equatorial diameter in equatorial view (E1) (16 specimens) 14 (18) 25 microns. Holotype 19 microns.
Equatorial diameter in polar view (E2) (2 specimens) 20 (25) 29 microns.
P/E1 (16 specimens) 1.3 (1.6) 1.9. Holotype 1.6.

Distribution: Middle and late Albian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Fraxinoipollenites venustus* n. sp. is characterized by the larger lumina in the polar regions. This species can be distinguished from *Retitricolpites vulgaris* Pierce, 1961, by its distinctly double-layered, tegillate exine, smaller lumina increasing in size in the polar regions, and a more elongate shape. *Tricolpopollenites crassimurus* Groot and Penny, 1960, differs from *F. venustus* n. sp. in having a scabrate sculpture. *F. venustus* n. sp. is distinct from *Fraxinoipollenites variabilis* Stanley, 1965, which is smaller, less elongate, and lacks the larger lumina in the polar regions.

The specific name is derived from *"venustus"* (beautiful, graceful).

Type locality:

Holotype: Pl. 29, figs. 12, 13.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Paratype: Pl. 29, fig. 14.	Sample No. 4-P-5;	Paddy Member.	Section 4.
Holotype: Pl. 29, figs. 12, 13.	Slide No. 4-P-6(1);	co-ord. 12.2/36.7.	
Paratype: Pl. 29, fig. 14.	Slide No. 4-P-5(2);	co-ord. 3.9/55.	

Genus **Psilatricolpites** van der Hammen, 1956

Type species **Psilatricolpites incomptus** van der Hammen, 1956

See Pierce (1961, p. 49) for generic diagnosis.

Remarks: This genus was proposed by van der Hammen (1956) to accommodate psilate, tricolpate pollen grains. The type species *Psilatricolpites incomptus* is, however, based on the pollen grain of a modern plant. Since the pollen grain already belongs to a modern natural genus it cannot serve as the nomenclatural type of the fossil form-genus *Psilatricolpites.* Subsequently van der Hammen and Wymstra (1964, p. 234) proposed *Psilatricolpites clarissimus* van der Hammen and Wymstra, 1964, as the lectogenotype. However, Potonié (1966, p. 163) considers *Psilatricolpites psilatus* Pierce, 1961, to be the type species under Article 42 of the International Code of Botanical Nomenclature (1961). The genus *Psilatricolpites* is of insecure validity and has been retained here provisionally pending a comprehensive revision of the tricolpate genera.

184 **Psilatricolpites parvulus** (Groot and Penny) Norris, 1967

Plate 29, figures 15, 16

1960 *Tricolpopollenites parvulus* Groot and Penny, Micropaleont., vol. 6, p. 232, pl. 2, figs. 8, 9.

1967 *Psilatricolpites parvulus* (Groot and Penny) Norris, Palaeontographica, Band 120, Abt. B, p. 107, pl. 17, figs. 5, 6.

See Groot and Penny (1960, p. 232) for description.

Distribution: Late Albian to Danian. Lower Shaftesbury Formation of the Peace River area; upper shale unit of the lower part of the Colorado Group of central Alberta (Norris, 1967); Cenomanian to Coniacian of the eastern United States (Groot and Penny, 1960; Groot, Penny and Groot, 1961); Danian of California, U.S.A. (Drugg, 1967).

Remarks: Groot and Penny (1960, p. 232), Groot, Penny and Groot (1961, p. 132), and Drugg (1967, p. 48) assigned this species to the genus *Tricolpopollenites* Thomson and Pflug, 1953, which is tricolporate (Potonié, 1966, p. 168). Insofar as this species is tricolpate and psilate, Norris (1967) has placed it in the genus *Psilatricolpites* van der Hammen, 1956.

Locality of figured specimens:

Pl. 29, fig. 15.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 29, fig. 16.	Sample No. 2-S-1;	lower Shaftesbury Formation.	Section 2.
Pl. 29, fig. 15.	Slide No. 2-S-3(1);	co-ord. 3/41.	
Pl. 29, fig. 16.	Slide No. 2-S-1(1);	co-ord. 18/60.8.	

Genus **Retitricolpites** van der Hammen, 1956 ex Pierce, 1961

Type species **Retitricolpites ornatus** van der Hammen, 1956

See Pierce (1961, p. 50) for generic diagnosis.

Remarks: The genus *Retitricolpites* was proposed by van der Hammen (1956) as a subform-genus of *Tricolpites* Erdtman, 1947, to accommodate reticulate, tricolpate pollen grains. Pierce (1961) raised *Retitricolpites* to the generic rank. The type species *Retitricolpites ornatus* is, however, based on the pollen grain of a modern plant. Since the pollen grain already belongs to a modern natural genus it cannot serve as the nomenclatural type of the fossil form-genus *Retitricolpites.* Subsequently van der Hammen and Wymstra (1964, p. 234) proposed *Retitricolpites ovalis* van der Hammen and Wymstra, 1964, as lectogenotype. Potonié (1966, p. 163), on the other hand, has selected *Retitricolpites vulgaris* Pierce, 1961, as the lectogenotype. The genus *Retitricolpites* is of insecure validity and has been retained here provisionally pending a comprehensive revision of the tricolpate genera.

The genus *Retitricolpites* is restricted in the present study only to those reticulate tricolpate forms whose lumina are on an average more than 1 micron in diameter.

195 **Retitricolpites georgensis** Brenner, 1963

Plate 30, figures 1-6

See Brenner (1963, p. 91) for description.

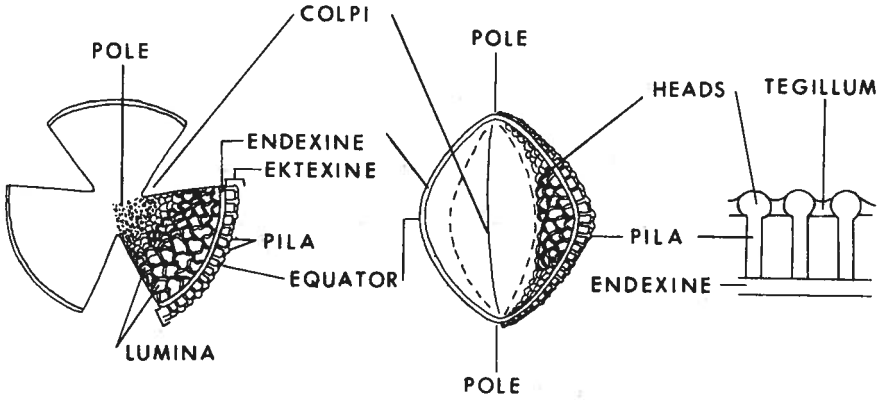


FIGURE 37. Retitricolpites georgensis *Brenner. Polar and equatorial views showing the details of exine structure and surface ornamentation.*

Distribution: Albian and early Cenomanian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species is characterized by the reduction in the size of lumina toward the poles and the pilate structure of the muri.

The Alberta specimens of *Retitricolpites georgensis* do not always show the pilate structure of the muri clearly.

This species has been described as *Tricolpopollenites georgensis* by Pannella (1966, p. 112).

Locality of figured specimens:

Pl. 30, fig. 1.	Sample No. 7-C-9;	Cadotte Member.	Section 7.
Pl. 30, figs. 2, 3.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 30, figs. 4-6.	Sample No. 2-S-7;	lower Shaftesbury Formation.	Section 2.
Pl. 30, fig. 1.	Slide No. 7-C-9(2);	co-ord. 6.8/52.5.	
Pl. 30, figs. 2, 3.	Slide No. 7-C-10(1);	co-ord. 3.1/75.	
Pl. 30, figs. 4-6.	Slide No. 2-S-7(1);	co-ord. 22.2/50.1.	

193 **Retitricolpites maximus** n. sp.

Plate 30, figures 7-9; plate 31, figures 1, 2

Description: Tricolpate; colpi wide, almost reaching the poles; polar outline subprolate to prolate; amb trilobate, fossaperturate with V-shaped colpi; endexine smooth, about 0.5 micron thick; ektexine with an imperfect-reticulate ornamentation, about 2 microns thick; muri supported on and connected to the endexine by about 2-micron high clavae; clavae about 0.8 micron thick, often distinct from one another, and spaced about 1 micron apart; muri vermiculate, about 0.5 micron thick, discontinuous forming imperfect reticulate pattern; tops of clavae appearing as dark dots at the points of insertion on muri; lumina 1 to 1.5 microns in diameter, irregular-shaped, and of uniform size all over the body; exine tegillate, about 2.5 microns thick.

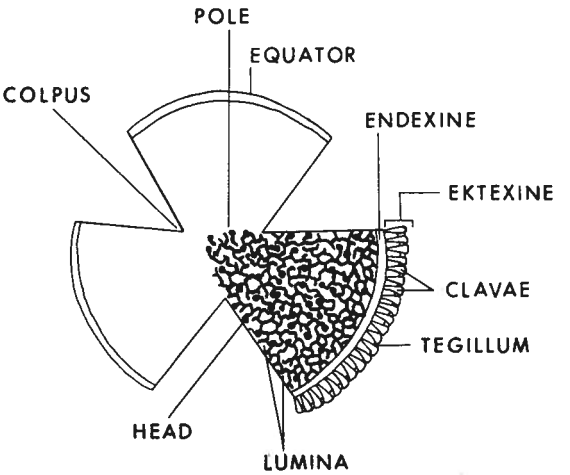


FIGURE 38. Retitricolpites maximus *n. sp. Polar view showing the details of exine structure and surface ornamentation.*

Size range: Polar diameter (P) (5 specimens) 30 (34) 39 microns.
Equatorial diameter in equatorial view (E1) (5 specimens) 21 (25) 27 microns.
Equatorial diameter in polar view (E2) (7 specimens) 26 (40) 53 microns. Holotype 53 microns.
P/E1 (5 specimens) 1.1 (1.4) 1.5.

Distribution: Middle and late Albian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Retitricolpites maximus* n. sp. is distinct from *Retitricolpites geranioides* (Couper) Brenner, 1963, whose lumina decrease in size toward the poles and are considerably larger (2 to 4 microns in diameter) in the equatorial region.

The specific name is derived from *"maximus"* (greatest, largest) and refers to the large size of the specimens.

Type locality:

Holotype: Pl. 30, figs. 7-9.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Paratype: Pl. 31, figs. 1, 2.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Holotype: Pl. 30, figs. 7-9.	Slide No. 7-C-10(1);	co-ord. 20.5/52.1.	
Paratype: Pl. 31, figs. 1, 2.	Slide No. 7-C-8(1);	co-ord. 9/54.2.	

194 **Retitricolpites prosimilis** Norris, 1967

Plate 31, figures 3, 4

See Norris (1967, p. 108) for description.

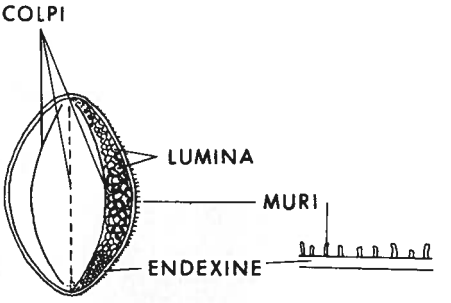


FIGURE 39. Retitricolpites prosimilis *Norris. Equatorial view showing the details of exine structure and surface ornamentation.*

Distribution: Middle and late Albian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967).

Remarks: This species is characterized by the reduction in the size of lumina toward the poles, mostly prolate shape, and nontegillate reticulate exine with simple muri.

Retitricolpites prosimilis is distinct from *Retitricolpites vulgaris* Pierce, 1961, which has lumina of equal size, spheroidal to subprolate shape, and larger dimensions. *Retitricolpites georgensis* Brenner, 1963, differs from *R. prosimilis* in having muri with pilate structure, tegillate exine, larger lumina, and larger overall dimensions.

Locality of figured specimen:

Pl. 31, figs. 3, 4.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 31, figs. 3, 4.	Slide No. 7-C-10(1);	co-ord. 5/52.8.	

192 **Retitricolpites virgeus** (Groot, Penny and Groot) Brenner, 1963

Plate 31, figures 5-10

1961 *Tricolpopollenites virgeus* Groot, Penny and Groot, Palaeontographica, Band 108, Abt. B, p. 133, pl. 26, figs. 16, 17.

Description: Tricolpate; colpi long, open; polar outline subprolate to prolate; amb trilobate, fossaperturate; endexine smooth, about 0.5 micron thick; ektexine reticulate, 1 to 1.5 microns thick; muri supported on and connected to the endexine by 1-to 1.5-micron high bacula; bacula about 0.5 micron thick, slightly wider at the tips, and spaced about 1 micron apart; muri straight to slightly sinuous, about 0.5 micron thick; tops of bacula appearing as dark dots at the points of insertion on muri; lumina 1.5 to 3 microns in diameter, angular to irregular-shaped, and of uniform size all over the body; exine tegillate, about 2 microns thick.

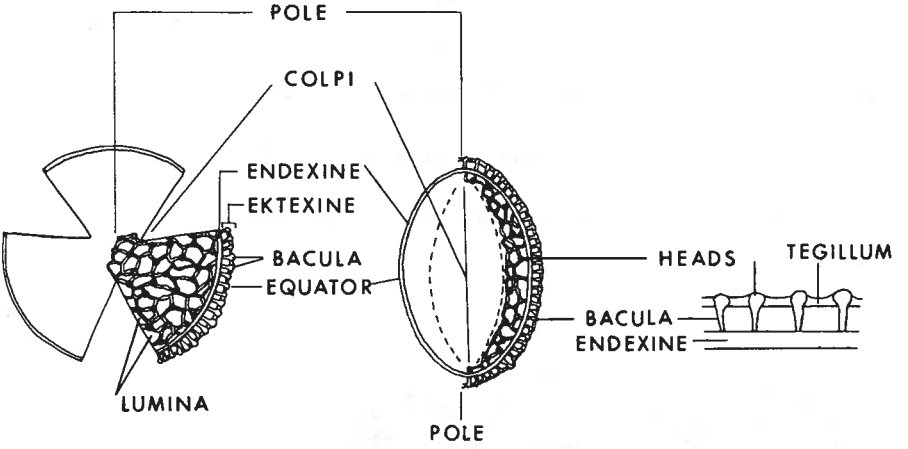


FIGURE 40. Retitricolpites virgeus *(Groot, Penny and Groot) Brenner. Polar and equatorial views showing the details of exine structure and surface ornamentation.*

Size range: Polar diameter (P) (10 specimens) 22 (26) 30 microns.
Equatorial diameter in equatorial view (E1) (10 specimens) 16 (19) 22 microns.
Equatorial diameter in polar view (E2) (11 specimens) 19 (25) 30 microns.
P/E1 (10 specimens) 1.1 (1.4) 1.6.

Distribution: Middle Albian to Coniacian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Cenomanian to Coniacian of the eastern United States (Groot, Penny and Groot, 1961); Albian (probably middle Albian) of Oklahoma, U.S.A. (Hedlund and Norris, 1968); middle and late Albian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: This species can be easily distinguished from *Retitricolpites vulgaris* Pierce, 1961, which has smaller lumina and lacks the baculate structure of the muri. *Retitricolpites georgensis* Brenner, 1963, differs from *Retitricolpites virgeus* in having smaller lumina which decrease in size toward the poles.

According to Norris (1967, p. 108), the specimens identified as *Retitricolpites virgeus* by Brenner (1963, p. 92) actually belong to *R. vulgaris.*

Locality of figured specimens:

Pl. 31, figs. 5-7.	Sample No. 7-C-3;	Cadotte Member.	Section 7.
Pl. 31, fig. 8.	Sample No. 7-H-1(A);	Harmon Member.	Section 7.
Pl. 31, figs. 9, 10.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Pl. 31, figs. 5-7.	Slide No. 7-C-3(2);	co-ord. 7.4/73.1.	
Pl. 31, fig. 8.	Slide No. 7-H-1(A) (1);	co-ord. 4.1/63.3.	
Pl. 31, figs. 9, 10.	Slide No. 4-P-8(1);	co-ord. 10.5/54.	

191 **Retitricolpites vulgaris** Pierce, 1961

Plate 31, figures 11-15

See Norris (1967, p. 108) for synonymy and description.

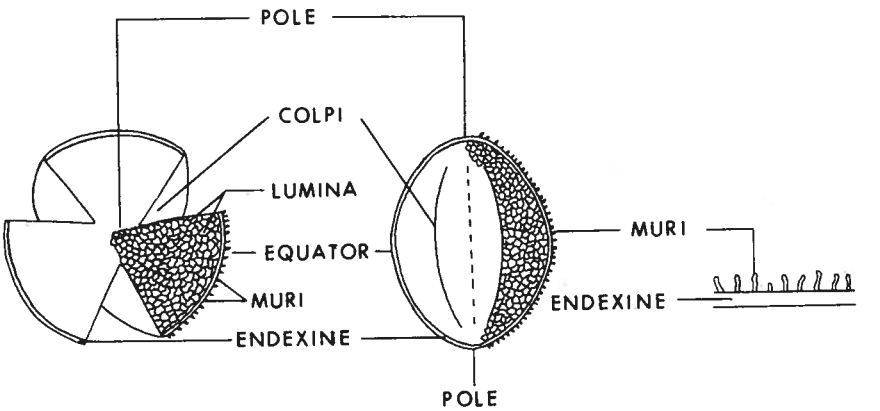


FIGURE 41. Retitricolpites vulgaris *Pierce. Polar and equatorial views showing the details of exine structure and surface ornamentation.*

Distribution: Middle Albian to Cenomanian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Cenomanian of Minnesota, U.S.A. (Pierce, 1961); late Albian of Maryland, U.S.A. (Brenner, 1963); Albian (probably middle Albian) of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species is characterized by spheroidal to subprolate pollen grains with lumina of uniform size all over the body, and nontegillate reticulate exine. The lumina are irregular to vermiculate in shape and often elongated in different directions. The muri are simple.

Retitricolpites vulgaris is distinct from *Retitricolpites virgeus* (Groot, Penny and Groot) Brenner, 1963, which has tegillate exine, larger lumina, and muri with baculate structure. According to Norris (1967, p. 108), the specimens identified as *R. virgeus* by Brenner (1963, p. 92) actually belong to *R. vulgaris.*

The specimens assigned to *Tricolpites* sp. cf. *T. reticulatus* Cookson, 1947, by Davis (1963, pl. 9, figs. 6, 8) probably belong to *R. vulgaris.*

This species closely resembles the pollen grains of the modern genus *Hamamelis* Gronovius ex Linnaeus, 1753.

Locality of figured specimens:

Pl. 31, fig. 11.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 31, figs. 12, 14.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 31, fig. 13.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 31, fig. 15.	Sample No. 7-C-9;	Cadotte Member.	Section 7.
Pl. 31, fig. 11.	Slide No. 7-C-8(1);	co-ord. 3/62.1.	
Pl. 31, fig. 12.	Slide No. 4-S-2(1);	co-ord. 16.2/68.1.	
Pl. 31, fig. 13.	Slide No. 4-P-3(1);	co-ord. 14.2/76.	
Pl. 31, fig. 14.	Slide No. 4-S-2(1);	co-ord. 5.5/32.7.	
Pl. 31, fig. 15.	Slide No. 7-C-9(1);	co-ord. 1.2/55.1.	

Genus **Striatopollis** Krutzsch, 1959

Type species **Striatopollis sarstedtensis** Krutzsch, 1959

See Krutzsch (1959b, p. 142) for generic diagnosis.

Remarks: Krutzsch (1959b) proposed the genus *Striatopollis* to accommodate oval to rhombic, tricolpate pollen grains with circular amb and coarsely striate ornamentation. The ridges are separated by very narrow and deep canals.

The generic circumscription has been slightly expanded here to include the forms with striato-reticulate ornamentation.

According to Potonié (1966, p. 164), the genus *Striopollenites* Rouse, 1962, is a junior synonym of *Striatopollis* Krutzsch, 1959.

197 **Striatopollis paraneus** (Norris) n. comb.

Plate 32, figures 1-3

1967 *Retitricolpites paraneus* Norris, Palaeontographica, Band 120, Abt. B, p. 109, pl. 18, figs. 15-20.

See Norris (1967, p. 109) for description.

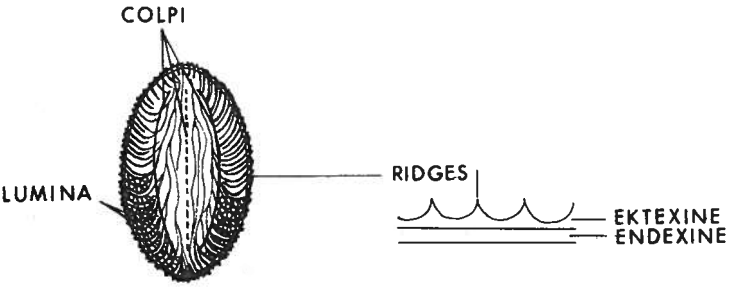


FIGURE 42. Striatopollis paraneus *(Norris) n. comb. Equatorial view showing the details of exine structure and surface ornamentation.*

Distribution: Middle and late Albian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967); Albian (probably middle Albian) of Oklahoma, U.S.A. (Hedlund and Norris, 1968).

Remarks: This species is characterized by subprolate to prolate pollen grains with striato-reticulate sculpture. The ridges are fine, sinuous, arranged in parallel sets with no preferred orientation and often running obliquely to the colpi. The minute lumina are arranged in single rows between the ridges. The exine is thin and nontegillate.

Striatopollis paraneus (Norris) n. comb. is distinct from *Striatopollis sarstedtensis* Krutzsch, 1959, which has coarser ridges running parallel to the colpi, and a simple striate sculpture. *Tricolpites striatus* Couper, 1954, is considerably larger than *S. paraneus. Striopollenites terasmaei* Rouse, 1962, differs from *S. paraneus* in being slightly larger (24 to 26 microns), and having striate sculpture consisting of fine ridges running parallel to the polar axis.

This species has been transferred here to the genus *Striatopollis* Krutzsch, 1959, because of its striato-reticulate ornamentation.

Locality of figured specimen:

Pl. 32, figs. 1-3.	Sample No. 7-C-1;	Cadotte Member.	Section 7.
Pl. 32, figs. 1-3.	Slide No. 7-C-1 (1);	co-ord. 3.8/58.8.	

Genus **Tricolpites** Cookson, 1947 ex Couper, 1953, emend. Potonié, 1960

Type species **Tricolpites reticulatus** Cookson, 1947

See Potonié (1960, p. 95) for emended generic diagnosis.

Remarks: The genus *Tricolpites* is used here in a restricted sense and includes only prolate to oblate tricolpate pollen grains, with wide colpi, trilobate amb, usually double-layered, tegillate exine, and microreticulate sculpture. The lumina are less than 1 micron in diameter.

The tricolpate forms with indistinctly microreticulate, subgranulate or scabrate sculpture have been provisionally included here in the genus *Tricolpites*.

The genus *Tricolpites* is distinct from *Retitricolpites* van der Hammen, 1956 ex Pierce, 1961, whose lumina are on an average more than 1 micron in diameter. The genus *Fraxinoipollenites* Potonié, 1951 ex Potonié, 1960, differs from *Tricolpites* in having a prolate shape.

Gunnerites Cookson and Pike, 1954, is a junior synonym of *Tricolpites*.

185 **Tricolpites crassimurus** (Groot and Penny) n. comb.

Plate 32, figures 4-6

1960 *Tricolpopollenites crassimurus* Groot and Penny, Micropaleont., vol. 6, p. 232, pl. 2, figs. 4, 5.

See Groot and Penny (1960, p. 232) for description.

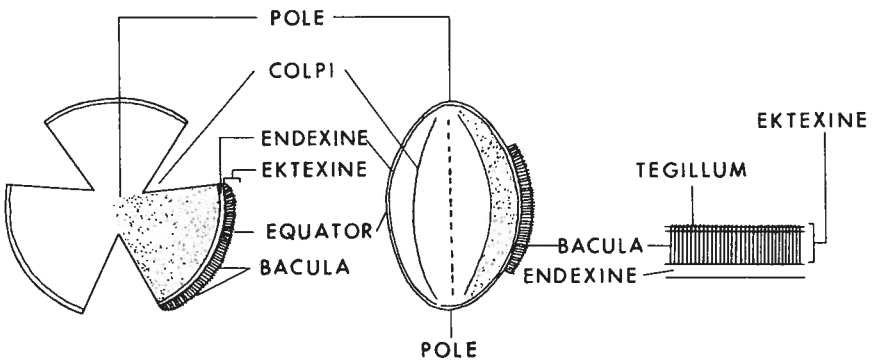


FIGURE 43. Tricolpites crassimurus *(Groot and Penny) n. comb. Polar and equatorial views showing the details of exine structure and surface ornamentation.*

Distribution: Albian to Coniacian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Albian of Maryland and Delaware, U.S.A. (Groot and Penny, 1960); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Cenomanian to Coniacian of the eastern United States (Groot, Penny and Groot, 1961); Albian of Maryland, U.S.A. (Brenner, 1963); Cenomanian of Portugal (Groot and Groot, 1962); Albian to Turonian of Peru (Brenner, 1968).

Remarks: This species is characterized by subprolate to prolate tricolpate pollen grains, with a trilobate, fossaperturate amb, long colpi, and a double-layered exine. The endexine is thin and smooth. The ektexine is baculate and tegillate. The tegillum covers the entire surface of the body. The bacula are densely packed. The tips of the bacula are fused producing a thick tegillum. The outer surface of the ektexine is scabrate.

Although Groot and Penny (1960) failed to mention the baculate elements of the ektexine in the description of this species, these can be faintly seen as radial striations near the margin in their figured specimens (pl. 2, figs. 4, 5). The specimens of this species subsequently illustrated by Groot and Groot (1962, pl. 9, figs. 4, 5) and Groot, Penny and Groot (1961, pl. 26, fig. 8), show the baculate elements of the ektexine more clearly.

Tricolpites crassimurus differs from *Tricolpites sagax* Norris, 1967, and *Tricolpites hians* Stanley, 1965, in having a larger size, thinner endexine, and scabrate surface.

Groot and Penny (1960, p. 232), Groot, Penny and Groot (1961, p. 133), and Brenner (1963, p. 92) assigned this species to the genus *Tricolpopollenites* Thomson and Pflug, 1953, which is tricolporate (Potonié, 1966, p. 168). Insofar as *T. crassimurus* is tricolpate, it has been transferred here to the genus *Tricolpites.*

According to Groot and Penny (1960), this species resembles the pollen grains of the modern genus *Quercus* (Tournefort) Linnaeus, 1753.

Locality of figured specimens:

Pl. 32, figs. 4, 5.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Pl. 32, fig. 6.	Sample No. 7-C-7;	Cadotte Member.	Section 7.
Pl. 32, fig. 4.	Slide No. 4-P-8 (1);	co-ord. 19.2/63.5.	
Pl. 32, fig. 5.	Slide No. 4-P-8(3);	co-ord. 17/42.5.	
Pl. 32, fig. 6.	Slide No. 7-C-7(1);	co-ord. 8/50.7.	

188 **Tricolpites micromunus** (Groot and Penny) n. comb.

Plate 32, figures 7-11

1960 *Tricolpopollenites micromunus* Groot and Penny, Micropaleont., vol. 6, p. 232, pl. 2, figs. 6, 7.

See Brenner (1963, p. 93) for description.

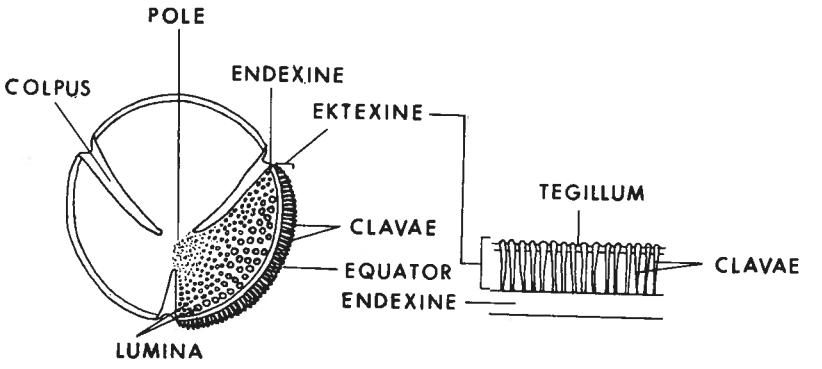


FIGURE 44. Tricolpites micromunus *(Groot and Penny) n. comb. Polar view showing the details of exine structure and surface ornamentation.*

Distribution: Albian to Danian. Loon River Formation, and Harmon, Cadotte, and Paddy Members of the Peace River area; Albian and Cenomanian of Maryland and Delaware, U.S.A. (Groot and Penny, 1960); Cenomanian to Coniacian of the eastern United States (Groot, Penny and Groot, 1961); Albian of Maryland, U.S.A. (Brenner, 1963); middle Albian to early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966); Maestrichtian and Danian of California, U.S.A. (Drugg, 1967); Albian of Oklahoma, U.S.A. (Hedlund and Norris, 1968); Turonian of Peru (Brenner, 1968).

Remarks: This species is characterized by spheroidal to prolate, tricolpate pollen grains with an almost circular amb, long and narrow colpi, and a double-layered exine. The endexine is thick and smooth. The ektexine is clavate and tegillate. The tegillum covers most of the body surface. The clavae are closely spaced. The heads of the clavae are fused producing a microreticulate sculpture. The lumina decrease in size toward the poles.

Tricolpites micromunus is distinct from *Tricolpites parvus* Stanley, 1965, which has larger dimensions, wider colpi, thicker endexine, pilate and tegillate ektexine, and lumina of uniform size all over the body.

Groot and Penny (1960, p. 232), Groot, Penny and Groot (1961, p. 133), and Brenner (1963, p. 93) assigned this species to the genus *Tricolpopollenites* Thomson and Pflug, 1953, which is tricolporate (Potonié, 1966, p. 168). Insofar as this species is tricolpate and microreticulate, it has been transferred here to the genus *Tricolpites*.

Locality of figured specimens:

Pl. 32, figs. 7-9.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 32, figs. 10, 11.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 32, figs. 7-9.	Slide No. 8-L-9(1);	co-ord. 1/32.9.	
Pl. 32, figs. 10, 11.	Slide No. 4-P-6(1);	co-ord. 11/64.1.	

187 **Tricolpites parvus** Stanley, 1965

Plate 32, figures 12-17

See Stanley (1965, p. 322) for description.

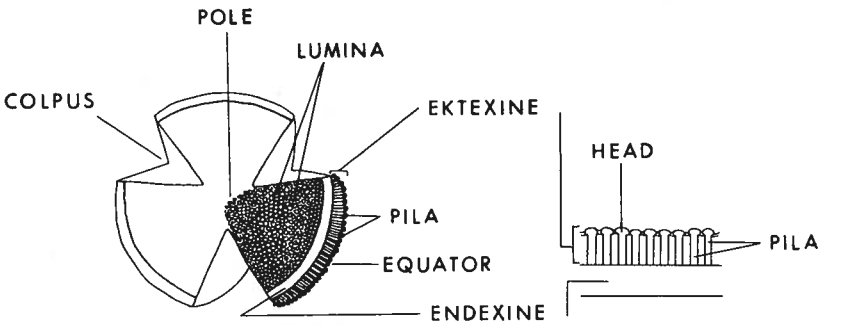


FIGURE 45. Tricolpites parvus *Stanley. Polar view showing the details of exine structure and surface ornamentation.*

Distribution: Middle Albian to early Paleocene. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; early Paleocene of South Dakota, U.S.A. (Stanley, 1965).

Remarks: This species is characterized by oblate to prolate tricolpate pollen grains with a trilobate, fossaperturate amb, long and wide colpi, and a double-layered exine. The endexine is about 1 micron thick and smooth. The ektexine is pilate and tegillate. The tegillum covers more than half of the body surface. The pila are closely spaced and about 1 micron high. The heads of pila are fused producing a microreticulate sculpture. The lumina are about 0.5 micron wide and of uniform size all over the body.

Although Stanley (1965) failed to mention the pilate elements of the ektexine in the description of this species, these can be seen in his illustrations (pl. 47, figs. 28, 29). The Alberta specimens of *Tricolpites parvus* appear to be identical with those described by Stanley.

Tricolpites reticulatus Cookson, 1947, is considerably larger than *T. parvus*. *T. parvus* closely resembles *Corylopsis compacta* Lubomirova, 1964, which differs, however, in having a thinner endexine.

Locality of figured specimens:

Pl. 32, figs. 12, 13.	Sample No. 7-C-1;	Cadotte Member.	Section 7.
Pl. 32, figs. 14, 15.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 32, figs. 16, 17.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 32, figs. 12, 13.	Slide No. 7-C-1(1);	co-ord. 16.1/74.	
Pl. 32, figs. 14, 15.	Slide No. 7-C-2(1);	co-ord. 20.8/38.8.	
Pl. 32, figs. 16, 17.	Slide No. 4-P-4(2);	co-ord. 17/65.9.	

186 **Tricolpites sagax** Norris, 1967

Plate 32, figures 18, 19

See Norris (1967, p. 107) for description.

Distribution: Middle and late Albian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area; lower part of the Colorado Group of central Alberta (Norris, 1967).

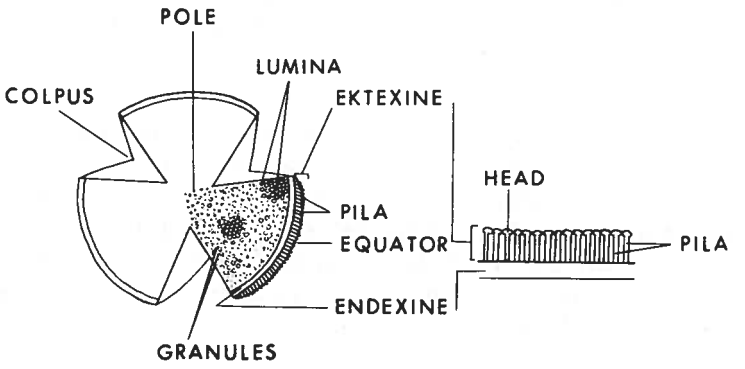


FIGURE 46. Tricolpites sagax *Norris. Polar view showing the details of exine structure and surface ornamentation.*

Remarks: This species is characterized by oblate to subprolate, tricolpate pollen grains with circular to fossaperturate amb, long and simple colpi, and a double-layered exine. The endexine is thick and highly refractive. The ektexine is pilate and tegillate, showing fine radial striations and a ragged outline at the edge. The tegillum covers most of the body surface. The heads of pila are expanded and partially fused producing a subgranulate to microreticulate sculpture.

Tricolpites sagax closely resembles *Tricolpites hians* Stanley, 1965, which differs, however, in lacking the pilate elements in the ektexine.

Locality of figured specimens:

Pl. 32, fig. 18.	Sample No. 7-C-8;	Cadotte Member.	Section 7.
Pl. 32, fig. 19.	Sample No. 2-S-1;	lower Shaftesbury Formation.	Section 2.
Pl. 32, fig. 18.	Slide No. 7-C-8(1);	co-ord. 12.1/40.8.	
Pl. 32, fig. 19.	Slide No. 2-S-1(1);	co-ord. 12.8/79.8.	

Genus **Nyssapollenites** Thiergart, 1937

Type species **Nyssapollenites pseudocruciatus** (Potonié) Thiergart, 1937

See Potonié (1960, p. 103) for generic diagnosis.

Remarks: The genus *Nyssapollenites* contains suboblate to spheroidal tricolporate pollen grains with triangular to rounded-triangular amb. The colpi are

long and situated at the apices of the triangle (angulaperturate). The pores are wide and present in each colpus at the equator. The margins of the colpi and the pores are distinctly thickened. The exine is infrapunctate.

The genus *Nyssapollenites* is used here as a form-genus, and no botanical affinities are implied.

198 **Nyssapollenites albertensis** n. sp.

Plate 32, figures 20, 21

Description: Tricolporate; colpi almost reaching the poles and about 2.5 microns wide at the equator; amb triangular, angulaperturate; pores about 2.5 microns in diameter and present in each colpus at the equator; a rim-like thickening present around each pore; the margin of colpi thickened and interrupted at the equator; exine scabrate, about 1.5 microns in thickness.

Size range: Equatorial diameter in polar view (E2) (2 specimens) 15 (16) 17 microns. Holotype 17 microns.

Distribution: Late Albian and early Cenomanian. Below and immediately above the "Fish-scale" marker bed in the Shaftesbury Formation of the Peace River area; late Albian and early Cenomanian of Colorado and Nebraska, U.S.A. (Pannella, 1966).

Remarks: *Nyssapollenites albertensis* n. sp. is distinct from *Tricolporopollenites triangulus* Groot, Penny and Groot, 1961, which has a smooth exine and smaller size (11 microns).

Tricolporites dakotensis n. sp. described by Pannella (1966, p. 114), in his unpublished Ph.D. thesis, is conspecific with *N. albertensis* n. sp.

Type locality:

Holotype: Pl. 32, fig. 20. Sample No. 2-S-3; lower Shaftesbury Formation. Section 2.
Paratype: Pl. 32, fig. 21. Sample No. 2-S-7; lower Shaftesbury Formation. Section 2.
Holotype: Pl. 32, fig. 20. Slide No. 2-S-3(1); co-ord. 12/61.1.
Paratype: Pl. 32, fig. 21. Slide No. 2-S-7(1); co-ord. 1.2/41.

MEGASPORES

Genus **Arcellites** Miner, 1935, emend. Ellis and Tschudy, 1964

Type species **Arcellites disciformis** Miner, emend. Ellis and Tschudy, 1964

See Singh (1964, p. 162) for synonymy and generic diagnosis.

Arcellites disciformis Miner, emend. Ellis and Tschudy, 1964

Plate 33, figures 1-3; plate 34, figures 1-3

See Singh (1964, p. 167) for description.

Distribution: Late Barremian to Cenomanian. Paddy Member of the Peace River area; Deville and Ellerslie Members, and Grand Rapids Formation of central Alberta (Singh, 1964); Upper Cretaceous of Greenland (Miner, 1935); Cenomanian of Iowa (Schemel, 1950; Hall, 1963); Barremian of Virginia, and Albian of the western interior United States (Ellis and Tschudy, 1964).

Remarks: The specimens of *Arcellites disciformis* recorded from the Paddy Member have coarsely pitted (Pl. 33, Fig. 3) to finely pitted (Pl. 34, Fig. 3) ektexines. However, they seem to intergrade into each other and are within the range of variation exhibited by the species.

Locality of figured specimens:

Pl. 33, figs. 1-3.	Sample No. 4-P-7;	Paddy Member.	Section 4.
Pl. 34, figs. 1, 3.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 34, fig. 2.	Sample No. 4-P-7;	Paddy Member.	Section 4.
Pl. 33, figs. 1-3.	Slide No. 4-P-7-Mega. 21;	co-ord. 8.9/37.5.	
Pl. 34, figs. 1, 3.	Slide No. 4-P-6-Mega. 26;	co-ord. 9.9/42.7.	
Pl. 34, fig. 2.	Slide No. 4-P-7-Mega. 19;	co-ord. 10/46.2.	

Arcellites nudus (Cookson and Dettmann) Potter, 1963

Plate 35, figures 1, 2

See Singh (1964, p. 166) for synonymy and description.

Distribution: Albian. Paddy Member of the Peace River area; Grand Rapids Formation of central Alberta (Singh, 1964); Albian of South Australia (Cookson and Dettmann, 1958b).

Locality of figured specimen:

Pl. 35, figs. 1, 2.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 35, figs. 1, 2.	Slide No. 4-P-6-Mega. 28;	co-ord. 10.8/37.	

Arcellites reticulatus (Cookson and Dettmann) Potter, 1963

Plate 35, figures 3-5

See Singh (1964, p. 165) for synonymy and description.

Distribution: Albian. Loon River Formation and Paddy Member of the Peace River area; Grand Rapids Formation of central Alberta (Singh, 1964); Albian of South Australia (Cookson and Dettmann, 1958b).

Locality of figured specimen:

Pl. 35, figs. 3-5.	Sample No. 4-P-6;	Paddy Member.	Section 4.
Pl. 35, figs. 3-5.	Slide No. 4-P-6-Mega. 57;	co-ord. 9.5/44.2.	

Genus **Balmeisporites** Cookson and Dettmann, 1958

Type species **Balmeisporites holodictyus** Cookson and Dettmann, 1958

See Cookson and Dettmann (1958b, p. 42) for generic diagnosis.

Remarks: The genus *Balmeisporites* was proposed by Cookson and Dettmann (1958b) to incorporate small megaspores having a spherical body 70 to 135 microns in equatorial diameter, with three equidistant, reticulate, equatorial outgrowths of ektexine and a more prominent neck at the proximal pole composed of three united leaf-like segments (laesurate lips). According to Dettmann (1963, p. 56), the lips are developed at the laesurate margins and not in the interlaesurate regions as shown by Cookson and Dettmann (1958b, text-fig. 3).

Balmeisporites differs from *Arcellites* Miner, 1935, emend. Ellis and Tschudy, 1964, in having only three neck segments (laesurate lips).

Balmeisporites sp.

Plate 36, figures 1-3

Description: Trilete megaspore; laesurae almost reaching the equator; spore body with a prominent neck at the proximal pole; neck composed of three united laesurate lips developed at the laesurate margins; three wing-like equatorial

outgrowths occurring at the extremities of the laesurate lips; spore body indistinctly reticulate; neck shorter than the diameter of the spore body; endexine smooth, 2 to 3 microns thick; ektexine membraneous, forming the laesurate lips, equatorial outgrowths, and the outer, indistinctly reticulate layer covering the spore body.

Size range: Total length including neck (5 specimens) 180 (196) 217 microns.
Diameter of body (5 specimens) 115 (120) 130 microns.
Length of neck (5 specimens) 65 (76) 87 microns.

Distribution: Middle and late Albian. Cadotte and Paddy Members of the Peace River area.

Remarks: *Balmeisporites* sp. resembles *Balmeisporites holodictyus* Cookson and Dettmann, 1958, but the reticulate sculpture, diagnostic of *B. holodictyus*, is imperfectly preserved in the Alberta specimens.

Locality of figured specimen:

Pl. 36, figs. 1-3.	Sample No. 4-P-4;	Paddy Member.	Section 4.
Pl. 36, figs. 1-3.	Slide No. 4-P-4-Mega. 59;	co-ord. 9.8/46.8.	

Genus **Biharisporites** Potonié, 1956

Type species **Biharisporites spinosus** (Singh) Potonié, 1956

See Potonié (1956, p. 31) for generic diagnosis.

Remarks: Potonié (1956) proposed the genus *Biharisporites* to accommodate trilete megaspores with a circular to triangular amb, thick exine uniformly ornamented by small coni, and laesurae longer than 2/3 of the spore radius.

Biharisporites sp.

Plate 36, figures 4, 5

Description: Trilete megaspore; laesurae more than 2/3 of the spore radius and covered by thick triradiate ridges; triradiate ridges about 40 microns high at the pole, diminishing to 10 microns at the extremities; amb subcircular; contact faces not distinguishable; endexine thin, distally detached from the ektexine and folded; ektexine 15 to 20 microns thick, ornamented by about 10-micron long coni; coni more sparse on the proximal surface.

Size range: Equatorial diameter (1 specimen) 452 microns.

Distribution: Middle Albian. Loon River Formation of the Peace River area.

Remarks: *Biharisporites* sp. resembles *Biharisporites echinatus* (Miner) Potonié, 1956, but is distinct in having sparsely distributed coni, more prominent triradiate ridges, and in being slightly larger.

Locality of figured specimen:

Pl. 36, figs. 4, 5. Sample No. 8-L-11; Loon River Formation. Section 8.
Pl. 36, figs. 4, 5. Slide No. 8-L-11-Mega. 5; co-ord. 12.2/39.2.

Genus **Callistosporites** n. gen.

Type species **Callistosporites graniferus** n. sp.

Diagnosis: Trilete megaspores with a membraneous zona; equatorial outline of the central body rounded-triangular to almost circular; zona narrow, entire, radially striated, and slightly wider at the apices; amb triangular; sides convex; laesurae with strongly raised, flap-like, membraneous triradiate lamellae (tecta); triradiate lamellae entire, extending to the outer margin of the zona at the apices; exine double-layered; endexine of the proximal side ornamented with round grana in the interradial regions; ektexine granulate.

Remarks: The ornamentation of *Callistosporites* n. gen. resembles that of *Duosporites* Hoeg, Bose and Manum, 1955. The sculptural elements in both the genera are in the endexine of the proximal side, below the ektexinal layer. However, *Callistosporites* n. gen. is readily distinguishable from *Duosporites*, which lacks the membraneous zona.

Callistosporites n. gen. is distinct from *Minerisporites* Potonié, 1956, *Henrisporites* Potonié, 1956, and *Dijkstraisporites* Potonié, 1956, which have a proximal as well as distal ornamentation, smooth endexine and a sculptured ektexine, and display a different type of sculpture.

The generic name is derived from *"callisto-"* (most beautiful).

Callistosporites graniferus n. sp.

Plate 36, figures 6, 7; plate 37, figures 1-7

Description: Trilete megaspore with a membraneous zona; central body rounded-triangular in equatorial outline and 180 to 310 microns in diameter; zona entire, radially striated, 20 to 40 microns in width, and slightly wider at the apices; amb triangular; sides convex; laesurae with strongly raised, flap-like, membraneous triradiate lamellae (tecta); triradiate lamellae entire, extending to the outer margin

of the zona at the apices, 20 to 30 microns high at the pole, diminishing to 10 microns at the extremities; exine double layered; endexine of the proximal side ornamented with round grana in the interradial regions; grana sparsely distributed and about 8 microns in diameter; ektexine granulate.

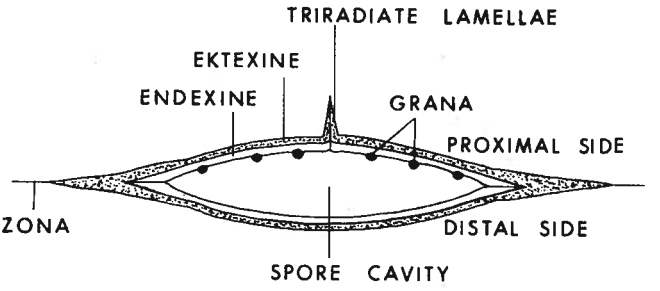


FIGURE 47. Callistosporites graniferus *n. sp. Vertical section.*

Size range: Total equatorial diameter including zona (48 specimens) 199 (282) 352 microns. Holotype 305 microns.

Distribution: Late Albian. Paddy Member of the Peace River area.

Remarks: *Minerisporites marginatus* (Dijkstra) Potonié, 1956, resembles *Callistosporites graniferus* n. sp., but is distinct in having a reticulate sculpture.

The grana are not very distinct in most of the specimens, which is probably due to poor preservation.

The specific name is derived from *"graniferus"* (bearing grains) and refers to the grana.

Type locality:

Holotype: Pl. 36, figs. 6, 7.	Sample No. 4-P-4;	Paddy Member. Section 4.
Paratypes: Pl. 37, figs. 1-7.	Sample No. 4-P-8;	Paddy Member. Section 4.
Holotype: Pl. 36, figs. 6, 7.	Slide No. 4-P-4-Mega. 60;	co-ord. 13.1/34.3.
Paratype: Pl. 37, figs. 1-3.	Slide No. 4-P-8-Mega. 11;	co-ord. 6.5/40.8.
Paratype: Pl. 37, figs. 4, 5.	Slide No. 4-P-8-Mega. 55;	co-ord. 11.1/38.
Paratype: Pl. 37, figs. 6, 7.	Slide No. 4-P-8-Mega. 55;	co-ord. 7/45.5.

Genus **Erlansonisporites** Potonié, 1956

Type species **Erlansonisporites erlansonii** (Miner) Potonié, 1956

See Singh (1964, p. 152) for synonymy and generic diagnosis.

Erlansonisporites sparassis? (Murray) Potonié, 1956

Plate 37, figure 8

See Singh (1964, p. 153) for synonymy and description.

Distribution: Middle Jurassic to Middle Albian. Cadotte Member of the Peace River area; Ellerslie Member of central Alberta (Singh, 1964); Middle Jurassic of England (Murray, 1939; Harris, 1961).

Remarks: It is not possible to identify this species with any degree of certainty as no complete specimens with membraneous lamellae were preserved.

Locality of figured specimen:

Pl. 37, fig. 8.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 37, fig. 8.	Slide No. 7-C-2-Mega. 9;	co-ord. 9.8/37.1.	

Genus **Minerisporites** Potonié, 1956

Type species **Minerisporites mirabilis** (Miner) Potonié, 1956

See Singh (1964, p. 157) for synonymy and generic diagnosis.

Minerisporites marginatus (Dijkstra) Potonié, 1956

Plate 37, figure 9

See Singh (1964, p. 158) for synonymy and description.

Distribution: Early Cretaceous. Loon River Formation and Cadotte Member of the Peace River area; Ellerslie Member and Grand Rapids Formation of central Alberta (Singh, 1964); Valanginian of England (Hughes, 1958); Lower Cretaceous of Holland (Dijkstra, 1951), Belgium (Delcourt and Sprumont, 1955), and South Australia (Cookson and Dettmann, 1958b).

Locality of figured specimen:

Pl. 37, fig. 9.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 37, fig. 9.	Slide No. 8-L-11-Mega. 3;	co-ord. 10.9/44.9.	

Minerisporites venustus Singh, 1964

Plate 37, figure 10

See Singh (1964, p. 159) for synonymy and description.

Distribution: Middle and late Albian. Loon River Formation and Paddy Member of the Peace River area; Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964).

Locality of figured specimen:

Pl. 37, fig. 10. Sample No. 8-L-11; Loon River Formation. Section 8.
Pl. 37, fig. 10. Slide No. 8-L-11-Mega. 54; co-ord. 17/38.2.

Genus **Verrutriletes** van der Hammen, 1954 ex Potonié, 1956

Type species **Verrutriletes compositipunctatus** (Dijkstra) Potonié, 1956

See Singh (1964, p. 151) for synonymy and generic diagnosis.

Verrutriletes sp. cf. **V. compositipunctatus** (Dijkstra) Potonié, 1956

Plate 38, figure 1

See Singh (1964, p. 151) for description.

Distribution: Aptian and Albian. Lower Shaftesbury Formation of the Peace River area; Ellerslie and Wabiskaw Members of central Alberta (Singh, 1964).

Locality of figured specimen:

Pl. 38, fig. 1. Sample No. 1-S-5; lower Shaftesbury Formation. Section 1.
Pl. 38, fig. 1. Slide No. 1-S-5-Mega. 49; co-ord. 13.5/44.5.

Verrutriletes sp.

Plate 38, figure 2

Description: Trilete megaspore; laesurae almost reaching the equator; trilete cracks present on conspicuous triradiate ridges; triradiate ridges about 25 microns high and 30 microns broad; amb subcircular; arcuate ridges not seen; exine ornamented with verrucae and coni, 5 to 40 microns in diameter and 5 to 40 microns high; verrucae usually fused with one another at bases forming an irregular outline; exine granulose and thick.

Size range: Equatorial diameter including coni (1 specimen) 556 microns.

Distribution: Middle Albian. Cadotte Member of the Peace River area.

Remarks: This species has not been formally named as only one poorly preserved specimen was found.

Locality of figured specimen:

Pl. 38, fig. 2.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 38, fig. 2.	Slide No. 7-C-2-Mega. 8;	co-ord. 13.8/40.	

Seed

Plate 38, figure 3

Description: Seed consisting of a slightly cutinized, collapsed nucellus enclosed in a rigid integument; nucellus composed of rows of elongated cells; integument membraneous with indistinct cell structure.

Size range: Length (1 specimen) 852 microns.
Breadth (1 specimen) 530 microns.

Distribution: Late Albian. Paddy Member of the Peace River area.

Locality of figured specimen:

Pl. 38, fig. 3.	Sample No. 4-P-8;	Paddy Member.	Section 4.
Pl. 38, fig. 3.	Slide No. 4-P-8-Mega. 13;	co-ord. 9.1/46.9.	

Lenticular bodies

Plate 38, figures 4-9

Description: Body elongate-lenticular in outline, sharply pointed at either end, and with a distinct median furrow; median furrow running entire length of the body; furrow bordered on either side by a prominent thickening and occasionally gaping; outer surface of the body finely fibrous; fibres oriented along the length of the body; size of body extremely variable; smaller specimens transparent and membraneous; larger specimens darker and thick walled; color varying from light yellow to amber yellow with a resinous lustre.

Size range: Length (65 specimens) 522 (1840) 2440 microns.
Breadth (65 specimens) 142 (438) 745 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: The lenticular bodies lack cellular structure, and therefore, it is highly improbable that they represent cutinized spore sacs. It is uncertain as to whether they belong to the plant or animal kingdom. *Lancettopsis lanceolata* Mädler, 1963, resembles the Alberta specimens of lenticular bodies but differs in being smaller (230 to 330 microns long).

The lenticular bodies are extremely abundant in the basal part of the Shaftesbury Formation.

Locality of figured specimens:

Pl. 38, figs. 4-9.	Sample No. 5-S-3;	lower Shaftesbury Formation. Section 5.
Pl. 38, fig. 4.	Slide No. 5-S-3-Mega. 36;	co-ord. 5/47.9.
Pl. 38, fig. 5.	Slide No. 5-S-3-Mega. 36;	co-ord. 6.9/51.8.
Pl. 38, fig. 6.	Slide No. 5-S-3-Mega. 36;	co-ord. 2.9/61.2.
Pl. 38, fig. 7.	Slide No. 5-S-3-Mega. 36;	co-ord. 12/38.5.
Pl. 38, fig. 8.	Slide No. 5-S-3-Mega. 38;	co-ord. 13.5/41.7.
Pl. 38, fig. 9.	Slide No. 5-S-3-Mega. 38;	co-ord. 12/66.5.

PLATES 1–38

Explanation of Plate 1

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Cingutriletes clavus* (Balme) Dettmann; 1–distal view; 2–distal view; 3–mid-focus ..... (p. 32)

Figures 4, 5: *Stereisporites antiquasporites* (Wilson and Webster) Dettmann; 4–mid-focus; 5–distal view ..... (p. 33)

Figure 6: *Aequitriradites spinulosus* (Cookson and Dettmann) Cookson and Dettmann; mid-focus ..... (p. 34)

Figure 7: *Couperisporites tabulatus* Dettmann; distal view ..... (p. 35)

Figure 8: *Foraminisporis dailyi* (Cookson and Dettmann) Dettmann; mid-focus ..... (p. 35)

Figures 9, 10: *Foraminisporis wonthaggiensis* (Cookson and Dettmann) Dettmann; 9–proximal view; 10–same specimen, distal view ..... (p. 36)

Figures 11, 12: *Rouseisporites reticulatus* Pocock; 11–proximal view; 12–same specimen, distal view ..... (p. 37)

Figure 13: *Rouseisporites* sp. cf. *R. radiatus* Dettmann; mid-focus ..... (p. 37)

Figure 14: *Rouseisporites triangularis* Pocock; mid-focus ..... (p. 38)

Figure 15: *Lycopodiacidites canaliculatus* n. sp.; (holotype) mid-focus ..... (p. 38)

Figures 16, 17: *Lycopodiacidites caperatus* n. sp.; 16–(holotype) proximal view; 17–(holotype) distal view ..... (p. 39)

PLATE 1

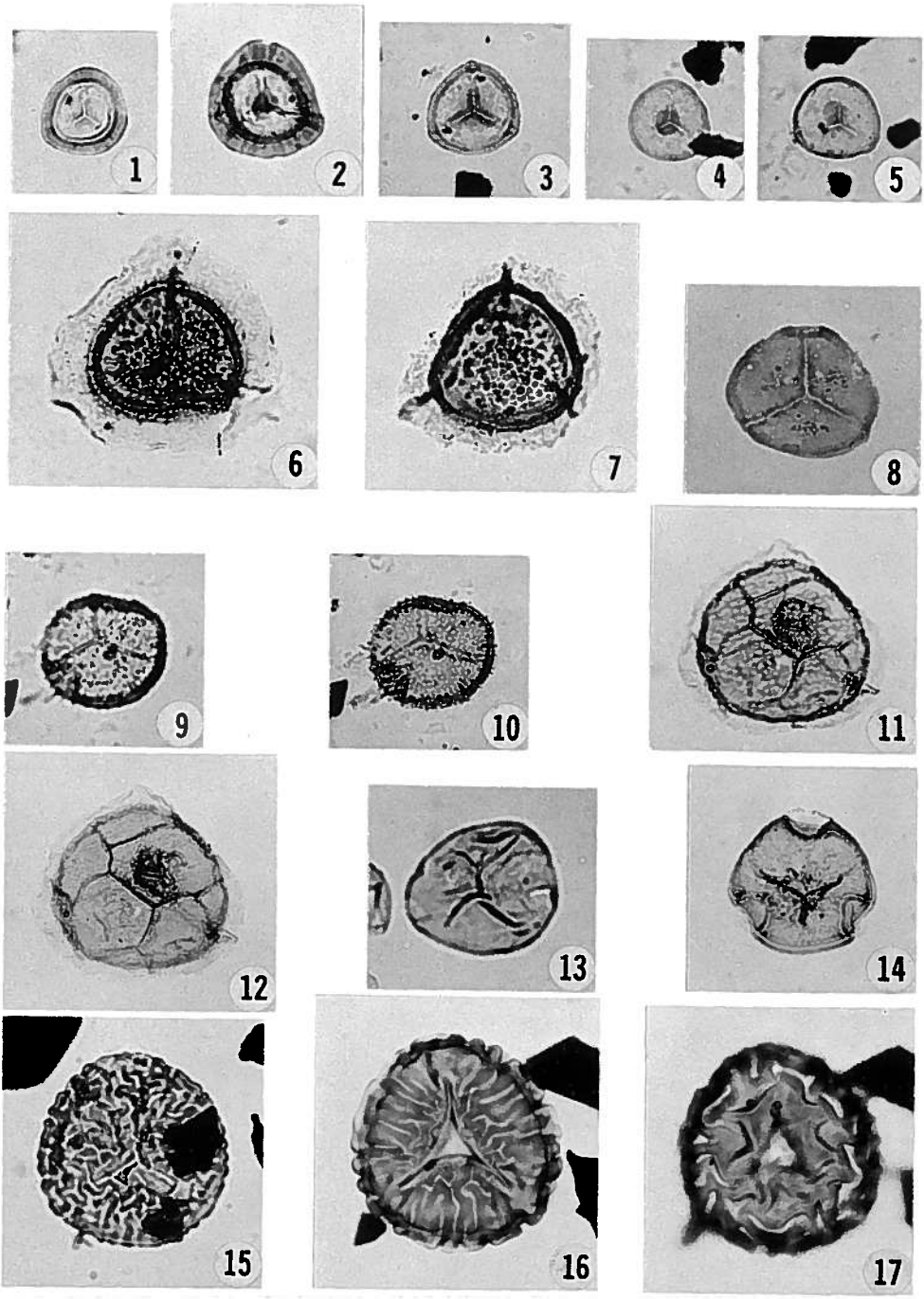
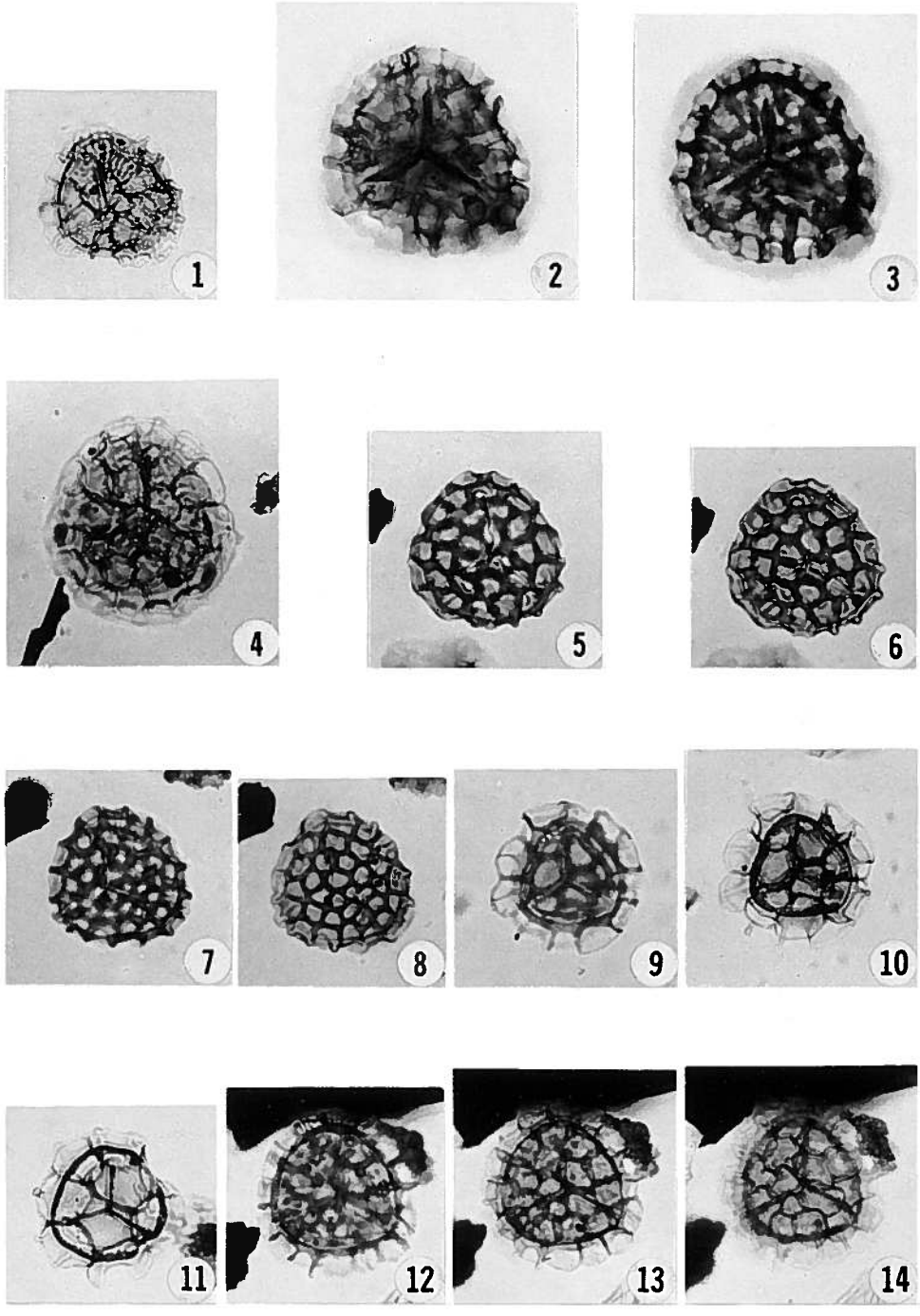


PLATE 2



Explanation of Plate 2

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Lycopodiumsporites austroclavatidites* (Cookson) Potonié; mid-focus.....(p. 40)

Figures 2-4: *Lycopodiumsporites crassatus* n. sp.; 2–(holotype) proximal view; 3–(holotype) mid-focus; 4–distal view.....(p. 41)

Figures 5-8: *Lycopodiumsporites crassimacerius* Hedlund; 5–proximal view; 6–same specimen, distal view; 7–proximal view; 8–same specimen, distal view.....(p. 41)

Figures 9-11: *Lycopodiumsporites expansus* n. sp.; 9–(holotype) proximal view; 10–(holotype) distal view; 11–distal view.....(p. 42)

Figures 12-14: *Lycopodiumsporites marginatus* Singh; 12–proximal view; 13–same specimen, mid-focus; 14–same specimen, distal view.....(p. 43)

Explanation of Plate 3

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Lycopodiumsporites reticulumsporites* (Rouse) Dettmann; 1–proximal view; 2–same specimen, distal view ..... (p. 43)

Figures 3-7: *Sestrosporites pseudoalveolatus* (Couper) Dettmann; 3–mid-focus; 4–proximal view; 5–same specimen, mid-focus; 6–same specimen, distal view; 7–distal view showing membraneous margin ..... (p. 44)

Figure 8: *Acanthotriletes varispinosus* Pocock; mid-focus ..... (p. 45)

Figures 9, 10: *Densoisporites velatus* Weyland and Krieger, emend. Krasnova; 9–proximal view; 10–same specimen, mid-focus ..... (p. 46)

Figures 11, 12: *Densoisporites microrugulatus* Brenner; 11–proximal view; 12–mid-focus (p. 46)

Figure 13: *Neoraistrickia truncata* (Cookson) Potonié; mid-focus ..... (p. 47)

Figure 14: *Baculatisporites comaumensis* (Cookson) Potonié; mid-focus ..... (p. 48)

Figures 15, 16: *Biretisporites potoniaei* Delcourt and Sprumont; 15–proximal view; 16–proximal view ..... (p. 49)

PLATE 3

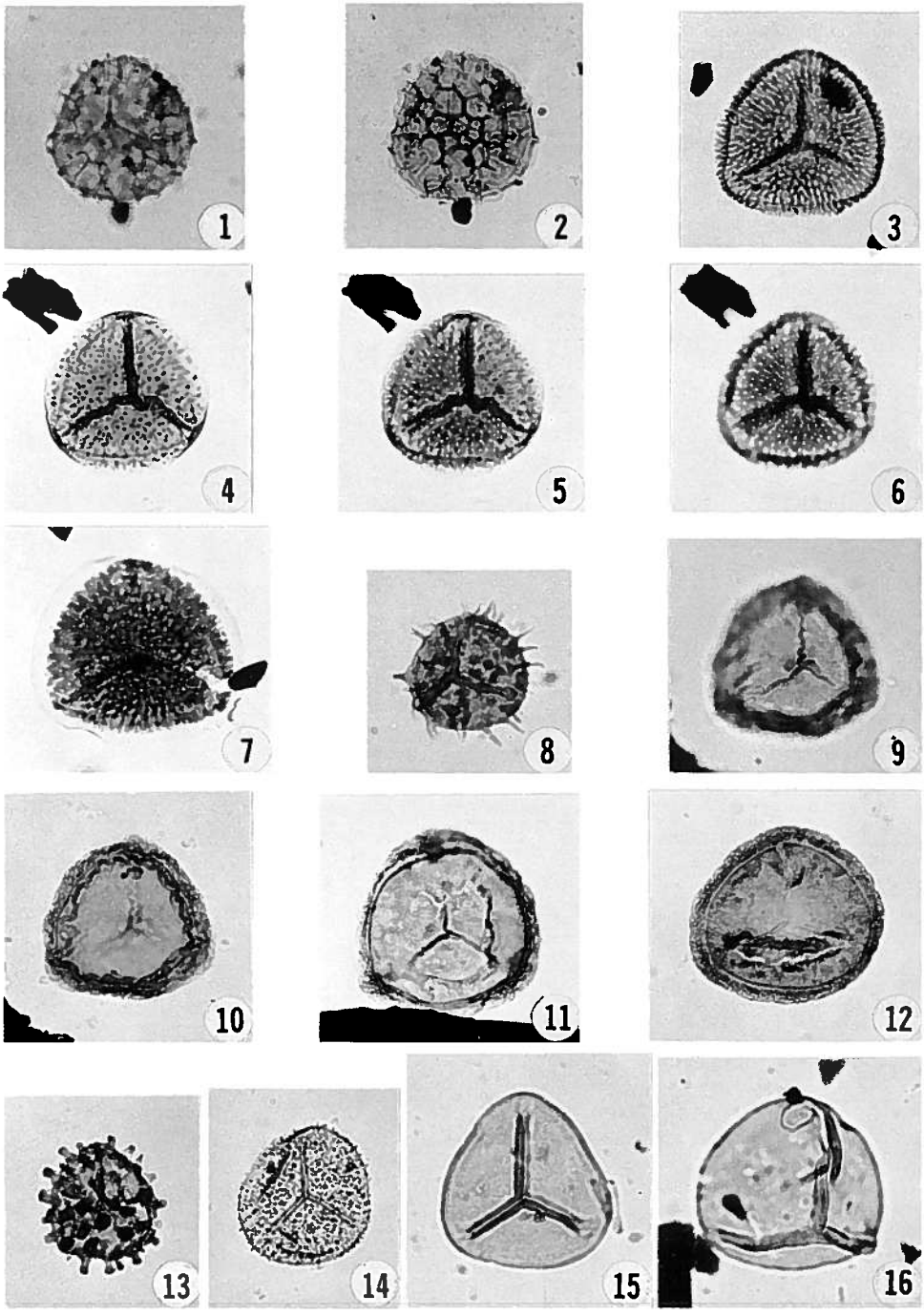
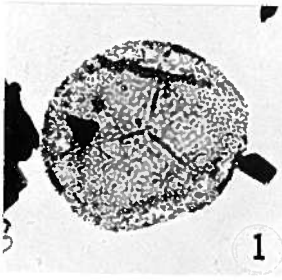


PLATE 4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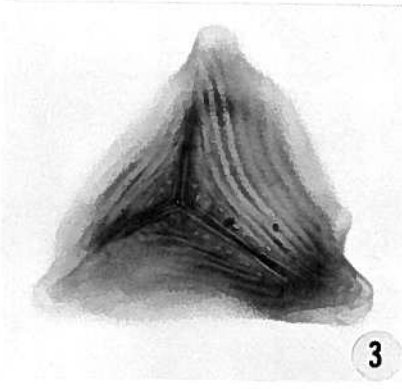
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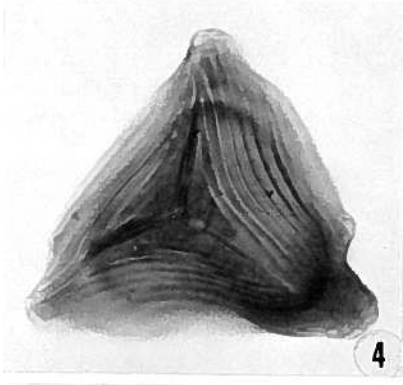
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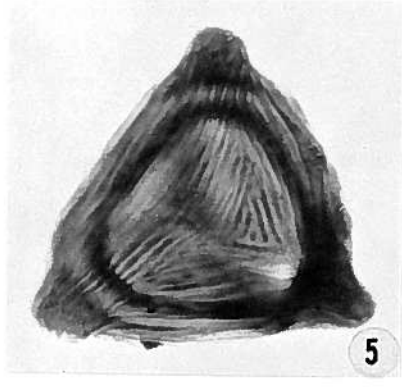
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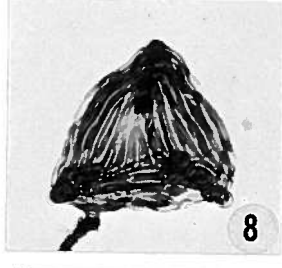
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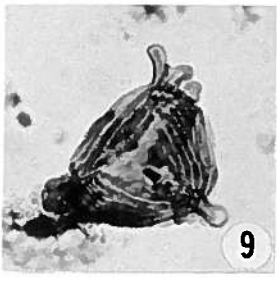
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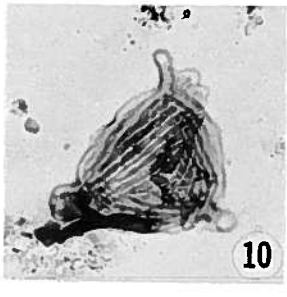
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Explanation of Plate 4

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Osmundacidites wellmanii* Couper; mid-focus ..... (p. 50)

Figure 2: *Todisporites minor* Couper; mid-focus ..... (p. 50)

Figures 3-5: *Appendicisporites bifurcatus* Singh; 3—proximal view; 4—same specimen, mid-focus; 5—same specimen, distal view ..... (p. 56)

Figures 6-8: *Appendicisporites bilateralis* n. sp.; 6—(holotype) proximal view; 7—(holotype) distal view; 8—distal view ..... (p. 56)

Figures 9, 10: *Appendicisporites* sp. cf. *A. cristatus* (Markova) Pocock; 9—proximal view; 10—same specimen, distal view ..... (p. 57)

Figure 11: *Appendicisporites erdtmanii* Pocock; distal view ..... (p. 58)

Explanation of Plate 5

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Appendicisporites jansonii* Pocock; 1–proximal view; 2–same specimen, distal view.....(p. 59)

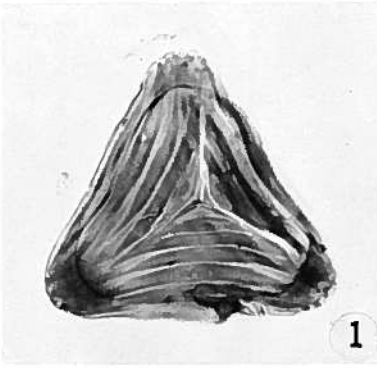
Figures 3, 4: *Appendicisporites* sp. cf. *A. jansonii* Pocock; 3–proximal view; 4–same specimen, distal view.....(p. 60)

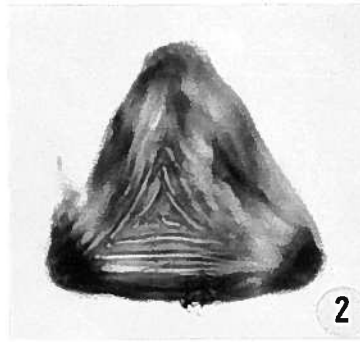
Figures 5-8: *Appendicisporites* sp. cf. *Anemia macrorhyza* (Maljavkina) Bolkhovitina; 5–proximal view; 6–same specimen, distal view; 7–proximal view; 8–same specimen, distal view.....(p. 60)

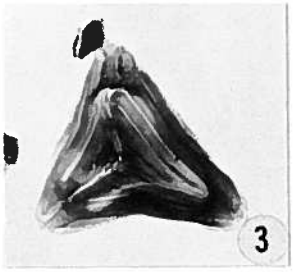
Figure 9: *Appendicisporites matesovae* (Bolkhovitina) Norris; equatorial view.....(p. 62)

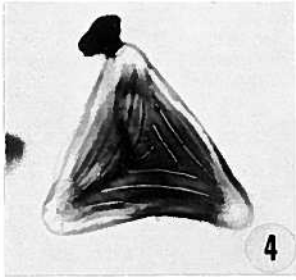
Figures 10-13: *Appendicisporites potomacensis* Brenner; 10–proximal view; 11–same specimen, distal view; 12–proximal view; 13–distal view.....(p. 62)

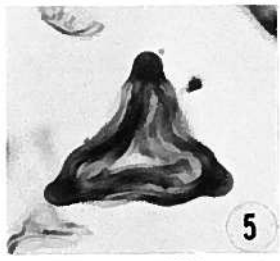
PLATE 5

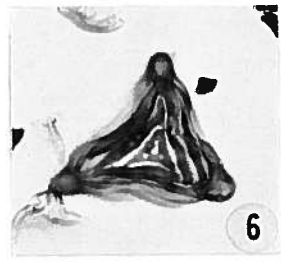


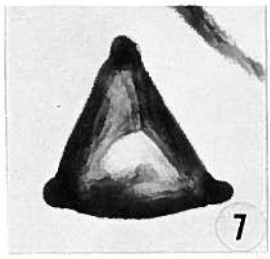


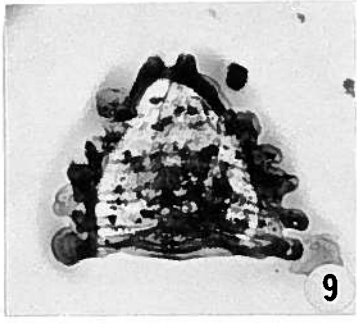


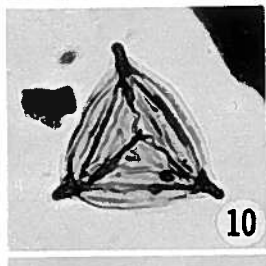


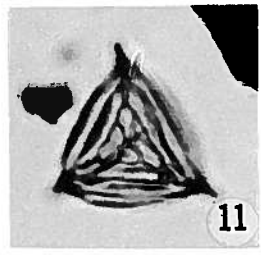


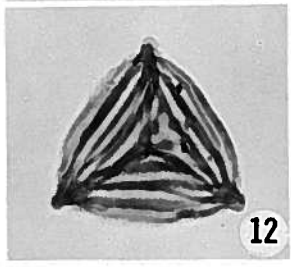












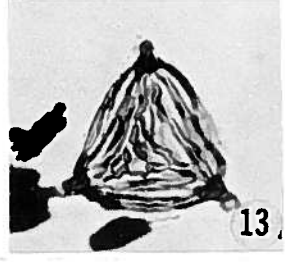
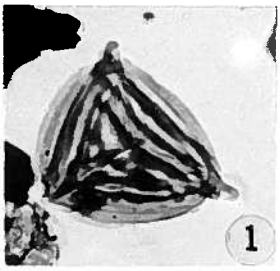


PLATE 6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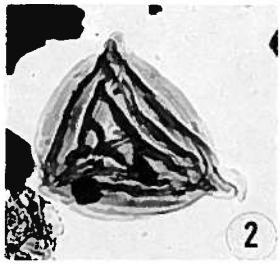
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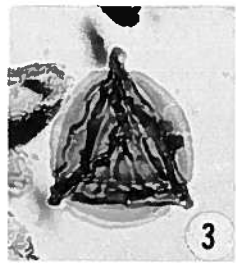
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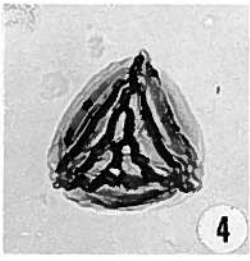
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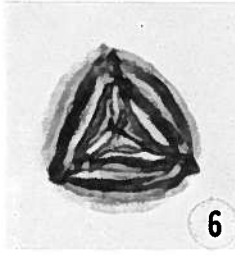
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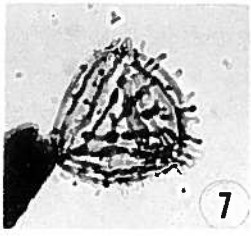
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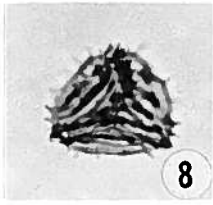
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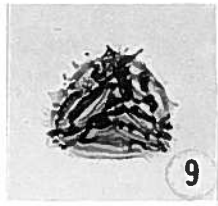
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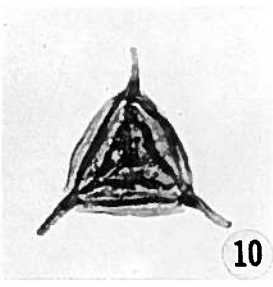
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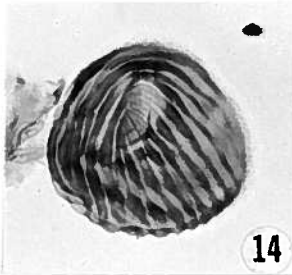
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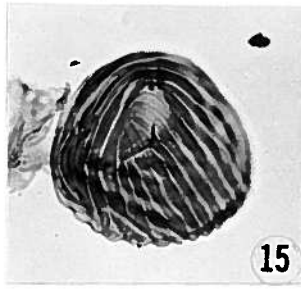
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Explanation of Plate 6

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-6: *Appendicisporites problematicus* (Burger) n. comb.; 1–proximal view; 2–same specimen, distal view; 3–proximal view; 4–distal view; 5–proximal view; 6–same specimen, distal view ..... (p. 63)

Figures 7-9: *Appendicisporites spinosus* Pocock; 7–mid-focus; 8–proximal view; 9–same specimen, distal view ..... (p. 65)

Figures 10-12: *Appendicisporites unicus* (Markova) Singh; 10–proximal view; 11–distal view; 12–distal view ..... (p. 65)

Figures 13-15: *Cicatricosisporites annulatus* Archangelsky and Gamerro; 13–proximal view; 14–same specimen, mid-focus; 15–same specimen, distal view ..... (p. 67)

Explanation of Plate 7

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Cicatricosisporites annulatus* Archangelsky and Gamerro; 1–proximal view; 2–same specimen, distal view ..... (p. 67)

Figures 3-11: *Cicatricosisporites augustus* n. sp.; 3–(holotype) proximal view; 4–(holotype) mid-focus; 5–(holotype) distal view; 6–proximal view; 7–same specimen, mid-focus; 8–same specimen, distal view; 9–proximal view; 10–same specimen, distal view; 11–equatorial view ..... (p. 68)

Figures 12-15: *Cicatricosisporites australiensis* (Cookson) Potonié; 12–proximal view; 13–distal view; 14–proximal view; 15–same specimen, distal view ..... (p. 69)

PLATE 7

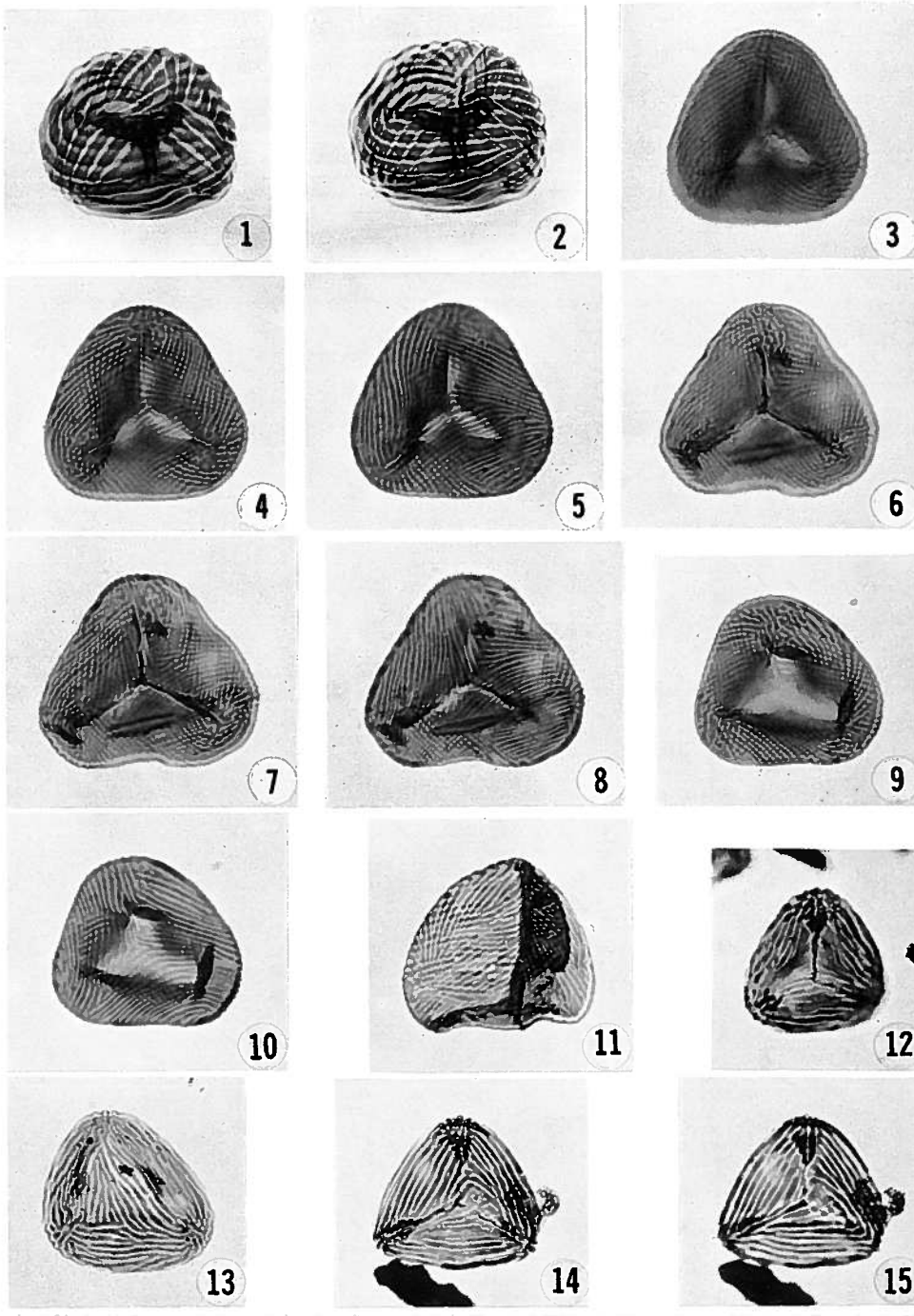

PLATE 8

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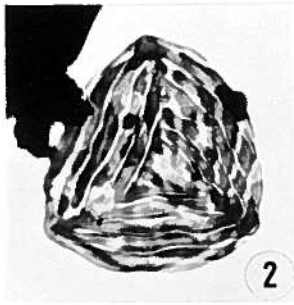
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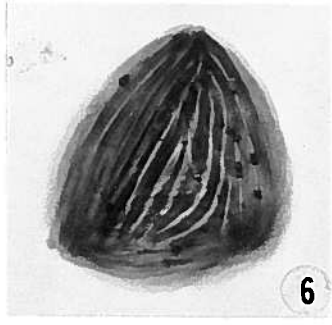
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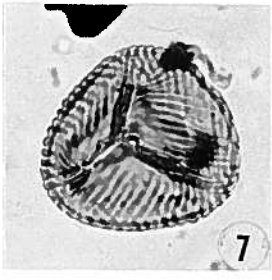
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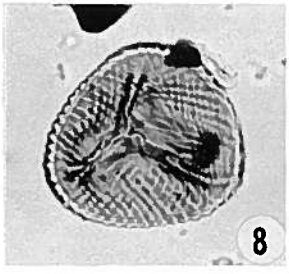
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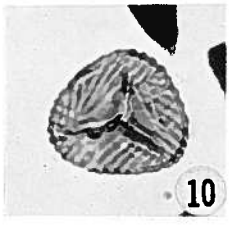
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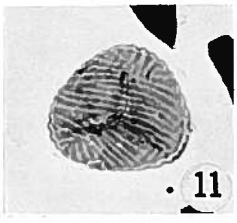
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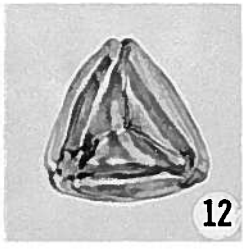
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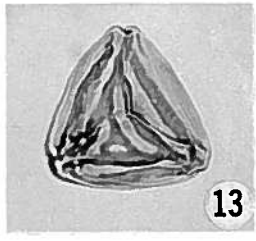
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Explanation of Plate 8

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-6: *Cicatricosisporites* sp. cf. *Anemia exilioides* (Maljavkina) Bolkhovitina; 1–proximal view; 2–same specimen, distal view; 3–proximal view; 4–same specimen, distal view; 5–proximal view; 6–same specimen, distal view.....(p. 70)

Figures 7-11: *Cicatricosisporites hallei* Delcourt and Sprumont; 7–proximal view; 8–same specimen, mid-focus; 9–same specimen, distal view; 10–proximal view; 11–same specimen, distal view .....(p. 71)

Figures 12, 13: *Cicatricosisporites hughesi* Dettmann; 12–proximal view; 13–same specimen, distal view.....(p. 72)

Explanation of Plate 9

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Cicatricosisporites hughesi* Dettmann; 1–distal view; 2–proximal view..... (p. 72)

Figures 3-5: *Cicatricosisporites imbricatus* (Markova) n. comb.; 3–proximal view; 4–same specimen, distal view; 5–distal view ..... (p. 73)

Figure 6: *Cicatricosisporites* sp. cf. *C. imbricatus* (Markova) n. comb.; distal view ..... (p. 74)

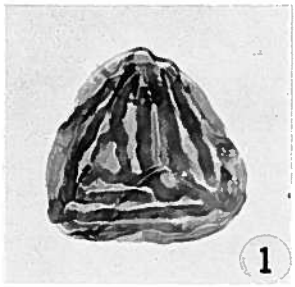
Figures 7, 8: *Cicatricosisporites minor* (Bolkhovitina) Pocock; 7–proximal view; 8–same specimen, distal view..... (p. 74)

Figure 9: *Cicatricosisporites mohrioides* Delcourt and Sprumont; distal view..... (p. 75)

Figures 10, 11: *Cicatricosisporites* sp. cf. *C. potomacensis* Brenner; 10–proximal view; 11–same specimen, distal view ..... (p. 76)

Figures 12-15: *Cicatricosisporites pseudotripartitus* (Bolkhovitina) Dettmann; 12–proximal view; 13–same specimen, distal view; 14–proximal view; 15–same specimen, distal view..... (p. 77)

PLATE 9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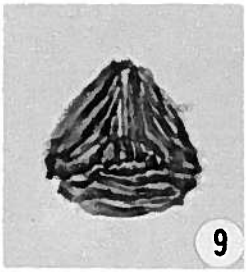
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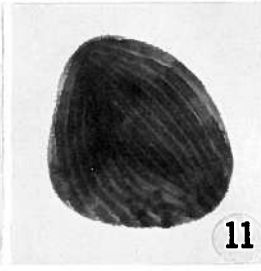
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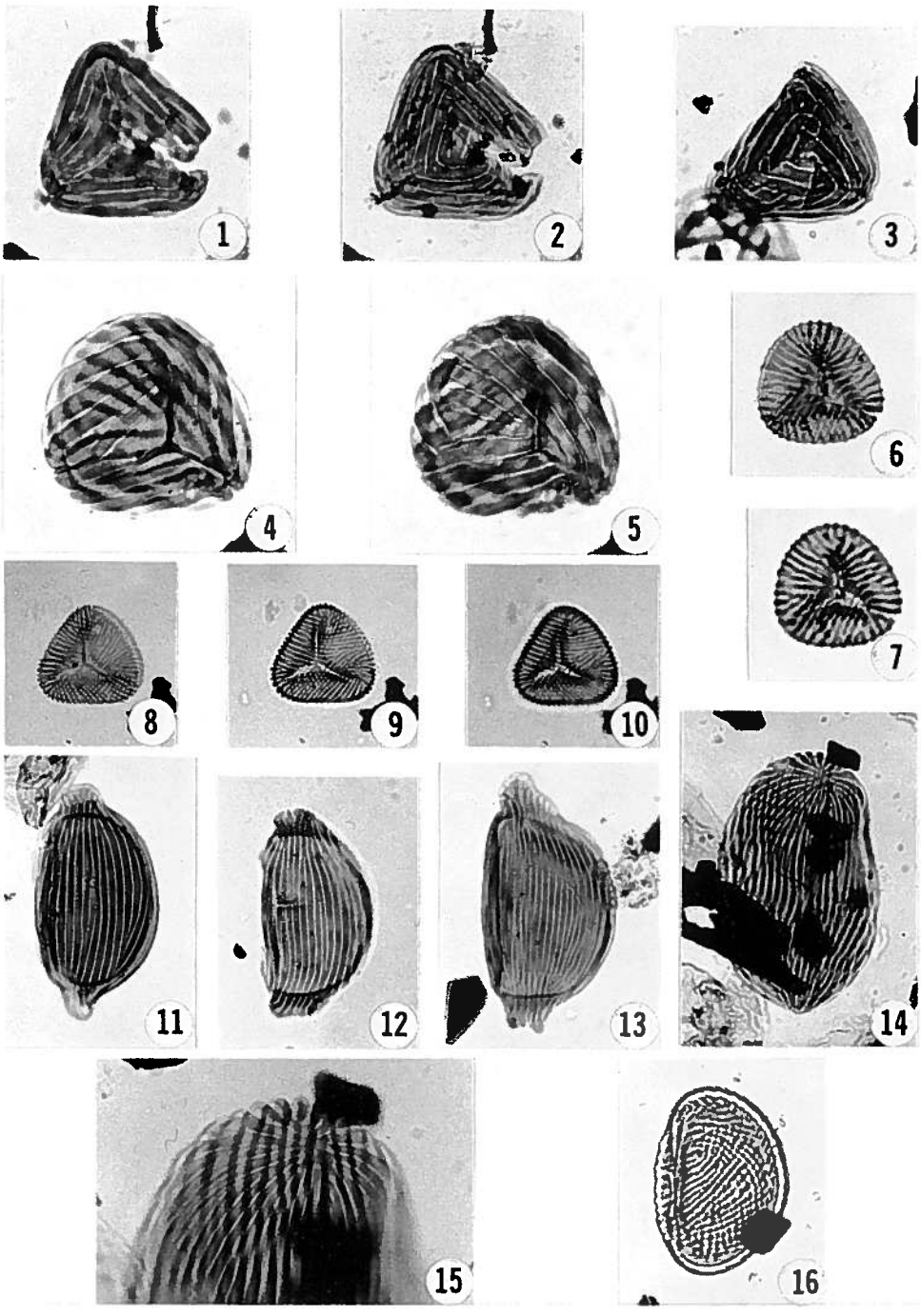
PLATE 10



Explanation of Plate 10

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Cicatricosisporites spiralis* n. sp.; 1–(holotype) proximal view; 2–(holotype) distal view; 3–distal view.....(p. 78)

Figures 4, 5: *Cicatricosisporites subrotundus* Brenner; 4–proximal view; 5–same specimen, distal view.....(p. 79)

Figures 6-10: *Cicatricosisporites venustus* Deák; 6–proximal view; 7–same specimen, distal view; 8–proximal view; 9–same specimen, mid-focus; 10–same specimen, distal view.....(p. 80)

Figures 11-15: *Cicatricososporites auritus* n. sp.; 11–(holotype) equatorial view; 12–equatorial view; 13–equatorial view; 14–equatorial view; 15–same specimen X1000, showing ribs converging and coalescing at the longitudinal end of the body.(p. 81)

Figure 16: *Cicatricososporites phaseolus* (Delcourt and Sprumont) Krutzsch; equatorial view .....(p. 83)

Explanation of Plate 11

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-4: *Contignisporites glebulentus* Dettmann; 1–proximal view; 2–same specimen, distal view; 3–proximal view; 4–distal view.....(p. 84)

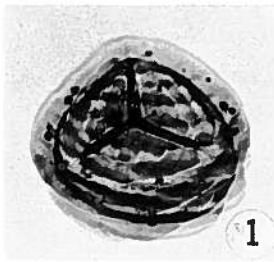
Figures 5, 6: *Contignisporites cooksonii* (Balme) Dettmann; 5–proximal view; 6–same specimen, distal view.....(p. 85)

Figures 7, 8: *Contignisporites multimuratus* Dettmann; 7–proximal view; 8–same specimen, distal view.....(p. 86)

Figures 9, 10: *Costatoperforosporites fistulosus* Deák; 9–proximal view; 10–same specimen, distal view.....(p. 86)

Figures 11-15: *Costatoperforosporites foveolatus* Deák; 11–proximal view; 12–same specimen, distal view; 13–proximal view; 14–same specimen, distal view; 15–same specimen, distal view, high focus.....(p. 87)

PLATE 11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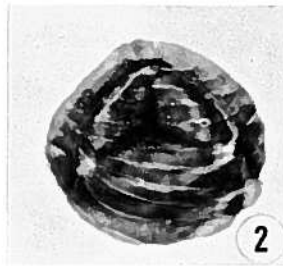
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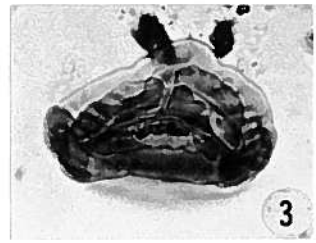
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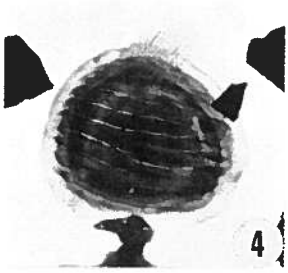
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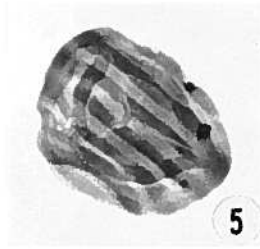
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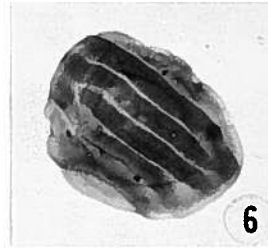
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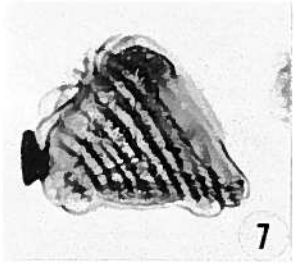
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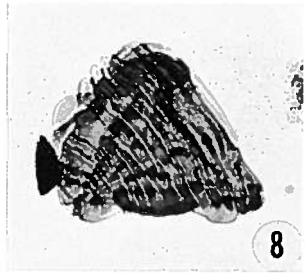
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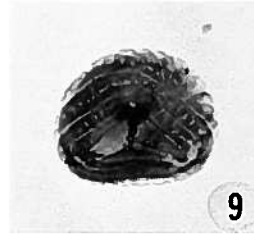
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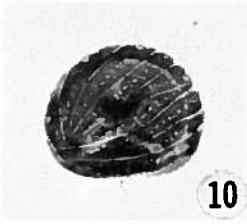
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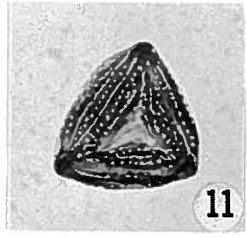
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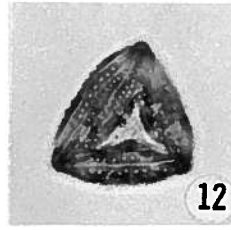
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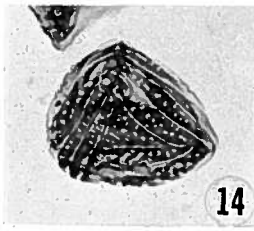
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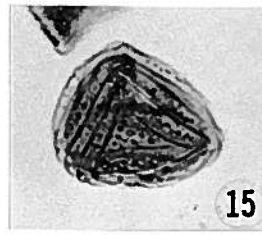
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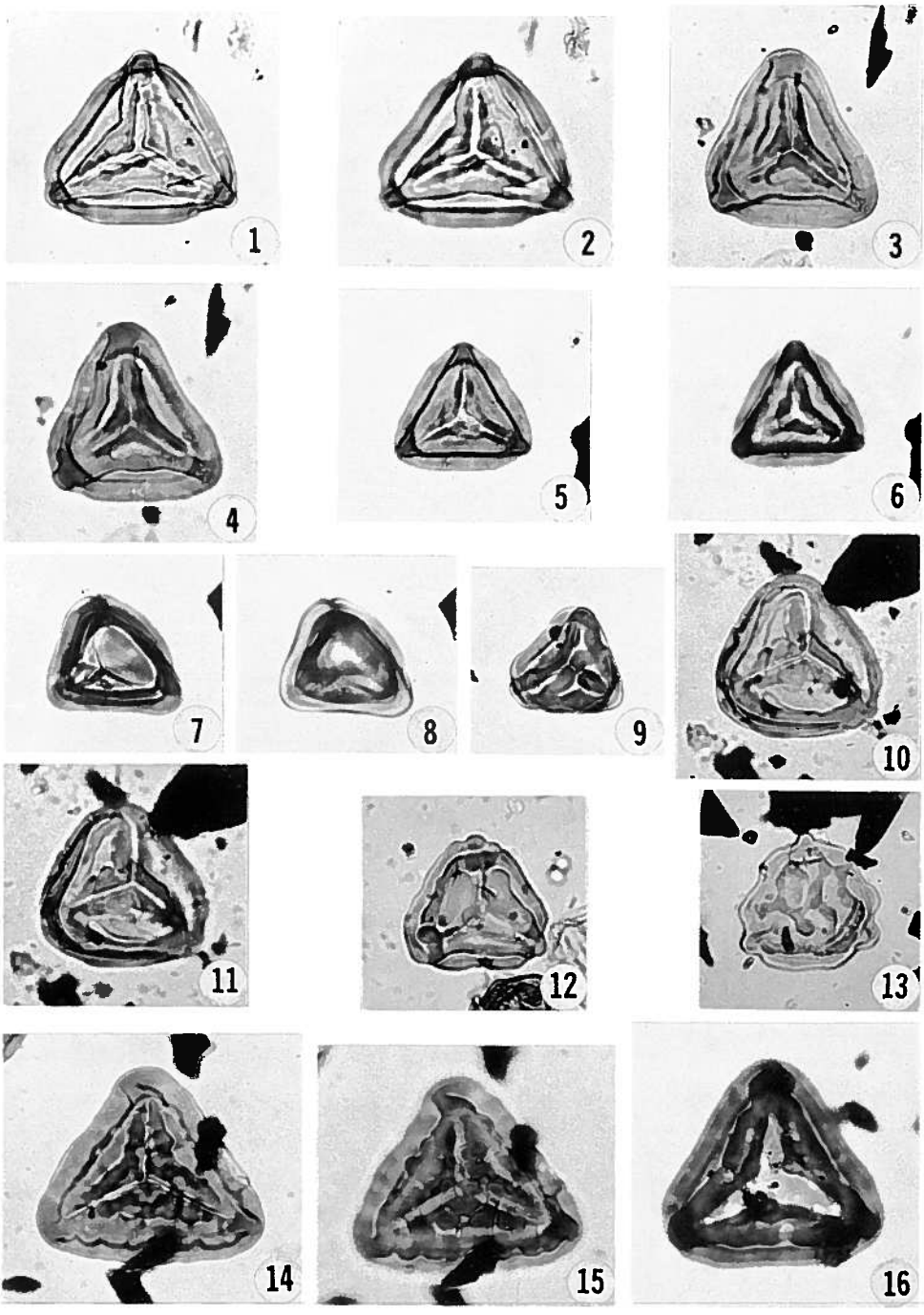
PLATE 12



Explanation of Plate 12

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-6: *Distaltriangulisporites perplexus* (Singh) n. comb.; 1–proximal view; 2–same specimen, distal view; 3–proximal view; 4–same specimen, distal view; 5–proximal view; 6–same specimen, distal view.....(p. 89)

Figures 7-9: *Distaltriangulisporites costatus* n. sp.; 7–(holotype) proximal view; 8–(holotype) distal view; 9–distal view.....(p. 90)

Figures 10-13: *Distaltriangulisporites irregularis* n. sp.; 10–(holotype) proximal view; 11–(holotype) distal view; 12–distal view; 13–distal view.....(p. 91)

Figures 14-16: *Distaltriangulisporites maximus* n. sp.; 14–(holotype) proximal view; 15–(holotype) distal view; 16–distal view.....(p. 92)

Explanation of Plate 13

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Distaltriangulisporites mutabilis* n. sp.; 1–(holotype) distal view; 2–proximal view; 3–same specimen, distal view.....(p. 93)

Figures 4-7: *Klukisporites areolatus* n. sp.; 4–(holotype) proximal view; 5–(holotype) distal view; 6–proximal view; 7–same specimen, distal view.....(p. 94)

Figures 8-11: *Klukisporites foveolatus* Pocock; 8–proximal view; 9–same specimen, distal view; 10–proximal view; 11–same specimen, distal view.....(p. 95)

Figures 12-15: *Klukisporites pseudoreticulatus* Couper; 12–proximal view; 13–same specimen, distal view; 14–proximal view; 15–same specimen, distal view.....(p. 96)

PLATE 13

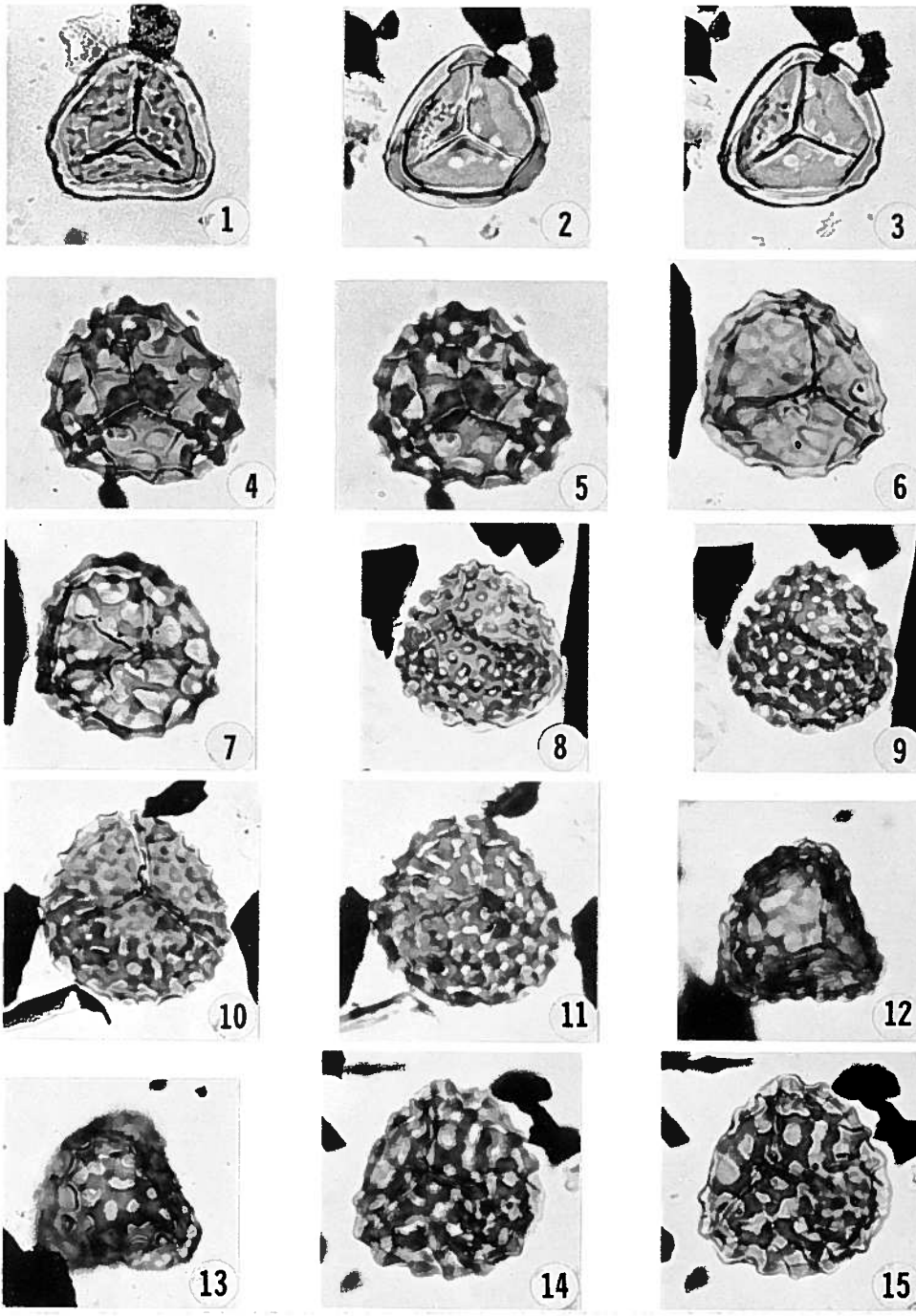
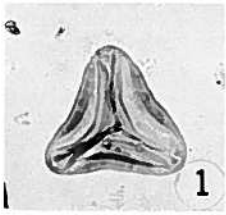
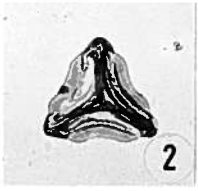
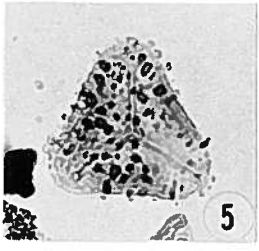
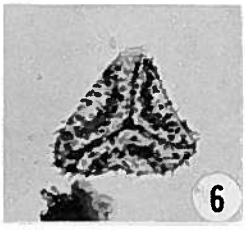


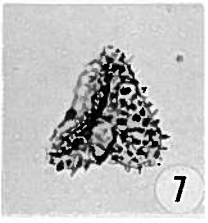
PLATE 14

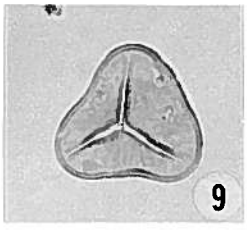


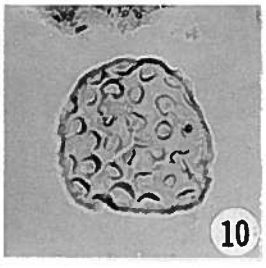


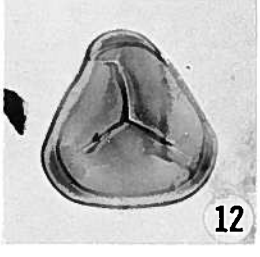


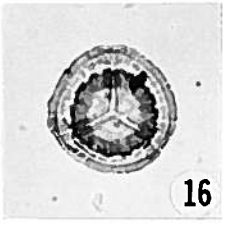


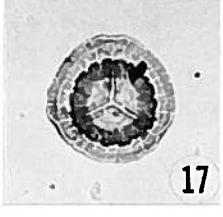


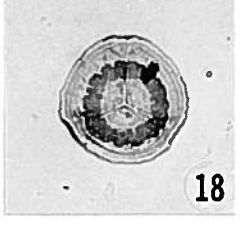












Explanation of Plate 14

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Gleicheniidites senonicus* Ross; mid-focus ..... (p. 97)

Figures 2, 3: *Gleicheniidites* sp. cf. *G. circinidites* (Cookson) Dettmann; 2–mid-focus; 3–mid-focus ..... (p. 97)

Figures 4, 5: *Ornamentifera baculata* n. sp.; 4–(holotype) mid-focus; 5–mid-focus.....(p. 100)

Figures 6, 7: *Ornamentifera echinata* (Bolkhovitina) Bolkhovitina; 6–mid-focus; 7–mid-focus .....(p. 98)

Figure 8: *Cyathidites australis* Couper; mid-focus.....(p. 101)

Figure 9: *Cyathidites minor* Couper; mid-focus.....(p. 101)

Figures 10, 11: *Kuylisporites lunaris* Cookson and Dettmann; 10–distal view; 11–mid-focus.....(p. 102)

Figure 12: *Matonisporites crassiangulatus* (Balme) Dettmann; mid-focus.....(p. 103)

Figure 13: *Dictyophyllidites* sp.; mid-focus. .....(p. 104)

Figure 14: *Laevigatosporites ovatus* Wilson and Webster; equatorial view.....(p. 105)

Figure 15: *Punctatosporites scabratus* (Couper) n. comb.; equatorial view.....(p. 106)

Figures 16-18: *Annulispora* sp.; 16–proximal view; 17–same specimen, mid-focus; 18–same specimen, distal view .....(p. 107)

Explanation of Plate 15

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-5: *Antulsporites baculatus* (Archangelsky and Gamerro) Archangelsky and Gamerro; 1–proximal view; 2–same specimen, distal view; 3–distal view; 4–proximal view; 5–same specimen, distal view..... (p. 108)

Figures 6, 7: *Antulsporites distaverrucosus* (Brenner) Archangelsky and Gamerro; 6–proximal view; 7–same specimen, distal view..... (p. 109)

Figures 8-13: *Camarozonosporites insignis* Norris; 8–proximal view; 9–same specimen, mid-focus; 10–same specimen, distal view; 11–proximal view; 12–same specimen, mid-focus; 13–same specimen, distal view..... (p. 111)

Figures 14, 15: *Cirratriradites teter* Norris; 14–mid-focus; 15–mid-focus..... (p. 112)

Figures 16, 17: *Concavisporites jurienensis* Balme; 16–proximal view; 17–same specimen, distal view..... (p. 112)

Figure 18: *Concavissimisporites minor* (Pocock) Delcourt, Dettmann and Hughes; mid-focus ..... (p. 113)

Figure 19: *Concavissimisporites punctatus* (Delcourt and Sprumont) Brenner; mid-focus. (p. 114)

PLATE 15

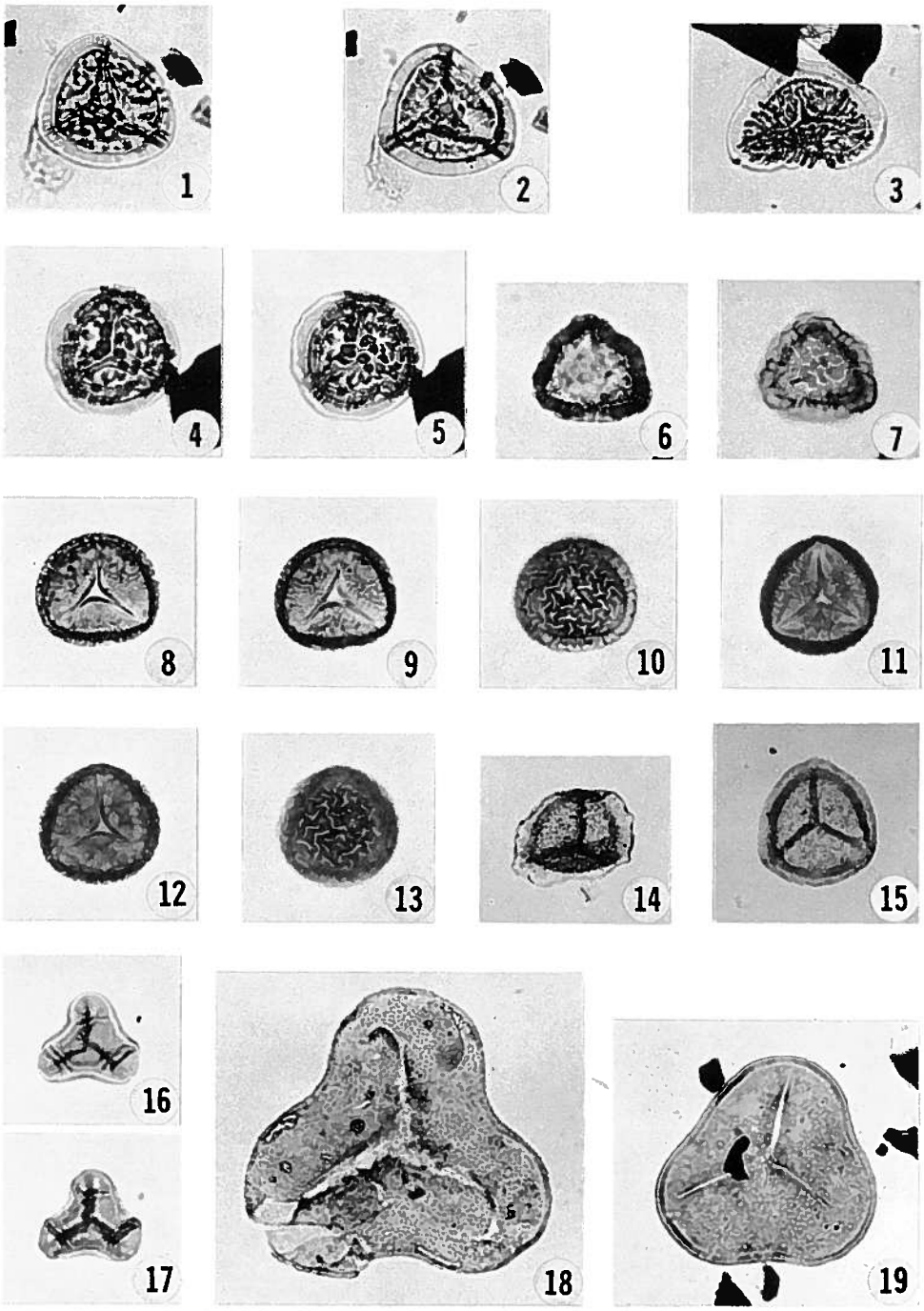
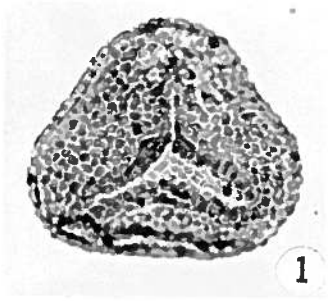
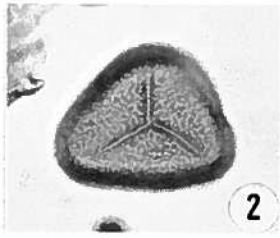
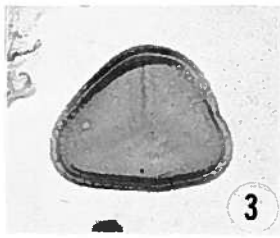
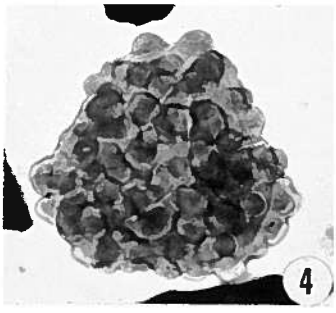


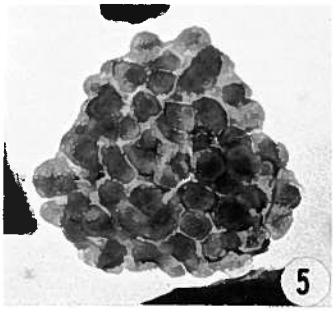
PLATE 16

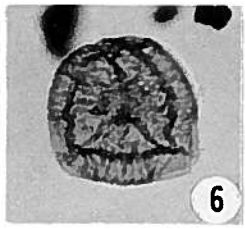


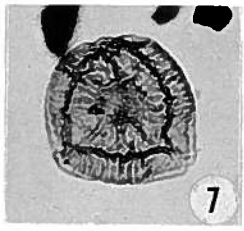


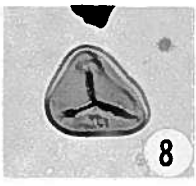


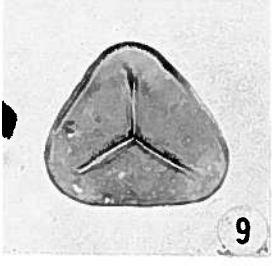


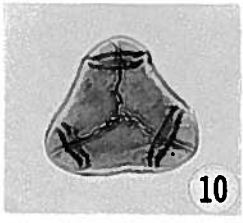


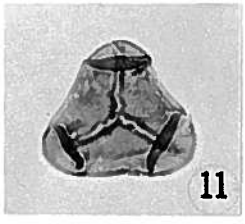


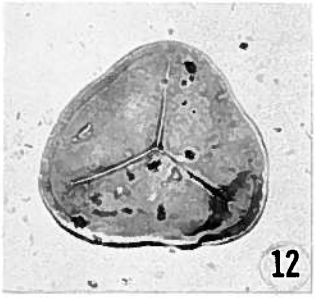


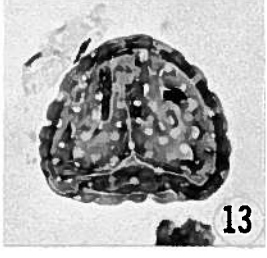


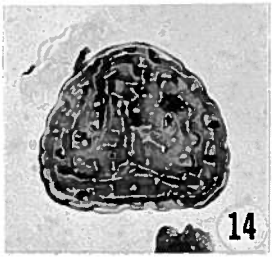












Explanation of Plate 16

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Concavissimisporites variverrucatus* (Couper) Brenner; mid-focus ..... (p. 114)

Figures 2, 3: *Concavissimisporites* sp.; 2–proximal view; 3–same specimen, mid-focus .... (p. 115)

Figures 4, 5: *Converrucosisporites exquisitus* n. sp.; 4–(holotype) proximal view; 5–(holotype) distal view..... (p. 116)

Figures 6, 7: *Coronatispora valdensis* (Couper) Dettmann; 6–proximal view; 7–same specimen, distal view..... (p. 117)

Figure 8: *Deltoidospora hallii* Miner; mid-focus..... (p. 118)

Figure 9: *Deltoidospora diaphana* Wilson and Webster; mid-focus. ..... (p. 119)

Figures 10, 11: *Deltoidospora juncta* (Kara-Murza) Singh; 10–proximal view; 11–same specimen, distal view..... (p. 119)

Figure 12: *Deltoidospora psilostoma* Rouse; mid-focus..... (p. 120)

Figures 13, 14: *Foveosporites* sp. cf. *F. canalis* Balme; 13–proximal view; 14–same specimen, distal view..... (p. 120)

Explanation of Plate 17

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Foveosporites labiosus* n. sp.; 1–(holotype) proximal view; 2–(holotype) distal view; 3–mid-focus.....(p. 121)

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Figures 6, 7: *Ischyosporites disjunctus* n. sp.; 6–(holotype) proximal view; 7–(holotype) distal view.....(p. 123)

Figures 8, 9: *Ischyosporites punctatus* Cookson and Dettmann; 8–proximal view; 9–same specimen, distal view.....(p. 123)

Figures 10, 11: *Kraeuselisporites* sp.; 10–proximal view; 11–same specimen, distal view.(p. 124)

Figures 12, 13: *Leptolepidites verrucatus* Couper; 12–proximal view; 13–same specimen, distal view.....(p. 125)

Figures 14, 15: *Leptolepidites* sp.; 14–proximal view; 15–same specimen, distal view.....(p. 126)

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Figures 17-19: *Microreticulatisporites uniformis* Singh; 17–proximal view; 18–same specimen, distal view; 19–distal view.....(p. 127)

PLATE 17

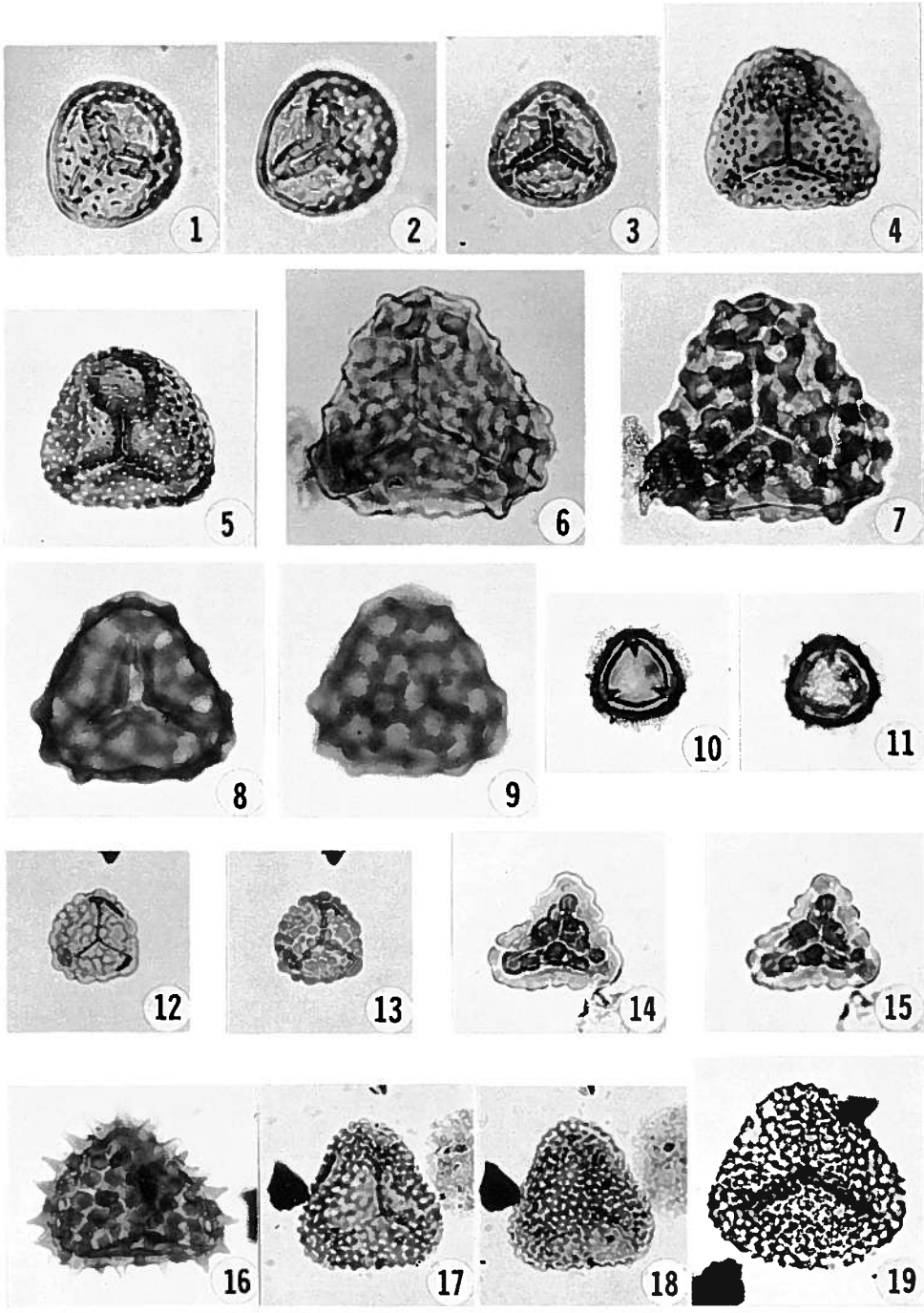
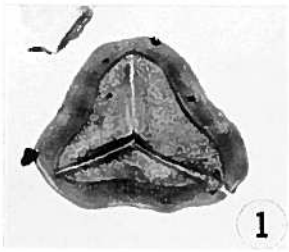


PLATE 18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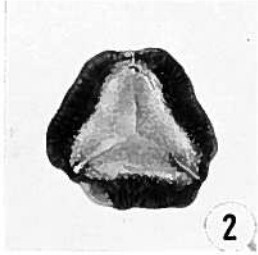
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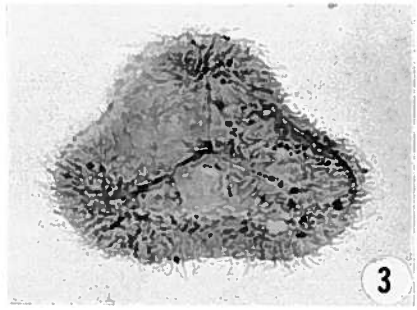
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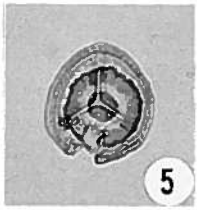
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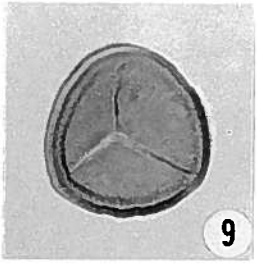
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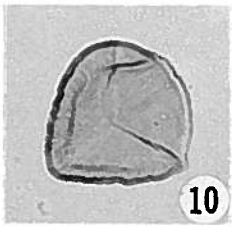
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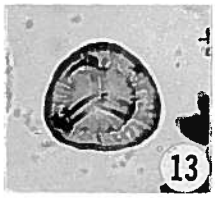
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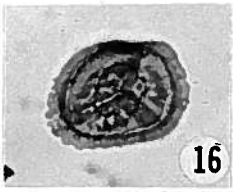
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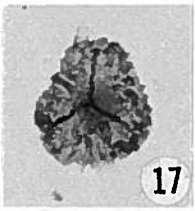
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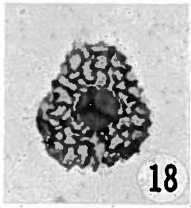
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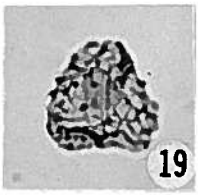

19

Explanation of Plate 18

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Murospora truncata* n. sp.; 1–(holotype) mid-focus; 2–mid-focus..... (p. 128)

Figure 3: *Pilosisporites trichopapillosus* (Thiergart) Delcourt and Sprumont; mid-focus... (p. 129)

Figures 4-7: *Polycingulatisporites radiatus* n. sp.; 4–(holotype) mid-focus; 5–mid-focus; 6–proximal view; 7–same specimen, distal view..... (p. 130)

Figure 8: *Polycingulatisporites reduncus* (Bolkhovitina) Playford and Dettmann; distal view .....(p. 132)

Figures 9, 10: *Psilatriletes radiatus* Brenner; 9–mid-focus; 10–mid-focus..... (p. 133)

Figures 11, 12: *Reticulisporites elongatus* n. sp.; 11–(holotype) proximal view; 12–(holotype) distal view..... (p. 134)

Figure 13: *Rogalskaisporites cicatricosus* (Rogalska) Danzé-Corsin and Laveine; distal view (p. 136)

Figure 14: *Rogalskaisporites cicatricosus* (Rogalska) var. *rotundus* Danzé-Corsin and Laveine; mid-focus.....(p. 137)

Figures 15, 16: *Taurocusporites segmentatus* Stover; 15–proximal view; 16–same specimen, distal view.....(p. 138)

Figures 17-19: *Tigrisporites reticulatus* n. sp.; 17–(holotype) proximal view; 18–(holotype) distal view; 19–distal view.....(p. 139)

Explanation of Plate 19

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-4: *Tigrisporites scurrandus* Norris; 1–proximal view; 2–same specimen, distal view; 3–distal view; 4–distal view ..... (p. 140)

Figure 5: *Tigrisporites* sp. A; distal view ..... (p. 140)

Figure 6: *Tigrisporites* sp. B; distal view ..... (p. 141)

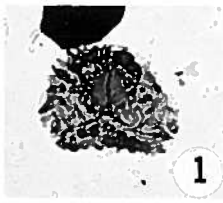
Figures 7, 8: *Trilobosporites apiverrucatus* Couper; 7–mid-focus; 8–mid-focus ..... (p. 142)

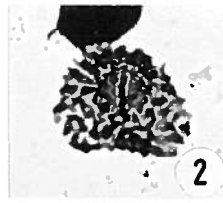
Figure 9: *Trilobosporites crassus* Brenner; distal view ..... (p. 142)

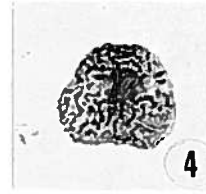
Figures 10-14: *Trilobosporites humilis* Delcourt and Sprumont; 10–proximal view; 11–same specimen, mid-focus; 12–same specimen, distal view; 13–proximal view; 14–same specimen, distal view ..... (p. 143)

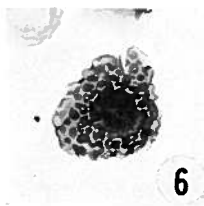
Figures 15, 16: *Trilobosporites marylandensis* Brenner; 15–mid-focus; 16–mid-focus .... (p. 144)

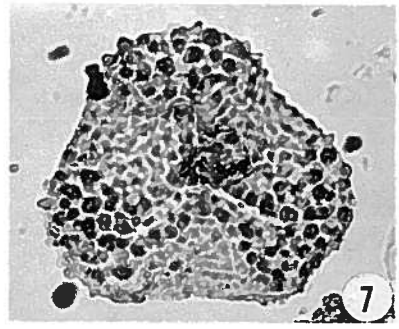
PLATE 19

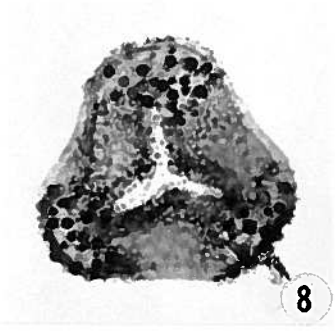


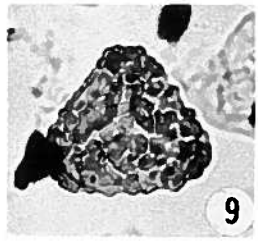


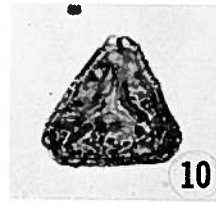


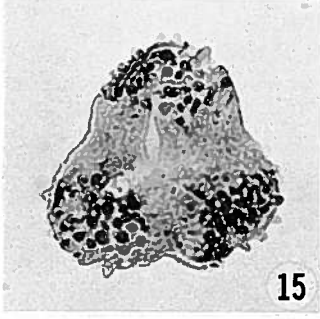












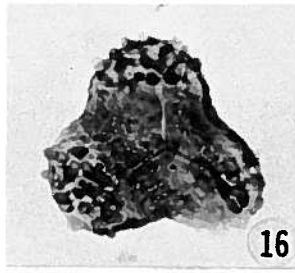
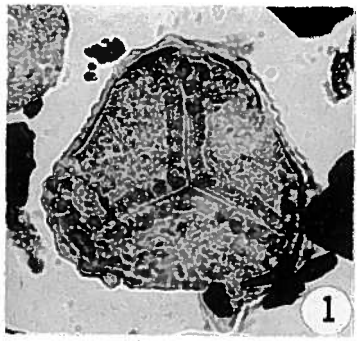


PLATE 20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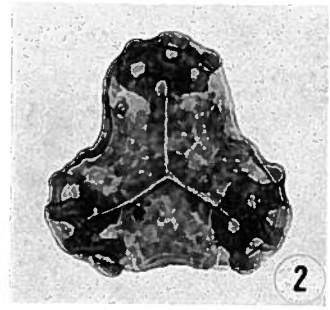
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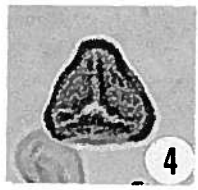
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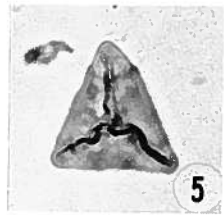
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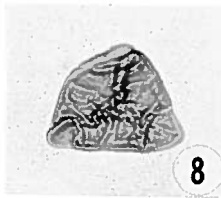
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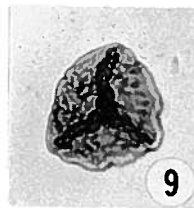
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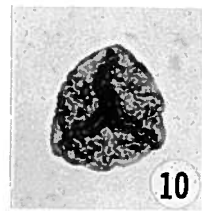
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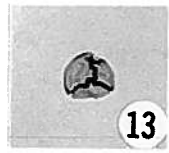
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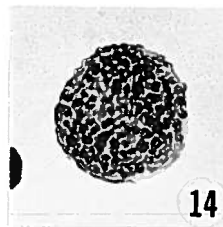
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Explanation of Plate 20

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Trilobosporites tribotrys* Dettmann; mid-focus ..... (p. 144)

Figure 2: *Trilobosporites trioreticulosus* Cookson and Dettmann; mid-focus ..... (p. 145)

Figures 3, 4: *Trilobosporites* sp.; 3–proximal view; 4–same specimen, distal view..... (p. 146)

Figures 5-8: *Undulatisporites fossulatus* n. sp.; 5–(holotype) proximal view; 6–(holotype) distal view; 7–proximal view; 8–same specimen, distal view..... (p. 146)

Figures 9, 10: *Undulatisporites pannuceus* (Brenner) n. comb.; 9–proximal view; 10–same specimen, distal view ..... (p. 147)

Figures 11, 12: *Undulatisporites undulapolus* Brenner; 11–proximal view; 12–proximal view ..... (p. 148)

Figure 13: *Undulatisporites* sp.; proximal view..... (p. 149)

Figure 14: *Verrucosisporites rotundus* Singh; proximal view..... (p. 149)

Explanation of Plate 21

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Inaperturopollenites* sp.; mid-focus ..... (p. 150)

Figure 2: *Schizosporis reticulatus* Cookson and Dettmann; mid-focus..... (p. 151)

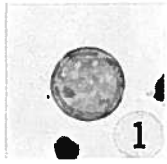
Figures 3, 4: *Schizosporis parvus* Cookson and Dettmann; 3–mid-focus; 4–mid-focus. (p. 151)

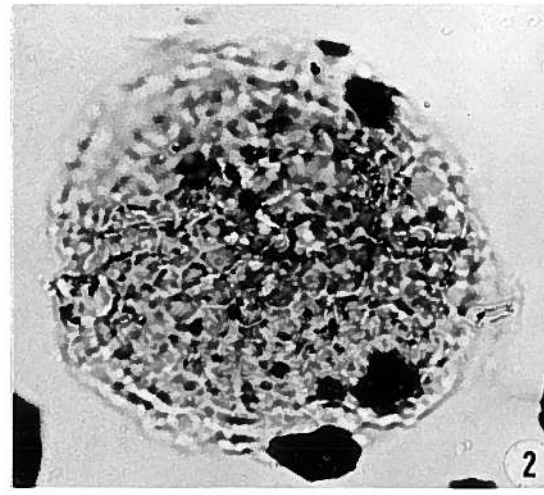
Figure 5: *Dyadosporites ellipsus* Clarke; mid-focus..... (p. 152)

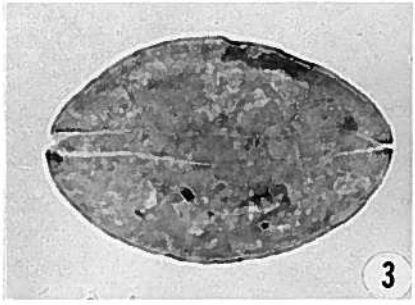
Figures 6, 7: *Pluricellaesporites psilatus* Clarke; 6–mid-focus; 7–mid-focus .....(p. 153)

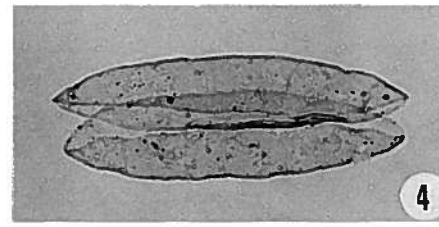
Figure 8: Fungal fruiting body of the family Microthyriaceae; mid-focus.....(p. 154)

PLATE 21









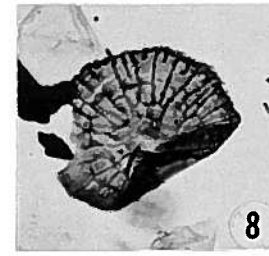
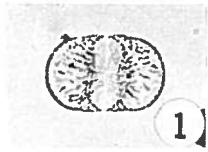
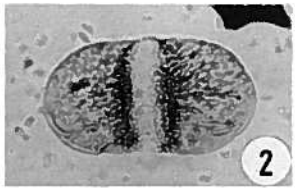
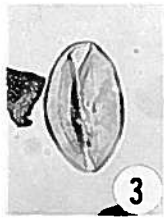
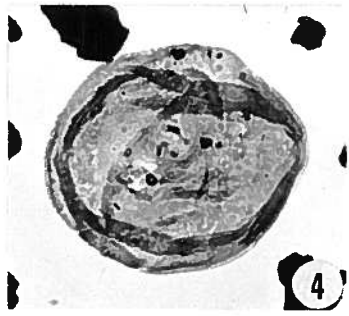


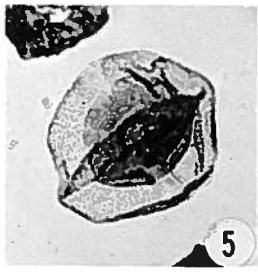
PLATE 22

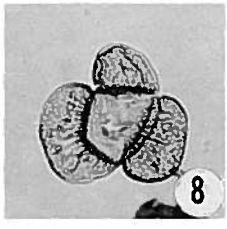


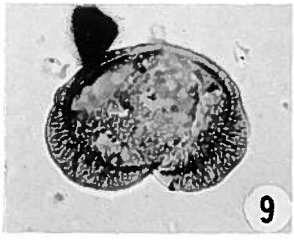


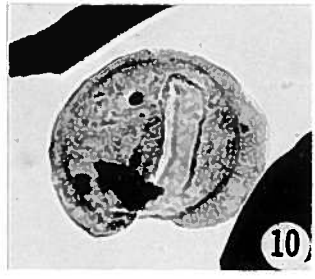


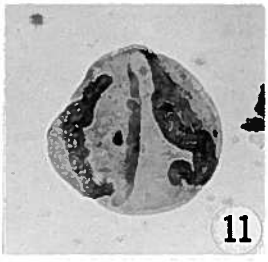


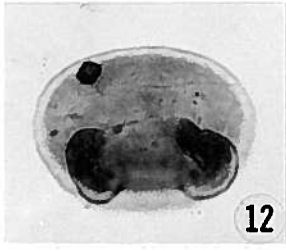


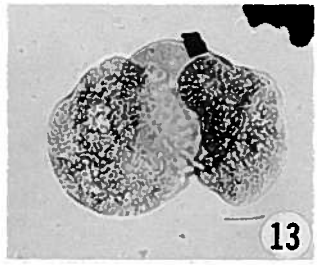












Explanation of Plate 22

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Vitreisporites pallidus* (Reissinger) Nilsson; distal view ..... (p. 154)

Figure 2: *Vitreisporites* sp.; distal view ..... (p. 155)

Figure 3: *Ginkgocycadophytus nitidus* (Balme) de Jersey; distal view ..... (p. 155)

Figure 4: *Araucariacites australis* Cookson; mid-focus ..... (p. 156)

Figures 5, 6: *Perinopollenites elatoides* Couper; 5–mid-focus; 6–mid-focus ..... (p. 157)

Figure 7: *Taxodiaceaepollenites hiatus* (Potonié) Kremp; mid-focus ..... (p. 158)

Figure 8: *Dacrycarpites* sp.; distal view ..... (p. 159)

Figures 9, 10: *Parvisaccites radiatus* Couper; 9–equatorial view; 10–equatorial view ... (p. 160)

Figure 11: *Phyllocladidites inchoatus* (Pierce) Norris; distal view ..... (p. 160)

Figure 12: *Phyllocladidites* sp.; equatorial view ..... (p. 161)

Figure 13: *Podocarpidites* sp. cf. *P. ellipticus* Cookson; distal view ..... (p. 162)

Explanation of Plate 23

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Podocarpidites biformis* Rouse; 1–proximal view; 2–same specimen X1000, showing microreticulate sculpture on the central body ..... (p. 162)

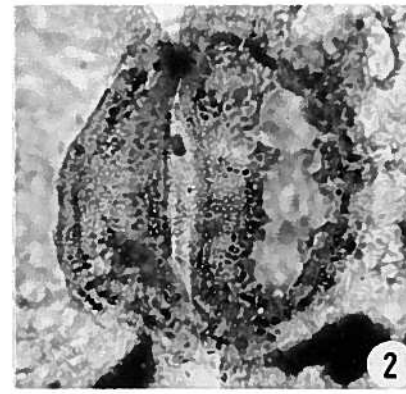
Figures 3, 4: *Podocarpidites canadensis* Pocock; 3–proximal view; 4–proximal view ..(p. 163)

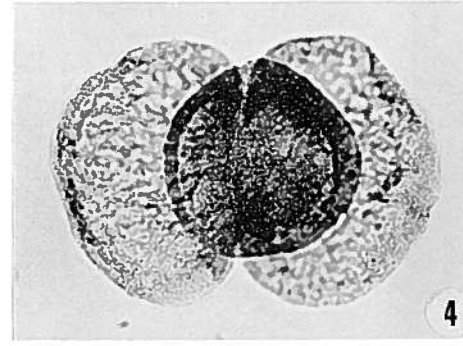
Figure 5: *Podocarpidites epistratus* Brenner; distal view.....(p. 163)

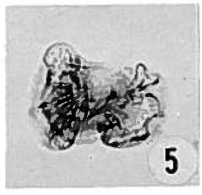
Figures 6-9: *Podocarpidites granulatus* n. sp.; 6–(holotype) proximal view; 7–proximal view; 8–same specimen, distal view; 9–equatorial view..... (p. 164)

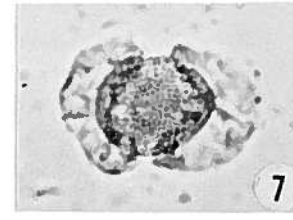
Figure 10: *Podocarpidites* sp. cf. *P. herbstii* Burger; distal view..... (p. 165)

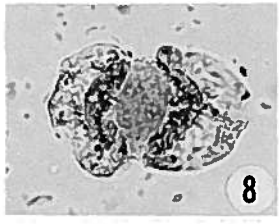
PLATE 23











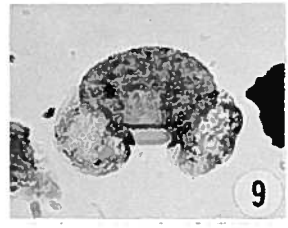
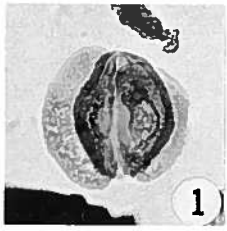
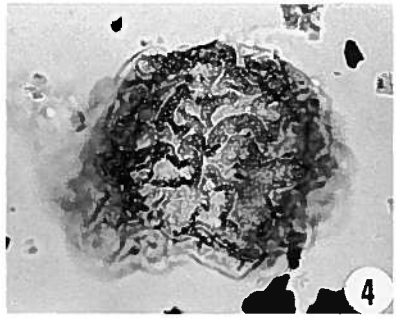
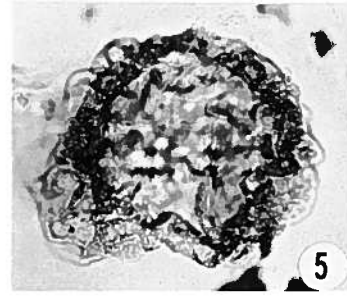
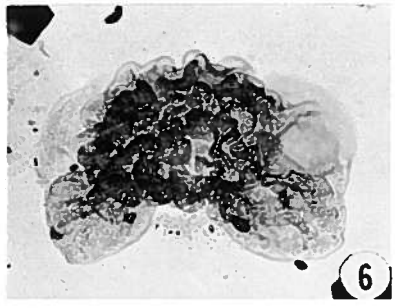


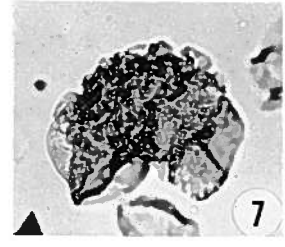
PLATE 24

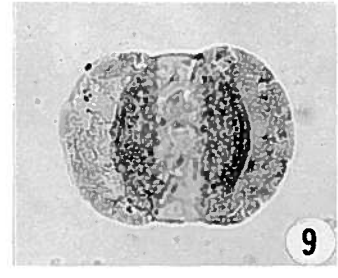












Explanation of Plate 24

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Podocarpidites minisculus* Singh; proximal view.....(p. 165)

Figure 2: *Podocarpidites multesimus* (Bolkhovitina) Pocock; proximal view.....(p. 166)

Figure 3: *Podocarpidites radiatus* Brenner; distal view.....(p. 166)

Figures 4, 5: *Rugubivesiculites reductus* Pierce; 4–proximal view; 5–same specimen, distal view.....(p. 167)

Figures 6, 7: *Rugubivesiculites rugosus* Pierce; 6–equatorial view; 7–equatorial view..(p. 167)

Figure 8: *Abiespollenites* sp.; equatorial view.....(p. 168)

Figure 9: *Alisporites bilateralis* Rouse; distal view.....(p. 169)

Explanation of Plate 25

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Alisporites grandis* (Cookson) Dettmann; 1–proximal view; 2–same specimen, distal view.....(p. 170)

Figure 3: *Alisporites* sp. cf. *A. microsaccus* (Couper) Pocock; distal view.....(p. 170)

Figures 4, 5: *Cedripites canadensis* Pocock; 4–distal view; 5–equatorial view.....(p. 171)

Figure 6: *Cedripites cretaceus* Pocock; equatorial view.....(p. 171)

Figure 7: *Cerebropollenites mesozoicus* (Couper) Nilsson; equatorial view.....(p. 172)

Figure 8: *Laricoidites magnus* (Potonié) Potonié, Thomson and Thiergart; mid-focus..(p. 173)

Figure 9: *Pityosporites alatipollenites* (Rouse) Singh; equatorial view.....(p. 173)

Figure 10: *Pityosporites constrictus* Singh; equatorial view.....(p. 174)

PLATE 25

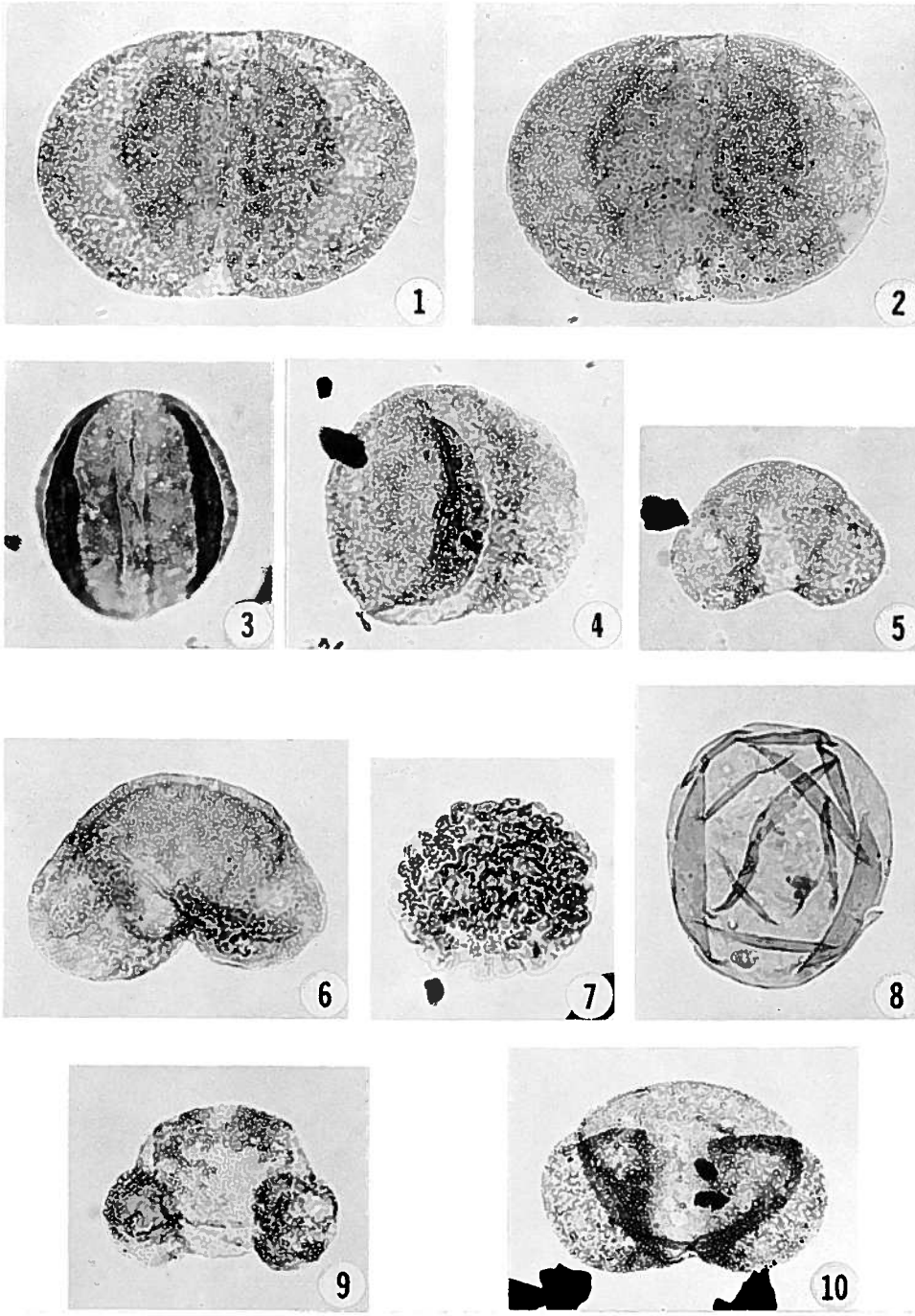
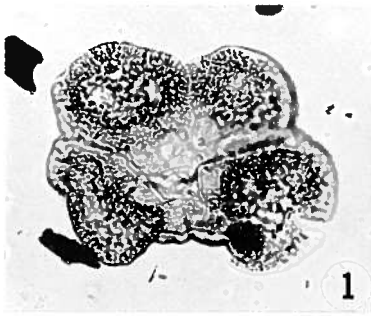
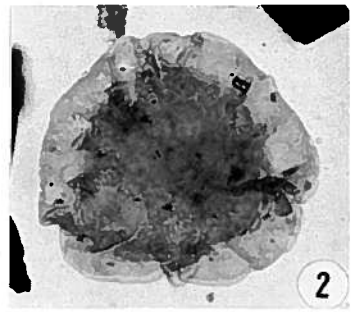
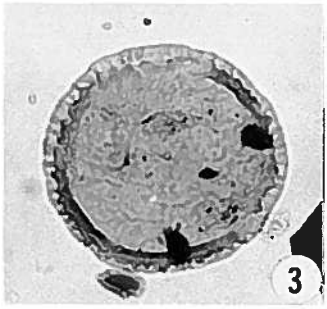
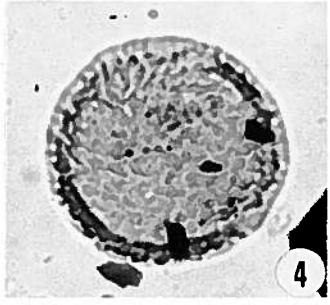


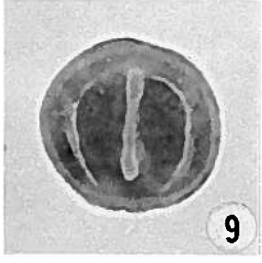
PLATE 26

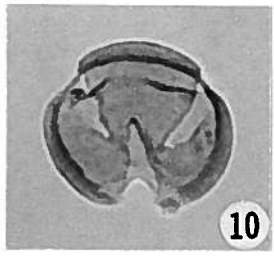


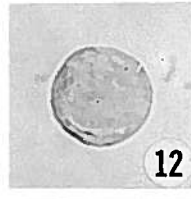


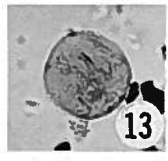












Explanation of Plate 26

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: Aberrant *Pityosporites* pollen; equatorial view ..... (p. 174)

Figure 2: *Callialasporites dampieri* (Balme) Dev; proximal view ..... (p. 175)

Figures 3, 4: *Callialasporites* sp.; 3–mid-focus; 4–same specimen, high focus ..... (p. 176)

Figures 5-7: *Classopollis classoides* Pflug, emend. Pocock and Jansonius; 5–a tetrad; 6–X1000, proximal view; 7–X1000, distal view ..... (p. 176)

Figure 8: *Eucommiidites troedssonii* Erdtman; X1000, front view ..... (p. 177)

Figures 9, 10: *Eucommiidites minor* Groot and Penny; 9–X1000, front view; 10–X1000, end view ..... (p. 177)

Figure 11: *Exesipollenites tumulus* Balme; mid-focus ..... (p. 178)

Figure 12: *Spheripollenites psilatus* Couper; mid-focus ..... (p. 179)

Figure 13: *Spheripollenites subgranulatus* Couper; mid-focus ..... (p. 179)

Figure 14: *Equisetosporites virginiaensis* (Brenner) n. comb.; mid-focus ..... (p. 180)

Explanation of Plate 27

All specimens are illustrated at a magnification of X1000 unless otherwise stated

Figures 1-3: *Clavatipollenites hughesii* Couper; 1–polar view, mid-focus; 2–same specimen, distal polar view; 3–distal polar view.....(p. 181)

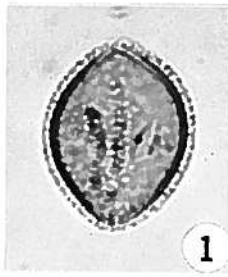
Figures 4-6: *Clavatipollenites minutus* Brenner; 4–proximal polar view; 5–same specimen, polar view, mid-focus; 6–polar view, mid-focus.....(p. 182)

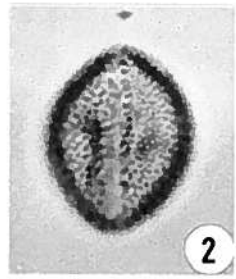
Figures 7-9: *Liliacidites clavatus* n. sp.; 7–(holotype) proximal polar view; 8–(holotype) polar view, mid-focus; 9–(holotype) distal polar view .....(p. 183)

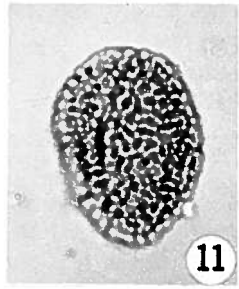
Figures 10-13: *Liliacidites crassatus* n. sp.; 10–(holotype) distal polar view; 11–(holotype) distal polar view, high focus; 12–polar view, mid-focus; 13–same specimen, distal polar view.....(p. 184)

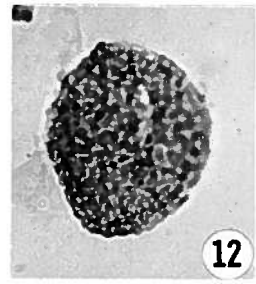
Figures 14, 15: *Liliacidites dividuus* (Pierce) Brenner; 14–proximal polar view; 15–same specimen, distal polar view.....(p. 185)

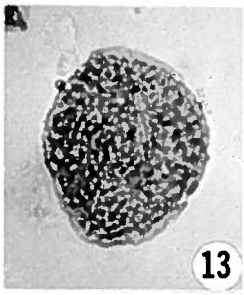
PLATE 27

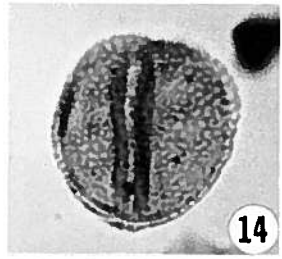












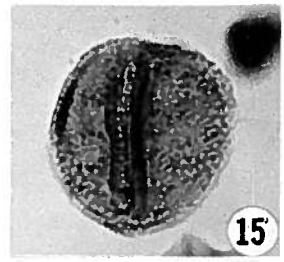
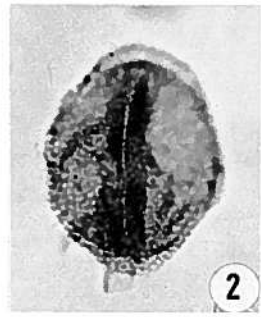
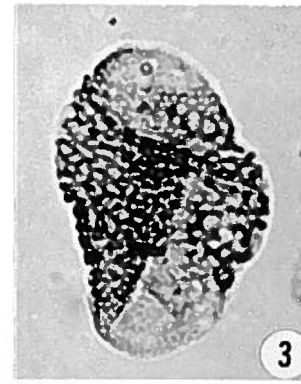
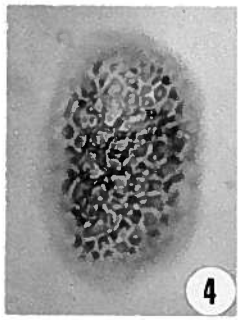
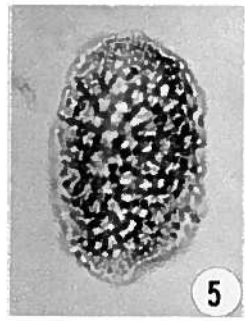


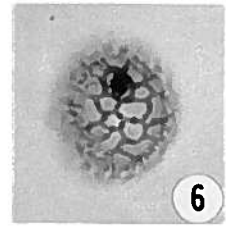
PLATE 28

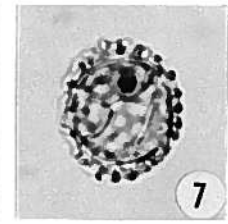


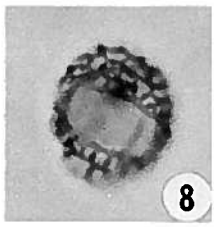


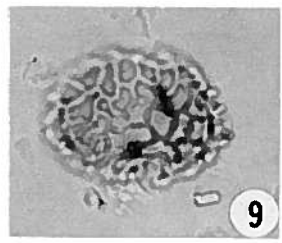


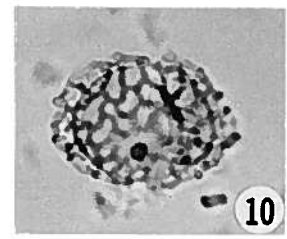


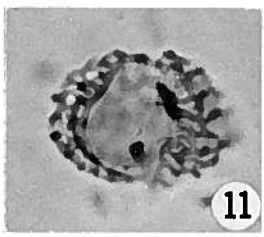


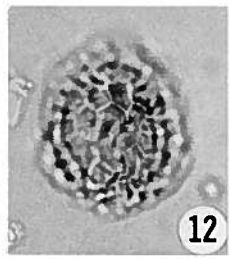


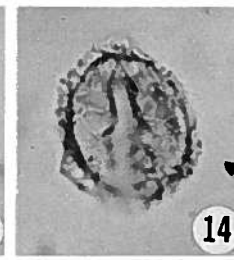












Explanation of Plate 28

All specimens are illustrated at a magnification of X1000 unless otherwise stated

Figures 1, 2: *Liliacidites dividuus* (Pierce) Brenner; 1–proximal polar view; 2–same specimen, distal polar view.....(p. 185)

Figures 3-5: *Liliacidites inaequalis* n. sp.; 3–(holotype) polar view, mid-focus; 4–proximal polar view; 5–same specimen, polar view, mid-focus..... (p. 186)

Figures 6-11: *Liliacidites peroreticulatus* (Brenner) n. comb.; 6–proximal polar view; 7–same specimen, polar view, mid-focus; 8–same specimen, distal polar view; 9–proximal polar view; 10–same specimen, polar view, mid-focus; 11–same specimen, distal polar view.....(p. 188)

Figures 12-14: *Liliacidites reticulatus* (Brenner) n. comb.; 12–proximal polar view; 13–same specimen, polar view, mid-focus; 14–same specimen, distal polar view .(p. 189)

Explanation of Plate 29

All specimens are illustrated at a magnification of X1000 unless otherwise stated

Figures 1-4: *Liliacidites textus* Norris; 1–proximal polar view; 2–same specimen, distal polar view; 3–proximal polar view; 4–same specimen, distal polar view..... (p. 190)

Figures 5-7: *Liliacidites trichotomosulcatus* n. sp.; 5–(holotype) proximal polar view; 6–(holotype) polar view, mid-focus; 7–(holotype) distal polar view..... (p. 191)

Figures 8, 9: *Cupuliferoidaepollenites minutus* (Brenner) n. comb.; 8–equatorial view, mid-focus; 9–same specimen, equatorial view, high focus..... (p. 194)

Figures 10, 11: *Foveotricolpites concinnus* n. sp.; 10–(holotype) equatorial view, mid-focus; 11–(holotype) equatorial view, high focus.....(p. 195)

Figures 12-14: *Fraxinoipollenites venustus* n. sp.; 12–(holotype) equatorial view, high focus, showing larger lumina in the polar regions; 13–(holotype) equatorial view, mid-focus; 14–equatorial view, mid-focus ..... (p. 196)

Figures 15, 16: *Psilatricolpites parvulus* (Groot and Penny) Norris; 15–equatorial view, mid-focus; 16–polar view, mid-focus.....(p. 198)

PLATE 29

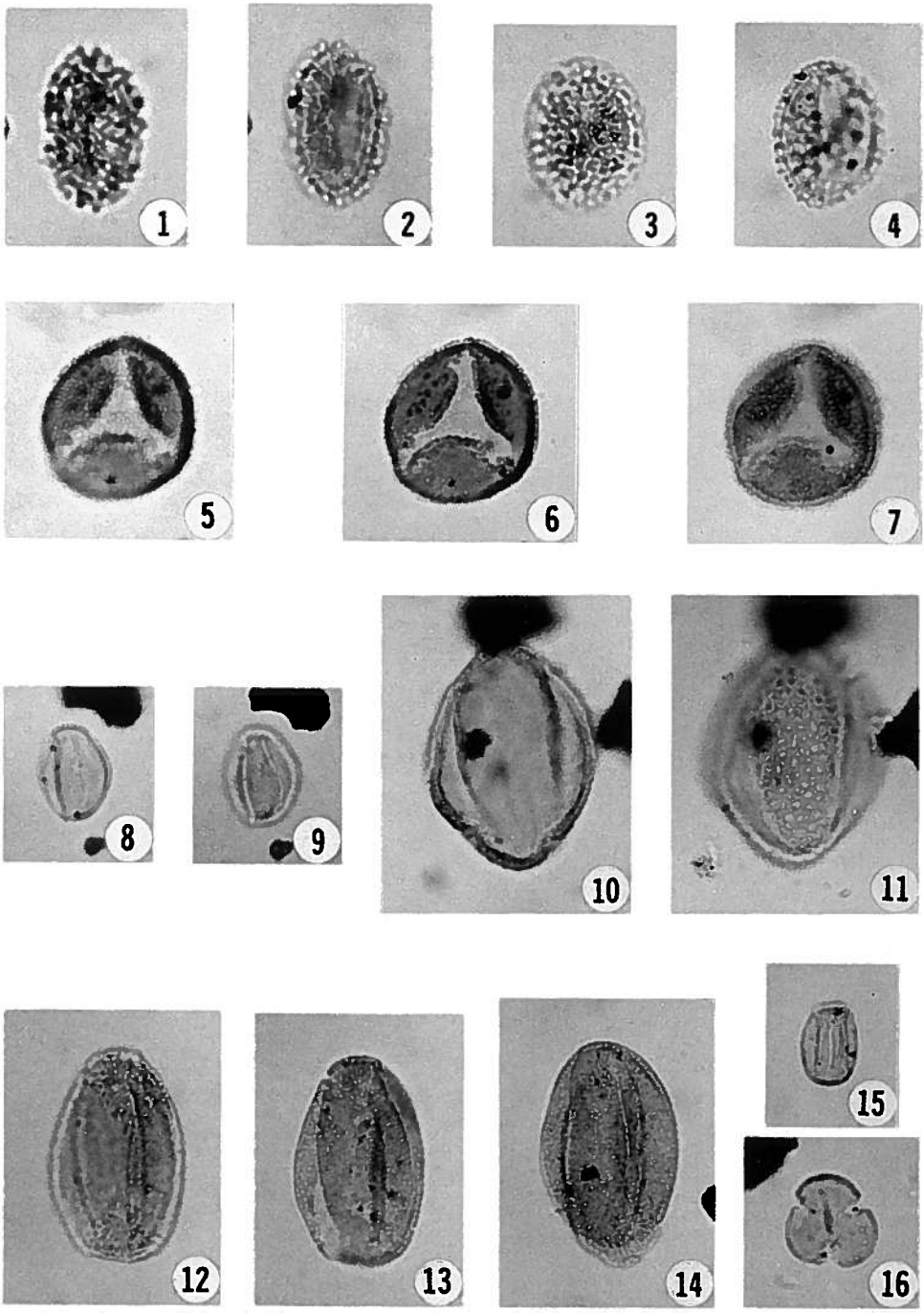
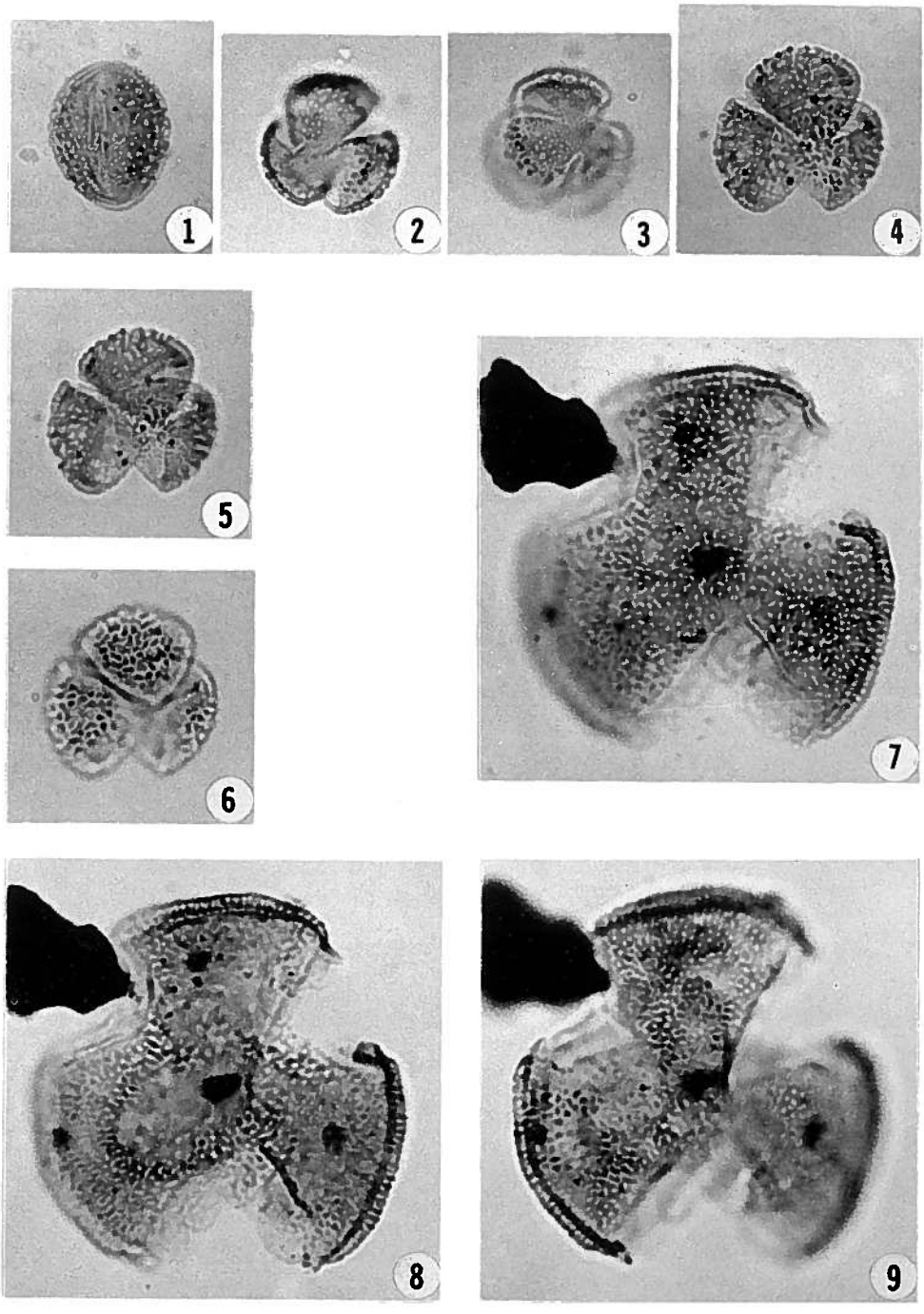


PLATE 30



Explanation of Plate 30

All specimens are illustrated at a magnification of X1000 unless otherwise stated

Figures 1-6: *Retitricolpites georgensis* Brenner; 1–equatorial view, mid-focus; 2–polar view, mid-focus; 3–same specimen, polar view, high focus; 4–polar view, mid-focus; 5–same specimen, polar view, high mid-focus; 6–same specimen, polar view, high focus (p. 200)

Figures 7-9: *Retitricolpites maximus* n. sp.; 7–(holotype) polar view, high focus; 8–(holotype) polar view, mid-focus; 9–(holotype) polar view, low focus (p. 201)

Explanation of Plate 31

All specimens are illustrated at a magnification of X1000 unless otherwise stated

Figures 1, 2: *Retitricolpites maximus* n. sp.; 1–equatorial view, high focus; 2–same specimen, equatorial view, mid-focus ..... (p. 201)

Figures 3, 4: *Retitricolpites prosimilis* Norris; 3–equatorial view, mid-focus; 4–same specimen, equatorial view, high focus ..... (p. 202)

Figures 5-10: *Retitricolpites virgeus* (Groot, Penny and Groot) Brenner; 5–polar view, low mid-focus; 6–same specimen, polar view, high focus; 7–same specimen, polar view, mid-focus; 8–polar view, high focus; 9–equatorial view, high focus; 10–same specimen, equatorial view, mid-focus..... (p. 203)

Figures 11-15: *Retitricolpites vulgaris* Pierce; 11–equatorial view, mid-focus; 12–equatorial view, mid-focus; 13–equatorial view, mid-focus; 14–polar view, mid-focus; 15–polar view, mid-focus..... (p. 204)

PLATE 31

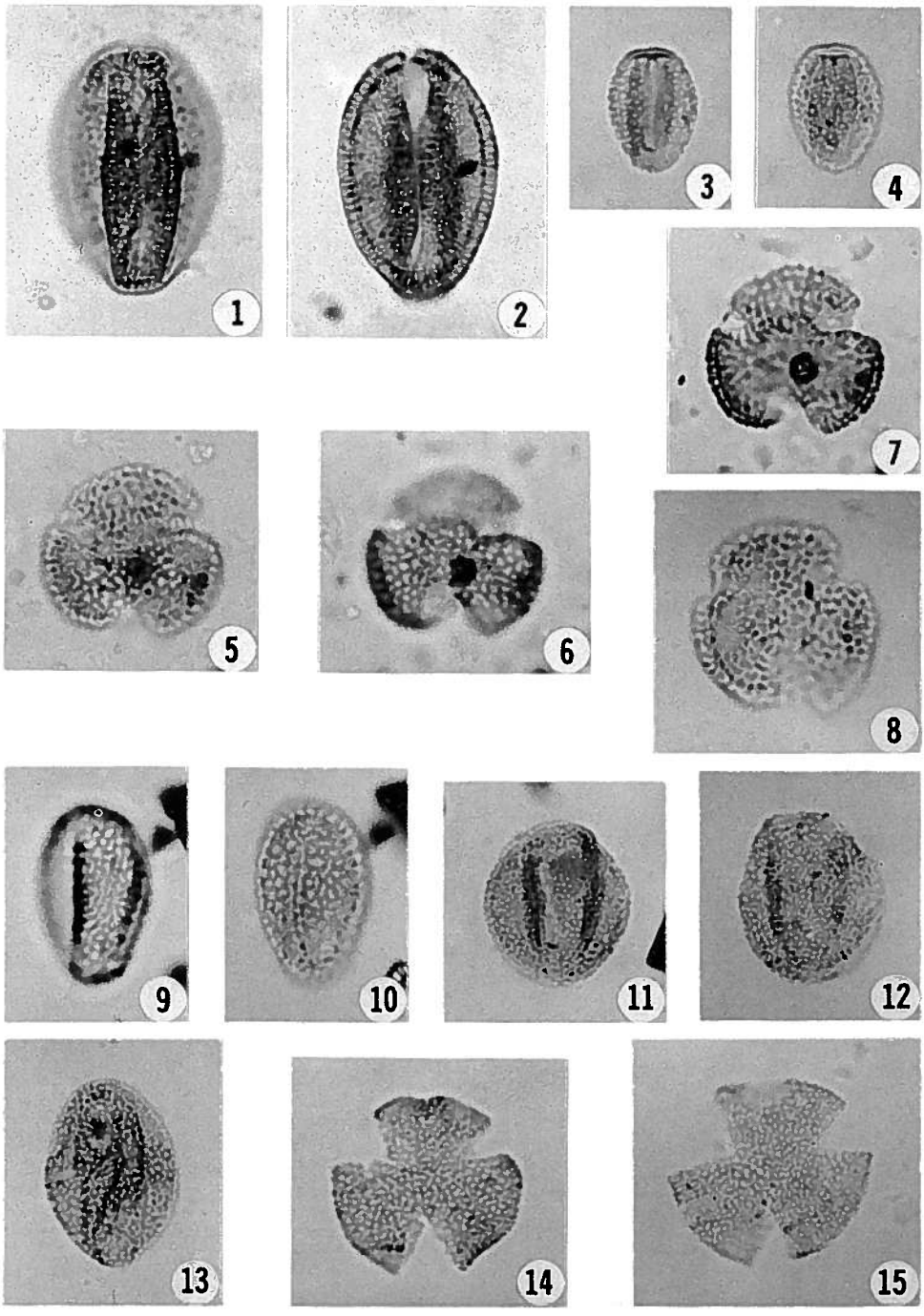
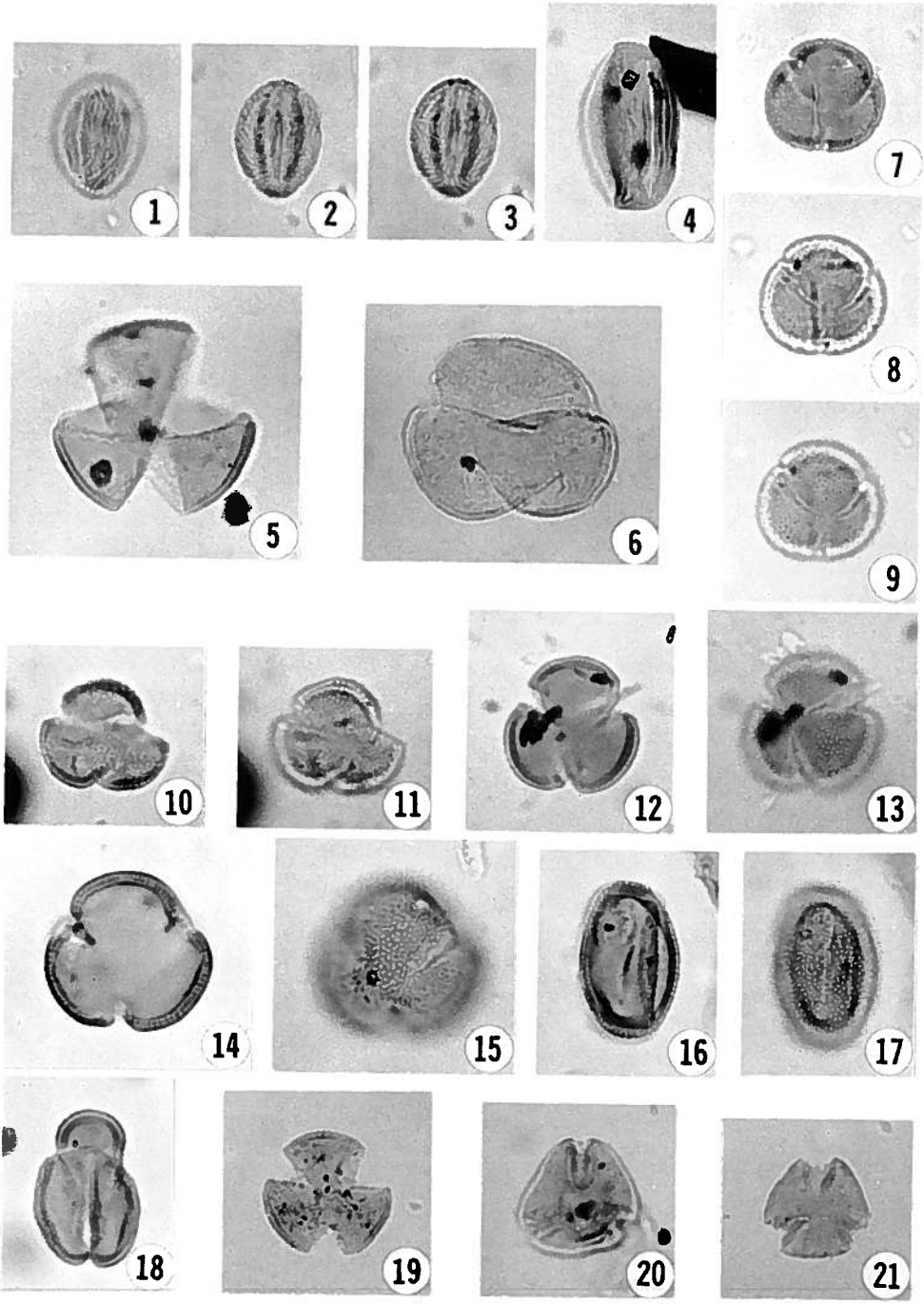


PLATE 32



Explanation of Plate 32

All specimens are illustrated at a magnification of X1000 unless otherwise stated

Figures 1-3: *Striatopollis paraneus* (Norris) n. comb.; 1–equatorial view, high focus; 2–same specimen, equatorial view, mid-focus; 3–same specimen, equatorial view, low mid-focus ..... (p. 206)

Figures 4-6: *Tricolpites crassimurus* (Groot and Penny) n. comb.; 4–equatorial view, mid-focus; 5–polar view, mid-focus; 6–polar view, mid-focus ..... (p. 207)

Figures 7-11: *Tricolpites micromunus* (Groot and Penny) n. comb.; 7–polar view, mid-focus; 8–same specimen, polar view, high mid-focus; 9–same specimen, polar view, high focus; 10–polar view, mid-focus; 11–same specimen, polar view, high focus ..... (p. 209)

Figures 12-17: *Tricolpites parvus* Stanley; 12–polar view, mid-focus; 13–same specimen, polar view, high focus; 14–polar view, mid-focus; 15–same specimen, polar view, high focus; 16–equatorial view, mid-focus; 17–same specimen, equatorial view, high focus ..... (p. 210)

Figures 18, 19: *Tricolpites sagax* Norris; 18–polar view, mid-focus; 19–polar view, mid-focus ..... (p. 211)

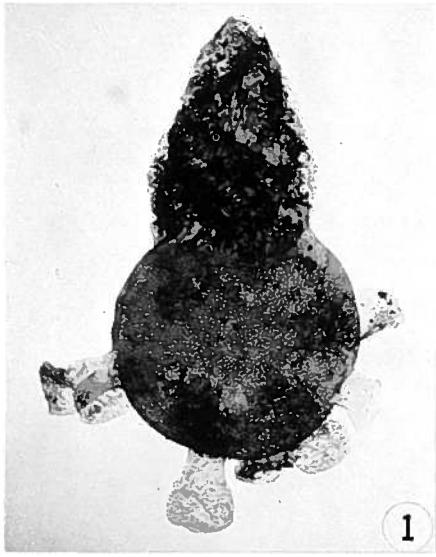
Figures 20, 21: *Nyssapollenites albertensis* n. sp.; 20–(holotype) polar view, mid-focus; 21–polar view, mid-focus ..... (p. 213)

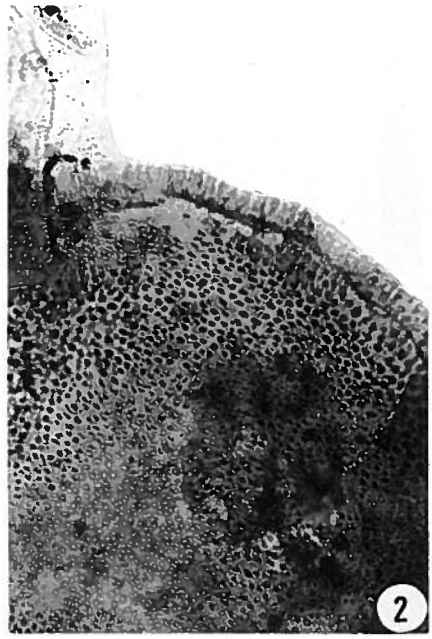
Explanation of Plate 33

All specimens are illustrated at a magnification of X100 unless otherwise stated

Figures 1-3: *Arcellites disciformis* Miner, emend. Ellis and Tschudy; 1–equatorial view; 2–same specimen X400, pitted ektexine; 3–same specimen X300, pitted ektexine (p. 214)

PLATE 33





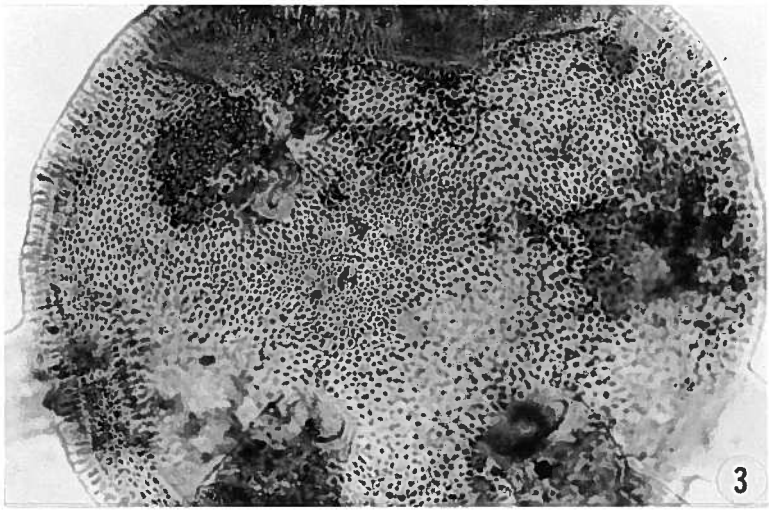
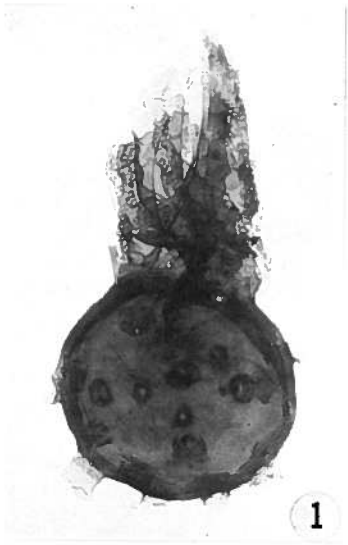
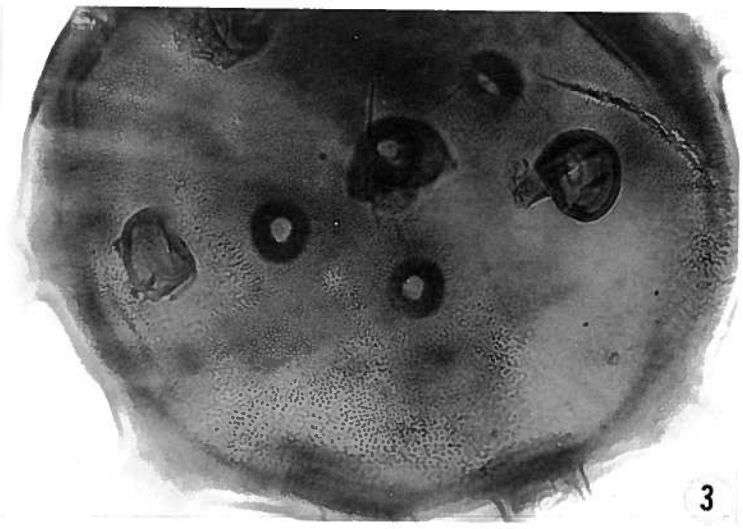


PLATE 34





Explanation of Plate 34

All specimens are illustrated at a magnification of X100 unless otherwise stated

Figures 1-3: *Arcellites disciformis* Miner, emend. Ellis and Tschudy; 1–equatorial view; 2–equatorial view; 3–X300, pitted ektexine enlarged from figure 1 .....(p. 214)

Explanation of Plate 35

All specimens are illustrated at a magnification of X100 unless otherwise stated

Figures 1, 2: *Arcellites nudus* (Cookson and Dettmann) Potter; 1–equatorial view; 2–same specimen X400, pitted ektexine ..... (p. 214)

Figures 3-5: *Arcellites reticulatus* (Cookson and Dettmann) Potter; 3–equatorial view; 4–same specimen X200, reticulate ektexine, high focus; 5–same specimen X200, reticulate ektexine, low focus ..... (p. 215)

PLATE 35

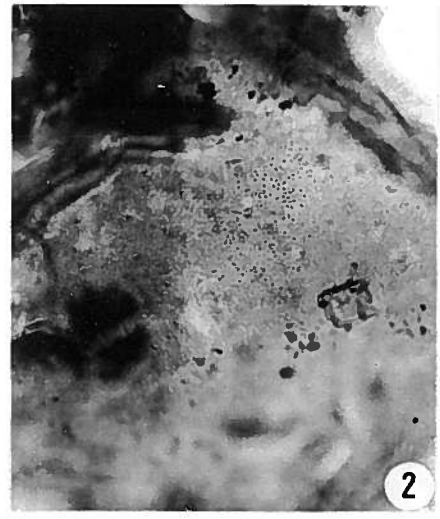


PLATE 36

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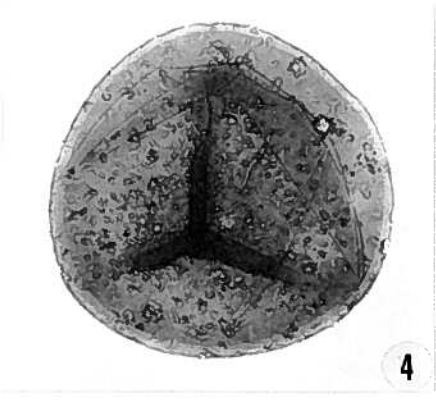
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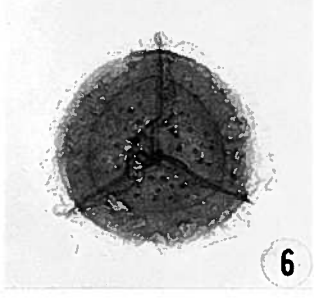
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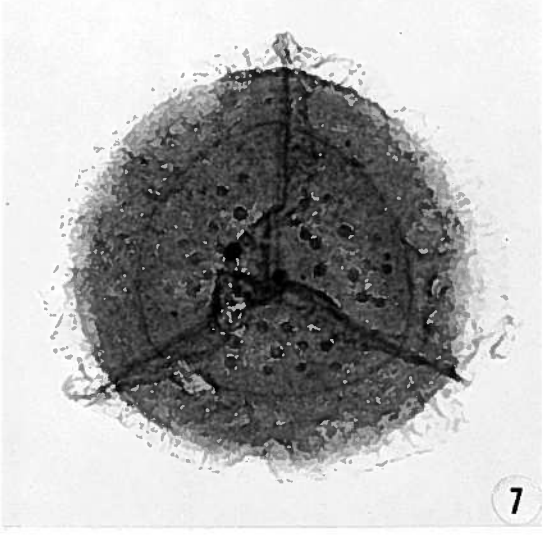
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Explanation of Plate 36

All specimens are illustrated at a magnification of X100 unless otherwise stated

Figures 1-3: *Balmeisporites* sp.; 1–equatorial view; 2–same specimen X200, showing trilete mark; 3–same specimen X200, showing imperfectly preserved reticulate pattern on the body ..... (p. 215)

Figures 4, 5: *Biharisporites* sp.; 4–proximal view; 5–same specimen, distal view ..... (p. 216)

Figures 6, 7: *Callistosporites graniferus* n. sp.; 6–(holotype) proximal view; 7–(holotype) X200, proximal view ..... (p. 217)

Explanation of Plate 37

All specimens are illustrated at a magnification of X100 unless otherwise stated

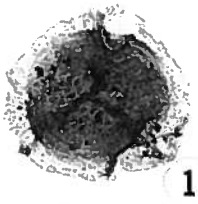
Figures 1-7: *Callistosporites graniferus* n. sp.; 1–proximal view, high focus; 2–same specimen, proximal view, low focus; 3–same specimen X200, proximal view, low focus; 4–proximal view, high focus; 5–same specimen, proximal view, low focus; 6–proximal view, high focus; 7–same specimen, proximal view, low focus..... (p. 217)

Figure 8: *Erlansonisporites sparassis*? (Murray) Potonié; equatorial view..... (p. 219)

Figure 9: *Minerisporites marginatus* (Dijkstra) Potonié; proximal view..... (p. 219)

Figure 10: *Minerisporites venustus* Singh; proximal view..... (p. 220)

PLATE 37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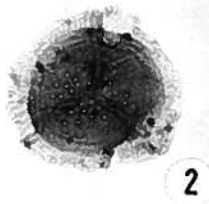
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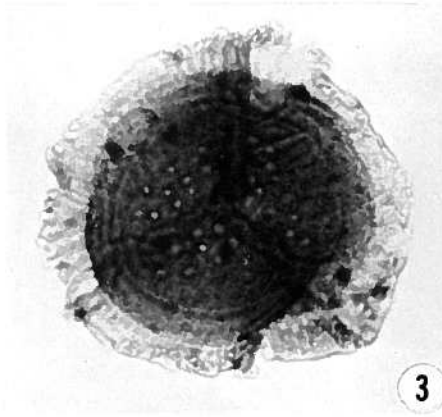
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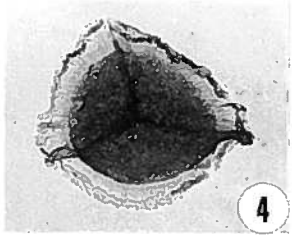
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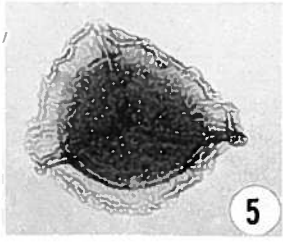
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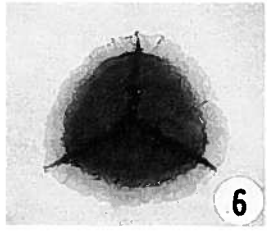
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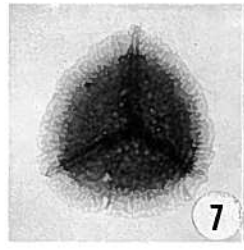
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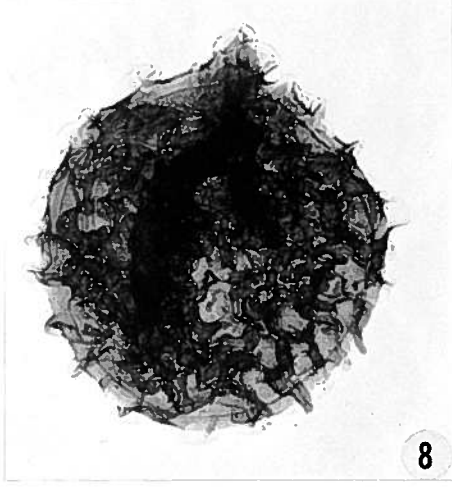
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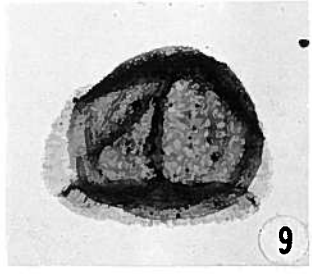
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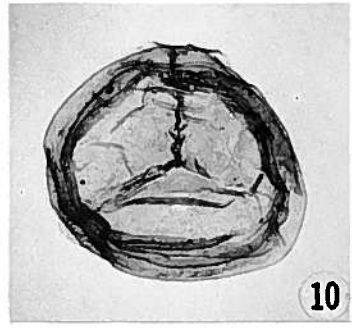
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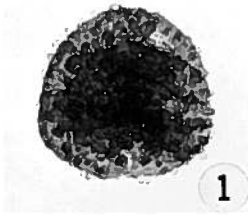
PLATE 38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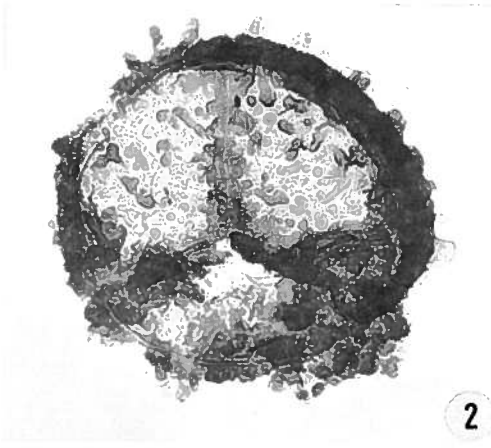
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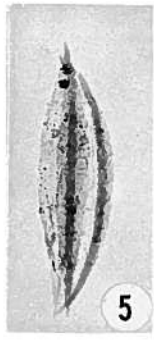
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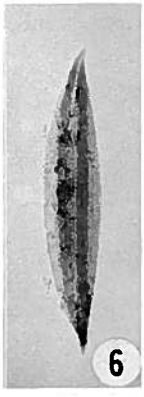
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Explanation of Plate 38

All specimens are illustrated at a magnification of X100 unless otherwise stated

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Figure 2: *Verrutriletes* sp.; proximal view (p. 220)

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PROVINCE OF ALBERTA

RESEARCH COUNCIL OF ALBERTA

Bulletin 28
Volume 2

Lower Cretaceous Microfloras of the Peace River Area, Northwestern Alberta

by
Chaitanya Singh

Research Council of Alberta
87th Avenue and 114th Street
Edmonton, Alberta
Canada

December, 1971

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MICROPLANKTON

Class **Dinophyceae**

Family **Gonyaulacystaceae**

Genus **Gonyaulacysta** Deflandre, 1964, emend. Sarjeant, 1966

Type species **Gonyaulacysta jurassica** (Deflandre) Deflandre, 1964

See Sarjeant (*in* Davey *et al.*, 1966, p. 111) for emended generic diagnosis.

Remarks: Sarjeant (*in* Davey *et al.*, 1966) emended the genus *Gonyaulacysta* to accommodate fossil dinoflagellate cysts having a spherical, ovoidal, ellipsoidal or polyhedral body possessing a tabulation of 3-4', 0-1a, 6", 6c, 6"', 1p, 0-1p.v., 1"", helicoid cingulum, sulcus, and a precingular archeopyle formed by the loss of plate 3". An apical horn is usually but not always present. The plate boundaries are marked by low (height less than 1/4 of body width) crests. The crests are usually smooth, denticulate, spinous, and either perforate or imperforate. The surface of the body is smooth, granulose, nodose, punctate or reticulate.

The genus *Cribroperidinium* Neale and Sarjeant, 1962, is basically a form of *Gonyaulacysta* which possesses intratabular ornamental ridges on the plates as a superficial cyst-strengthening device. The complex tabulation attributed to *Cribroperidinium* by Neale and Sarjeant (1962) and Davey (1969, p. 125) is in the writer's opinion erroneous, because it is based upon the intratabular ornamental ridges on the plates. The tabulation should be based upon the plate boundaries and the arrangement of the plates on the body. The arrangement of the plates (tabulation) in *Cribroperidinium,* when the intratabular ornamental ridges are disregarded, appears to be the same as in *Gonyaulacysta.* There seems to be no essential difference between the two genera. Therefore, the reassignment of various species of *Gonyaulacysta* to the genus *Cribroperidinium* by Davey (1969) appears to be unwarranted.

The distinction between genera similar to *Gonyaulacysta* has been tabulated by Sarjeant (*in* Davey *et al.*, 1966, Table 4).

Gonyaulacysta cassidata (Eisenack and Cookson) Sarjeant, 1966

Plate 39, figures 1-3

1960 *Gonyaulax helicoidea* subsp. *cassidata* Eisenack and Cookson, Proc. Roy. Soc. Victoria, vol. 72, pt. 1, p. 3, pl. 1, figs. 5, 6.

1962a *Gonyaulax cassidata* (Eisenack and Cookson) Cookson and Eisenack, Micropaleont., vol. 8, p. 486, pl. 2, figs. 11, 12.

1964 *Gonyaulax cassidata* (Eisenack and Cookson) Cookson and Eisenack–Cookson and Hughes, Palaeont., vol. 7, p. 42, pl. 5, fig. 10 only.

1966 *Gonyaulacysta cassidata* (Eisenack and Cookson) Sarjeant, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 125, pl. 14, figs. 3, 4, text-fig. 31.

Description: Test pentagonal in outline; body broadly ovoidal, surmounted by a dome-shaped, apical pericoel terminating in a short, blunt, apical horn; tabulation 4', 1a, 6'', 6c, 6''', 1p, 1''''; plate 1''' greatly reduced and elongate; plate boundaries marked by smooth to denticulate crests about 5 microns high; antapical crests surrounding the polygonal antapical plate 1'''' slightly higher, and supported by thin spines at the angles; cingulum strongly helicoid, laevo-rotatory, about 4 to 5 microns wide, and dividing the test into a larger epitract and smaller hypotract; sulcus widening posteriorly, weakly sigmoidal, and occurring on hypotract and epitract; archeopyle precingular, formed by the loss of plate 3''; surface of the plates ornamented by 1-micron high, blunt, irregularly scattered tubercles.

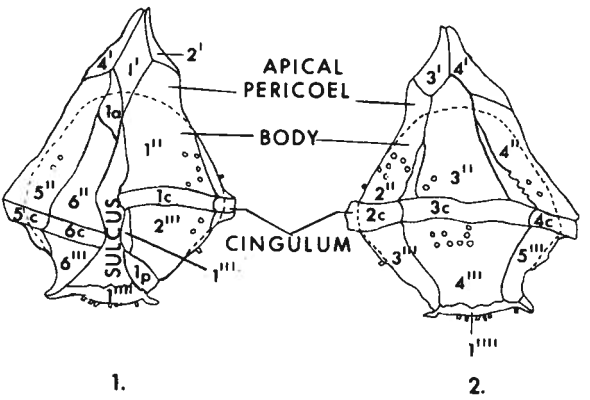

FIGURE 48. Gonyaulacysta cassidata *(Eisenack and Cookson) Sarjeant.*
1. Tabulation on the ventral surface. 2. Tabulation on the dorsal surface.

Size range: Total length of the test, including the apical horn (1 specimen) 84 microns.
Total breadth of the test (1 specimen) 66 microns.
Length of the body (1 specimen) 60 microns.
Breadth of the body (1 specimen) 58 microns.
Length of the apical pericoel (1 specimen) 17 microns.
Breadth of the apical pericoel (1 specimen) 29 microns.
Length of the apical horn (1 specimen) 7 microns.

Distribution: Aptian to Cenomanian. Lower Shaftesbury Formation of the Peace River area; late Albian and early Cenomanian (Cookson and Hughes, 1964), Cenomanian (Sarjeant *in* Davey *et al.*, 1966; Clarke and Verdier, 1967; Davey,

1969) of England; Aptian to Cenomanian of Australia (Eisenack and Cookson, 1960; Cookson and Eisenack, 1962a).

Remarks: *Gonyaulacysta cassidata* is characterized by a large, dome-shaped apical pericoel and a strongly helicoid, laevo-rotatory cingulum. It differs from *Psaligonyaulax deflandrei* Sarjeant, 1966, which is bicavate and possesses apical as well as antapical pericoels. The specimens illustrated as *G. cassidata* by Cookson and Hughes (1964, pl. 5, fig. 11) and Baltes (1967b, pl. 1, figs. 1, 2) belong to *P. deflandrei.*

Locality of figured specimen:

Pl. 39, figs. 1-3. Sample No. 5-S-3; lower Shaftesbury Formation. Section 5.
Pl. 39, figs. 1-3. Slide No. 5-S-3(1); co-ord. 4.5/77.1.

Gonyaulacysta edwardsi (Cookson and Eisenack) Clarke and Verdier, 1967

Plate 39, figures 4, 5; plate 40, figures 1, 2

1958 *Gonyaulax edwardsi* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 32, pl. 3, figs. 5, 6, text-fig. 7.

1964 *Gonyaulax edwardsi* Cookson and Eisenack–Cookson and Hughes, Palaeont., vol. 7, p. 43, pl. 5, fig. 9.

1966 *Gonyaulacysta edwardsi* (Cookson and Eisenack) Sarjeant, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 130 (n. comb. invalid under Art. 33, ICBN, 1961).

1967 *Gonyaulacysta edwardsi* (Cookson and Eisenack) Clarke and Verdier, Verhandel. Koninkl. Nederlandse Akad. Wetenschap., Afdel. Natuurk., Eerste Reeks, Deel 24, no. 3, p. 31, pl. 5, fig. 1.

1969 *Cribroperidinium edwardsi* (Cookson and Eisenack) Davey, Bull. British Museum (Natural History), Geol., vol. 17, p. 125, 128.

Description: Body subspherical, slightly wider than long, and surmounted by a stiff, tapering apical horn; horn about 18 microns wide at the base, and with a short, median, terminal projection at the tip; tabulation presumably as specified for the genus, difficult to determine precisely due to the presence of intratabular ridges on the plates; plate boundaries marked by membraneous crests up to 6 microns high; crests often bearing a few pointed spines; cingulum helicoid, laevo-rotatory, about 6 microns wide, and bordered by about 6-micron high, thick crests; sulcus moderately wide, occurring on hypotract and epitract; archeopyle precingular, formed by the loss of plate 3"; surface of the plates granular; wall of the body double layered; inner layer thick; outer layer membraneous.

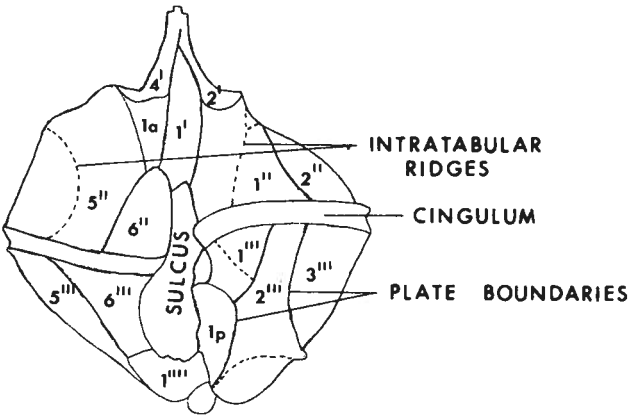

FIGURE 49. Gonyaulacysta edwardsi *(Cookson and Eisenack) Clarke and Verdier. Tabulation on the ventral surface.*

Size range: Total length of the test, including the apical horn (9 specimens) 108(127)150 microns.
Total breadth of the test (8 specimens) 95(106)120 microns.
Length of the body (8 specimens) 88(98)116 microns.
Length of the apical horn (8 specimens) 22(26)34 microns.

Distribution: Albian to Campanian. Lower Shaftesbury Formation of the Peace River area; late Albian. and early Cenomanian (Cookson and Hughes, 1964), Cenomanian to Campanian (Clarke and Verdier, 1967) of England; Albian to early Turonian of Australia (Cookson and Eisenack, 1958).

Remarks: The specimens of *Gonyaulacysta edwardsi* found in Alberta agree in general characters and in tabulation with those described from England by Cookson and Hughes (1964).

Gonyaulacysta orthoceras (Eisenack) Sarjeant, 1966, differs from *G. edwardsi* in possessing lower crests and a more elongate body.

The transfer of *G. edwardsi* to the genus *Cribroperidinium* Neale and Sarjeant, 1962, by Davey (1969) appears to be unwarranted (see remarks for the genus).

Locality of figured specimens:

Pl. 39, figs. 4,5.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 40, figs. 1,2.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 39, figs. 4,5.	Slide No. 5-S-3-Micro. 120;	co-ord. 11.6/44.1.	
Pl. 40, figs. 1,2.	Slide No. 7-S-2(1);	co-ord. 12/71.2.	

Gonyaulacysta episoma Sarjeant, 1966

Plate 41, figures 1-3

1966 *Gonyaulacysta episoma* Sarjeant, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 118, pl. 13, figs. 9, 10, text-fig. 27.

Description: Body spherical to subspherical, surmounted by a short, stiff apical horn; horn about 4 microns wide at the base and tipped by plate 4' represented by a short median terminal projection; plate 4' bounded by high crests giving the tip of the horn a characteristic trifurcate appearance; tabulation 4', 1a, 6", ?6c, 6"', 1p, 1p.v., 1""; plate boundaries marked by crests about 2 microns high; crests consisting of rows of fine spinules connected distally by trabeculum and supporting a delicate membrane; cingulum helicoid, laevo-rotatory, and about 4 microns wide; sulcus broad, short, and occurring on hypotract and epitract; archeopyle precingular, formed by the loss of plate 3"; surface of the plates densely covered with granules and short, conical spines; sulcus almost smooth.

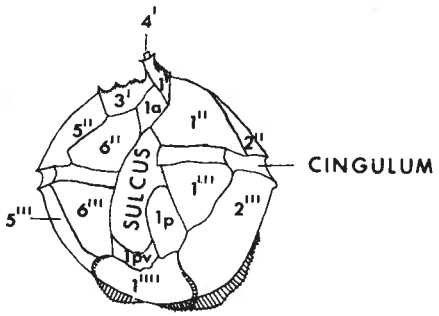

FIGURE 50. Gonyaulacysta episoma *Sarjeant. Tabulation on the ventral surface.*

Size range: Total length of the test, including the apical horn (31 specimens) 72(94)114 microns.
Total breadth of the test (29 specimens) 60(78)96 microns.
Length of the body (29 specimens) 64(82)98 microns.
Length of the apical horn (29 specimens) 7(11)18 microns.

Distribution: Late Barremian to Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; late Barremian of England (Sarjeant *in* Davey *et al.*, 1966).

Remarks: *Gonyaulacysta episoma* resembles the specimens assigned to *Gonyaulacysta nuciformis* by Sarjeant (1962, p. 482), but differs in possessing a thinner wall, different tabulation, differently formed crests, and in being larger.

Gonyaulacysta tenuiceras (Eisenack, 1958) is distinct in having higher crests and a markedly different tabulation.

Locality of figured specimens:

Pl. 41, figs. 1,2.	Sample No. 7-S-2;	lower Shaftesbury Fm.	Section 7.
Pl. 41, fig. 3.	Sample No. 6-H-5;	Harmon Member.	Section 6.
Pl. 41, figs. 1,2.	Slide No. 7-S-2-Micro. 102;	co-ord. 10.9/44.7.	
Pl. 41, fig. 3.	Slide No. 6-H-5(2);	co-ord. 3/70.8.	

Gonyaulacysta helicoidea (Eisenack and Cookson) Sarjeant, 1966

Plate 41, figures 4-7

1960 *Gonyaulax helicoidea* Eisenack and Cookson, Proc. Roy. Soc. Victoria, vol. 72, pt. 1, p. 2, pl. 1, figs. 4, 9.

1966 *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 116, pl. 13, figs. 7, 8, pl. 15, figs. 8, 9, text-fig. 26.

Description: Body broadly ovoidal, surmounted by a blunt, hollow apical horn; tabulation presumably 4', 1a, 6", 6c, 6"', 1p, 1""; tabulation on the ventral surface not clear; plate boundaries marked by up to 3-micron high, serrate crests; cingulum strongly helicoid, laevo-rotatory, about 4 microns wide, and dividing the test into a larger epitract and a smaller hypotract; sulcus markedly sigmoidal, occurring on hypotract and epitract; archeopyle precingular, formed by the loss of plate 3"; surface of the plates ornamented by small, irregularly scattered tubercles.

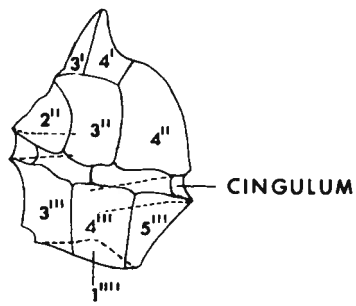

FIGURE 51. Gonyaulacysta helicoidea *(Eisenack and Cookson) Sarjeant. Tabulation on the dorsal surface.*

Size range: Total length of the test, including the apical horn (6 specimens) 55(61)70 microns.
Total breadth of the test (6 specimens) 42(49)56 microns.
Length of the body (6 specimens) 48(53)61 microns.
Length of the apical horn (6 specimens) 7(8)10 microns.

Distribution: Barremian to middle Albian. Harmon and Cadotte Members of the Peace River area; early Barremian of England (Sarjeant *in* Davey *et al.*, 1966); Aptian of Australia (Eisenack and Cookson, 1960).

Remarks: The Australian specimens of *Gonyaulacysta helicoidea,* recorded by Eisenack and Cookson (1960), are slightly larger (overall length: 62 to 86 microns) than those found in Alberta during the present study. On the other hand, the British specimens of *G. helicoidea,* described by Sarjeant (*in* Davey *et al.*, 1966), are considerably smaller (overall length: 44 to 53 microns) than the Australian and Alberta specimens.

G. helicoidea closely resembles *Gonyaulacysta cretacea* (Neale and Sarjeant, 1962), which differs in having a markedly polygonal outline and in lacking tubercles. *Gonyaulacysta cassidata* (Eisenack and Cookson) Sarjeant, 1966, is distinct in possessing a large, dome-shaped apical pericoel.

Locality of figured specimens:

Pl. 41, figs. 4,5.	Sample No. 6-H-2;	Harmon Member.	Section 6.
Pl. 41, figs. 6,7.	Sample No. 7-H - 4;	Harmon Member.	Section 7.
Pl. 41, figs. 4,5.	Slide No. 6-H-2(2);	co-ord. 10/62.8.	
Pl. 41, figs. 6,7.	Slide No. 7-H - 4(2);	co-ord. 13.8/34.9.	

Gonyaulacysta orthoceras (Eisenack) Sarjeant, 1966

Plate 42, figures 1- 4; plate 43, figures 1- 4; plate 44, figures 1-3

1958 *Gonyaulax orthoceras* Eisenack, Neues Jahrb. Geol. Paläont., Abhandl., vol. 106, p. 388, pl. 21, figs. 3-11, pl. 24, fig. 1, text-figs. 2, 3.

1966 *Gonyaulacysta orthoceras* (Eisenack) Sarjeant, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 121, pl. 14, figs. 5, 6.

1969 *Cribroperidinium orthoceras* (Eisenack) Davey, Bull. British Museum (Natural History), Geol., vol. 17, p. 128, figs. 13A,B.

See Sarjeant (*in* Davey *et al.*, 1966, p. 121) for detailed synonymy.

Description: Body ovoidal, equidimensional to slightly longer than wide, and surmounted by a stiff apical horn; horn from 10 to 14 microns wide at the base, and with a short, median, terminal projection at the tip; tabulation not clear, presumably as specified for the genus; tabulation difficult to determine precisely due to the presence of intratabular ridges on the plates; plate boundaries marked by very low crests bearing spinules; cingulum helicoid, laevo-rotatory, from 2 to 4

microns wide, and bordered by 3- to 6-micron high, thick crests; sulcus moderately wide, occurring on hypotract and epitract; archeopyle precingular, formed by the loss of plate 3"; surface of the plates granular to tuberculate; wall of the body double layered; inner layer thick; outer layer membraneous.

Size range: Total length of the test, including the apical horn (15 specimens) 120(140)162 microns.
Total breadth of the test (13 specimens) 88(104)118 microns.
Length of the body (13 specimens) 98(113)127 microns.
Length of the apical horn (13 specimens) 20(28)35 microns.

Distribution: Valanginian to Turonian. Harmon Member and lower Shaftesbury Formation of the Peace River area; late Barremian of England (Sarjeant *in* Davey *et al.*, 1966); late Aptian (Eisenack, 1958), Valanginian to Hauterivian (Gocht, 1959), Barremian to Cenomanian (Alberti, 1961) of Germany; Hauterivian of Switzerland (Millioud, 1967); Cenomanian and Turonian of Poland (Górka, 1963); Valanginian to Albian (Baltes, 1965), late Albian (Baltes, 1967b) of Rumania.

Remarks: The specimens of *Gonyaulacysta orthoceras* described by Eisenack (1958) are smaller (overall length: 70 to 105 microns) than those described in the present study. However, the Alberta specimens are comparable to the larger specimens (overall length: 90 to 160 microns) of *G. orthoceras*, recorded by Alberti (1961, p. 6).

G. orthoceras differs from *Gonyaulacysta apionis* (Cookson and Eisenack, 1958), which has a more elongate body.

The transfer of *G. orthoceras* to the genus *Cribroperidinium* Neale and Sarjeant, 1962, by Davey (1969) appears to be unwarranted (see remarks for the genus).

Locality of figured specimens:

Pl. 42, figs. 1-4.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 43, figs. 1-4.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 44, figs. 1,2.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 44, fig. 3.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 42, figs. 1,2.	Slide No. 7-S-2-Micro. 77;	co-ord. 12.6/42.7.	
Pl. 42, figs. 3,4.	Slide No. 7-S-2-Micro. 77;	co-ord. 9.8/46.	
Pl. 43, figs. 1,2.	Slide No. 5-S-3-Micro. 105;	co-ord. 12/45.2.	
Pl. 43, figs. 3,4.	Slide No. 5-S-3-Micro. 118;	co-ord. 11.8/46.1.	
Pl. 44, figs. 1,2.	Slide No. 5-S-3-Micro. 114;	co-ord. 12.3/46.8.	
Pl. 44, fig. 3.	Slide No. 4-S-2-Micro. 123;	co-ord. 12.3/43.	

Gonyaulacysta sp. A

Plate 45, figures 1, 2

Description: Body spherical to subspherical, surmounted by a stout, tapering apical horn; horn about 20 microns wide at the base, and with a short, median terminal projection at the tip; tabulation not clear, presumably as specified for the genus; tabulation difficult to determine precisely due to the presence of intratabular ridges on the plates; plate boundaries marked by very low crests; cingulum helicoid, laevo-rotatory, about 4 microns wide, and bordered by about 4-micron high crests; sulcus moderately wide, occurring on hypotract and epitract; archeopyle precingular, very wide; surface of the plates microreticulate; lumina less than 1 micron wide; sulcus almost smooth.

Size range: Total length of the test, including the apical horn (8 specimens) 150 (167)181 microns.
Total breadth of the test (8 specimens) 118(128)138 microns.
Length of the body (8 specimens) 120 (128)137 microns.
Length of the apical horn (7 specimens) 32(41)48 microns.

Distribution: Middle Albian. Loon River Formation and Harmon Member of the Peace River area.

Remarks: *Gonyaulacysta* sp. A is characterized by its large size, almost spherical body, very low crests, stout apical horn, and microreticulate ornamentation.

Locality of figured specimen:

Pl. 45, figs. 1,2. Sample No. 8-L-11; Loon River Formation. Section 8.
Pl. 45, figs. 1,2. Slide No. 8-L-11-Micro. 41; co-ord. 12.2/43.2.

Gonyaulacysta sp. B

Plate 46, figure 1

Description: Body spherical to subspherical, surmounted by a long, stiff apical horn; horn about 10 microns wide at the base, and with a short, median terminal projection at the tip; tabulation not clear; plate boundaries marked by low crests; cingulum helicoid, laevo-rotatory, and about 4 microns wide; sulcus moderately wide, occurring on hypotract and epitract; archeopyle precingular, very wide; surface of the plates granular.

Size range: Total length of the test, including the apical horn (3 specimens) 203(211)218 microns.
Total breadth of the test (3 specimens) 145(151)157 microns.
Length of the body (3 specimens) 142(149)158 microns.
Length of the apical horn (3 specimens) 55(62)70 microns.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Remarks: *Gonyaulacysta* sp. B differs from all the described species of this genus in having an overall length of over 200 microns.

Locality of figured specimen:

Pl. 46, fig. 1.	Sample No. 6-H-3;	Harmon Member.	Section 6.
Pl. 46, fig. 1.	Slide No. 6-H-3(2);	co-ord. 3/50.	

Precingular archeopyle operculum Type A

Plate 46, figure 2

Description: Operculum polygonal in shape and with broadly rounded apices; ornamentation consisting of two parallel intratabular ridges, starting from the wider cingular side and running parallel to the outer margin; intratabular ridges about 1 micron wide and 3 to 4 microns apart; outer ridge 8 to 12 microns inside the outer margin; many ridges running from the outer ridge to the margin on the narrower apical side; surface of the operculum granulate.

Size range: Maximum length (13 specimens) 37(44)50 microns.
Maximum breadth (13 specimens) 30(39)46 microns.

Distribution: Middle and late Albian. Loon River Formation and lower Shaftesbury Formation of the Peace River area.

Remarks: Isolated opercula representing plate 3" of the genus *Gonyaulacysta,* similar to those illustrated by Evitt and Davidson (1964, pl. 1, fig. 5), are quite frequent in the Loon River and Shaftesbury Formations.

Locality of figured specimen:

Pl. 46, fig. 2.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 46, fig. 2.	Slide No. 2-S-3(1);	co-ord. 1.3/61.	

Precingular archeopyle operculum Type B

Plate 46, figures 3, 4

Description: Operculum polygonal in shape and with broadly rounded apices; ornamentation consisting of a main intratabular ridge starting from the wider cingular side and running parallel to the outer margin; main intratabular ridge 6 to 16 microns inside the outer margin; 2 to 4 ridges running from the main intratabular ridge to the outer margin on the narrower apical side; ridges of uneven width, usually 1 to 2 microns wide, and ornamented by tubercles or short conical spines; area inside the main intratabular ridge ornamented by sparsely distributed tubercles; surface of the operculum granulate.

Size range: Maximum length (12 specimens) 48(59)76 microns.
Maximum breadth (12 specimens) 41(55)72 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: The isolated opercula belonging to type B can be distinguished from those assigned to type A by their larger size, the presence of a single main intratabular ridge, and the ornamentation consisting of tubercles and conical spines.

Locality of figured specimens:

Pl. 46, fig. 3.	Sample No. 2-S-7;	lower Shaftesbury Formation.	Section 2.
Pl. 46, fig. 4.	Sample No. 2-S-8;	lower Shaftesbury Formation.	Section 2.
Pl. 46, fig. 3.	Slide No. 2-S-7(1);	co-ord. 9.8/33.5.	
Pl. 46, fig. 4.	Slide No. 2-S-8(1);	co-ord. 2.2/63.1.	

Family **Pareodiniaceae**

Genus **Apteodinium** Eisenack, 1958

Type species **Apteodinium granulatum** Eisenack, 1958

See Norris and Sarjeant (1965, p. 11) for generic diagnosis.

Remarks: The genus *Apteodinium* consists of fossil dinoflagellate cysts having a globular, oval or ovoid test with a short, pointed apical horn. Occasionally, a small antapical horn is also present. The test is without tabulation and large ornamentation (spines, ridges). The cingulum is circular, faint, and often not visible. The archeopyle is precingular (Evitt, 1961, p. 402).

The genus *Pareodinia* Deflandre, 1947, differs from *Apteodinium* in having an intercalary archeopyle (see Evitt, 1967, p. 38) and in the absence of a cingulum. *Pareodinia* differs also in having an elongated body and a strongly developed apical horn. The genus *Eodinia* Eisenack, 1936, is distinct from *Apteodinium* in having an equatorial ring suture along which it easily breaks into two halves, a sulcus restricted to the hypotract, and a very thick, porous wall.

Apteodinium reticulatum n. sp.

Plate 47, figures 1 - 4

Description: Test dorsoventrally compressed; body usually folded and with one short, smooth, hollow apical horn; horn narrowing toward a blunt tip; tip mostly broken, but often terminated by a short, solid, blunt process in perfect specimens; cingulum very faint, often not visible; archeopyle precingular and hoof shaped; surface of the body reticulate, covered with 0.5-micron high and equally wide ridges; ridges often discontinuous, sinuous, and enclosing 2- to 3-micron wide spaces; body wall about 2 microns thick.

Size range: Total length of the test, including the horn (13 specimens) 78(92)99 microns. Holotype 87 microns.
Total breadth of the test (13 specimens) 67(75)84 microns. Holotype 73 microns.
Length of the body (13 specimens) 66(80)87 microns. Holotype 77 microns.
Length of the apical horn (13 specimens) 9(12)14 microns. Holotype 10 microns.
Width of the apical horn at the base (3 specimens) 8(10)12 microns. Holotype 9 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Apteodinium reticulatum* n. sp. differs from all other described species of the genus *Apteodinium* in having a reticulate ornamentation.

The specific name is derived from "*reticulatum*" (net-like) and refers to the reticulate ornamentation of the body.

Type locality:

Holotype: Pl. 47, figs. 1,2.	Sample No. 7-S-2;	lower Shaftesbury Fm. Sec. 7.
Paratypes: Pl. 47, figs. 3,4.	Sample No. 7-S-2;	lower Shaftesbury Fm. Sec. 7.
Holotype: Pl. 47, figs. 1,2.	Slide No. 7-S-2-Micro. 95;	co-ord. 10.9/43.7.
Paratype: Pl. 47, fig. 3.	Slide No. 7-S-2-Micro. 97;	co-ord. 10/44.9.
Paratype: Pl. 47, fig. 4.	Slide No. 7-S-2-Micro. 72;	co-ord. 10.2/45.

Genus **Pareodinia** Deflandre, 1947

Type species **Pareodinia ceratophora** Deflandre, 1947

See Norris and Sarjeant (1965, p. 47) for generic diagnosis.

Remarks: The genus *Pareodinia* consists of fossil dinoflagellate cysts having an ellipsoidal or oval body which is drawn out into a prominent apical horn. The archeopyle is intercalary (Evitt, 1967, p. 38). The tabulation, cingulum, and sulcus are absent.

Pareodinia ceratophora Deflandre, 1947

Plate 47, figures 5-7; plate 48, figures 1, 2

1947 *Pareodinia ceratophora* Deflandre, Bull. Inst. Océanographique, no. 921, p. 4, text-figs. 1-3.

1958 *Pareodinia aphelia* Cookson and Eisenack (part), Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 60, pl. 12, fig. 9 only.

See Sarjeant (*in* Davey *et al.*, 1966, p. 211) for detailed synonymy.

Description: Test dorsoventrally compressed, longer than broad; body oval to elongate oval in outline, with an apical horn of variable length; horn pointed to blunt, occasionally with a 1-micron wide, solid, spherical granule at the tip; tabulation, cingulum, and sulcus absent; archeopyle intercalary, formed by the loss of plates 2a and 3a; body wall about 0.5 micron thick, often folded, and with pieces of membraneous tissue attached to the outer surface; surface of the test almost smooth to finely granulose.

Size range: Total length of the test, including the horn (13 specimens) 57(75)106 microns.
Total breadth of the test (13 specimens) 32(45)60 microns.
Length of the body (13 specimens) 47(60)80 microns.
Length of the apical horn (13 specimens) 6(16)26 microns.
Width of the apical horn (13 specimens) 4(6)7 microns.

Distribution: Bajocian to Albian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; Callovian and Oxfordian (Sarjeant, 1962), Hauterivian and Barremian (Sarjeant *in* Davey *et al.*, 1966) of England; Bajocian (Deflandre, 1947), Bajocian and Bathonian (Valensi, 1953) of France; Bathonian and Callovian of Germany (Alberti, 1961); Upper Jurassic of Denmark (Evitt, 1967); Upper Jurassic of Western Australia (Cookson and Eisenack, 1958).

Remarks: The specimens assigned to *Pareodinia ceratophora* in the present

study are extremely variable. They vary in size, in length to breadth ratio, in the shape and size of the apical horn, and in the intensity of the surface ornamentation. According to Sarjeant (1962, p. 483), the British specimens of *P. ceratophora* are also very variable. The French specimens of *P. ceratophora,* described by Deflandre (1947), are on an average slightly smaller (overall length: 65 to 78 microns) and have smooth to granular surface.

Pareodinia aphelia Cookson and Eisenack, 1958, differs from *P. ceratophora* in having a very short and narrow apical horn with an abruptly delimited neck.

Locality of figured specimens:

Pl. 47, fig. 5.	Sample No. 7-H-6;	Harmon Member.	Section 7.
Pl. 47, fig. 6.	Sample No. 6-H-3;	Harmon Member.	Section 6.
Pl. 47, fig. 7.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 48, fig. 1.	Sample No. 6-H-3;	Harmon Member.	Section 6.
Pl. 48, fig. 2.	Sample No. 7-H-6;	Harmon Member.	Section 7.
Pl. 47, fig. 5.	Slide No. 7-H-6(1);	co-ord. 19.8/77.2.	
Pl. 47, fig. 6.	Slide No. 6-H-3(2);	co-ord. 2.8/56.1.	
Pl. 47, fig. 7.	Slide No. 7- C-2(1);	co-ord. 15.2/47.1.	
Pl. 48, fig. 1.	Slide No. 6-H-3(2);	co-ord. 1.2/46.5.	
Pl. 48, fig. 2.	Slide No. 7-H-6(1);	co-ord. 14.9/56.2.	

Pareodinia sp.

Plate 48, figures 3-7

Description: Test dorsoventrally compressed, longer than broad; body oval with a short, blunt apical horn, and two minute prominences at the antapex; body wall double layered; outer layer membraneous, showing traces of tabulation, cingulum, and sulcus; inner layer smooth, about 1 micron thick; cingulum laevorotatory, about 5 microns wide, and bordered by two parallel ridges; sulcus narrow, present on ventral hypotract and epitract; details of tabulation in the apical and antapical regions not clear; remaining tabulation consisting of ?4a, 6", 6'''; archeopyle intercalary, probably formed by the loss of plates 2a and 3a; operculum present but slightly displaced; surface of the test almost smooth to finely granulose.

Size range: Total length of the test, including the horn (1 specimen) 86 microns.
Total breadth of the test (1 specimen) 51 microns.
Length of the body (1 specimen) 74 microns.
Length of the apical horn (1 specimen) 12 microns.
Width of the apical horn (1 specimen) 8 microns.

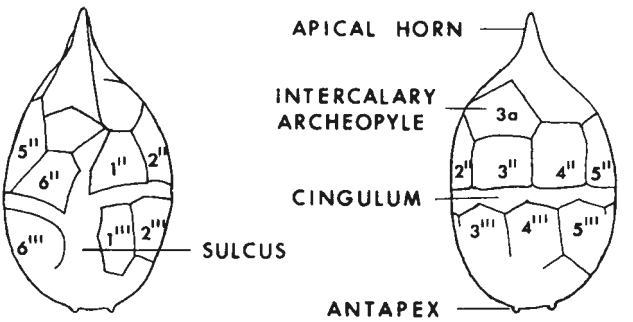

FIGURE 52. Pareodinia *sp. 1. Tabulation on the ventral surface. 2. Tabulation on the dorsal surface.*

Distribution: Middle Albian. A single specimen was found in the Loon River Formation.

Remarks: *Pareodinia* sp. differs from all the described species of the genus *Pareodinia* Deflandre, 1947, in exhibiting traces of tabulation, cingulum, and sulcus and in possessing a double-layered wall. However, the disintegration of the outer membraneous layer bearing the plates, cingulum, and sulcus would expose the smooth inner wall, and give the body an appearance similar to the other species of the genus *Pareodinia.*

Pareodinia sp. resembles some species of the genus *Broomea* Cookson and Eisenack, 1958, in possessing an intercalary archeopyle, but differs in the mode of formation and position of the archeopyle, and in having a distinctly laevo-rotatory cingulum. It also lacks the characteristic, well developed antapical horns of the genus *Broomea.*

Locality of figured specimen:

Pl. 48, figs. 3-7.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 48, figs. 3-7.	Slide No. 8-L-11(3);	co-ord. 19.8/76.8.	

Genus **Trichodinium** Eisenack and Cookson, 1960

Type species **Trichodinium pellitum** Eisenack and Cookson, 1960

See Norris and Sarjeant (1965, p. 61) for generic diagnosis.

Remarks: The genus *Trichodinium* consists of fossil dinoflagellate cysts having a spherical to oval, nontabulate test with a cingulum, short apical horn, precingular archeopyle, and an ornamentation of hairs, bristles or spines.

The genus *Apteodinium* Eisenack, 1958, differs from *Trichodinium* in lacking major surface ornamentation.

Trichodinium spinosum n. sp.

Plate 48, figures 8, 9

Description: Test oval with one short, tubular, apical horn; horn usually wider at the tip; cingulum very faint, often not visible; archeopyle precingular; surface of the test granular, densely covered with stiff, pointed spines of medium length; spines curved and with slightly expanded bases; body wall about 1.5 microns thick.

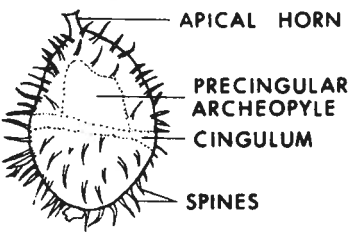

FIGURE 53. Trichodinium spinosum *n. sp. Dorsal view.*

Size range: Total length of the test, including the horn (4 specimens) 63(69)72 microns. Holotype 63 microns.
Total breadth of the test, including the spines (4 specimens) 48(55)58 microns. Holotype 48 microns.
Total length of the body (4 specimens) 48(54)57 microns. Holotype 48 microns.
Total breadth of the body (4 specimens) 37(46)53 microns. Holotype 37 microns.
Length of the apical horn (4 specimens) 8(9)10 microns. Holotype 8 microns.
Length of the spines (4 specimens) 5(7)8 microns. Holotype 8 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Trichodinium intermedium* Eisenack and Cookson, 1960, resembles *Trichodinium spinosum* n. sp., but differs in having shorter spines, small spiny apical horn, and in being larger (overall length: 90 to 100 microns; overall breadth:

76 to 81 microns). *Trichodinium pellitum* Eisenack and Cookson, 1960, *Trichodinium hirsutum* Cookson, 1965, and *Coronifera oceanica* Cookson and Eisenack, 1958, are distinct from *T. spinosum* n. sp. in possessing an antapical projection, and in being larger.

The specific name is derived from "*spinosum*" (spine-bearing) and refers to the spines on the test.

Type locality:

Holotype: Pl. 48, fig. 8.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Sec. 3.
Paratype: Pl. 48, fig. 9.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Sec. 3.
Holotype: Pl. 48, fig. 8.	Slide No. 3-S-5-Micro. 139;	co-ord. 13.2/43.	
Paratype: Pl. 48, fig. 9.	Slide No. 3-S-5-Micro. 145;	co-ord. 11/41.8.	

Family **Fromeaceae**

Genus **Chytroeisphaeridia** (Sarjeant, 1962)
Downie, Evitt and Sarjeant, 1963

Type species **Chytroeisphaeridia chytroeides** (Sarjeant, 1962) Downie and Sarjeant, 1964

See Norris and Sarjeant (1965, p. 18) for generic diagnosis.

Remarks: The genus *Chytroeisphaeridia* consists of fossil dinoflagellate cysts having a spherical to oval test, smooth, granular or punctate surface, and polygonal to subpolygonal apical archeopyle.

Chytroeisphaeridia was proposed by Sarjeant (1962) as a subgenus of *Leiosphaeridia* Eisenack, 1958, and was subsequently elevated to the generic rank by Downie, Evitt and Sarjeant (1963).

Chytroeisphaeridia sp.

Plate 48, figure 10

Description: Test spherical, with an apical archeopyle; outline of the archeopyle and the lid-like operculum roughly pentagonal; archeopyle 12 microns wide; wall about 1 micron thick and finely granular.

Size range: Length of the test (1 specimen) 28 microns.
Breadth of the test (1 specimen) 26 microns.

Distribution: Middle Albian. A single specimen was found in the Cadotte Member of the Peace River area.

Locality of figured specimen:

Pl. 48, fig. 10.	Sample No. 7-C-2;	Cadotte Member.	Section 7.
Pl. 48, fig. 10.	Slide No. 7-C-2(1);	co-ord. 13/69.2.	

Genus **Fromea** Cookson and Eisenack, 1958

Type species **Fromea amphora** Cookson and Eisenack, 1958

See Norris and Sarjeant (1965, p. 29) for generic diagnosis.

Remarks: The genus *Fromea* consists of fossil dinoflagellate cysts having a smooth and elongated test with a cingulum and a wide aperture at one end. The archeopyle is apical (Evitt, 1961, p. 401).

The genus *Ascostomocystis* Drugg and Loeblich, 1967, differs from *Fromea* in having an outer, bag-like, membraneous covering. *Fromea* is easily distinguishable from the genus *Palaeostomocystis* Deflandre, 1935, which lacks a cingulum.

Fromea amphora Cookson and Eisenack, 1958

Plate 49, figures 1-3

1958 *Fromea amphora* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 56, pl. 5, figs. 10, 11.

Description: Test dorsoventrally flattened, elliptical in outline, and concave in the apertural region; archeopyle apical, represented by a wide, elliptical opening rimmed by a thicker wall; body wall from 1.5 to 2.5 microns thick; cingulum distinct on most specimens, usually marked by a narrow ridge on the surface of the body; body smooth, light to dark brown in color.

Size range: Length of the test (31 specimens) 67(98)125 microns.
Breadth of the test (31 specimens) 50(80)107 microns.
Width of the archeopyle (5 specimens) 28(30)34 microns.

Distribution: Barremian to Cenomanian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; early

Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); late Albian to early Cenomanian (Cookson and Hughes, 1964), late Barremian (Sarjeant *in* Davey *et al.*, 1966) of England; Barremian and Aptian of Germany (Alberti, 1961); late Albian of Rumania (Baltes, 1967b); Aptian to Cenomanian of Australia (Cookson and Eisenack, 1958).

Remarks: The specimens of *Fromea amphora* described by Cookson and Eisenack (1958) are on an average smaller (overall length: 62 to 95 microns; overall breadth: 47 to 81 microns) than those described in the present study. However, they are identical in all other respects.

The specimens which are more than 100 microns in length are restricted to the basal portion of the Shaftesbury Formation.

Locality of figured specimens:

Pl. 49, figs. 1,3.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 49, fig. 2.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 49, fig. 1.	Slide No. 7-S-2-Micro. 75;	co-ord. 10/45.6.	
Pl. 49, fig. 2.	Slide No. 5-S-3(2);	co-ord. 5/45.	
Pl. 49, fig. 3.	Slide No. 7-S-2-Micro. 75;	co-ord. 15.1/43.1.	

Family **Canningiaceae**

Genus **Broomea** Cookson and Eisenack, 1958

Type species **Broomea ramosa** Cookson and Eisenack, 1958

See Norris and Sarjeant (1965, p. 14) for generic diagnosis.

Remarks: Cookson and Eisenack (1958) described their new genus *Broomea* as follows: 'Test elongate with a longer apical horn and two shorter antapical horns. A shallow "girdle" situated below the middle of the body may be present. A pylome is developed in the apical region'. Evitt (1961, p. 401) recognized that the feature described as pylome (in the type species *Broomea ramosa* only) by Cookson and Eisenack (1958) is an intercalary archeopyle. Subsequently, Evitt (1967, p. 32) pointed out that the Lower Cretaceous species referred to *Broomea* by Alberti (1961) exhibit an apical archeopyle. A detailed revision of the genus *Broomea*, in order to transfer the species with an apical archeopyle to another genus, seems to be necessary.

Broomea jaegeri Alberti, 1961

Plate 49, figure 4

1957 *Pseudoceratium?* sp. Gocht, Paläont. Z., vol. 31, p. 167, fig. 6.

1961 *Broomea jaegeri* Alberti, Palaeontographica, Band 116, Abt. A, p. 26, pl. 5, figs. 1-7.

1962 *Pseudoceratium gochtii* Pocock, Palaeontographica, Band 111, Abt. B, p. 79, pl. 14, figs. 213, 214.

1964 *Pseudoceratium gochtii* Pocock–Singh, Res. Coun. Alberta, Bull. 15, p. 145, pl. 20, fig. 7.

1964 *Broomea* cf. *jaegeri* Alberti–Cookson and Hughes, Palaeont., vol. 7, p. 53, pl. 11, fig. 10.

Description: Test flat, elongate, with slightly convex sides; body with one long apical and two short antapical horns; apical horn distinct from the body, about 3 microns wide, and with a pointed tip; length of the apical horn variable; antapical horns short, wide based, pointed, often unequal and situated close to one another at the antapical end of the body; antapical horns often not in the same plane; body without plates; cingulum absent; archeopyle apical, marked by an irregular suture below the apex; wall thin, smooth to finely granulate, and hyaline.

Size range: Total length of the test, including the horns (7 specimens) 108(125)148 microns.
Total breadth of the test (7 specimens) 26(34)45 microns.
Length of the body (7 specimens) 72(78)90 microns.
Length of the apical horn (4 specimens) 40(47)60 microns.
Length of the antapical horns (6 specimens) 11(12)14 microns.

Distribution: Cretaceous. Harmon Member and lower Shaftesbury Formation of the Peace River area; Clearwater Formation of central Alberta (Singh, 1964); Cretaceous of Western Canada (Pocock, 1962); late Albian and early Cenomanian of England (Cookson and Hughes, 1964); late Hauterivian of northwest Germany (Gocht, 1957); late Barremian of Germany (Alberti, 1961).

Remarks: *Pseudoceratium gochtii* Pocock, 1962, is a junior synonym of *Broomea jaegeri* Alberti, 1961.

Broomea jaegeri is not strictly conformable with the genus *Broomea.* This species has an apical archeopyle and lacks a cingulum, whereas, the type species *Broomea ramosa* Cookson and Eisenack, 1958, exhibits an intercalary archeopyle and a cingulum. It would be desirable to transfer *B. jaegeri* and other species with an apical archeopyle, presently assigned to *Broomea,* to a new genus.

Locality of figured specimen:

Pl. 49, fig. 4. Sample No. 2-S-7; lower Shaftesbury Formation. Section 2.
Pl. 49, fig. 4. Slide No. 2-S-7-Micro. 73; co-ord. 11.7/44.8.

Broomea sp.

Plate 49, figure 5

Description: Test flat, elongate, with slightly convex sides; body with one long apical and two medium-sized, antapical horns; apical horn distinct from the body, antapical horns about 1/2 of the length of body, wide based, pointed, and situated close to one another at the antapical end of the body; antapical horns almost parallel to one another; body without plates; cingulum and archeopyle absent; wall thin, smooth, and hyaline.

Size range: Total length of the test, excluding the broken portion of the apical horn (1 specimen) 130 microns.
Total breadth of the test (1 specimen) 34 microns.
Length of the body (1 specimen) 78 microns.
Length of the antapical horns (1 specimen) 40 to 44 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Broomea* sp. differs from *Broomea simplex* Cookson and Eisenack, 1958, which is larger (overall length: 285 to 314 microns) and has stiff, divergent antapical horns with rounded tips. *Broomea? longicornuta* Alberti, 1961, is distinct in having perforated apical and antapical horns.

Locality of figured specimen:

Pl. 49, fig. 5. Sample No. 2-S-7; lower Shaftesbury Formation. Section 2.
Pl. 49, fig. 5. Slide No. 2-S-7(1); co-ord. 6/46.2.

Genus **Canningia** Cookson and Eisenack, 1960

Type species **Canningia reticulata** Cookson and Eisenack, 1960

See Norris and Sarjeant (1965, p. 16) for generic diagnosis.

Remarks: The genus *Canningia* consists of fossil dinoflagellate cysts having a roughly five sided to almost circular outline, a short blunt apical horn, two broad, blunt, equal or unequal, pronounced or reduced antapical horns, and an apical archeopyle. The cingulum is either absent or faintly indicated on the surface and by re-entrant angles at the sides.

On the whole, the characters used for the separation of species within the genus *Canningia* are not very distinctive, and it seems possible that the genus, as it now stands, contains a heterogeneous assemblage of fossil dinoflagellate cysts.

Canningia aspera n. sp.

Plate 50, figure 1

Description: Test roughly five sided and widest at the equator; length and breadth of the body almost equal; body with one apical and two antapical, barely discernible prominences indicated by slight projections in the outline and thicker ornamentation; cingulum faint, bordered on either side by a row of closely spaced, fine spinules; archeopyle apical and opening along a downwardly directed curved line; body ornamented by thick, irregular-shaped elevations surmounted by 2- to 4-micron long, conical spines; body wall about 2.5 microns thick.

Size range: Length of the test (4 specimens) 96(100)105 microns. Holotype 100 microns.
Breadth of the test (4 specimens) 94(97)103 microns. Holotype 98 microns.

Distribution: Middle Albian. Cadotte Member of the Peace River area.

Remarks: *Canningia aspera* n. sp. differs from *Canningia rotundata* Cookson and Eisenack, 1961, which has a vermiculate surface ornamentation and a slight, median, antapical prominence, and lacks the cingulum.

The specific name has been derived from "*aspera*" (rough, uneven) and refers to the rough surface of the test.

Type locality:

Holotype: Pl. 50, fig. 1.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Holotype: Pl. 50, fig. 1.	Slide No. 7-C-10(1);	co-ord. 11.3/64.	

Canningia colliveri Cookson and Eisenack, 1960

Plate 50, figures 2, 3

1960 *Canningia colliveri* Cookson and Eisenack, Palaeont., vol. 2, p. 251, pl. 38, figs. 3, 4.

Description: Test roughly five sided to almost circular, slightly longer than broad, widest at the equator; body with one apical and two antapical horns; horns wide based, almost merging with the outline of the body; apical horn short, conical, and blunt; antapical horns short, wide, blunt, separated from one another by an obtuse indentation, and barely discernible in more rounded specimens; cingulum faint, bordered on either side by a row of closely spaced, fine spinules or indicated by slightly re-entrant angles at the sides; archeopyle apical; apical portion usually detached from the body along the notched archeopyle suture; spinules short on the body, but 2 to 6 microns long on the apical and antapical horns and along the cingulum; body wall about 1.5 microns thick.

Size range: Length of the test (8 specimens) 103(111)125 microns.
Breadth of the test (8 specimens) 95(104)114 microns.

Distribution: Aptian and Albian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; Clearwater Formation of central Alberta (Singh, 1964); Aptian of Queensland and Western Australia (Cookson and Eisenack, 1960).

Remarks: *Canningia colliveri* is characterized by the extreme variability in the size of the antapical horns and ornamentation. The Alberta specimens of *C. colliveri* resemble the paratype of this species illustrated by Cookson and Eisenack (1960, pl. 38, fig. 3), but vary slightly in having longer and coarser spinules. This variation, however, is gradational.

Circulodinium hirtellum Alberti, 1961, resembles *C. colliveri* but lacks a cingulum and is devoid of spinules in the central area of the dorsal and ventral surfaces of the body. *Palaeohystrichophora brevispinosa* Pocock, 1962, is distinct from *C. colliveri* in being encysted. The specimens assigned to *C. colliveri* by Clarke and Verdier (1967) are smaller and probably belong to *Canningia ringnesii* Manum and Cookson, 1964.

Locality of figured specimens:

Pl. 50, fig. 2.	Sample No. 2-S-7;	lower Shaftesbury Formation.	Section 2.
Pl. 50, fig. 3.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 50, fig. 2.	Slide No. 2-S-7-Micro. 158;	co-ord. 11/44.5.	
Pl. 50, fig. 3.	Slide No. 5-S-3-Micro. 112;	co-ord. 12.2/45.8.	

Family **Hystrichosphaeridiaceae**

Genus **Cleistosphaeridium** Davey, Downie, Sarjeant and Williams, 1966

Type species **Cleistosphaeridium diversispinosum** Davey, Downie, Sarjeant and Williams, 1966

See Davey, Downie, Sarjeant and Williams (1966, p. 166) for generic diagnosis.

Remarks: The genus *Cleistosphaeridium* consists of fossil dinoflagellate cysts having a spherical to ovoidal central body bearing 50 or more distally closed processes. The processes do not open proximally into the inner cavity of the central body. The archeopyle is apical and has a zigzag margin.

This genus is characterized by its numerous, distally closed processes and an apical archeopyle. The genus *Polysphaeridium* Davey and Williams, 1966, differs from *Cleistosphaeridium* in possessing distally open processes.

Cleistosphaeridium polypes (Cookson and Eisenack) Davey, 1969

Plate 50, figures 4,5

1962a *Hystrichosphaeridium recurvatum* (White) Lejeune-Carpentier subsp. *polypes* Cookson and Eisenack, Micropaleont., vol. 8, p. 491, pl. 4, figs. 11-13.

1966 *?Polysphaeridium polypes* (Cookson and Eisenack) Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 95.

1969 *Cleistosphaeridium polypes* (Cookson and Eisenack) Davey, Bull. British Museum (Natural History), Geol., vol. 17, p. 154, pl. 6, figs. 7, 8.

Description: Central body spherical, bearing 40 or more, uniformly distributed, slender processes; processes about 0.8 micron wide with slightly expanded bases; tips of the processes closed, fringed with short, straight or recurved spinules; spinules dividing once or twice into hair-like branches visible only under high magnification; archeopyle probably apical, large, and with a zigzag margin; length of the processes from 1/3 to 1/2 of the diameter of the central body; surface of the central body finely granular.

Size range: Maximum dimension of the test, including the processes (12 specimens) 60(64)72 microns.
Diameter of the central body (12 specimens) 34(41)47 microns.
Length of the processes (12 specimens) 12(14)19 microns.

Distribution: Aptian to Cenomanian. Harmon Member and lower Shaftesbury Formation of the Peace River area; Cenomanian of Saskatchewan, Canada (Davey, 1969); late Cenomanian of Texas, U.S.A. (Davey, 1969); late Albian and early

Cenomanian (Cookson and Hughes, 1964), middle and late Cenomanian (Davey, 1969) of England; Aptian to Cenomanian of Australia (Cookson and Eisenack, 1962a).

Remarks: The Alberta specimens of *Cleistosphaeridium polypes* closely resemble the British specimens of this species described by Cookson and Hughes (1964, pl. 9, fig. 14). They differ slightly from the Australian specimens of *C. polypes* described by Cookson and Eisenack (1962a), which have more prominently developed, hair-like branches at the tip of the processes, and a higher upper size limit (overall diameter: 52 to 99 microns). These differences are presumably within the range of variation of this species.

Locality of figured specimens:

Pl. 50, fig. 4.	Sample No. 7-H- 4;	Harmon Member.	Section 7.
Pl. 50, fig. 5.	Sample No. 6-H- 6;	Harmon Member.	Section 6.
Pl. 50, fig. 4.	Slide No. 7-H- 4 -Micro. 84;	co-ord. 13/40.1.	
Pl. 50, fig. 5.	Slide No. 6-H- 6-Micro. 88;	co-ord. 9.8/43.4.	

Genus **Cordosphaeridium** Eisenack, 1963, emend. Davey and Williams, 1966

Type species **Cordosphaeridium inodes** (Klumpp) Eisenack, 1963

See Davey and Williams (*in* Davey *et al.*, 1966, p. 83) for emended generic diagnosis.

Remarks: Davey and Williams (*in* Davey *et al.*, 1966) emended the genus *Cordosphaeridium* to contain subspherical fossil dinoflagellate cysts having tubiform to buccinate, solid or hollow, intratabular processes reflecting a tabulation of 1', 6", 6c, 6"', (1p), 1"", and a variable number of sulcal processes. The wall of the central body is double layered. The outer layer and the processes are usually strongly fibrous. The archeopyle is apical and formed by the loss of the single apical plate.

Cordosphaeridium sp.

Plate 50, figure 6

Description: Central body subspherical, hyaline, and bearing a small number of fibrous processes; processes short, wide, cylindrical, and open distally; body wall double layered; outer layer fibrous; processes with fibrous and perforate wall and an entire rim; length of the processes less than 1/2 of the diameter of the body.

Size range: Maximum dimension of the test, including the processes (1 specimen) 84 microns.
Diameter of the central body (1 specimen) 54 microns.
Length of the processes (1 specimen) 16 to 20 microns.
Width of the processes (1 specimen) 15 to 22 microns.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Locality of figured specimen:

Pl. 50, fig. 6.	Sample No. 6-H-6;	Harmon Member.	Section 6.
Pl. 50, fig. 6.	Slide No. 6-H-6(1);	co-ord. 18.9/68.	

Genus **Hystrichokolpoma** Klumpp, 1953, emend. Williams and Downie, 1966

Type species **Hystrichokolpoma cinctum** Klumpp, 1953

See Williams and Downie (*in* Davey *et al.*, 1966, p. 176) for emended generic diagnosis.

Remarks: Williams and Downie (*in* Davey *et al.*, 1966) emended the genus *Hystrichokolpoma* to accommodate fossil dinoflagellate cysts having a spherical to ellipsoidal central body bearing two types of intratabular processes: large types with expanded bases and slender ones. Each large process has an expanded base with a four-sided cross section and occupies a single, reflected plate area, leaving a narrow border around it. Distally these processes taper and may be open or closed. The large processes are restricted to the apical, precingular, postcingular, antapical, and usually anterior sulcal plates. The antapical process is longer than others. The slender processes are restricted to the cingular and sulcal zones. The reflected tabulation is 4', 6", 6c, 5"', 1p, 1''''. The cingulum is helicoid. The archeopyle is apical and formed by the removal of the 4 apical plates.

The genus *Diphyes* Cookson, 1965, emend. Davey and Williams, 1966, differs from *Hystrichokolpoma* in possessing 1 to 4 fine processes on each reflected plate area, and a single, large antapical process.

Hystrichokolpoma ferox (Deflandre) Davey, 1969

Plate 51, figures 1-5

1937 · *Hystrichosphaeridium ferox* Deflandre, Ann. Paléont., vol. 26, p. 72, pl. 14, figs. 3, 4.

1961 *Hystrichokolpoma* sp. A Alberti, Palaeontographica, Band 116, Abt. A, p. 39, pl. 9, fig. 12.

1963 *Baltisphaeridium ferox* (Deflandre) Downie and Sarjeant, Palaeont., vol. 6, p. 91.

1969 *Hystrichokolpoma ferox* (Deflandre) Davey, Bull. British Museum (Natural History), Geol., vol. 17, p. 159, pl. 9, figs. 5-7.

See Clarke and Verdier (1967, p. 73) for detailed synonymy.

Description: Central body ellipsoidal to ovoidal, bearing two types of intratabular processes; one type consisting of wide, short, cylindrical processes deeply divided into several long, conical projections at their distal ends; each wide process occupying a single reflected plate area; antapical process tubular and open distally with a smooth or serrate rim; antapical process longer, narrower, and less deeply divided distally than others; the other type consisting of slender, conical, straight to recurved processes with slightly expanded bases and pointed to blunt tips; reflected tabulation as specified for the genus; archeopyle apical; length of the processes from 1/3 to 1/2 of the diameter of the central body; wall of the central body double layered; outer layer granular.

Size range: Maximum dimension of the test, including the processes (7 specimens) 72(77)84 microns.
Diameter of the central body (7 specimens) 42(48)53 microns.
Length of the processes (7 specimens) 15(18)24 microns.

Distribution: Late Aptian to Danian. Lower Shaftesbury Formation of the Peace River area; Danian of California, U.S.A. (Drugg, 1967); Cenomanian to Santonian (Clarke and Verdier, 1967), Cenomanian and Turonian (Davey, 1969), late Albian and early Cenomanian (Cookson and Hughes, 1964) of England; Senonian of France (Deflandre, 1937; Deflandre and Courteville, 1939); Danian (W. Wetzel, 1952), late Aptian (Eisenack, 1958), Cenomanian (Alberti, 1961) of Germany; Albian and Cenomanian of Western Australia (Cookson and Eisenack, 1962a).

Remarks: *Hystrichokolpoma ferox* is distinct from *Hystrichokolpoma clavigerum* (Deflandre, 1937), which has elongate, subconical processes with expanded but separate bases and capitate tips.

The specimen illustrated as *Hystrichosphaeridium ferox* by Gocht (1959, pl. 4, fig. 1) from the Hauterivian of Germany, most probably belongs to a distinct species of the genus *Hystrichosphaera.*

Williams and Downie (*in* Davey *et al.*, 1966, p. 181) informally mentioned that *Baltisphaeridium ferox* (Deflandre) Downie and Sarjeant, 1963, should be transferred to the genus *Hystrichokolpoma.* This does not constitute a validly published new combination under Article 33 of the International Code of Botanical Nomenclature (1961). *Hystrichokolpoma ferox* was first validly published as a new combination by Davey (1969).

Locality of figured specimens:

Pl. 51, figs. 1-5.	Sample No. 5-S-3; lower Shaftesbury Formation.	Section 5.
Pl. 51, fig. 1.	Slide No. 5-S-3-Micro. 107; co-ord. 12.4/45.	
Pl. 51, fig. 2.	Slide No. 5-S-3-Micro. 110; co-ord. 12/44.5.	
Pl. 51, fig. 3.	Slide No. 5-S-3-Micro. 109; co-ord. 9.2/43.	
Pl. 51, fig. 4.	Slide No. 5-S-3-Micro. 106; co-ord. 9.8/44.	
Pl. 51, fig. 5.	Slide No. 5-S-3-Micro. 108; co-ord. 11.3/43.7.	

Genus **Hystrichosphaeridium** Deflandre, 1937, emend. Davey and Williams, 1966

Type species **Hystrichosphaeridium tubiferum** (Ehrenberg) Deflandre, 1937

See Davey and Williams (*in* Davey *et al.*, 1966, p. 55) for emended generic diagnosis.

Remarks: Davey and Williams (*in* Davey *et al.*, 1966) emended the genus *Hystrichosphaeridium* to accommodate fossil dinoflagellate cysts having a subspherical central body possessing a reflected tabulation of 4-5', 6", 6c, 5-6"', 1p, 1"", and a variable number of sulcal processes. The processes rarely exceed 30 in number and are hollow, cylindrical to funnel-like, and open distally. One process occupies the center of each reflected plate area. The archeopyle is apical. The wall of the central body is double layered. The outer layer covers the central body and forms the processes. Thus, the processes do not open proximally into the inner cavity of the central body.

The sulcal processes of this genus are often noticeably smaller, and the antapical process may be considerably larger than the other processes.

The genus *Hystrichosphaeridium* differs from *Oligosphaeridium* Davey and Williams, 1966, which has a barren cingular zone without processes and a relatively small number (18 or less) of processes. The genus *Perisseiasphaeridium* Davey and Williams, 1966, is distinct in possessing a variable number of closed cingular and sulcal processes.

Hystrichosphaeridium arundum Eisenack and Cookson, 1960

Plate 51, figure 6

1960 *Hystrichosphaeridium arundum* Eisenack and Cookson, Proc. Roy. Soc. Victoria, vol. 72, pt. 1, p. 8, pl. 3, figs. 7-9.

Description: Central body spherical, bearing about 30 short processes; reflected tabulation not clear; processes tubular, open, of variable width, and slightly flared

distally; rims of the processes entire and smooth; processes 2 to 3 microns wide in the proximal portion and 4 to 6 microns wide at the distal end; length of the processes from 1/4 to 1/2 of the diameter of the central body; archeopyle apical; wall of the central body double layered; outer layer slightly granular.

Size range: Maximum dimension of the test, including the processes (7 specimens) 42(46)54 microns.
Diameter of the central body (7 specimens) 25(29)36 microns.
Length of the processes (7 specimens) 8(9)12 microns.

Distribution: Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area; late Albian of England (Cookson and Hughes, 1964); Albian of Australia (Eisenack and Cookson, 1960).

Remarks: The specimens of *Hystrichosphaeridium arundum* recorded during the present study are poorly preserved. The number of processes and other morphological features given above are based upon composite study of all the specimens.

Locality of figured specimen:

Pl. 51, fig. 6. Sample No. 2-S-16; lower Shaftesbury Formation. Section 2.
Pl. 51, fig. 6. Slide No. 2-S-16(1); co-ord. 9.1/40.

Hystrichosphaeridium cooksoni n. sp.

Plate 51, figures 7, 8; plate 52, figures 1 - 4

Description: Central body ovoidal to subspherical, bearing about 25 wide processes; reflected tabulation as specified for the genus; each reflected plate area occupied by one process; processes increasing in size toward the antapex; postcingular processes about 2 to 3 times larger than the precingular processes; antapical process distinctly larger and wider than other processes; processes very wide, open distally, cylindrical with straight sides and denticulate to serrate rims; width of the broad processes from about 1/2 to equal to their length; narrow processes often slightly flared distally; length of the processes from 1/6 to 1/2 of the diameter of the central body; archeopyle apical; wall of the central body double layered; outer layer smooth to slightly granular; wall of the processes smooth to faintly fibrous.

Size range: Maximum dimension of the test, including the processes (13 specimens) 60(80)105 microns. Holotype 98 microns.

Length of the central body (13 specimens) 36(51)67 microns. Holotype 67 microns.
Breadth of the central body (4 specimens) 36(42)50 microns. Holotype 50 microns.
Length of the processes (13 specimens) 7(20)28 microns. Holotype 14 to 28 microns.
Breadth of the processes (13 specimens) 3(15)20 microns. Holotype 6 to 20 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Hystrichosphaeridium cooksoni* n. sp. is characterized by the marked increase in the size of the processes toward the antapex, a large antapical process, and very wide, cylindrical processes with denticulate to serrate rims.

H. cooksoni n. sp. is distinct from *Hystrichosphaeridium deanei* Davey and Williams, 1966, which possesses a large, subconical to flask-shaped antapical process, and many longer (15 to 45 microns long), subconical to tubiform processes with terminal expansions. *Litosphaeridium truncigerum* (Deflandre, 1937) differs from *H. cooksoni* n. sp. in having longitudinal striations on the processes, radial striations on the body at the base of the processes, closed, narrow, pointed sulcal processes, and wide processes which are evenly distributed on the central body. *Hystrichosphaeridium stellatum* Maier, 1959, is distinct in possessing narrower, equally long processes with slightly flared tips and in having an even distribution of the wide and narrow processes on the central body.

This species has been named in honor of I. C. Cookson.

Type locality:

Holotype: Pl. 51, fig. 7.	Sample No. 3-S- 4;	lower Shaftesbury Fm.	Sec. 3.
Paratype: Pl. 51, fig. 8.	Sample No. 2-S-7;	lower Shaftesbury Fm.	Sec. 2.
Paratype: Pl. 52, fig. 1.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Sec. 3.
Paratype: Pl. 52, fig. 2.	Sample No. 1-S-11;	lower Shaftesbury Fm.	Sec. 1.
Paratype: Pl. 52, fig. 3.	Sample No. 3-S- 4;	lower Shaftesbury Fm.	Sec. 3.
Paratype: Pl. 52, fig. 4.	Sample No. 2-S-7;	lower Shaftesbury Fm.	Sec. 2.
Holotype: Pl. 51, fig. 7.	Slide No. 3-S- 4 -Micro. 153;	co-ord. 12.2/44.5.	
Paratype: Pl. 51, fig. 8.	Slide No. 2-S-7-Micro. 157;	co-ord. 13.2/45.6.	
Paratype: Pl. 52, fig. 1.	Slide No. 3-S-5-Micro. 138;	co-ord. 12.8/44.	
Paratype: Pl. 52, fig. 2.	Slide No. 1-S-11-Micro. 56;	co-ord. 10.9/40.9.	
Paratype: Pl. 52, fig. 3.	Slide No. 3-S- 4 -Micro. 148;	co-ord. 10.9/43.1.	
Paratype: Pl. 52, fig. 4.	Slide No. 2-S-7-Micro. 162;	co-ord. 11.5/43.9.	

Hystrichosphaeridium recurvatum (White) Lejeune-Carpentier, 1940

Plate 52, figures 5, 6

1842 *Xanthidium tubiferum recurvatum* White, Microsc. Jour., vol. 2, p. 39, pl. 4, div. 3, fig. 12.

1937 *Hystrichosphaeridium tubiferum* (Ehrenberg) Deflandre, Ann. Paléont., vol. 26, p. 69, pl. 13, figs. 2, 4.

1940 *Hystrichosphaeridium recurvatum* (White) Lejeune-Carpentier, Ann. Soc. Géol. Belgique, vol. 63, p. B221, fig. 6.

Description: Central body spherical to subspherical, bearing about 25 long, thin processes; reflected tabulation not clear; stalks of processes tubular, 1 to 2 microns wide, widening slightly at the base, and terminating distally with a few, 4- to 6-micron long, recurved spines; processes open distally; length of the processes from 1/2 to equal to the diameter of the central body; archeopyle apical; wall of the central body double layered and smooth.

Size range: Maximum dimension of the test, including the processes (3 specimens) 80(85)88 microns.
Diameter of the central body (3 specimens) 38(41)44 microns.
Length of the processes (3 specimens) 16(26)32 microns.

Distribution: Late Albian to Maestrichtian. "Fish-scale" marker bed and immediately above it in Shaftesbury Formation of the Peace River area; Senonian of England (White, 1842), France (Deflandre, 1937), Belgium (Lejeune-Carpentier, 1940); Maestrichtian of Poland (Górka, 1963).

Remarks: Some of the processes of the specimens of *Hystrichosphaeridium recurvatum* recorded during the present study, are broken.

Locality of figured specimens:

Pl. 52, figs. 5,6.	Sample No. 1-US-1;	upper Shaftesbury Formation.	Section 1.
Pl. 52, fig. 5.	Slide No. 1-US-1(1);	co-ord. 16.9/73.9.	
Pl. 52, fig. 6.	Slide No. 1-US-1(1);	co-ord. 10/42.9.	

Hystrichosphaeridium stellatum Maier, 1959

Plate 53, figures 1-3

1959 *Hystrichosphaeridium stellatum* Maier, Neues Jahrb. Geol. Paläont., Abhandl., vol. 107, p. 320, pl. 33, figs. 3, 4.

See Clarke and Verdier (1967, p. 55) for detailed synonymy.

Description: Central body spherical, bearing about 25 long processes; reflected tabulation as specified for the genus; processes varying from very narrow to very wide and occurring all over the central body without any differentiation in position; antapical process usually wider than other processes; processes cylindrical, open, and slightly flared distally; rims of the processes serrated; bases of the wider processes usually expanded; processes 3 to 12 microns wide at the base and 6 to 16 microns wide at the distal end; length of the processes from 1/2 to 2/3 of the diameter of the central body; archeopyle apical; wall of the central body double layered and smooth.

Size range: Maximum dimension of the test, including the processes (9 specimens) 70(81)96 microns.
Diameter of the central body (9 specimens) 36(44)48 microns.
Length of the processes (9 specimens) 20(25)27 microns.

Distribution: Albian to middle Miocene. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); Danian of California, U.S.A. (Drugg, 1967); late Albian and early Cenomanian of England (Cookson and Hughes, 1964); middle Oligocene and middle Miocene of Germany (Maier, 1959); Albian and Cenomanian of Australia (Cookson and Eisenack, 1962a).

Remarks: The specimens of *Hystrichosphaeridium stellatum* described in the present study closely resemble those described from the Arctic Islands of Canada by Manum and Cookson (1964).

The type material of *H. stellatum* described by Maier (1959) from the Oligocene of Germany is characterized by a fibrous outer layer covering the central body, very wide and very narrow processes without any intergradation, and the even distribution of the wide processes in a triangular pattern on the central body. The specimens assigned to *H. stellatum* by Cookson and Eisenack (1962a), Cookson and Hughes (1964), Manum and Cookson (1964), and Drugg (1967) differ from the type in possessing a smooth central body and an antapical process which is wider than other processes (visible in lateral view only), and in exhibiting an intergradation between the narrow and wide processes. These specimens, including those described in the present study, most probably belong to a distinct species. However, the final decision in this matter must await a re-examination of the type material of *H. stellatum.*

The specimens illustrated by Baltes (1965, pl. 4, figs. 114, 115) as *H. stellatum* have short processes and closely resemble *Hystrichosphaeridium arundum* Eisenack and Cookson, 1960. One of the specimens illustrated by Clarke and Verdier (1967,

pl. 12, fig. 2) as *H. stellatum* has a large flask-shaped, antapical process, and belongs to *Hystrichosphaeridium deanei* Davey and Williams, 1966 (see Davey and Williams *in* Davey *et al.*, 1966, pl. 6, fig. 8).

Locality of figured specimens:

Pl. 53, fig. 1.	Sample No. 7-H- 6;	Harmon Member.	Section 7.
Pl. 53, fig. 2.	Sample No. 6-H-7;	Harmon Member.	Section 6.
Pl. 53, fig. 3.	Sample No. 5-S-3;	lower Shaftesbury Fm.	Section 5.
Pl. 53, fig. 1.	Slide No. 7-H- 6(1);	co-ord. 1.8/62.2.	
Pl. 53, fig. 2.	Slide No. 6-H-7(1);	co-ord. 9.2/48.	
Pl. 53, fig. 3.	Slide No. 5-S-3(1);	co-ord. 5.1/78.	

Genus **Oligosphaeridium** Davey and Williams, 1966

Type species **Oligosphaeridium complex** (White) Davey and Williams, 1966

See Davey and Williams (*in* Davey *et al.*, 1966, p. 70) for generic diagnosis.

Remarks: The genus *Oligosphaeridium* consists of fossil dinoflagellate cysts having a smooth, spherical to ovoidal central body possessing a reflected tabulation of 4', 6", 5-6"', 1p, 1"", and 18 or less, cylindrical to funnel-like, distally open processes. One process occupies the center of each reflected plate area. The archeopyle is apical. The wall of the central body is double layered. The outer layer covers the central body and forms the processes. Thus, the processes do not open proximally into the inner cavity of the central body.

The genus *Oligosphaeridium* is characterized by a barren cingular zone devoid of processes and a body with a relatively small number (18 or less) of processes. It differs from the genus *Hystrichosphaeridium* Deflandre, 1937, emend. Davey and Williams, 1966, which possesses 6 cingular processes, a variable number of small sulcal processes, and a relatively large number (up to 30) of processes.

Oligosphaeridium complex (White) Davey and Williams, 1966

Plate 53, figures 4 - 6

1842 *Xanthidium tubiferum complex* White, Microsc. Jour., vol. 2, p. 39, pl. 4, div. 3, fig. 11.

1940 *Hystrichosphaeridium elegantulum* Lejeune-Carpentier, Ann. Soc. Géol. Belgique, vol. 63, p. B222, figs. 11, 12.

1946 *Hystrichosphaeridium complex* (White) Deflandre, Compt. Rend. Soc. Géol., France, no. 7, p. 111.

1966 *Oligosphaeridium complex* (White) Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 71, pl. 7, figs. 1, 2, pl. 10, fig. 3, text-fig. 14.

See Davey and Williams (*in* Davey *et al.*, 1966, p. 71) for detailed synonymy.

Description: Central body subspherical, bearing 18 long processes; reflected tabulation as specified for the genus; one process occupying the center of each reflected plate area; processes cylindrical for most of their length, open, expanded, and occasionally branched distally; rims of the processes bearing 3- to 9-micron long, pointed (aculeate) to irregularly bifurcate (secate) spines; processes 3 to 8 microns wide at the base and 11 to 25 microns wide at the rim; length of the processes from 1/2 to 3/4 of the diameter of the central body; cingular zone without processes; archeopyle apical; wall of the central body double layered and smooth; wall of the processes smooth to faintly fibrous.

FIGURE 54. Oligosphaeridium complex *(White) Davey and Williams. Structure of processes.*

Size range: Maximum dimension of the test, including the processes (20 specimens) 75(98)155 microns.
Diameter of the central body (20 specimens) 34(47)70 microns.
Length of the processes (20 specimens) 19(30)52 microns.

Distribution: Valanginian to early Eocene. Harmon Member and lower Shaftesbury Formation of the Peace River area; late Albian and early Cenomanian of Saskatchewan, Canada (Davey, 1969); Danian of California, U.S.A. (Drugg, 1967); Senonian (White, 1842), Albian and Cenomanian (Cookson and Hughes, 1964), Barremian to early Eocene (Davey and Williams *in* Davey *et al.*, 1966), Albian to Turonian (Davey, 1969), Cenomanian to Campanian (Clarke and Verdier, 1967) of England; late Turonian to Senonian of Belgium (Lejeune-Carpentier, 1940); Cretaceous (Valensi, 1955), early Cenomanian (Firtion, 1952) of France; late Aptian (Eisenack, 1958), Valanginian to Barremian (Gocht, 1959) of Germany; Lower Cretaceous to Senonian (Deflandre and Cookson, 1955), late Neocomian to Senonian (Cookson and Eisenack, 1958) of Australia.

Remarks: This species is characterized by the long, pointed (aculeate) to irregularly bifurcate (secate) spines on the rim of its processes.

Locality of figured specimens:

Pl. 53, fig. 4.	Sample No. 7-H- 4;	Harmon Member.	Section 7.
Pl. 53, fig. 5.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 53, fig. 6.	Sample No. 6-H-7;	Harmon Member.	Section 6.
Pl. 53, fig. 4.	Slide No. 7-H- 4 -Micro. 81;	co-ord. 11.5/44.	
Pl. 53, fig. 5.	Slide No. 2-S-3(1);	co-ord. 19.1/43.2.	
Pl. 53, fig. 6.	Slide No. 6-H-7(1);	co-ord. 2.2/37.8.	

Oligosphaeridium anthophorum (Cookson and Eisenack) Davey, 1969

Plate 54, figures 1, 2; plate 55, figures 1-3

1958 *Hystrichosphaeridium anthophorum* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 43, pl. 11, figs. 12, 13.

1966 *Oligosphaeridium anthophorum* (Cookson and Eisenack) Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 77 (n. comb. invalid under Art. 33, ICBN, 1961).

1969 *Oligosphaeridium anthophorum* (Cookson and Eisenack) Davey, Bull. British Museum (Natural History), Geol., vol. 17, p. 147, pl. 5, figs. 1-3.

Description: Central body subspherical, bearing 18 long processes; reflected tabulation as specified for the genus; one process occupying the center of each reflected plate area; stalks of the processes short, tubular, from 3 to 12 microns wide, and showing distinct longitudinal fibrils; processes gradually widening distally into 20- to 40-micron wide terminal expansions; terminal expansion of each process with completely and irregularly reticulate wall, longitudinally oriented strands, and an entire, continuous, smooth to finely serrated rim; length of the processes from 1/2 to 2/3 of the diameter of the central body; cingular zone without processes; archeopyle apical; wall of the central body double layered; outer layer slightly granular.

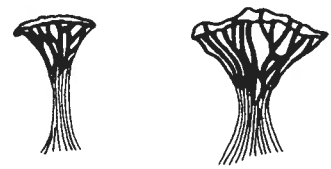

FIGURE 55. Oligosphaeridium anthophorum *(Cookson and Eisenack) Davey. Structure of processes.*

Size range: Maximum dimension of the test, including the processes (19 specimens) 96(115)140 microns.
Diameter of the central body (17 specimens) 48(58)72 microns.
Length of the processes (17 specimens) 26(35)46 microns.

Distribution: Late Jurassic to Albian. Lower Shaftesbury Formation of the Peace River area; late Albian of Saskatchewan, Canada (Davey, 1969); late Barremian to Albian of Germany (Alberti, 1961); Upper Jurassic of Australia and New Guinea (Cookson and Eisenack, 1958).

Remarks: The holotype of *Oligosphaeridium anthophorum* is larger (overall diameter: 210 microns) than the specimens described in the present study. The specimens of *O. anthophorum* described by Alberti (1961) have an overall diameter ranging from 110 to 120 microns and are identical with the Alberta specimens.

According to Evitt (1961, p. 395), the specimens assigned to *O. anthophorum* by Eisenack (1958) differ from the type in possessing a distinct row of small cingular processes. These specimens have been reassigned to the genus *Perisseiasphaeridium* by Davey and Williams (*in* Davey *et al.*, 1966, p. 79).

O. anthophorum differs from *Oligosphaeridium dictyophorum* (Cookson and Eisenack, 1958), which has processes with thin and solid stalks and abruptly widening, reticulate terminal expansions, and from *Oligosphaeridium pulcherrimum* (Deflandre and Cookson) Davey and Williams, 1966, whose processes have perforated terminal expansions with discontinuous, spinose rims and lack the longitudinal fibrils in the stalks. *Cordosphaeridium diktyoplokus* (Klumpp) Eisenack, 1963, is distinct in having a different arrangement of the processes, which have narrower and longer stalks and abruptly widening, foveate terminal expansions with spinulose rims.

Locality of figured specimens:

Pl. 54, fig. 1.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 54, fig. 2.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 55, fig. 1.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 55, fig. 2.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 55, fig. 3.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 54, fig. 1.	Slide No. 4-S-2-Micro. 122;	co-ord. 11.5/42.1.	
Pl. 54, fig. 2.	Slide No. 7-S-2-Micro. 76;	co-ord. 10/46.6.	
Pl. 55, fig. 1.	Slide No. 4-S-2-Micro. 121;	co-ord. 11.3/45.2.	
Pl. 55, fig. 2.	Slide No. 7-S-2-Micro. 103;	co-ord. 10.8/44.	
Pl. 55, fig. 3.	Slide No. 5-S-3(2);	co-ord. 15/65.6.	

Oligosphaeridium diastema n. sp.

Plate 55, figures 4, 5; plate 56, figures 1, 2

Description: Central body ovoidal, bearing 9 to 11 long processes; reflected tabulation not clear; processes concentrated in the apical and antapical regions and separated by a wide, smooth cingular zone (diastema) without processes; stalks of the processes long, smooth, cylindrical, and 3 to 6 microns wide; processes hollow and widening distally into 8- to 18-micron wide terminal expansions; rim of the terminal expansions entire and usually without spines; length of the processes from 1/2 to 3/4 of the length of the central body; archeopyle apical; wall of the central body double layered and smooth.

Size range: Total length of the test, including the processes (7 specimens) 72(87)96 microns. Holotype 96 microns.
Length of the central body (7 specimens) 38(44)48 microns. Holotype 48 microns.
Breadth of the central body (4 specimens) 29(34)38 microns. Holotype 36 microns.
Length of the processes (7 specimens) 19(26)36 microns. Holotype 30 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Oligosphaeridium diastema* n. sp. is characterized by a wide cingular zone without processes (i.e. diastema) and few (9 to 11), long, cylindrical processes whose terminal expansions usually lack spines.

The arrangement and the number of the processes in *O. diastema* n. sp. differs from that of the genus. However, this species has been tentatively assigned here to the genus *Oligosphaeridium* because of the absence of cingular processes.

The specific name is derived from "*diastema*" (a space, gap) and refers to the wide cingular zone which lacks processes.

Type locality:

Holotype: Pl. 55, fig. 4.	Sample No. 2-S-10;	lower Shaftesbury Fm.	Sec. 2.
Paratype: Pl. 55, fig. 5.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Sec. 3.
Paratypes: Pl. 56, figs. 1,2.	Sample No. 2-S-7;	lower Shaftesbury Fm.	Sec. 2.
Holotype: Pl. 55, fig. 4.	Slide No. 2-S-10(1);	co-ord. 8.1/36.	
Paratype: Pl. 55, fig. 5.	Slide No. 3-S-5-Micro. 141;	co-ord. 10.1/49.9.	
Paratype: Pl. 56, fig. 1.	Slide No. 2-S-7-Micro. 165;	co-ord. 11.9/44.	
Paratype: Pl. 56, fig. 2.	Slide No. 2-S-7-Micro. 161;	co-ord. 13/45.	

Oligosphaeridium prolixispinosum Davey and Williams, 1966

Plate 56, figures 3, 4

1966 *Oligosphaeridium prolixispinosum* Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 76, pl. 8, figs. 2, 3.

Description: Central body elongate oval, bearing 16 to 18 long processes; reflected tabulation not clear; 6 precingular, 6 postcingular, 3 antapical, 1 sulcal, and an indefinite number of apical processes usually present; stalks of the processes long, smooth, tubular, and slightly tapering; bases of the processes 5 to 6 microns wide; stalks about 2 microns wide, tapering to 1 micron distally before giving rise to delicate, filiform, and recurved spines; spines 5 to 8 in number, up to 10 microns in length, and arranged in a circle around the distal opening of the processes; length of the processes from approximately 1/2 to 2/3 of the length of the central body; cingular zone without processes, and marked by a wide, smooth area (diastema); archeopyle apical; wall of the central body double layered and smooth.

Size range: Total length of the test, including the processes (11 specimens) 60(78)115 microns.
Length of the central body (11 specimens) 30(43)60 microns.
Breadth of the central body (11 specimens) 21(30)43 microns.
Length of the processes (10 specimens) 14(22)36 microns.

Distribution: Middle Albian to Cenomanian. Harmon Member and lower Shaftesbury Formation of the Peace River area; Cenomanian of England (Davey and Williams *in* Davey *et al.*, 1966; Davey, 1969).

Remarks: *Oligosphaeridium prolixispinosum* is characterized by its elongate oval central body, a wide cingular zone without processes (i.e. diastema), and long, tubular, narrow, and tapering processes, which give rise distally to long, filiform, and recurved spines.

The presence of three antapical processes, and the arrangement of processes on the central body in *O. prolixispinosum* are contrary to the arrangement of processes specified for the genus. However, this species has been tentatively assigned to the genus *Oligosphaeridium* by Davey and Williams (*in* Davey *et al.*, 1966), because of the absence of cingular processes.

Locality of figured specimens:

Pl. 56, fig. 3.	Sample No. 6-H- 6;	Harmon Member.	Section 6.
Pl. 56, fig. 4.	Sample No. 6-H-3;	Harmon Member.	Section 6.
Pl. 56, fig. 3.	Slide No. 6-H- 6-Micro. 85;	co-ord. 11.1/43.8.	
Pl. 56, fig. 4.	Slide No. 6-H-3(1);	co-ord. 8.8/43.8.	

Oligosphaeridium pulcherrimum (Deflandre and Cookson) Davey and Williams, 1966

Plate 56, figure 5

1955 *Hystrichosphaeridium pulcherrimum* Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 270, pl. 1, fig. 8, text-figs. 21, 22.

1966 *Oligosphaeridium pulcherrimum* (Deflandre and Cookson) Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 75, pl. 10, fig. 9, pl. 11, fig. 5.

Description: Central body subspherical, bearing 18 long processes; reflected tabulation as specified for the genus; one process occupying the center of each reflected plate area; stalks of the processes long, smooth, cylindrical, and 2 to 10 microns wide; processes widening distally into 15- to 36-micron wide terminal expansions; terminal expansion of each process having perforated to reticulate wall with spinose and often discontinuous rim; apical processes relatively small; length of the processes from approximately 1/2 to 4/5 of the diameter of the central body; cingular zone without processes; archeopyle apical; wall of the central body double layered and smooth.

FIGURE 56. Oligosphaeridium pulcherrimum *(Deflandre and Cookson) Davey and Williams. Structure of a process.*

Size range: Maximum dimension of the test, including the processes (19 specimens) 84(115)156 microns.
Diameter of the central body (19 specimens) 43(56)65 microns.
Length of the processes (19 specimens) 19(34)53 microns.

Distribution: Early Cretaceous to early Eocene. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; Cenomanian to Coniacian of Alabama, U.S.A. (Leopold and Pakiser, 1964); early Eocene (Davey and Williams *in* Davey *et al.*, 1966), Cenomanian to Coniacian (Clarke and Verdier, 1967) of England; Cretaceous of France (Valensi, 1955); "Wealden" of Belgium (Delcourt and Sprumont, 1957); Lower Cretaceous of Australia (Deflandre and Cookson, 1955).

Locality of figured specimen:

Pl. 56, fig. 5. Sample No. 6-H-7; Harmon Member. Section 6.
Pl. 56, fig. 5. Slide No. 6-H-7-Micro. 12; co-ord. 11.1/46.

Oligosphaeridium sp.

Plate 56, figure 6

Description: Central body spherical, bearing about 18 processes; reflected tabulation as specified for the genus; stalks of the processes short, cylindrical, from 2 to 4 microns wide, and progressively widening distally into 8- to 14-micron wide terminal expansions; rim of the processes bearing 2- to 4-micron long, recurved spines; length of the processes from 1/2 to 2/3 of the diameter of the central body; cingular zone without processes; archeopyle apical; wall of the central body double layered and smooth.

Size range: Maximum dimension of the test, including the processes (1 specimen) 60 microns.
Diameter of the central body (1 specimen) 28 microns.
Length of the processes (1 specimen) 14(16)18 microns.

Distribution: Late Albian. A single specimen was found in the lower Shaftesbury Formation of the Peace River area.

Remarks: *Oligosphaeridium* sp. differs from *Oligosphaeridium complex* (White) Davey and Williams, 1966, in possessing shorter and wider processes with simple spines on the rim, and in being smaller.

Locality of figured specimen:

Pl. 56, fig. 6. Sample No. 2-S-7; lower Shaftesbury Formation. Section 2.
Pl. 56, fig. 6. Slide No. 2-S-7(1); co-ord. 2.2/76.2.

Genus **Polystephanephorus** Sarjeant, 1961

Type species **Polystephanephorus calathus** (Sarjeant) Sarjeant, 1961

See Norris and Sarjeant (1965, p. 50) for generic diagnosis.

Remarks: The genus *Polystephanephorus* consists of spherical fossil

dinoflagellate cysts having strand-like processes arranged in circles or polygons and connected together at their tips by a trabecula forming a ring. Each group of processes has the appearance of an open-walled, open-ended tube. The groups of processes thus formed are arranged in a set pattern on the central body.

Polystephanephorus can be easily distinguished from *Systematophora* Klement, 1960, which lacks the ring trabeculae joining the tips of the processes. The genus *Cannosphaeropsis* O. Wetzel, 1932, is distinct in having lateral trabeculae which connect the groups of processes to each other.

Polystephanephorus sp. cf. **P. urnaformis** (Cookson) Sarjeant, 1961

Plate 57, figures 1, 2

Description: Central body oval, granulate, and yellowish brown in color; body bearing about 14 short, broad, radially arranged, vase-shaped processes; 8 processes on one surface and 6 on the opposite surface; width of the processes at the base about half of their width at the rim; wall of the processes perforated and finely fibrous; perforations round and 0.5 to 2 microns in diameter; processes thickened at the base; rim of the processes entire and slightly fluted.

Size range: Total length of the test, including the processes (1 specimen) 75 microns.
Total breadth of the test, including the processes (1 specimen) 62 microns.
Length of the body (1 specimen) 52 microns.
Breadth of the body (1 specimen) 46 microns.
Length of the processes (1 specimen) 8 to 10 microns.
Width of the processes at the rim (1 specimen) 20 to 30 microns.
Width of the processes at the base (1 specimen) 12 to 14 microns.

Distribution: Late Albian. A single specimen was found in the lower Shaftesbury Formation of the Peace River area.

Remarks: The specimen described above differs from *Polystephanephorus urnaformis* (Cookson) Sarjeant, 1961, in having shorter processes which are narrower at the base. It also differs in having small, round perforations in the wall of the processes producing a fine-meshed network. This specimen has been compared here to *P. urnaformis* because of its vase-shaped processes.

Locality of figured specimen:

Pl. 57, figs. 1,2. Sample No. 7-S-2; lower Shaftesbury Formation. Section 7.
Pl. 57, figs. 1,2. Slide No. 7-S-2(1); co-ord. 21/35.6.

Genus **Prolixosphaeridium** Davey, Downie, Sarjeant and Williams, 1966

Type species **Prolixosphaeridium deirense** Davey, Downie, Sarjeant and Williams, 1966

See Davey, Downie, Sarjeant and Williams (1966, p. 171) for generic diagnosis.

Remarks: The genus *Prolixosphaeridium* consists of fossil dinoflagellate cysts with an elongate oval to ellipsoidal body, more than 30 processes arranged in rows encircling the body, and granulate, spinulose or smooth surface. The rows of processes are slightly offset at a position corresponding to the sulcus. The processes are closed proximally, closed or open distally, and have pointed, flaring or slightly furcate tips. The archeopyle is apical. The body has one or two antapical processes.

Prolixosphaeridium capitatum (Cookson and Eisenack) n. comb.

Plate 57, figure 3

1960 *Hystrichosphaeridium capitatum* Cookson and Eisenack, Palaeont., vol. 2, p. 252, pl. 39, fig. 9.

Description: Central body elongate oval, yellow in color, and densely covered with short, solid, equal processes having capitate tips and slightly expanded bases; archeopyle apical, marked by a rupture at one end of the body; wall of the central body thin and granulate; length of the processes from 1/9 to 1/7 of the breadth of the central body.

Size range: Total length of the test, including the processes (1 specimen) 65 microns.
Total breadth of the test, including the processes (1 specimen) 35 microns.
Length of the central body (1 specimen) 58 microns.
Breadth of the central body (1 specimen) 28 microns.
Length of the processes (1 specimen) 3 to 4 microns.

Distribution: Oxfordian to Albian. A single specimen was found in the lower Shaftesbury Formation of the Peace River area; Oxfordian to Kimmeridgian of Western Australia (Cookson and Eisenack, 1960).

Remarks: This species is here assigned to the genus *Prolixosphaeridium* because of its elongate central body, large number of short, narrow, capitate processes, and apical archeopyle. However, the antapical processes, linear arrangement of the processes, and sulcus, which constitute a part of the generic characteristics, are not clearly discernible, and the apical archeopyle is marked by a rupture rather than a complete removal of the apical area.

Locality of figured specimen:

Pl. 57, fig. 3. Sample No. 3 - S - 4; lower Shaftesbury Formation. Section 3.
Pl. 57, fig. 3. Slide No. 3 - S - 4 - Micro. 151; co-ord. 12.5/45.

Prolixosphaeridium sp.

Plate 57, figures 4-6

Description: Central body elongate oval, light brown in color, and bearing about 65 hollow processes; processes about 1.5 microns wide, and closed proximally as well as distally; processes with blunt to slightly swollen tips and abruptly widening bases; archeopyle apical, marked by a rupture at one end of the body; wall of the central body about 2 microns thick; surface of body finely granulate; length of the processes about 1/2 of the breadth of the central body.

Size range: Total length of the test, including the processes (1 specimen) 46 microns.
Total breadth of the test, including the processes (1 specimen) 38 microns.
Length of the central body (1 specimen) 38 microns.
Breadth of the central body (1 specimen) 22 microns.
Length of the processes (1 specimen) 6 to 11 microns.

Distribution: Middle Albian. A single specimen was found in the Loon River Formation of the Peace River area.

Remarks: In *Prolixosphaeridium* sp. the antapical processes, linear arrangement of the processes, and sulcus are not clearly discernible. Also, the apical archeopyle is marked by a rupture rather than a complete removal of the apical area.

Prolixosphaeridium sp. resembles *Prolixosphaeridium mixtispinosum* (Klement, 1960) and *Prolixosphaeridium deirense* Davey, Downie, Sarjeant and Williams, 1966, in having a large number of processes, but lacks the hairy to spinulose surface ornamentation characteristic of these two species. *Prolixosphaeridium granulosum* (Deflandre) Davey, Downie, Sarjeant and Williams, 1966, differs from *Prolixosphaeridium* sp. in having fewer (20 to 30), considerably longer, sharply pointed processes. *Prolixosphaeridium parvispinum* (Deflandre, 1937) is distinct in possessing very short, conical, sharply pointed spines. *Prolixosphaeridium* sp. differs from all other described species of the genus in having a very thick wall.

Locality of figured specimen:

Pl. 57, figs. 4-6.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 57, figs. 4-6.	Slide No. 8-L-9(3);	co-ord. 21.1/76.9.	

Genus **Tanyosphaeridium** Davey and Williams, 1966

Type species **Tanyosphaeridium variecalamum** Davey and Williams, 1966

See Davey and Williams (*in* Davey *et al.*, 1966, p. 98) for generic diagnosis.

Remarks: The genus *Tanyosphaeridium* consists of fossil dinoflagellate cysts having an elongate-oval central body bearing numerous, long, tubular, and distally open processes. The processes are arranged in a more or less regular circular manner around the central body. The number of processes is variable, and usually one or two (occasionally three) processes occupy each reflected plate area. The archeopyle is apical and is formed by the detachment of the whole apical region. The wall of the central body is double layered. The outer layer covers the central body and forms the processes. Thus, the processes do not open proximally into the inner cavity of the central body.

The genus *Tanyosphaeridium* differs from *Prolixosphaeridium* Davey, Downie, Sarjeant and Williams, 1966, in possessing long, tubular, and distally open processes and in lacking elongate antapical processes and a sulcus.

Tanyosphaeridium sp.

Plate 57, figure 7

Description: Central body elongate oval, bearing between 20 and 30 long, tubular, distally open processes; processes 1.8 microns wide, with slightly expanded (buccinate), 4-micron wide, smooth extremities; processes arranged in a circular manner around the central body; archeopyle apical, formed by the detachment of the apical region; length of the processes about 1/2 of the breadth of the central body; central body double layered; outer layer granular.

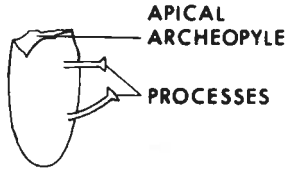

FIGURE 57. Tanyosphaeridium *sp. A specimen showing the structure of processes.*

Size range: Total length of the test, including the processes (2 specimens) 50(56)62 microns.
Total breadth of the test, including the processes (2 specimens) 38(40.5)43 microns.
Length of the central body (2 specimens) 40(41.5)43 microns.
Breadth of the central body (2 specimens) 21(22.5)24 microns.
Length of the processes (2 specimens) 10(11.5)13 microns.

Distribution: Middle and late Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Tanyosphaeridium* sp. closely resembles *Tanyosphaeridium isocalamus* (Deflandre and Cookson, 1955), but differs in possessing processes with slightly expanded (buccinate) extremities. It is distinct from *Tanyosphaeridium variecalamum* Davey and Williams, 1966, which has longer and slightly tapering processes with fairly broad bases, and from *Tanyosphaeridium regulare* Davey and Williams, 1966, which possesses a larger number of longer and thinner processes.

Locality of figured specimen:

Pl. 57, fig. 7. Sample No. 2-S-7; lower Shaftesbury Formation. Section 2.
Pl. 57, fig. 7. Slide No. 2-S-7(1); co-ord. 7/49.2.

Family **Exochosphaeridiaceae**

Genus **Exochosphaeridium** Davey, Downie, Sarjeant and Williams, 1966

Type species **Exochosphaeridium phragmites** Davey, Downie, Sarjeant and Williams, 1966

See Davey, Downie, Sarjeant and Williams (1966, p. 165) for generic diagnosis.

Remarks: The genus *Exochosphaeridium* consists of fossil dinoflagellate cysts having a subspherical body bearing numerous, simple, closed processes. The apical process is longer than the other processes and is irregularly branched. The archeopyle is precingular. Occasionally the cingulum is marked by two parallel rows of processes.

The genus *Trichodinium* Eisenack and Cookson, 1960, resembles *Exochosphaeridium*, but differs in having a distinct cingulum, simple and short processes, and a short, solid, unbranched apical horn. The genus *Exochosphaeridium* differs from *Cometodinium* Deflandre and Courteville, 1939, in possessing an apical process.

Exochosphaeridium scitulum n. sp.

Plate 57, figures 8, 9

Description: Central body ovoid with a small elevation at one end marking the apex; apical process equal to other processes in length, but variable in shape (Fig. 58); apical process slightly thicker than other processes and with a trifurcate to bifurcate tip; central body bearing numerous (more than 100), simple, unbranched, hollow, spinose processes; rarely some processes fused to form wide membraneous projections and splitting into 2 to 4 pointed spines at their outer ends; bases of the processes expanded, confluent, forming a web-like pattern, and ornamented by very faint, converging striations; aligned processes faintly marking the parallel sides of the cingulum; cingular processes identical to other processes; archeopyle precingular; central body thin walled, smooth, and hyaline.

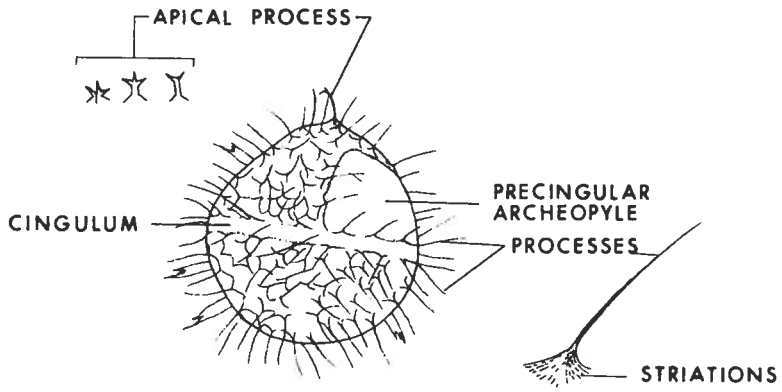

FIGURE 58. Exochosphaeridium scitulum *n. sp. Lateral view.*

Size range: Total diameter of the test, including the processes (7 specimens) 54(63)86 microns. Holotype 86 microns.
Diameter of the central body (7 specimens) 48(54)65 microns. Holotype 65 microns.
Length of the processes (7 specimens) 5(8)12 microns. Holotype 8 microns.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Remarks: *Exochosphaeridium scitulum* n. sp. is characterized by the web-like pattern formed by the confluent bases of the spinose processes. *Baltisphaeridium spinosum* (White) var. *deflandrei* Lejeune-Carpentier, 1941, resembles *E. scitulum*

n. sp., but differs in having smaller body (36 to 49 microns), longer processes (14 to 21 microns), more prominent network on the body, and in lacking an archeopyle and cingulum.

The specific name is derived from "*scitulum*" (handsome).

Type locality:

Holotype: Pl. 57, fig. 8.	Sample No. 6-H- 6;	Harmon Member.	Section 6.
Paratype: Pl. 57, fig. 9.	Sample No. 7-H- 4;	Harmon Member.	Section 7.
Holotype: Pl. 57, fig. 8.	Slide No. 6-H- 6(1);	co-ord. 13.8/68.	
Paratype: Pl. 57, fig. 9.	Slide No. 7-H- 4(2);	co-ord. 3.2/73.1.	

Family **Areoligeraceae**

Genus **Cyclonephelium** Deflandre and Cookson, 1955,
emend. Cookson and Eisenack, 1962

Type species **Cyclonephelium compactum** Deflandre and Cookson, 1955

See Norris and Sarjeant (1965, p. 22) for generic diagnosis.

Remarks: The genus *Cyclonephelium*, as emended by Cookson and Eisenack (1962a), consists of fossil dinoflagellate cysts having a circular to slightly oval outline, poorly developed or imperceptible apical and antapical prominences, an apical archeopyle, and an ornamentation, which is restricted to the circumferential zone, surrounding a smooth inner area. The ornamentation consists of processes which are distinct or more or less confluent, membranes supported at intervals by strong processes, and densely arranged surface thickenings.

Cyclonephelium distinctum Deflandre and Cookson, 1955

Plate 57, figures 10-12

1955 *Cyclonephelium distinctum* Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 285, pl. 2, fig. 14.

1961 *Circulodinium deflandrei* Alberti, Palaeontographica, Band 116, Abt. A, p. 29, pl. 4, figs. 7-13.

See Clarke and Verdier (1967, p. 22) for detailed synonymy.

Description: Test flat with circular to slightly oval outline and reduced apical and antapical prominences; antapex usually rounded; archeopyle apical; circumferential zone of the body ornamented by 2- to 6-micron long, narrow processes with blunt, capitate or bifid tips; processes often fused with one another near their bases, forming short lamellae, but remaining free at their distal ends; inner smooth area 25 to 35 microns wide; body wall thin.

Size range: Total length of the test, including the processes (22 specimens) 60(74)84 microns.
Total breadth of the test, including the processes (22 specimens) 50(64)78 microns.

Distribution: Valanginian to Danian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; Cenomanian of Saskatchewan, Canada (Davey, 1969); early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); Danian of California, U.S.A. (Drugg, 1967); Cenomanian (Davey, 1969), Cenomanian to late Campanian (Clarke and Verdier, 1967) of England; Valanginian to Hauterivian (Gocht, 1959), Hauterivian to Albian (Alberti, 1961) of Germany; Albian of Rumania (Baltes, 1967a); Hauterivian of Switzerland (Millioud, 1967); Senonian (Deflandre and Cookson, 1955), Albian to Senonian (Cookson and Eisenack, 1962a) of Western Australia.

Remarks: The specimens of *Cyclonephelium distinctum* described in the present study are thin walled and have poorly developed, short, fragile processes. However, they seem to fall within the range of variation of this species.

Locality of figured specimens:

Pl. 57, figs. 10-12.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 57, fig. 10.	Slide No. 8-L-7(2);	co-ord. 19/70.	
Pl. 57, fig. 11.	Slide No. 8-L-7-Micro. 18;	co-ord. 10.8/41.1.	
Pl. 57, fig. 12.	Slide No. 8-L-7-Micro. 20;	co-ord. 11.7/42.7.	

Family **Hystrichosphaeraceae**

Genus **Hystrichosphaera** O. Wetzel, 1933, emend. Davey and Williams, 1966[1]

Type species **Hystrichosphaera ramosa** (Ehrenberg) O. Wetzel, 1933

[1] While the manuscript was in press the International Association for Plant Taxonomy rejected the name *Hystrichosphaera* as a junior synonym of the generic name *Spiniferites* Mantell, 1850 (see Sarjeant, 1970).

See Davey and Williams (*in* Davey *et al.*, 1966, p. 29) for emended generic diagnosis.

Remarks: Davey and Williams (*in* Davey *et al.*, 1966) emended the genus *Hystrichosphaera* to accommodate fossil dinoflagellate cysts having a subspherical or ovoidal central body with a clearly defined reflected tabulation of 3 - 4', 6", 6c, 5"', 0-1p, 1"", laevo-rotatory cingulum, sulcus, variably developed sutural crests, and gonal and sutural processes. The processes are open or closed, solid or hollow, simple or branching, and of variable length. The apex is often marked by an elongate process. The archeopyle is precingular and formed by the loss of reflected plate 3". The central body wall is double layered.

O. Wetzel (1933, p. 33) designated *Hystrichosphaera furcata* (Ehrenberg) O. Wetzel, 1933, and *Hystrichosphaera ramosa* as joint type species of his new genus *Hystrichosphaera.* The writer is in agreement with the arguments presented by Davey and Williams (*in* Davey *et al.*, 1966, p. 32) for the transfer of *H. furcata* to *H. ramosa* and the acceptance of *H. ramosa* as the type species.

Hystrichosphaera ramosa (Ehrenberg) O. Wetzel, 1933,
var. **ramosa** Davey and Williams, 1966

Plate 57, figure 13; plate 58, figures 1-5

1838 *Xanthidium ramosum* Ehrenberg, Abhandl. Kön. Akad. Wiss. (Berlin), pt. 1, p. 109-136, pl. 1, fig. 15, no. 1-5.

1838 *Xanthidium furcatum* Ehrenberg, Abhandl. Kön. Akad. Wiss. (Berlin), pt. 1, p. 109-136, pl. 1, figs. 12, 14.

1933 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel, Palaeontographica, Band 78, Abt. A, p. 35, pl. 5, figs. 7, 8, 10-12, 18, 19.

1933 *Hystrichosphaera furcata* (Ehrenberg) O. Wetzel, Palaeontographica, Band 78, Abt. A, p. 34, pl. 2, figs. 35a, b, pl. 5, figs. 1, 9, 15, 16.

1966 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *ramosa* Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 33, pl. 1, figs. 1, 6, pl. 3, fig. 1, text-fig. 8.

See Davey and Williams (*in* Davey *et al.*, 1966, p. 33) for detailed synonymy.

Description: Central body ovoidal, bearing gonal and rarely a few sutural processes; process bases joined by low sutural crests; reflected tabulation as specified for the genus; cingulum laevo-rotatory; sulcus distinct, wider on the

ventral hypotract; archeopyle precingular, trapezoid in shape, and formed by the loss of the reflected plate 3"; gonal processes triangular in cross section and trifurcate distally; process branches usually with bifid tips; processes tapering and closed distally; length of the processes variable; wall of the central body smooth, thin, and double layered.

FIGURE 59. Hystrichosphaera ramosa *(Ehrenberg) O. Wetzel var.* ramosa *Davey and Williams. Structure of processes.*

Size range: Maximum dimension of the test, including the processes (16 specimens) 60(75)96 microns.
Length of the central body (15 specimens) 45(51)64 microns.
Breadth of the central body (7 specimens) 40(46)52 microns.
Length of the processes (15 specimens) 8(15)22 microns.

Distribution: Oxfordian to early Eocene. Widespread in various parts of the world, including Western Canada.

Remarks: *Hystrichosphaera ramosa* var. *ramosa* is characterized by the form of its processes, and the absence or scarcity of sutural processes.

Locality of figured specimens:

Pl. 57, fig. 13.	Sample No. 7-S-2;	lower Shaftesbury Fm.	Section 7.
Pl. 58, figs. 1,2,4,5.	Sample No. 7-S-2;	lower Shaftesbury Fm.	Section 7.
Pl. 58, fig. 3.	Sample No. 5-S-3;	lower Shaftesbury Fm.	Section 5.
Pl. 57, fig. 13.	Slide No. 7-S-2-Micro. 74;	co-ord. 10.5/41.	
Pl. 58, fig. 1.	Slide No. 7-S-2(1);	co-ord. 17.5/33.	
Pl. 58, fig. 2.	Slide No. 7-S-2-Micro. 99;	co-ord. 13/41.2.	
Pl. 58, fig. 3.	Slide No. 5-S-3-Micro. 117;	co-ord. 9.8/42.9.	
Pl. 58, figs. 4,5.	Slide No. 7-S-2-Micro. 99;	co-ord. 10.5/45.5.	

Hystrichosphaera ramosa (Ehrenberg) O. Wetzel, 1933, var. **gracilis** Davey and Williams, 1966

Plate 58, figure 6

1955 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel–Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 263, pl. 5, fig. 8 only.

1963 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel– Górka, Acta Palaeontologica Polonica, vol. 8, p. 48, pl. 6, figs. 6, 7 only.

1966 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *gracilis* Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 34, pl. 1, fig. 5, pl. 5, fig. 6.

Description: Central body ovoidal, bearing long and slender gonal and sutural processes; process bases joined by low sutural crests; cingulum laevo-rotatory, faint; tabulation indistinct; gonal processes trifurcate; sutural processes bifurcate; process branches usually with trifurcate tips; length of the processes about 1/2 of the diameter of the central body; wall of the central body smooth, thin, and double layered.

Size range: Maximum dimension of the test, including the processes (3 specimens) 72(81)87 microns.
Length of the central body (3 specimens) 43(50)57 microns.
Breadth of the central body (2 specimens) 41(42)43 microns.
Length of the processes (3 specimens) 18(20)24 microns.

Distribution: Middle Albian to Miocene. Harmon Member of the Peace River area; Cenomanian of England (Davey and Williams *in* Davey *et al.*, 1966; Davey, 1969); Campanian of Poland (Górka, 1963); Miocene of Australia (Deflandre and Cookson, 1955).

Remarks: *Hystrichosphaera ramosa* var. *gracilis* is characterized by its long, slender gonal and sutural processes, and predominantly trifurcate branching of the gonal processes and smaller process branches.

Locality of figured specimen:

Pl. 58, fig. 6.	Sample No. 6-H- 6;	Harmon Member.	Section 6.
Pl. 58, fig. 6.	Slide No. 6-H- 6-Micro. 87;	co-ord. 11.5/43.	

Hystrichosphaera ramosa (Ehrenberg) O. Wetzel, 1933, var. **multibrevis** Davey and Williams, 1966

Plate 58, figures 7, 8

1955 *Hystrichosphaera furcata* (Ehrenberg) O. Wetzel–Valensi, Bull. Soc. Préhist. France, vol. 52, p. 586, pl. 4, fig. 4, pl. 5, fig. 12.

1958 *Hystrichosphaera furcata* (Ehrenberg) O. Wetzel–Eisenack, Neues Jahrb. Geol. Paläont., Abhandl., vol. 106, p. 406, pl. 25, figs. 4-8.

1966 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *multibrevis* Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 35, pl. 1, fig. 4, pl. 4, fig. 6, text-fig. 9.

Description: Central body ovoidal, bearing short, solid, gonal and sutural processes; process bases joined by low sutural crests; crests extending along gonal processes, making them subconical in shape; cingulum laevo-rotatory, faint; gonal processes trifurcate; sutural processes bifurcate; process branches usually with bifurcate tips; length of the processes less than 1/2 of the diameter of the central body; wall of the central body smooth and thin.

Size range: Maximum dimension of the test, including the processes (4 specimens) 48(58)70 microns.
Diameter of the central body (4 specimens) 38(40)42 microns.
Length of the processes (3 specimens) 7(11)14 microns.

Distribution: Hauterivian to early Eocene. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; late Albian of Saskatchewan, Canada (Davey, 1969); Cenomanian (Davey, 1969), Hauterivian to early Eocene (Davey and Williams *in* Davey *et al.*, 1966) of England; Upper Cretaceous of France (Valensi, 1955); late Aptian of Germany (Eisenack, 1958).

Remarks: *Hystrichosphaera ramosa* var. *multibrevis* is characterized by its short, subconical to rudimentary processes which are less than half the diameter of the central body in length.

Locality of figured specimens:

Pl. 58, fig. 7.	Sample No. 6-H-5;	Harmon Member.	Section 6.
Pl. 58, fig. 8.	Sample No. 5-S-3;	lower Shaftesbury Fm.	Section 5.
Pl. 58, fig. 7.	Slide No. 6-H-5(2);	co-ord. 4.2/32.	
Pl. 58, fig. 8.	Slide No. 5-S-3(1);	co-ord. 21/51.6.	

Hystrichosphaera cingulata (O. Wetzel) Deflandre and Cookson, 1955

Plate 59, figures 1-3

1933 *Cymatiosphaera cingulata* O. Wetzel, Palaeontographica, Band 78, Abt. A, p. 28, pl. 4, fig. 10.

1955 *Hystrichosphaera cingulata* (O. Wetzel) Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 267, pl. 6, figs. 4, 5.

See Clarke and Verdier (1967, p. 45) for detailed synonymy.

Description: Central body spherical to ovoidal, bearing up to 12-micron high sutural crests; gonal processes or thickenings not extending beyond the crests, and acting only as supporting structures; processes either simple or terminating with a small bifurcation; reflected tabulation as specified for the genus; cingulum laevo-rotatory; sulcus distinct; wall of the central body smooth, thin, and double layered.

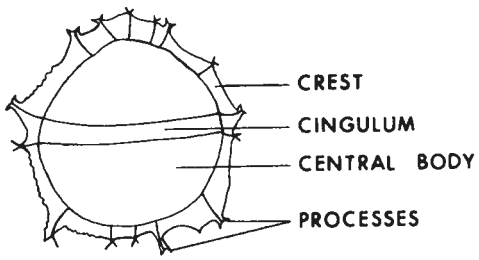

FIGURE 60. Hystrichosphaera cingulata *(O. Wetzel) Deflandre and Cookson. Dorsal view.*

Size range: Maximum dimension of the test, including the crests (12 specimens) 51(58)72 microns.
Length of the central body (7 specimens) 40(46)55 microns.
Breadth of the central body (6 specimens) 30(42)54 microns.
Height of the sutural crests (7 specimens) 7(9)12 microns.

Distribution: Albian to Pleistocene. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; Cenomanian (Davey and Williams *in* Davey *et al.*, 1966; Davey, 1969), Cenomanian to Santonian (Clarke and Verdier, 1967) of England; Senonian of Baltic region (O. Wetzel, 1933); Cenomanian and Maestrichtian of Poland (Górka, 1963); late Albian of Rumania (Baltes, 1967b); Pleistocene of eastern Mediterranean region (Rossignol, 1964); Eocene to Miocene of Australia (Deflandre and Cookson, 1955).

Remarks: *Hystrichosphaera cingulata* is characterized by high sutural crests beyond which the processes do not protrude. The processes are either simple or terminate with a small bifurcation.

Locality of figured specimen:

Pl. 59, figs. 1-3. Sample No. 3-S-4; lower Shaftesbury Formation. Section 3.
Pl. 59, figs. 1-3. Slide No. 3-S-4-Micro. 150; co-ord. 11/44.

Hystrichosphaera cingulata (O. Wetzel) Deflandre and Cookson, 1955, var. **reticulata** Davey and Williams, 1966

Plate 59, figure 4

1966 *Hystrichosphaera cingulata* (O. Wetzel) Deflandre and Cookson var. *reticulata* Davey and Williams, Bull. British Museum (Natural History), Geol., Suppl. no. 3, p. 39, pl. 1, fig. 10, pl. 2, fig. 4.

1967 *Hystrichosphaera cingulata* (O. Wetzel) Deflandre and Cookson var. *perforata* Clarke and Verdier, Verhandel. Koninkl. Nederlandse Akad. Wetenschap., Afdel. Natuurk., Eerste Reeks, Deel 24, no. 3, p. 46, pl. 9, figs. 2-4, text-fig. 19.

Description: Central body spherical to ovoidal, bearing up to 12-micron high sutural crests; gonal processes or thickenings not extending beyond the crests; processes either simple or terminating with a small bifurcation; reflected tabulation as specified for the genus; cingulum laevo-rotatory; sulcus distinct; wall of the central body double layered; inner layer smooth; outer layer finely reticulate with about 0.5-micron wide lumina.

Size range: Maximum dimension of the test, including the crests (1 specimen) 66 microns.
Length of the central body (1 specimen) 55 microns.
Breadth of the central body (1 specimen) 50 microns.
Height of the sutural crests (1 specimen) 12 microns.

Distribution: Middle Albian to Santonian. Harmon Member of the Peace River area; Cenomanian (Davey and Williams *in* Davey *et al.*, 1966; Davey, 1969), Cenomanian to Santonian (Clarke and Verdier, 1967) of England.

Remarks: This variety strongly resembles *Hystrichosphaera cingulata* (O. Wetzel) Deflandre and Cookson, 1955, but differs in having a central body which has a finely reticulate surface.

Locality of figured specimen:

Pl. 59, fig. 4.	Sample No. 7-H-3;	Harmon Member.	Section 7.
Pl. 59, fig. 4.	Slide No. 7-H-3(2);	co-ord. 6.8/46.9.	

Hystrichosphaera scabrosa Clarke and Verdier, 1967

Plate 59, figures 5-8; plate 60, figure 1

1967 *Hystrichosphaera scabrosa* Clarke and Verdier, Verhandel. Koninkl. Nederlandse Akad. Wetenschap., Afdel. Natuurk., Eerste Reeks, Deel 24, no. 3, p. 49, pl. 9, figs. 7-10, text-fig. 21.

Description: Central body ovoidal, bearing gonal and sutural processes; process bases joined by sutural crests; crests extending along gonal processes, making them subconical in shape; sutural crests usually quite high in the cingular and antapical regions giving rise to plate-like (taeniate), membraneous processes; reflected tabulation as specified for the genus; cingulum laevo-rotatory; sulcus distinct; gonal processes trifurcate; sutural processes bifurcate; process branches often with bifid tips; wall of the central body double layered; inner layer smooth; outer layer ornamented by about 0.5-micron wide, closely spaced granules and minute rugulae; crests and processes often ornamented by widely spaced scabrae.

Size range: Maximum dimension of the test, including the processes (6 specimens) 54(67)74 microns.
Length of the central body (6 specimens) 43(45)48 microns.
Breadth of the central body (2 specimens) 36(38)41 microns.
Length of the processes (6 specimens) 12(15)20 microns.

Distribution: Middle Albian to Santonian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; Cenomanian to Santonian of England (Clarke and Verdier, 1967).

Remarks: *Hystrichosphaera scabrosa* differs from *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel, 1933, var. *reticulata* Davey and Williams, 1966, which has a fine-meshed reticulate ornamentation. *Hystrichosphaera crassipellis* Deflandre and Cookson, 1955, is distinct in possessing an extremely thick-walled central body with a reticulate surface.

Locality of figured specimens:

Pl. 59, figs. 5-8.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 60, fig. 1.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 59, figs. 5,6.	Slide No. 8-L-9-Micro. 24;	co-ord. 11.1/45.1.	
Pl. 59, figs. 7,8.	Slide No. 8-L-9-Micro. 22;	co-ord. 10/41.	
Pl. 60, fig. 1.	Slide No. 8-L-9-Micro. 23;	co-ord. 12.2/44.6.	

Hystrichosphaera wetzeli Deflandre, 1935

Plate 60, figures 2,3

1933 *Hystrichosphaera* cf. *furcata* (Ehrenberg) O. Wetzel, Palaeontographica, Band 78, Abt. A, p. 35, pl. 5, fig. 13 only.

1935 *Hystrichosphaera wetzeli* Deflandre, Bull. Biologique France et Belge., vol. 69, p. 232, pl. 8, fig. 5.

Description: Central body ovoidal, bearing up to 24-micron high sutural crests; antapical region with the highest, wing-like crest oriented parallel to the long axis of the body; gonal processes or thickenings not extending beyond the crests; processes either pointed or branched into short spinules at the tip; cingulum laevo-rotatory; wall of the central body smooth, thin, and double layered.

Size range: Total length of the test, including the crests (9 specimens) 60(71)84 microns.
Total breadth of the test, including the crests (9 specimens) 48(60)70 microns.
Length of the central body (7 specimens) 36(44)57 microns.
Breadth of the central body (7 specimens) 35(37)43 microns.
Height of the sutural crests (7 specimens) 12(18)24 microns.

Distribution: Cretaceous. Harmon Member and lower Shaftesbury Formation of the Peace River area; Senonian of France (Deflandre, 1935, 1937); Senonian of Baltic region (O. Wetzel, 1933); Lower Cretaceous of Australia (Deflandre and Cookson, 1955).

Remarks: *Hystrichosphaera wetzeli* is characterized by a high, wing-like sutural crest in the antapical region.

Locality of figured specimens:

Pl. 60, fig. 2.	Sample No. 6-H-3;	Harmon Member.	Section 6.
Pl. 60, fig. 3.	Sample No. 6-H- 4;	Harmon Member.	Section 6.
Pl. 60, fig. 2.	Slide No. 6-H-3(1);	co-ord. 6.2/32.1.	
Pl. 60, fig. 3.	Slide No. 6-H- 4(1);	co-ord. 21.4/41.	

Genus **Pterodinium** Eisenack, 1958

Type species **Pterodinium aliferum** Eisenack, 1958

See Norris and Sarjeant (1965, p. 52) for generic diagnosis.

Remarks: The genus *Pterodinium* contains fossil dinoflagellate cysts having a tabulate body with wing-like, high sutural crests marking the boundaries of the plates. The cingulum is laevo-rotatory and a distinct sulcus is present on the ventral epitract and hypotract. The archeopyle is precingular (Evitt, 1961, p. 402). A short apical horn may be developed.

The tabulation of *Pterodinium* is similar to that of *Hystrichosphaera* O. Wetzel, 1933, and the two genera seem to be closely related. However, *Pterodinium* differs in having wing-like, high sutural crests without distinct processes. The genus *Heslertonia* Sarjeant, 1966, closely resembles *Pterodinium* but probably has a different tabulation.

Pterodinium cornutum Cookson and Eisenack, 1962

Plate 60, figures 4, 5

1962a *Pterodinium cornutum* Cookson and Eisenack, Micropaleont., vol. 8, p. 490, pl. 3, figs. 1-6.

Description: Test with a flat ventral and an arched dorsal surface; body oval, tabulate, with wing-like, up to 12-micron high sutural crests; crests membraneous, smooth to finely serrate, and forming a 10-micron high, narrow apical horn; tabulation ?3', 6", 6"', 1"", not clear in the apical region and within the cingular furrow; cingulum laevo-rotatory, bordered by high crests; sulcus wide, present on ventral hypotract and epitract; archeopyle precingular; body dark, finely granular, and about 0.8 micron thick.

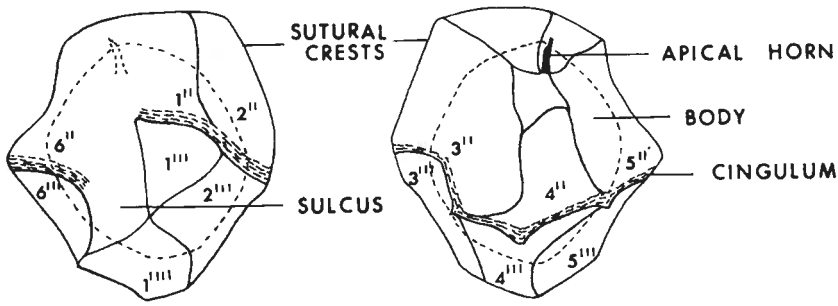

FIGURE 61. Pterodinium cornutum *Cookson and Eisenack. 1. Tabulation on the ventral surface. 2. Tabulation on the dorsal surface.*

Size range: Total length of the test, including the crests (2 specimens) 84(85)86 microns.
Total breadth of the test, including the crests (2 specimens) 74(75)76 microns.

Length of the body (2 specimens) 62(63)65 microns.
Breadth of the body (2 specimens) 54(56)58 microns.

Distribution: Aptian and Albian. Harmon and Cadotte Members of the Peace River area; Aptian and Albian of Rumania (Baltes, 1965); Aptian and Albian? of Western Australia (Cookson and Eisenack, 1962a).

Remarks: The illustrated specimen is slightly tilted so that the apex and the apical horn are inclined forward in the dorsal view (Pl. 60, Fig. 5). However, the short apical horn, smooth to finely serrate crest edges, and the tabulation characteristic of *Pterodinium cornutum* can be distinguished on the illustrated specimen.

Locality of figured specimen:

Pl. 60, figs. 4,5.	Sample No. 7-C-3;	Cadotte Member.	Section 7.
Pl. 60, figs. 4,5.	Slide No. 7-C-3(1);	co-ord. 21.2/75.8.	

Pterodinium reticulatum n. sp.

Plate 60, figures 6, 7

Description: Test dorsoventrally oriented; body oval, tabulate, with wing-like, up to 16-micron high sutural crests; crests membraneous, coarsely serrate, with 3- to 4-micron high spines at the points of junction; tabulation not clear; a large antapical plate (1'''') clearly outlined; cingulum laevo-rotatory, bordered by low crests; sulcus present on ventral hypotract and epitract; archeopyle precingular, quadrangular in outline, and formed by the loss of plate 3''; body finely reticulate with thin muri and 0.5- to 1.5-micron wide lumina; body wall about 1 micron thick.

Size range: Total length of the test, including the crests (4 specimens) 92(100)105 microns. Holotype 105 microns.
Total breadth of the test, including the crests (4 specimens) 70(78)88 microns. Holotype 88 microns.
Length of the body (4 specimens) 70(73)76 microns. Holotype 76 microns.
Breadth of the body (4 specimens) 63(67)70 microns. Holotype 70 microns.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Remarks: *Pterodinium reticulatum* n. sp. can be easily distinguished from *Pterodinium magnoserratum* Cookson and Eisenack, 1962, which has a smooth body and bifurcate projections at the points of junction of the crests.

The specific name is derived from "*reticulatum*" (net-like) and refers to the reticulate ornamentation of the body.

Type locality:

Holotype: Pl. 60, figs. 6,7. Sample No. 6-H- 4; Harmon Member. Section 6.
Holotype: Pl. 60, figs. 6,7. Slide No. 6-H- 4(2); co-ord. 15/52.2.

Family **Deflandreaceae**

Genus **Deflandrea** Eisenack, 1938, emend. Williams and Downie, 1966

Type species **Deflandrea phosphoritica** Eisenack, 1938

See Williams and Downie (*in* Davey *et al.*, 1966, p. 231) for emended generic diagnosis.

Remarks: The genus *Deflandrea* consists of fossil dinoflagellate cysts having an elongated pentagonal (often somewhat rounded to rhomboidal) body with one apical and two antapical horns, a circular cingulum, a spherical to ovoid capsule, and an intercalary archeopyle. The body is smooth or with a faint peridinoid tabulation. A sulcus, if present, is usually restricted to the ventral hypotract. The surface of the outer wall is smooth, granular or spinulose.

The genus *Spinidinium* Cookson and Eisenack, 1962, closely resembles *Deflandrea*. According to Stanley (1965, p. 226), the inner layer of wall in *Spinidinium* can be interpreted as the wall of a large capsule which almost completely fills the body cavity. Thus, *Spinidinium* can be distinguished from *Deflandrea* by its large capsule almost filling the body cavity and its heavy surface ornamentation consisting of short spines. *Rhombodinium* Gocht, 1955, and *Wetzeliella* Eisenack, 1938, differ from *Deflandrea* in possessing lateral horns.

Deflandrea limpida n. sp.

Plate 61, figures 1-12

Description: Test dorsoventrally compressed with elongated pentagonal outline; epitract conical with a blunt apex representing the apical horn; hypotract with a wide-based, pointed, reduced antapical horn on the left side and a rudimentary one, often marked by a small bulge, on the right side; body with a thin-walled capsule; capsule spherical, smooth, hyaline, and filling the body cavity laterally; capsule almost imperceptible in some specimens; tabulation on the outer body wall faint; plates outlined by the breakdown of sutures and by rows of

spinules and pila bordering the plates; tabulation pattern typically peridinoid (?4', 3a, 7", 5"', 2""); cingulum circular, bordered on either side by a ridge bearing spinules and pila, and dividing the test into a larger epitract and smaller hypotract; sulcus 12 to 15 microns wide, delimited on the ventral hypotract by two longitudinal ridges bearing spinules and pila, and on the epitract by two longitudinal rows of spinules and pila; archeopyle intercalary, hexagonal, formed by the loss of plate 2a; operculum often in position; outer wall ornamented by 0.5- to 1.5-micron long, conical spinules, short blunt rods, and round-headed pila; spinules and pila forming a circlet at the apex, bordering the plates, cingulum, and sulcus, and also occurring on the plates; outer wall membraneous and less than 0.5 micron thick.

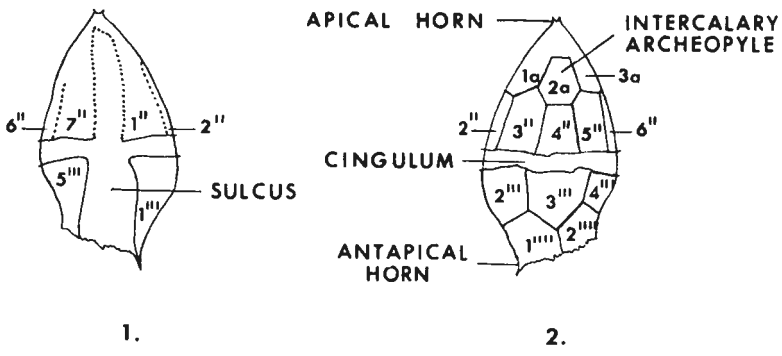

FIGURE 62. Deflandrea limpida *n. sp. 1. Tabulation on the ventral surface. 2. Tabulation on the dorsal surface.*

Size range: Total length of the test, including the horns (38 specimens) 43(61)75 microns. Holotype 72 microns.
Total breadth of the test (35 specimens) 33(43)50 microns. Holotype 41 microns.
Length of the capsule (9 specimens) 24(32)36 microns. Holotype 36 microns.
Breadth of the capsule (9 specimens) 32(38)42 microns. Holotype 40 microns.

Distribution: Middle and late Albian. Cadotte and Paddy Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Deflandrea limpida* n. sp. is characterized by a very hyaline capsule which is almost imperceptible in unstained specimens.

Deflandrea echinoidea Cookson and Eisenack, 1960, resembles *D. limpida*

n. sp., but differs in having a more circular outline, a prominently developed antapical horn, up to 5-micron long, randomly distributed, stiff spines, a sulcus restricted to the ventral hypotract, and a nontabulate body. *Deflandrea sverdrupiana* Manum, 1962, can be easily distinguished from *D. limpida* n. sp. in possessing a broken cingulum, and a prominently developed antapical horn.

The species name has been derived from "*limpida*" (clear, transparent) and refers to the hyaline capsule.

Type locality:

Holotype: Pl. 61, figs. 1,2.	Sample No. 3-S- 4; lower Shaftesbury Fm. Sec. 3.	
Paratypes: Pl. 61, figs. 3-6,11,12.	Sample No. 3-S-5; lower Shaftesbury Fm. Sec. 3.	
Paratypes: Pl. 61, figs. 7-10.	Sample No. 4-S-2; lower Shaftesbury Fm. Sec. 4.	
Holotype: Pl. 61, figs. 1,2.	Slide No. 3-S- 4-Micro. 149;	co-ord. 10.5/42.7.
Paratype: Pl. 61, figs. 3,4.	Slide No. 3-S-5-Micro. 143;	co-ord. 11.2/43.9.
Paratype: Pl. 61, figs. 5,6.	Slide No. 3-S-5-Micro. 130;	co-ord. 13.1/44.8.
Paratype: Pl. 61, figs. 7,8.	Slide No. 4-S-2(1);	co-ord. 16.6/39.1.
Paratype: Pl. 61, figs. 9,10.	Slide No. 4-S-2(2);	co-ord. 5.5/70.2.
Paratype: Pl. 61, figs. 11,12.	Slide No. 3-S-5-Micro. 133;	co-ord. 12.2/44.1.

Genus **Dingodinium** Cookson and Eisenack, 1958

Type species **Dingodinium jurassicum** Cookson and Eisenack, 1958

See Norris and Sarjeant (1965, p. 25) for generic diagnosis.

Remarks: The genus *Dingodinium* consists of fossil dinoflagellate cysts having a smooth, membraneous, nontabulate, dorsoventrally compressed, elliptical body with an inconspicuously short to elongate apical horn and a helicoid cingulum. The cingulum is bounded on either side by a distinct fold. The membraneous body contains a spherical to elongate-oval, eccentrically placed capsule. The capsule is thick walled and smooth or spinulose.

Dingodinium cerviculum Cookson and Eisenack, 1958

Plate 62, figures 1 - 4

1958 *Dingodinium cerviculum* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 40, pl. 1, figs. 12-14.

Description: Test dorsoventrally compressed; body oval to almost circular; outer body wall smooth, membraneous, and drawn out into a relatively long,

hollow, often conical, apical horn; tip of the apical horn open; length of the apical horn about 1/3 of the length of the body; cingulum helicoid, situated on the outer surface of the membraneous body wall, and bounded on either side by a distinct, often elevated fold; membraneous body containing a spherical to oval, eccentrically placed, thick-walled capsule; capsule covered with less than 1-micron high, conical, spine-like outgrowths.

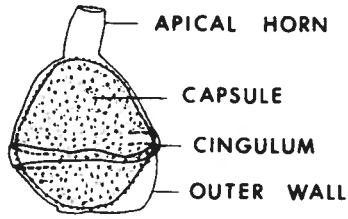

FIGURE 63. Dingodinium cerviculum *Cookson and Eisenack. Dorsal view.*

Size range: Total length of the test, including the apical horn (19 specimens) 48(57)64 microns.
Total breadth of the test (19 specimens) 41(48)54 microns.
Length of the body (15 specimens) 36(45)54 microns.
Length of the capsule (16 specimens) 31(36.5)43 microns.
Breadth of the capsule (16 specimens) 31(37.5)43 microns.
Length of the apical horn (15 specimens) 9(12)20 microns.

Distribution: Hauterivian to Turonian. Harmon Member and lower Shaftesbury Formation of the Peace River area; Hauterivian to Turonian of Germany (Alberti, 1961); Albian of Rumania (Baltes, 1967a); late Neocomian and Aptian of Australia (Cookson and Eisenack, 1958).

Remarks: The specimens of *Dingodinium cerviculum* described by Cookson and Eisenack (1958) and Alberti (1961) have an overall length of 81 to 109 microns and 76 to 86 microns, respectively. The specimens of *D. cerviculum* described in the present study seem to be smaller because the tip of the apical horn is usually broken off.

D. cerviculum can be easily distinguished from *Dingodinium europaeum* Eisenack, 1956, which has a smooth capsule.

Locality of figured specimens:

Pl. 62, fig. 1.	Sample No. 6-H-1;	Harmon Member.	Section 6.
Pl. 62, figs. 2,3.	Sample No. 7-H-3;	Harmon Member.	Section 7.

Pl. 62, fig. 4.	Sample No. 6-H-5;	Harmon Member.	Section 6.
Pl. 62, fig. 1.	Slide No. 6-H-1(1);	co-ord. 12.8/37.1.	
Pl. 62, fig. 2.	Slide No. 7-H-3(2);	co-ord. 13.2/58.1.	
Pl. 62, fig. 3.	Slide No. 7-H-3(3);	co-ord. 2.1/57.	
Pl. 62, fig. 4.	Slide No. 6-H-5(2);	co-ord. 4.3/69.2.	

Family **Endoscriniaceae**

Genus **Scriniodinium** Klement, 1957

Subgenus **Endoscrinium** Klement, 1960

Type species **Scriniodinium galeritum** (Deflandre) Klement, 1960

See Norris and Sarjeant (1965, p. 27) for generic diagnosis.

Remarks: The subgenus *Endoscrinium* of the genus *Scriniodinium* consists of fossil dinoflagellate cysts having an ovoid, dorsoventrally compressed body with a darker, spherical to ovoid inner body, spiral cingulum, sulcus, and trapezoid-shaped, precingular archeopyle on the dorsal surface. The tabulation pattern is: 3-4', 6", 5"', 0-1p, 0"". However, in some species the tabulation pattern is not clear.

Scriniodinium campanula Gocht, 1959

Plate 62, figure 5

1959 *Scriniodinium campanula* Gocht, Paläont. Z., vol. 33, p. 61, pl. 4, fig. 6, pl. 5, fig. 1.

Description: Test dorsoventrally compressed; body four sided, with a strongly convex dorsal surface and a flat ventral surface; body with a wide-based, short, hollow, blunt apical horn; antapex rounded to slightly angular; cingulum slightly

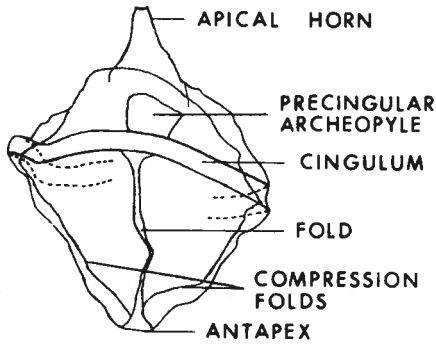

FIGURE 64. Scriniodinium campanula *Gocht. Dorsal view.*

spiral, deeply folded, crossing the dorsal surface somewhat above the equatorial axis, and terminating on the ventral surface a short distance from the margin of the test; a fold in the middle of dorsal convexity extending from the cingulum to the antapex; tabulation pattern not clear; archeopyle precingular, trapezoid shaped, and situated on the dorsal surface; lines running parallel to the edge of the test representing compression folds; presence of an inner body uncertain; body wall thin, smooth, and hyaline.

Size range: Total length of the test, including the apical horn (4 specimens) 82(95)108 microns.
Total breadth of the test (4 specimens) 61(72)84 microns.
Length of the apical horn (1 specimen) 20 microns.

Distribution: Valanginian to early Turonian. Harmon Member and lower Shaftesbury Formation of the Peace River area; late Albian and early Cenomanian (Cookson and Hughes, 1964), Cenomanian and early Turonian (Clarke and Verdier, 1967) of England; Hauterivian (Gocht, 1959), Valanginian to early Aptian (Alberti, 1961) of Germany; Albian of Rumania (Baltes, 1967a).

Remarks: The cingulum of *Scriniodinium campanula* appears to be slightly spiral rather than circular as interpreted by Cookson and Hughes (1964, p. 42).

The presence of an inner body in *S. campanula* is doubtful. According to Cookson and Hughes (1964, p. 42), the lines running parallel to the edge of the test are compression folds, rather than an inner body. The tabulation pattern also is not clear. Therefore, the relationship of this species to the genus *Scriniodinium* is uncertain.

Locality of figured specimen:

Pl. 62, fig. 5. Sample No. 3-S-5; lower Shaftesbury Formation. Section 3.
Pl. 62, fig. 5. Slide No. 3-S-5-Micro. 140; co-ord. 13/42.8.

Scriniodinium eurypylum Manum and Cookson, 1964

Plate 62, figures 6-10

1964 *Scriniodinium eurypylum* Manum and Cookson, Skrifter Norske Videnskaps-Akad. Oslo, I. Mat.-Naturv. Klasse, n. s., no. 17, p. 20, pl. 4, figs. 7-13.

Description: Test dorsoventrally compressed; body rounded to roughly pentagonal, narrowing toward apex and forming a short, conical, blunt apical horn; antapical horns unequal; the longer antapical horn conical, pointed, and situated on the left side; the shorter antapical horn conical and blunt, frequently not

developed; body almost entirely filled by a circular, darker inner body; wall of the inner body about 1 micron thick and laterally appressed to the outer wall; epitract and hypotract usually projecting for some distance above and below the inner body; cingulum slightly laevo-rotatory and dividing the body equally; sulcus wide and distinct; inner body with a precingular archeopyle; archeopyle broad, extending almost to the lateral margins of the test, and presumably formed by the loss of an operculum consisting of three precingular plates *viz.* 2", 3", and 4"; archeopyle in the outer wall not seen; outer wall membraneous, less than 0.5 micron thick, and sparsely ornamented by minute spinules.

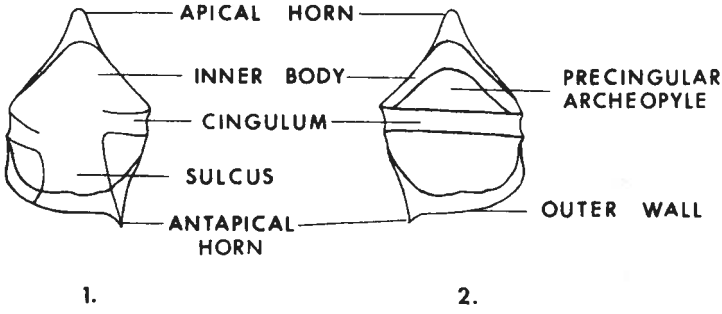

FIGURE 65. Scriniodinium eurypylum *Manum and Cookson. 1. Ventral view. 2. Dorsal view.*

Size range: Total length of the test (12 specimens) 58(71)84 microns.
Total breadth of the test (12 specimens) 40(49)60 microns.
Length of the inner body (10 specimens) 40(47)54 microns.
Breadth of the inner body (8 specimens) 37(44)58 microns.

Distribution: Late Albian and early Late Cretaceous. Lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964).

Remarks: According to Evitt (1967, p. 43), the inner body of *Scriniodinium eurypylum* has a precingular archeopyle (Type 3P), but the nature of the archeopyle in the outer wall of this species is unknown. *S. eurypylum* has a rather *Deflandrea*-like appearance. It was assigned to the genus *Scriniodinium* by Manum and Cookson (1964) because it has a precingular archeopyle, and differs from *Deflandrea* which possesses an intercalary archeopyle.

The specimens of *S. eurypylum* described in the present study differ slightly from those described by Manum and Cookson (1964) in having a less prominent ornamentation and in possessing a hypotheca which usually projects some distance below the central body.

Locality of figured specimens:

Pl. 62, figs. 6-8,10.	Sample No. 3-S-5;	lower Shaftesbury Formation.	Section 3.
Pl. 62, fig. 9.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 62, figs. 6,7.	Slide No. 3-S-5-Micro. 136;	co-ord. 11.5/43.1.	
Pl. 62, fig. 8.	Slide No. 3-S-5-Micro. 137;	co-ord. 11.8/42.9.	
Pl. 62, fig. 9.	Slide No. 2-S-3(1);	co-ord. 19.7/76.8.	
Pl. 62, fig. 10.	Slide No. 3-S-5-Micro. 135;	co-ord. 11.2/43.9.	

Family **Hexagoniferaceae**

Genus **Ascodinium** Cookson and Eisenack, 1960

Type species **Ascodinium acrophorum** Cookson and Eisenack, 1960

See Norris and Sarjeant (1965, p. 13) for generic diagnosis.

Remarks: The genus *Ascodinium* consists of oval to rhomboidal, untabulated fossil dinoflagellate cysts having an oval, spherical or rhomboidal capsule. The capsule either lies freely in the body cavity or in partial contact with the outer wall. A circular cingulum, an apical horn, and one or two antapical horns are usually present. The archeopyle is apical and is formed by the removal of the apical region of the test and capsule. A sulcus, if present, is usually restricted to the ventral hypotract.

The genus *Deflandrea* Eisenack, 1938, emend. Williams and Downie, 1966, differs from *Ascodinium* in possessing an intercalary archeopyle.

Ascodinium verrucosum Cookson and Hughes, 1964

Plate 63, figure 1

1964 *Ascodinium verrucosum* Cookson and Hughes, Palaeont., vol. 7, p. 41, pl. 5, figs. 4-7.

Description: Test dorsoventrally compressed, longer than broad, with roughly pentagonal outline; sides strongly convex; epitract conical with a short blunt apical horn; hypotract with a prominent antapical horn having a wide, slanting, asymmetrical base; body with a thick-walled, smooth capsule; capsule almost completely filling the body cavity, leaving a small unoccupied space in the apical region and a larger space in the antapical region; cingulum circular, faint; sulcus about 12 to 14 microns wide, delimited on the ventral hypotract by two faint longitudinal ridges; sulcal region with an opening formed by the incomplete release of a portion of outer wall corresponding to the antapically expanded portion of the

sulcus; cover of the opening remaining attached along its cingular edge; archeopyle apical, formed by the removal of the apical region of the test and capsule; outer wall membraneous, ornamented by densely arranged hollow verrucae.

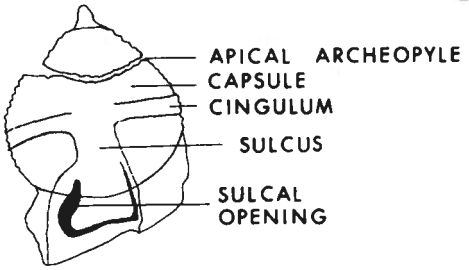

FIGURE 66. Ascodinium verrucosum *Cookson and Hughes. Ventral view.*

Size range: Total length of the test, including the horns (12 specimens) 58(68)76 microns.
Total breadth of the test (12 specimens) 41(47)51 microns.
Length of the capsule (12 specimens) 42(45)48 microns.

Distribution: Late Albian and early Cenomanian. "Fish-scale" marker bed, and immediately below and above it, in the Shaftesbury Formation of the Peace River area; early Cenomanian of England (Cookson and Hughes, 1964); late Albian of Rumania (Baltes, 1967b).

Remarks: The specimens illustrated as *Ascodinium* sp. cf. *A. verrucosum* by Evitt (1967, pl. 7, figs. 7-12), from the Lower Cretaceous of Montana, U.S.A., closely resemble the specimens assigned to *Ascodinium verrucosum* in the present study.

Locality of figured specimen:

Pl. 63, fig. 1. Sample No. 1-US-2; upper Shaftesbury Formation. Section 1.
Pl. 63, fig. 1. Slide No. 1-US-2(1); co-ord. 20.8/45.1.

Genus **Hexagonifera** Cookson and Eisenack, 1961,
emend. Cookson and Eisenack, 1962

Type species **Hexagonifera glabra** Cookson and Eisenack, 1961

See Norris and Sarjeant (1965, p. 31) for generic diagnosis.

Remarks: The genus *Hexagonifera* consists of fossil dinoflagellate cysts having an oval, smooth or ornamented body which may or may not be enclosed in a thin, transparent, detachable membrane. The archeopyle is formed by the removal of a six-sided portion of the body at one end.

The genus *Pyxidiella* Cookson and Eisenack, 1958, differs from *Hexagonifera* in having an intercalary archeopyle.

Hexagonifera chlamydata Cookson and Eisenack, 1962

Plate 63, figures 2 - 4

1962a *Hexagonifera chlamydata* Cookson and Eisenack, Micropaleont., vol. 8, p. 496, pl. 7, figs. 1-3, 5-8.

Description: Test consisting of a broadly oval to spherical, rather thick-walled, inner body enveloped completely by a thin, transparent, outer membrane; transparent membrane very loose and often ruptured; surface of the body finely to coarsely verrucose; archeopyle apical; hexagonal operculum remaining in position in most specimens; operculum surrounded by archeopyle suture.

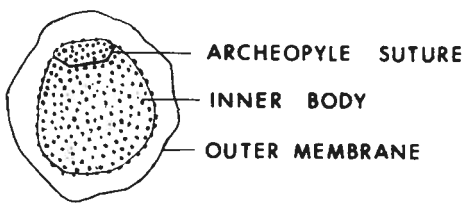

FIGURE 67. Hexagonifera chlamydata *Cookson and Eisenack.*

Size range: Total length of the test (14 specimens) 43(52)63 microns.
Total breadth of the test (14 specimens) 39(47)57 microns.
Length of the inner body (14 specimens) 30(37)45 microns.
Breadth of the inner body (14 specimens) 28(34)36 microns.

Distribution: Albian to Santonian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; late Albian and basal Cenomanian (Cookson and Hughes, 1964), Cenomanian to Santonian (Clarke and Verdier, 1967) of England; late Albian of Rumania (Baltes, 1967b); Albian and Cenomanian of Australia (Cookson and Eisenack, 1962a).

Remarks: The specimens of *Hexagonifera chlamydata* described by Cookson

and Eisenack (1962a) are larger (overall length: 68 to 75 microns) and slightly more elongate than those described in the present study. However, they are identical in all other respects.

The archeopyle is not distinct in most of the Alberta specimens of *H. chlamydata* because the hexagonal operculum remains in position. However, its outline is faintly marked by an archeopyle suture.

Hexagonifera vermiculata Cookson and Eisenack, 1961, differs from *H. chlamydata* in having a small-meshed, thin-walled, reticuloid pattern on the body. *Dingodinium jurassicum* Cookson and Eisenack, 1958, is distinct in having a cingulum and an eccentrically placed inner body, and in lacking the hexagonal archeopyle.

Locality of figured specimens:

Pl. 63, figs. 2,3.	Sample No. 7-H-3;	Harmon Member.	Section 7.
Pl. 63, fig. 4.	Sample No. 6-H- 4;	Harmon Member.	Section 6.
Pl. 63, fig. 2.	Slide No. 7-H-3(2);	co-ord. 11.5/78.5.	
Pl. 63, fig. 3.	Slide No. 7-H-3(1);	co-ord. 15.2/61.	
Pl. 63, fig. 4.	Slide No. 6-H- 4(1);	co-ord. 18.9/54.	

Family **Pseudoceratiaceae**

Genus **Aptea** Eisenack, 1958

Type species **Aptea polymorpha** Eisenack, 1958

See Norris and Sarjeant (1965, p. 11) for generic diagnosis.

Remarks: The genus *Aptea* was proposed by Eisenack (1958) to incorporate fossil dinoflagellate cysts having an asymmetrically triangular to oval or circular body with one apical and two poorly developed antapical horns. Antapical horns are widely divergent and often barely discernible or absent. The archeopyle is apical (Evitt, 1961, p. 401).

The genus *Aptea* can be easily distinguished from *Pseudoceratium* Gocht, 1957, by its poorly developed horns. *Cyclonephelium* Deflandre and Cookson, 1955, resembles *Aptea*, but differs in having an ornamentation which is restricted to the periphery of the test.

Aptea polymorpha Eisenack, 1958

Plate 63, figures 5-7; plate 64, figure 1

1958 *Aptea polymorpha* Eisenack, Neues Jahrb. Geol. Paläont., Abhandl., vol. 106, p. 394, pl. 22, figs. 5-12, pl. 24, fig. 5.

1960 *Aptea* cf. *polymorpha* Eisenack–Eisenack and Cookson, Proc. Roy. Soc. Victoria, vol. 72, pt. 1, p. 9, pl. 3, figs. 2-4.

Description: Test dorsoventrally compressed; outline of body asymmetrically triangular with convex sides, frequently oval or almost circular in outline; body longer than broad, with one apical and two antapical horns; horns poorly developed; antapical horns widely divergent, barely discernible or absent in more rounded specimens; archeopyle apical; surface of the test covered with low, irregular ridges forming a fine-meshed, indistinct network; ridges giving rise to numerous, short, irregular processes joined to one another and forming lamella-like projections; height of processes variable; processes best developed in the peripheral area but covering the entire surface of the test.

Size range: Total length of the test, including the horns (59 specimens) 81(118)149 microns.
Total breadth of the test (57 specimens) 66(100)126 microns.
Length of the apical horn (35 specimens) 7(16)34 microns.
Length of the antapical horns (12 specimens) 5(12)24 microns; (2 specimens) 5(8)12 microns.
Height of the processes (16 specimens) 4(10)18 microns.

Distribution: Aptian and Albian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; late Aptian of north Germany (Eisenack, 1958); Aptian of Queensland and Albian of Western Australia (Eisenack and Cookson, 1960).

Remarks: The specimens of *Aptea polymorpha* described by Eisenack (1958) are on an average slightly smaller (overall length: 80(101)120 microns) than those described in the present study. However, they are identical in all other respects.

Cyclonephelium compactum Deflandre and Cookson, 1955, resembles *Aptea polymorpha* in having lamella-like processes and an apical archeopyle, but differs in being smaller (overall diameter: 72 to 87 microns) and in possessing an ornamentation which is restricted to the periphery of the test.

Locality of figured specimens:

Pl. 63, figs. 5,6.	Sample No. 7-H-4;	Harmon Member.	Section 7.
Pl. 63, fig. 7.	Sample No. 8-L-9;	Loon River Formation.	Section 8.

Pl. 64, fig. 1.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 63, fig. 5.	Slide No. 7-H- 4-Micro. 71;	co-ord. 11.2/44.8.	
Pl. 63, fig. 6.	Slide No. 7-H- 4-Micro. 83;	co-ord. 10/44.8.	
Pl. 63, fig. 7.	Slide No. 8-L-9-Micro. 25;	co-ord. 18/44.8.	
Pl. 64, fig. 1.	Slide No. 8-L-9-Micro. 25;	co-ord. 11.4/43.9.	

Genus **Odontochitina** Deflandre, 1935

Type species **Odontochitina operculata** (O. Wetzel) Deflandre, 1946

See Singh (1964, p. 146) for generic diagnosis.

Remarks: The genus *Odontochitina* consists of fossil dinoflagellate cysts having a globular to elongate oval body, one long apical and two antapical horns, an apical archeopyle, and a distinct inner body. The antapical horns are widely divergent as one of them is situated almost at the equator. The body is smooth and lacks tabulation and cingulum. A large proportion of the specimens are broken into two unequal parts along the apical archeopyle.

Odontochitina operculata (O. Wetzel) Deflandre, 1946

Plate 64, figure 2

1933 *Ceratium (Euceratium) operculatum* O. Wetzel, Palaeontographica, Band 77, 78, Abt. A, p. 170, pl. 2, figs. 21, 22.

1935 *Odontochitina silicorum* Deflandre, Bull. Biologique France et Belge., vol. 69, p. 234, pl. 9, figs. 8-10.

1946 *Odontochitina operculata* (O. Wetzel) Deflandre, Fichier micropaléontologique, ser. 6, card nos. 1016-1019.

1955 *Odontochitina operculata* (O. Wetzel) Deflandre–Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 291, pl. 3, figs. 5, 6.

1962 *Odontochitina silicorum* Deflandre–Pocock, Palaeontographica, Band 111, Abt. B, p. 78, pl. 14, figs. 211, 212.

See Sarjeant (*in* Davey *et al.*, 1966, p. 208) for detailed synonymy.

Description: Body elongate oval, dorsoventrally flattened, with one long apical and two antapical horns; antapical horns widely divergent; one antapical horn in direct axial continuation of the lower part of the body, the other, which is usually smaller, branching off near the equator; horns mostly longer than or equal to the length of the body, about 12 to 15 microns wide at the base, and pointed at the tip; archeopyle apical, marked by an archeopyle suture close to the base of the apical horn; body usually broken into two unequal parts along the archeopyle suture;

body containing an inner body closely appressed to the outer wall of the test and distinct at the horn bases; body wall smooth, hyaline, without any trace of a cingulum or tabulation.

Size range: Total length of the test, including the horns (8 specimens) 226(329)405 microns.
Length of the body (7 specimens) 48(78)102 microns.
Breadth of the body (7 specimens) 36(45)54 microns.
Length of the apical horn (7 specimens) 115(146)191 microns.
Length of the antapical horns (7 specimens) 84(93)108 microns; 60(74)90 microns.

Distribution: Late Hauterivian to Maestrichtian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; uppermost "calcareous member" and Clearwater Formation of central Alberta (Singh, 1964); Mannville and Colorado Groups of Western Canada (Pocock, 1962); late Albian of northern Wyoming, U.S.A. (Davis, 1963); late Barremian and Cenomanian (Sarjeant *in* Davey *et al.*, 1966), Cenomanian to Campanian (Clarke and Verdier, 1967) of England; Senonian (Deflandre, 1935), early Cenomanian (Firtion, 1952) of France; late Hauterivian (Gocht, 1959), late Aptian (Eisenack, 1958), Barremian to Senonian (Alberti, 1961) of Germany; Maestrichtian (Alberti, 1961), Cenomanian to Campanian (Górka, 1963) of Poland; late Albian of Rumania (Baltes, 1967b); Senonian of Baltic region (O. Wetzel, 1933); Lower Cretaceous (Deflandre and Cookson, 1955), Albian to early Turonian (Cookson and Eisenack, 1958) of Australia.

Locality of figured specimen:

Pl. 64, fig. 2. Sample No. 6-H-7; Harmon Member. Section 6.
Pl. 64, fig. 2. Slide No. 6-H-7-Micro. 13; co-ord. 6.8/44.5.

Odontochitina striatoperforata Cookson and Eisenack, 1962

Plate 64, figures 3, 4; plate 65, figures 1, 2

1961 *Odontochitina* spp. Evitt, Micropaleont., vol. 7, pl. 6, figs. 15, 16.

1962a *Odontochitina striatoperforata* Cookson and Eisenack, Micropaleont., vol. 8, p. 490, pl. 3, figs. 14-19.

Description: Body globular, dorsoventrally flattened, with one long apical and two antapical horns; antapical horns widely divergent; one antapical horn in direct axial continuation of the lower part of the body, the other, which is smaller, branching off near the equator; horns longer than the body, about 16 to 36 microns

wide at the base, and pointed at the tip; horns longitudinally striated; striations very faint and discontinuous; perforations of varying size and number developed along the course of striae, and often arranged in longitudinal rows; perforations progressively decreasing in size toward the tip of the horns; archeopyle apical, marked by an archeopyle suture close to the base of the apical horn; body usually broken into two unequal parts along the archeopyle suture; body containing a darker inner body closely appressed to the outer wall of the test; inner body often forming a conical to knob-like protrusion projecting into the base of the apical and the longer antapical horn; body wall smooth, hyaline, without any trace of a cingulum or tabulation.

Size range: Total length of the test, including the horns (6 specimens) 316(459)547 microns.
Length of the body (6 specimens) 84(105)135 microns.
Breadth of the body (6 specimens) 60(65.5)72 microns.
Length of the apical horn (6 specimens) 130(222)262 microns.
Length of the antapical horns (6 specimens) 86(156)194 microns; 84(106)126 microns.

Distribution: Albian to Senonian. Harmon Member and lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); late Albian to early Cenomanian of England (Cookson and Hughes, 1964); Senonian of West Pakistan (Evitt, 1961); Albian to Cenomanian of Western Australia (Cookson and Eisenack, 1962a).

Remarks: This species differs from *Odontochitina costata* Alberti, 1961, in having distinctly perforated horns. These perforations are similar in nature to those of *Odontochitina porifera* Cookson, 1956, and are of genetic significance. Due to these reasons, the treatment of *Odontochitina striatoperforata* Cookson and Eisenack, 1962, as a junior synonym of *O. costata* Alberti, 1961, by Clarke and Verdier (1967), does not seem to be justified. Most of the specimens illustrated by Clarke and Verdier belong to *O. costata.*

Locality of figured specimens:

Pl. 64, figs. 3,4.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 65, figs. 1,2.	Sample No. 5-S-3;	lower Shaftesbury Formation.	Section 5.
Pl. 64, figs. 3,4.	Slide No. 5-S-3-Micro. 14;	co-ord. 8.9/48.8.	
Pl. 65, figs. 1,2.	Slide No. 5-S-3-Micro. 113;	co-ord. 13.2/45.2.	

Genus **Pseudoceratium** Gocht, 1957

Type species **Pseudoceratium pelliferum** Gocht, 1957

See Norris and Sarjeant (1965, p. 51) for generic diagnosis.

Remarks: The genus *Pseudoceratium* consists of fossil dinoflagellate cysts having peridinoid shape, several more or less elongated horns, and an apical archeopyle. The test is smooth or covered with short processes. The body is without plates or cingulum.

The species so far assigned to the genus *Pseudoceratium* have three or four horns. One horn is apical, another one antapical, and one or two horns are equatorial in position.

The genus *Muderongia* Cookson and Eisenack, 1958, differs from *Pseudoceratium* in having an internal body or capsule and a shallow cingulum.

Pseudoceratium pelliferum Gocht, 1957

Plate 66, figure 1

1957 *Pseudoceratium pelliferum* Gocht, Paläont. Z., vol. 31, p. 166, pl. 18, figs. 1, 2.

Description: Test flat; body asymmetrically triangular with convex sides, longer than broad, with a strongly developed apical horn and two shorter, unequal, widely divergent antapical horns; smaller antapical horn situated near the equator and the larger one at the antapex closer to one side, and not in median position; archeopyle apical; body densely ornamented by blunt processes with wide tips and pointed setaceous processes; processes up to 4 microns long, single or fused at their bases; processes perpendicular to the surface on the main part of the body but almost parallel to it on the horns; body wall about 2 microns thick.

Size range: Total length of the test, including the horns (1 specimen) 127 microns.
Total breadth of the test, including the horns (1 specimen) 87 microns.
Length of the body (1 specimen) 82 microns.
Breadth of the body (1 specimen) 72 microns.
Length of the apical horn (1 specimen) 33 microns.
Length of the antapical horns (1 specimen) 12 microns; 11 microns.

Distribution: Valanginian to middle Albian. Cadotte Member of the Peace River area; uppermost "calcareous member", Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964); Garbutt Formation of the Northwest

Territories (Pocock, 1962); Valanginian to Hauterivian (Gocht, 1957), Valanginian to middle Albian (Alberti, 1961) of Germany.

Locality of figured specimen:

Pl. 66, fig. 1.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 66, fig. 1.	Slide No. 7-C-10(2);	co-ord. 8.9/54.2.	

Pseudoceratium regium n. sp.

Plate 66, figures 2 - 4; plate 67, figures 1, 2

Description: Test flat; body asymmetrically triangular with convex sides, elongate to equidimensional, with one long apical and two widely divergent antapical horns; smaller antapical horn situated near the equator and the larger one at the antapex closer to one side and not in median position; horns varying from wide-based, conical protuberances to narrow elongate processes distinct from the body; apical horn often surmounted by a 3-micron long, solid rod; cingulum faint, marked by two parallel ridges near the sides, and seen only in a few specimens; archeopyle apical with a notched archeopyle suture; surface of the body finely granulate and ornamented by a small-meshed network formed by faint, narrow, low muri; lumina on the horns often elongated lengthwise; body wall less than 1 micron thick.

Size range: Total length of the test, including the horns (32 specimens) 92(114)150 microns. Holotype 123 microns.
Total breadth of the test, including the horns (31 specimens) 48(75)108 microns. Holotype 70 microns.
Length of the body (4 specimens) 68(73)80 microns. Holotype 68 microns.
Breadth of the body (4 specimens) 60(74)84 microns. Holotype 60 microns.
Length of the apical horn (14 specimens) 24(28)32 microns. Holotype 30 microns.
Length of the antapical horns (14 specimens) 15(21)27 microns. Holotype 25 microns; 11(15)20 microns. Holotype 16 microns.

Distribution: Middle and late Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area.

Remarks: This species is characterized by extreme variability in the length and shape of the apical and antapical horns, and by the small-meshed network on the surface of the body.

Pseudoceratium regium n. sp. differs from *Pseudoceratium nudum* Gocht, 1957, which is larger (overall length: 190 to 288 microns) and smooth. *Pseudoceratium turneri* Cookson and Eisenack, 1958, is distinct in being ornamented by lamella-like membrane.

The specific name has been derived from "*regium*" (regal, majestic).

Type locality:

Holotype: Pl. 66, figs. 2,3.	Sample No. 1-S-11;	lower Shaftesbury Fm.	Sec. 1.
Paratype: Pl. 66, fig. 4.	Sample No. 6-H-7;	Harmon Member.	Sec. 6.
Paratype: Pl. 67, fig. 1.	Sample No. 6-H-5;	Harmon Member.	Sec. 6.
Paratype: Pl. 67, fig. 2.	Sample No. 7-H-6;	Harmon Member.	Sec. 7.
Holotype: Pl. 66, figs. 2,3.	Slide No. 1-S-11-Micro. 57;	co-ord. 11.8/43.9.	
Paratype: Pl. 66, fig. 4.	Slide No. 6-H-7(1);	co-ord. 13.9/31.8.	
Paratype: Pl. 67, fig. 1.	Slide No. 6-H-5(1);	co-ord. 1/75.8.	
Paratype: Pl. 67, fig. 2.	Slide No. 7-H-6(1);	co-ord. 3.8/68.2.	

Family **Membranilarnaciaceae**

Genus **Chlamydophorella** Cookson and Eisenack, 1958

Type species **Chlamydophorella nyei** Cookson and Eisenack, 1958

See Norris and Sarjeant (1965, p. 18) for generic diagnosis.

Remarks: Cookson and Eisenack (1958) described their new genus *Chlamydophorella* as follows: "Shell enclosed in a delicate membrane that is supported by closely arranged, slender, bifurcate spines of approximately equal length". Besides these characters, *Chlamydophorella* has an apical archeopyle (Evitt, 1967, p. 34). The type species *C. nyei* possesses a short apical projection and displays a bilateral symmetry. The cingulum is usually indicated by the alignment of longer processes on either side of the equatorial region.

The genus *Gardodinium* Alberti, 1961, closely resembles *Chlamydophorella*, but differs in having a more elongate apical horn, dorsoventrally flattened body, and distinct cingulum and tabulation. It also differs in having a precingular archeopyle (Clarke and Verdier, 1967, p. 27).

Chlamydophorella nyei Cookson and Eisenack, 1958

Plate 67, figures 3, 4

1958 *Chlamydophorella nyei* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 56, pl. 11, figs. 1-3.

Description: Test approximately spherical with a short apical projection; body covered with numerous, short, slender, equal, hollow processes with bifurcate tips; processes supporting a delicate membrane enveloping the test; processes perpendicular to the surface of the body and parallel to the polar axis in the apical region; enveloping membrane covering the apical projection and prolonged into a short neck; cingulum indistinct; archeopyle apical; body thin walled and hyaline.

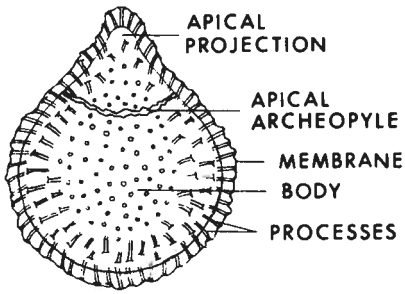

FIGURE 68. Chlamydophorella nyei *Cookson and Eisenack.*

Size range: Total length of the test, including the processes (6 specimens) 48(53)62 microns.
Total breadth of the test, including the processes (20 specimens) 40(46)56 microns.
Diameter of the body (10 specimens) 37(42)50 microns.
Length of the apical projection (4 specimens) 8(9)10 microns.
Length of the processes (14 specimens) 4(5)6 microns.

Distribution: Aptian to early Turonian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); late Albian and early Cenomanian of England (Cookson and Hughes, 1964); Albian of Rumania (Baltes, 1967a); Aptian to early Turonian of Australia (Cookson and Eisenack, 1958, 1962a).

Locality of figured specimens:

Pl. 67, fig. 3.	Sample No. 6-H-1;	Harmon Member.	Section 6.
Pl. 67, fig. 4.	Sample No. 8-L-13;	Loon River Formation.	Section 8.

Pl. 67, fig. 3. Slide No. 6-H-1(1); co-ord. 17.2/70.1.
Pl. 67, fig. 4. Slide No. 8-L-13(3); co-ord. 2.8/78.2.

Chlamydophorella largissima n. sp.

Plate 67, figures 5, 6

Description: Test approximately spherical with a short apical projection; body covered with numerous, medium-sized, 1-micron wide, equal, hollow processes with bifurcate tips; processes supporting a delicate membrane enveloping the test; processes perpendicular to the surface of body, and parallel to the polar axis in the apical region; enveloping membrane covering the apical projection and prolonged into a short neck; cingulum not seen; archeopyle apical; body and processes thin walled and hyaline.

Size range: Total length of the test, including the processes (1 specimen) 82 microns. Holotype 82 microns.
Total breadth of the test, including the processes (7 specimens) 57(62)67 microns. Holotype 65 microns.
Diameter of the body (6 specimens) 48(52)60 microns. Holotype 60 microns.
Length of the apical projection (1 specimen) 15 microns. Holotype 15 microns.
Length of the processes (7 specimens) 6(10)12 microns. Holotype 10 microns.

Distribution: Middle Albian. Loon River Formation and Harmon Member of the Peace River area.

Remarks: *Chlamydophorella largissima* n. sp. can be distinguished from *Chlamydophorella nyei* Cookson and Eisenack, 1958, by its larger size and longer, more widely spaced processes. *Chlamydophorella grossa* Manum and Cookson, 1964, differs from *C. largissima* n. sp. in being larger (overall diameter: 78 to 136 microns) and in having a thicker body wall and shorter, rod-like processes.

The specific name has been derived from "*largissima*" (very large).

Type locality:

Holotype: Pl. 67, figs. 5,6. Sample No. 8-L-9; Loon River Formation. Sec. 8.
Holotype: Pl. 67, figs. 5,6. Slide No. 8-L-9(3); co-ord. 7.4/68.1.

Chlamydophorella tabulata n. sp.

Plate 67, figure 7

Description: Test approximately spherical, tabulate, and divided into about 8 plates; plates smooth, 15 to 22 microns wide, and bordered by a row of closely spaced processes; processes short, slender, and equal; tips of processes bifurcate; processes supporting a delicate membrane enveloping the test; processes perpendicular to the surface of plates; cingulum present but often indistinct; archeopyle not seen; body thin walled and hyaline.

Size range: Maximum diameter of the test, including the processes (4 specimens) 51(54.5)58 microns. Holotype 51 microns.
Maximum diameter of the body (4 specimens) 44(46)49 microns. Holotype 44 microns.
Length of the processes (4 specimens) 3(6)9 microns. Holotype 6 microns.

Distribution: Middle Albian. Loon River Formation and Harmon Member of the Peace River area.

Remarks: These specimens have not been assigned to the genus *Gardodinium* Alberti, 1961, because they lack an apical horn.

Chlamydophorella tabulata n. sp. differs from all the described species of the genus *Chlamydophorella* Cookson and Eisenack, 1958, in possessing a body which is divided into plates.

The specific name has been derived from "*tabulata*" (tabulated) and refers to the plates of the body.

Type locality:

Holotype: Pl. 67, fig. 7. Sample No. 8-L-11; Loon River Formation. Sec. 8.
Holotype: Pl. 67, fig. 7. Slide No. 8-L-11(2); co-ord. 13/57.5.

Chlamydophorella sp.

Plate 67, figure 8

Description: Outline of the test circular; body covered with numerous, short, slender, equal processes with bifurcate tips; processes supporting a delicate membrane enveloping the test; membrane ruptured and missing from most of the test; processes perpendicular to the surface of the body; apical projection,

cingulum, and archeopyle not seen; body wall about 0.3 micron thick.

Size range: Maximum diameter of the test, including the processes (1 specimen) 80 microns.
Maximum diameter of the body (1 specimen) 70 microns.
Length of the processes (1 specimen) 4(6)8 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Chlamydophorella* sp. resembles *Chlamydophorella grossa* Manum and Cookson, 1964, but differs in having more closely spaced, slender processes and a thinner body wall.

Locality of figured specimen:

Pl. 67, fig. 8. Sample No. 3-S-4; lower Shaftesbury Formation. Section 3.
Pl. 67, fig. 8. Slide No. 3-S-4(1); co-ord. 7/45.2.

Genus **Gardodinium** Alberti, 1961

Type species **Gardodinium eisenacki** Alberti, 1961

See Norris and Sarjeant (1965, p. 29) for generic diagnosis.

Remarks: The genus *Gardodinium* consists of fossil dinoflagellate cysts having a dorsoventrally flattened, rounded-polygonal to oval body with a long apical horn, cingulum, and sulcus. The body contains a closely fitting, inner capsule ornamented by numerous slender processes with bifurcate tips. The processes border the plates and support the outer, membraneous body wall. The inner capsule has a knob-like apical protrusion which projects slightly into the base of the apical horn. The archeopyle is precingular (Clarke and Verdier, 1967, p. 27).

The genus *Gardodinium* can be distinguished from *Chlamydophorella* Cookson and Eisenack, 1958, by its long apical horn, dorsoventrally flattened body, cingulum, sulcus, plates, and precingular archeopyle. *Dingodinium* Cookson and Eisenack, 1958, differs from *Gardodinium* in having a helicoid cingulum and a loosely fitting, eccentrically placed capsule which lacks tabulation. The capsule of *Dingodinium* is either smooth or bears simple, unforked spinules.

Gardodinium eisenacki Alberti, 1961

Plate 68, figures 1, 2

1961 *Gardodinium eisenacki* Alberti, Palaeontographica, Band 116, Abt. A, p. 18, pl. 3, figs. 8-13.

Description: Test dorsoventrally flattened; body rounded-polygonal to oval in outline; apical horn about 6 to 8 microns wide and from 1/3 to 1/2 of the length of the body; tip of the apical horn usually open; cingulum distinct, bordered on either side by a row of closely spaced, slender processes; some specimens showing distinct plates; plate boundaries marked by a row of closely spaced, slender processes; plate arrangement not clear; inner capsule ornamented by numerous, short, slender, and equal processes; tips of the processes bifurcate and supporting the outer body wall; inner capsule with a knob-like protrusion projecting into the base of the apical horn; outer body wall membraneous and hyaline.

Size range: Total length of the test, including the apical horn (8 specimens) 54(65)78 microns.
Total breadth of the test, including the processes (8 specimens) 33(46)54 microns.
Length of the body (8 specimens) 40(46)50 microns.
Length of the apical horn (8 specimens) 12(20)30 microns.
Length of the processes (8 specimens) 2(4)6 microns.

Distribution: Hauterivian to Albian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; late Albian of northern Wyoming, U.S.A. (Davis, 1963); middle Hauterivian to early Barremian of England (Sarjeant *in* Davey *et al.*, 1966); Hauterivian to Aptian of Germany (Alberti, 1961).

Remarks: The specimens of *Gardodinium eisenacki* described by Alberti (1961) are larger (overall length: 77 to 85 microns) than those described in the present study. However, they are identical in all other respects.

G. eisenacki can be distinguished from *Chlamydophorella nyei* Cookson and Eisenack, 1958, by its longer apical horn, dorsoventrally flattened body, cingulum, and tabulation. The specimen illustrated as *Chlamydophorella* sp. cf. *C. nyei* by Davis (1963, pl. 11, fig. 7) probably belongs to *G. eisenacki.*

Locality of figured specimens:

Pl. 68, fig. 1.	Sample No. 8-L-11;	Loon River Formation.	Section 8.
Pl. 68, fig. 2.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Section 3.
Pl. 68, fig. 1.	Slide No. 8-L-11(1);	co-ord. 1.8/58.5.	
Pl. 68, fig. 2.	Slide No. 3-S-5(1);	co-ord. 13.2/46.	

Gardodinium elongatum n. sp.

Plate 68, figures 3, 4

Description: Test dorsoventrally flattened; body elongate-oval in outline; apical horn about 8 to 10 microns wide and more than 1/2 of the length of the body; tip of the apical horn open; overall length of the test always more than twice its breadth; cingulum distinct, bordered on either side by a row of closely-spaced,

slender processes; some specimens showing sulcus on epitract and hypotract; inner capsule ornamented by numerous short, slender, equal processes; tips of the processes bifurcate and supporting the outer body wall; inner capsule with a prominent, knob-like protrusion projecting into the base of the apical horn; tip of the knob-like protrusion bearing two to three, up to 20-micron long, thread-like, flexuous setae; outer body wall membraneous and hyaline.

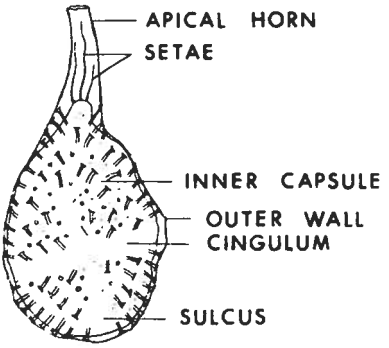

FIGURE 69. Gardodinium elongatum *n. sp. Ventral view.*

Size range: Total length of the test, including the apical horn (2 specimens) 94(96)98 microns. Holotype 98 microns.
Total breadth of the test, including the processes (2 specimens) 35(40.5)46 microns. Holotype 46 microns.
Length of the body (2 specimens) 66(67)68 microns. Holotype 68 microns.
Length of the apical horn (2 specimens) 35(36)37 microns. Holotype 37 microns.
Length of the processes (2 specimens) 2(3)4 microns. Holotype 2 to 4 microns.

Distribution: Middle Albian. Harmon and Cadotte Members of the Peace River area.

Remarks: *Gardodinium elongatum* n. sp. differs from all the described species of the genus *Gardodinium* Alberti, 1961, in having a very elongate and narrow test.

The specific name has been derived from "*elongatum*" (elongate).

Type locality:

Holotype: Pl. 68, fig. 3.	Sample No. 7-H-4;	Harmon Member.	Section 7.
Paratype: Pl. 68, fig. 4.	Sample No. 7-C-1;	Cadotte Member.	Section 7.
Holotype: Pl. 68, fig. 3.	Slide No. 7-H-4-Micro. 82;	co-ord. 12/42.1.	
Paratype: Pl. 68, fig. 4.	Slide No. 7-C-1(1);	co-ord. 13.2/69.4.	

Class **Dinophyceae – Incertae Sedis**

Genus **Diconodinium** Eisenack and Cookson, 1960

Type species **Diconodinium multispinum** (Deflandre and Cookson) Eisenack and Cookson, 1960

See Norris and Sarjeant (1965, p. 24) for generic diagnosis.

Remarks: The genus *Diconodinium* consists of fossil dinoflagellate cysts having a nontabulate, fusiform to almost spherical test, an apical horn with a bifid to concave tip, and a single, spine-like antapical horn. The body wall is smooth or ornamented by granules, spinules or small spines. A circular cingulum divides the body equally or unequally and a sulcus is usually present.

The genus *Palaeohystrichophora* Deflandre, 1934, differs from *Diconodinium* in having a capsule, simple apical and antapical processes, and in lacking a sulcus.

Diconodinium pusillum n. sp.

Plate 68, figures 5-8

Description: Test broadly fusiform with one side more convex than the other; body with one short, blunt, and bifid apical horn, and a single, spine-like, 2- to 4-micron long antapical horn; antapical horn situated closer to one side, and not median in position; cingulum faint, 2 to 3 microns wide, and dividing the body unequally into a larger, slightly conical epitract and a smaller, rounded hypotract; sulcus very faint and wide, barely discernible on the ventral surface of some specimens; body wall ornamented by 0.5-micron long spinules; test thin walled and hyaline.

Size range: Total length of the test (16 specimens) 40(47)54 microns. Holotype 50 microns.
Total breadth of the test (16 specimens) 28(36.5)43 microns. Holotype 36 microns.

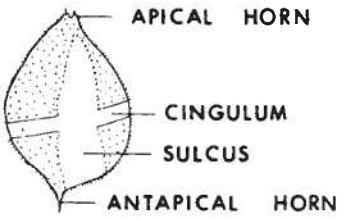

FIGURE 70. Diconodinium pusillum *n. sp. Ventral view.*

Distribution: Middle and late Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Diconodinium multispinum* (Deflandre and Cookson) Eisenack and Cookson, 1960, resembles *Diconodinium pusillum* n. sp. but differs in being larger (overall length: 56 to 100 microns) and in having equally convex sides. The antapical horn in *D. multispinum* is in median position and the cingulum divides the body equally. *Diconodinium arcticum* Manum and Cookson, 1964, can be distinguished from *D. pusillum* n. sp. in being larger (overall length: 50 to 73 microns) and in having a granular ornamentation. The apical horn in *D. arcticum* is truncate or toothed, and the body wall is double layered.

The specific name has been derived from "*pusillum*" (very small).

Type locality:

Holotype: Pl. 68, fig. 5.	Sample No. 6-H-1;	Harmon Member.	Section 6.
Paratype: Pl. 68, fig. 6.	Sample No. 6-H-1;	Harmon Member.	Section 6.
Paratype: Pl. 68, fig. 7.	Sample No. 8-L-4;	Loon River Fm.	Section 8.
Paratype: Pl. 68, fig. 8.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Holotype: Pl. 68, fig. 5.	Slide No. 6-H-1(1);	co-ord. 14.2/40.	
Paratype: Pl. 68, fig. 6.	Slide No. 6-H-1(1);	co-ord. 6/57.8.	
Paratype: Pl. 68, fig. 7.	Slide No. 8-L-4(3);	co-ord. 16.2/44.2.	
Paratype: Pl. 68, fig. 8.	Slide No. 7-C-10(2);	co-ord. 14.8/71.5.	

Genus **Palaeoperidinium** Deflandre, 1934, emend. Sarjeant, 1967

Type species **Palaeoperidinium pyrophorum** (Ehrenberg) Deflandre, 1935, emend. Sarjeant, 1967

See Sarjeant (1967, p. 246) for emended generic diagnosis and synonymy.

Remarks: Sarjeant (1967) emended the genus *Palaeoperidinium* to contain fossil dinoflagellate cysts having an ovoidal or polygonal to subpolygonal outline with one apical and two antapical horns and an epitractal archeopyle. The tabulation pattern is: 4', 3a, 7", 5-?7c, 5"', 2"". The sutures are with or without crests.

Palaeoperidinium? cretaceum Pocock, 1962

Plate 68, figures 9-11

1962 *Palaeoperidinium cretaceum* Pocock, Palaeontographica, Band 111, Abt. B, p. 80, pl. 14, figs. 219-221.

Description: Test dorsoventrally flattened, longer than broad, and pentagonal in outline; epitract conical with a blunt apex representing the apical horn; apex often surmounted by a minute, solid apical horn; hypotract with two unequal and pointed horns; tabulation and archeopyle not seen; cingulum slightly helicoid and marked by two parallel, equatorial or slightly subequatorial ridges; sulcus absent; compression folds starting from the apex and running parallel to the edge of the test; test wall membraneous, less than 0.5 micron thick; surface scabrate to finely granulose.

Size range: Total length of the test, including the horns (13 specimens) 68(80)92 microns.
Total breadth of the test (13 specimens) 48(61.5)72 microns.
Length of the apical horn (4 specimens) 2(3)8 microns.
Length of the antapical horns (4 specimens) 12(15)19 microns; 4(7)10 microns.

Distribution: Cretaceous. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; uppermost "calcareous" member, Clearwater and lower Grand Rapids Formation of central Alberta (Singh, 1964); Cretaceous of Western Canada (Pocock, 1962); early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964).

Remarks: The assignment of this species to the genus *Palaeoperidinium* is questionable as it does not possess a distinct tabulation. *Palaeoperidinium? cretaceum* is closer to the genus *Lejeunia* Gerlach, 1961, which differs, however, in having a bilaterally symmetrical test and a strongly helicoid cingulum.

Locality of figured specimens:

Pl. 68, fig. 9. Sample No. 2-S-16; lower Shaftesbury Formation. Section 2.
Pl. 68, figs. 10, 11. Sample No. 2-S-7; lower Shaftesbury Formation. Section 2.
Pl. 68, fig. 9. Slide No. 2-S-16-Micro. 155; co-ord. 11.9/43.

Pl. 68, fig. 10. Slide No. 2-S-7-Micro. 163; co-ord. 11.9/43.8.
Pl. 68, fig. 11. Slide No. 2-S-7-Micro. 166; co-ord. 12.8/44.5.

Class **Chlorophyceae**

Family **Tasmanaceae**

Genus **Crassosphaera** Cookson and Manum, 1960

Type species **Crassosphaera concinna** Cookson and Manum, 1960

See Norris and Sarjeant (1965, p. 20) for generic diagnosis.

Remarks: The genus *Crassosphaera* consists of hollow, spherical forms with surface prominences or projections which may or may not form a regular pattern. Each prominence is perforated by a single, minute, radial tubule which may subdivide into a few smaller branches on entering the wall or may remain unbranched throughout its course. The thickness of the wall is from 1/20 to 1/10 of the diameter of the body.

The genus *Tytthodiscus* Norem, 1955, differs from *Crassosphaera* in having a segmented wall composed of discrete hexagonal columnar units, and in lacking surface prominences. *Noremia* Kedves, 1962, can be distinguished from *Crassosphaera* by its veil-like velamen which surrounds the body. *Hungarodiscus* Kriván-Hutter, 1963, and *Tasmanites* Newton, 1875, emend. Eisenack, 1958, lack the surface prominences and the branched tubules.

Crassosphaera bella n. sp.

Plate 69, figures 1-11; plate 70, figures 1-3

Description: Test spherical, hollow, thick walled, and usually becoming disk shaped due to compression; outer surface with minute coni spaced 4 to 10 microns apart; each conus with one tubule opening to the exterior; tubule dividing into numerous branches slightly below the outer surface; tubule branches opening into the interior of the test; branched tubules appearing as radially arranged, outwardly pointed, conical, perforated sections in the wall separated from each other by the solid portions of the wall; a circular pylome, about 3 microns in diameter, present in some thick-walled specimens; test yellowish brown to dark reddish brown in color.

Size range: Diameter of the test (23 specimens) 48(66)90 microns. Holotype 78 microns.

Thickness of the wall (17 specimens) 5(8)14 microns. Holotype 10 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

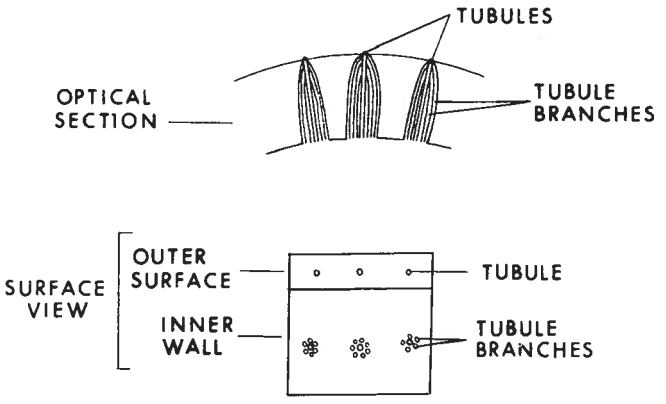

FIGURE 71. Crassosphaera bella *n. sp. Wall structure.*

Remarks: *Crassosphaera bella* n. sp. displays a considerable variation in the thickness of the wall, but the general structure of the branched tubules in the wall remains the same.

C. bella n. sp. differs from other species of the genus *Crassosphaera* in lacking strongly developed prominences on the outer surface. However, the presence of branched tubules in the wall of *C. bella* n. sp. indicates that it is more closely related to the genus *Crassosphaera* than *Tasmanites.*

The specific name has been derived from "*bella*" (beautiful).

Type locality:

Holotype: Pl. 69, figs. 1-3.	Sample No. 2-S-8;	lower Shaftesbury Fm.	Sec. 2.
Paratype: Pl. 69, figs. 4-6.	Sample No. 2-S-8;	lower Shaftesbury Fm.	Sec. 2.
Paratypes: Pl. 69, figs. 7-11.	Sample No. 7-S-2;	lower Shaftesbury Fm.	Sec. 7.
Paratype: Pl. 70, figs. 1-3.	Sample No. 7-S-2;	lower Shaftesbury Fm.	Sec. 7.
Holotype: Pl. 69, figs. 1-3.	Slide No. 2-S-8(1);	co-ord. 6.5/59.8.	
Paratype: Pl. 69, figs. 4-6.	Slide No. 2-S-8(1);	co-ord. 14.8/60.2.	
Paratype: Pl. 69, figs. 7, 8.	Slide No. 7-S-2(1);	co-ord. 2.8/77.9.	
Paratype: Pl. 69, figs. 9-11.	Slide No. 7-S-2(1);	co-ord. 19.1/68.8.	
Paratype: Pl. 70, figs. 1-3.	Slide No. 7-S-2-Micro. 96;	co-ord. 12/42.	

Crassosphaera ornata n. sp.

Plate 70, figures 4-6

Description: Test spherical, hollow, thick walled, and usually flattened due to compression; outer surface covered with closely spaced prominences having a trilobate outline and a few sparsely distributed prominences with a circular outline; prominences appearing as about 1-micron high, straight-sided papillae in profile; each prominence with a minute axial tubule running radially from the top of the prominence to the inner surface of the wall; test yellowish brown in color.

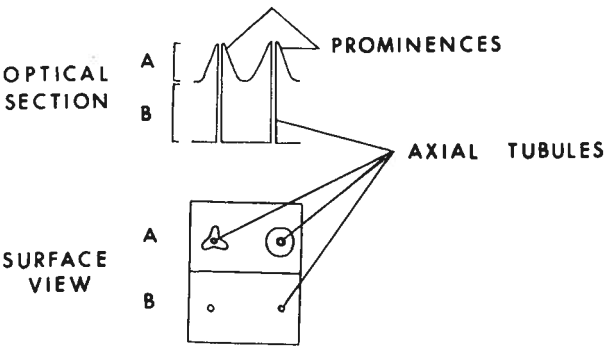

FIGURE 72. Crassosphaera ornata *n. sp. Wall structure.*

Size range: Diameter of the test (4 specimens) 25(30)36 microns. Holotype 36 microns.
Thickness of the wall (4 specimens) 1.5(2)2.5 microns. Holotype 2.5 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Crassosphaera concinna* Cookson and Manum, 1960, differs from *Crassosphaera ornata* n. sp. in possessing subcircular to nearly hexagonal prominences, and in being larger (diameter: 65 to 106 microns).

The specific name has been derived from "*ornata*" (adorned, ornate).

Type locality:

Holotype: Pl. 70, figs. 4-6. Sample No. 4-S-2; lower Shaftesbury Fm. Sec. 4.
Holotype: Pl. 70, figs. 4-6. Slide No. 4-S-2(1); co-ord. 12/52.2.

Crassosphaera papillata n. sp.

Plate 70, figures 7-9; plate 71, figures 1, 2

Description: Test spherical, hollow, thick walled, and usually flattened due to compression; outer surface covered with closely spaced prominences having subcircular to hexagonal outline in surface view; prominences forming a surface pattern resembling the cast of a honeycomb and appearing as 1.5- to 2-micron high and about 1.5-micron wide, straight-sided papillae in profile; hexagonal prominences about 2 microns wide at the base and spaced about 0.5 micron apart; each prominence with a minute axial tubule running radially from the top of the prominence to the inner surface of the wall; test yellowish brown in color.

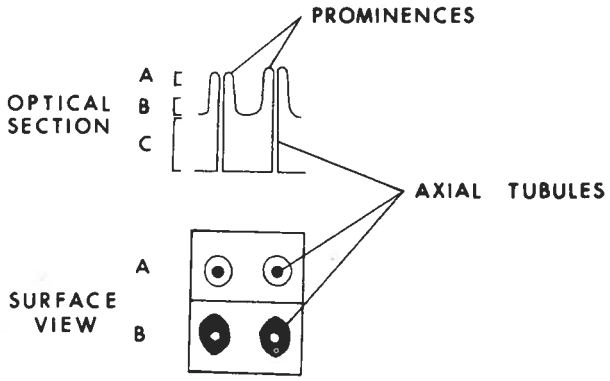

FIGURE 73. Crassosphaera papillata *n. sp. Wall structure.*

Size range: Diameter of the test (1 specimen) 61 microns.
Thickness of the wall (1 specimen) 3 microns.

Distribution: Early Cenomanian. Immediately above the "Fish-scale" marker bed in Shaftesbury Formation of the Peace River area.

Remarks: *Crassosphaera papillata* n. sp. differs from *Crassosphaera concinna* Cookson and Manum, 1960, in possessing a thinner wall and in having narrower and higher papillate prominences on the outer surface of body.

The specific name is derived from "*papillata*" (covered with papilli) and refers to the papillate prominences on the body.

Type locality:

Holotype: Pl. 70, figs. 7-9.
Holotype: Pl. 71, figs. 1, 2. Sample No. 1-US-2; upper Shaftesbury Fm. Sec. 1.
Holotype: Pl. 70, figs. 7-9.
Holotype: Pl. 71, figs. 1, 2. Slide No. 1-US-2(1); co-ord. 5.2/58.5.

Genus **Tasmanites** Newton, 1875, emend. Eisenack, 1958

Type species **Tasmanites punctatus** Newton, 1875

See Norris and Sarjeant (1965, p. 58) for emended generic diagnosis.

Remarks: Eisenack (1958) emended the generic diagnosis of *Tasmanites* to contain hollow, spherical, comparatively thick-walled forms possessing a porous wall. The pores rarely penetrate the entire wall and often end blindly in the thick wall from the outside or from the inside. A pylome is sometimes present. The size is usually large ranging from less than 100 microns to approximately 600 microns.

The specimens become disk shaped in compressed state and are yellow to dark reddish brown in color. In some species the pores are differentiated into minute radial pores (punctae) and larger pore canals.

The genus *Leiosphaeridia* Eisenack, 1958, differs from *Tasmanites* in possessing a nonporous, thinner wall. However, it is often indistinguishable from the younger, thin-walled specimens of *Tasmanites*. The genus *Hungarodiscus* Kriván-Hutter, 1963, closely resembles *Tasmanites* (e.g. *Tasmanites suevicus* (Eisenack) Wall, 1965), but is probably distinguishable by the tubules running through its wall and by its large, round pylome. The genus *Tytthodiscus* Norem, 1955, is distinct in having a wall composed of discrete hexagonal columnar units with central tubules.

Tasmanites newtoni Wall, 1965

Plate 71, figures 3, 4

1962 *Tasmanites* sp. cf. *T. tardus* Eisenack–Wall, Geol. Mag., vol. 99, p. 358, pl. 17, figs. 7, 8, text-fig. 2a-b.

1964 *Tasmanites* cf. *tardus* Eisenack–Manum and Cookson, Skrifter Norske Videnskaps-Akad. Oslo, I. Mat.-Naturv. Klasse, n.s., no. 17, p. 22, pl. 7, fig. 9.

1965 *Tasmanites newtoni* Wall, Micropaleont., vol. 11, p. 163, pl. 9, fig. 11, text-fig. 3A-D.

Description: Test spherical, hollow, thick walled, and usually becoming disk shaped due to compression; wall penetrated partly or wholly by coarser, sparsely

distributed pore canals, and dense, minute pores (punctae); both types of canals arranged radially in the wall; minute pores often not visible; test often splitting at one end along a short, simple, linear suture; test smooth, yellow to dark brown in color.

Size range: Diameter of the test (8 specimens) 45(60)78 microns.
Thickness of the wall (6 specimens) 3(5)7 microns.

Distribution: Early Jurassic to early Late Cretaceous. Harmon Member and lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); Lower Jurassic of England (Wall, 1965).

Remarks: *Tasmanites tardus* Eisenack, 1957, differs from *Tasmanites newtoni* Wall, 1965, in having a thicker wall (about 13 microns), larger size (diameter: 80 to 135 microns) and in lacking the minute pores (punctae).

Locality of figured specimens:

Pl. 71, fig. 3.	Sample No. 6-H-3;	Harmon Member.	Section 6.
Pl. 71, fig. 4.	Sample No. 6-H-2;	Harmon Member.	Section 6.
Pl. 71, fig. 3.	Slide No. 6-H-3(2);	co-ord. 2/71.9.	
Pl. 71, fig. 4.	Slide No. 6-H-2(1);	co-ord. 21/66.1.	

Tasmanites suevicus (Eisenack) Wall, 1965

Plate 71, figures 5, 6; plate 72, figures 1, 2

1957 *Tytthodiscus suevicus* Eisenack, Neues Jahrb. Geol. Paläont., Abhandl., vol. 105, p. 241, pl. 19, figs. 1-3, pl. 20, figs. 1, 2.

1965 *Tasmanites suevicus* (Eisenack) Wall, Micropaleont., vol. 11, p. 163, text-fig. 3E-G.

Description: Test spherical, hollow, thick walled, usually becoming disk shaped due to compression; wall penetrated partly or wholly by coarser, sparsely distributed pore canals, and dense, minute pores (punctae); both types of canals arranged radially in the wall; pore canals usually penetrating the wall entirely and surrounded by a circular, smooth, nonporous area about 5 microns in diameter; minute pores (punctae) arranged in clusters in the outer wall region producing a honeycombed surface pattern; each cluster consisting of 4 to 8 pores; minute pores (punctae) uniformly distributed over the inner wall surface; test dark brown in color.

Size range: Diameter of the test (1 specimen) 140 microns.
Thickness of the wall (1 specimen) 12 microns.

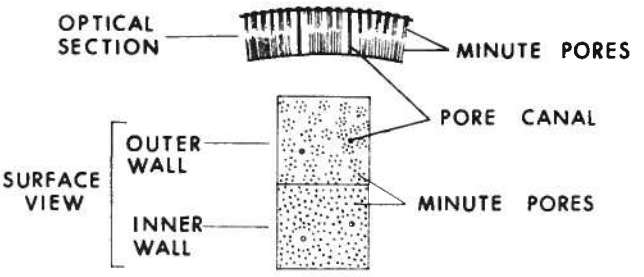

FIGURE 74. Tasmanites suevicus *(Eisenack) Wall. Wall structure.*

Distribution: Early Jurassic to late Oligocene. Lower Shaftesbury Formation of the Peace River area; Lower Jurassic of England (Wall, 1965); Lower Jurassic (Eisenack, 1957), Lower and Middle Jurassic (Gocht, 1964), Valanginian and Hauterivian (Gocht, 1959), late Oligocene (Brosius, 1963) of Germany; Maestrichtian of Poland (Górka, 1963).

Remarks: The honeycombed surface pattern in *Tasmanites suevicus* (Eisenack) Wall, 1965, is formed by clusters of minute radial pores (punctae). The transfer of this species from *Tytthodiscus* to *Tasmanites* by Wall (1965) is justified, as its wall does not contain discrete hexagonal columnar units with central tubules.

The canals appear like small granules in surface view, but in optical section they can be seen penetrating the wall.

The specimen described here as *T. suevicus* differs slightly from those described from Europe, in having a small, circular, smooth, nonporous area around the larger pore canals, and in the uniform distribution of the minute pores (punctae) in the inner portion of the wall.

Locality of figured specimen:

Pl. 71, figs. 5, 6.
Pl. 72, figs. 1, 2. Sample No. 4-S-2; lower Shaftesbury Formation. Section 4.
Pl. 71, figs. 5,6.
Pl. 72, figs. 1, 2. Slide No. 4-S-2-Micro. 93; co-ord. 10/44.

Group **Acritarcha**

Subgroup **Acanthomorphitae**

Genus **Baltisphaeridium** Eisenack, 1958, emend. Downie and Sarjeant, 1963

Type species **Baltisphaeridium longispinosum** (Eisenack) Eisenack, 1958

See Norris and Sarjeant (1965, p. 13) for generic diagnosis.

Remarks: The genus *Baltisphaeridium* was proposed by Eisenack (1958) to accommodate forms with a spherical to oval, nontabulate central body bearing numerous, hollow, branched or unbranched processes which are closed at the outer end. Downie and Sarjeant (1963) emended the genus to include only those forms whose central body has a mean and modal diameter of more than 20 microns.

Micrhystridium Deflandre, 1937, emend. Downie and Sarjeant, 1963, is distinct from *Baltisphaeridium* in having a central body whose mean and modal diameter is less than 20 microns.

Baltisphaeridium crameri n. sp.

Plate 73, figures 1-3

Description: Central body polygonal, smooth, thin walled, and bearing 7 to 10, long, sharply pointed processes; 4 to 6 processes situated at the apices, the remainder on the upper and lower surfaces of the central body; processes 1.5 to 2 microns wide, unbranched, and slightly curved; processes hollow, slightly expanded at their bases, and opening proximally into the body cavity; length of the processes equal to or more than the diameter of the central body.

Size range: Total diameter of the test, including the processes (5 specimens) 54(65)78 microns. Holotype 75 microns.
Diameter of the central body (5 specimens) 19(23)26 microns. Holotype 26 microns.
Length of the processes (5 specimens) 22(26)29 microns. Holotype 29 microns.

Distribution: Middle and late Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Baltisphaeridium longispinosum* (Eisenack) Eisenack, 1958, can be distinguished from *Baltisphaeridium crameri* n. sp. in possessing a spherical central body, and in being considerably larger (overall size: 120 to 300 microns). *B. crameri* n. sp. differs also from *Veryhachium ambiguum* Deunff, 1955, which is

larger (115 microns), and from *Baltisphaeridium spiciferum* (Deunff) Downie and Sarjeant, 1963, whose processes are ornamented by short, oblique spinules. *Baltisphaeridium stimuliferum* (Deflandre) Sarjeant, 1960, is distinct in possessing a spherical central body bearing about 15 processes whose length is less than the diameter of the central body.

The specimen illustrated as *Veryhachium* sp. by Clarke and Verdier (1967, pl. 13, fig. 2) is probably conspecific with *B. crameri* n. sp.

This species has been named in honor of F. H. Cramer.

Type locality:

Holotype: Pl. 73, fig. 1.	Sample No. 6-H-4;	Harmon Member.	Sec. 6.
Paratype: Pl. 73, fig. 2.	Sample No. 7-H-6;	Harmon Member.	Sec. 7.
Paratype: Pl. 73, fig. 3.	Sample No. 3-S-4;	lower Shaftesbury Fm.	Sec. 3.
Holotype: Pl. 73, fig. 1.	Slide No. 6-H-4(1);	co-ord. 17.2/52.2.	
Paratype: Pl. 73, fig. 2.	Slide No. 7-H-6-Micro. 80;	co-ord. 10/46.2.	
Paratype: Pl. 73, fig. 3.	Slide No. 3-S-4(1);	co-ord. 7.8/39.6.	

Baltisphaeridium fimbriatum (White) Sarjeant, 1959

Plate 73, figures 4, 5

1842 *Xanthidium fimbriatum* White, Microsc. Jour., vol. 2, p. 35, pl. 4, div. 3, fig. 3.

1946 *Hystrichosphaeridium fimbriatum* (White) Deflandre, Fichier micropaléontologique, ser. 8, card no. 899.

1955 *Hystrichosphaeridium fimbriatum* (White) Deflandre–Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 273, pl. 2, fig. 4.

1959 *Baltisphaeridium fimbriatum* (White) Sarjeant, Geol. Mag., vol. 96, p. 339.

Description: Central body spherical to ovoidal, thin walled, and densely covered with short processes distributed all over the surface; processes of equal length, unbranched, about 0.3 micron wide, and with capitate or bifid tips giving the appearance of continuity between them; length of the processes from 1/10 to 1/7 of the diameter of the central body.

Size range: Total diameter of the test, including the processes (3 specimens) 48(53)60 microns.
Diameter of the central body (3 specimens) 38(43)51 microns.
Length of the processes (3 specimens) 4(5)6 microns.

Distribution: Cretaceous. Harmon Member of the Peace River area; Upper Cretaceous of England (White, 1842); Lower Cretaceous of Australia (Deflandre and Cookson, 1955).

Locality of figured specimens:

Pl. 73, figs. 4, 5.	Sample No. 6-H-1;	Harmon Member.	Section 6.
Pl. 73, fig. 4.	Slide No. 6-H-1(1);	co-ord. 0.9/62.	
Pl. 73, fig. 5.	Slide No. 6-H-1(1);	co-ord. 4/52.5.	

Baltisphaeridium multispinosum Singh, 1964

Plate 73, figure 6

1964 *Baltisphaeridium multispinosum* Singh, Res. Coun. Alberta, Bull. 15, p. 141, pl. 20, figs. 1, 2.

Description: Central body circular, thin walled, and densely covered with processes distributed all over the surface; processes usually unbranched, about 1 micron wide, hollow, tapering, and with pointed tips; some processes bifurcating at the tips; length of the processes about 1/4 of the diameter of the central body.

Size range: Total diameter of the test, including the processes (22 specimens) 43(55)72 microns.
Diameter of the central body (22 specimens) 36(42)55 microns.
Length of the processes (22 specimens) 6(10)14 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Clearwater and Grand Rapids Formations of central Alberta (Singh, 1964).

Remarks: *Baltisphaeridium multispinosum* resembles the specimen illustrated as *Cometodinium* sp. by Sarjeant (*in* Davey *et al.*, 1966, pl. 22, fig. 6), but differs in lacking any trace of cingulum. The genus *Cometodinium* Deflandre and Courteville, 1939, is restricted to forms whose cingulum is in the form of a circular transverse furrow bordered by irregular ridges and whose central body is covered with long, flexuous, hair-like processes.

Baltisphaeridium whitei (Deflandre and Courteville) Sarjeant, 1959, differs from *B. multispinosum* in having slightly longer, flexuous, hair-like processes. *Baltisphaeridium polytrichum* (Valensi) Sarjeant, 1959, is distinct in having longer processes (about 1/2 of the diameter of central body). *B. multispinosum* can be distinguished from *Baltisphaeridium varispinosum* Sarjeant, 1959, which has slender processes with mostly capitate to bifid tips.

Locality of figured specimen:

Pl. 73, fig. 6.	Sample No. 8-L-12;	Loon River Formation.	Section 8.
Pl. 73, fig. 6.	Slide No. 8-L-12(1);	co-ord. 1/42.	

Baltisphaeridium whitei (Deflandre and Courteville) Sarjeant, 1959

Plate 73, figures 7, 8

1939 *Hystrichosphaeridium whitei* Deflandre and Courteville, Bull. Soc. Francaise Microscopie, vol. 8, p. 103, pl. 3, figs. 5, 6.

1959 *Baltisphaeridium whitei* (Deflandre and Courteville) Sarjeant, Geol. Mag., vol. 96, p. 339.

See Clarke and Verdier (1967, p. 76) for detailed synonymy.

Description: Central body spherical, thin walled, and light brown in color; surface of the central body finely granulate and densely covered with long, filamentous to hair-like processes, producing a characteristic impression of a head covered with hair; processes unbranched, about 0.5 micron wide, with pointed tips; processes curved in different directions and remaining separate from one another throughout their length; length of the processes about 1/3 of the diameter of the central body.

Size range: Total diameter of the test, including the processes (4 specimens) 60(68.5)84 microns.
Diameter of the central body (4 specimens) 36(42)52 microns.
Length of the processes (4 specimens) 12(14)17 microns.

Distribution: Middle Albian to Senonian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area; Cenomanian to Santonian of England (Clarke and Verdier, 1967); Senonian of France (Deflandre and Courteville, 1939; Valensi, 1955); Turonian of Poland (Górka, 1963).

Remarks: The Alberta specimens of *Baltisphaeridium whitei* are identical with those described by Górka (1963) and slightly smaller than those described by Deflandre and Courteville (1939). They differ from the specimens of *B. whitei* illustrated by Clarke and Verdier (1967, pl. 16, figs. 1, 2), which have a matted or membraneous zone surrounding the body.

Baltisphaeridium nanum Cookson, 1965, can be distinguished from *B. whitei* by its smaller size (overall diameter: 36 to 55 microns), shorter processes (1/5 to 1/4 of the body diameter), and the occasional presence of a small opening.

Locality of figured specimens:

Pl. 73, figs. 7, 8.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 73, fig. 7.	Slide No. 7-S-2(1);	co-ord. 18/47.1.	
Pl. 73, fig. 8.	Slide No. 7-S-2(1);	co-ord. 6.8/61.8.	

Baltisphaeridium sp. A

Plate 73, figures 9, 10

Description: Central body oval and brown in color; surface of the central body granulate and densely covered with broad-based, fibrous processes; bases of the processes confluent and forming a broken network of irregular, low ridges on the body; processes splitting into numerous, slender, pointed spines at their outer ends; wall of the central body about 2 microns thick.

Size range: Total length of the test, including the processes (1 specimen) 80 microns.
Total breadth of the test, including the processes (1 specimen) 70 microns.
Length of the central body (1 specimen) 60 microns.
Breadth of the central body (1 specimen) 55 microns.
Length of the processes (1 specimen) 10 to 12 microns.

Distribution: Middle Albian. A single specimen was found in the Harmon Member of the Peace River area.

Remarks: *Baltisphaeridium severinii* Cookson and Cranwell, 1967, differs from *Baltisphaeridium* sp. A in possessing thick processes which remain free throughout their length.

Locality of figured specimen:

Pl. 73, figs. 9, 10.	Sample No. 6-H-6;	Harmon Member.	Section 6.
Pl. 73, figs. 9, 10.	Slide No. 6-H-6-Micro. 89;	co-ord. 11.2/45.7.	

Baltisphaeridium sp. B

Plate 73, figures 11, 12

Description: Central body spherical, thin walled, and light brown in color; surface of the central body finely granulate and densely covered with short,

flexuous, hair-like processes; processes unbranched, about 0.3 micron wide, with pointed tips; processes remaining separate throughout their length; length of the processes about 1/10 of the diameter of the central body.

Size range: Total diameter of the test, including the processes (4 specimens) 50(51.5)53 microns.
Diameter of the central body (4 specimens) 45(46)48 microns.
Length of the processes (4 specimens) 3(4)5 microns.

Distribution: Middle and late Albian. Loon River Formation, Harmon Member, and lower Shaftesbury Formation of the Peace River area.

Remarks: *Baltisphaeridium* sp. B differs from *Baltisphaeridium whitei* (Deflandre and Courteville) Sarjeant, 1959, which has very long, filamentous to hair-like processes. *Baltisphaeridium nanum* Cookson, 1965, resembles *Baltisphaeridium* sp. B in general appearance, but differs in having a thicker body wall, a pylome, and slightly longer processes.

Locality of figured specimens:

Pl. 73, fig. 11.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 73, fig. 12.	Sample No. 6-H-6;	Harmon Member.	Section 6.
Pl. 73, fig. 11.	Slide No. 8-L-9(3);	co-ord. 16/47.1.	
Pl. 73, fig. 12.	Slide No. 6-H-6-Micro. 90;	co-ord. 11.2/43.8.	

Genus **Micrhystridium** Deflandre, 1937, emend. Downie and Sarjeant, 1963

Type species **Micrhystridium inconspicuum** (Deflandre) Deflandre, 1937

See Norris and Sarjeant (1965, p. 40) for generic diagnosis.

Remarks: Downie and Sarjeant (1963, p. 92) emended the genus *Micrhystridium* to include only those forms whose central body has a mean and modal diameter of less than 20 microns. They further restricted the genus to forms with a spherical to oval, nontabulate central body bearing numerous processes with closed tips. The processes are generally simple and of one type only. In rare cases, the processes may be branching or ramifying but are always without any distal connections.

Micrhystridium fragile Deflandre, 1947

Plate 74, figure 1

1947 *Micrhystridium fragile* Deflandre, Bull. Inst. Océanographique, no. 921, p. 8, figs. 13-18.

Description: Body spherical and bearing from 10 to 18 spines; spine bases narrow and distinct from the body; spines simple, hollow, pointed, slender and flexuous; length of the spines about 1/2 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Total diameter of the test, including the spines (2 specimens) 23(25)27 microns.
Diameter of the body (4 specimens) 15(18)20 microns.
Length of the spines (4 specimens) 7(8)10 microns.

Distribution: Jurassic to Oligocene (*fide* Drugg, 1967, p. 34). Widespread in various parts of the world, including Western Canada.

Remarks: The specimens of *Micrhystridium fragile* described by Deflandre (1947) are smaller (overall diameter: 12 to 28 microns; body diameter: 8 to 10.5 microns) and have longer spines than those described in the present study. However, Valensi (1953, p. 42) has subsequently assigned larger specimens (overall diameter: 15 to 40 microns; body diameter: 7 to 20 microns) to *M. fragile.*

M. fragile differs from *Micrhystridium inconspicuum* Deflandre, 1937, which has expanded spine bases, polyhedral shape, and is smaller (body diameter: 5 to 9 microns).

Locality of figured specimen:

Pl. 74, fig. 1.	Sample No. 8-L-3;	Loon River Formation.	Section 8.
Pl. 74, fig. 1.	Slide No. 8-L-3(1);	co-ord. 7.2/52.9.	

Micrhystridium singulare Firtion, 1952

Plate 74, figure 2

1952 *Micrhystridium singulare* Firtion, Ann. Soc. Géol. Nord, vol. 72, p. 160, pl. 8, figs. 1, 2.

Description: Body pentagonal, with straight sides, and bearing 9 spines; each apex of pentagonal body bearing one spine; 3 equally long spines occurring on one surface and one short, about 7-micron long, almost vertical spine occurring on the opposite surface of the body; spine bases slightly expanded but separate from each other; spines simple, hollow, pointed, straight or slightly curved; length of the spines from 2/3 to 4/5 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (4 specimens) 46(51)60 microns.

Diameter of the body (4 specimens) 18(23.5)28 microns.
Length of the long spines (4 specimens) 12(15)18 microns.

Distribution: Devonian to early Eocene (*fide* Tynan, 1962, p. 58). Widespread in various parts of the world, including Western Canada.

Remarks: The specimens of *Micrhystridium singulare* described by Firtion (1952), differ from the Alberta specimens in being slightly smaller (body diameter: 18.5 microns) and more inflated. However, they are identical in all other respects.

M. singulare is characterized by the typical distribution of the spines and the presence of a single, short, vertical spine on one surface of the body. *Micrhystridium stellatum* Deflandre forma 1 Wall and Downie, 1962, resembles *M. singulare*, but differs in being smaller (body diameter: 11 to 17 microns) and in having only 8 spines of equal length.

Locality of figured specimen:

Pl. 74, fig. 2.	Sample No. 6-H-4;	Harmon Member.	Section 6.
Pl. 74, fig. 2.	Slide No. 6-H-4(2);	co-ord. 20/49.9.	

Micrhystridium stellatum Deflandre, 1945

Plate 74, figure 3

1942 *Micrhystridium stellatum* Deflandre, Compt. Rend. Acad. Sci., vol. 215, p. 476, fig. 7 (holotype), not described.

1945 *Micrhystridium stellatum* Deflandre, Ann. Paléont., vol. 31, p. 65, pl. 3, figs. 16-19.

1959 *Micrhystridium stellatum* Deflandre–Downie, Palaeont., vol. 2, p. 61, pl. 11, figs. 11, 14.

1962 *Micrhystridium stellatum* Deflandre forma *stellatum* Wall and Downie, Palaeont., vol. 5, p. 780, pl. 112, fig. 10.

Description: Body subpolygonal, with straight to rounded sides, and bearing about 11 spines; spine bases expanded but separate from each other; spines simple, hollow, pointed, thin, and straight or slightly curved; length of the spines slightly more than 1/2 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Total diameter of the test, including the spines (2 specimens) 42(42.5)43 microns.
Diameter of the body (2 specimens) 21(22.5)24 microns.
Length of the spines (2 specimens) 11(11.5)12 microns.

Distribution: Silurian to Cretaceous. Widespread in various parts of the world, including Western Canada.

Remarks: Deflandre's (1945) specimens of *Micrhystridium stellatum* are smaller (overall diameter: 25 microns; body diameter: 11 to 16 microns) than those described in the present study. However, Downie (1959, p. 61) has assigned larger specimens (body diameter: 9 to 24 microns) to *M. stellatum* which are identical with the Alberta specimens.

Micrhystridium fragile Deflandre, 1937, differs from *M. stellatum* in being smaller and in having a spherical body bearing spines with restricted bases. *Baltisphaeridium stimuliferum* (Deflandre) Sarjeant, 1960, is distinct in being larger and in having a globular body bearing more and longer spines. *Micrhystridium sydus* Valensi, 1953, is distinguishable from *M. stellatum* by its smaller size (body diameter: 5 to 7 microns) and broad-based, radiating spines.

Locality of figured specimen:

Pl. 74, fig. 3.	Sample No. 6-H-6;	Harmon Member.	Section 6.
Pl. 74, fig. 3.	Slide No. 6-H-6(1);	co-ord. 17/63.2.	

Micrhystridium stellatum Deflandre, 1945, forma 6 Wall and Downie, 1962

Plate 74, figures 4-6

1962 *Micrhystridium stellatum* Deflandre forma 6 Wall and Downie, Palaeont., vol. 5, p. 781, pl. 113, fig. 5.

Description: Body polygonal or rounded and bearing about 7 spines; spine bases expanded; spines simple, hollow, pointed, about 2 microns wide, straight or slightly curved; length of the spines about 2/3 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (8 specimens) 38(48.5)60 microns.
Diameter of the body (9 specimens) 17(23)26 microns.
Length of the spines (9 specimens) 12(14)19 microns.

Distribution: Permian to Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Permian of Britain (Wall and Downie, 1962).

Remarks: The specimens of *Micrhystridium stellatum* forma 6, described by

Wall and Downie (1962) are smaller (body diameter: 11 to 17 microns) than those described in the present study. However, they are identical in all other respects.

M. stellatum forma 6 differs from *Veryhachium rhomboidium* Downie, 1959, in having more spines.

Locality of figured specimens:

Pl. 74, fig. 4.	Sample No. 2-S-8;	lower Shaftesbury Formation.	Section 2.
Pl. 74, figs. 5, 6.	Sample No. 3-S-4;	lower Shaftesbury Formation.	Section 3.
Pl. 74, fig. 4.	Slide No. 2-S-8(1);	co-ord. 2/72.9.	
Pl. 74, figs. 5, 6.	Slide No. 3-S-4(1);	co-ord. 13/41.	

Micrhystridium sp.

Plate 74, figure 7

Description: Central body elongate oval, bearing 20 to 30 processes; length of the processes approximately equal to the breadth of the central body; processes unbranched, about 0.5 micron wide, with closed, capitate to bifid tips; central portion of body without processes; central body thin walled, hyaline, and smooth.

Size range: Total length of the test, including the processes (2 specimens) 36 microns.
Total breadth of the test, including the processes (2 specimens) 26(28)30 microns.
Length of the central body (2 specimens) 15(16)17 microns.
Breadth of the central body (2 specimens) 10(12)14 microns.
Length of the processes (2 specimens) 6(10)13 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Micrhystridium* sp. is characterized by an elongate central body which lacks processes in the central portion.

Locality of figured specimen:

Pl. 74, fig. 7.	Sample No. 7-S-2;	lower Shaftesbury Formation.	Section 7.
Pl. 74, fig. 7.	Slide No. 7-S-2(1);	co-ord. 12/44.2.	

Subgroup **Polygonomorphitae**

Genus **Veryhachium** Deunff, 1954, emend. Downie and Sarjeant, 1963

Type species **Veryhachium trisulcum** (Deunff) Deunff, 1954

See Norris and Sarjeant (1965, p. 62) for generic diagnosis.

Remarks: The genus *Veryhachium* contains forms with a triangular, tetrahedral, polygonal or subpolygonal body bearing 3 to 8 hollow, pointed spines with closed tips. The diameter of the body is usually between 10 and 40 microns.

The genus *Domesia* Downie, 1960, resembles *Veryhachium* in possessing 3 spines, but differs in having 2 spines near one pole and the third spine at the opposite pole. *Veryhachium* can be easily distinguished from *Deunffia* Downie, 1960, which has a single spine at one end, and from *Leiofusa* Eisenack, 1938, which has one spine at each pole.

Veryhachium collectum Wall, 1965

Plate 74, figures 8, 9

1965 *Veryhachium collectum* Wall, Micropaleont., vol. 11, p. 159, pl. 3, figs. 11-14, pl. 8, fig. 6.

Description: Body trapezoidal with three equal sides and a fourth, shorter side; body bearing from 4 to 8 simple, hollow spines; each apex of the trapezoidal body bearing one spine; additional 1 to 4 spines usually occurring on the upper and lower surfaces of the body near its broader end; spine bases narrow to slightly expanded; spines simple, pointed, straight or slightly curved; length of the apical spines from slightly less than 1/2 to equal to the maximum diameter of the body; body thin walled and smooth.

Size range: Maximum dimension, including the spines (3 specimens) 44(48)55 microns.
Maximum diameter of the body (3 specimens) 24(26)29 microns.
Length of the longer sides (3 specimens) 22(24)27 microns.
Length of the shorter side (3 specimens) 12(13)15 microns.
Length of the spines (3 specimens) 9(12)17 microns.

Distribution: Early Jurassic to middle Albian. Harmon and Cadotte Members of the Peace River area; Lower Jurassic of Britain (Wall, 1965).

Remarks: *Veryhachium collectum* is characterized by a trapezoidal body with three equal sides and one short side.

The specimens of *V. collectum* described by Wall (1965) are smaller (maximum body diameter: 11 to 16 microns) than those described in the present study. However, the difference in size alone does not provide sufficient justification for the separation of the two at specific level.

Locality of figured specimens:

Pl. 74, fig. 8.	Sample No. 7-C-5;	Cadotte Member.	Section 7.
Pl. 74, fig. 9.	Sample No. 7-H-1;	Harmon Member.	Section 7.
Pl. 74, fig. 8.	Slide No. 7-C-5(1);	co-ord. 4/34.	
Pl. 74, fig. 9.	Slide No. 7-H-1(1);	co-ord. 8/72.	

Veryhachium europaeum Stockmans and Willière, 1960,
forma 1 Wall and Downie, 1962

Plate 74, figures 10-13

1962 *Veryhachium europaeum* Stockmans and Willière forma 1 Wall and Downie, Palaeont., vol. 5, p. 782, pl. 114, figs. 4, 5.

Description: Body tetrahedral with triangular outline and bearing 4 simple, hollow, and equal spines; sides of the body more or less straight; each apex of the triangular body bearing one spine; fourth spine almost vertical and occupying the center of the triangular face; spine bases expanded; spines simple, pointed, and straight; length of the spines from 1/3 to 1/2 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (8 specimens) 30(38)53 microns.
Maximum diameter of the body (5 specimens) 20(22)24 microns.
Length of the spines (5 specimens) 5(8)12 microns.

Distribution: Permian to Albian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; Permian (Wall and Downie, 1962) and Lower Jurassic (Wall, 1965) of Britain.

Remarks: The specimens of *Veryhachium europaeum* forma 1 described by Wall and Downie (1962) are slightly smaller (body diameter: 15 to 20 microns) than those described in the present study.

The morphotypes of *V. europaeum* proposed by Wall and Downie (1962) are based mainly upon the relation between the length of the spines and the diameter of the body. The typical specimens of *V. europaeum* described by Stockmans and

Willière (1960), from the Devonian of Belgium, differ from *V. europaeum* forma 1 in having spines which are longer than the diameter of the body. *Veryhachium irregulare* forma *subtetraedron* Jekhowsky, 1961, can be distinguished from *V. europaeum* forma 1 by its inflated, subglobular appearance.

Locality of figured specimens:

Pl. 74, figs. 10-13.	Sample No. 7-C-1;	Cadotte Member.	Section 7.
Pl. 74, figs. 10,11.	Slide No. 7-C-1(2);	co-ord. 10/48.5.	
Pl. 74, figs. 12, 13.	Slide No. 7-C-1(1);	co-ord. 10.1/34.2.	

Veryhachium europaeum Stockmans and Willière, 1960,
forma 2 Wall and Downie, 1962

Plate 74, figures 14, 15

1962 *Veryhachium europaeum* Stockmans and Willière forma 2 Wall and Downie, Palaeont., vol. 5, p. 782, pl. 114, fig. 6.

Description: Body tetrahedral with triangular outline and bearing 4 simple, hollow, and equal spines; sides of the body more or less straight; each apex of the triangular body bearing one spine; fourth spine almost vertical and occupying the center of the triangular face; spine bases relatively narrow; spines simple, pointed, straight or slightly curved; length of the spines more than 1/2 to equal to the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (9 specimens) 39(49)70 microns.
Maximum diameter of the body (9 specimens) 19(23)30 microns.
Length of the spines (9 specimens) 11(17)24 microns.

Distribution: Permian to Albian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; Permian (Wall and Downie, 1962) and Lower Jurassic (Wall, 1965) of Britain.

Remarks: The specimens of *Veryhachium europaeum* forma 2 described by Wall and Downie (1962) are slightly smaller (body diameter: 15 to 20 microns) than those described in the present study.

V. europaeum forma 1 Wall and Downie, 1962, differs from *V. europaeum* forma 2 in having spines whose length is less than half of the diameter of the body. The typical specimens of *V. europaeum* described by Stockmans and Willière

(1960) are distinct from *V. europaeum* forma 2 in having spines which are longer than the diameter of the body.

Locality of figured specimens:

Pl. 74, fig. 14.	Sample No. 7-C-10;	Cadotte Member.	Section 7.
Pl. 74, fig. 15.	Sample No. 7-H-1(A);	Harmon Member.	Section 7.
Pl. 74, fig. 14.	Slide No. 7-C-10(1);	co-ord. 11/44.	
Pl. 74, fig. 15.	Slide No. 7-H-1(A)(1);	co-ord. 9/63.9.	

Veryhachium formosum Stockmans and Willière, 1960,
forma 2 Wall and Downie, 1962

Plate 74, figures 16-18

1962 *Veryhachium formosum* Stockmans and Willière forma 2 Wall and Downie, Palaeont., vol. 5, p. 783, pl. 114, figs. 9-11.

Description: Body tetrahedral with triangular outline and bearing from 6 to 8 spines; sides of the body more or less straight; each apex of the triangular body bearing one spine; the remaining 3 to 5 spines occurring on the upper and lower surfaces of the body; spine bases slightly expanded but distinct from the body; spines simple, hollow, pointed, straight or slightly curved; length of the spines less than the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (5 specimens) 38(52)63 microns.
Maximum diameter of the body (5 specimens) 20(25)30 microns.
Length of the spines (5 specimens) 11(17)22 microns.

Distribution: Permian to Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area; Permian (Wall and Downie, 1962) and Lower Jurassic (Wall, 1965) of Britain.

Remarks: The specimens of *Veryhachium formosum* forma 2 described by Wall and Downie (1962) are smaller (body diameter: 15 microns) than those described in the present study. However, the difference in size alone does not provide sufficient basis for the separation of the two at specific level.

The typical specimens of *Veryhachium formosum* described by Stockmans and Willière (1960) differ from *V. formosum* forma 2 in having spines which are considerably longer than the diameter of the body.

Locality of figured specimens:

Pl. 74, fig. 16.	Sample No. 7-H-1;	Harmon Member.	Section 7.
Pl. 74, figs. 17, 18.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Section 3.
Pl. 74, fig. 16.	Slide No. 7-H-1(1);	co-ord. 16/69.5.	
Pl. 74, figs. 17, 18.	Slide No. 3-S-5(1);	co-ord. 13/78.5.	

Veryhachium irregulare forma **subtetraedron** Jekhowsky, 1961

Plate 74, figure 19

1961 *Veryhachium*? *irregulare* forma *subtetraedron* Jekhowsky, Rev. Micropaléont., vol. 3, p. 208, pl. 1, figs. 4-9.

Description: Body subtetrahedral, inflated, with convex sides and bearing 4 spines; one spine at each apex; outline inflated quadrangular or triangular; spines simple, short, and conical; length of the spines from 1/4 to 1/2 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (5 specimens) 21(27)33 microns.
Maximum diameter of the body (5 specimens) 9(16)20 microns.
Length of the spines (5 specimens) 5(6)7 microns.

Distribution: Permian to Albian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Permian (Wall and Downie, 1962) and Lower Jurassic (Wall, 1965) of Britain; Permo-Trias of Brazil and Yugoslavia, Anisian and Norian of the Soviet Arctic (*fide* Jekhowsky, 1961, p. 210).

Locality of figured specimen:

Pl. 74, fig. 19.	Sample No. 7-H-2;	Harmon Member.	Section 7.
Pl. 74, fig. 19.	Slide No. 7-H-2(2);	co-ord. 1/66.1.	

Veryhachium lairdi (Deflandre) Deunff, 1954

Plate 74, figure 20; plate 75, figures 1-3

1946 *Hystrichosphaeridium lairdi* Deflandre, Fichier micropaléontologique, ser. 8, card no. 1112.

1954 *Veryhachium lairdi* (Deflandre) Deunff, Compt. Rend. Soc. Géol. France, no. 13, p. 306.

1958 *Veryhachium lairdi* (Deflandre) Deunff, Bull. Soc. Géol. Mineral. Bretagne, n.s., fasc. 2, p. 28, pl. 8, figs. 75-79.

Description: Body rectangular with straight to slightly concave sides and bearing 4 spines; each apex of the rectangular body bearing one spine; spine bases narrow to slightly expanded and distinct from the body; spines simple, hollow, about 2 microns wide, pointed, and straight or slightly curved; length of the spines from 1/2 to 1½ times the maximum diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (21 specimens) 40(61)84 microns.
Length of the body (25 specimens) 17(22)27 microns.
Breadth of the body (8 specimens) 15(18)20 microns.
Length of the spines (25 specimens) 11(21)31 microns.

Distribution: Ordovician to Albian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; Middle Silurian of Ontario, Canada (Laird, 1935); Ordovician of France (Deunff, 1958); Silurian of Belgium (Stockmans and Willière, 1963); Ordovician to Lower Devonian of northwestern Spain (Cramer, 1964b).

Remarks: The Alberta specimens of *Veryhachium lairdi* closely resemble the holotype figured by Deflandre (1946) and the specimens illustrated by Cramer (1964b) and Stockmans and Willière (1963). However, Deunff's (1958) specimens differ in having extremely expanded spine bases, which merge with the outline of the body producing concave sides.

Veryhachium valiente Cramer, 1964, differs from *V. lairdi* in having a square body and in being smaller (overall dimension: 30 to 40 microns).

Locality of figured specimens:

Pl. 74, fig. 20.	Sample No. 2-S-3;	lower Shaftesbury Fm.	Section 2.
Pl. 75, fig. 1.	Sample No. 6-H-7;	Harmon Member.	Section 6.
Pl. 75, fig. 2.	Sample No. 2-S-7;	lower Shaftesbury Fm.	Section 2.
Pl. 75, fig. 3.	Sample No. 7-C-9;	Cadotte Member.	Section 7.
Pl. 74, fig. 20.	Slide No. 2-S-3(1);	co-ord. 14.3/36.8.	
Pl. 75, fig. 1.	Slide No. 6-H-7(1);	co-ord. 0.8/59.9.	
Pl. 75, fig. 2.	Slide No. 2-S-7(1);	co-ord. 4.5/68.5.	
Pl. 75, fig. 3.	Slide No. 7-C-9(1);	co-ord. 12/62.	

Veryhachium minutum Downie, 1958

Plate 75, figure 4

1958 *Veryhachium minutum* Downie, Proc. Yorkshire Geol. Soc., vol. 31, p. 344, pl. 17, fig. 4, text-fig. 3c.

Description: Body quadrangular with concave sides and bearing 5 spines; each apex bearing one spine and the fifth spine borne on the upper or lower surface of the body; spine bases expanded and indistinguishable from the body; spines simple, hollow, pointed, straight or curved; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (1 specimen) 33 microns.
Maximum diameter of the body (1 specimen) 16 microns.
Length of the spines (1 specimen) 8 microns.

Distribution: Probably reworked from Ordovician strata. A single specimen was found in the upper portion of the Harmon Member.

Remarks: *Veryhachium minutum* differs from *Veryhachium rhomboidium* Downie, 1959, in having very expanded spine bases and in being smaller.

Locality of figured specimen:

Pl. 75, fig. 4.	Sample No. 7-H-4;	Harmon Member.	Section 7.
Pl. 75, fig. 4.	Slide No. 7-H-4(1);	co-ord. 9.5/36.2.	

Veryhachium reductum (Deunff) Jekhowsky, 1961

Plate 75, figures 5-7

1958 *Veryhachium trisulcum* Deunff var. *reductum* Deunff, Bull. Soc. Géol. Mineral. Bretagne, n.s., fasc. 2, p. 27, pl. 1, figs. 1, 3, 8, 10, 11.

1961 *Veryhachium reductum* (Deunff) Jekhowsky, Rev. Micropaléont., vol. 3, p. 210, pl. 2, figs. 22-44.

Description: Body triangular with slightly convex to straight sides; each apex of the triangular body bearing one spine; spine bases narrow and distinct from the body; spines simple, hollow, pointed, straight or curved; spines closed at the tip and opening proximally into the body; length of the spines from 1/3 to 3/4 of the diameter of the body; body thin walled, hyaline, and smooth.

Size range: Maximum dimension, including the spines (13 specimens) 34(40)48 microns.

Maximum diameter of the body (13 specimens) 18(22)25 microns.
Length of the spines (13 specimens) 6(10)16 microns.

Distribution: Ordovician to Cenomanian. Widespread in various parts of the world, including Western Canada.

Remarks: The specimens of *Veryhachium reductum* described by Singh (1964, p. 142) from the Grand Rapids Formation are approximately twice the size of the specimens described in the present study. However, they are within the limits of the size range given for this species by Deunff (1958).

Locality of figured specimens:

Pl. 75, fig. 5.	Sample No. 2-S-16;	lower Shaftesbury Fm.	Section 2.
Pl. 75, fig. 6.	Sample No. 7-H-1(A);	Harmon Member.	Section 7.
Pl. 75, fig. 7.	Sample No. 7-C-9;	Cadotte Member.	Section 7.
Pl. 75, fig. 5.	Slide No. 2-S-16(1);	co-ord. 18.2/41.5.	
Pl. 75, fig. 6.	Slide No. 7-H-1(A)(1);	co-ord. 19.1/42.5.	
Pl. 75, fig. 7.	Slide No. 7-C-9(1);	co-ord. 19/61.7.	

Veryhachium reductum (Deunff) Jekhowsky, 1961, forma 1

Plate 75, figure 8

Description: Body triangular with slightly concave sides; apices of the body pointed; apical spines indistinguishable from the body; a thin area of weakness developed at mid-point on each side; surface of the body smooth; body wall about 1 micron thick.

Size range: Maximum dimension, including the spines (1 specimen) 46 microns.
Maximum diameter of the body (1 specimen) 34 microns.

Distribution: Middle Albian. A single specimen was found in the Cadotte Member of the Peace River area.

Remarks: *Veryhachium reductum* (Deunff) var. *concavum* Cookson and Eisenack, 1962, resembles *Veryhachium reductum* forma 1, but differs in having more sharply concave sides and an undulant process at each apex.

Locality of figured specimen:

Pl. 75, fig. 8.	Sample No. 7-C-2;	Cadotte Member.	Section 7.

Pl. 75, fig. 8. Slide No. 7-C-2(1); co-ord. 16.2/66.

Veryhachium rhomboidium Downie, 1959

Plate 75, figures 9-13

1959 *Veryhachium rhomboidium* Downie, Palaeont., vol. 2, p. 62, pl. 12, fig. 10.

Description: Body rhomboidal with more or less straight sides and bearing 5 to 6 spines; each apex of the rhomboidal body bearing one spine; remaining 1 to 2, almost vertical spines occurring on the upper or lower surface of the body; spine bases slightly expanded but distinct from the body; body usually elongate; spines simple, hollow, pointed, straight or slightly curved; length of the spines from 1/2 to equal to the maximum diameter of the body; surface of the body smooth; body wall moderately thick.

Size range: Maximum dimension, including the spines (13 specimens) 39(55)77 microns.
Maximum diameter of the body (13 specimens) 16(22.5)30 microns.
Length of the spines (13 specimens) 9(17)30 microns.

Distribution: Silurian to Albian. Loon River Formation, Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Silurian (Downie, 1959) and Permian (Wall and Downie, 1962) of Britain.

Remarks: *Veryhachium rhomboidium* is characterized by the rhombic shape of its body. The specimens described in the present study closely resemble the typical Silurian form described by Downie (1959), but differ from the Permian morphotypes of *V. rhomboidium* of Wall and Downie (1962), which have more slender and flexuous spines.

Locality of figured specimens:

Pl. 75, figs. 9, 10.	Sample No. 7-C-10;	Cadotte Member.	Section 7
Pl. 75, fig. 11.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Section 3
Pl. 75, figs. 12, 13.	Sample No. 7-C-7;	Cadotte Member.	Section 7
Pl. 75, figs. 9, 10.	Slide No. 7-C-10(1);	co-ord. 6.2/52.9.	
Pl. 75, fig. 11.	Slide No. 3-S-5(1);	co-ord. 14/65.8.	
Pl. 75, figs. 12, 13.	Slide No. 7-C-7(2);	co-ord. 6.2/68.8.	

Subgroup **Sphaeromorphitae**

Genus **Leiosphaeridia** Eisenack, 1958, emend. Downie and Sarjeant, 1963

Type species **Leiosphaeridia baltica** Eisenack, 1958

See Norris and Sarjeant (1965, p. 36) for generic diagnosis.

Remarks: The genus *Leiosphaeridia* consists of spherical to ellipsoidal, nontabulate forms with thin, often folded, smooth, punctate or granular wall. The body is with or without a pylome.

Leiosphaeridium Timofeyev, 1959, and *Protoleiosphaeridium* Timofeyev, 1959, are junior synonyms of *Leiosphaeridia* Eisenack, 1958.

Leiosphaeridia sp.

Plate 75, figure 14

Description: Test spherical, with numerous folds; wall about 0.5 micron thick, hyaline, and smooth; test without pylome; a light yellow-green, round spot, about 10 microns in diameter, present on the inner side of the body wall.

Size range: Diameter of the test (1 specimen) 52 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Leiosphaeridia hyalina* Deflandre, 1941, resembles *Leiosphaeridia* sp. but differs in having yellow-green crystalline bodies arranged in a circular area and appressed to the inside of the body wall.

Locality of figured specimen:

Pl. 75, fig. 14. Sample No. 3-S-4; lower Shaftesbury Formation. Section 3.
Pl. 75, fig. 14. Slide No. 3-S-4(1); co-ord. 3.1/80.

Subgroup **Netromorphitae**

Genus **Leiofusa** Eisenack, 1938

Type species **Leiofusa fusiformis** (Eisenack) Eisenack, 1938

See Norris and Sarjeant (1965, p. 35) for generic diagnosis.

Remarks: The genus *Leiofusa* consists of forms having an elongate fusiform body which is often prolonged into one pointed process at either end. It also contains forms having an oval body with one spine at either end. The surface is smooth to striated.

The genus *Leiofusa* differs from *Leiovalia* Eisenack, 1965, which contains smooth, oval forms, and from *Navifusa* Combaz, Lange, and Pansart, 1967, which accommodates elongate ellipsoidal to cylindrical forms with rounded ends. *Dactylofusa* Brito and Santos, 1965, is distinct in being ornamented by longitudinal rows of small spines or claviform processes.

Leiofusa bernesga Cramer, 1964

Plate 75, figures 15, 16

1964a *Leiofusa bernesga* Cramer, Bull. Soc. Belge Géol. Paléont. Hydrol., vol. 73, p. 37, pl. 2, fig. 10.

Description: Body almost circular to oval, with one hollow and pointed spine at either end; body length to breadth ratio between 1.1 and 1.3; spine bases narrow and distinct from the body; length of the spines from almost equal to 1½ times the length of the body; spines about 1 micron wide and usually curved; specimens usually split into two equal halves by a rupture along the width of the body; body thin walled, hyaline, and smooth.

Size range: Total length, including the spines (6 specimens) 31(39)48 microns.
Length of the body (6 specimens) 11(13)14 microns.
Breadth of the body (6 specimens) 10(10.5)12 microns.
Body length to breadth ratio (6 specimens) 1.1(1.2)1.3.
Length of the spines (6 specimens) 10(14)19 microns.

Distribution: Late Silurian to Albian. Harmon and Cadotte Members, and lower Shaftesbury Formation of the Peace River area; Upper Silurian (Cramer, 1964a) and Upper Silurian to Lower Devonian (Cramer, 1964b) of northwestern Spain.

Remarks: The upper size limit of Cramer's (1964a, 1964b) specimens of *Leiofusa bernesga* is higher (maximum length: 60 microns; maximum breadth: 30 microns) than that of the Alberta specimens. The lower size limit has not been given by Cramer. Presumably, the Alberta specimens of *L. bernesga* are within the size limits of this species. The specimens of *L. bernesga* illustrated by Combaz, Lange, and Pansart (1967) are identical with those found in Alberta.

L. bernesga is characterized by its small size, almost circular body, spines with

restricted bases, and the tendency to split along the width into two equal halves. *Leiofusa tumida* Downie, 1959, differs from *L. bernesga* in being larger (overall length: 110 microns).

Locality of figured specimens:

Pl. 75, figs. 15, 16.	Sample No. 7-H-1;	Harmon Member.	Section 7.
Pl. 75, fig. 15.	Slide No. 7-H-1(1);	co-ord. 2/49.2.	
Pl. 75, fig. 16.	Slide No. 7-H-1(1);	co-ord. 8/58.1.	

Leiofusa jurassica Cookson and Eisenack, 1958

Plate 75, figures 17, 18

1958 *Leiofusa jurassica* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 51, pl. 10, figs. 3, 4.

Description: Body elongate oval to fusiform, prolonged into one hollow and pointed spine at either end; body length to breadth ratio between 1.4 and 2.4; spine bases narrow to slightly expanded; length of the spine from 1/4 to almost equal to the length of the body; body thin walled, hyaline, and smooth.

Size range: Total length, including the spines (7 specimens) 28(44.5)60 microns.
Length of the body (7 specimens) 19(25)36 microns.
Breadth of the body (7 specimens) 12(14)16 microns.
Body length to breadth ratio (7 specimens) 1.4(1.8)2.4.
Length of the spines (7 specimens) 5(11)20 microns.

Distribution: Permian to Oligocene (*fide* Combaz, Lange, and Pansart, 1967, p. 300, 301). Widespread in various parts of the world, including Western Canada.

Remarks: The specimens of *Leiofusa jurassica* described in the present study are similar to those described by Wall (1965). The Australian specimens of *L. jurassica* described by Cookson and Eisenack (1958) are slightly longer (overall length: 67 to 72 microns) and possess more elongate bodies.

Locality of figured specimens:

Pl. 75, figs. 17, 18.	Sample No. 2-S-3;	lower Shaftesbury Formation.	Section 2.
Pl. 75, fig. 17.	Slide No. 2-S-3(1);	co-ord. 9/77.	
Pl. 75, fig. 18.	Slide No. 2-S-3(1);	co-ord. 5.2/38.5.	

Subgroup **Herkomorphitae**

Genus **Cymatiosphaera** O. Wetzel, 1933, emend. Deflandre, 1954

Type species **Cymatiosphaera radiata** O. Wetzel, 1933

See Norris and Sarjeant (1965, p. 22) for generic diagnosis.

Remarks: The genus *Cymatiosphaera* consists of hollow, spherical to elliptical forms whose external surface is divided into polygonal fields by high or low membraneous crests perpendicular to the surface. The crests are usually thickened at the points of junction giving the impression of short rods in lateral view. The surface of the test is smooth or punctate or with granules. Some species (e.g. *Cymatiosphaera pachytheca* Eisenack, 1957) are characterized by a radial pore canal in the center of each field. No pylome or system of equatorial differentiation of the fields is present.

The generic diagnosis of *Cymatiosphaera* has been slightly altered here to include those forms which have a radial pore canal in the center of each field.

The genus *Dictyotidium* Eisenack, 1955, emend. Staplin, 1961, differs from *Cymatiosphaera* in possessing differentiated polar polygons and short spines or apiculae on the crests.

Cymatiosphaera pachytheca Eisenack, 1957

Plate 76, figures 1-11

1957 *Cymatiosphaera pachytheca* Eisenack, Neues Jahrb. Geol. Paläont., Abhandl., vol. 105, p. 244, pl. 19, figs. 4, 5, pl. 20, fig. 11.

Description: Test spherical, hollow, and thick walled; surface of the test divided into 20 to 25 pentagonal to hexagonal fields by about 2-micron high membraneous crests; fields straight sided and relatively large; a single radial pore canal usually occurring in the center of each field; crests slightly fluted and often enclosing less than 1-micron wide circular spaces at the angles or along the sides of the fields; test smooth, yellow to dark reddish brown in color.

Size range: Total diameter of the test (45 specimens) 37(61)84 microns.
Thickness of the wall (41 specimens) 2(7.5)12 microns; 5(12)15 per cent of the test diameter.
Diameter of the fields (39 specimens) 8(22)34 microns; 22(36)40 per cent of the test diameter.

Distribution: Early Jurassic to Albian. Harmon and Cadotte Members and lower Shaftesbury Formation of the Peace River area; Lower Jurassic of England

(Wall, 1965); Lower Jurassic (Eisenack, 1957) and Middle Jurassic (Gocht, 1964) of Germany.

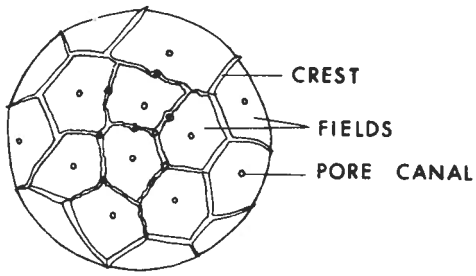

FIGURE 75. Cymatiosphaera pachytheca *Eisenack.*

Remarks: The radial pore canals usually appear like short spines or small tubercles under low magnification. However, in optical section and under high magnification, the pore canals can be seen penetrating the wall and opening at the center of each field. They are similar in nature to the pore canals of *Tasmanites* Newton, 1875, emend. Eisenack, 1958.

Some of the specimens included here in *Cymatiosphaera pachytheca* do not show the pore canals, and others are slightly smaller than the specimens originally assigned to this species by Eisenack (1957) which have a test diameter ranging from 50 to 100 microns.

Cymatiosphaera stigmata Cookson and Eisenack, 1958, differs from *C. pachytheca* in having a small, circular thickening in the center of each field and in possessing a larger number (up to 40) of fields.

Locality of figured specimens:

Pl. 76, figs. 1-11.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 76, figs. 1, 2.	Slide No. 4-S-2(1);	co-ord. 13/71.	
Pl. 76, figs. 3-5.	Slide No. 4-S-2(1);	co-ord. 8.2/69.5.	
Pl. 76, figs. 6, 7.	Slide No. 4-S-2(1);	co-ord. 20/76.2.	
Pl. 76, fig. 8.	Slide No. 4-S-2-Micro. 128;	co-ord. 12.2/42.2.	
Pl. 76, figs. 9-11.	Slide No. 4-S-2(1);	co-ord. 7.5/67.8.	

Cymatiosphaera sp. A

Plate 77, figures 1, 2

Description: Test spherical, hollow, and thin walled; surface of the test divided into about 15 polygonal fields by about 5-micron high membraneous crests; fields relatively large with sinuous sides; crests usually enclosing about 1-micron wide, circular spaces at the angles of the fields; test smooth, yellow in color.

Size range: Total diameter of the test (1 specimen) 63 microns.
Thickness of the wall (1 specimen) 3 microns.
Diameter of the fields (1 specimen) 16 to 24 microns.

Distribution: Middle Albian. A single specimen was found in the Loon River Formation of the Peace River area.

Remarks: *Cymatiosphaera* sp. A differs from *Cymatiosphaera pachytheca* Eisenack, 1957, in possessing higher membraneous crests and in lacking a pore canal in the center of each field.

Locality of figured specimen:

Pl. 77, figs. 1, 2.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 77, figs. 1, 2.	Slide No. 8-L-9(3);	co-ord. 9.3/76.2.	

Cymatiosphaera sp. B

Plate 77, figures 3, 4

Description: Test spherical, hollow, and thick walled; surface of the test divided into about 65 polygonal fields by about 2-micron high membraneous crests; fields relatively small; crests slightly fluted and usually enclosing less than 1-micron wide circular spaces at the angles of the fields; test smooth, reddish brown in color.

Size range: Total diameter of the test (2 specimens) 65(67.5)70 microns.
Thickness of the wall (2 specimens) 7 microns.
Diameter of the fields (2 specimens) 6(10)14 microns.

Distribution: Middle Albian. Harmon Member of the Peace River area.

Remarks: *Cymatiosphaera* sp. B differs from *Cymatiosphaera pachytheca* Eisenack, 1957, in possessing a larger number of fields and in lacking a pore canal in the center of each field.

Locality of figured specimen:

Pl. 77, figs. 3, 4.	Sample No. 6-H-6;	Harmon Member.	Section 6.
Pl. 77, figs. 3, 4.	Slide No. 6-H-6(2);	co-ord. 2/35.	

Cymatiosphaera sp. C

Plate 77, figures 5, 6

Description: Test spherical, hollow, and thin walled; surface of the test divided into about 22 polygonal fields by about 2-micron high membraneous crests; fields relatively large; a single radial pore canal usually occurring in the center of each field; crests slightly fluted; test smooth, brownish yellow in color.

Size range: Total diameter of the test (5 specimens) 24(27)31 microns.
Thickness of the wall (5 specimens) 2 microns.
Diameter of the fields (5 specimens) 6(10)14 microns.

Distribution: Middle and late Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area.

Remarks: *Cymatiosphaera* sp. C resembles *Cymatiosphaera parva* Sarjeant, 1959, but differs in being slightly larger and in having a pore canal in the center of each field.

Locality of figured specimen:

Pl. 77, figs. 5, 6.	Slide No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 77, figs. 5, 6.	Sample No. 4-S-2(2);	co-ord. 8/61.2.	

Subgroup **Pteromorphitae**

Genus **Pterospermopsis** W. Wetzel, 1952

Type species **Pterospermopsis danica** W. Wetzel, 1952

See Norris and Sarjeant (1965, p. 52) for generic diagnosis.

Remarks: The genus *Pterospermopsis* accommodates forms having a spherical to ellipsoidal central body surrounded by a flat, membraneous, equatorial wing lamella. The wing lamella is often strengthened by radial folds. The central body is frequently compressed giving the test a disk-shaped appearance.

The genus *Thalassiphora* Eisenack and Gocht, 1960, emend. Gocht, 1968, differs from *Pterospermopsis* in having a helmet-shaped, double-layered, membraneous wing which is in contact with only the dorsal surface of the central body. *Thalassiphora* also differs in having a hoof-shaped precingular archeopyle, and in often being tabulate.

Pterospermopsis aureolata Cookson and Eisenack, 1958

Plate 77, figures 7-9

1958 *Pterospermopsis aureolata* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 49, pl. 9, figs. 10-12.

Description: Test disk shaped; central body thick walled, smooth, circular in polar view, and biconvex in equatorial view; body surrounded by a flat, smooth, membraneous, firm, equatorial wing lamella; diameter of the central body 1/2 or more than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (24 specimens) 67(88)125 microns.
Diameter of the central body (24 specimens) 36(53)83 microns.
Width of the wing (24 specimens) 12(18)28 microns.

Distribution: Aptian to early Turonian. Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Aptian to early Turonian of Australia (Cookson and Eisenack, 1958).

Remarks: The specimens of *Pterospermopsis aureolata* described by Cookson and Eisenack (1958) are larger (overall diameter: 109 to 208 microns) than those described in the present study. However, this difference in size is insufficient for the separation of the two at the specific level.

Locality of figured specimens:

Pl. 77, figs. 7-9.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 77, fig. 7.	Slide No. 4-S-2-Micro. 126;	co-ord. 13.5/46.8.	
Pl. 77, fig. 8.	Slide No. 4-S-2(2);	co-ord. 13/41.8.	
Pl. 77, fig. 9.	Slide No. 4-S-2(1);	co-ord. 19.1/36.	

Pterospermopsis sp. cf. **P. aureolata** Cookson and Eisenack, 1958

Plate 77, figure 10

Description: Test disk shaped; central body smooth, circular in polar view, and biconvex in equatorial view; body surrounded by a flat, smooth, membraneous,

equatorial wing lamella; diameter of the central body 1/2 or more than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (6 specimens) 42(44)48 microns.
Diameter of the central body (4 specimens) 24(25)26 microns.
Width of the wing (4 specimens) 9(10)12 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: The specimens of *Pterospermopsis aureolata* described by Cookson and Eisenack (1958) are considerably larger (overall diameter: 109 to 208 microns) than *Pterospermopsis* sp. cf. *P. aureolata.*

Locality of figured specimen:

Pl. 77, fig. 10. Sample No. 4-S-2; lower Shaftesbury Formation. Section 4.
Pl. 77, fig. 10. Slide No. 4-S-2(1); co-ord. 16.2/64.9.

Pterospermopsis australiensis Deflandre and Cookson, 1955

Plate 77, figures 11, 12

1955 *Pterospermopsis australiensis* Deflandre and Cookson, Australian Jour. Marine and Freshwater Res., vol. 6, p. 286, pl. 3, fig. 4, text-figs. 52, 53.

Description: Test disk shaped; central body smooth, circular in polar view, and ellipsoidal in equatorial view; body surrounded by an undulating, radially folded, relatively wide, membraneous, equatorial wing lamella; folds in the wing irregularly spaced and of varying magnitude; diameter of the central body less than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (14 specimens) 24(34)40 microns.
Diameter of the central body (14 specimens) 10(14)17 microns.
Width of the wing (12 specimens) 8(11)14 microns.

Distribution: Early Cretaceous to Paleocene. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; late Albian of northern Wyoming, U.S.A. (Davis, 1963); Paleocene of northwestern South Dakota, U.S.A. (Stanley, 1965); Lower Cretaceous of Rumania (Baltes, 1965) and Australia (Deflandre and Cookson, 1955).

Remarks: *Pterospermopsis helios* Sarjeant, 1959, can be distinguished from *Pterospermopsis australiensis* in having regularly spaced folds in the wing and in being smaller (overall diameter: 25 microns). *Pterospermopsis microptera* Deflandre and Cookson, 1955, is distinct in possessing a narrower wing with regularly spaced folds.

Locality of figured specimens:

Pl. 77, fig. 11.	Sample No. 7-H-1;	Harmon Member.	Section 7.
Pl. 77, fig. 12.	Sample No. 6-H-1;	Harmon Member.	Section 6.
Pl. 77, fig. 11.	Slide No. 7-H-1(1);	co-ord. 17.1/76.	
Pl. 77, fig. 12.	Slide No. 6-H-1(1);	co-ord. 1.2/73.1.	

Pterospermopsis eurypteris Cookson and Eisenack, 1958

Plate 78, figures 1-3

1958 *Pterospermopsis eurypteris* Cookson and Eisenack, Proc. Roy. Soc. Victoria, vol. 70, pt. 1, p. 49, pl. 9, figs. 9, 13.

Description: Test disk shaped; central body thick walled, smooth, circular in polar view, and biconvex in equatorial view; body surrounded by a flat, smooth, relatively wide, rather thick, equatorial wing lamella; diameter of the central body less than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (33 specimens) 70(87)105 microns.
Diameter of the central body (33 specimens) 24(37)52 microns.
Width of the wing (30 specimens) 19(25)30 microns.

Distribution: Barremian to Albian. Harmon Member and lower Shaftesbury Formation of the Peace River area; middle and late Albian of northern Wyoming, U.S.A. (Davis, 1963); Barremian and early Aptian of Germany (Alberti, 1961); Aptian of Australia (Cookson and Eisenack, 1958).

Remarks: The specimens of *Pterospermopsis eurypteris* described by Cookson and Eisenack (1958) are slightly larger (overall diameter: 95 to 123 microns) than those described in the present study. However, they are identical in all other respects.

P. eurypteris differs from *Pterospermopsis aureolata* Cookson and Eisenack, 1958, in possessing a smaller central body.

Locality of figured specimens:

Pl. 78, figs. 1-3.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.
Pl. 78, fig. 1.	Slide No. 4-S-2-Micro. 124;	co-ord. 12/42.3.	
Pl. 78, fig. 2.	Slide No. 4-S-2(1);	co-ord. 9/32.5.	
Pl. 78, fig. 3.	Slide No. 4-S-2(1);	co-ord. 8/69.1.	

Pterospermopsis harti Sarjeant, 1960

Plate 78, figures 4-7

1960 *Pterospermopsis harti* Sarjeant, Proc. Yorkshire Geol. Soc., vol. 32, p. 402, pl. 14, fig. 16, text-fig. 3a.

Description: Test disk shaped with circular to oval outline; central body thick walled, smooth, circular to oval in polar view, and biconvex in equatorial view; body surrounded by a radially folded, relatively wide, membraneous, equatorial wing lamella; wing with 9 to 21 irregularly spaced radial folds; folds of varying magnitude and in the form of slightly curved, tapering to lanceolate overfolds; overfolds usually reaching the outer margin of the wing; diameter of the central body approximately between 1/3 and 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (21 specimens) 48(61)90 microns.
Diameter of the central body (18 specimens) 16(28)48 microns.
Width of the wing (18 specimens) 15(20)26 microns.

Distribution: Corallian to Albian. Loon River Formation, Harmon, Cadotte, and Paddy Members, and lower Shaftesbury Formation of the Peace River area; Corallian of England (Sarjeant, 1960).

Remarks: *Pterospermopsis harti* was originally described by Sarjeant (1960) on the basis of a single specimen which is indistinguishable from an average specimen assigned to *P. harti* in the present study.

Pterospermopsis barbarae Górka, 1963, differs from *P. harti* in being considerably larger (overall diameter: 160 to 175 microns).

Locality of figured specimens:

Pl. 78, fig. 4.	Sample No. 8-L-9;	Loon River Formation.	Section 8.
Pl. 78, fig. 5.	Sample No. 8-L-7;	Loon River Formation.	Section 8.
Pl. 78, figs. 6, 7.	Sample No. 4-S-2;	lower Shaftesbury Formation.	Section 4.

Pl. 78, fig. 4. Slide No. 8-L-9(3); co-ord. 19.7/75.2.
Pl. 78, fig. 5. Slide No. 8-L-7-Micro. 16; co-ord. 13.8/46.8.
Pl. 78, fig. 6. Slide No. 4-S-2(1); co-ord. 17.9/60.8.
Pl. 78, fig. 7. Slide No. 4-S-2(1); co-ord. 9.2/32.2.

Pterospermopsis sp. A

Plate 78, figure 8

Description: Test disk shaped with circular to oval outline; central body very thick walled, smooth, circular to oval in polar view, and biconvex in equatorial view; body surrounded by a radially folded, membraneous, undulating, equatorial wing lamella; wing with about 15 irregularly spaced folds; folds usually reaching the outer margin of the wing and in the form of straight-sided overfolds; diameter of the central body more than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (2 specimens) 94(99)104 microns.
Diameter of the central body (2 specimens) 63(65)67 microns.
Width of the wing (2 specimens) 16(17.5)19 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Pterospermopsis harti* Sarjeant, 1960, can be distinguished from *Pterospermopsis* sp. A, by its smaller central body, thinner body wall, almost flat equatorial wing, and smaller size.

Locality of figured specimen:

Pl. 78, fig. 8. Sample No. 4-S-2; lower Shaftesbury Formation. Section 4.
Pl. 78, fig. 8. Slide No. 4-S-2-Micro. 127; co-ord. 11.3/43.3.

Pterospermopsis sp. B

Plate 79, figure 1

Description: Test disk shaped; central body thick walled, smooth, circular in polar view, and biconvex in equatorial view; body surrounded by a flat, smooth, relatively wide, rather thick, equatorial wing lamella; wing lamella with a 7-micron wide, thickened, outer rim; diameter of the central body less than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (1 specimen) 100 microns.
Diameter of the central body (1 specimen) 48 microns.
Width of the wing (1 specimen) 26 microns.

Distribution: Late Albian. A single specimen was found in the lower Shaftesbury Formation of the Peace River area.

Remarks: *Pterospermopsis* sp. B differs from *Pterospermopsis eurypteris* Cookson and Eisenack, 1958, in possessing a thickened outer rim.

Locality of figured specimen:

Pl. 79, fig. 1. Sample No. 4-S-2; lower Shaftesbury Formation. Section 4.
Pl. 79, fig. 1. Slide No. 4-S-2(1); co-ord. 18.2/69.8.

Pterospermopsis sp. C

Plate 79, figure 2

Description: Test disk shaped; central body smooth, circular in polar view, and biconvex in equatorial view; body surrounded by a flat, smooth, membraneous, equatorial wing lamella; wing lamella with a 2-micron wide, thickened, outer rim; diameter of the central body less than 1/2 of the total diameter of the test.

Size range: Total diameter of the test, including the wing (1 specimen) 38 microns.
Diameter of the central body (1 specimen) 17 microns.
Width of the wing (1 specimen) 11 microns.

Distribution: Late Albian. A single specimen was found in the lower Shaftesbury Formation of the Peace River area.

Remarks: *Pterospermopsis* sp. C differs from *Pterospermopsis eurypteris* Cookson and Eisenack, 1958, in possessing a thickened outer rim and in being smaller.

Locality of figured specimen:

Pl. 79, fig. 2. Sample No. 4-S-2; lower Shaftesbury Formation. Section 4.
Pl. 79, fig. 2. Slide No. 4-S-2(1); co-ord. 13.8/67.1.

Group **Acritarcha – Incertae Sedis**

Genus **Ascostomocystis** Drugg and Loeblich, 1967

Type species **Ascostomocystis hydria** Drugg and Loeblich, 1967

See Drugg and Loeblich (1967, p. 187) for generic diagnosis.

Remarks: The genus *Ascostomocystis* consists of flask-shaped cysts having an elliptical outline and an aperture at one end. The body wall is double layered. The inner wall is thick and rigid and the outer wall is membraneous. The membraneous outer wall tends to adhere to the inner wall dorsally and ventrally but remains free around the circumference.

The test is dorsoventrally flattened. The archeopyle is apical. The cingulum is represented by a noticeable transverse "equatorial wrinkle" on the membraneous outer wall. *Ascostomocystis* seems to be closely related to the genus *Fromea,* from which it differs in having an outer, bag-like, membraneous covering.

Ascostomocystis maxima n. sp.

Plate 79, figures 3, 4

Description: Test dorsoventrally flattened, elliptical in outline, and with an apical archeopyle at one end; body wall double layered; inner wall 1 to 2 microns thick and forming a thick rim around the apical archeopyle; outer wall membraneous, adhering to the inner wall dorsally and ventrally; cingulum represented by two distinct, parallel transverse ridges on the outer membraneous wall and occasionally by a faint ridge on the inner wall; longitudinal ridges on the membraneous outer wall marking the outlines of plates; plate arrangement not clear; body smooth, light to dark brown in color.

Size range: Length of the test (5 specimens) 135(143)155 microns. Holotype 155 microns.
Breadth of the test (5 specimens) 96(107)118 microns. Holotype 118 microns.
Width of the archeopyle (5 specimens) 30(33)36 microns. Holotype 36 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Ascostomocystis maxima* n. sp. is distinct from *Ascostomocystis hydria* Drugg and Loeblich, 1967, which is smaller (overall length: 53 to 83

microns; overall width: 49 to 67 microns) and lacks the longitudinal ridges on the membraneous outer wall.

A. maxima n. sp. appears to be closely related to *Fromea amphora.*

The specific name has been derived from "*maxima*" (greatest, largest).

Type locality:

Holotype: Pl. 79, fig. 3. Sample No. 5-S-3; lower Shaftesbury Fm. Section 5.
Paratype: Pl. 79, fig. 4. Sample No. 5-S-3; lower Shaftesbury Fm. Section 5.
Holotype: Pl. 79, fig. 3. Slide No. 5-S-3-Micro. 104; co-ord. 12.2/44.
Paratype: Pl. 79, fig. 4. Slide No. 4-S-3-Micro. 104; co-ord. 11.2/46.3.

Genus **Lecaniella** Cookson and Eisenack, 1962

Type species **Lecaniella margostriata** Cookson and Eisenack, 1962

See Norris and Sarjeant (1965, p. 35) for generic diagnosis.

Remarks: The genus *Lecaniella* accommodates saucer-shaped forms having a single-layered wall and variously patterned outer surface.

The species so far assigned to this genus have a reticulate to foveate surface ornamentation and radially directed muri near the rim.

Lecaniella foveata n. sp.

Plate 79, figures 5-10; plate 80, figure 1

Description: Test saucer shaped, oval to circular in outline, and relatively thick walled; ornamentation highly variable, ranging from foveolate to imperfect foveo-reticulate to rugulate pattern; most of the specimens with imperfect foveo-reticulate sculpture consisting of intercommunicating lumina and low, irregular ridges of uneven width; lumina 2 to 10 microns in diameter; ridges 2 to 4 microns in width; test with a 4- to 6-micron wide marginal rim having closely spaced radial ridges; surface of the test finely granulate.

Size range: Maximum diameter of the test (20 specimens) 41(60)78 microns. Holotype 65 microns.

Distribution: Late Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area.

Remarks: This species is readily distinguishable from *Lecaniella dictyota* Cookson and Eisenack, 1962, which has a reticulate ornamentation with polygonal lumina, and distinct, narrow muri of uniform width.

Lecaniella foveata n. sp. seems to open by a median split (Pl. 79, Fig. 7) into two equal halves. According to Cookson and Eisenack (1962b, p. 270), this mode of opening is common in some recent members of the Chlorophyceae.

The specific name has been derived from "*foveata*" (pitted).

Type locality:

Holotype: Pl. 79, figs. 5, 6.	Sample No. 4-S-4;	lower Shaftesbury Fm.	Sec. 4.
Paratype: Pl. 79, fig. 7.	Sample No. 4-P-5;	Paddy Member.	Sec. 4.
Paratype: Pl. 79, fig. 8.	Sample No. 4-S-4;	lower Shaftesbury Fm.	Sec. 4.
Paratype: Pl. 79, fig. 9.	Sample No. 4-P-3;	Paddy Member.	Sec. 4.
Paratype: Pl. 79, fig. 10.	Sample No. 4-P-6;	Paddy Member.	Sec. 4.
Paratype: Pl. 80, fig. 1.	Sample No. 4-P-3;	Paddy Member.	Sec. 4.
Holotype: Pl. 79, figs. 5, 6.	Slide No. 4-S-4(1);	co-ord. 10.8/77.2.	
Paratype: Pl. 79, fig. 7.	Slide No. 4-P-5(1);	co-ord. 20/31.7.	
Paratype: Pl. 79, fig. 8.	Slide No. 4-S-4(1);	co-ord. 9/55.2.	
Paratype: Pl. 79, fig. 9.	Slide No. 4-P-3(1);	co-ord. 19.1/38.	
Paratype: Pl. 79, fig. 10.	Slide No. 4-P-6(1);	co-ord. 18.5/75.	
Paratype: Pl. 80, fig. 1.	Slide No. 4-P-3(2);	co-ord. 19.8/46.9.	

Genus **Palaeostomocystis** Deflandre, 1935

Type species **Palaeostomocystis reticulata** Deflandre, 1935

See Norris and Sarjeant (1965, p. 46) for generic diagnosis.

Remarks: Deflandre (1935) proposed the genus *Palaeostomocystis* for forms which are either closed or have a small pore or fairly wide aperture at one end. These forms are similar to the modern genus *Trachelomonas* Ehrenberg.

The genus *Palaeostomocystis*, as constituted at present, contains an unrelated and heterogeneous assemblage of fossil cysts.

Palaeostomocystis fragilis Cookson and Eisenack, 1962

Plate 80, figures 2, 3

1962a *Palaeostomocystis fragilis* Cookson and Eisenack, Micropaleont., vol. 8, p. 496, pl. 7, figs. 10, 11.

Description: Test dorsoventrally flattened, longer than broad, and with a wide apical archeopyle; body elongate elliptical in outline; body wall membraneous, readily folded and crumpled, and usually with a prominent longitudinal fold; surface of wall finely and faintly granular.

Size range: Length of the test (7 specimens) 72(108)145 microns.
Breadth of the test (7 specimens) 55(68)110 microns.
Width of the archeopyle (7 specimens) 18(21)25 microns.

Distribution: Aptian to Cenomanian. Lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); Aptian to Cenomanian of Western Australia (Cookson and Eisenack, 1962a).

Remarks: This species differs from *Fromea amphora* Cookson and Eisenack, 1958, which has a cingulum, thickened rim around the apical archeopyle, and a thicker body wall.

Locality of figured specimens:

Pl. 80, fig. 2.	Sample No. 3-S-4;	lower Shaftesbury Formation.	Section 3.
Pl. 80, fig. 3.	Sample No. 2-S-7;	lower Shaftesbury Formation.	Section 2.
Pl. 80, fig. 2.	Slide No. 3-S-4-Micro. 152;	co-ord. 12.5/42.8.	
Pl. 80, fig. 3.	Slide No. 2-S-7-Micro. 164;	co-ord. 10.8/43.	

Palaeostomocystis glabella n. sp.

Plate 80, figure 4

Description: Test dorsoventrally flattened, longer than broad, and with an apical archeopyle at one end; width of the archeopyle about 1/2 to 3/4 of the width of the body; body elliptical to almost cylindrical in outline; body wall hyaline and smooth, occasionally with a longitudinal fold.

Size range: Length of the test (7 specimens) 36(43.5)52 microns. Holotype 48 microns.
Breadth of the test (7 specimens) 27(31)36 microns. Holotype 36 microns.
Width of the archeopyle (7 specimens) 17(22)26 microns. Holotype 19 microns.

Distribution: Late Albian. Lower Shaftesbury Formation of the Peace River area.

Remarks: *Palaeostomocystis glabella* n. sp. can be easily distinguished from *Palaeostomocystis fragilis* Cookson and Eisenack, 1962, by its smaller size and smooth surface, and from *Palaeostomocystis laevigata* Drugg, 1967, by the lack of a thickened rim around the archeopyle.

The specific name has been derived from "*glabella*" (smooth).

Type locality:

Holotype: Pl. 80, fig. 4. Sample No. 2-S-7; lower Shaftesbury Fm. Sec. 2.
Holotype: Pl. 80, fig. 4. Slide No. 2-S-7-Micro. 167; co-ord. 12/44.

Genus **Palambages** O. Wetzel, 1961

Type species **Palambages morulosa** O. Wetzel, 1961

See Manum and Cookson (1964, p. 23) for comment.

Remarks: The genus *Palambages* consists of spherical colonies of many (usually 8 to 128) oval, membraneous cells. Each colony consists of a single peripheral layer of cells. The cell walls are usually finely granular to smooth and occasionally coarsely granular to finely warty. The size of the colony and the number and size of the cells in it are extremely variable within the same species.

O. Wetzel (1933, p. 23) described these forms under the provisional name "Morulosae". The natural affinity of *Palambages* is as yet uncertain, although the clusters of cells are suggestive of green algal colonies.

Palambages Form A Manum and Cookson, 1964

Plate 80, figures 5, 6

1964 *Palambages* Form A Manum and Cookson, Skrifter Norske Videnskaps-Akad. Oslo, I. Mat.-Naturv. Klasse, n.s., no. 17, p. 24, pl. 7, figs. 3-6.

Description: Colony spherical; individual cells 12 to 20 microns in diameter; cell walls about 1 micron thick, finely granular in profile, and with faint dots in surface view; number of cells per colony variable; most colonies with over 100 cells.

Size range: Total diameter of the colony (2 specimens) 118(124)130 microns.

Distribution: Albian and Late Cretaceous. Lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); Albian and Upper Cretaceous of Australia (Cookson, 1965).

Remarks: The specimens of *Palambages* Form A, described in the present study, closely resemble the specimen illustrated by Manum and Cookson (1964, pl. 7, fig. 6) from the Arctic Islands of Canada.

Locality of figured specimens:

Pl. 80, figs. 5, 6. Sample No. 5-S-3; lower Shaftesbury Formation. Section 5.
Pl. 80, fig. 5. Slide No. 5-S-3-Micro. 116; co-ord. 12.5/42.9.
Pl. 80, fig. 6. Slide No. 5-S-3-Micro. 116; co-ord. 13.1/43.2.

Genus **Schizocystia** Cookson and Eisenack, 1962

Type species **Schizocystia rugosa** Cookson and Eisenack, 1962

See Norris and Sarjeant (1965, p. 54) for generic diagnosis.

Remarks: The genus *Schizocystia* consists of four-sided forms having almost straight to deeply concave sides and smooth to patterned surfaces. The body separates into two approximately equal halves along a straight line. The two halves are rarely found together.

Schizocystia laevigata Cookson and Eisenack, 1962

Plate 80, figures 7-9

1962b *Schizocystia laevigata* Cookson and Eisenack, Proc. Roy. Soc. Victoria, n.s., vol. 75, pt. 2, p. 270, pl. 37, figs. 13, 14.

Description: Test four sided with moderately to deeply concave sides and broadly rounded corners; body separating into two approximately equal halves along a straight line; two halves seldom found together; body wall 1.5 to 2 microns thick, smooth in optical section, and indistinctly vermiculate in surface view.

Size range: Maximum length of half the test (8 specimens) 25(34)42 microns.
Maximum breadth of the test (8 specimens) 47(52)58 microns.

Distribution: Late Albian and Cenomanian. Paddy Member and lower Shaftesbury Formation of the Peace River area; early Late Cretaceous of the Arctic Islands, Canada (Manum and Cookson, 1964); ?late Albian and Cenomanian of Western Australia (Cookson and Eisenack, 1962b).

Locality of figured specimens:

Pl. 80, fig. 7.	Sample No. 3-S-5;	lower Shaftesbury Fm.	Section 3.
Pl. 80, fig. 8.	Sample No. 5-P-2;	Paddy Member.	Section 5.
Pl. 80, fig. 9.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 80, fig. 7.	Slide No. 3-S-5(1);	co-ord. 4/59.8.	
Pl. 80, fig. 8.	Slide No. 5-P-2(1);	co-ord. 3/55.8.	
Pl. 80, fig. 9.	Slide No. 4-P-3(1);	co-ord. 4.2/46.8.	

Genus **Tetraporina** Naumova, 1939 ex Naumova, 1950

Type species **Tetraporina antiqua** Naumova, 1950 (designated by Potonié, 1960, p. 130)

See Potonié (1960, p. 130) for generic diagnosis.

Remarks: Naumova (1939) originally diagnosed the genus *Tetraporina* as follows: "Pollen with four pores, without folds". However, the supposedly diagnostic four "pores" are either simulated by arcuate folds at the four corners of the body or not developed at all. The outline of the test is quadrilateral with concave to slightly convex sides. The surface is smooth to lightly ornamented.

The attribution of angiospermous affinity to various Russian Lower Carboniferous species of *Tetraporina* by Naumova (1939, 1950) is untenable, because they are obviously not tetraporate. The genus *Tetraporina* appears to have an algal affinity. The aplanospores of a member of the order Chlorococcales, found in modern lake sediments, have a striking resemblance to various species assigned to the genus *Tetraporina.* The genus *Tetraporina* has been reviewed in detail by Playford (1963, p. 658) and Segroves (1967, p. 302).

The genus *Horologinella* Cookson and Eisenack, 1962, differs from *Tetraporina* in having a slightly biconvex, hour-glass-shaped test (two opposite sides are strongly concave and the remaining two sides are straight to convex) and a surface which may be divided into plates.

Tetraporina horologia (Staplin) Playford, 1963

Plate 80, figures 10-12

1960 *Azonotetraporina? horologia* Staplin, Palaeontographica, Band 107, Abt. B, p. 6, pl. 1, figs. 4, 6.

1963 *Tetraporina horologia* (Staplin) Playford, Palaeont., vol. 5, p. 659, pl. 95, figs. 14, 15.

Description: Test quadrangular, nonaperturate, with concave to almost straight sides and rounded corners; arcuate folds at the corners simulating "pores" in some specimens; body wall thin, readily folded and distorted; surface finely granulate.

Size range: Maximum diagonal length of the test (5 specimens) 26(40)56 microns.
Length of the test (7 specimens) 24(35)48 microns.
Breadth of the test (7 specimens) 22(28)41 microns.

Distribution: Mississippian to Albian. Paddy Member and lower Shaftesbury Formation of the Peace River area; Late Mississippian of Alberta (Staplin, 1960); Lower Carboniferous of Spitzbergen (Playford, 1963) and Saudi Arabia (Hemer and Nygreen, 1967); Lower Triassic (Balme, 1963) and Permian (Segroves, 1967) of Western Australia.

Locality of figured specimens:

Pl. 80, figs. 10-12.	Sample No. 4-P-3;	Paddy Member.	Section 4.
Pl. 80, fig. 10.	Slide No. 4-P-3(1);	co-ord. 12.2/67.	
Pl. 80, fig. 11.	Slide No. 4-P-3(1);	co-ord. 12.8/64.1.	
Pl. 80, fig. 12.	Slide No. 4-P-3(1);	co-ord. 18/35.8.	

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PLATES 39 – 80

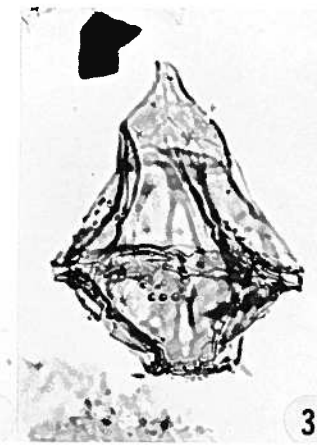
Explanation of Plate 39

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Gonyaulacysta cassidata* (Eisenack and Cookson) Sarjeant; 1–ventral surface, viewed by transparency; 2–same specimen, mid-focus; 3–same specimen, dorsal surface showing precingular archeopyle ..... (p. 301)

Figures 4, 5: *Gonyaulacysta edwardsi* (Cookson and Eisenack) Clarke and Verdier; 4–ventral surface, viewed by transparency; 5–same specimen, dorsal surface showing precingular archeopyle ..... (p. 303)

PLATE 39



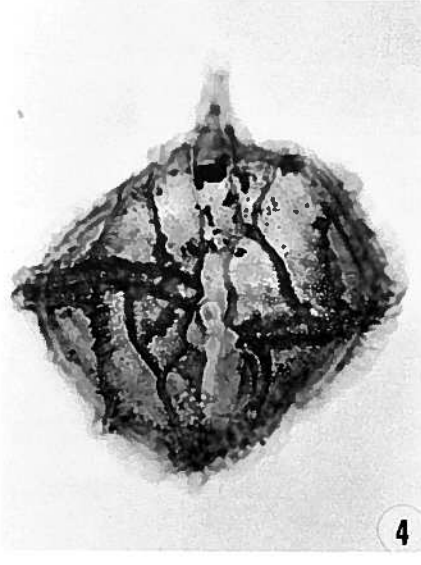
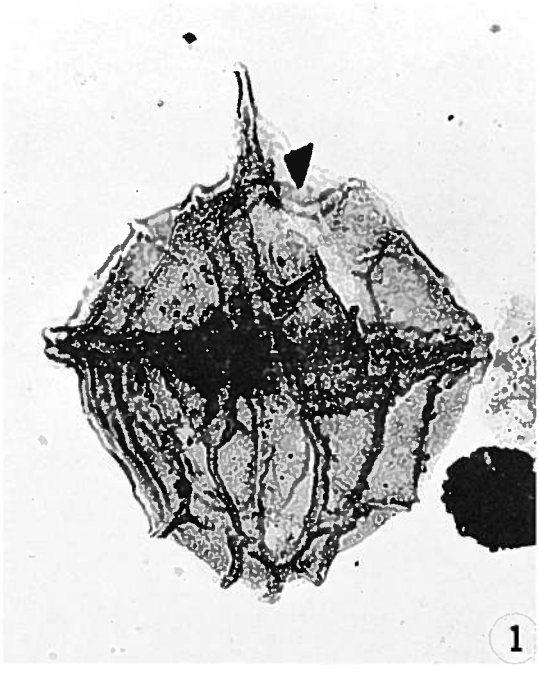
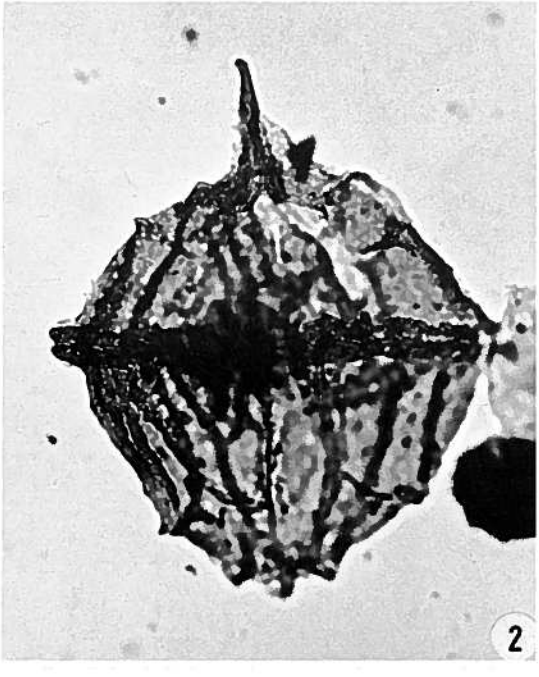


PLATE 40





Explanation of Plate 40

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Gonyaulacysta edwardsi* (Cookson and Eisenack) Clarke and Verdier; 1–ventral surface, viewed by transparency; 2–same specimen, dorsal surface showing precingular archeopyle ..... (p. 303)

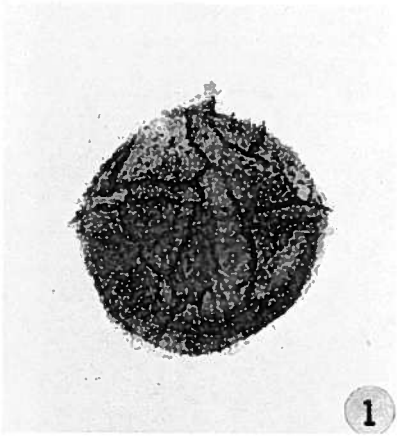
Explanation of Plate 41

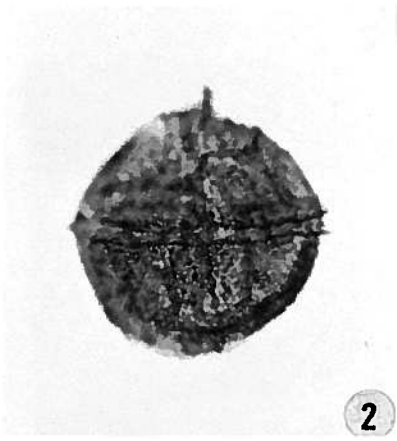
All specimens are illustrated at a magnification of X500 unless otherwise stated

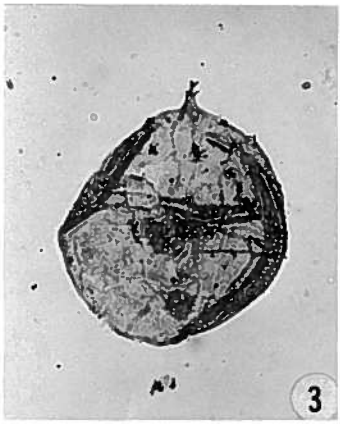
Figures 1-3: *Gonyaulacysta episoma* Sarjeant; 1–ventral surface, viewed by transparency; 2–same specimen, dorsal surface; 3–ventral surface, viewed by transparency ..... (p. 305)

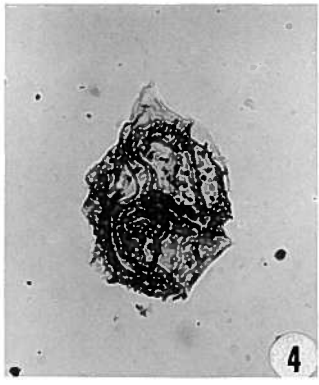
Figures 4-7: *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant; 4–ventral surface; 5–same specimen, dorsal surface, viewed by transparency; 6–ventral surface, viewed by transparency; 7–same specimen, dorsal surface ..... (p. 306)

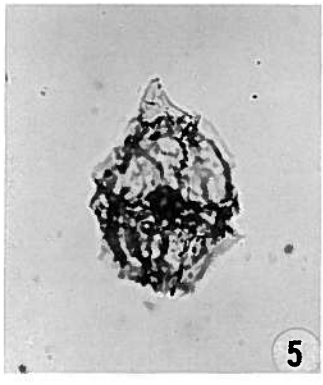
PLATE 41

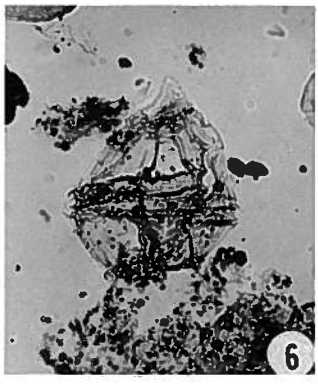












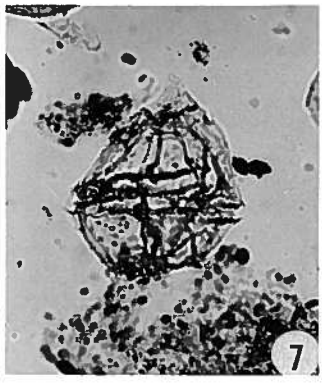
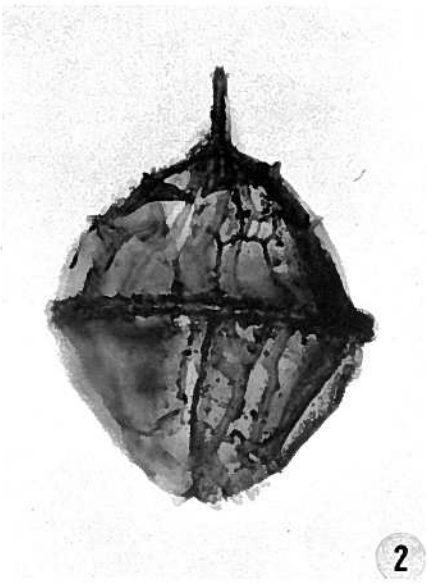
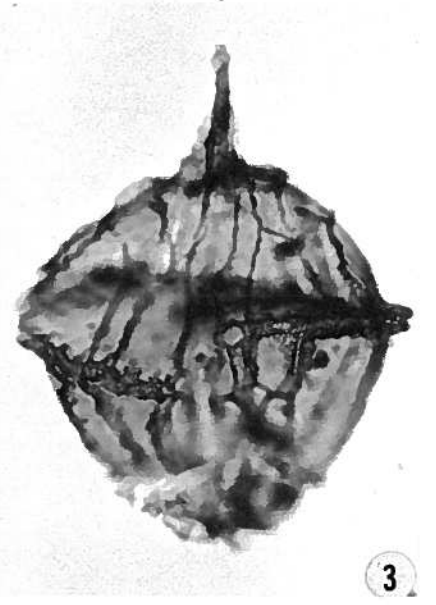
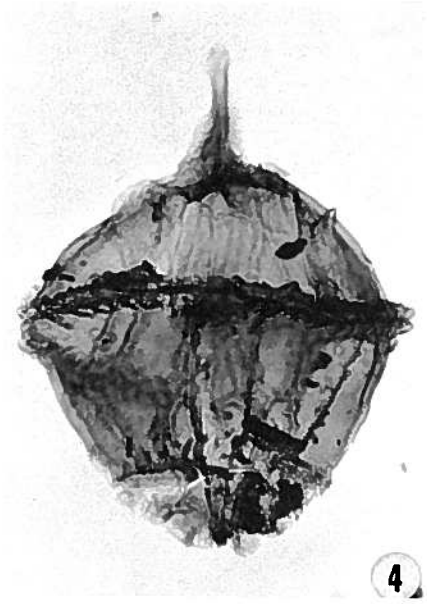


PLATE 42







Explanation of Plate 42

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-4: *Gonyaulacysta orthoceras* (Eisenack) Sarjeant; 1–ventral surface; 2–same specimen, dorsal surface, viewed by transparency; 3–ventral surface; 4–same specimen, dorsal surface showing precingular archeopyle, viewed by transparency ..... (p. 307)

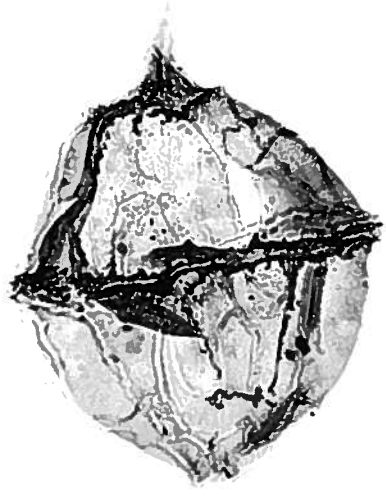
Explanation of Plate 43

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-4: *Gonyaulacysta orthoceras* (Eisenack) Sarjeant; 1–ventral surface; 2–same specimen, dorsal surface showing precingular archeopyle, viewed by transparency; 3–ventral surface; 4–same specimen, dorsal surface showing precingular archeopyle, viewed by transparency ..... (p. 307)

PLATE 43

1



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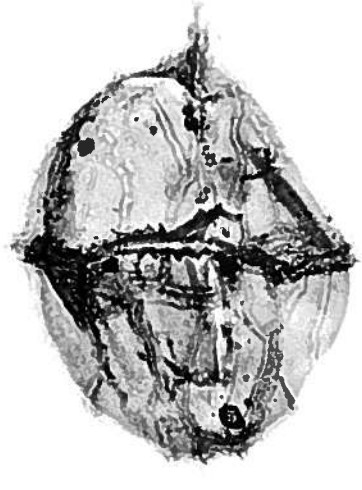

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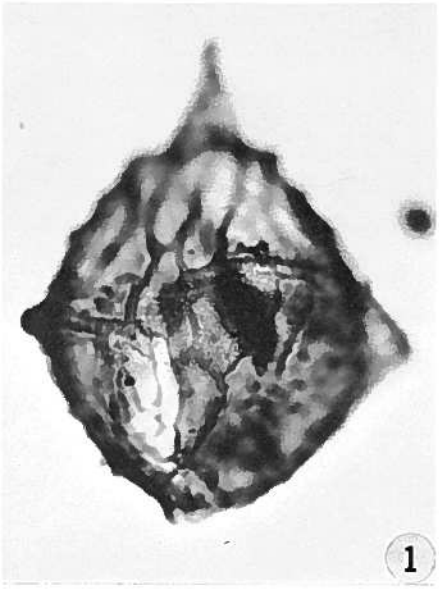
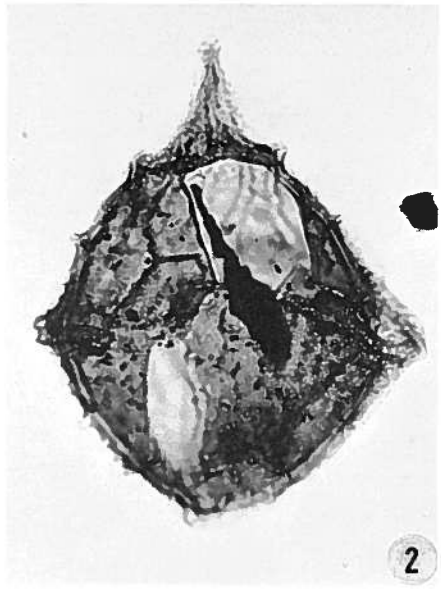
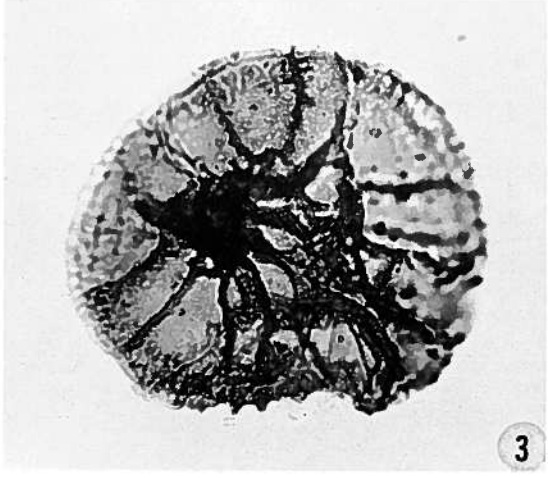
PLATE 44







Explanation of Plate 44

All specimens are illustrated at a magnification of X500 unless otherwise stated

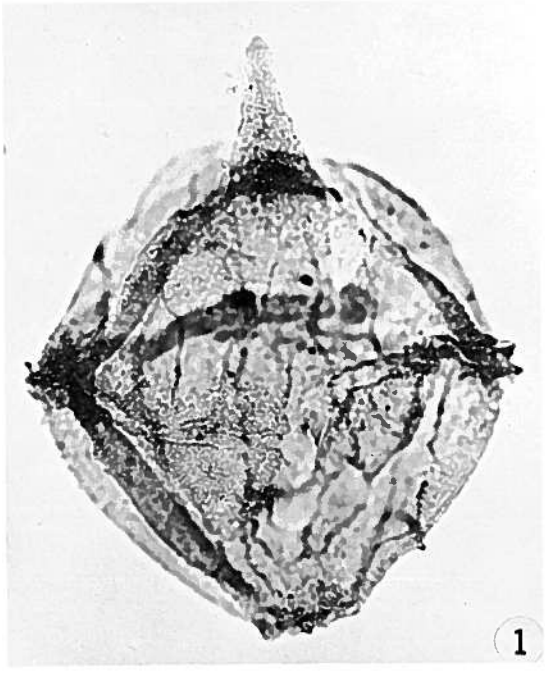
Figures 1-3: *Gonyaulacysta orthoceras* (Eisenack) Sarjeant; 1–ventral surface; 2–same specimen, dorsal surface showing precingular archeopyle, viewed by transparency; 3–flattened epitheca ..... (p. 307)

Explanation of Plate 45

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Gonyaulacysta* sp. A; 1–ventral surface; 2–same specimen, dorsal surface showing precingular archeopyle, viewed by transparency ..... (p. 309)

PLATE 45



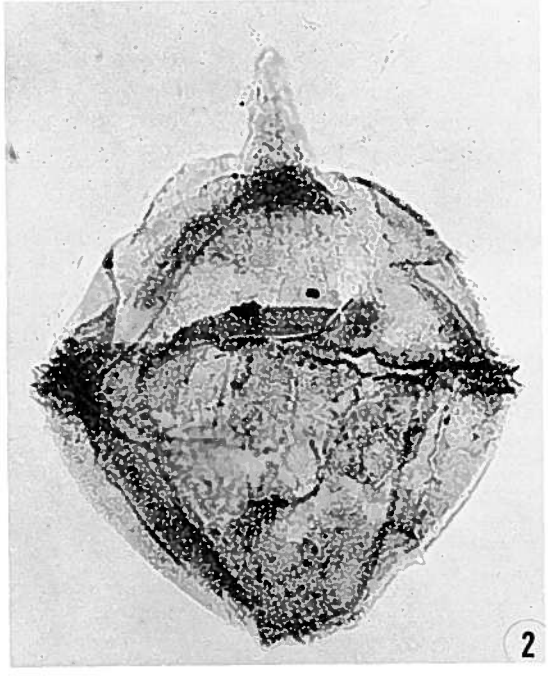
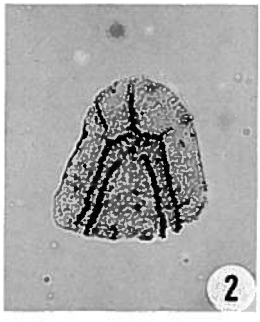
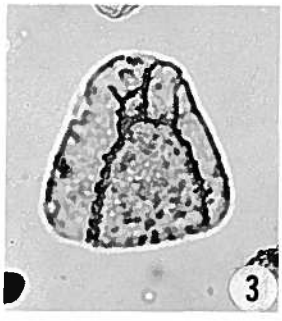


PLATE 46





Explanation of Plate 46

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Gonyaulacysta* sp. B; dorsal surface ..... (p. 309)

Figure 2: Precingular archeopyle operculum Type A ..... (p. 310)

Figures 3, 4: Precingular archeopyle operculum Type B ..... (p. 311)

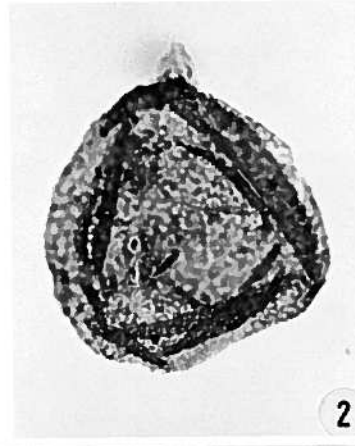
Explanation of Plate 47

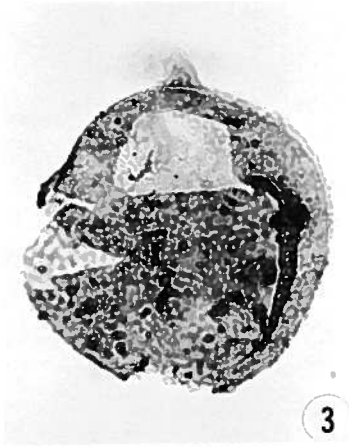
All specimens are illustrated at a magnification of X500 unless otherwise stated

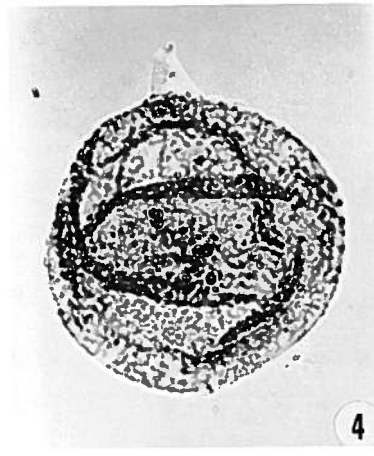
Figures 1-4: *Apteodinium reticulatum* n. sp.; 1–(holotype) ventral surface; 2–(holotype) dorsal surface operculum in position; 3–dorsal surface showing precingular archeopyle; 4–dorsal surface ..... (p. 312)

Figures 5-7: *Pareodinia ceratophora* Deflandre; 5–lateral view showing intercalary archeopyle; 6–mid-focus; 7–mid-focus ..... (p. 313)

PLATE 47







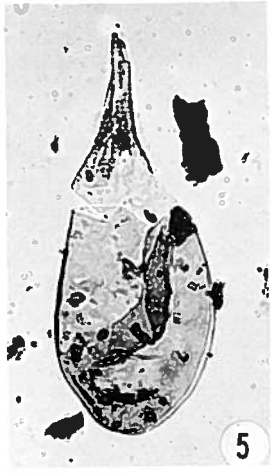
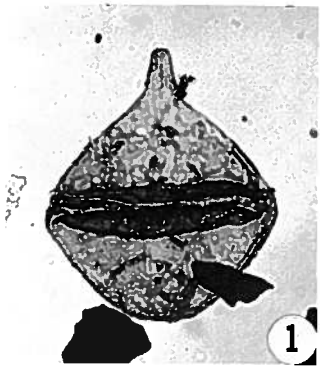


PLATE 48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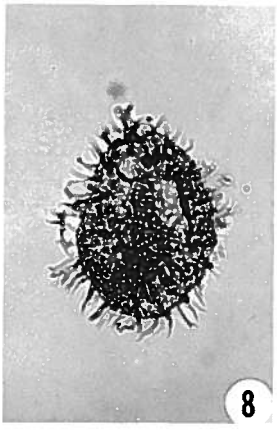
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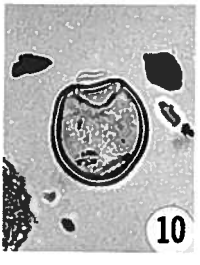
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Explanation of Plate 48

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Pareodinia ceratophora* Deflandre ..... (p. 313)

Figures 3-7: *Pareodinia* sp.; 3–ventral surface; 4–same specimen, mid-focus; 5–same specimen, dorsal surface; 6–same specimen X1000, showing intercalary archeopyle; 7–same specimen X1000, showing double-layered wall ..... (p. 314)

Figures 8, 9: *Trichodinium spinosum* n. sp.; 8–(holotype) dorsal surface showing precingular archeopyle; 9–ventral view ..... (p. 316)

Figure 10: *Chytroeisphaeridia* sp.; showing apical archeopyle ..... (p. 317)

Explanation of Plate 49

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Fromea amphora* Cookson and Eisenack; showing apical archeopyle ..... (p. 318)

Figure 4: *Broomea jaegeri* Alberti; showing apical archeopyle ..... (p. 320)

Figure 5: *Broomea* sp. ..... (p. 321)

PLATE 49

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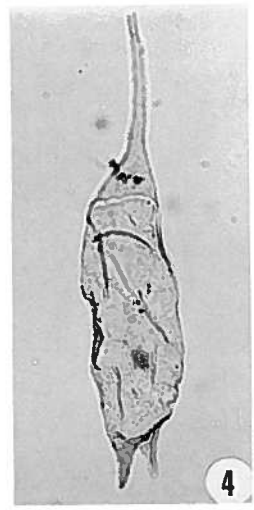
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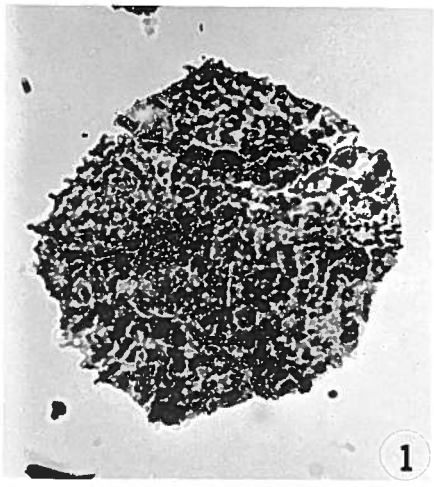
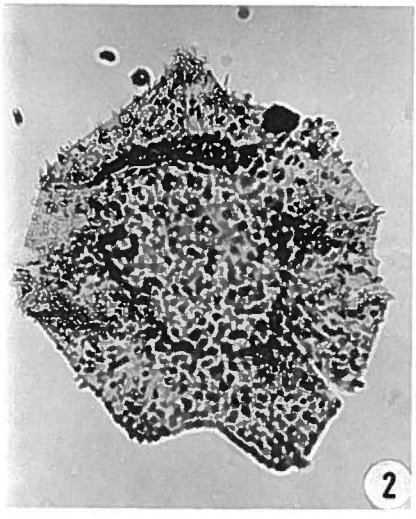
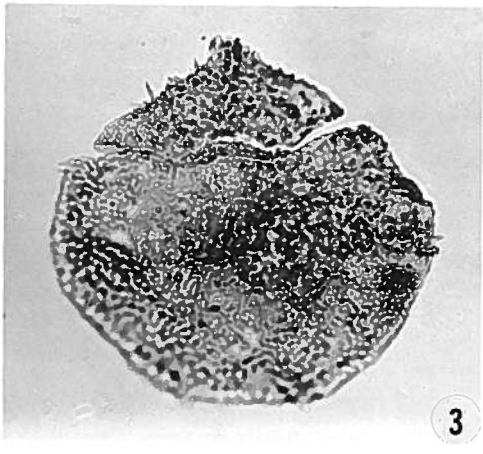
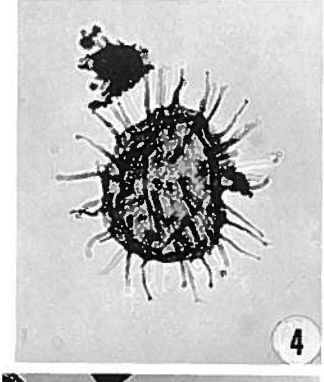
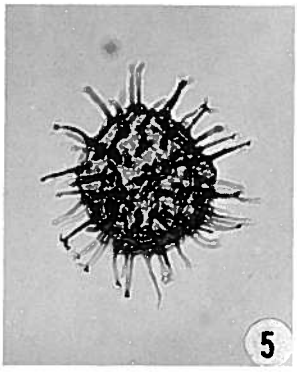
PLATE 50

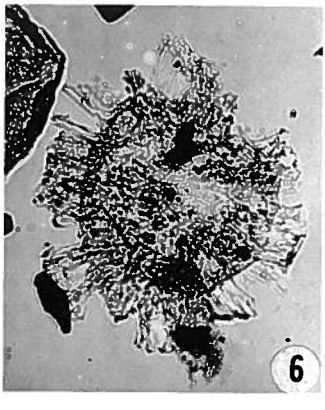












Explanation of Plate 50

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Canningia aspera* n. sp.; (holotype) showing apical archeopyle ..... (p. 322)

Figures 2, 3: *Canningia colliveri* Cookson and Eisenack; showing apical archeopyle .... (p. 323)

Figures 4, 5: *Cleistosphaeridium polypes* (Cookson and Eisenack) Davey ..... (p. 324)

Figure 6: *Cordosphaeridium* sp. ..... (p. 325)

Explanation of Plate 51

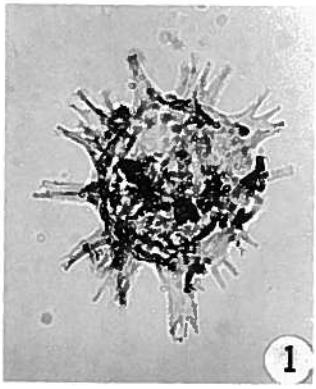
All specimens are illustrated at a magnification of X500 unless otherwise stated

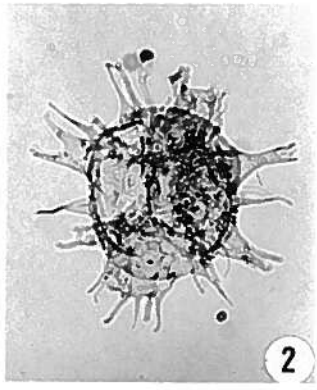
Figures 1-5: *Hystrichokolpoma ferox* (Deflandre) Davey; showing apical archeopyle . (p. 326)

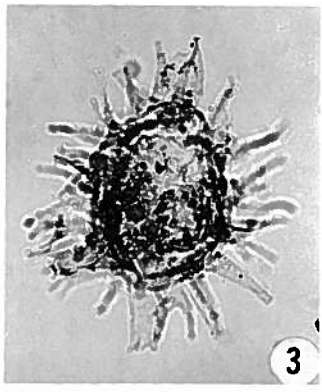
Figure 6: *Hystrichosphaeridium arundum* Eisenack and Cookson ..... (p. 328)

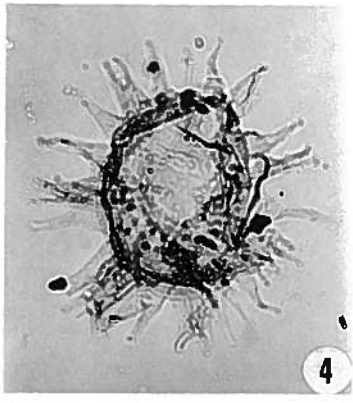
Figures 7, 8: *Hystrichosphaeridium cooksoni* n. sp.; 7–(holotype) showing large processes in the antapical region; 8–showing large processes in the antapical region ..... (p. 329)

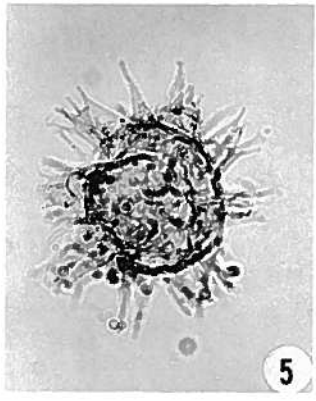
PLATE 51

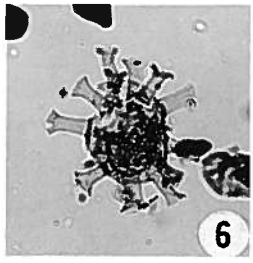


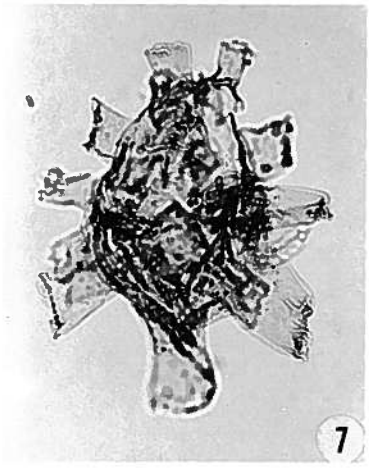












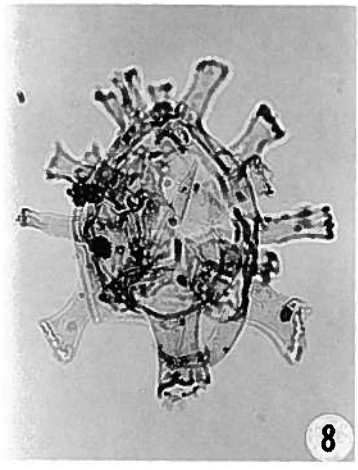
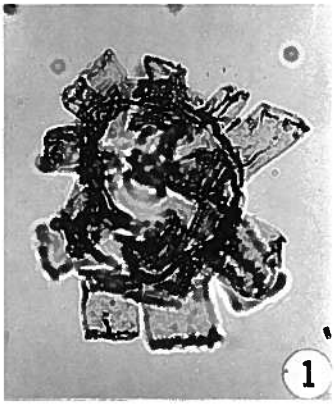
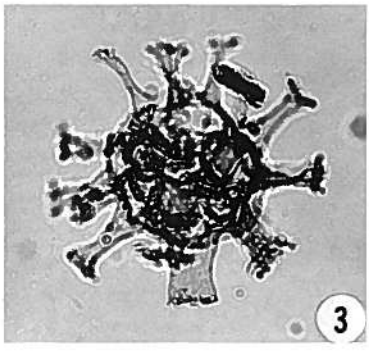
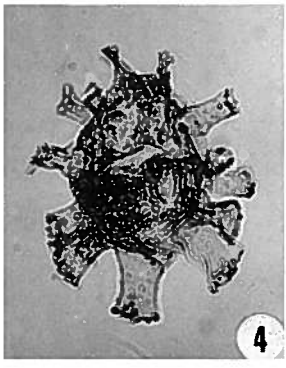
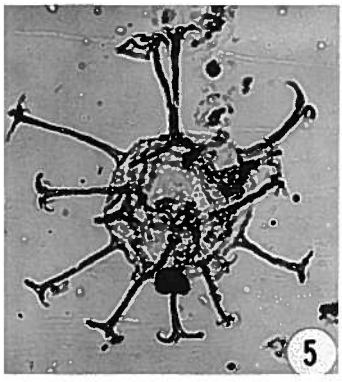


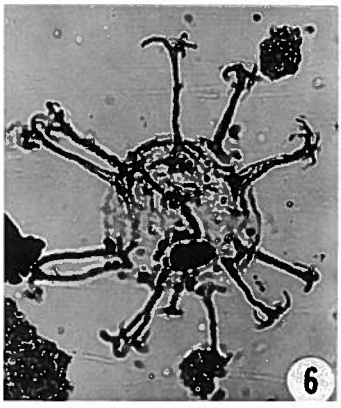
PLATE 52











Explanation of Plate 52

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-4: *Hystrichosphaeridium cooksoni* n. sp.; showing large processes in the antapical region ..... (p. 329)

Figures 5, 6: *Hystrichosphaeridium recurvatum* (White) Lejeune-Carpentier ..... (p. 331)

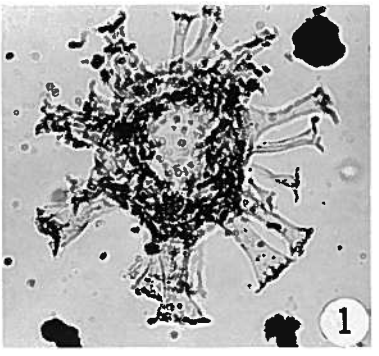
Explanation of Plate 53

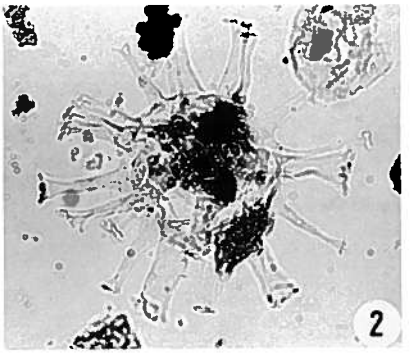
All specimens are illustrated at a magnification of X500 unless otherwise stated

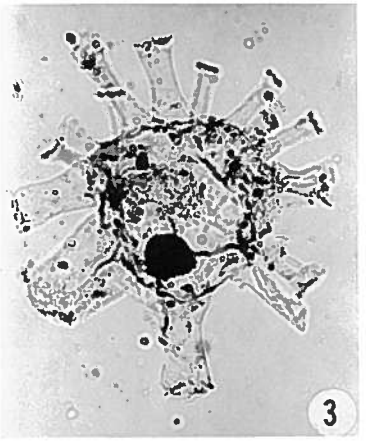
Figures 1-3: *Hystrichosphaeridium stellatum* Maier ..... (p. 331)

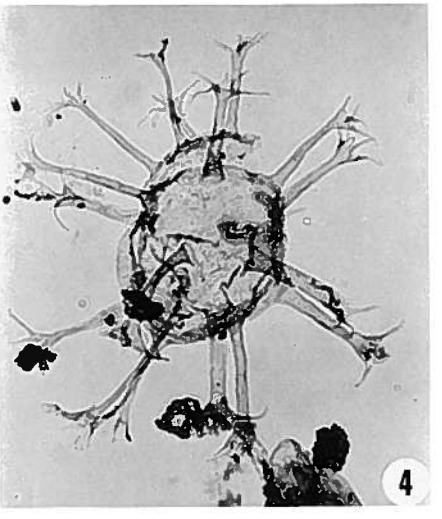
Figures 4-6: *Oligosphaeridium complex* (White) Davey and Williams; 4–showing partially attached operculum in the apical region; 5–oblique view showing apical archeopyle; 6–mid-focus ..... (p. 333)

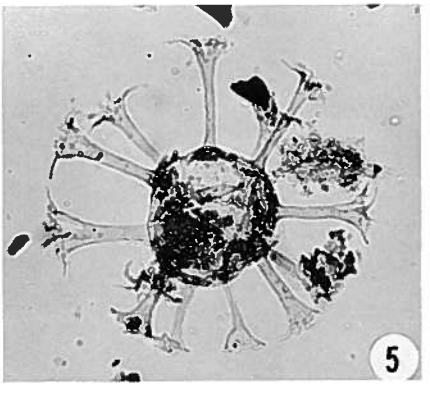
PLATE 53











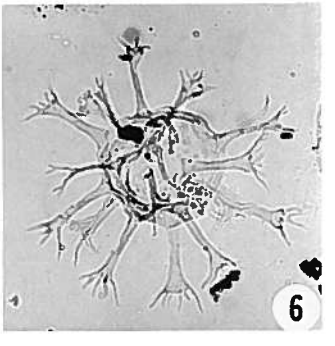
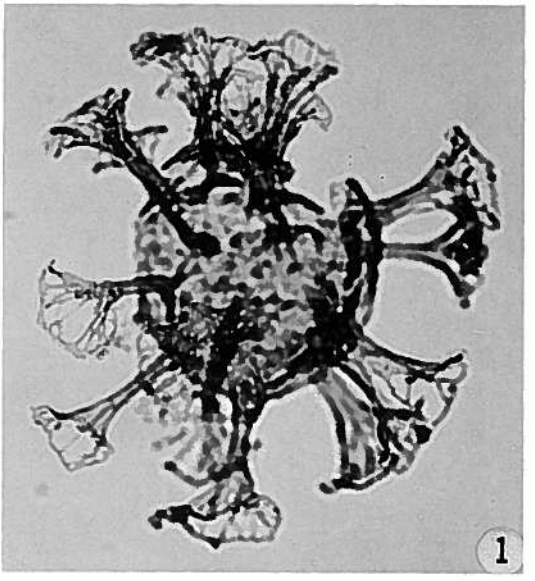
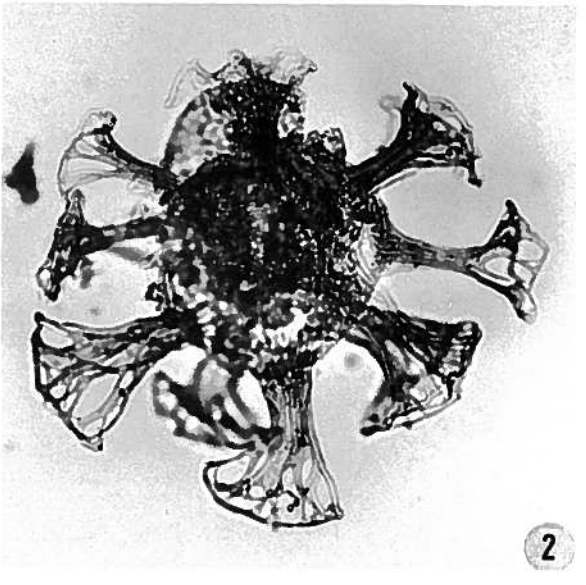


PLATE 54





Explanation of Plate 54

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Oligosphaeridium anthophorum* (Cookson and Eisenack) Davey; showing apical archeopyle ..... (p. 335)

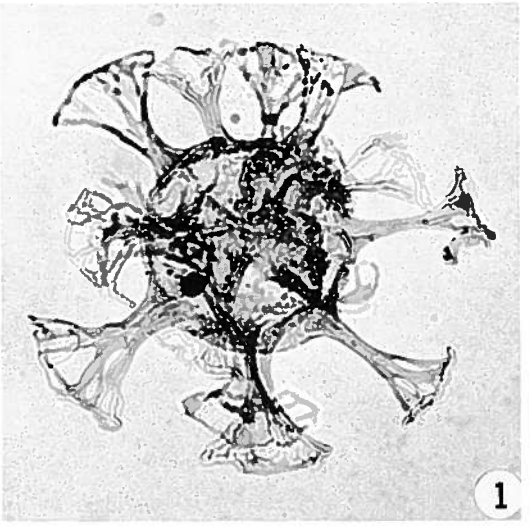
Explanation of Plate 55

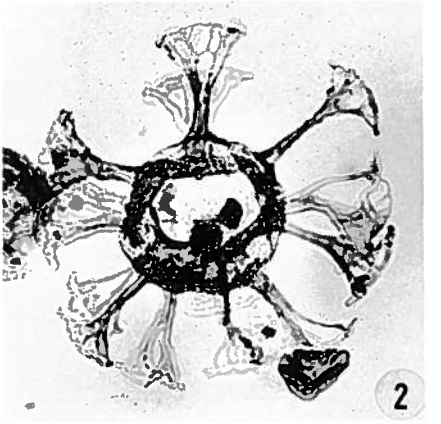
All specimens are illustrated at a magnification of X500 unless otherwise stated

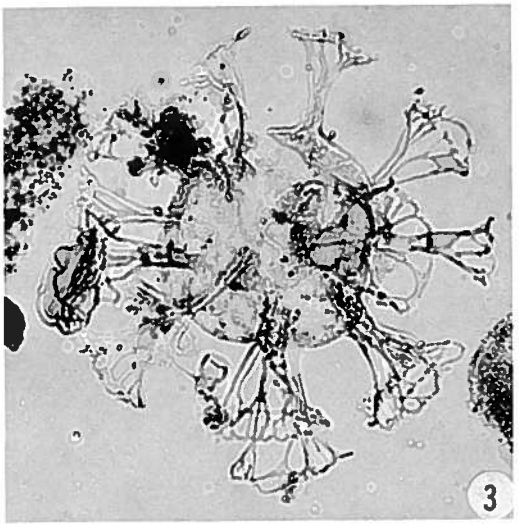
Figures 1-3: *Oligosphaeridium anthophorum* (Cookson and Eisenack) Davey; 1—mid-focus; 2—apical view showing apical archeopyle; 3—a poorly preserved specimen ..... (p. 335)

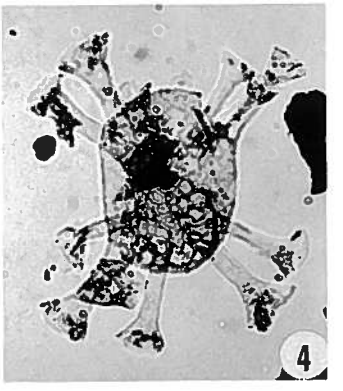
Figures 4, 5: *Oligosphaeridium diastema* n. sp.; 4—(holotype) showing a wide cingular zone without processes; 5—mid-focus ..... (p. 337)

PLATE 55









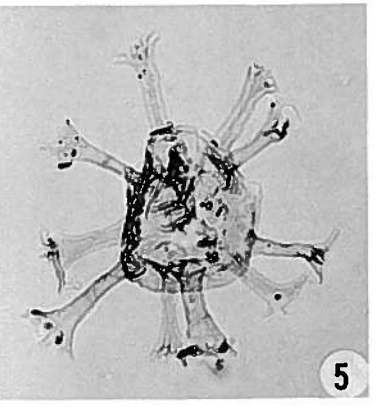
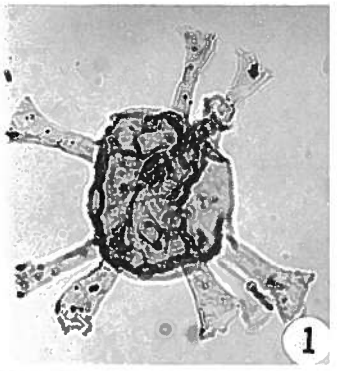
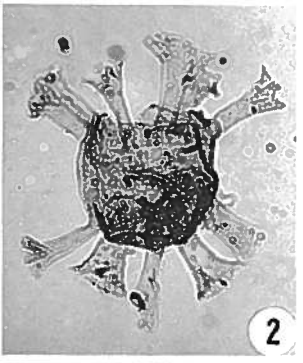
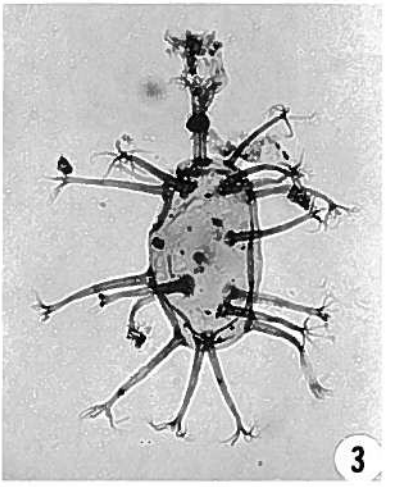
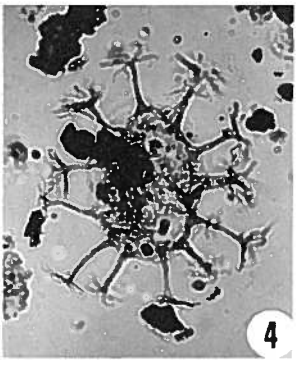


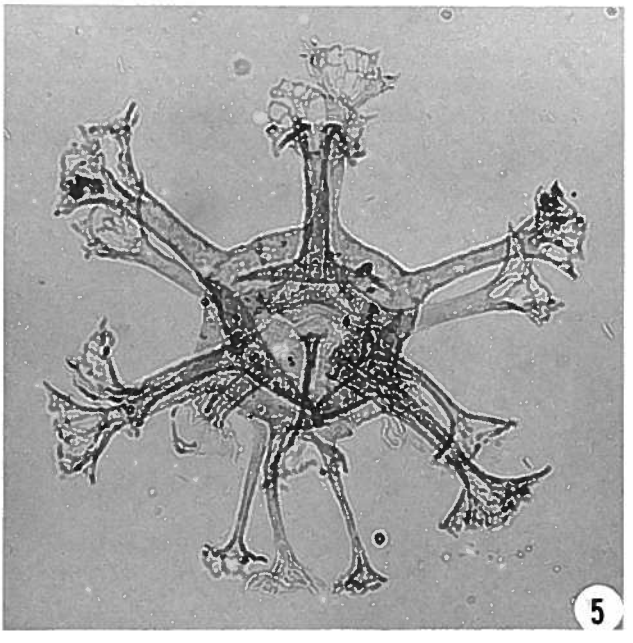
PLATE 56

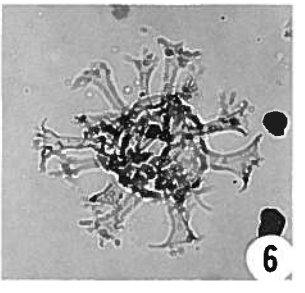












Explanation of Plate 56

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Oligosphaeridium diastema* n. sp.; 1–mid-focus; 2–showing apical archeopyle ..... (p. 337)

Figures 3, 4: *Oligosphaeridium prolixispinosum* Davey and Williams ..... (p. 338)

Figure 5: *Oligosphaeridium pulcherrimum* (Deflandre and Cookson) Davey and Williams ..... (p. 339)

Figure 6: *Oligosphaeridium* sp. ..... (p. 340)

Explanation of Plate 57

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Polystephanephorus* sp. cf. *P. urnaformis* (Cookson) Sarjeant; 1–high focus; 2–same specimen, mid-focus ..... (p. 341)

Figure 3: *Prolixosphaeridium capitatum* (Cookson and Eisenack) n. comb.; showing apical archeopyle ..... (p. 342)

Figures 4-6: *Prolixosphaeridium* sp.; 4–mid-focus; 5–same specimen, high mid-focus; 6–same specimen, high focus ..... (p. 343)

Figure 7: *Tanyosphaeridium* sp.; showing apical archeopyle ..... (p. 344)

Figures 8, 9: *Exochosphaeridium scitulum* n. sp.; 8–(holotype) lateral view faintly showing a precingular archeopyle; 9–mid-focus ..... (p. 346)

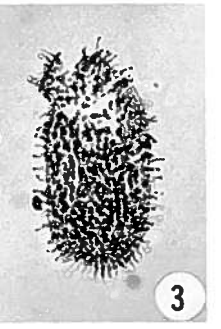
Figures 10-12: *Cyclonephelium distinctum* Deflandre and Cookson ..... (p. 347)

Figure 13: *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *ramosa* Davey and Williams ..... (p. 349)

PLATE 57

1

2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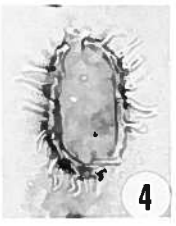
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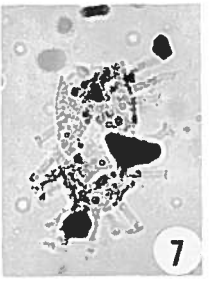
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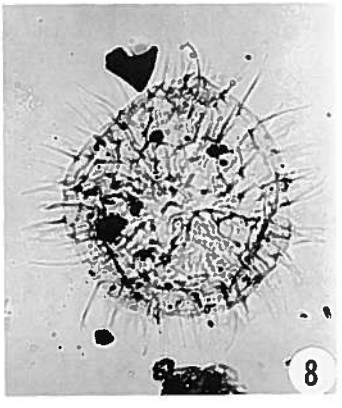
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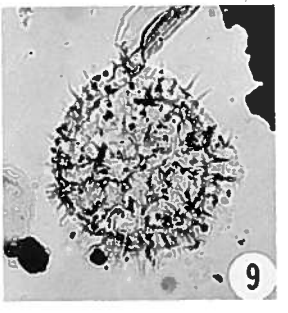
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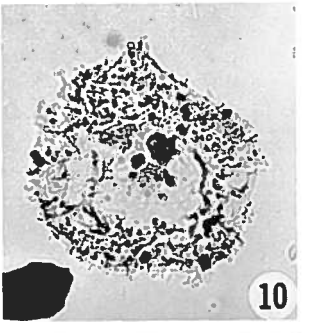
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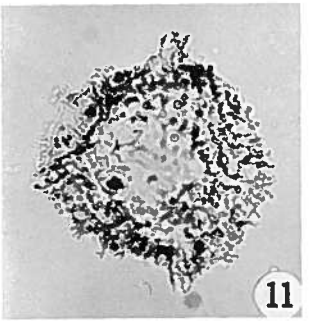
11

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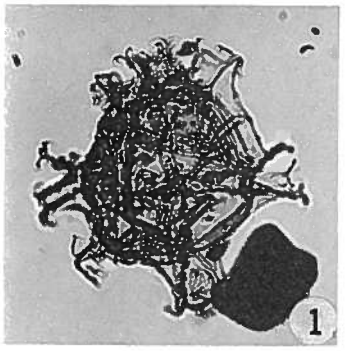
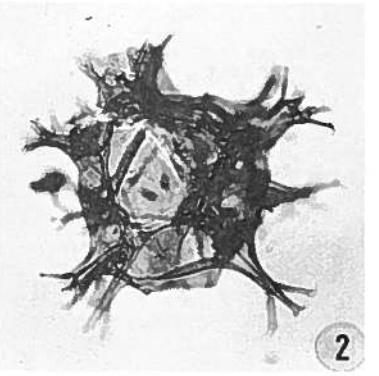
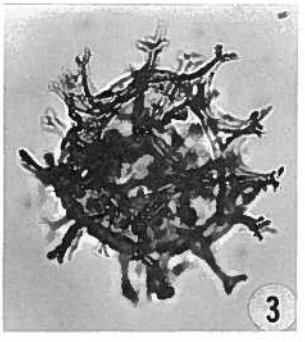
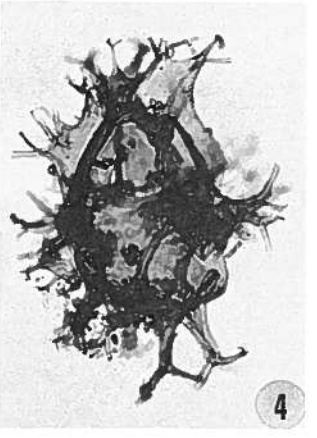
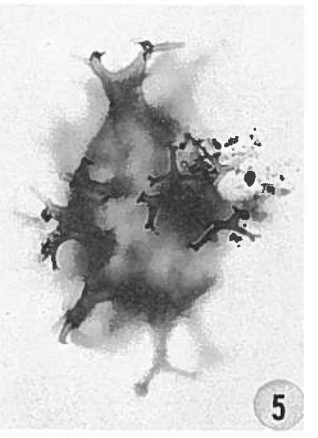
PLATE 58

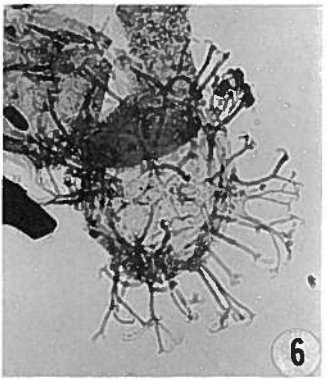


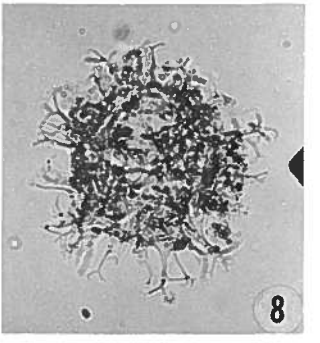












Explanation of Plate 58

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-5: *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *ramosa* Davey and Williams; 1–mid-focus; 2–dorsal view showing precingular archeopyle; 3–apical view; 4–mid-focus; 5–high focus, showing branching of the processes ..... (p. 349)

Figure 6: *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *gracilis* Davey and Williams ..... (p. 350)

Figures 7, 8: *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel var. *multibrevis* Davey and Williams ..... (p. 351)

Explanation of Plate 59

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Hystrichosphaera cingulata* (O. Wetzel) Deflandre and Cookson; 1–ventral surface; 2–same specimen, mid-focus; 3–same specimen, dorsal surface ..... (p. 352)

Figure 4: *Hystrichosphaera cingulata* (O. Wetzel) Deflandre and Cookson var. *reticulata* Davey and Williams; dorsal surface ..... (p. 354)

Figures 5-8: *Hystrichosphaera scabrosa* Clarke and Verdier; 5–mid-focus; 6–same specimen X1000, showing granulate ornamentation; 7–oblique view; 8–same specimen X1000, showing granulate ornamentation ..... (p. 354)

PLATE 59

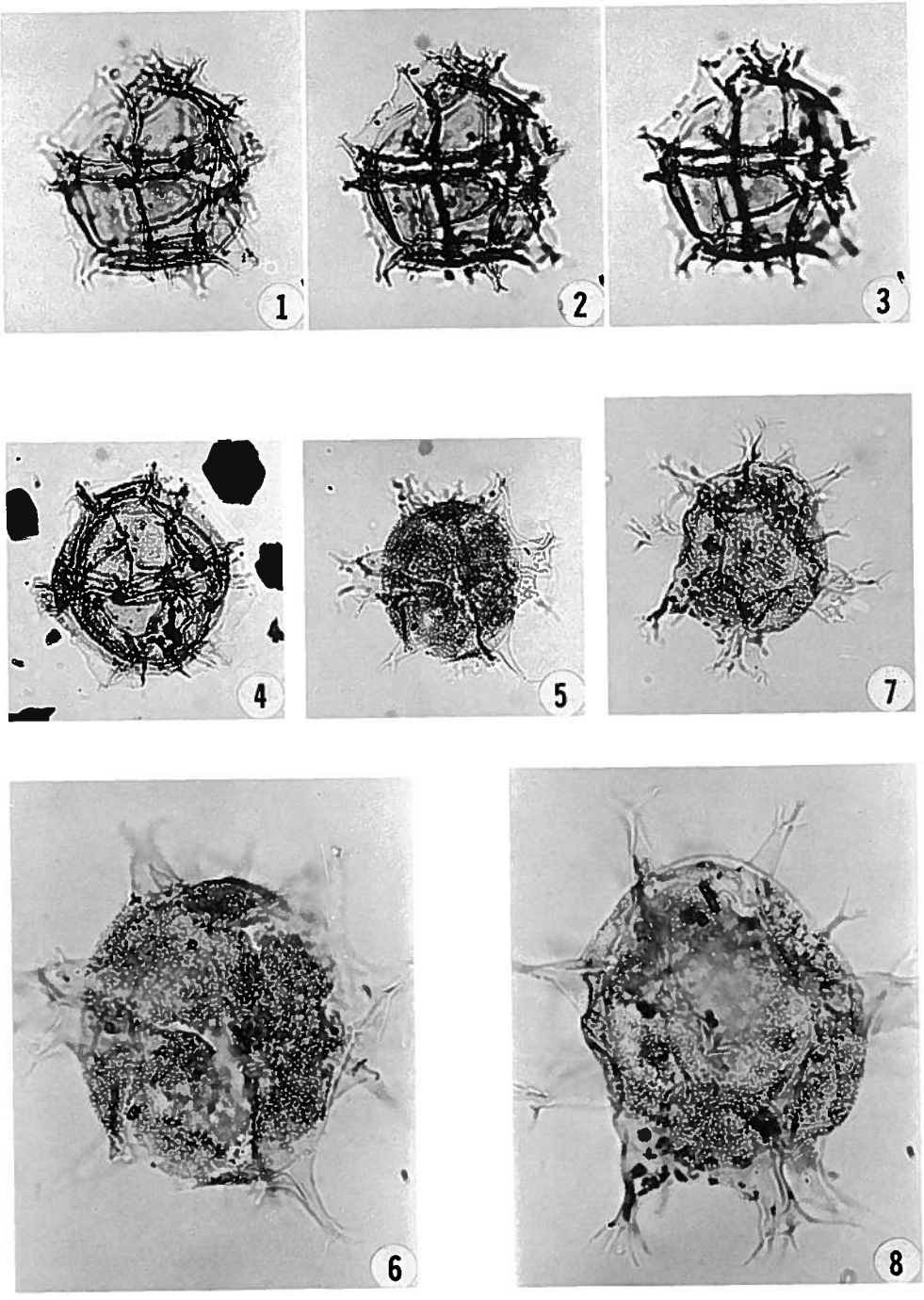
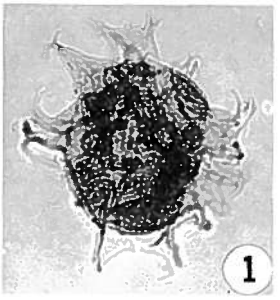
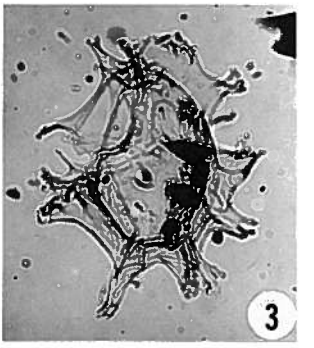
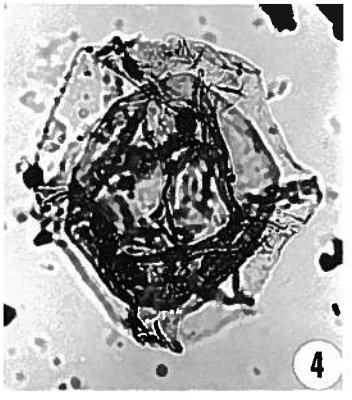
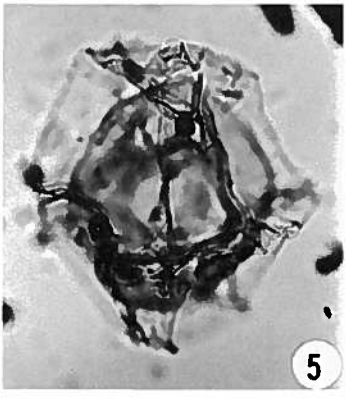


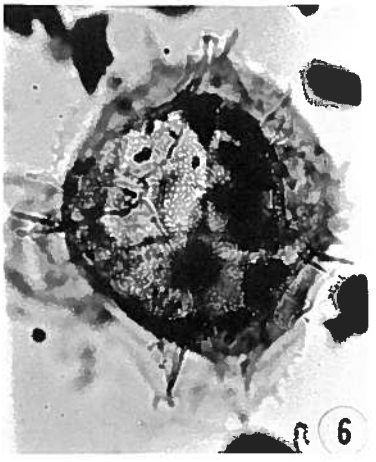
PLATE 60

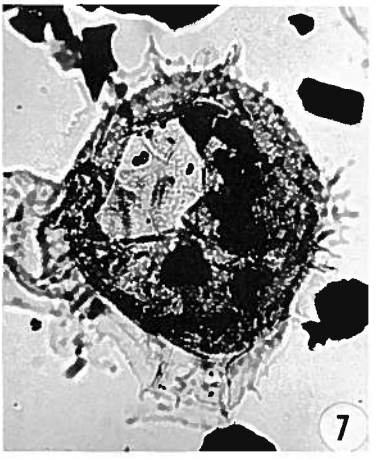












Explanation of Plate 60

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Hystrichosphaera scabrosa* Clarke and Verdier ..... (p. 354)

Figures 2, 3: *Hystrichosphaera wetzeli* Deflandre ..... (p. 355)

Figures 4, 5: *Pterodinium cornutum* Cookson and Eisenack; 4–ventral surface, viewed by transparency; 5–same specimen, dorsal surface ..... (p. 357)

Figures 6, 7: *Pterodinium reticulatum* n. sp.; 6–(holotype) ventral surface, viewed by transparency; 7–(holotype) dorsal surface showing precingular archeopyle (p. 358)

Explanation of Plate 61

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-12: *Deflandrea limpida* n. sp.; 1–(holotype) ventral surface; 2–(holotype) dorsal surface; 3–ventral surface; 4–same specimen, dorsal surface showing intercalary archeopyle; 5–ventral surface; 6–same specimen, dorsal surface; 7–ventral surface; 8–same specimen, dorsal surface; 9–ventral surface; 10–same specimen, dorsal surface; 11–ventral surface; 12–same specimen, dorsal surface ..... (p. 359)

PLATE 61

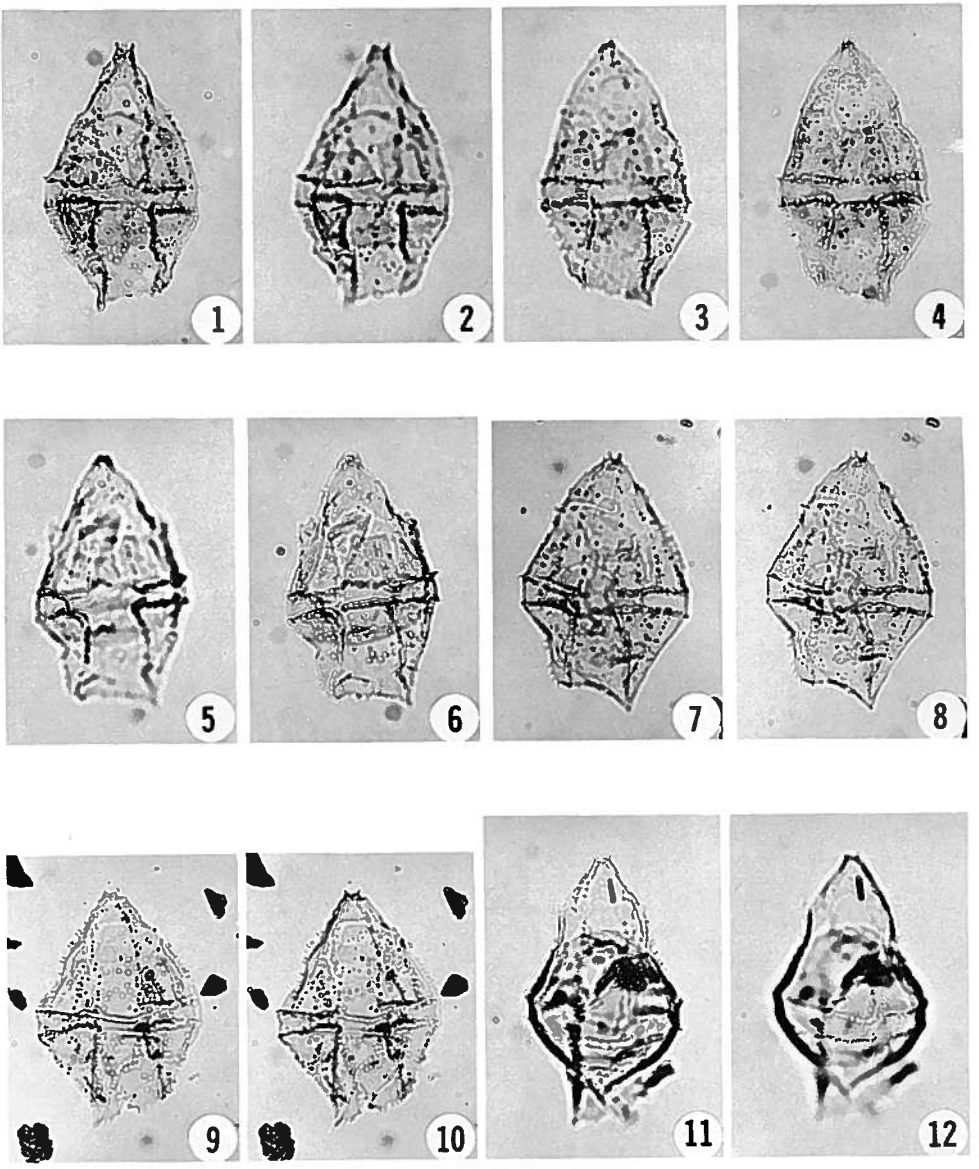
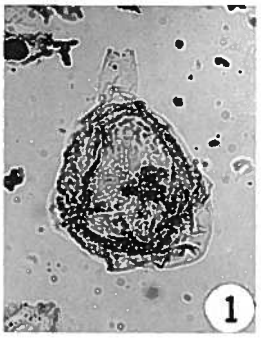
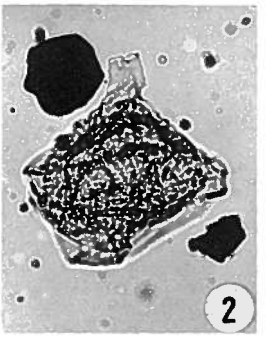
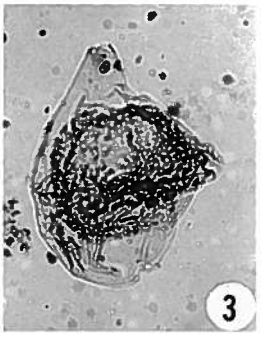
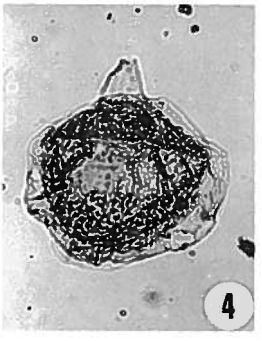


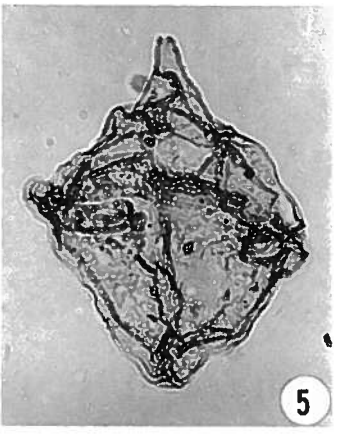
PLATE 62

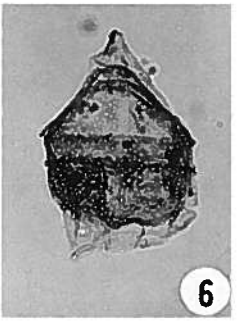


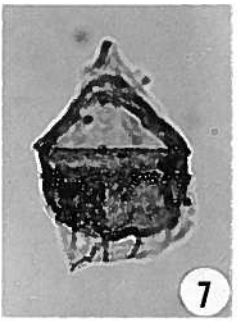


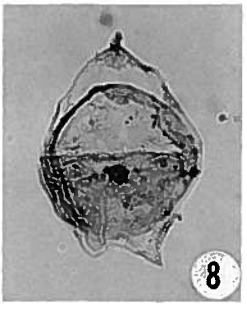


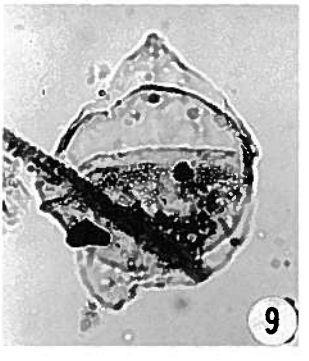


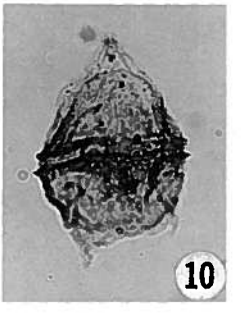












Explanation of Plate 62

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-4: *Dingodinium cerviculum* Cookson and Eisenack ..... (p. 361)

Figure 5: *Scriniodinium campanula* Gocht; dorsal surface showing precingular archeopyle ..... (p. 363)

Figures 6-10: *Scriniodinium eurypylum* Manum and Cookson; 6–ventral surface; 7–same specimen, dorsal surface showing precingular archeopyle; 8–dorsal surface; 9–dorsal surface; 10–ventral surface ..... (p. 364)

Explanation of Plate 63

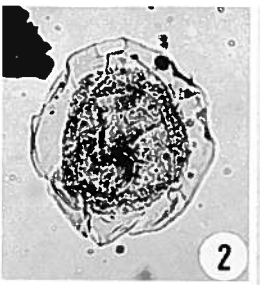
All specimens are illustrated at a magnification of X500 unless otherwise stated

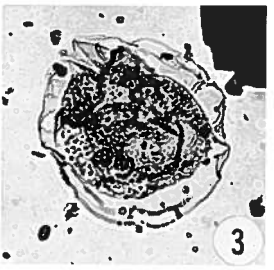
Figure 1: *Ascodinium verrucosum* Cookson and Hughes; ventral surface showing apical archeopyle and sulcal opening ..... (p. 366)

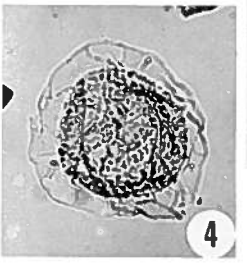
Figures 2-4: *Hexagonifera chlamydata* Cookson and Eisenack; specimens with apical archeopyles outlined by archeopyle sutures surrounding the operculum ..... (p. 368)

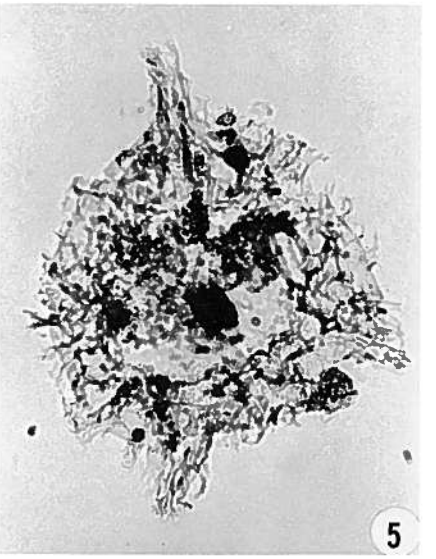
Figures 5-7: *Aptea polymorpha* Eisenack; 5–mid-focus, showing apical archeopyle; 6–mid-focus; 7–mid-focus, showing apical archeopyle ..... (p. 370)

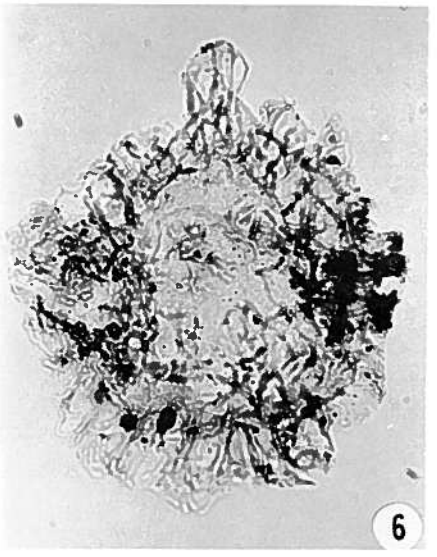
PLATE 63











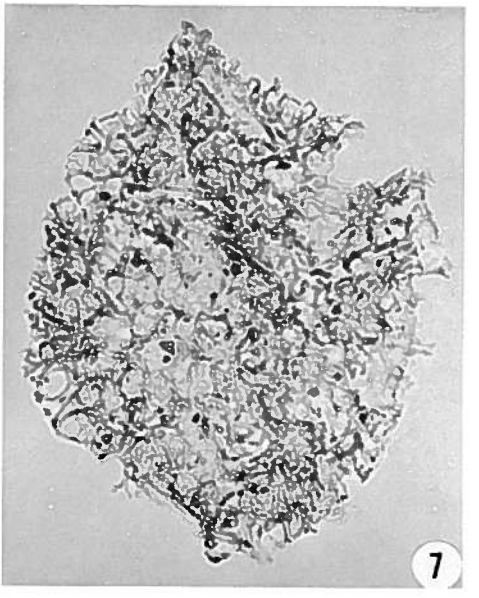
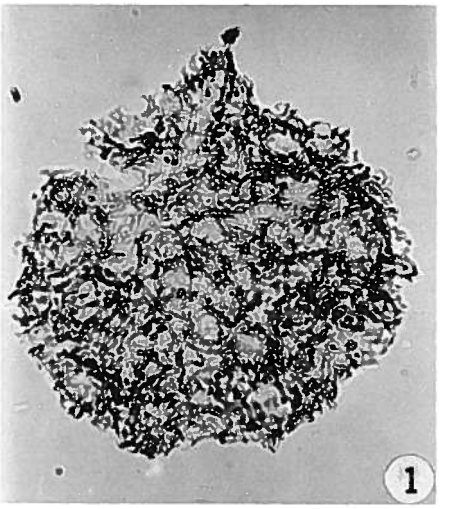
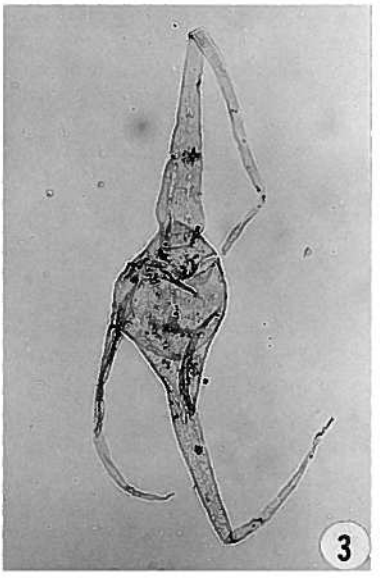
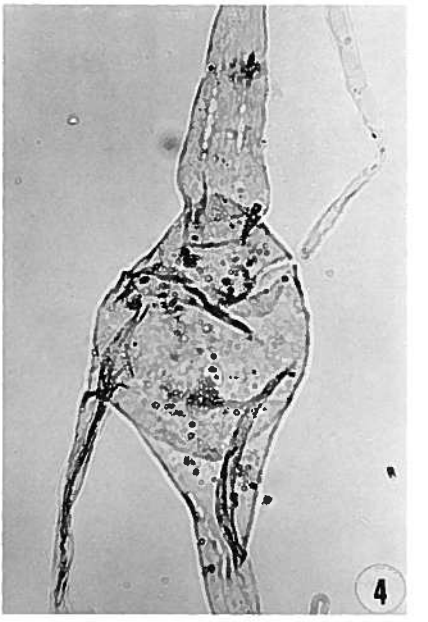


PLATE 64







Explanation of Plate 64

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Aptea polymorpha* Eisenack; showing apical archeopyle ..... (p. 370)

Figure 2: *Odontochitina operculata* (O. Wetzel) Deflandre; X250, showing apical archeopyle ..... (p. 371)

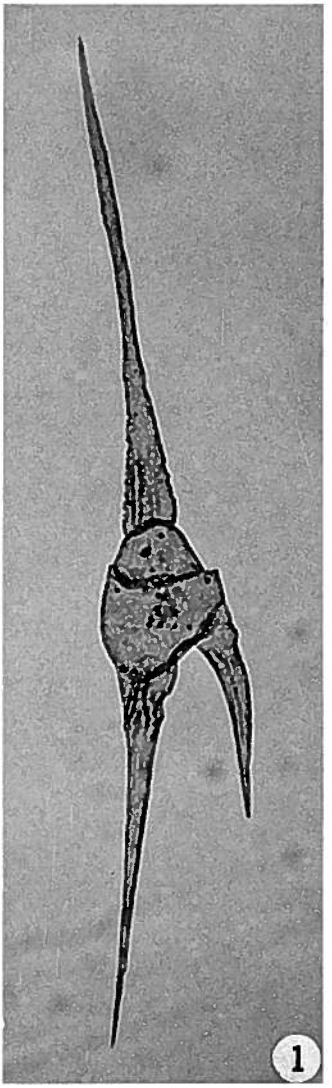
Figures 3, 4: *Odontochitina striatoperforata* Cookson and Eisenack; 3—X250, showing apical archeopyle; 4—same specimen, showing longitudinal rows of perforations near the base of the horns ..... (p. 372)

Explanation of Plate 65

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Odontochitina striatoperforata* Cookson and Eisenack; 1–X250, showing apical archeopyle; 2–same specimen, showing longitudinal rows of perforations near the base of the horns ..... (p. 372)

PLATE 65



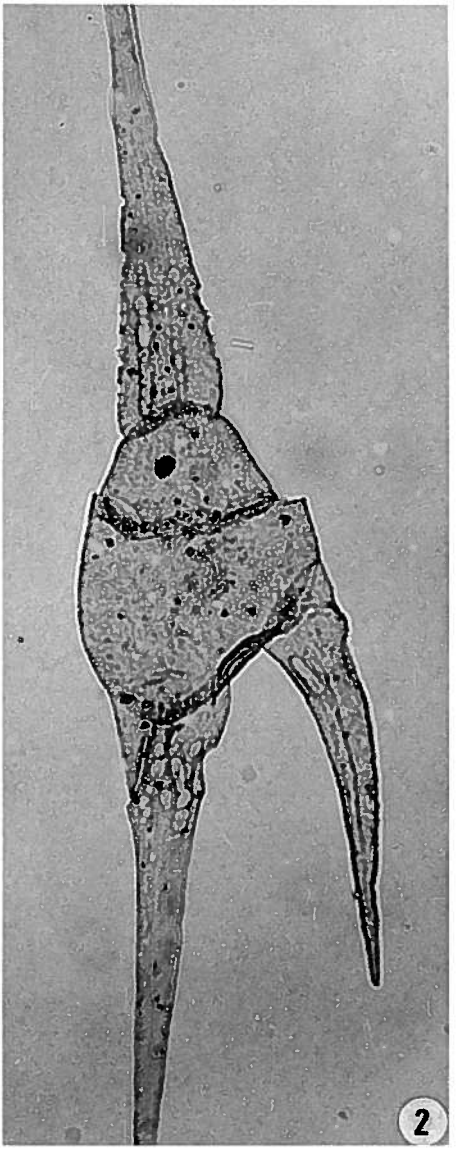
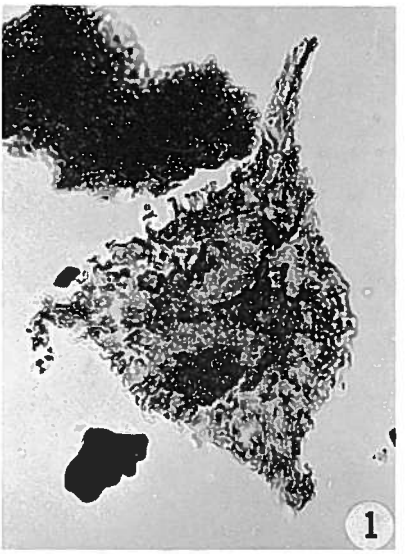
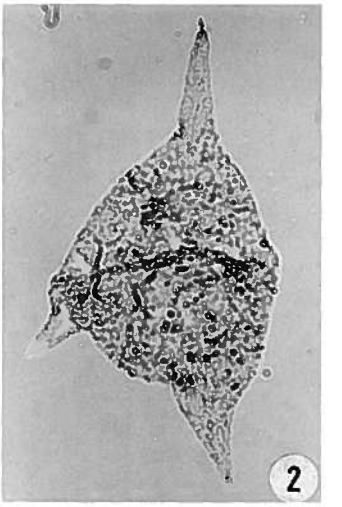
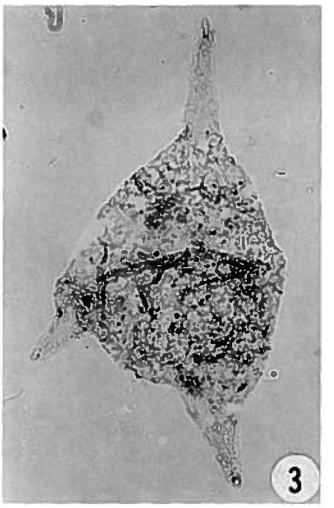
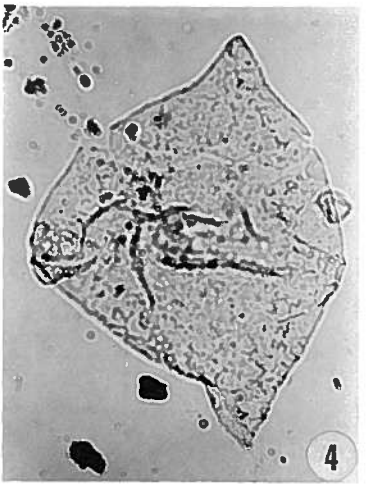


PLATE 66









Explanation of Plate 66

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Pseudoceratium pelliferum* Gocht; showing apical archeopyle ..... (p. 374)

Figures 2-4: *Pseudoceratium regium* n. sp.; 2–(holotype); 3–(holotype) showing small-meshed network on the body; 4–showing apical archeopyle ..... (p. 375)

Explanation of Plate 67

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Pseudoceratium regium* n. sp. ..... (p. 375)

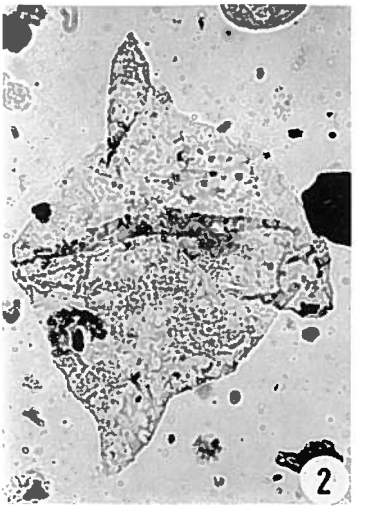
Figures 3, 4: *Chlamydophorella nyei* Cookson and Eisenack; 3—showing apical archeopyle; 4—apical view ..... (p. 376)

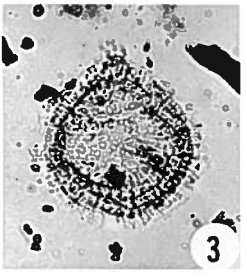
Figures 5, 6: *Chlamydophorella largissima* n. sp.; 5—(holotype); 6—(holotype) X1000, showing processes supporting the outer membrane ..... (p. 378)

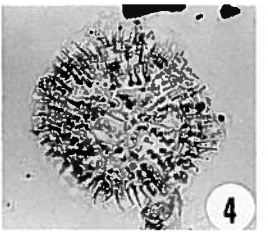
Figure 7: *Chlamydophorella tabulata* n. sp.; (holotype) showing plates ..... (p. 379)

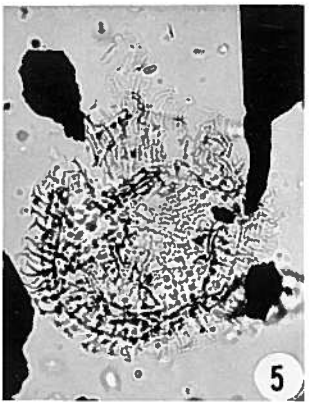
Figure 8: *Chlamydophorella* sp.; apical view ..... (p. 379)

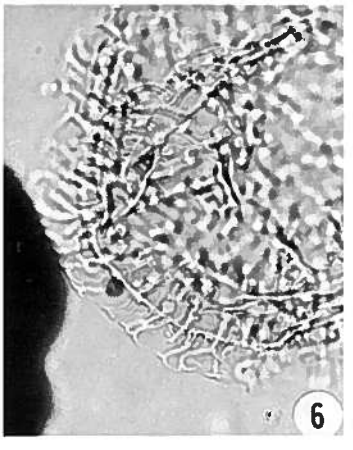
PLATE 67

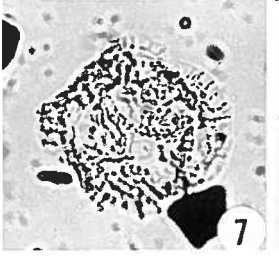












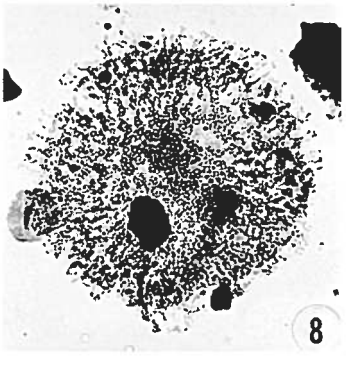
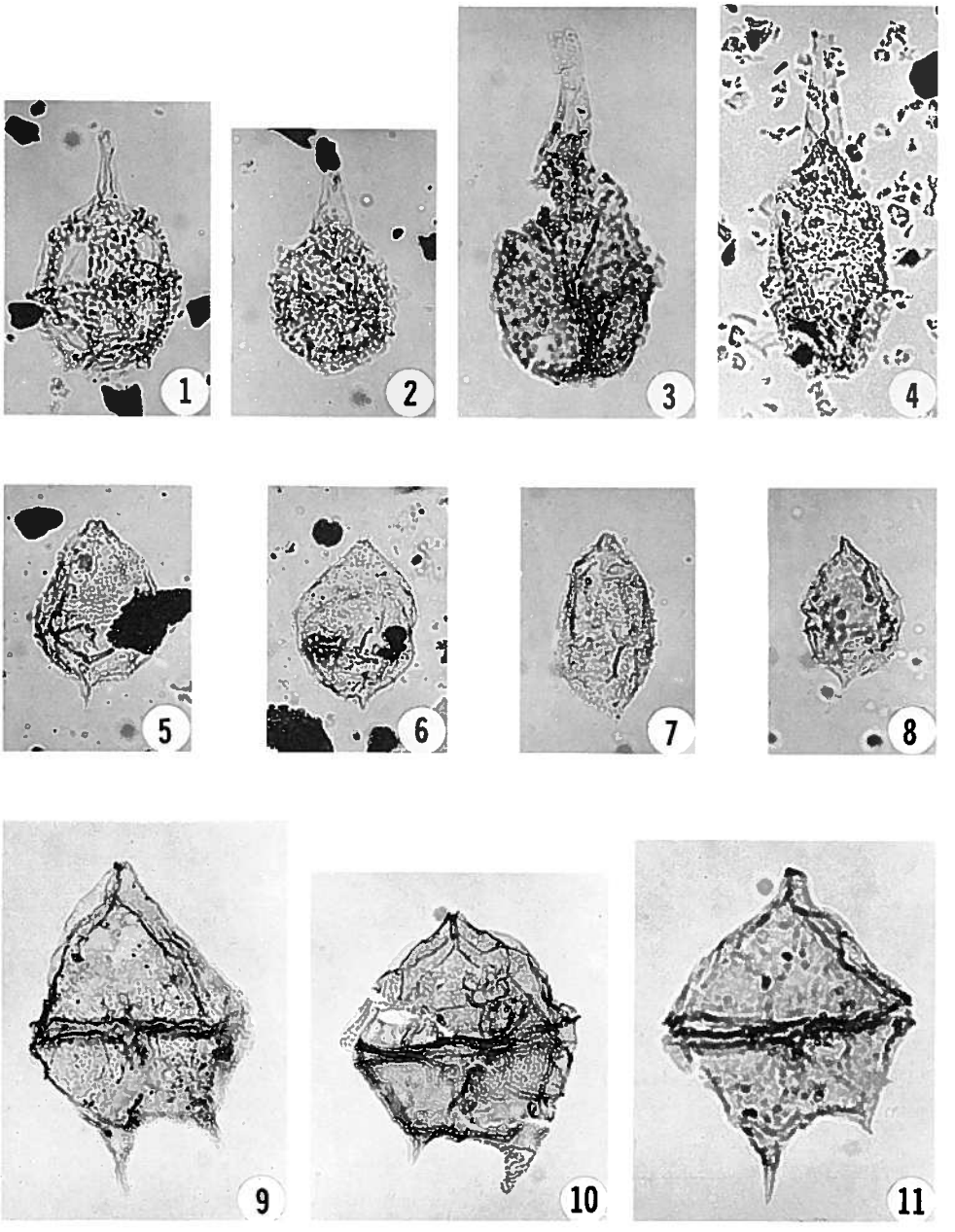


PLATE 68



Explanation of Plate 68

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Gardodinium eisenacki* Alberti ..... (p. 380)

Figures 3, 4: *Gardodinium elongatum* n. sp.; 3–(holotype) ventral surface; 4–mid-focus ..... (p. 381)

Figures 5-8: *Diconodinium pusillum* n. sp.; 5–(holotype) ventral surface; 6–mid-focus; 7–mid-focus; 8–mid-focus ..... (p. 383)

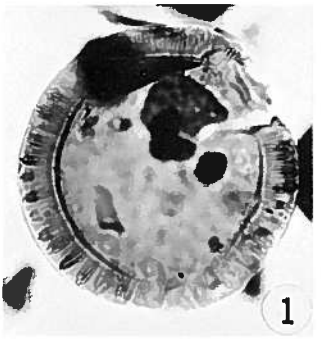
Figures 9-11: *Palaeoperidinium*? *cretaceum* Pocock ..... (p. 385)

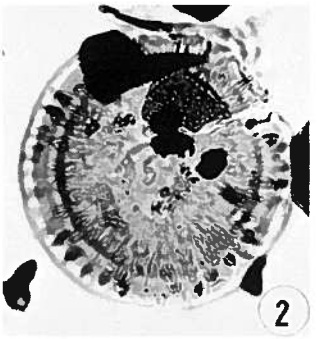
Explanation of Plate 69

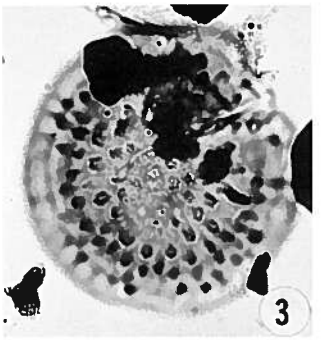
All specimens are illustrated at a magnification of X500 unless otherwise stated

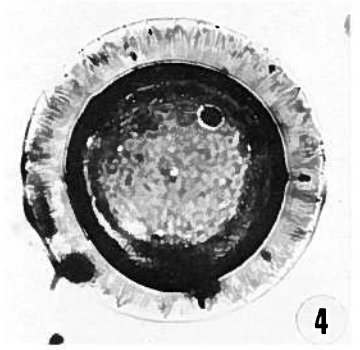
Figures 1-11: *Crassosphaera bella* n. sp.; 1–(holotype) mid-focus; 2–(holotype) high mid-focus; 3–(holotype) high focus; 4–mid-focus; 5–same specimen, high mid-focus; 6–same specimen, high focus; 7–mid-focus; 8–same specimen, high focus; 9–mid-focus; 10–same specimen, high mid-focus; 11–same specimen, high focus ..... (p. 386)

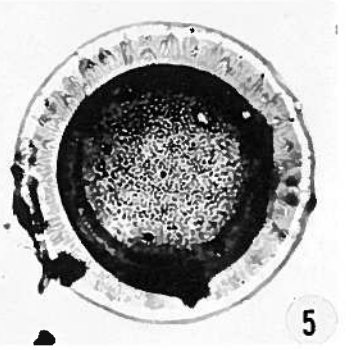
PLATE 69

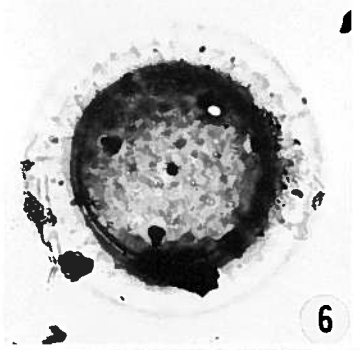


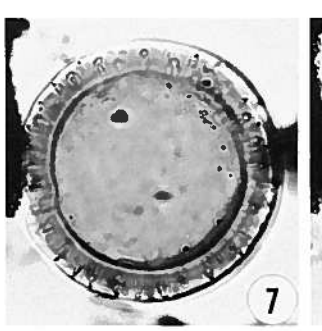


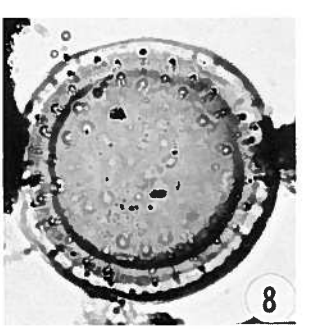


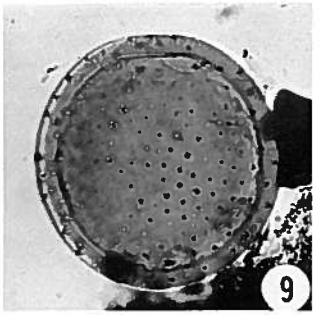


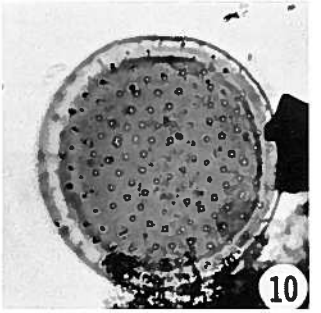












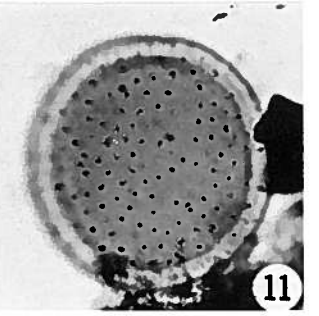
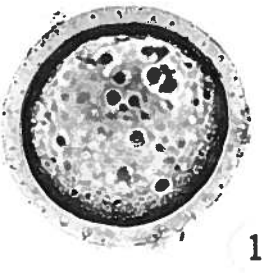


PLATE 70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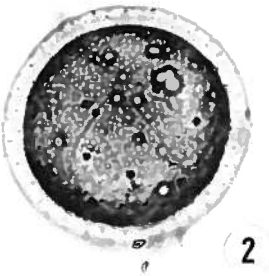
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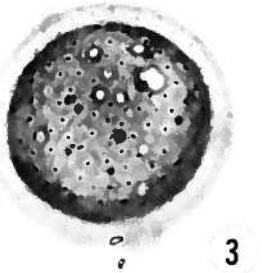
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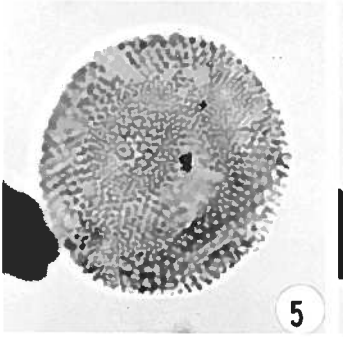
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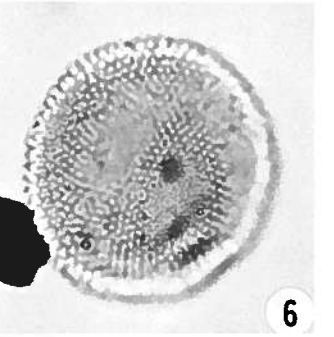
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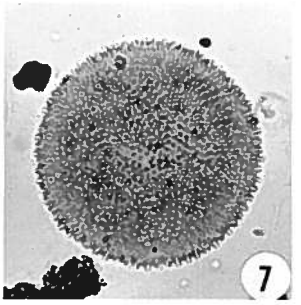
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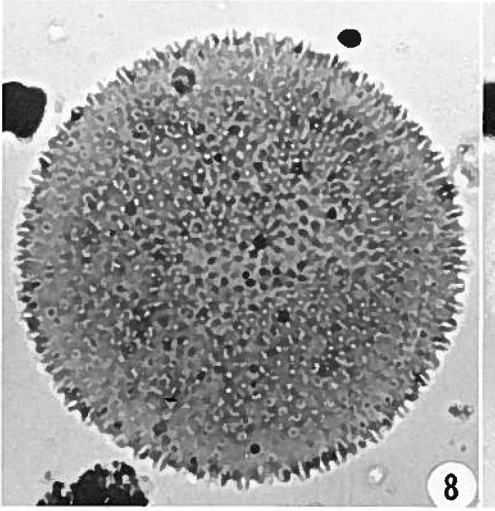
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Explanation of Plate 70

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Crassosphaera bella* n. sp.; 1–mid-focus; 2–same specimen, high mid-focus; 3–same specimen, high focus ..... (p. 386)

Figures 4-6: *Crassosphaera ornata* n. sp.; 4–(holotype) mid-focus; 5–(holotype) X1000, showing trilobate outline of the papillae; 6–(holotype) X1000, showing trilobate outline of the papillae ..... (p. 388)

Figures 7-9: *Crassosphaera papillata* n. sp.; 7–(holotype) mid-focus; 8–(holotype) X1000, mid-focus, showing axial tubules in the papillae; 9–(holotype) X1000, low focus, showing honeycomb pattern formed by the papillae ..... (p. 389)

Explanation of Plate 71

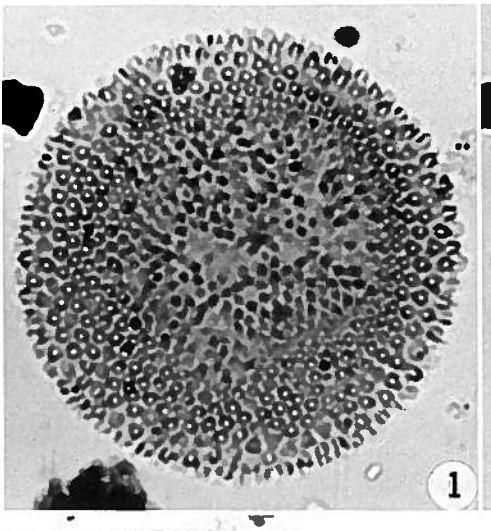
All specimens are illustrated at a magnification of X500 unless otherwise stated

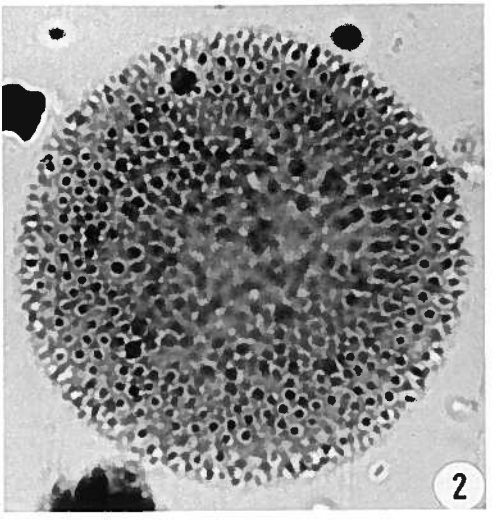
Figures 1, 2: *Crassosphaera papillata* n. sp.; 1–(holotype) X1000, mid-focus, showing axial tubules (white dots) in the hexagonal papillae; 2–(holotype) X1000, high focus, showing axial tubules (black dots) opening at the tip of the papillae ..... (p. 389)

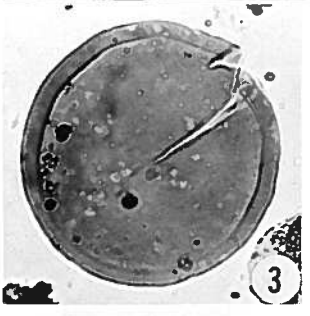
Figures 3, 4: *Tasmanites newtoni* Wall; 3–mid-focus, showing linear suture; 4–mid-focus, showing pore canals ..... (p. 390)

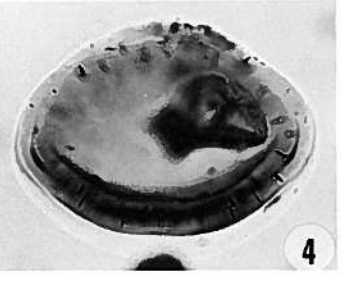
Figures 5, 6: *Tasmanites suevicus* (Eisenack) Wall; 5–mid-focus; 6–same specimen X1000, high focus, showing punctae arranged in clusters ..... (p. 391)

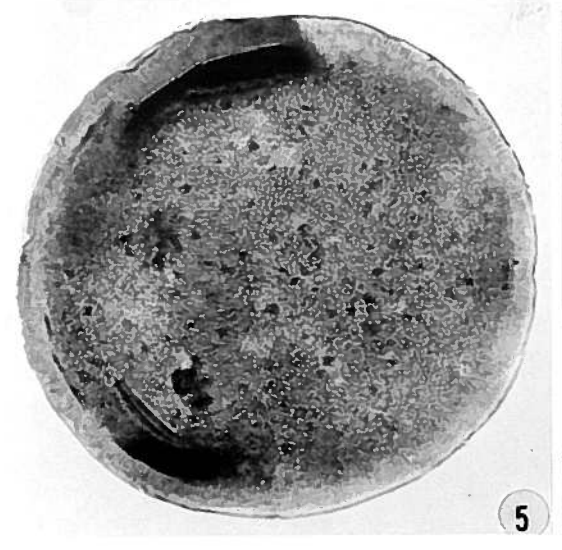
PLATE 71











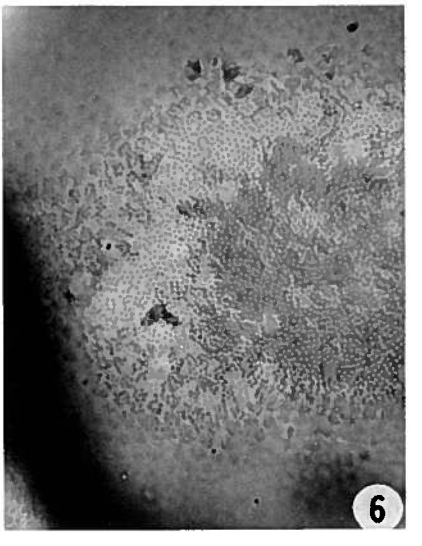
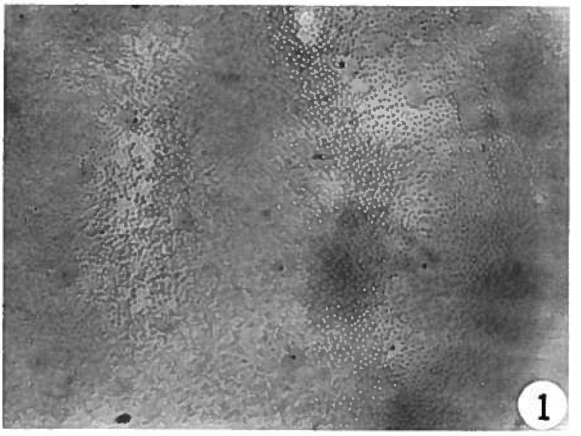
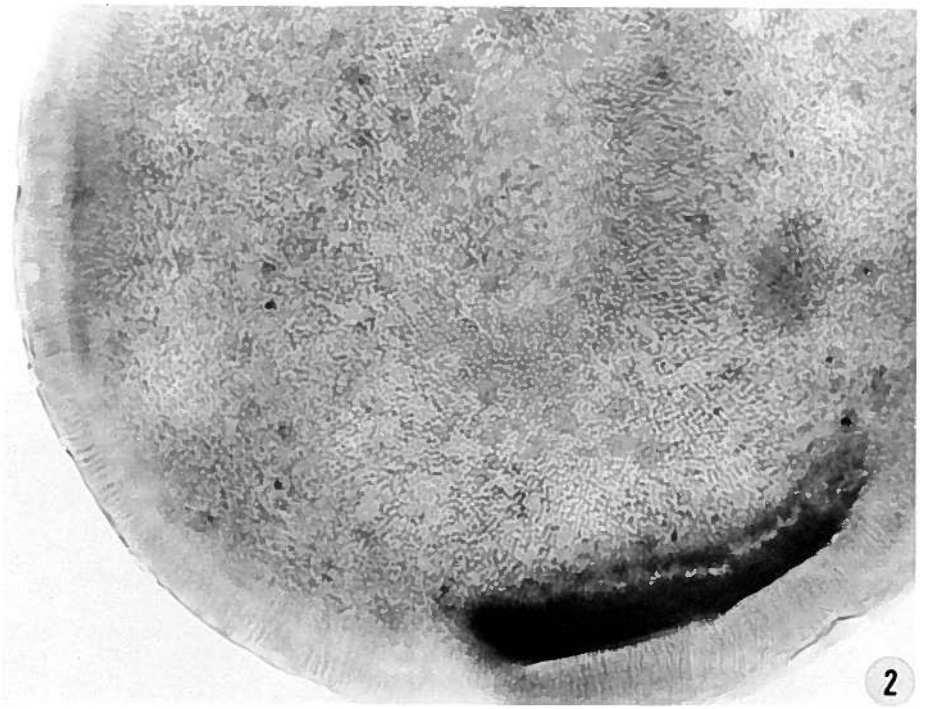


PLATE 72





Explanation of Plate 72

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Tasmanites suevicus* (Eisenack) Wall; 1–X1000, low focus, showing pore canals and uniformly distributed punctae (enlarged from the specimen illustrated on plate 71, figure 5); 2–same specimen X1000, mid-focus, showing radially arranged pore canals and punctae in the wall ..... (p. 391)

Explanation of Plate 73

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Baltisphaeridium crameri* n. sp.; 1–(holotype) mid-focus; 2–mid-focus; 3–mid-focus ..... (p. 393)

Figures 4, 5: *Baltisphaeridium fimbriatum* (White) Sarjeant ..... (p. 394)

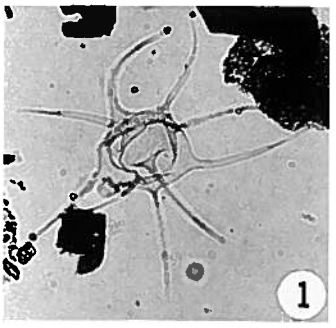
Figure 6: *Baltisphaeridium multispinosum* Singh ..... (p. 395)

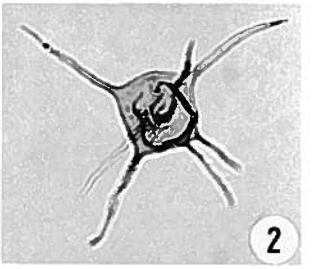
Figures 7, 8: *Baltisphaeridium whitei* (Deflandre and Courteville) Sarjeant ..... (p. 396)

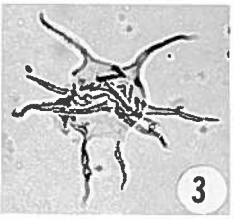
Figures 9, 10: *Baltisphaeridium* sp. A ..... (p. 397)

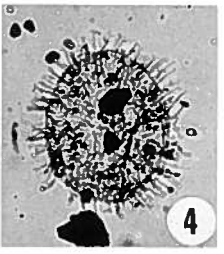
Figures 11, 12: *Baltisphaeridium* sp. B ..... (p. 397)

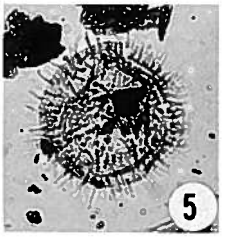
PLATE 73

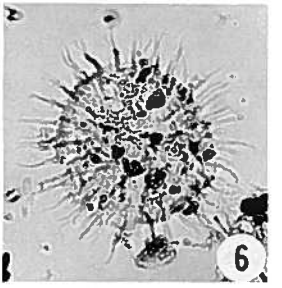


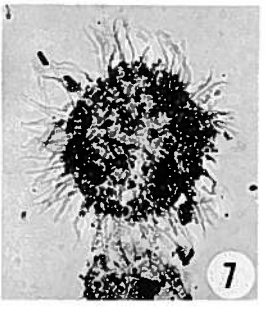


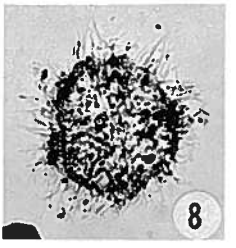


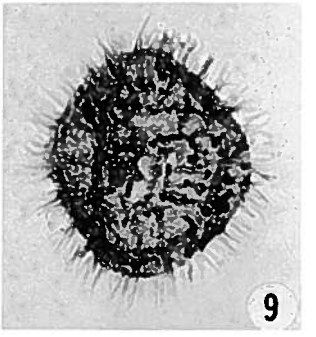


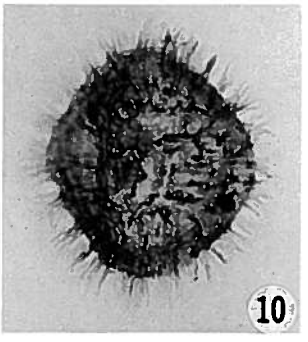


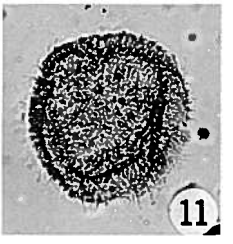












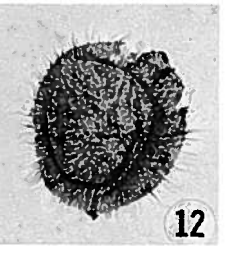
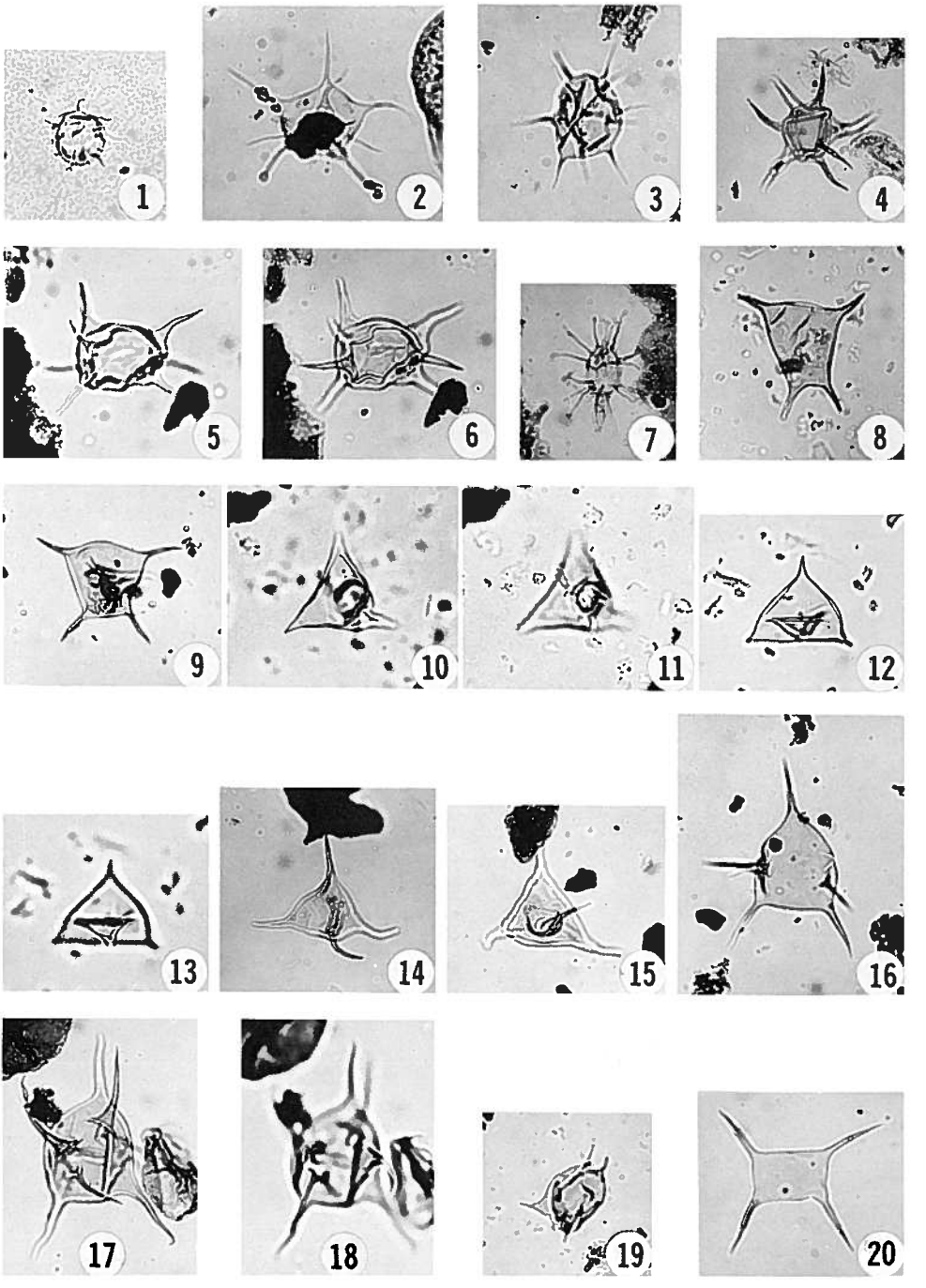


PLATE 74



Explanation of Plate 74

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Micrhystridium fragile* Deflandre ..... (p. 398)

Figure 2: *Micrhystridium singulare* Firtion ..... (p. 399)

Figure 3: *Micrhystridium stellatum* Deflandre ..... (p. 400)

Figures 4-6: *Micrhystridium stellatum* Deflandre forma 6 Wall and Downie ..... (p. 401)

Figure 7: *Micrhystridium* sp. ..... (p. 402)

Figures 8, 9: *Veryhachium collectum* Wall ..... (p. 403)

Figures 10-13: *Veryhachium europaeum* Stockmans and Willière forma 1 Wall and Downie ..... (p. 404)

Figures 14, 15: *Veryhachium europaeum* Stockmans and Willière forma 2 Wall and Downie ..... (p. 405)

Figures 16-18: *Veryhachium formosum* Stockmans and Willière forma 2 Wall and Downie ..... (p. 406)

Figure 19: *Veryhachium irregulare* forma *subtetraedron* Jekhowsky ..... (p. 407)

Figure 20: *Veryhachium lairdi* (Deflandre) Deunff ..... (p. 407)

Explanation of Plate 75

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Veryhachium lairdi* (Deflandre) Deunff ..... (p. 407)

Figure 4: *Veryhachium minutum* Downie ..... (p. 409)

Figures 5-7: *Veryhachium reductum* (Deunff) Jekhowsky ..... (p. 409)

Figure 8: *Veryhachium reductum* (Deunff) Jekhowsky forma 1 ..... (p. 410)

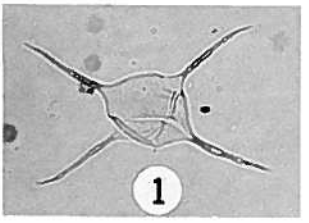
Figures 9-13: *Veryhachium rhomboidium* Downie ..... (p. 411)

Figure 14: *Leiosphaeridia* sp. ..... (p. 412)

Figures 15, 16: *Leiofusa bernesga* Cramer ..... (p. 413)

Figures 17, 18: *Leiofusa jurassica* Cookson and Eisenack ..... (p. 414)

PLATE 75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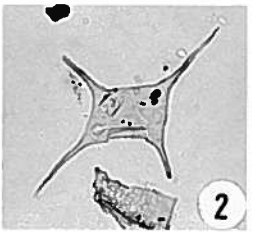
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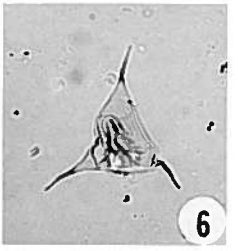
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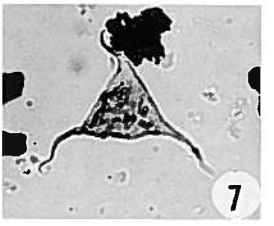
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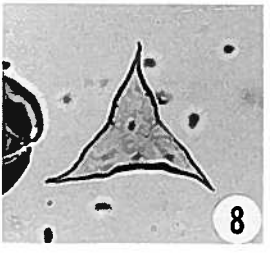
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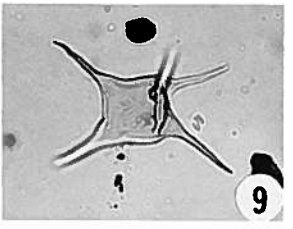
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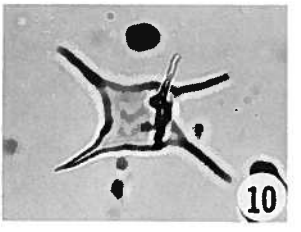
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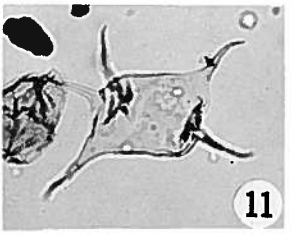
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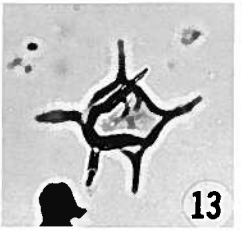
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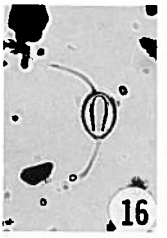
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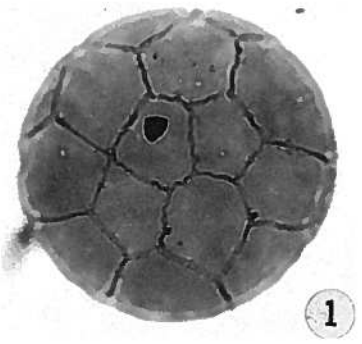
PLATE 76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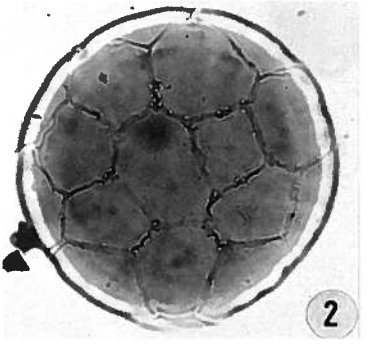
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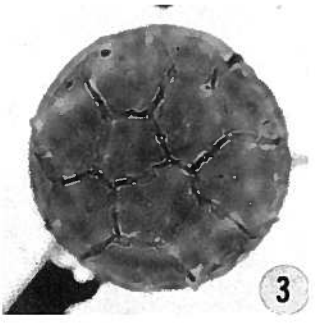
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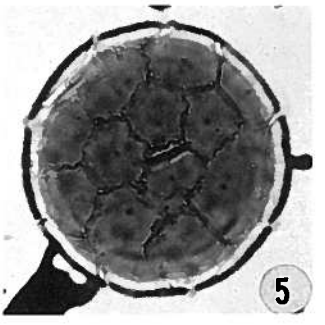
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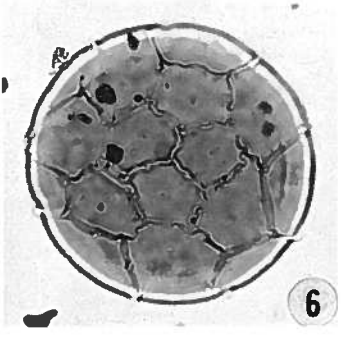
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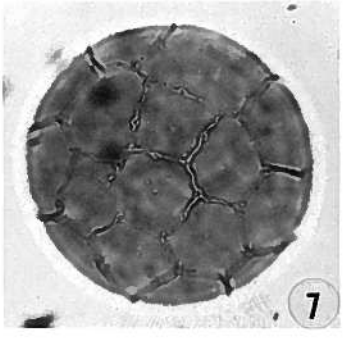
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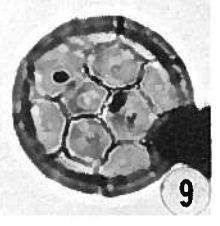
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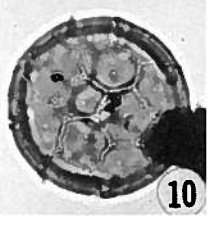
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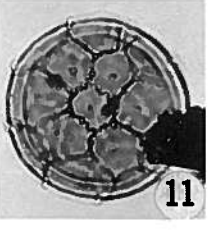

11

Explanation of Plate 76

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-11: *Cymatiosphaera pachytheca* Eisenack; 1–high focus, showing polygonal fields; 2–same specimen, low focus, opposite surface showing polygonal fields; 3–high focus, showing polygonal fields; 4–same specimen, mid-focus, showing a single radial pore canal (white dots) in the center of each field; 5–same specimen, low focus, opposite surface showing polygonal fields; 6–high focus, showing polygonal fields with radial pore canals; 7–same specimen, low focus, opposite surface showing polygonal fields with radial pore canals; 8–mid-focus, showing a single radial pore canal (black dots) in the center of each field; 9–high focus, showing polygonal fields; 10–same specimen, mid-focus, showing a single radial pore canal (white dots) in the center of each field; 11–same specimen, low focus, opposite surface showing polygonal fields ..... (p. 415)

Explanation of Plate 77

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1, 2: *Cymatiosphaera* sp. A; opposite surfaces of the same specimen ..... (p. 417)

Figures 3, 4: *Cymatiosphaera* sp. B; opposite surfaces of the same specimen ..... (p. 417)

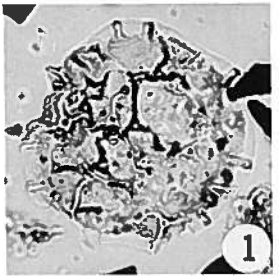
Figures 5, 6: *Cymatiosphaera* sp. C; opposite surfaces of the same specimen ..... (p. 418)

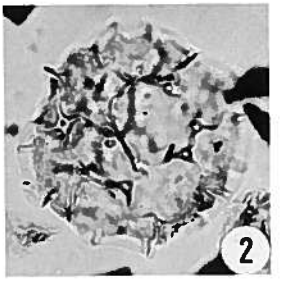
Figures 7-9: *Pterospermopsis aureolata* Cookson and Eisenack ..... (p. 419)

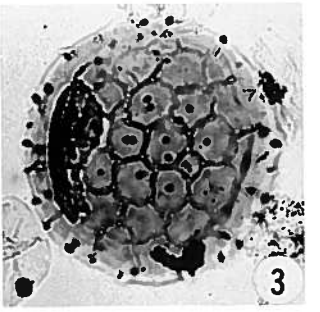
Figure 10: *Pterospermopsis* sp. cf. *P. aureolata* Cookson and Eisenack ..... (p. 419)

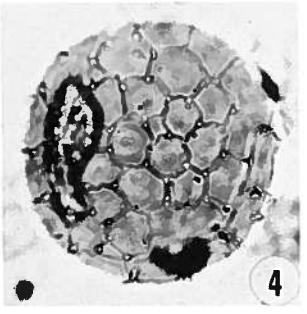
Figures 11, 12: *Pterospermopsis australiensis* Deflandre and Cookson ..... (p. 420)

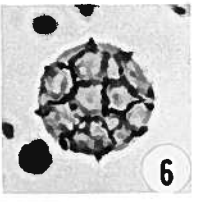
PLATE 77

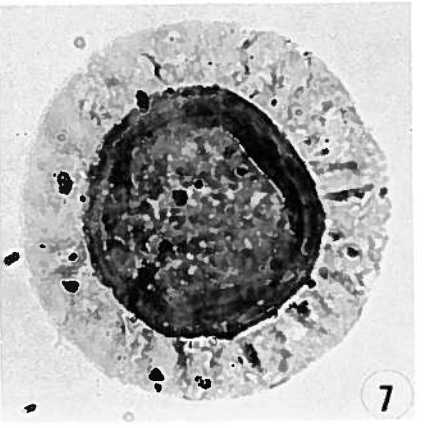


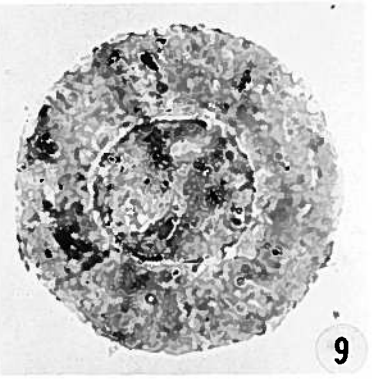


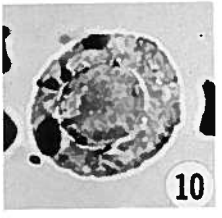


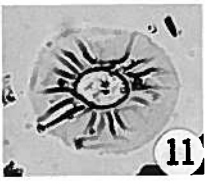


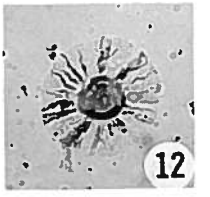












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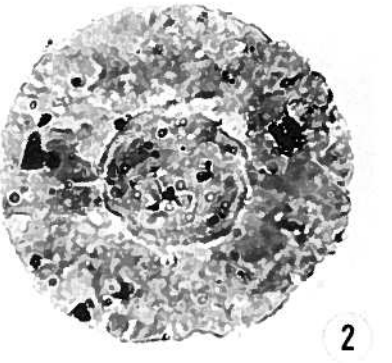
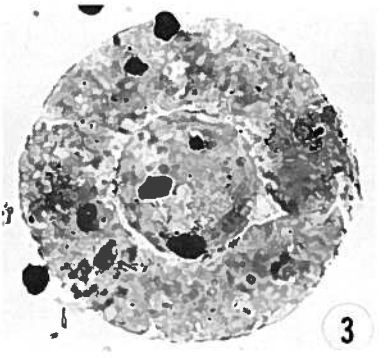
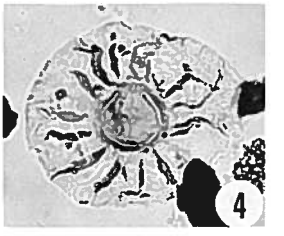
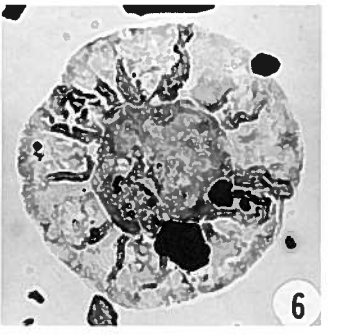
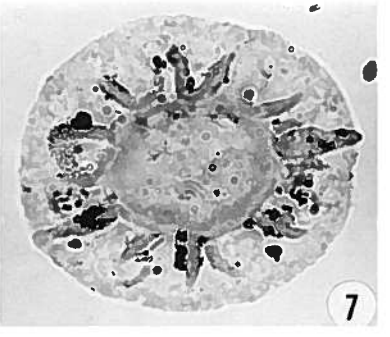
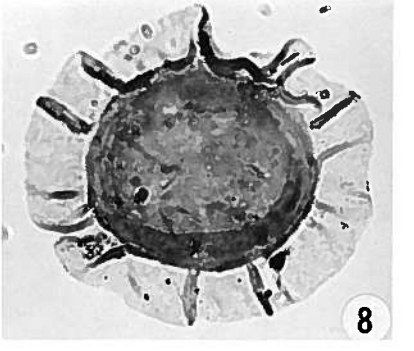












Explanation of Plate 78

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figures 1-3: *Pterospermopsis eurypteris* Cookson and Eisenack ..... (p. 421)

Figures 4-7: *Pterospermopsis harti* Sarjeant ..... (p. 422)

Figure 8: *Pterospermopsis* sp. A ..... (p. 423)

Explanation of Plate 79

All specimens are illustrated at a magnification of X500 unless otherwise stated

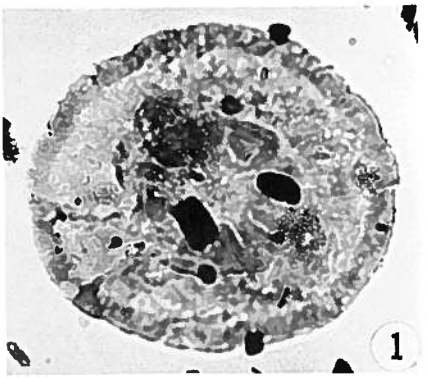
Figure 1: *Pterospermopsis* sp. B ..... (p. 423)

Figure 2: *Pterospermopsis* sp. C ..... (p. 424)

Figures 3, 4: *Ascostomocystis maxima* n. sp.; 3–(holotype) showing cingulum and apical archeopyle; 4–showing cingulum and apical archeopyle ..... (p. 425)

Figures 5-10: *Lecaniella foveata* n. sp.; 5–(holotype) mid-focus; 6–(holotype) high focus; 7–two halves of one specimen opening by a median split; 8–high focus; 9–high focus; 10–high focus ..... (p. 426)

PLATE 79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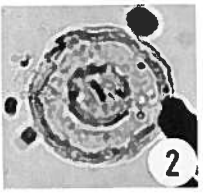
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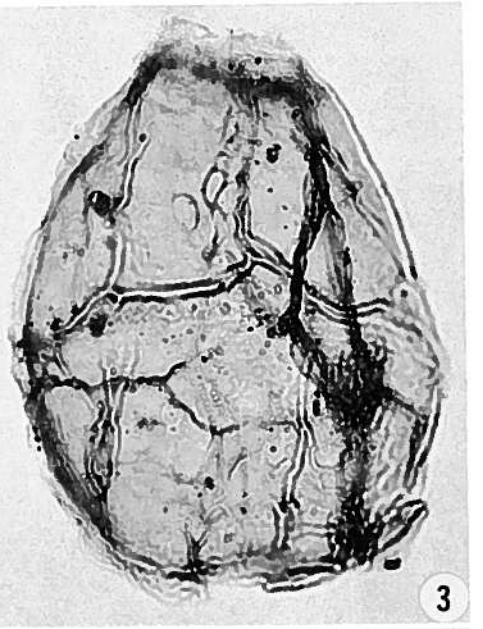
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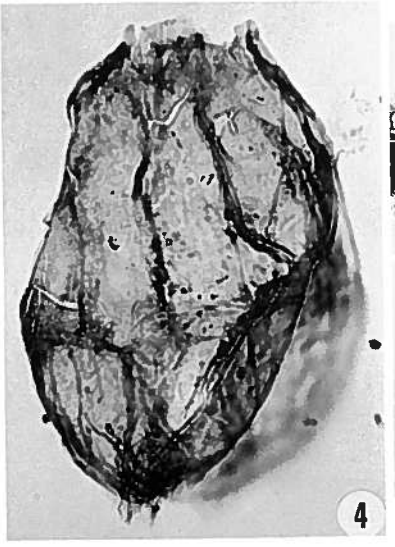
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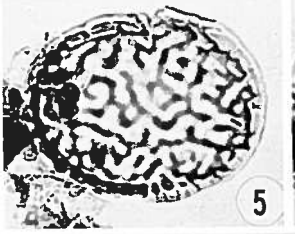
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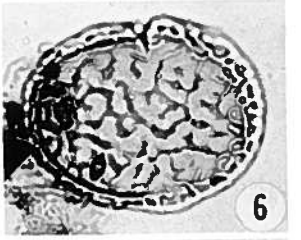
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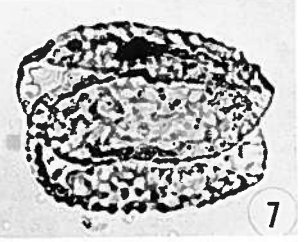
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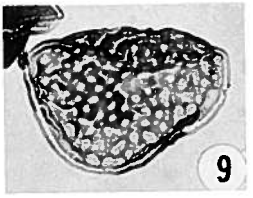
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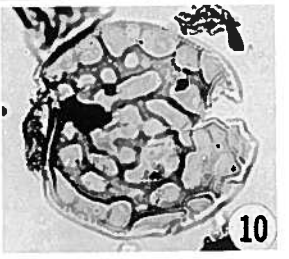
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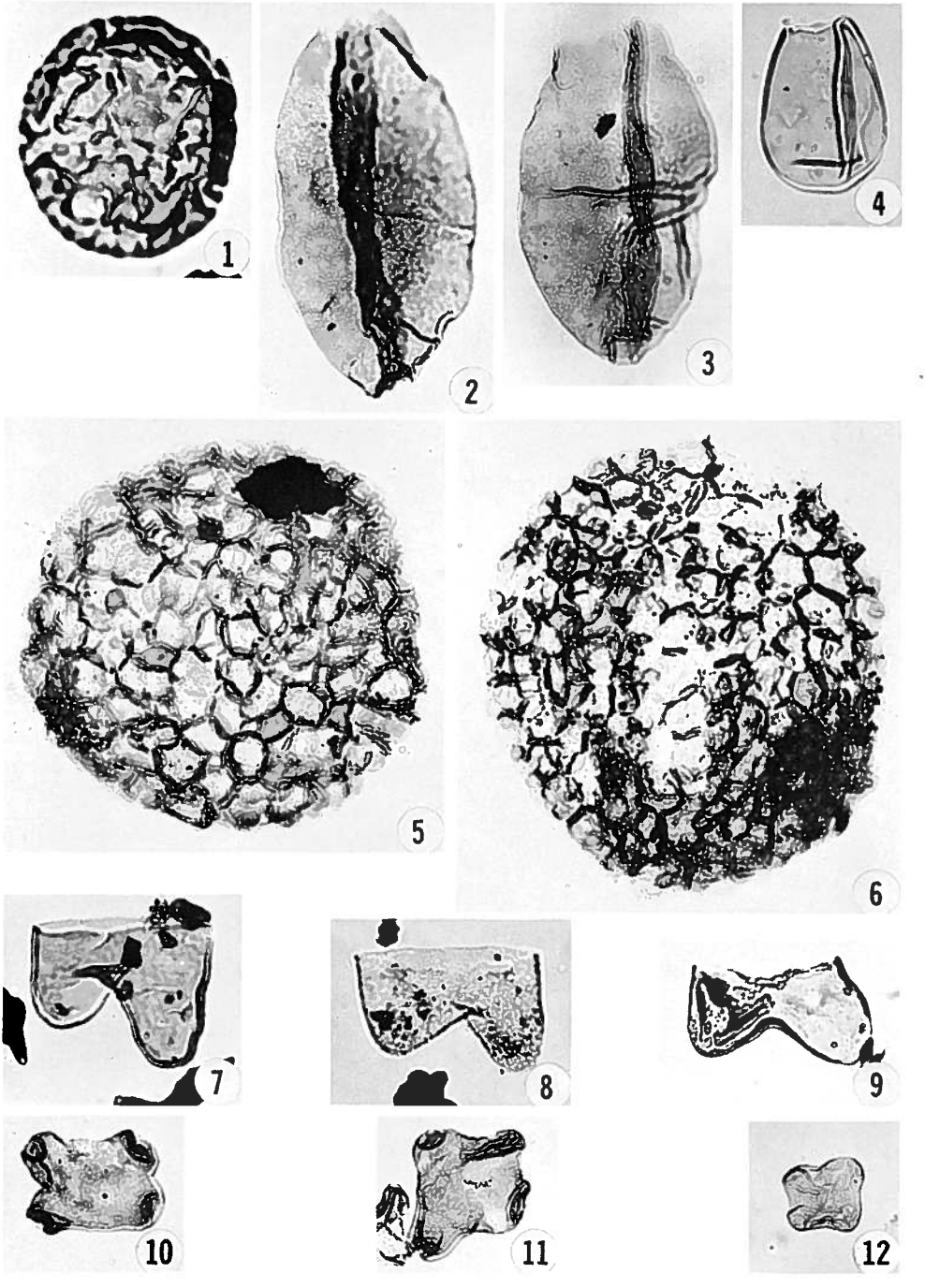

Explanation of Plate 80

All specimens are illustrated at a magnification of X500 unless otherwise stated

Figure 1: *Lecaniella foveata* n. sp.; high focus ..... (p. 426)

Figures 2, 3: *Palaeostomocystis fragilis* Cookson and Eisenack; showing apical archeopyle ..... (p. 427)

Figure 4: *Palaeostomocystis glabella* n. sp.; (holotype) showing apical archeopyle ..... (p. 428)

Figures 5, 6: *Palambages* Form A Manum and Cookson ..... (p. 429)

Figures 7-9: *Schizocystia laevigata* Cookson and Eisenack ..... (p. 430)

Figures 10-12: *Tetraporina horologia* (Staplin) Playford ..... (p. 431)

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Bulletin 28

Appendix

Lower Cretaceous Microfloras of the Peace River Area, Northwestern Alberta

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March, 1971

APPENDIX

TABULATED DESCRIPTIONS

OF

MICROSPORE AND POLLEN SPECIES

	LAEVIGATI	PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				*LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL	DISTAL			
1	Cyathidites australis	14	8	4/5	Simple	Smooth	Triangular	Concave	Rounded	Smooth	Smooth	2μ	49 (56) 64μ	Jurassic and Cretaceous
2	Cyathidites minor	14	9	4/5	Simple	Smooth	Triangular	Concave	Rounded	Smooth	Smooth	1μ	27 (34) 44μ	Jurassic and Cretaceous
3	Concavisporites jurienensis	15	16,17	5/5	Raised	Smooth	Triangular	Concave	Rounded	Arcuate interradial thickenings	Exinal folds below the apices	1.5μ	23 (28) 36μ	Late Jurassic and Early Cretaceous
4	Deltoidospora hallii	16	8	4/5	Simple	Smooth	Triangular	Straight	Rounded	Smooth	Smooth	1μ	24 (28) 32μ	Jurassic and Cretaceous
5	Deltoidospora diaphana	16	9	4/5	Simple	Smooth	Triangular	Straight	Rounded	Smooth	Smooth	1.5μ	40 (44) 50μ	Late Jurassic to Tertiary
6	Deltoidospora psilostoma	16	12	4/5	Simple	Smooth	Triangular	Straight	Rounded	Weakly punctate	Weakly punctate	3μ	50 (56) 68μ	Late Jurassic to Late Cretaceous
7	Deltoidospora juncta	16	10,11	5/5	Raised	Smooth	Triangular	Straight	Rounded	Smooth	Exinal folds below the apices	1.5μ	26 (32) 38μ	Late Jurassic and Early Cretaceous
8	Dictyophyllidites sp.	14	13	5/5	Raised	Smooth, 4μ wide thickened margo	Triangular	Straight	Sharply rounded	Smooth	Smooth	1μ	24 (25) 26μ	Aptian and Albian
9	Stereisporites antiquasporites	1	4,5	2/3	Simple	Smooth	Rounded-triangular	Convex	Broadly rounded	Smooth	Polar thickening disk-like, 7μ wide	1μ	20 (23) 26μ	Jurassic to Tertiary
10	Biretisporites potoniaei	3	15,16	4/5	3μ high	Smooth	Rounded-triangular	Convex	Broadly rounded	Smooth	Smooth	2μ	36 (44) 62μ	Early Cretaceous
11	Psilatriletes radiatus	18	9,10	5/5	Simple	Smooth	Rounded-triangular	Convex	Broadly rounded to acute	Fine radial folds near equatorial margin	Smooth	1.5μ	42 (45) 48μ	Barremian to early Cenomanian
12	Undulatisporites undulapolus	20	11,12	5/5	3μ high, undulate	Smooth	Rounded-triangular	Convex	Broadly rounded	Smooth	Smooth	2μ	37 (40) 43μ	Barremian to Albian
13	Undulatisporites sp.	20	13	5/5	1.5μ high, undulate	Smooth	Rounded-triangular	Convex	Broadly rounded	Smooth	Smooth	1μ	14μ	Late Albian
14	Undulatisporites pannuceus	20	9,10	5/5	2μ wide, undulate	Finely wrinkled	Triangular	Straight to convex	Acute	Finely wrinkled	Finely wrinkled	2μ	36 (38) 42μ	Barremian to early Cenomanian
15	Undulatisporites fossulatus	20	5-8	5/5	3μ high, undulate	Smooth	Triangular	Straight	Acute	Smooth	Fossulate	2μ	27 (32.5) 38μ	Middle and late Albian
16	Todisporites minor	4	2	3/4	Simple	Smooth	Circular to subcircular	Convex	Broadly rounded	Smooth	Smooth	1μ	28 (36) 53μ	Bajocian to Cenomanian

*length relative to spore radius

APICULATI		PLATE	FIGURES	TRILETE MARK				SHAPE			ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	MARGO	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL	DISTAL			
17	Osmundacidites wellmanii	4	1	3/4	Simple	Absent	Granulate	Circular	Convex	Broadly rounded	Granulate; grana with irregular, confluent bases	Granulate as on the proximal surface	1.5μ	31 (44) 60μ	Jurassic and Cretaceous
18	Baculatisporites comaumensis	3	14	3/4	Bordered by closely spaced bacula	Absent	Baculate	Circular	Convex	Broadly rounded	Baculate; bacula 1μ long, 1μ wide, spaced about 2μ apart	Baculate as on the proximal surface	1μ	29 (42) 53μ	Late Triassic to Cretaceous
19	Concavissimisporites punctatus	15	19	3/4	Simple	Present	Subgranulate	Triangular	Concave	Broadly rounded	Indistinct subgranulate to undulose	Indistinct subgranulate to undulose	2μ	48 (61) 68μ	Berriasian to Albian
20	Concavissimisporites minor	15	18	3/4	Simple	Weakly developed	Verrucate	Triangular	Concave	Broadly rounded	Verrucate; verrucae 0.8μ in diameter and widely spaced	Verrucate as on the proximal surface	2.5μ	73 (76) 78μ	Late Jurassic to Albian
21	Concavissimisporites sp.	16	2,3	3/4	Bordered by confluent verrucae	Present	Verrucate	Triangular	Straight	Broadly rounded	Verrucate; verrucae flat, confluent, irregular shaped, elongate, 1 to 3μ in diameter	Verrucate as on the proximal surface	3μ thick, double layered, ektexine detached from endexine	48μ	Middle Albian
22	Concavissimisporites variverrucatus	16	1	3/4	Simple	Weakly developed	Verrucate	Triangular	Concave	Broadly rounded	Verrucate; verrucae 1.5 to 5μ in diameter, up to 2μ high, closely spaced	Verrucate as on the proximal surface	2 to 4μ	47 (63) 72μ	Bajocian to Albian
23	Verrucosisporites rotundus	20	14	2/3	Simple, indistinct	Absent	Verrucate	Circular	Convex	Broadly rounded	Verrucate; verrucae flat, round, 2 to 5μ in diameter, closely spaced	Verrucate as on the proximal surface	2μ	37μ	Aptian and Albian
24	Converrucosisporites exquisitus	16	4,5	2/3	Simple, indistinct	Absent	Verrucate	Triangular	Straight	Broadly rounded	Verrucate; verrucae hemispherical, 6 to 10μ in diameter, 4 to 7μ high, spaced 1 to 4μ apart	Verrucate as on the proximal surface	4μ	68 (71) 84μ	Middle and late Albian
25	Leptolepidites verrucatus	17	12,13	5/5	Simple	Absent	Smooth	Triangular	Convex	Rounded	Smooth	Verrucate; verrucae dome shaped, about 5μ in diameter, 3μ high, closely spaced	1.5μ	25 (30) 36μ	Jurassic and Cretaceous
26	Leptolepidites sp.	17	14,15	5/5	Simple indistinct	Absent	Verrucate	Triangular	Concave	Rounded	Verrucate; verrucae larger at the poles, dome shaped, 3 to 7μ in diameter, 3 to 5μ high, clustered at the poles and around the equator	Verrucate as on the proximal surface	2μ	36μ	Middle Albian
27	Kuylisporites lunaris	14	10,11	5/5	Simple, indistinct	Absent	Finely granulate	Rounded-triangular	Convex	Broadly rounded	Finely granulate	5 to 30 crescent-shaped elevations (scutula) enclosing shallow, 3 to 8μ wide lumina	2μ	36 (45) 54μ	Early Cretaceous
28	Neoraistrickia truncata	3	13	5/5	Raised	Absent	Smooth	Rounded-triangular	Convex	Broadly rounded	Baculate; bacula small and sparsely distributed	Baculate; bacula 3 to 4μ long, 2 to 3μ wide, spaced 4 to 6μ apart	2μ	34 (37) 40μ including bacula	Jurassic and Cretaceous
29	Pilosisporites trichopapillosus	18	3	3/4	Simple	Weakly developed	Echinate	Triangular	Slightly convex to concave	Broadly rounded	Echinate; spines sparse in the contact area	Echinate; spines about 5μ long, curved, usually crowded in the apical areas	3.5μ	50 (67) 78μ excluding spines	Purbeckian to Albian
30	Acanthotriletes varispinosus	3	8	4/5	Bordered by 1μ wide lips	Absent	Scabrate	Subcircular	Convex	Broadly rounded	Scabrate	Echinate; spines about 6μ long, 2 to 4μ wide, often bifurcating and irregularly distributed	2μ	25 (33) 41μ excluding spines	Early Cretaceous
31	Lophotriletes babsae	17	16	3/4	Simple	Absent	Smooth	Triangular	Straight	Acute	Apiculate; coni not present in the contact area	Apiculate; coni blunt, 3 to 6μ long, 2 to 5μ wide, spaced 2 to 3μ apart	2.5μ	48μ excluding coni	Albian

MURORNATI		PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL	DISTAL			
32	Lycopodiumsporites crassimacerius	2	5-8	3/4	Raised membraneous lips	Smooth	Rounded-triangular	Convex	Broadly rounded	Reticulate sculpture near the equatorial margin	Coarsely reticulate; lumina polygonal, 6 to 7μ wide; muri about 2μ high, 2 to 3μ wide	2 to 3μ	39 (45) 53 μ	Middle Albian to Cenomanian
33	Lycopodiumsporites reticulumsporites	3	1,2	2/3	Raised membraneous lips	Smooth	Rounded-triangular	Convex	Broadly rounded	Rectilinear lumina, about 7μ in length, near the equatorial margin	Reticulate; lumina polygonal, 2 to 6μ wide; muri 1μ high, 0.8μ wide	1μ	32 (37) 41 μ	Bathonian to Albian
34	Lycopodiumsporites austroclavatidites	2	1	3/4	Raised membraneous lips	Smooth	Rounded-triangular	Convex	Broadly rounded	Smooth	Reticulate; lumina polygonal, 7 to 10μ wide; raised muri forming a 2 to 4μ wide margin of membraneous network around the spore body	1.5μ	32 (41) 48μ	Jurassic and Cretaceous
35	Lycopodiumsporites crassatus	2	2-4	4/5	5μ high membraneous lips	Reticulate	Rounded-triangular	Convex	Broadly rounded	Reticulate; radially elongate, raised muri enclosing rectilinear lumina	Reticulate; lumina polygonal, 8 to 12μ wide; raised muri forming a 4 to 5μ wide margin of membraneous network around the spore body; muri 2μ wide at base	4 to 6μ	48 (56) 65 μ	Middle and late Albian
36	Lycopodiumsporites marginatus	2	12-14	5/5	6μ high membraneous lips	With irregular ridges	Rounded-triangular	Convex	Broadly rounded	Reticulate sculpture near the equatorial margin	Reticulate; lumina polygonal, 8 to 12μ wide; raised muri forming a 7 to 10μ wide margin of membraneous network around the spore body	1.5μ	42 (49) 58 μ	Aptian and Albian
37	Lycopodiumsporites expansus	2	9-11	4/5	Raised membraneous lips	Smooth	Subcircular	Convex	Broadly rounded	Reticulate sculpture near the equatorial margin	Reticulate; lumina pentagonal or hexagonal, 10 to 16μ wide; raised muri forming a 6 to 8μ wide margin of membraneous network around the spore body	2μ	36 (41) 46 μ	Middle and late Albian
38	Reticulisporites elongatus	18	11,12	4/5	Raised membraneous lips	Smooth to scabrate	Triangular	Concave	Rounded	Smooth to scabrate	Imperfect reticulate; lumina polygonal, elongate, 4 to 10μ long, 2 to 3μ wide; muri 1μ high, 0.5μ wide	1.5μ	30 (33) 35 μ	Middle and late Albian
39	Microreticulatisporites uniformis	17	17-19	3/4	Raised membraneous lips	Smooth	Triangular with crenate margin	Straight	Rounded	Reticulate sculpture near the equatorial margin	Reticulate; lumina 2 to 3μ in diameter; muri 1 to 2μ in width	2μ	40 (46) 58 μ	Aptian to early Cenomanian
40	Tigrisporites reticulatus	18	17-19	5/5	Raised membraneous lips	Smooth	Triangular	Slightly convex to concave	Rounded	Reticulate sculpture near the equatorial margin	Polar thickening disk-like, smooth, 10 to 12μ wide, surrounded by a perfect reticulate sculpture; lumina 4 to 8μ long, 2 to 4μ wide; muri 0.5μ wide	1μ	29 (35.5) 41 μ	Middle Albian to early Cenomanian
41	Tigrisporites sp. A	19	5	5/5	Simple	Smooth	Rounded-triangular	Convex	Broadly rounded	Reticulate sculpture near the equatorial margin	Polar thickening disk-like, smooth, 10 to 12μ wide, surrounded by a perfect reticulate sculpture; lumina 2 to 4μ long, 1 to 2μ wide	1μ	33 (34.5) 36 μ	Middle Albian

MURORNATI		PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL	DISTAL			
42	Tigrisporites scurrandus	19	1-4	5/5	Raised membraneous lips	Smooth	Triangular	Slightly convex to concave	Rounded	Radially arranged rugulae near the equatorial margin	Polar thickening disk-like, smooth, 10 to 12μ wide, surrounded by rugulae, 2 to 9μ long, about 1μ wide, 1.5μ high, spaced 1 to 4μ apart	2μ	29 (33) 39 μ	Middle and late Albian
43	Tigrisporites sp. B	19	6	5/5	Simple	Smooth	Triangular	Slightly convex to straight	Broadly rounded	Smooth	Polar thickening disk-like, smooth, 10 to 14μ wide, surrounded by verrucae, 1 to 3μ in diameter, spaced about 1μ apart	1.5μ	30 (31.5) 33.5 μ	Late Albian
44	Klukisporites pseudoreticulatus	13	12-15	4/5	Raised membraneous lips	Smooth	Triangular	Slightly concave to straight	Rounded	Foveo-reticulate sculpture near the equatorial margin	Foveo-reticulate; lumina angular, 3 to 6μ wide, spaced about 4μ apart	3μ	45 (49) 51 μ	Late Jurassic to early Cenomanian
45	Klukisporites foveolatus	13	8-11	5/5	Raised membraneous lips	Smooth	Rounded-triangular	Convex	Broadly rounded	Foveo-reticulate sculpture near the equatorial margin	Foveo-reticulate; lumina circular, 2 to 4μ wide, spaced 3 to 5μ apart	2.5μ	40 (47) 55 μ	Barremian to Albian
46	Klukisporites areolatus	13	4-7	5/5	Raised membraneous lips	Smooth	Rounded-triangular	Convex	Broadly rounded	Foveo-reticulate sculpture near the equatorial margin	Foveo-reticulate; lumina pentagonal or hexagonal, 6 to 12μ wide, larger at distal pole, spaced 2 to 5μ apart	2.5μ	41 (50) 55 μ	Middle Albian
47	Foveotriletes subtriangularis	17	4,5	4/5	Raised membraneous lips	Smooth	Triangular	Convex	Rounded	Foveolate sculpture near the equatorial margin	Foveolate; foveolae round, about 1μ wide, spaced 2 to 3μ apart	1.5μ	36 (48) 54 μ	Berriasian to Albian
48	Foveosporites sp. cf. F. canalis	16	13,14	4/5	Raised membraneous lips	Smooth	Rounded-triangular	Convex	Broadly rounded	A few foveolae near the equatorial margin	Foveolate; foveolae sparsely distributed, about 1μ wide, irregular-shaped, often coalescing to form short channels	2.5μ	50 μ	Middle Albian
49	Foveosporites labiosus	17	1-3	4/5	Simple	Foveolate, 4μ wide thickened margo	Rounded-triangular	Convex	Broadly rounded	Foveolate as on the distal surface	Foveolate; foveolae irregular shaped, coalescing to form short channels, about 0.5μ wide, 2 to 3μ apart; exine near the equator thickened in a 2μ wide band	1.5μ	32 (38) 46 μ	Middle and late Albian
50	Lycopodiacidites canaliculatus	1	15	2/3	Simple	Rugulate	Rounded-triangular, crenellated	Convex	Broadly rounded	Rugulate; rugulae low	Rugulate; rugulae flat-crested, 2 to 6μ wide, separated by 1μ wide branching grooves following acute zigzag courses	2μ	36 (46) 55 μ	Middle and late Albian
51	Lycopodiacidites caperatus	1	16,17	2/3	Simple slits or gaping	Rugulate	Rounded-triangular, crenellated	Convex	Broadly rounded	Rugulate; rugulae low, radially oriented	Coarsely rugulate; rugulae round-crested, 4 to 10μ wide, 3 to 4μ high, separated by about 3μ wide branching grooves	4μ	48 (58.5) 63 μ	Late Albian

MURORNATI (RIBBED)		PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION			EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL RIB PATTERN	DISTAL RIB PATTERN	RIBS AND CANALS			
52	Cicatricosisporites hughesi	8 9	12,13 1,2	5/5	2.5μ high membraneous lips	Smooth	Triangular	Convex	Rounded	See Fig.7 O; alternate ribs of the adjacent sides coalescing in the radial regions (Fig.8 B); 3 ribs in each interradial region	See Fig.7 A; 3 to 5 ribs in each interradial region	Cicatricose; ribs sinuous, sharp crested, and 2 to 4μ wide; canals 4 to 6μ wide	2 to 3μ	38 (48) 63μ	Aptian to Danian
53	Cicatricosisporites pseudotripartitus	9	12-15	5/5	2.5μ high membraneous lips	Ribbed	Triangular	Slightly convex to straight	Rounded	See Fig.7 O; 2 to 3 ribs in each interradial region	See Fig.7 B; 4 to 5 ribs in each interradial region	Canaliculate; ribs slightly sinuous, low, broadly rounded, 3 to 4.5μ wide; canals 0.5 to 1μ wide	2 to 3μ	31 (45) 54μ	Albian and Cenomanian
54	Cicatricosisporites subrotundus	10	4,5	1/2 to 3/4	Raised membraneous lips	Ribbed	Subcircular	Strongly convex	Broadly rounded	See Fig.7 P; 3 to 5 ribs in each interradial region	See Fig.7 C, but pattern variable; 5 to 6 ribs in each interradial region	Canaliculate; ribs flat topped, sharp edged, 5 to 6μ wide; canals 1μ wide	2 to 3μ	41 (54) 64μ	Albian
55	Cicatricosisporites spiralis	10	1-3	5/5	Simple	Ribbed	Triangular	Slightly convex to straight	Rounded	See Fig.7 O; 4 to 5 ribs in each interradial region	See Fig.7 D; 5 to 7 ribs in each interradial region	Canaliculate; ribs flat topped, 2.5 to 4μ wide; canals 0.5 to 1μ wide	2.5μ	46 (47) 48μ	Middle Albian
56	Cicatricosisporites australiensis	7	12-15	3/4 to 4/5	2.5μ high membraneous lips	Smooth	Triangular	Slightly convex to slightly concave	Rounded, notched	See Fig.7 O; equatorial ribs converging toward the apices and coalescing with the adjacent ribs of their own side in the radial regions (Fig.8 A); 2 to 3 ribs in each interradial region	See Fig.7 E; 7 to 12 ribs in each interradial region	Cicatricose; ribs sharp crested, narrow, straight, occasionally bifurcating, 1.5 to 2.5μ wide; canals 1.5 to 2.5μ wide	1 to 2μ	32 (43.5) 51μ	Cretaceous
57	Cicatricosisporites mohrioides	9	9	5/5	Raised membraneous lips	Smooth	Triangular	Slightly convex to straight	Rounded	See Fig.7 O; 2 to 3 ribs in each interradial region; for junction of ribs in the radial regions see Fig.8 A	See Fig.7 F; 4 to 5 ribs in each interradial region	Canaliculate; ribs slightly sinuous, irregularly branching, often discontinuous, uneven in width ranging from 1.5 to 3μ; canals about 2μ wide	2μ	38 (43) 50μ	Purbeckian to Albian
58	Cicatricosisporites sp. cf. Anemia exilioides	8	1-6	2/3 to 3/4	Raised membraneous lips	Ribbed	Triangular	Convex	Sharply rounded with small thickenings	See Fig.7 N; 6 to 8 ribs in each interradial region	Rib pattern variable. See Fig.7 C, G and I; 6 to 8 ribs in each interradial region	Canaliculate; ribs flat topped, sharp edged, straight, 2.5 to 5μ wide; canals 1 to 1.5μ wide	4μ	54 (65) 84μ	Middle and late Albian
59	Cicatricosisporites imbricatus	9	3-5	5/5	Raised membraneous lips	Ribbed	Rounded triangular, one apex more pointed	Convex	Two apices broadly rounded, one apex more pointed and with a small thickening	See Fig.7 O; 5 to 7 ribs in each interradial region	See Fig.7 H; 18 to 20 distal ribs	Cicatricose; ribs sinuous, round topped, bifurcating, 1.5 to 2μ wide; canals 1 to 3μ wide	1.5μ	46 (54.5) 60μ	Middle Albian to Cenomanian

	MURORNATI (RIBBED)	PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION			EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL RIB PATTERN	DISTAL RIB PATTERN	RIBS AND CANALS			
60	Cicatricosisporites sp. cf. C. imbricatus	9	6	5/5	Raised membraneous lips	Ribbed	As above	Convex	As above	See Fig.7 O; about 5 ribs in each interradial region	See Fig.7 H; 12 to 14 distal ribs	Cicatricose; ribs sinuous, round topped, bifurcating, about 4μ wide; canals about 4μ wide	2.5μ	70 (71) 72μ	Middle Albian
61	Cicatricosisporites sp. cf. C. potomacensis	9	10,11	3/4	Raised membraneous lips	Ribbed	Triangular	Convex	Rounded	See Fig.7 N; about 10 ribs in each interradial region	See Fig.7 I; about 17 distal ribs	Canaliculate; ribs flat topped, straight, about 2μ wide; canals 0.5μ wide	4μ	48 (51) 54μ	Middle Albian
62	Cicatricosisporites minor	9	7,8	5/5	Raised; bordered by 1μ wide lips	Ribbed	Triangular	Slightly convex to straight	Sharply rounded	See Fig.7 P	See Fig.7 I	Cicatricose; ribs sharp crested, often bifurcating, 0.8μ wide; canals 1.5μ wide	1μ	25 (26) 26.5μ	Middle Albian to Late Cretaceous
63	Cicatricosisporites hallei	8	7-11	2/3 to 3/4	Raised membraneous lips	Ribbed	Rounded-triangular	Convex	Rounded	See Fig.7 P; 7 to 15 ribs in each interradial region	See Fig.7 J; two sets of ribs, 8 to 16 ribs in each set	Canaliculate; ribs flat topped, sharp edged, straight, occasionally bifurcating, 1.5 to 2.5μ wide; canals 0.8μ wide	2μ	32 (41.5) 55μ	Early Cretaceous and Cenomanian
64	Cicatricosisporites annulatus	6 7	13-15 1,2	2/3 to 3/4	Raised; bordered by 1μ wide lips	Smooth	Subcircular	Convex	Broadly rounded	See Fig.7 N; 3 ribs in each interradial region	See Fig.7 K; two sets of ribs, 6 ribs in the outer set and 8 ribs in the inner set	Canaliculate; ribs flat topped, 2 to 3μ wide; canals 1.5μ wide	2.5μ	54 (55) 56μ	Cretaceous
65	Cicatricosisporites venustus	10	6-10	2/3 to 3/4	Raised membraneous lips	Smooth	Triangular	Convex	Rounded	See Fig.7 P; 15 to 25 ribs in each interradial region	See Fig.7 L; three sets of ribs, 15 to 25 ribs in each set	Cicatricose; ribs sharp crested, bifurcating on the distal surface, 0.5 to 0.8μ wide; canals 1 to 2μ wide	2μ	26 (33) 40μ	Barremian to Cenomanian-Turonian
66	Cicatricosisporites augustus	7	3-11	3/4	Raised membraneous lips	Ribbed	Triangular	Slightly convex to slightly concave	Broadly rounded	See Fig.7 P; 12 to 20 ribs in each interradial region	See Fig.7 M; three sets of ribs, 12 to 20 ribs in each set	Cicatricose; ribs sharp crested, bifurcating, 0.8μ wide; canals 1.5 to 2μ wide	1.5μ	39 (50) 58μ	Middle and late Albian
67	Costatoperforosporites foveolatus	11	11-15	5/5	Usually gaping	Ribbed	Triangular	Slightly convex	Sharply rounded with small thickenings	See Fig.7 O; 3 to 4 ribs in each interradial region	See Fig.7 C; 10 to 15μ wide, triangular fused area centered on the distal pole; 3 to 4 ribs in each interradial region	Canaliculate; ribs flat topped, with a single row of 1 to 2μ wide holes, spaced 2 to 3μ apart; ribs 4 to 6μ wide; canals 0.5μ wide	2 to 3μ	41 (46) 53μ	Late Aptian and Albian
68	Costatoperforosporites fistulosus	11	9-10	5/5	Simple	Ribbed	Rounded-triangular	Convex	Broadly rounded	See Fig.7 O; 3 to 4 ribs in each interradial region	See Fig.7 I; 8 to 10 distal ribs	Canaliculate; ribs flat topped, with a single row of 0.8μ wide holes, spaced 2 to 3μ apart; ribs 4 to 6μ wide; canals 0.5μ wide	2 to 3μ	36 (39.5) 43μ	Late Aptian and Albian

AURICULATI		PLATE	FIGURES	TRILETE MARK				SHAPE			ORNAMENTATION			EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	MARGO	CONTACT AREA	AMB	SIDES	APICES	PROXIMAL	DISTAL	APICAL (valvae)			
69	Matonisporites crassiangulatus	14	12	4/5	Raised membraneous lips	4 to 8μ wide exinal thickening	Smooth	Triangular	Slightly convex to straight	Broadly rounded	Smooth	Smooth	Exinal thickenings (valvae) at the apices about 4μ wide	2μ	48 (49.5) 51μ	Oxfordian to Albian
70	Ischyosporites punctatus	17	8,9	4/5	Simple	3.5μ wide exinal thickening	Smooth	Triangular	Slightly concave to straight	Broadly rounded	Mostly smooth; foveo-reticulate near the equatorial margin	Foveo-reticulate; lumina circular, 4 to 8μ wide; muri 3 to 5μ wide	Foveo-reticulate; exine thicker and lumina larger than on the rest of the body	3 to 5μ	56 (63) 72μ	Late Jurassic to Albian
71	Ischyosporites disjunctus	17	6,7	4/5	Slightly raised	Absent	Smooth	Triangular	Slightly convex to straight	Broadly rounded	Mostly smooth; imperfect foveo-reticulate sculpture on the apices	Imperfect foveo-reticulate; lumina intercommunicating, 6 to 10μ wide; muri discontinuous, 4 to 6μ wide	Imperfect foveo-reticulate; exine thicker than on the rest of the body	3μ	54 (64) 75μ	Middle and late Albian
72	Trilobosporites sp.	20	3,4	4/5	Simple	2.5μ wide exinal thickening	Granulate	Triangular	Straight	Rounded	Granulate	Verrucate; verrucae confluent, flat, irregular shaped, up to 2μ in diameter	About 2μ wide exinal thickenings at the apices	1μ	25 (27) 29μ	Middle Albian
73	Trilobosporites humilis	19	10-14	5/5	Simple	Verrucae, 2 to 4μ in diameter, bordering the commissures	Verrucate	Triangular	Straight	Rounded	Verrucate along the laesurae; interradial regions granulate	Verrucate; verrucae at the distal pole confluent, flat, irregular shaped, 5 to 10μ in diameter; interradial regions granulate	Two or three enlarged verrucae at the apices; verrucae 4 to 5μ in diameter	2 to 4μ	29 (32.5) 36μ	Early Cretaceous
74	Trilobosporites crassus	19	9	3/4	Simple	2.5μ wide exinal thickening	Smooth	Triangular	Slightly concave to straight	Rounded	Verrucate to rugulate near the equatorial margin and apices	Verrucate to rugulate; verrucae irregular shaped and confluent	Strongly developed, confluent verrucae at the apices	3μ	33 (37) 41μ	Middle Albian to early Cenomanian
75	Trilobosporites marylandensis	19	15, 16	3/4	Simple	Present	Granulate	Triangular	Concave	Broadly rounded	Granulate in the polar and interradial areas	Granulate in the polar and interradial areas	Verrucate to tuberculate; verrucae 2 to 3μ in diameter, about 2μ high, spaced 1 to 3μ apart	2μ	54 (56) 58μ	Early Cretaceous
76	Trilobosporites apiverrucatus	19	7,8	3/4	Simple	5μ wide exinal thickening and enlarged verrucae	Verrucate	Triangular	Strongly concave to straight	Broadly rounded	Verrucate; verrucae 1 to 2μ in diameter in the polar and interradial areas	Verrucate as on the proximal surface	Verrucate; verrucae 2 to 6μ in diameter, 2 to 4μ high, spaced 1 to 5μ apart	3μ	60 (72) 90μ	Late Jurassic to Albian
77	Trilobosporites trioreticulosus	20	2	3/4	Simple	4μ wide, composed of coalescent verrucae	Granulate to verrucate	Triangular	Strongly concave to straight	Broadly rounded	Verrucate; verrucae 1 to 2μ in diameter in the polar and interradial areas	Verrucate as on the proximal surface	Reticulate; lumina polygonal to sub-circular, shallow, 7 to 9μ wide; 10 to 20 lumina on each apex; muri 3 to 5μ wide, 2 to 3μ high	2 to 4μ	53 (64) 76μ	Aptian and Albian
78	Trilobosporites tribotrys	20	1	3/4	Simple	Conspicuous, 5 to 7μ wide, composed of coalescent verrucae	Granulate to verrucate	Triangular	Slightly concave to straight	Broadly rounded	Verrucate; verrucae 1 to 3μ in diameter, closely spaced in the polar and interradial areas	Verrucate as on the proximal surface	Reticulate; lumina polygonal, about 4μ wide; muri 2 to 3μ wide, bearing spherical verrucae about 4μ in diameter	3μ	50 (58) 66μ	Late Aptian to Cenomanian

AURICULATI (RIBBED)		PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION			EXINE THICKNESS	EQUATORIAL DIAMETER (including appendices)	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APPENDICES	PROXIMAL RIB PATTERN	DISTAL RIB PATTERN	RIBS AND CANALS			
79	Appendicisporites potomacensis	5	10-13	5/5	Raised membraneous lips	Smooth	Triangular	Slightly convex to straight	See Fig. 8 E; appendices 4 to 8μ long, 4μ wide	See Fig. 7 O; about 3 ribs in each interradial region	See Fig. 7 A; inner triangular area 7 to 10μ wide; 4 to 5 ribs in each interradial region	Cicatricose; ribs round topped, straight, 2 to 2.5μ wide; canals 3 to 5μ wide	2.5μ	48 (53.5) 62μ	Barremian to Albian
80	Appendicisporites unicus	6	10-12	5/5	Raised membraneous lips	Ribbed	Triangular	Convex	See Fig. 8 C; appendices 12 to 18μ long, 2 to 5μ wide	See Fig. 7 O; 3 to 4 ribs in each interradial region	See Fig. 7 A; inner triangular area 5 to 10μ wide; 3 to 5 ribs in each interradial region	Cicatricose; ribs slightly sinuous, high, 2 to 3μ wide; canals 3 to 5μ wide	3μ	46 (54.5) 65μ	Middle Albian to Cenomanian
81	Appendicisporites spinosus	6	7-9	5/5	Raised membraneous lips	Ribbed	Rounded-triangular	Convex	Represented by minute thickenings at the apices, 2μ long, 2μ wide	See Fig. 7 O; 3 to 4 ribs in each interradial region	See Fig. 7 A; 3 to 5 ribs in each interradial region	Cicatricose; ribs with 1 to 4μ long clavate and spinose processes; ribs 1 to 2μ wide; canals 3 to 4μ wide	2μ	35 (38) 43μ	Middle Albian
82	Appendicisporites erdtmanii	4	11	2/3 to 3/4	Simple	Smooth	Rounded-triangular	Strongly convex	See Fig. 8 E; appendices about 6μ long, 6 to 7μ wide	See Fig. 7 O; about 3 ribs in each interradial region	See Fig. 7 B; inner triangular area 15 to 20μ wide; 4 to 6 ribs in each interradial region	Canaliculate; ribs round topped, straight, 2.5 to 3.5μ wide; canals 1 to 1.5μ wide	2.5 to 3μ	49 (54) 60μ	Barremian to Cenomanian-Turonian
83	Appendicisporites sp. cf. Anemia macrorhyza	5	5-8	4/5	Simple	Ribbed	Triangular	Slightly convex to slightly concave	See Fig. 8 E; appendices knob-shaped, 6 to 8μ long, 5 to 8μ wide	See Fig. 7 O; about 4 ribs in each interradial region	See Fig. 7 B; 4 to 6 ribs in each interradial region	Canaliculate; ribs flat topped, 2 to 2.5μ wide; canals 1 to 1.5μ wide	2.5μ	44 (55) 63μ	Middle and late Albian
84	Appendicisporites jansonii	5	1,2	4/5	Raised membraneous lips	Ribbed	Triangular	Straight	See Fig. 8 D; blunt apical thickenings not projecting beyond the amb	See Fig. 7 O; about 6 ribs in each interradial region	See Fig. 7 B; 6 to 10 ribs in each interradial region	Canaliculate; ribs flat topped, straight, 3 to 4μ wide; canals 0.5 to 1μ wide	4μ	63 (73) 78μ	Barremian to Albian
85	Appendicisporites sp. cf. A. jansonii	5	3,4	4/5	Raised membraneous lips	Ribbed	Triangular	Straight	See Fig. 8 D; blunt apical thickenings not projecting beyond the amb	See Fig. 7 O; 3 to 5 ribs in each interradial region	See Fig. 7 C; 4 to 5 ribs in each interradial region	Canaliculate; ribs flat topped, sharp edged, about 4μ wide; canals 0.5μ wide	4μ	55μ	Middle Albian
86	Appendicisporites bifurcatus	4	3-5	4/5	Simple, bordered by 5μ wide, smooth, and thickened margo	Ribbed	Subcircular to rounded-triangular	Strongly convex	See Fig. 8 D; appendices very thick with rounded, foveolate tip, about 15μ long, 15μ wide	See Fig. 7 O; about 10 ribs in each interradial region	See Fig. 7 E; about 15 ribs in each interradial region	Canaliculate; ribs flat topped, straight, 2 to 2.5μ wide; canals 0.5μ wide	5μ	92 (93) 94μ	Middle and late Albian
87	Appendicisporites bilateralis	4	6-8	2/3	Raised membraneous lips	Smooth	Triangular	Slightly convex to straight	See Fig. 8 E; appendices conical, 4 to 6μ long, 3 to 6μ wide	See Fig. 7 O; 3 to 4 ribs in each interradial region	See Fig. 9 ; 5 to 7 ribs in two interradial regions running obliquely to the 3 ribs in the third interradial region	Canaliculate; ribs flat topped, 2 to 3μ wide; canals 1 to 2μ wide	3μ	42 (46.5) 60μ	Middle and late Albian
88	Appendicisporites problematicus	6	1-6	5/5	Raised membraneous lips	Smooth	Rounded-triangular	Convex	See Fig. 8 E; length of appendices variable, usually 3 to 8μ long, 2 to 5μ wide	See Fig. 7 O; 1 to 2 ribs in each interradial region	See Fig. 10 ; inner triangular area 5 to 12μ wide; outermost ribs flange-like; inner ribs forming the straight sides of a triangle; 3 to 5 ribs in each interradial region	Cicatricose; ribs very high and sharp crested; outermost ribs flattened, producing a flange-like effect; ribs 4 to 6μ high, 2 to 3μ wide; canals 3 to 5μ wide	3.5μ	36 (46) 60μ	Berriasian to Albian

AURICULATI (RIBBED)		PLATE	FIGURES	TRILETE MARK			SHAPE			ORNAMENTATION			EXINE THICKNESS	EQUATORIAL DIAMETER (including appendices)	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APPENDICES	PROXIMAL RIB PATTERN	DISTAL RIB PATTERN	RIBS AND CANALS			
89	Appendicisporites matesovae	5	9	4/5	Raised membraneous lips	Smooth	Triangular	Convex	See Fig.8 F, G; several appendices at the junctions of the distal ribs along the radial lines; each appendix about 8μ long, 6 to 10μ wide	Single rib in each interradial region running parallel to the sides	See Fig. 8 F, G; about 6 ribs in each interradial region running parallel to the sides	Cicatricose; ribs 3μ wide; canals 4μ wide	3μ	66μ	Albian to Turonian
90	Appendicisporites sp. cf. A. cristatus	4	9,10	5/5	Gaping	Ribbed	Rounded-triangular	Convex	See Fig.8 H; several 8μ long comb-like projections at the junctions of the distal ribs along the radial lines; a single 11μ long and 3 to 4μ wide appendix at each apex	See Fig.7 O; 6 to 8 ribs in each interradial region	See Fig.8 H; 6 to 8 ribs in each interradial region	Canaliculate; ribs flat topped, 1.5 to 2μ wide; canals 0.5μ wide	2.5μ	45 (52) 60μ	Middle and late Albian

TRICRASSATI		PLATE	FIGURES	TRILETE MARK			SHAPE			INTERRADIAL CRASSITUDES	ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL			
91	Gleicheniidites senonicus	14	1	5/5	Simple	Smooth	Triangular	Concave to straight	Sharply rounded	About 4μ wide distal interradial folds	Smooth	Smooth; distal face strongly convex	1μ	24 (33) 40μ	Jurassic and Cretaceous
92	Gleicheniidites sp. cf. G. circinidites	14	2,3	5/5	Raised membraneous lips	Smooth	Triangular	Concave to straight	Acute	4 to 6μ wide distal interradial folds	Smooth	Smooth; distal face strongly convex	1.5μ	21 (25) 38μ	Late Jurassic and Early Cretaceous
93	Ornamentifera echinata	14	6,7	5/5	Raised membraneous lips	Smooth	Triangular	Slightly concave	Sharply rounded	3 to 4μ wide distal interradial folds	Echinate; spines sparse	Echinate; spines 0.5 to 2.5μ long, up to 1μ in basal diameter, spaced 2 to 3μ apart; distal face strongly convex	1 to 2μ	27 (36) 40μ	Hauterivian to Senonian
94	Ornamentifera baculata	14	4,5	5/5	Raised membraneous lips	Smooth	Triangular	Slightly concave to straight	Sharply rounded	3 to 4μ wide distal interradial folds	Baculate; bacula sparse	Baculate; bacula 2 to 4μ long, up to 2μ wide, slightly expanded at the tips, spaced 2 to 3μ apart; distal face strongly convex	1.5μ	33 (42) 52μ	Middle and late Albian
95	Camarozonosporites insignis	15	8-13	3/4	Simple, often gaping	Rugulate	Rounded-triangular	Strongly convex	Broadly rounded	3 to 4μ wide interradial equatorial thickenings	Rugulate; rugulae 1μ wide, low, tortuous with a slight radial arrangement	Rugulate; rugulae 2 to 3μ wide, 2μ high, spaced 1.5μ apart and following acute zigzag courses	2μ	29 (38) 50μ	Albian and Cenomanian
96	Sestrosporites pseudoalveolatus	3	3-7	5/5	2 to 4μ high membraneous lips	Foveolate	Rounded-triangular	Convex	Broadly rounded	Interradial equatorial thickenings 4 to 6μ wide, cavate, often ruptured to form membraneous equatorial margin	Foveolate; foveolae deep, round, 0.5 to 1μ wide, spaced 2 to 3μ apart	Foveolate as on the proximal surface	2μ	43 (46) 63μ	Bajocian to early Cenomanian
97	Coronatispora valdensis	16	6,7	5/5	2μ high membraneous lips	Minutely rugulate	Rounded-triangular	Convex	Broadly rounded	Interradial equatorial regions slightly thickened	Minutely rugulate	Circumpolar ridge 2μ wide, encircling a polar thickening about 14μ in diameter; polar thickening granulate; polar, circumpolar and interradial equatorial thickenings connected by radially disposed, 1μ wide rugulae	2μ	41 (45) 52μ	Late Jurassic to Albian

CINGULATI		PLATE	FIGURES	TRILETE MARK				SHAPE			CINGULUM	ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	MARGO	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL			
98	Cingutriletes clavus	1	1-3	Reaching the inner margin of cingulum	Low membraneous lips	Absent	Smooth	Subcircular	Convex	Broadly rounded	2.5 to 5.5μ wide	Smooth	Polar thickening disk-like, smooth, 14 to 18μ in diameter	1.5μ	25 (31) 42μ	Jurassic to Tertiary
99	Murospora truncata	18	1,2	Reaching the inner margin of cingulum	Raised membraneous lips	Absent	Smooth	Triangular	Slightly concave	Truncated	6 to 8μ wide interradially, 2 to 4μ wide at the truncated apices	Smooth	Smooth; corroded specimens with pitted polar exines and radially disposed corrosion channels on the cingulum	3 to 7μ	44 (51) 63μ	Late Albian
100	Foraminisporis dailyi	1	8	5/5	Raised membraneous lips	Absent	Granulate	Subcircular, triangular or subquadrangular	Convex	Broadly rounded	About 3μ wide	A cluster of small, distinct granules on the central area of each contact face	Irregularly disposed, low granules and verrucae, 1 to 5μ in diameter	2μ	31 (41) 53μ	Early Cretaceous
101	Foraminisporis wonthaggiensis	1	9,10	5/5	Raised membraneous lips	Absent	Spinulose	Subcircular to triangular	Convex	Broadly rounded	About 2μ wide	Spinulose; spinulae about 0.8μ high, closely spaced, often with confluent bases	Spinulose; spinulae about 1.5μ high, 1μ wide, spaced 1 to 3μ apart	2.5μ	31 (38) 45μ	Valanginian to Turonian
102	Antulsporites baculatus	15	1-5	4/5 to 5/5	Raised membraneous lips	3μ wide exinal thickening	Smooth	Triangular	Convex	Rounded	4 to 5μ wide, radially striped	Smooth in a circular area around the pole; area outside the circle with short spinules or fused granules	Baculate; bacula near the pole equidimensional, about 3 to 4μ long, with jagged edges and arranged vertically; bacula near equator elongate, spinose, oriented horizontally, overlapping the inner margin of cingulum; distal surface strongly convex	2 to 4μ	33 (39) 45μ	Cretaceous
103	Antulsporites distaverrucosus	15	6,7	Reaching the inner margin of cingulum	Raised membraneous lips	Absent	Smooth	Triangular	Convex	Sharply rounded	About 4μ wide, radially segmented	Smooth	Verrucate; verrucae 2 to 5μ in diameter, confluent	3μ	34μ	Late Jurassic to Albian
104	Rogalskaisporites cicatricosus	18	13	3/4	Simple	2μ wide exinal thickening	Smooth	Subcircular to rounded-triangular	Convex	Broadly rounded	1.5 to 2μ wide	Smooth	Polar thickening disk-like, about 20μ in diameter, surrounded by 20 to 25 radially disposed ridges and canals; ridges up to 2μ wide; canals about 0.5μ wide	1μ	24 (27) 36μ	Keuper to Albian

CINGULATI		PLATE	FIGURES	TRILETE MARK				SHAPE			CINGULUM	ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	MARGO	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL			
105	Rogalskaisporites cicatricosus var. rotundus	18	14	4/5	Simple	About 1μ wide exinal thickening	Smooth	Circular	Convex	Broadly rounded	1 to 2μ wide	Smooth	Polar thickening disk-like, 15 to 20μ in diameter, surrounded by 15 to 20 small crescent-shaped lumina; lumina separated by radially disposed ridges; lumina 1 to 0.5μ wide; ridges up to 2μ wide	1μ	21μ	Lias to Albian
106	Annulispora sp.	14	16-18	2/3	Simple	About 1.5μ wide exinal thickening	Smooth	Subcircular	Convex	Broadly rounded	About 2μ wide	Smooth	Circumpolar ridge about 5μ wide, with an entire inner and a lobate outer margin, and surrounded by 25 to 30 radially disposed canals; canals 0.5μ wide, spaced 3 to 4μ apart, reaching the equator	1.5μ	32 (34) 36μ	Middle Albian
107	Polycingulatisporites reduncus	18	8	5/5	Simple	About 2μ wide exinal thickening	Smooth	Subcircular	Convex	Broadly rounded	3 to 4μ wide	Smooth	Polar thickening disk-like, 10 to 12μ in diameter, surrounded by a 4μ wide circumpolar ridge; polar thickening and the ridge usually irregularly circular with many indentations or gaps and with a concentric and imbricated arrangement	2.5μ	30 (38) 48μ	Middle Jurassic to Paleocene
108	Polycingulatisporites radiatus	18	4-7	5/5	Simple	About 2.5μ wide exinal thickening	Smooth	Rounded-triangular	Convex	Broadly rounded	2 to 2.5μ wide	Smooth	Polar thickening disk-like, about 8μ in diameter, surrounded by a 4μ wide circumpolar ridge; circumpolar ridge surrounded by 15 to 22 radially disposed ridges and canals; ridges 2 to 3μ wide; canals 0.5μ wide, usually reaching the equator	2μ	26 (30) 33μ	Middle and late Albian
109	Taurocusporites segmentatus	18	15, 16	5/5	Simple	About 3μ wide, transversely segmented, thickened lips	Verrucate	Rounded-triangular to subcircular with smooth to crenulate margin	Convex	Broadly rounded	About 4μ wide	Verrucate; verrucae 1 to 3μ in diameter, irregular shaped, closely spaced forming a negative reticulum up to the inner margin of the cingulum	Polar thickening disk-like, 8 to 15μ in diameter, surrounded by a 6μ wide circumpolar ridge; the polar thickening, the ridge, and the cingulum separated from each other by two 1μ wide, concentric grooves	3μ	29 (37) 51μ	Early Cretaceous

CINGULATI (RIBBED)		PLATE	FIGURES	TRILETE MARK				SHAPE			CINGULUM	ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	MARGO	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL			
110	Distaltriangulisporites perplexus	12	1–6	Reaching the inner margin of cingulum	Simple	3 to 6μ wide exinal thickening	Smooth	Triangular	Straight	Rounded	4 to 6μ wide	Smooth	See Fig.11; distal triangular shield 32 to 44μ in diameter; apical thickenings (appendices) 4 to 7μ long, equally wide, not projecting beyond the amb; inner ribs not precisely defined, separated by irregular-shaped and wide, intervening spaces	2.5μ	31 (42) 53μ	Middle and late Albian
111	Distaltriangulisporites costatus	12	7–9	Reaching or almost reaching the inner margin of cingulum	Simple	Absent	Smooth	Triangular	Straight to convex	Rounded	About 4μ wide	Smooth	See Fig.12; distal surface strongly convex; sculpture consisting of ribs forming the sides of the triangular shield and a single rib running across the shield and bifurcating before joining the opposite side; ribs flat topped, straight, about 4μ wide; apices of the shield slightly thickened	3.5μ	31 (37) 42μ	Middle and late Albian
112	Distaltriangulisporites irregularis	12	10–13	Reaching the inner margin of cingulum	Simple	About 5μ wide exinal thickening	Smooth	Triangular	Convex	Rounded	About 4μ wide, usually with an undulate margin	Smooth	See Fig.13; distal triangular shield with irregularly formed wavy ribs and wide, intervening spaces; ribs occasionally joining to form an imperfect reticulate pattern; apices of the shield very slightly thickened and occasionally bifid	2.5μ	36 (41) 48μ	Middle and late Albian
113	Distaltriangulisporites mutabilis	13	1–3	Reaching the inner margin of cingulum	Simple	3 to 6μ wide exinal thickening	Smooth	Triangular	Straight to convex	Broadly rounded	About 4μ wide	Smooth	Distal triangular shield ornamented by closely spaced coalescent foveolae forming short channels and irregular-shaped lumina; shield occasionally ornamented by only a few sparsely distributed foveolae; apices of the shield slightly thickened	2.5μ	31 (40) 48μ	Middle and late Albian
114	Distaltriangulisporites maximus	12	14–16	Reaching the inner margin of cingulum	Simple	6 to 10μ wide, outer margin wavy	Smooth	Triangular	Straight	Rounded	About 8μ wide	Smooth	Distal triangular shield ornamented by closely spaced, anastomosing, elongate verrucae and coarse rugulae; apical thickenings (appendices) 6 to 8μ long, 6 to 12μ wide, not projecting beyond the amb	4μ	57 (58) 60μ	Middle Albian
115	Contignisporites glebulentus	11	1–4	Reaching the inner margin of cingulum	Simple	Absent	Verrucate	Triangular	Convex	Broadly rounded	7 to 9μ wide	Verrucate; sculpture radially symmetrical; polar interradial regions with low, sometimes elongated verrucae, 2 to 14μ in diameter; equatorial region of each contact face with one, 3 to 4μ wide, tangentially disposed rib	Canaliculate; sculpture bilaterally symmetrical; 7 to 10 parallel ribs running across the distal surface; ribs occasionally bifurcating, round topped, 3 to 4μ wide, coalescing with the cingulum along its inner margin; canals 1 to 2μ wide	5μ	54 (58) 65μ	Aptian and Albian
116	Contignisporites cooksonii	11	5,6	Reaching the inner margin of cingulum	Raised membraneous lips	Absent	Smooth	Rounded-triangular	Convex	Broadly rounded	4 to 7μ wide	Sculpture radially symmetrical; equatorial region of each contact face with one, 4μ wide, tangentially disposed rib	Canaliculate; sculpture bilaterally symmetrical; 5 to 7 parallel ribs running across the distal surface; ribs round topped, 4 to 5μ wide, coalescing with the cingulum towards the equator; canals 1 to 2μ wide	4μ	48 (51) 55μ	Callovian to Albian
117	Contignisporites multimuratus	11	7,8	Reaching the inner margin of cingulum	Raised membraneous lips	Absent	Verrucate	Triangular	Convex	Rounded	About 7μ wide	Verrucate; sculpture radially symmetrical; verrucae in the polar region 1 to 2μ in diameter (on the Alberta specimens); equatorial region of each contact face with one, 2μ wide, tangentially disposed rib	Canaliculate; sculpture bilaterally symmetrical; 11 to 16 parallel ribs running across the distal surface; ribs bifurcating, round topped, 2 to 4μ wide, 5 to 6μ high, coalescing with the cingulum near the equator; canals about 1 to 2μ wide; distal surface strongly arched	5μ	54 (62) 70μ	Early Cretaceous

ZONATI		PLATE	FIGURES	TRILETE MARK			SHAPE			ZONA	ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER (including zona)	KNOWN STRATIGRAPHIC RANGE
				LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL			
118	Cirratriradites teter	15	14,15	4/5 to 5/5	Raised, 1 to 2μ wide granulate lips	Granulate	Rounded-triangular to subcircular	Convex	Rounded	2 to 4μ wide, outer 1 to 2μ thickened, with irregularly spaced radial thickenings	Granulate; granules 0.5μ in diameter, spaced about 1μ apart	Granulate to verrucate; verrucae irregular shaped, up to 3μ in diameter	2μ	29 (35) 40μ	Middle and late Albian
119	Kraeuselisporites sp.	17	10,11	4/5	Gaping	Smooth	Rounded-triangular	Convex	Rounded	About 5μ wide, granulate; compression causing secondary folding at the base of zona	Smooth, flat	Clavate; clavae up to 6μ long, sparsely distributed; distal surface strongly convex	2μ	31 (34) 40μ	Middle Albian

HILATES		PLATE	FIGURES	TRILETE MARK		SHAPE			ZONA	ORNAMENTATION		GERMINAL APPARATUS	EXINE THICKNESS	EQUATORIAL DIAMETER (including zona)	KNOWN STRATIGRAPHIC RANGE
				LAESURAE	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL				
120	Aequitriradites spinulosus	1	6	Variable in length; visible in some specimens on the zona only, in others traceable to within a short distance of the proximal pole; nonfunctional	Scabrate	Rounded-triangular to subcircular	Convex	Rounded	5 to 15μ wide, membraneous, scabrate, overlapping the distal face for a short distance	Scabrate; proximally inaperturate	Spinulose; spinulae 1 to 4μ in diameter, with polygonal bases and becoming smaller and more sparse near the equator of the central body	Distal polar area occasionally with an irregular to circular opening (hilum)	3μ	57 (73) 84μ	Early Cretaceous to Danian
121	Couperisporites tabulatus	1	7	Extending from the equator toward the proximal pole; nonfunctional	Verrucate	Rounded-triangular to subcircular	Convex	Rounded	5 to 7μ wide, membraneous, scabrate; sclerine double layered; outer enveloping layer forming the zona; inner layer bearing impression of polar verrucae and tetrad mark	Verrucate in the polar area; verrucae hexagonal, 2 to 3μ in diameter, separated by narrow channels	Verrucate in the polar area; verrucae considerably lower than those on the proximal surface	Proximal polar area occasionally with an irregular rupture (hilum)	3μ	60μ	Early Cretaceous
122	Rouseisporites reticulatus	1	11,12	Faint, extending from the proximal pole to the invaginations in the zona at the apices; nonfunctional	Reticulate	Rounded-triangular to subcircular	Convex	Rounded	3 to 6μ wide, membraneous, with an invagination at each apex; sclerine double layered; outer membraneous layer forming the zona	Finely reticulate; lumina circular to polygonal, 1 to 4μ wide; muri low, 0.5μ wide; proximally inaperturate	Coarsely reticulate; with 2 to 3μ high muroid ridges enclosing 15 to 30μ wide, hexagonal lumina	Muroid ridges possibly serving as lines of rupture during spore germination	2μ	44 (52) 58μ	Barremian to Turonian
123	Rouseisporites triangularis	1	14	Faint, extending from the proximal pole to the invaginations in the zona at the apices; nonfunctional	Scabrate	Triangular to rounded-triangular	Convex	Sharply rounded	Reduced; represented by three membraneous structures covering the 10μ wide conical invaginations at the apices of the central body; sclerine double layered; outer layer membraneous	Scabrate; proximally inaperturate	Scabrate; with 2 to 3μ high, Y-shaped muroid ridge; arms of the Y-shaped ridge interradial in position, emanating from the distal pole and extending from 2/3 to 3/4 of the distance to the equator; distal pole usually with reticulate ridges, reduced to a scabrate structure near the equator	Muroid ridges possibly serving as lines of rupture during spore germination	2μ	41 (46) 52μ	Aptian and Albian
124	Rouseisporites sp. cf. R. radiatus	1	13	Indistinct	Scabrate	Rounded-triangular to subcircular	Convex	Broadly rounded	Missing; small, conical invaginations at the apices of the central body	Scabrate; proximally inaperturate	Scabrate; with four to six, 2 to 3μ high muroid ridges, which emanate from the distal pole and bifurcate toward the equator	Muroid ridges possibly serving as lines of rupture during spore germination	1.5μ	43μ	Late Albian

PERINOTRILETES	PLATE	FIGURES	TRILETE MARK			SHAPE			CINGULUM	ORNAMENTATION		EXINE	EQUATORIAL DIAMETER	KNOWN STRATIGRAPHIC RANGE
			LENGTH	COMMISSURES	CONTACT AREA	AMB	SIDES	APICES		PROXIMAL	DISTAL			
125 Densoisporites velatus	3	9,10	3/4	Straight to sinuous, raised membraneous lips	Proximal inner smooth layer with three circular, 4μ wide, interradial, polar thickenings	Rounded-triangular	Convex	Rounded	Cingulum formed by equatorially thickened sculptine, about 4μ wide interradially, up to 8μ wide radially	Scabrate; sculptine with sinuous folds parallel to the inner margin of cingulum	Scabrate	Double-layered; an outer loose, structured sculptine layer and an inner smooth layer; sculptine attached proximally to the inner layer; sculptine 2μ thick; inner smooth layer about 1μ thick	36 (51) 60μ	Lias to Danian
126 Densoisporites microrugulatus	3	11,12	1/2 to 3/4	Raised membraneous lips	Proximal inner smooth layer with three circular, 4μ wide, interradial, polar thickenings	Rounded-triangular to subcircular	Convex	Broadly rounded	Cingulum formed by equatorially thickened sculptine, 2 to 4μ wide	Microrugulate; fine reticulate pattern on the cingulum; lumina lineated parallel to the equator; sculptine loose, usually widely separated from the inner smooth layer	Micro-rugulate	Double-layered; an outer loose, structured sculptine layer and an inner smooth layer; sculptine attached proximally to the inner layer; sculptine 2μ thick; inner smooth layer about 1μ thick	48 (55) 64μ	Barremian to Albian

MONOLETES	PLATE	FIGURES	MONOLETE MARK			SHAPE (equatorial view)	ORNAMENTATION	RIBS AND CANALS	EXINE THICKNESS	LENGTH	BREADTH	LENGTH TO BREADTH RATIO (average)	KNOWN STRATIGRAPHIC RANGE
			LENGTH	COMMISSURES	CONTACT AREA								
127 Laevigatosporites ovatus	14	14	About 1/2 of spore length	Mostly gaping	Smooth	Kidney-shaped	Smooth		1μ	29 (40) 54μ	18 (26) 40μ	1.5	Jurassic and Cretaceous
128 Punctatosporites scabratus	14	15	About 4/5 of spore length	Simple slits	Granulate-scabrate	Plano-convex to biconvex	Granulate-scabrate		1μ	24 (28) 31μ	17 (21) 25μ	1.4	Late Triassic to Albian
129 Cicatricososporites phaseolus	10	16	About 2/3 of spore length	Simple slits	Smooth	Bean-shaped	Ribs running parallel to each other and obliquely to the laesura; ribs forming a "criss cross" pattern and continuous with the ribs on the opposite side	Canaliculate; ribs commonly branching, about 2μ wide; canals 1μ wide	1.5μ	46 (48) 51μ	27 (32) 36μ	1.5	Early Cretaceous and Cenomanian
130 Cicatricososporites auritus	10	11-15	About 2/3 of spore length	Slightly raised; a rupture perpendicular to the laesura and cutting across the ribs frequently present	Ribbed	Bean-shaped; with a 6 to 9μ long and 8 to 14μ wide, auriculate protrusion at the two longitudinal ends	Ribs running parallel to each other and to the laesura; ribs converging towards and continuing onto the auriculate protrusions to coalesce with one another at a point or along a short thickened ridge	Canaliculate; ribs usually branching, 1 to 2μ wide; canals about 0.5μ wide	2.5μ	52 (63) 78μ	31 (38) 45μ	1.7	Middle and late Albian

INCERTAE SEDIS	PLATE	FIGURES	GERMINAL APPARATUS	SHAPE		ORNAMENTATION	EXINE THICKNESS	EQUATORIAL DIAMETER	POLAR DIAMETER	KNOWN STRATIGRAPHIC RANGE
				POLAR VIEW	EQUATORIAL VIEW					
131 Schizosporis reticulatus	21	2	Splitting equatorially into two approximately equal parts	Circular, flattened at the poles	Elliptical, biconvex	Coarsely reticulate; lumina pentagonal or hexagonal, 8 to 10μ wide; muri about 1μ wide, 4 to 6μ high; exine double layered	7 to 11μ	91 (115) 135μ		Berriasian to Cenomanian
132 Schizosporis parvus	21	3,4	Splitting equatorially into two approximately equal parts	Elliptical, flattened at the poles	Elliptical, biconvex	Smooth, exine double layered	2μ	66 (92) 113μ	34 (51) 62μ	Barremian to Cenomanian

ALETES		PLATE	FIGURES	GERMINAL APPARATUS	SHAPE	ORNAMENTATION	EXINE THICKNESS	DIAMETER	KNOWN STRATIGRAPHIC RANGE
133	Inaperturopollenites sp.	21	1	Inaperturate	Spherical	Smooth; exine rigid	1μ	13 (16) 20μ	Middle and late Albian
134	Laricoidites magnus	25	8	Inaperturate	Spherical, with many folds	Smooth to faintly scabrate	1μ	52 (77) 84μ	Cretaceous and Tertiary
135	Spheripollenites psilatus	26	12	A poorly developed pore	Spherical	Smooth	1μ	25 (31) 38μ	Late Jurassic to Albian
136	Spheripollenites subgranulatus	26	13	A poorly developed pore	Spherical	Subgranulate; granules dense, less than 0.5μ in diameter	1.5μ	24μ	Middle Jurassic to middle Albian
137	Taxodiaceaepollenites hiatus	22	7	Inaperturate; usually splitting into halves which remain attached at one end	Spherical	Scabrate; exine double layered	0.5μ	31 (35) 40μ	Middle Albian to Miocene
138	Araucariacites australis	22	4	Inaperturate	Spherical, with many folds	Subgranulate to scabrate	1μ	50 (62) 82μ	Jurassic to Tertiary
MONOPORINES									
139	Exesipollenites tumulus	26	11	One of the poles marked by darker exine in a circular area, about 15μ in diameter, containing in the center a circular area of exinal thinning about 4μ in diameter	Circular	Smooth, with a few scattered granules	2μ	22 (30) 36μ	Jurassic and Cretaceous
140	Classopollis classoides	26	5-7	Distally monoporate; pore 6 to 12μ in diameter; proximal pole with an exinal thinning over a triangular area, about 10μ in diameter; triangular area sometimes showing a faint, nonfunctional trilete mark	Circular in polar view; spherical in equatorial view, flattened at the poles; commonly occurring in tetrads	Exine double layered; endexine thin and smooth; ektexine absent or reduced over the poles, and thickened over the equator forming a 8μ wide girdle; girdle ornamented by 4 or more annular striations; remaining surface pitted, granulate or microreticulate	2.5μ	Equatorial diameter 25 (31) 40μ Polar diameter 22 (24) 25μ	Rhaetic to Eocene
141	Perinopollenites elatoides	22	5,6	Monoporate; pore in the central body about 2μ in diameter, often indistinct	Spherical; occasionally folded	Central body smooth to scabrate, surrounded by a loosely fitting, thin scabrate perispore	1.5μ	Total diameter 40 (48) 60μ Diameter of the central body 30 (33) 36μ	Early Jurassic to Cenomanian

PRAECOLPATES		PLATE	FIGURES	GERMINAL APPARATUS	SHAPE	ORNAMENTATION	EXINE THICKNESS	LENGTH	BREADTH	LENGTH TO BREADTH RATIO	KNOWN STRATIGRAPHIC RANGE
142	Eucommiidites troedssonii	26	8	One face flat, bearing a long, median furrow with rounded ends; median furrow parallel to the long axis; opposite face convex, with a ring-furrow near the margin, ring-furrow usually incomplete at the ends of the long axis	Ellipsoidal, longer than wide	Smooth	2μ	24 (29) 33μ	19 (24) 28μ	1.1 (1.2) 1.3	Jurassic and Cretaceous
143	Eucommiidites minor	26	9, 10	One face flat, bearing a long, median furrow with rounded ends; median furrow parallel to the long axis; opposite face convex, with a ring-furrow near the margin, ring-furrow usually incomplete at the ends of the long axis	Spherical, often wider than long	Smooth	2μ	23 (26) 29μ	23 (26) 29μ	0.9 (1.0) 1.1	Late Jurassic to Albian
POLYPLICATES											
144	Equisetosporites virginiaensis	26	14	Acolpate; furrows probably serving as lines of rupture during germination	Ellipsoidal	Exine double layered; endexine smooth, overlain by about 10 ektexinous ridges converging at the thickened longitudinal ends of the grain; ridges about 1.5μ wide; furrows about 0.5μ wide	2μ	43μ	24μ	1.8	Barremian to middle Albian

DISACCITES FAMILY PODOCARPACEAE		PLATE	FIGURES	CENTRAL BODY						BLADDERS (bisaccate)				TOTAL BREADTH OF GRAIN	KNOWN STRATIGRAPHIC RANGE
				SHAPE	PROXIMAL CAP	DISTAL FURROW	BREADTH	LENGTH	HEIGHT	ATTACHMENT	ORNAMENTATION	BREADTH	LENGTH		
145	Podocarpidites biformis	23	1, 2	Almost circular; marginal crest present; exine thick	Microreticulate	Smooth, with convex sides	42 (48) 50μ	46 (50) 54μ		Longer than the central body, distally pendant, with a concave base of attachment	Coarsely reticulate	40 (43) 46μ	54 (62) 68μ longer than broad	89 (90) 96μ	Late Jurassic to Campanian
146	Podocarpidites canadensis	23	3, 4	Four-sided to subcircular; marginal crest present; exine thick	Granulate	Smooth to scabrate, with convex sides	54 (57) 58μ usually broader than long	48 (51) 53μ		Longer than the central body, distally pendant	Coarsely reticulate; lumina 2 to 5μ wide; muri with faint indications of radial arrangement near the base	48 (53) 55μ	70 (71) 72μ longer than broad	90 (102) 120μ	Hauterivian to middle Albian
147	Podocarpidites multesimus	24	2	Almost circular; marginal crest present; exine thick	Granulate	Smooth	33 (34) 36μ	31 (33) 35μ		Longer than the central body, distally pendant, with a concave base of attachment; occasionally one bladder larger than the other	Finely reticulate; lumina 1 to 2μ wide; muri with faint indications of radial arrangement near the base	29 (30) 31μ	41 (43) 45μ longer than broad	60 (64) 70μ	Jurassic and Cretaceous
148	Podocarpidites radiatus	24	3	Almost circular; marginal crest present; exine thick	Scabrate	Smooth	31 (43) 51μ	31 (39) 48μ		Longer than the central body, distally pendant, broadly attached	Finely reticulate; lumina 1 to 2μ wide; basal one-third of the bladders with thick, radially arranged muri	26 (35) 41μ	39 (51) 60μ length about 1.5 times the breadth	58 (80) 85μ	Late Jurassic to Albian
149	Podocarpidites sp. cf. P. ellipticus	22	13	Oval to almost circular; marginal crest present; exine thick	Granulate	Smooth, wide	30 (36) 42μ	34 (41) 55μ usually longer than broad		Longer than the central body, distally pendant	Finely reticulate; muri with faint indications of radial arrangement near the base	24 (30) 35μ	40 (50) 61μ longer than broad	51 (60) 72μ	Jurassic and Early Cretaceous

DISACCITES FAMILY PODOCARPACEAE		PLATE	FIGURES	CENTRAL BODY						BLADDERS (bisaccate)				TOTAL BREADTH OF GRAIN	KNOWN STRATIGRAPHIC RANGE
				SHAPE	PROXIMAL CAP	DISTAL FURROW	BREADTH	LENGTH	HEIGHT	ATTACHMENT	ORNAMENTATION	BREADTH	LENGTH		
150	Podocarpidites granulatus	23	6-9	Subcircular; marginal crest present; exine thick	Distinctly granulate; granules 0.5 to 1.5μ in diameter, closely spaced	Smooth, 8 to 12μ wide	33 (36) 38μ broader than long	27 (29) 31μ	24 (26) 28μ	Slightly longer than the central body, distally pendant, with a concave base of attachment	Finely reticulate	19 (21) 24μ	31 (35) 36μ length about 1.5 times the breadth	42 (48.5) 57μ	Middle and late Albian
151	Podocarpidites epistratus	23	5	Almost circular; exine about 1μ thick	Scabrate to microrugulate	Smooth	24 (25) 26μ	24 (29) 34μ		Approximately equal to the length of central body, distally pendant, broadly attached	Indistinctly microreticulate, membraneous; basal half of the bladders with thick radially arranged muri	15 to 16μ	28 to 29μ length about twice the breadth	29 (34) 38μ	Late Jurassic to early Cenomanian
152	Podocarpidites minisculus	24	1	Oval; marginal crest present; exine thick	Scabrate	Smooth	20 (24) 28μ	27 (33) 38μ longer than broad		Longer than the central body, distally pendant, broadly attached	Finely reticulate, membraneous	19 (24) 30μ	35 (38) 46μ length 2 to 1.5 times the breadth	40 (47) 55μ	Aptian and Albian
153	Podocarpidites sp. cf. P. herbstii	23	10	Oblate; marginal crest present; exine thick	Scabrate	Smooth; bases of the bladders about 10μ apart	36 to 37μ breadth about 1.4 times the length	21 (24) 27μ		Longer than the central body, distally pendant, constricted at the base	Finely reticulate; muri with faint indications of radial arrangement near the base	27 to 28μ	28 (30) 32μ	60 (62) 66μ breadth about twice the length of grain	Middle and late Albian
154	Parvisaccites radiatus	22	9,10	Almost circular; marginal crest present; exine thick	Scabrate, 2 to 3μ thick, well developed	Smooth; bases of the bladders 8 to 10μ apart	44 (45) 46μ	38 (41) 44μ	32μ	Shorter than the central body, distally pendant, broadly attached, smaller in comparison to the central body	Indistinctly reticulate; thick, radially arranged muri running from the bases of the bladders to the margin	18 (20) 22μ	34 (35) 36μ length 2 to 1.5 times the breadth	41 (53) 60μ	Late Jurassic to early Cenomanian
155	Phyllocladidites inchoatus	22	11	Almost circular; exine 1 to 3μ thick	Subgranulate to smooth	Smooth; furrow represented by a 10 to 20μ wide, diffuse area of thinner exine between the bases of bladders	34 (40) 44μ	34 (40) 48μ		Shorter than the central body, very small, usually not projecting beyond the margin of central body, strongly distally pendant, broadly attached; bladders often folded over the distal furrow	Microreticulate	10 (14) 18μ	26 (32) 36μ length more than twice the breadth	36 (44) 51μ	Middle Albian to Cenomanian
156	Phyllocladidites sp.	22	12	Circular; exine 5μ thick	Subgranulate to smooth	Smooth; bases of the bladders about 20μ apart	58μ	60μ	43 (46) 51μ	Shorter than the central body, very small, usually not projecting beyond the margin of central body, strongly distally pendant, broadly attached; bladders often folded over the distal furrow	Smooth, very thick, rudimentary bladders	8μ	23μ length more than twice the breadth	60 (62) 65μ	Middle and late Albian
157	Rugubivesiculites reductus	24	4,5	Almost circular; exine 2μ thick	Rugulate; rugulae 1 to 4μ wide, weakly developed, sparsely distributed; proximal surface and the rugulate ridges granulate to pitted	Furrow indistinct; bases of the bladders about 20μ apart, and with characteristic saccate marginal frills	48 (55) 63μ	50 (53) 57μ		Shorter than the central body, distally pendant, slightly constricted at the base	Finely reticulate	30 (33) 36μ	48 (49) 50μ	70 (74) 82μ	Middle Albian to Paleocene
158	Rugubivesiculites rugosus	24	6,7	Subcircular; exine thick	Rugulate; rugulae 1 to 4μ wide, 2 to 4μ high, closely spaced, with sharp angular bends	Furrow indistinct; bases of the bladders about 15μ apart	40 (47) 53μ usually broader than long	30 (37) 43μ		Shorter than the central body, distally pendant, broadly attached	Finely reticulate	24 (28) 31μ	30 (39) 48μ	54 (69) 83μ	Late Albian and Cenomanian

DISACCITES		PLATE	FIGURES	CENTRAL BODY						BLADDERS (bisaccate)				TOTAL BREADTH OF GRAIN	KNOWN STRATIGRAPHIC RANGE
				SHAPE	PROXIMAL CAP	DISTAL FURROW	BREADTH	LENGTH	HEIGHT	ATTACHMENT	ORNAMENTATION	BREADTH	LENGTH		
159	Vitreisporites pallidus	22	1	Oval; exine less than 1μ thick	Subgranulate	Smooth, 7 to 8μ wide, parallel sided	8 (10) 15μ	16 (19) 22μ length 1.5 times to twice the breadth		Equal to or slightly longer than the central body, proximally attached at the equator, slightly distally pendant, broadly attached	Microreticulate; basal half of the bladders with thick, radially arranged muri	9 (12) 15μ	16 (20) 22μ length 1.5 times to twice the breadth	28 (33) 39μ	Triassic to Cretaceous
160	Vitreisporites sp.	22	2	Oval; exine about 1μ thick	Subgranulate	Smooth, 6 to 8μ wide, parallel sided	12 (14) 15μ	29 (30) 31μ length about twice the breadth		Equal to or slightly longer than the central body, proximally attached at the equator, slightly distally pendant, broadly attached	Microreticulate; basal half of the bladders with thick, radially arranged muri	18 (20) 22μ	28 (29) 30μ length about 1.5 times the breadth	50 (54.5) 58μ	Middle Albian
161	Alisporites sp. cf. A. microsaccus	25	3	Oval; exine about 1.5μ thick	Scabrate	Smooth, about 8μ wide, parallel sided; bases of the bladders about 30μ apart	34 (54) 72μ	42 (61) 80μ longer than broad		Shorter than the central body, slightly distally pendant, broadly attached, poorly developed	Finely reticulate	8 (11) 17μ	30 (43) 60μ length more than twice the breadth	34 (54) 72μ	Late Jurassic and Early Cretaceous
162	Alisporites bilateralis	24	9	Oval; exine about 1.5μ thick	Scabrate	Smooth, about 10μ wide, parallel sided; the furrow sides marking the bladder bases	29 (36) 44μ	39 (46) 52μ longer than broad		Equal to or slightly longer than the central body, slightly distally pendant, broadly attached, merging with the proximal cap	Finely reticulate	20 (26) 35μ	41 (47) 54μ length 1.5 times to twice the breadth	59 (67) 75μ	Late Jurassic to Cenomanian
163	Alisporites grandis	25	1,2	Oval; exine about 2μ thick	Finely reticulate	Smooth, about 14μ wide, parallel sided; the furrow sides marking the bladder bases	40 (53) 71μ	50 (64) 83μ longer than broad		Equal to or slightly longer than the central body, slightly distally pendant, broadly attached, merging with the proximal cap	Coarsely reticulate; lumina up to 2.5μ wide	30 (43) 60μ	52 (65) 85μ longer than broad	78 (99) 115μ	Late Jurassic and Early Cretaceous
164	Cedripites cretaceus	25	6	Subcircular; exine thick	Granulate, about 3μ thick, well developed	Scabrate, indistinct	58 (62) 66μ usually broader than long	52 (53) 55μ	44μ	Slightly longer than the central body, distally pendant, broadly attached, merging with the proximal cap giving an impression of continuity along the proximal pole; bladders concave on the distal side, partially covering the central body in that region	Coarsely reticulate	36 (42) 50μ	58 (59) 60μ longer than broad	72 (86) 100μ	Barremian to Albian
165	Cedripites canadensis	25	4,5	Almost circular; exine thick	Granulate, about 2μ thick, well developed	Smooth, about 8μ wide	41 (60) 78μ	46 (66) 80μ	36 (38) 43μ	Considerably shorter than the central body, distally pendant, broadly attached, merging with the proximal cap giving an impression of continuity along the proximal pole; bladders concave on the distal side, partially covering the central body in that region	Coarsely reticulate	19 (28) 35μ	31 (49) 57μ longer than broad	58 (78) 93μ	Barremian to Albian
166	Pityosporites alatipollenites	25	9	Elliptical; exine about 1.5μ thick	Finely reticulate	Scabrate; bases of the bladders about 16μ apart	48 (49) 51μ broader than long		36 (40) 43μ	Considerably smaller and shorter than the central body, strongly distally pendant, constricted toward the base, and diverging	Coarsely reticulate	22 (26) 31μ		65 (68) 72μ	Late Jurassic to Late Cretaceous
167	Pityosporites constrictus	25	10	Elliptical; exine about 2μ thick	Finely granulate	Scabrate; bases of the bladders about 16μ apart	38 (45) 60μ broader than long	33 (39) 48μ	48μ	Slightly shorter than the central body, strongly distally pendant, constricted toward the base, and diverging	Coarsely reticulate	22 (28) 33μ	30 (37) 42μ	60 (67) 80μ	Aptian and Albian
168	Abiespollenites sp.	24	8	Elliptical; exine about 2μ thick	Finely reticulate	Smooth to scabrate, wide	106μ		82μ	Smaller than the central body; bladders almost circular, strongly distally pendant, distinctly set off from the central body	Finely reticulate	76μ		135 (140) 150μ	Middle Albian

TRISACCITES	PLATE	FIGURES	CENTRAL BODY				BLADDERS					MAXIMUM DIAMETER OF GRAINS	KNOWN STRATIGRAPHIC RANGE
			SHAPE	PROXIMAL SURFACE	DISTAL SURFACE	MAXIMUM DIAMETER	NUMBER OF BLADDERS	ATTACHMENT	ORNAMENTATION	BREADTH	LENGTH		
169 Dacrycarpites sp.	22	8	Circular to triangular	Very finely rugulate	Furrow smooth, triangular in shape, and very wide	15 (19) 24μ	Three	Approximately equal in size to the central body, distally pendant, broadly attached near the margin of the central body	Finely reticulate; basal half of the bladders with radially disposed muri	12 (14) 17μ	15 (23) 26μ longer than broad	26 (30) 36μ	Middle Albian
POLYSACCITES													
170 Callialasporites dampieri	26	2	Circular to rounded-triangular; exine 1 to 2μ thick	Finely granulate; trilete mark faint	Finely granulate	35 (45) 52μ	One	A narrow equatorial bladder surrounding the central body	Bladder finely granulate, with radial folds and indented outline	6 to 12μ		50 (61) 75μ	Jurassic to Eocene
171 Callialasporites sp.	26	3,4	Spherical; exine about 3μ thick	Vesiculate; trilete mark inconspicuous	Vesiculate; vesiculae elongate, rugulate, anastomosing, and up to 2μ high	59μ	One	A very narrow equatorial bladder surrounding the central body	Bladder finely granulate, with numerous radial folds reaching the outer margin	3 to 4μ		65μ	Middle Albian
SACCIZONATI													
172 Cerebropollenites mesozoicus	25	7	Spherical	Numerous small, saccate, corrugated protrusions of uniform size	A 12 to 20μ wide, smooth and thin area lacking the ektexinal layer at the distal pole; remaining distal surface saccate as on the proximal side		Numerous small saccate projections	Exine double layered; endexine thin and smooth; ektexine about 1.5μ thick, forming numerous saccate projections	Sacci 3 to 5μ wide, and up to 5μ high, with granulate structure			46 (55) 70μ	Jurassic and Cretaceous

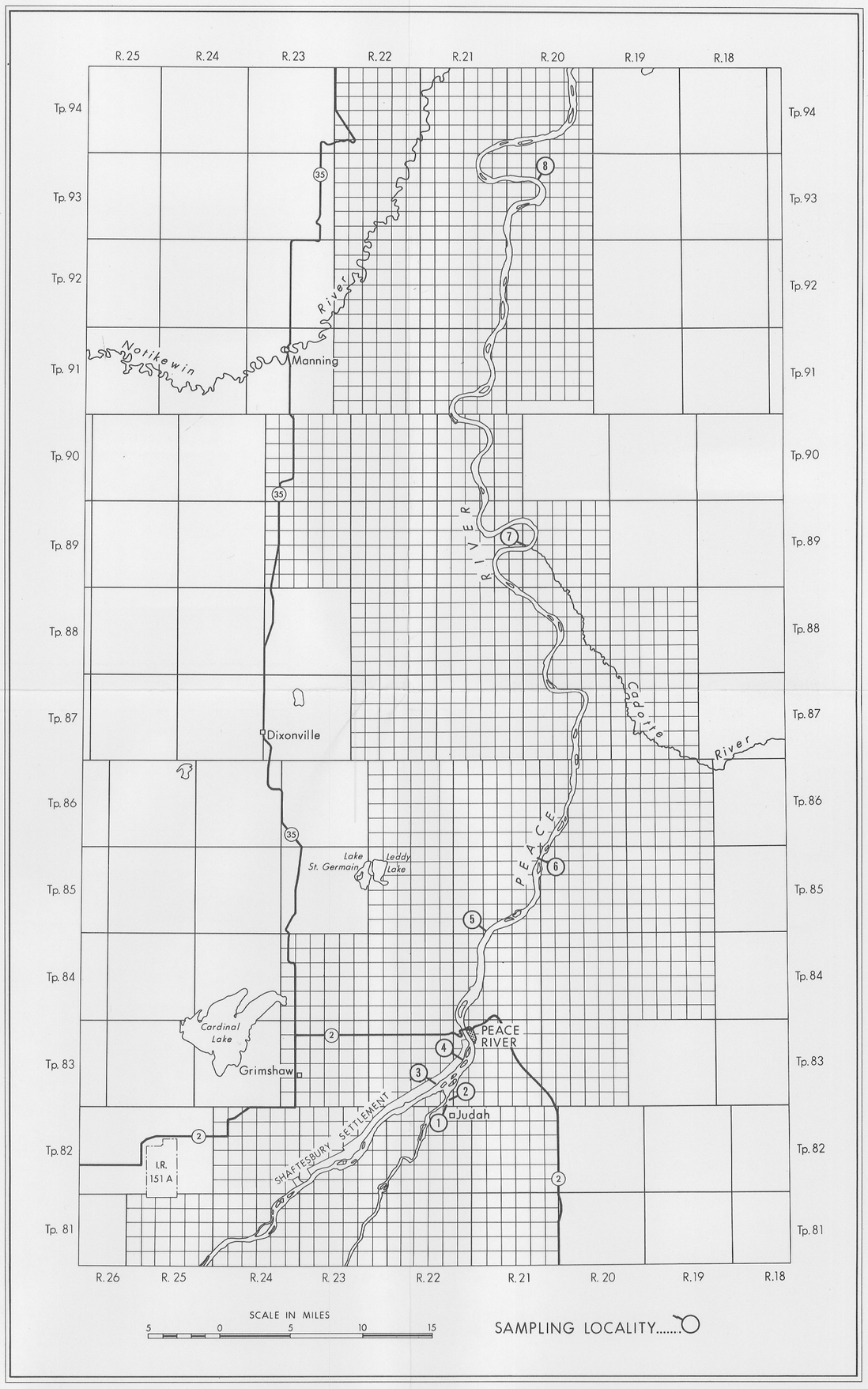
MONOCOLPATES	PLATE	FIGURES	GERMINAL APPARATUS	SHAPE	ORNAMENTATION		EXINE THICKNESS	LENGTH	BREADTH	LENGTH TO BREADTH RATIO	KNOWN STRATIGRAPHIC RANGE
					EXINE	SURFACE SCULPTURE					
173 Ginkgocycadophytus nitidus	22	3	Monosulcate; sulcus extending full length of the grain, widening at both the longitudinal ends and merging with the outline of the body; furrow edges touching but not overlapping at the distal pole	Fusiform	Exinal layers not distinguishable	Smooth to faintly scabrate	1.5μ	29 (33) 36μ	13 (20) 24μ	1.3 (1.6) 2.2	Triassic to Cretaceous
174 Clavatipollenites hughesii	27	1-3	Monosulcate; sulcus extending full length of the grain, gaping in the central region and narrowing toward extremities; sulcus frequently indistinct	Broadly elliptical	Exine double layered; endexine unsculptured, 0.5 to 1μ thick; ektexine composed of 1μ long, closely spaced pila; heads of pila fused producing a microreticulate surface and a tectate exine	Microreticulate; lumina 1μ wide, angular to almost circular, of uniform size and shape	2μ	17 (24) 29μ	13 (20) 25μ	1 (1.2) 1.5	Barremian to early Cenomanian
175 Clavatipollenites minutus	27	4-6	Monosulcate; sulcus distinct, extending full length of the grain; body usually split along the sulcus	Broadly elliptical to circular	Exine double layered; endexine unsculptured, 0.5μ thick; ektexine composed of up to 0.8μ long, closely spaced pila; heads of pila fused producing a microreticulate surface and a tectate exine	Microreticulate; lumina 1μ wide, angular to almost circular, of uniform size and shape	1.3μ	13 (16) 20μ	10 (14) 19μ	1 (1.1) 1.5	Barremian to Albian

MONOCOLPATES		PLATE	FIGURES	GERMINAL APPARATUS	SHAPE	ORNAMENTATION		EXINE THICKNESS	LENGTH	BREADTH	LENGTH TO BREADTH RATIO	KNOWN STRATIGRAPHIC RANGE
						EXINE	SURFACE SCULPTURE					
176	Liliacidites dividuus	27 28	14,15 1,2	Monosulcate; sulcus almost reaching the longitudinal ends of the grain and bordered by a 1.5 to 2μ wide, thickened margin; extremities of the sulcus rounded	Elliptical to spherical	Exine double layered; endexine unsculptured, about 0.5μ thick; ektexine reticulate; muri supported on and connected to the endexine by about 1μ long columellae; reticulate ektexine usually separated from the smooth endexine	Reticulate; lumina 1 to 2μ wide, angular to almost circular, of uniform size and shape; muri 0.3μ wide	1.5μ	24 (26) 32μ	22 (24) 25μ	1 (1.1) 1.3	Albian and Cenomanian
177	Liliacidites crassatus	27	10-13	Monosulcate; sulcus 1.5 to 2μ wide in the middle, narrowing toward extremities and reaching or almost reaching the longitudinal ends of the grain; sulcus smooth	Oval; distal surface flatter than the proximal surface	Exine double layered; endexine smooth, about 1μ thick; ektexine reticulate; muri supported on and connected to the endexine by about 1.5μ high clavae; clavae spaced about 1.5μ apart	Reticulate; lumina 1 to 2.5μ wide, elongate to irregular shaped, of uniform size; muri 0.5 to 1μ wide, sinuous to convolute, swollen at the points of insertion of clavae	2.5μ	22 (25.5) 27.5μ	16 (20) 24μ	1 (1.26) 1.6	Late Albian
178	Liliacidites textus	29	1-4	Monosulcate; sulcus about half the width of the body and almost reaching the longitudinal ends of the grain; sulcus smooth	Elongate oval	Exine double layered; endexine unsculptured, about 0.5μ thick; ektexine reticulate; muri supported on and connected to the endexine by 1μ long pila; pila spaced 1 to 2μ apart	Reticulate; lumina 1 to 4μ wide, angular to equidimensional, of uniform size; muri 0.5μ wide, sinuous to convolute, swollen at the points of insertion of pila	1.5μ	21 to 24μ	16 to 18μ	1.3	Late Albian
179	Liliacidites clavatus	27	7-9	Monosulcate; sulcus about 4.5μ wide in the middle, narrowing toward extremities and reaching or almost reaching the longitudinal ends of the grain; sulcus smooth	Elongate oval, with acute to sharply rounded ends; distal surface flatter than the proximal surface	Exine double layered; endexine unsculptured, about 1μ thick; ektexine reticulate; muri supported on and connected to the endexine by about 2μ high clavae; clavae 1μ thick, spaced 1 to 2μ apart	Reticulate; lumina 2 to 4μ wide, elongate to equidimensional, 4- to 6-sided, angular, of uniform size and shape; muri about 1μ wide, straight, with dark dots at the points of insertion of clavae	3μ	40 (41) 42μ	22 (24.5) 27μ	1.55 (1.7) 1.8	Late Albian
180	Liliacidites inaequalis	28	3-5	Monosulcate; sulcus wide and indistinct, reaching or almost reaching the longitudinal ends of the grain	Elongate oval; distal surface flatter than the proximal surface	Exine double layered; endexine unsculptured, about 0.5μ thick; ektexine reticulate; muri supported on and connected to the endexine by about 1μ high clavae; clavae 0.5 to 1μ thick	Reticulate; diameter of lumina 3 to 6μ in the middle region, diminishing to 1μ near the longitudinal ends of the grain; lumina mostly angular and equidimensional; muri 0.5 to 1μ wide, straight, with dark dots at the points of insertion of clavae	2μ	30 (40) 48μ	22 (29) 36μ	1.25 (1.4) 1.6	Late Albian
181	Liliacidites trichotomosulcatus	29	5-7	Trichotomosulcate; sulcus about 6μ wide at the distal pole, narrowing toward the extremities and reaching or almost reaching the equator; sulcus smooth	Circular	Exine double layered; endexine unsculptured, about 1μ thick; ektexine reticulate; muri supported on and connected to the endexine by about 0.8μ high columellae; columellae about 0.5μ thick, spaced 0.5 to 1μ apart	Reticulate; lumina about 1μ wide, circular to irregular shaped, of uniform size, muri about 0.5μ wide, sinuous to convolute, with dark dots at the points of insertion of columellae	2μ	23 (24.5) 26μ	23 (24.5) 26μ	1	Middle and late Albian
182	Liliacidites peroreticulatus	28	6-11	Monosulcate; sulcus wide, smooth, extending full length of the grain; reticulate ektexine interrupted at the position of the sulcus	Fusiform to almost circular	Exine double layered; endexine unsculptured, about 1μ thick; ektexine reticulate, loosely attached to the inner endexinal body; muri supported on and connected to the endexine by 1 to 3μ long pila; pila about 1μ thick, spaced 2.5 to 4μ apart	Reticulate; lumina 3 to 7μ wide, angular, elongate to equidimensional, of uniform size; muri 0.5 to 1μ wide, straight to slightly sinuous, with swellings at the points of insertion of pila; pila longest in the middle region of the grain producing a frill-like extension of the reticulate ektexine	2 to 4μ	20μ Inner body 16 to 17μ	18 (22) 26μ Inner body 15 (18) 20μ	0.8 (0.9) 1.1 Inner body 0.85 (0.9) 1.1	Barremian to early Cenomanian
183	Liliacidites reticulatus	28	12-14	Monosulcate; sulcus wide, smooth, extending full length of the grain; reticulate ektexine interrupted at the position of the sulcus	Fusiform	Exine double layered; endexine unsculptured, about 1μ thick; ektexine reticulate, loosely attached to the inner endexinal body; muri supported on and connected to the endexine by 1 to 3μ long pila; pila about 1μ thick, spaced 2.5 to 4μ apart	Reticulate; lumina 2 to 4μ wide; angular, elongate to equidimensional, of uniform size; muri 0.5μ wide; straight to slightly sinuous, with swellings at the points of insertion of pila; pila longest in the middle region of the grain producing a frill-like extension of the reticulate ektexine	2 to 4μ	25 (26) 29μ Inner body 22μ	18 (21) 24μ Inner body 17μ	1.19 (1.24) 1.4 Inner body 1.3	Barremian to Albian

	TRIPTYCHES (TRICOLPATE)	PLATE	FIGURES	GERMINAL APPARATUS	SHAPE		ORNAMENTATION		EXINE THICKNESS	POLAR DIAMETER (P)	EQUATORIAL DIAMETER IN EQUATORIAL VIEW (E 1)	EQUATORIAL DIAMETER IN POLAR VIEW (E 2)	P/E1	KNOWN STRATIGRAPHIC RANGE
					POLAR OUTLINE	EQUATORIAL OUTLINE	EXINE	SURFACE SCULPTURE						
184	Psilatricolpites parvulus	29	15,16	Tricolpate; colpi narrow and short, reaching half-way to the poles	Subprolate to almost isodiametric	Almost spherical to slightly lobate	Smooth	Smooth	1μ	12 (12.5) 14μ	9 (10) 12μ	14μ	1.2 (1.25) 1.3	Late Albian to Danian
185	Tricolpites crassimurus	32	4-6	Tricolpate; colpi long and wide, almost reaching the poles	Subprolate to prolate	Trilobate, fossaperturate	Exine double layered; endexine thin and smooth; ektexine baculate and tegillate; bacula 1μ high, densely packed; tips of bacula fused forming a thick tegillum; tegillum covering the entire surface of the body	Scabrate	1.3μ	24μ	14μ	22 (26) 30μ	1.7	Albian to Coniacian
186	Tricolpites sagax	32	18,19	Tricolpate; colpi long and wide, almost reaching the poles	Oblate to subprolate	Circular to fossaperturate	Exine double layered; endexine 0.8μ thick, highly refractive; ektexine pilate and tegillate; pila 1μ high; heads of pila partially fused forming a tegillum; tegillum covering most of the body surface	Subgranulate to microreticulate; pila producing fine radial striations and a ragged outline at the edge	1.8μ			15 (18) 22μ		Middle and late Albian
187	Tricolpites parvus	32	12-17	Tricolpate; colpi long and wide, almost reaching the poles	Oblate to prolate	Trilobate, fossaperturate	Exine double layered; endexine about 1μ thick, smooth, highly refractive; ektexine pilate and tegillate; pila 1μ high, closely spaced; heads of pila fused forming a tegillum; tegillum covering more than half of the body surface	Microreticulate; lumina about 0.5μ wide, of uniform size and shape all over the body	2μ	23μ	15μ	20 (23) 27μ	1.5	Middle Albian to early Paleocene
188	Tricolpites micromunus	32	7-11	Tricolpate; colpi long and narrow, almost reaching the poles	Spheroidal to prolate	Circular	Exine double layered; endexine 0.5μ thick and smooth; ektexine clavate and tegillate; clavae 1μ high, closely spaced; heads of clavae fused forming a tegillum; tegillum covering most of the body surface	Microreticulate; lumina about 0.5μ wide on the mesocolpia and decreasing in size toward the poles	1.5μ	15μ	13μ	13 (16) 19μ	1.15	Albian to Danian
189	Cupuliferoidaepollenites minutus	29	8,9	Tricolpate; colpi long and narrow, almost reaching the poles	Subprolate to prolate	Circular	Exine double layered; endexine thin and smooth; ektexine baculate and tegillate; bacula 0.8μ high, closely spaced; tips of bacula fused forming a tegillum; tegillum covering most of the body surface	Microreticulate; lumina about 0.2μ wide, of uniform size and shape all over the body	1μ	13 to 14μ	10μ		1.35	Albian and early Cenomanian
190	Fraxinoipollenites venustus	29	12-14	Tricolpate; colpi long and narrow, almost reaching the poles	Prolate	Trilobate, fossaperturate	Exine double layered; endexine 0.3μ thick and smooth; ektexine clavate and tegillate; clavae about 1μ high, densely packed; heads of clavae fused forming a smooth flat-topped tegillum; tegillum covering more than 2/3 of the body surface	Microreticulate to pitted; lumina 0.2 to 0.4μ wide on the mesocolpia, increasing to 0.8μ in the polar regions; lumina in the polar regions widely spaced producing a pitted effect; lumina circular to elongate, usually widely spaced; muri 0.5 to 1μ wide, supported on the clavae	1.3μ	22 (29) 41μ	14 (18) 25μ	20 (25) 29μ	1.3 (1.6) 1.9	Middle and late Albian
191	Retitricolpites vulgaris	31	11-15	Tricolpate; colpi long and narrow, almost reaching the poles	Spheroidal to subprolate	Circular, often fossaperturate	Two layers of exine not clearly distinguished; endexine thin and smooth; ektexine reticulate, nontegillate; muri simple	Reticulate; lumina 0.5 to 1.5μ wide, irregular to vermiculate in shape, of uniform size all over the body; muri simple, 0.5μ wide, about 0.3μ high	1μ	21 (26) 31μ	15 (20) 25μ	25 (28) 30μ	1.1 (1.3) 1.7	Middle Albian to Cenomanian
192	Retitricolpites virgeus	31	5-10	Tricolpate; colpi long and wide, almost reaching the poles	Subprolate to prolate	Trilobate, fossaperturate	Exine double layered, tegillate; endexine smooth, about 0.5μ thick; ektexine reticulate, 1 to 1.5μ thick; muri supported on and connected to the endexine by 1 to 1.5μ high bacula; bacula about 0.5μ thick, slightly wider at the tips and spaced about 1μ apart	Reticulate; lumina 1.5 to 3μ wide, angular to irregular shaped, of uniform size all over the body; muri straight to slightly sinuous, about 0.5μ wide, with dark dots at the points of insertion of bacula	2μ	22 (26) 30μ	16 (19) 22μ	19 (25) 30μ	1.1 (1.4) 1.6	Middle Albian to Coniacian

TRIPTYCHES (TRICOLPATE)		PLATE	FIGURES	GERMINAL APPARATUS	SHAPE		ORNAMENTATION		EXINE THICKNESS	POLAR DIAMETER (P)	EQUATORIAL DIAMETER IN EQUATORIAL VIEW (E1)	EQUATORIAL DIAMETER IN POLAR VIEW (E2)	P/E1	KNOWN STRATIGRAPHIC RANGE
					POLAR OUTLINE	EQUATORIAL OUTLINE	EXINE	SURFACE SCULPTURE						
193	Retitricolpites maximus	30 31	7-9 1,2	Tricolpate; colpi long and wide, almost reaching the poles	Subprolate to prolate	Trilobate, fossaperturate with V-shaped colpi	Exine double layered, tegillate; endexine smooth, about 0.5μ thick; ektexine with an imperfect-reticulate ornamentation, about 2μ thick; muri supported on and connected to the endexine by about 2μ high clavae; clavae about 0.8μ thick, often distinct from one another, spaced about 1μ apart	Imperfect-reticulate; lumina 1 to 1.5μ wide, irregular shaped, of uniform size all over the body; muri vermiculate, about 0.5μ wide, discontinuous forming imperfect-reticulate pattern, with dark dots at the points of insertion of clavae	2.5μ	30 (34) 39μ	21 (25) 27μ	26 (40) 53μ	1.1 (1.4) 1.5	Middle and late Albian
194	Retitricolpites prosimilis	31	3,4	Tricolpate; colpi long and narrow, almost reaching the poles	Subprolate to perprolate, mostly prolate and seen in the equatorial view		Two layers of exine not clearly distinguished; endexine thin and smooth; ektexine reticulate, nontegillate; muri simple	Reticulate; lumina 0.5 to 1.2μ wide on the mesocolpia, decreasing to 0.2μ in the polar regions, grading to an infrapunctate pattern; lumina equidimensional and polygonal; muri simple, about 0.3μ wide and equally high	0.5 to 1μ	13 (19) 25μ	7 (13) 18μ		1.2 (1.5) 2	Middle and late Albian
195	Retitricolpites georgensis	30	1-6	Tricolpate; colpi long and narrow, almost reaching the poles	Subprolate to prolate	Fossaperturate; colpi ruptured due to compression	Exine double layered, tegillate; endexine smooth, about 0.5μ thick; ektexine reticulate, about 1μ thick; muri supported on and connected to the endexine by about 1μ high pila; pila about 0.5μ thick, spaced about 1μ apart; Alberta specimens often not showing the pilate structure of the muri clearly	Reticulate; lumina 1 to 2μ wide on the mesocolpia, decreasing to 0.5μ in the polar regions; lumina polygonal to irregular shaped; muri straight, about 0.5μ wide, usually with dark dots at the points of insertion of pila	1.5μ	18 (24) 36μ	15 (17) 24μ	17 (21) 32μ	1.1 (1.4) 1.7	Albian and early Cenomanian
196	Foveotricolpites concinnus	29	10,11	Tricolpate; colpi long and wide, reaching or almost reaching the poles; margin of colpi thickened	Subprolate to prolate, rhomboidal, seen only in the equatorial view		Exine double layered, tegillate; endexine smooth, about 0.5μ thick; ektexine foveolate, about 1.5μ thick; muri supported on and connected to the endexine by 1 to 1.5μ high, densely packed bacula; muri forming a smooth, flat-topped tegillum; tegillum covering more than half of the body surface	Foveolate; lumina 1 to 2μ wide, angular, equidimensional to occasionally elongate, of uniform size all over the body; muri 1 to 3μ wide	2μ	25 (28) 33μ	14 (19) 25μ		1.3 (1.5) 1.8	Middle Albian to Cenomanian
197	Striatopollis paraneus	32	1-3	Tricolpate; colpi long and narrow, almost reaching the poles	Subprolate to prolate	Trilobate, fossaperturate	Exine double layered; endexine very thin and smooth; ektexine striato-reticulate, nontegillate; muri simple	Striato-reticulate; lumina 0.25μ wide, arranged in single rows between the ridges; ridges about 0.25μ wide, spaced 0.5μ apart, curved, arranged in parallel sets with no preferred orientation, often running obliquely to the colpi and the body margin	0.5 to 1μ	16 (19) 23μ	12 (14) 21μ	15 (18) 20μ	1.1 (1.3) 1.7	Middle and late Albian

PTYCHOTRIPORINES (TRICOLPORATE)		PLATE	FIGURES	GERMINAL APPARATUS	SHAPE		ORNAMENTATION		EXINE THICKNESS	EQUATORIAL DIAMETER IN POLAR VIEW (E2)	KNOWN STRATIGRAPHIC RANGE
					POLAR OUTLINE	EQUATORIAL OUTLINE	EXINE	SURFACE SCULPTURE			
198	Nyssapollenites albertensis	32	20,21	Tricolporate; colpi almost reaching the poles and about 2.5μ wide at the equator; margin of the colpi thickened, interrupted at the equator; pores about 2.5μ wide, present in each colpus at the equator; a rim-like thickening present around each pore	Suboblate	Triangular, angulaperturate	Two layers of exine not clearly distinguished	Scabrate	1.5μ	15 (16) 17μ	Late Albian and early Cenomanian



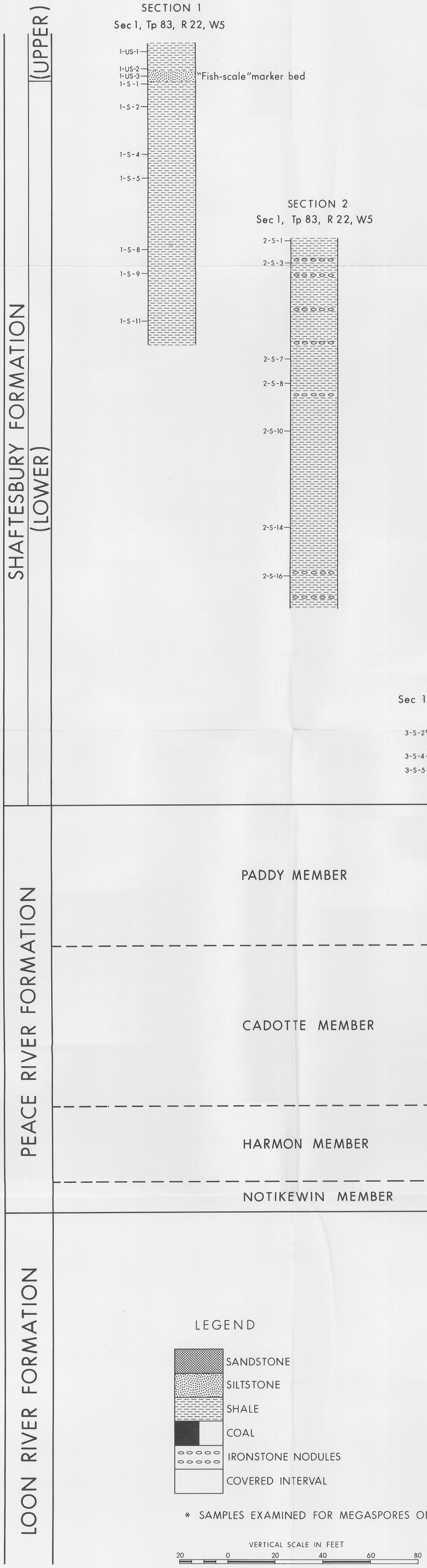


FIGURE 2. COLUMNAR SECTIONS SHOWING LITHOLOGIES, SAMPLE POSITIONS AND CORRELATION OF LOWER CRETACEOUS OUTCROP SECTIONS IN THE PEACE RIVER AREA

To accompany Research Council of Alberta Bulletin 28, by C. Singh

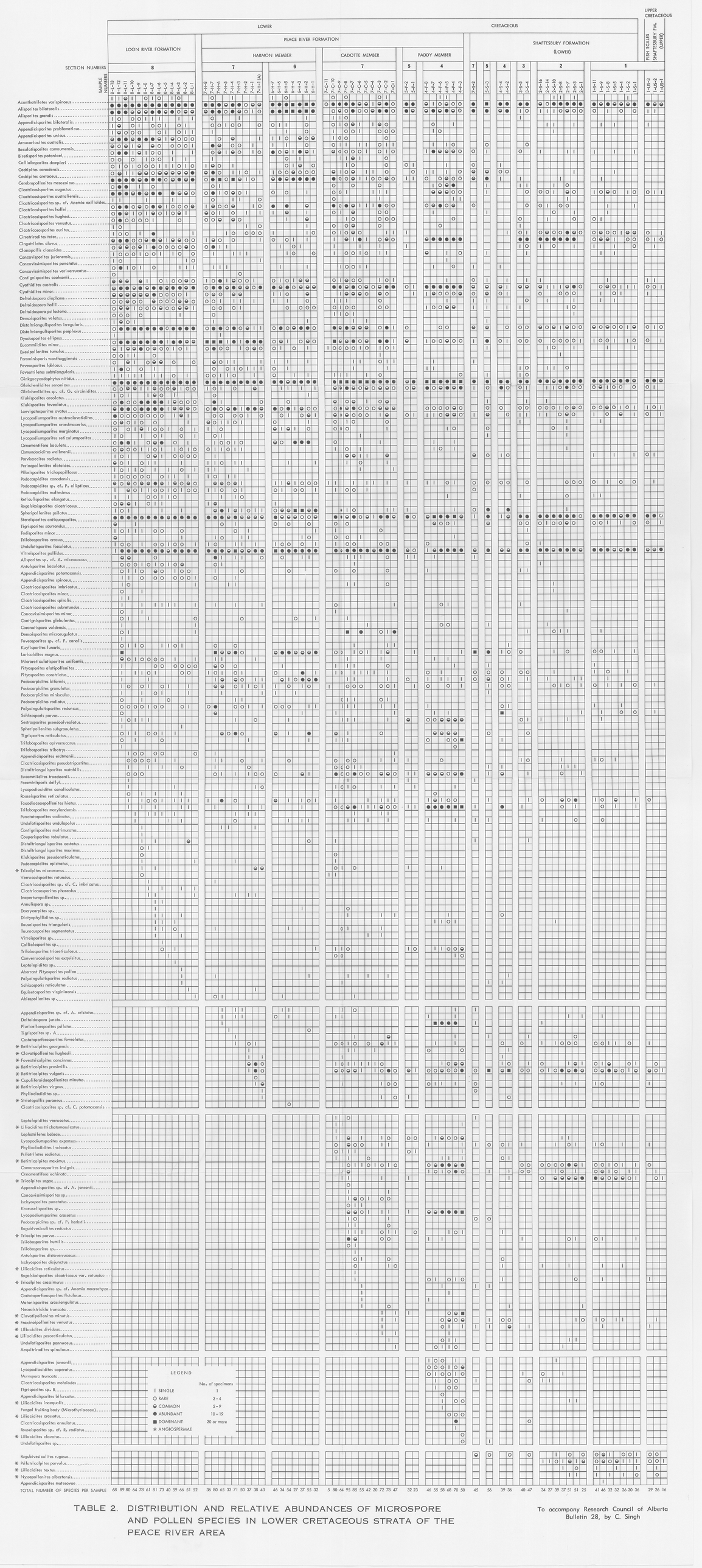


TABLE 2. DISTRIBUTION AND RELATIVE ABUNDANCES OF MICROSPORE AND POLLEN SPECIES IN LOWER CRETACEOUS STRATA OF THE PEACE RIVER AREA

To accompany Research Council of Alberta Bulletin 28, by C. Singh

TABLE 3. DISTRIBUTION AND RELATIVE ABUNDANCES OF MICROPLANKTON SPECIES IN LOWER CRETACEOUS STRATA OF THE PEACE RIVER AREA

To accompany Research Council of Alberta Bulletin 28, by C. Singh

LOWER CRETACEOUS — UPPER CRETACEOUS

Formation / Member	Section number	Sample numbers	Total number of species per sample
Loon River Formation	8	8-L-13, 8-L-12, 8-L-11, 8-L-10, 8-L-9, 8-L-8, 8-L-7, 8-L-6, 8-L-5, 8-L-4, 8-L-3, 8-L-2, 8-L-1	8, 13, 14, 6, 11, 1, 10, 6, 0, 4, 4, 2, 5
Peace River Formation, Harmon Member	7	7-H-8, 7-H-7, 7-H-6, 7-H-5, 7-H-4, 7-H-3, 7-H-2, 7-H-1, 7-H-1 (A)	0, 1, 20, 16, 27, 26, 6, 13, 12
Peace River Formation, Harmon Member	6	6-H-7, 6-H-6, 6-H-5, 6-H-4, 6-H-3, 6-H-2, 6-H-1	27, 30, 19, 23, 31, 20, 28
Peace River Formation, Cadotte Member	7	7-C-11, 7-C-10, 7-C-9, 7-C-8, 7-C-7, 7-C-6, 7-C-5, 7-C-4, 7-C-3, 7-C-2, 7-C-1	0, 12, 7, 6, 6, 3, 6, 0, 2, 18, 7
Peace River Formation, Paddy Member	5	5-P-2, 5-P-1	8, 2
Peace River Formation, Paddy Member	4	4-P-8, 4-P-7, 4-P-6, 4-P-5, 4-P-4, 4-P-3	1, 3, 2, 4, 3, 3
Shaftesbury Formation (Lower)	7	7-S-2	31
Shaftesbury Formation (Lower)	5	5-S-3	38
Shaftesbury Formation (Lower)	4	4-S-4, 4-S-2	4, 16
Shaftesbury Formation (Lower)	3	3-S-5, 3-S-4	30, 41
Shaftesbury Formation (Lower)	2	2-S-16, 2-S-14, 2-S-10, 2-S-8, 2-S-7, 2-S-3, 2-S-1	28, 13, 17, 32, 43, 26, 12
Shaftesbury Formation (Lower)	1	1-S-11, 1-S-9, 1-S-8, 1-S-5, 1-S-4, 1-S-2, 1-S-1	26, 17, 25, 28, 32, 17, 22
Fish Scales Shaftesbury Fm. (Upper)	1	1-US-3, 1-US-2, 1-US-1	13, 21, 22

Species (rows of the distribution chart, in order):

Aptea polymorpha; Baltisphaeridium multispinosum; Chlamydophorella largissima; Chlamydophorella nyei; Fromea amphora; Hystrichosphaera cingulata; Odontochitina operculata; Oligosphaeridium pulcherrimum; Gonyaulacysta sp. A; Hystrichosphaera ramosa var. ramosa; Precingular archeopyle operculum Type A; Precingular archeopyle operculum Type B; Pterospermopsis harti; Veryhachium rhomboidium; Baltisphaeridium sp. B; Chlamydophorella tabulata; Gardodinium eisenacki; Gonyaulacysta episoma; Pareodinia sp. A; Veryhachium reductum; Micrhystridium stellatum forma 6; Pterospermopsis australiensis; Baltisphaeridium whitei; Cymatiosphaera sp. A; Hystrichosphaera scabrosa; Micrhystridium fragile; Prolixosphaeridium sp.; Cyclonephelium distinctum; Palaeoperidinium ? cretaceum; Diconodinium pusillum; Hystrichosphaeridium stellatum.

Baltisphaeridium crameri; Broomea jaegeri; Gonyaulacysta helicoidea; Oligosphaeridium complex; Pareodinia ceratophora; Pseudoceratium regium; Veryhachium lairdi; Hexagonifera chlamydata; Leiofusa jurassica; Oligosphaeridium prolixispinosum; Cleistosphaeridium polypes; Cymatiosphaera pachytheca; Cymatiosphaera sp. B; Exochosphaeridium scitulum; Gardodinium elongatum; Hystrichosphaera ramosa var. gracilis; Hystrichosphaera ramosa var. multibrevis; Hystrichosphaeridium arundum; Veryhachium minutum; Dingodinium cerviculum; Gonyaulacysta orthoceras; Hystrichosphaera cingulata var. reticulata; Veryhachium formosum forma 2; Veryhachium irregulare forma subtetraedron; Leiofusa bernesga; Veryhachium collectum; Veryhachium europaeum forma 1; Canningia colliveri; Veryhachium europaeum forma 2; Hystrichosphaera wetzeli; Tanyosphaeridium sp.; Baltisphaeridium sp. A; Cordosphaeridium sp.; Micrhystridium stellatum; Pterodinium cornutum; Pterospermopsis eurypteris; Scriniodinium campanula; Micrhystridium singulare; Pterodinium reticulatum; Gonyaulacysta sp. B; Odontochitina striatoperforata; Pterospermopsis aureolata; Tasmanites newtoni; Baltisphaeridium fimbriatum; Cymatiosphaera sp. C.

Canningia aspera; Pseudoceratium pelliferum; Chytroeisphaeridia sp.; Deflandrea limpida; Veryhachium reductum forma 1.

Lecaniella foveata; Schizocystia laevigata; Tetraporina horologia.

Apteodinium reticulatum; Crassosphaera bella; Gonyaulacysta edwardsi; Hystrichosphaeridium cooksoni; Micrhystridium sp.; Oligosphaeridium anthophorum; Oligosphaeridium diastema; Palaeostomocystis fragilis; Polystephanephorus sp. cf. P. urnaformis; Ascostomocystis maxima; Gonyaulacysta cassidata; Hystrichokolpoma ferox; Palambages Form A; Crassosphaera ornata; Pterospermopsis sp. cf. P. aureolata; Pterospermopsis sp. A; Pterospermopsis sp. B; Pterospermopsis sp. C; Tasmanites suevicus; Scriniodinium eurypylum; Trichodinium spinosum; Chlamydophorella sp.; Leiosphaeridia sp.; Prolixosphaeridium capitatum; Palaeostomocystis glabella; Broomea sp.; Oligosphaeridium sp.; Ascodinium verrucosum.

Hystrichosphaeridium recurvatum; Crassosphaera papillata.

LEGEND

Symbol	No. of specimens
I SINGLE	1
○ RARE	2–4
◒ COMMON	5–9
● ABUNDANT	10–19
■ DOMINANT	20 or more