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Palynology of the Cenomanian of Bathurst Island, Northern Territory, Australia

BY

M. S. NORVICK AND D. BURGER

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CONTENTS

STRATIGRAPHIC PALYNOLOGY OF THE CENOMANIAN OF BATHURST ISLAND, NORTHERN TERRITORY, AUSTRALIA, by M. S. Norvick and D. Burger

	Page
Summary	iv
Introduction	1
Methods of investigation	2
Regional geology and stratigraphy	2
The microplankton zonation	7
The spore-pollen zonation	12
Comparison of palynological zonations in Australia	17
Conclusions	19
Acknowledgements	20

MID-CRETACEOUS MICROPLANKTON FROM BATHURST ISLAND, by M. S. Norvick

Previous work on Cretaceous microplankton	21
Classification and morphology	22
Systematic descriptions:	25
Dinoflagellates	104
Acritarchs	107
Chlorophyta	112

CENOMANIAN SPORES AND POLLEN GRAINS FROM BATHURST ISLAND, by D. Burger

Classification of fossil spores and pollen grains	114
Secondary (recycled) palynomorphs	115
Systematic descriptions:	
Sporites	116
Pollenites	139
REFERENCES (for all three papers)	155
SPECIES INDEX	166

SUMMARY

Bathurst Island lies north of Darwin, Northern Territory; it measures 2050 km^2. Cenomanian marine argillaceous sediments are exposed in cliffs at the south coast, and were first reported and diagnosed to be of Cretaceous age by Daily in 1955. Molluscs collected from various outcrop localities were dated mid- to late Cenomanian by Wright in 1963. Gravity and seismic refraction surveys by petroleum companies since 1956 established the presence of a considerable rock sequence of Mesozoic age. Subsequent regional field work by the BMR concluded that the Cenomanian strata probably accumulated in a shallow sea bordered in the north by scattered land areas.

Two wells, Bathurst Island Nos. 1 and 2, penetrated the rock sequence at the south coast of the island to a depth of slightly over 300 m, and were continuously cored. Examination of ammonites and foraminifera established the sequence as Cenomanian to possibly lower Turonian. Samples from 20 cores from these wells were selected for palynological study. The results are presented in this Bulletin. The spores and pollen grains are thought to have been shed by temperate vegetation. The spore-pollen sequence is divided into 2 intervals, palynological unit K3a, of Cenomanian age, and palynological unit K3b, of possibly early Turonian age. The microplankton sequence represents Evans' *Ascodinium parvum* Dinoflagellate Zone. Two subdivisions are distinguished: a lower *Diconodinium dispersum* Subzone, of Cenomanian age, and an upper *Palaeostomocystis fragilis* Subzone, of late Cenomanian to possibly early Turonian age.

In the descriptive and taxonomic work of the microplankton by M. S. Norvick, 104 dinoflagellate cyst and 16 acritarch species, varieties, and species groups are differentiated, belonging to a total of 61 previously known genera. Eight new species of dinoflagellate cysts are described: *Adnatosphaeridium uncinatum*, *Cribroperidinium cooksonae*, *Exochosphaeridium brevispinum*, *E. cenomaniense*, *Membranosphaera granulata*, *?Ovoidinium fragile*, *Tanyosphaeridium salpinx*, and *Valensiella griphus*.

In the systematic study of the spores and pollen grains by D. Burger, 40 spore species and 23 pollen species are described or documented. Two new genera, *Stoverisporites* and *Foveogleicheniidites*, and 7 new species are proposed: *Herkosporites proxistriatus*, *Stoverisporites microverrucatus*, *Ornamentifera minima*, *Camarozonosporites australiensis*, *Antulsporites varizonatus*, *Perotrilites oepikii*, and *Fraxinoipollenites variformis*.

INTRODUCTION

Marine and nonmarine sediments of mid-Cretaceous age are known from several areas in the Australian region (Text-fig. 1), and a number of systematic studies have appeared on their dinoflagellate and acritarch assemblages. The spores and pollen grains have been studied to a lesser extent, and only in restricted areas. The discovery of rich microfloras in sediments of mid-Cretaceous (Cenomanian to ?early Turonian) age, drilled at the south coast of Bathurst Island, Northern Territory, provided an excellent opportunity to describe and illustrate the microplankton, spores and pollen from a little known region as exhaustively as possible.

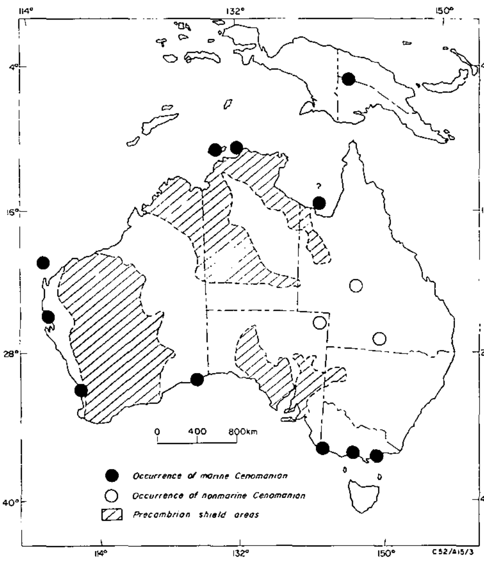

Figure 1. Known occurrence of Cenomanian sediments in the Australian region.

The present Bulletin is in three parts; Norvick has studied the microplankton, Burger the spores and pollen grains; both authors have discussed the geological background and stratigraphic implications.

This work has been undertaken with a threefold aim:

1. To create, by describing the microfloral assemblages in detail, a foundation for further study of the mid-Cretaceous in the Darwin area and Queensland;
2. To investigate whether the results show analogies between the geological history of the Great Artesian Basin and Bathurst Island;
3. To seek eventual correlations with palynological sequences in the early Late Cretaceous of Papua New Guinea (in progress), the Darwin area, and southeastern Australia.

More work in the Great Artesian Basin is needed before firm conclusions on the analogies with Bathurst Island can be made. Considerable work has been done on Cenomanian-Turonian palynology of eastern Australia by Dettmann (1973) and more is in progress.

Preliminary studies on the Otway and Gippsland Basins have already appeared (Dettmann & Playford, 1968, 1969). Initial unpublished results of Balme's work in the subsurface Upper Cretaceous of Western Australia are available, but do not yet tie in with the picture in northeastern Australia.

Methods of Investigation

Twenty samples from Bathurst Island Nos. 1 and 2 wells were processed for palynology, using standard BMR procedures (Burger, 1970); 17 yielded very rich microfloral residues. Two microscope preparations of each sample were examined in detail. The preparations are stored in the Palynological Laboratory of the Bureau of Mineral Resources, Canberra, A.C.T.; those containing type material are kept in the Commonwealth Palaeontological Collection of the Bureau.

The stratigraphic positions of the samples are shown in Text-figure 3; the occurrence of individual microplankton species in each sample is given in Text-figures 21 and 22 (after p. 113), and those of the spores and pollen grains in Text-figures 29 and 30 (after p. 154). Stratigraphic distribution of species and species groups is given in Text-figures 8 and 9. The samples and corresponding preparations are indicated by their BMR Palynological Sample Register Number (MFP). Each figured specimen is documented by a preparation number (MFP), slide number (1 or 2), six-figure co-ordinate stage, and Commonwealth Palaeontological Collection (CPC) number. The locations of the figured microplankton specimens in the preparations (Pls. 1-17) are expressed in metric co-ordinates, measured from a reference point (a small cross engraved on the glass slides near the upper right corner of the coverslip). The locations of the figured spores and pollen grains (Pls. 18-34) are expressed in true vernier readings for Leitz Ortholux Binocular microscope no. 741826, which is part of the permanent optical equipment of the Palynological Laboratory. True co-ordinates of the reference points on each slide are given in Table 1.

Table 1: Stage co-ordinates of reference points on microscope preparations from Bathurst Island Nos. 1 and 2 wells (true vernier readings for Leitz Ortholux microscope no. 741826).

Preparation	Coordinates	Preparation	Coordinates
MFP 4429-1	245/1216	MFP 4437-2	234/1220
4429-2	245/1218	4438-1	219/1210
4430-1	241/1217	4438-2	245/1215
4430-2	221/1216	4439-1	230/1222
4431-1	230/1216	4439-2	209/1217
4431-2	215/1220	4440-1	239/1221
4432-1	221/1213	4440-2	222/1219
4432-2	228/1212	4445-1	203/1215
4433-1	228/1214	4445-2	216/1215
4433-2	214/1213	4447-1	220/1215
4434-1	237/1219	4447-2	235/1217
4434-2	213/1219	4449-1	207/1219
4435-1	226/1217	4449-2	208/1213
4435-2	231/1219	4450-1	240/1212
4436-1	217/1218	4450-2	226/1220
4436-2	229/1218	4455-1	218/1216
4437-1	237/1216	4455-2	215/1220

The microplankton specimens illustrated were photographed on Kodak Panatomic X 35 mm film using Leitz Ortholux Binocular microscope no. 742105, with a Leitz Orthomat camera attached. The spores and pollen grains were photographed with a Leica M1 camera on Ilford Pan F film (negative film file nos. 71/10 to 71/22).

REGIONAL GEOLOGY AND STRATIGRAPHY

Bathurst and Melville Islands are the two largest islands off the north coast of Australia, about 65 km north of Darwin, Northern Territory (Fig. 2). Bathurst Island is the smaller of the two (about 2050 km^2) and is separated from Melville Island (about 5650 km^2) by the Apsley Strait. Both have a subdued topography with

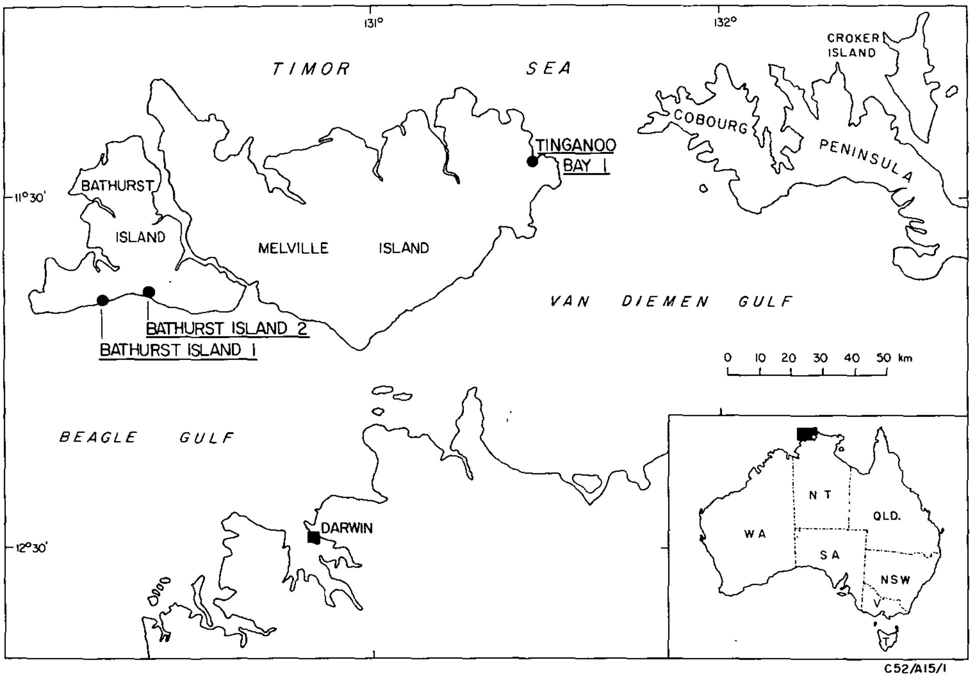

Figure 2. General location map.

a central plateau, generally under 90 m in elevation. The plateaux slope gently to the north, east, and west towards coastal tidal estuaries and mangrove swamps. On Bathurst Island deeply weathered Cainozoic quartzose sandstone, the Van Diemen Sandstone (Hughes & Senior, 1973), and marine Cretaceous mudstone, siltstone, and sublabile sandstone, the Bathurst Island Formation (Hughes & Senior, op. cit.), are exposed on the plateaux. Along the south coast, the Bathurst Island Formation is exposed in sea cliffs, which reach 90 m in height and provide the only good exposures of Mesozoic rocks on the islands.

Melville Island was first surveyed in the latter part of the nineteenth century. The presence of Cretaceous sediments became known from the reconnaissance surveys of Brown (1906) and Etheridge (1907). Etheridge collected and described Cretaceous fossils (*Inoceramus* and *Metacanthoplites*) in a cliff near Arangimpi Creek on the southwest coast.

Daily (1955) reconnoitred Melville and Bathurst Islands during a National Geographic Society expedition in 1954. He examined the same cliff at Arangimpi Creek and measured 13.1 m of sands and clays. Here he collected *Baculites*, *Inoceramus*, and fragments of acanthoceratids, plus other bivalves and one gastropod. He also examined the south coast of Bathurst Island, where Cretaceous strata are exposed for about 48 km. In the southeast corner of the island he measured 76 m of exposed glauconitic sands and clays with horizontal bedding. Here he reported the occurrence of the following fossils:

Baculites spp.	*Trigonia* valve
Scaphites	*Mytilus*
cf. *Beudanticeras*	*Dentalium*
Hamites	*Hemiaster*
Turrilites	Nautiloid shells

Acanthoceratids	Gastropods
Inoceramus	Belemnites
	lignified tree trunk (in situ)

Daily regarded this fauna as equivalent in age to that from Melville Island. The exposed coastal sequences to the south and west of Bathurst Island No. 1 well are about 110 m thick and consist mainly of glauconitic sands and clays. Fossils collected from these strata are in Daily's opinion younger, but he gave no details of them. No pre-Cretaceous rocks were found cropping out on either island.

Wright (1963) re-examined Daily's collections of ammonites in more detail. He distinguished three faunas, the first of which, from the so-called 'Tapara Bed' on the southeastern coast of Bathurst Island, he dated as mid- to late Cenomanian. This assemblage includes the following forms:

Stomohamites simplex d'Orbigny	cf. *Borissiakoceras* sp.
Sciponoceras glaessneri Wright	*Acanthoceras tapara* Wright
Hypoturrilites gravesianus (d'Orbigny)	*Acanthoceras mirialampiense* Wright
Turrilites costatus Lamarck	*Parengonoceras attenuatum spinosum* (Sommermeier) (derived from the lower Albian)

A second fauna, which occurred in boulders on the beach, was dated as late Cenomanian and contained:

Sciponoceras sp.	*Chimbuites mirindowensis* Wright
Hypoturrilites gravesianus (d'Orbigny)	*Acanthoceras* cf. *A. quadratum* Crick
Scaphites dailyi Wright	*Euomphaloceras cunningtoni* (Sharpe)
	Euomphaloceras lonsdalei (Adkins)

Kennedy (1971) briefly compared Wright's assemblages with those from southern England. He concluded that both the *in situ* fauna from the 'Tapara Bed' and that extracted from the fallen boulders seemed to be mid-Cenomanian in age.

In the coastal cliffs near Bathurst Island No. 1 well, about 8 m above the base of the main sandstone sequence, a species was found (*Collignoniceras* cf. *C. woollgari*) which is widespread in the middle Turonian of the Northern Hemisphere (Wade, *in* Hare & Associates, 1962).

A seismic and gravity survey by Santos Limited in 1956 showed that on Bathurst Island the sequence above basement thickens towards the west. This was confirmed by a ground reconnaissance by Oil Development N.L. along the south coast, where the exposed strata show a general westward dip. Bathurst Island No. 1 was drilled as a diamond drill-hole at the south coast, approximately at latitude 11°47′40″ South and longitude 130°13′30″ East, in order to investigate the presence of potentially oil-bearing sediments. Cores were taken from virtually the entire section. A total depth of 252.4 m was reached in September 1960 without reaching basement, after which drilling was halted for technical reasons (Hare & Associates, 1961). Before continuing more extensive geophysical surveys, O.D.N.L. drilled Bathurst Island No. 2, also as a diamond drill-hole, about 17 km farther east along the coast at approximately latitude 11°45′30″ South and longitude 130°22′ East in order to test further the thickness of prospective sediments. Again, this well was continuously cored. A total depth of 312.1 m was reached in October 1961 (Hare & Associates, 1962). Preliminary study of foraminifera suggested that the well had not fully penetrated the Cenomanian (Wade, *in* Hare & Associates, 1962). Both wells were dry.

Glaessner & Wade (*in* Hare & Associates, loc. cit.), having studied the core material, delineated five faunal intervals: in stratigraphic succession Foraminiferal Zones 5 and 4, and Molluscan Zones 3, 2, and 1. Zone F5 to M2 were dated Cenomanian, and Zone M1 as Turonian.

The planktonic foraminifera from the Bathurst Island wells have been examined by M. Owen, of the Bureau of Mineral Resources. His findings agreed with those of Wade, but he suggested a slightly different age for the fauna from the basal sample in No. 2 well at 312.1 m (Owen, pers. comm.). This assemblage includes *Planomalina buxtorfi* and *Rotalipora* of the *appenninica-greenhornensis* group. *P. buxtorfi* is known to be restricted to upper Albian and lowermost Cenomanian strata in many parts of the world (Loeblich & Tappan, 1961; Douglas, 1969). *Rotalipora* of the type identified first appears at the base of the Cenomanian (Loeblich & Tappan, op. cit.; Pessagno, 1967). Thus the fauna from No. 2 well, and the upper limit of Zone F5, can probably be dated as earliest Cenomanian, rather than late early to middle Cenomanian, as suggested by Wade.

Assemblages from the succeeding Zone F4 contain *Rotalipora greenhornensis* and *Rotalipora* cf. *R. appenninica*, but lack *Planomalina buxtorfi*. These assemblages cannot be dated as precisely, but are probably early to mid-Cenomanian. The higher assemblages in both Bathurst Island wells (Zones M3 and M2) are much poorer in species, which points to decreasing depth of the sea floor; this must be the continuation of a long-range regressive trend of which Skwarko (1966), Day (1969), and Burger (1973b) found evidence in upper Albian strata from Queensland and Northern Territory (see also Senior & Hughes, 1973).

The higher sediments in Nos. 1 and 2 wells can only be dated from the presence of ammonites. The occurrence of *Sciponoceras glaessneri* in the mudstone sequence of No. 2 well at 70.1 m in Zone M2 might indicate that this horizon forms the continuation of exposed strata rich in this species, which occur immediately underneath the 'Tapara Bed' (Wade, *in* Hare & Associates, 1962). Bearing in mind the presence of *Collignoniceras* cf. *C. woollgari* in the overlying sandstone sequence of No. 1 well at 12.6 m, Wade (op. cit.) suggested that the Cenomanian-Turonian boundary, although not accurately established in the rock sequence, could be assumed for the sake of convenience to coincide with the base of the main sandstone sequence.

Details of lithology and occurrence of fossils in Nos. 1 and 2 wells are given in Figure 3 (adapted after Wade, *in* Hare & Associates, 1961, and Glaessner & Wade, *in* Hare & Associates, 1962).

After Bathurst Island No. 2 well was drilled a seismic refraction survey on Bathurst Island indicated that the sedimentary sequence above basement varied in thickness from 353.6 m in the southeast to nearly 900 m in the northwestern corner (Skwarko, 1966). In 1971 Flinders Petroleum N.L. and Pexa Oil N.L. drilled Tinganoo Bay No. 1 well on the east coast of Melville Island (Fig. 2), at latitude 11°23′42″ South, and longitude 131°29′02″ East, to a total depth of 583.4 m (Pemberton, 1971). A thick, predominantly argillaceous sequence was penetrated in the 350.8-569.4 m interval. Foraminifera studied from core material (Owen, *in* Pemberton, op. cit.) suggested that the strata between 491.1 m and 528.2 m are lower Cenomanian. Our initial palynological examination of samples from that interval gave less definite results; detailed work on the entire well section has yet to be done.

Regional mapping was carried out in 1972 by the Bureau of Mineral Resources in the Darwin region, including Bathurst and Melville Islands, in which Burger took part. The field work (Senior & Hughes, 1973) showed that, in the Cenomanian, land must have existed north of Bathurst Island. The lithology of the sediments indicated shallow, near-coastal deltaic environments, at least in the upper part of the Cenomanian.

The Upper Cretaceous may regionally be of limited extent (Fig. 1). Skwarko (1966) described strata no younger than Albian ('Mullaman Beds') from the adjacent mainland. Study of recently obtained subsurface material from the Darwin area is expected to give more detailed information on the presence or absence of the Cenomanian

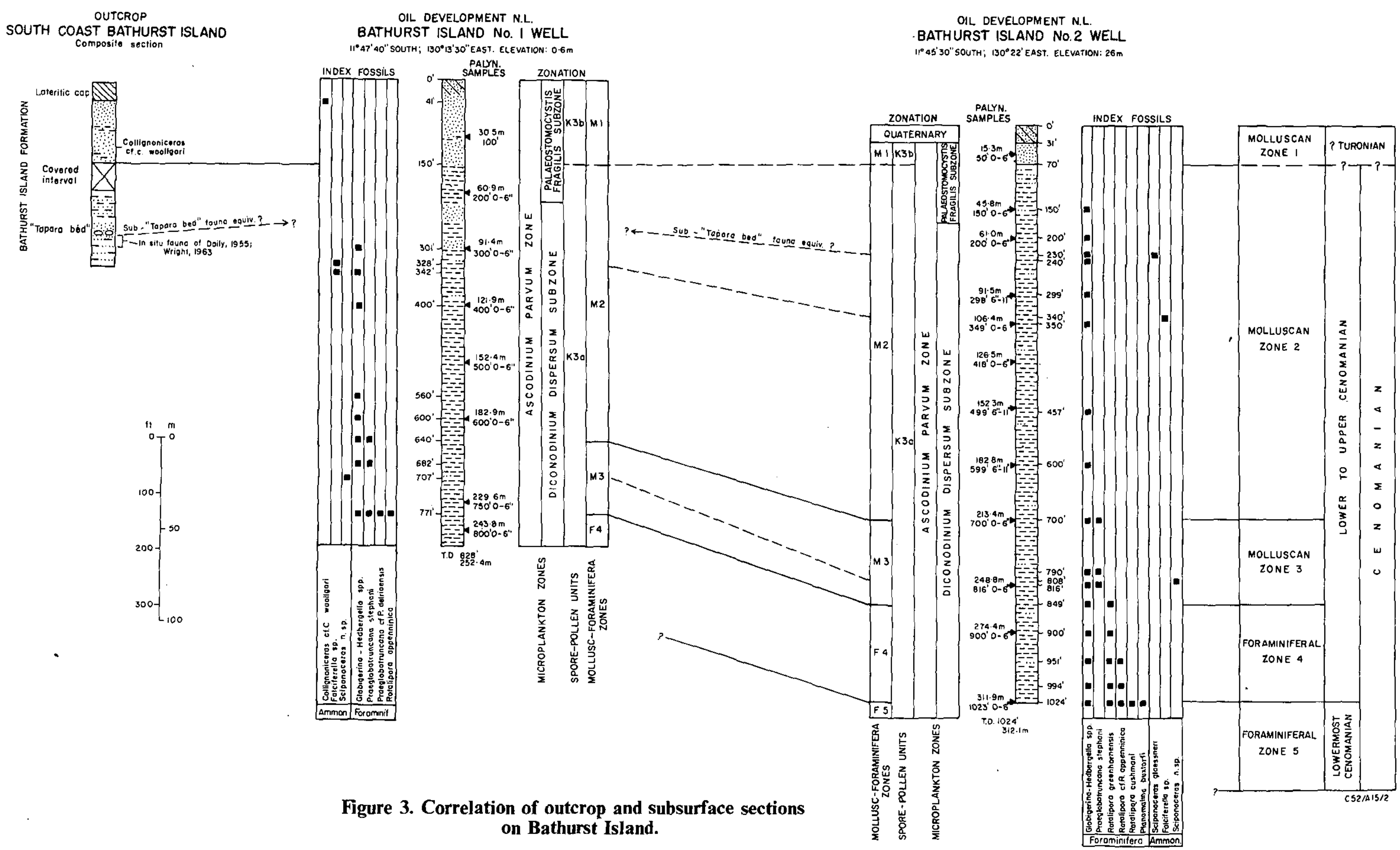

Figure 3. Correlation of outcrop and subsurface sections on Bathurst Island.

outside the islands. Towards the west, in the Bonaparte Gulf, the Cretaceous thickens markedly; almost 2000 m of Upper Cretaceous were penetrated in Petrel No. 1 well (Arco & AAP, 1969). To the south, however, in Lacrosse No. 1 well, the Cainozoic rests immediately on Triassic (Arco, 1969). Mesozoic sedimentation in this area was probably controlled by existing Palaeozoic or Precambrian structures (Caye, 1968).

Beneath the Northwest Shelf, southwest of the Londonderry Arch, thick sequences of Upper Cretaceous sediments lie in a series of probably fault-controlled grabens (Challinor, 1970; Kaye, Edmond, & Challinor, 1972). In the Browse Basin, sedimentation was continuous from the Early Jurassic to the mid-Cretaceous; this sequence is separated from overlying Senonian and Tertiary strata by an unconformity (Halse & Hayes, 1971).

Little is known about the rock sequence underneath the Arafura Sea, north of Bathurst and Melville Islands. Recent aeromagnetic and seismic surveys showed that the basement becomes considerably deeper northwards (Nicol, 1970). Lower Mesozoic and possibly Palaeozoic rocks wedge out beneath the higher Mesozoic to Cainozoic sediments about 100 km north of the islands. The eastern margin of the Arafura Basin is marked by the stable, cratonic Carpentaria Basin. In the Morehead Basin, the southern part of the Papuan Basin, and southern Irian Jaya, Cainozoic carbonate strata rest unconformably upon Lower Cretaceous clastics (APC, 1961; Visser & Hermes, 1962; also unpublished information). So far, there is no evidence of the presence of younger Mesozoic sediments in these areas. The Upper Cretaceous reappears as a thick marine sequence in the folded zone of Irian Jaya and the New Guinea Highlands farther north (Davies et al., 1972).

In the Eromanga Basin, central Queensland, a thick nonmarine sequence (Winton Formation) of restricted lateral extent rests conformably upon marine upper Albian strata. This sequence is poorly dated because of lack of faunal evidence; indirect palaeontological and palynological information suggests that the Winton Formation may be of Cenomanian age (Vine & Day, 1965; Burger, 1970, 1973b). Detailed spore-pollen study of the formation is in preparation.

THE MICROPLANKTON ZONATION

The dinoflagellate cysts and acritarchs from the 17 core samples of the Bathurst Island wells are described in detail below. A total of 120 species and species groups were identified (104 dinoflagellates and 16 acritarchs), of which 78 were named (including 8 new species and 17 questionable identifications). The remaining 42 species and species groups were either poorly characterized (particularly the acritarchs) or very rare, and have not been formally named at specific level.

The vertical distribution of microplankton species is shown in Text-fig. 8 (after p. 20). In general the assemblages are quite uniform throughout the succession. Relatively few forms have a sufficiently limited stratigraphic range or occur in sufficient numbers to be of use for subdivision of the well sections. Only five previously described species have well defined top limits within the succession, and most of the base ranges shown in the Figure represent rare or questionably identifiable forms. For these reasons the zonal subdivision of the microplankton floras has been kept to a minimum and the unit boundaries are defined upon the tops of ranges of selected species.

The whole succession in the Bathurst Island wells is placed within a single unit, the *Ascodinium parvum* total range Zone. This is divisible into the *Diconodinium dispersum* partial range Subzone below and the *Palaeostomocystis fragilis* partial range Subzone above. In No. 1 well, the subzone boundary falls between the samples at 61.0 m, MFP. 4449, and 91.4 m, MFP. 4455. In No. 2 well, it is placed below 45.8 m, MFP. 4439, and above 61.0 m, MFP. 4438. Thus the *Palaeostomocystis fragilis* Subzone is identified in the top two samples in each borehole, and the *Diconodinium dispersum* Subzone occupies the remaining section to total depth.

The *Ascodinium parvum* Zone was first described by Evans (1966a) in the Otway Basin, where it marks the onset of marine deposition. Its definition remains unchanged, but this study has slightly extended its age, so that it now includes sediments dated on foraminiferal and ammonite evidence as lowermost Cenomanian to lower Turonian. The unit is a total range zone, whose upper and lower limits coincide with those of the nominate species. In the Otway Basin, Evans described the occurrence of *Ascodinium parvum* associated with *Odontochitina operculata*, *Hystrichodinium* cf. *H. oligacanthum*, *Palaeohystrichophora infusorioides*, and *Ascodinium serratum*. *Hystrichodinium* cf. *H. oligacanthum*, *Ascodinium serratum*, and the contemporaneous Otway Basin species *Deflandrea acuminata* have not been identified in Bathurst Island, but the other forms occur in rich assemblages dominated by *Cyclonephelium* spp., *Diconodinium* spp., *Cribroperidinium* spp., *Odontochitina* spp., and a variety of chorate cysts. Since the base of the *Ascodinium parvum* Zone was not penetrated by the Bathurst Island wells, the criteria for its differentiation from Evans' (1966b) late Albian *Odontochitina operculata* Zone can only be discussed by comparison with other areas.

In the Great Artesian and Papuan Basins, microplankton associations typical of the *Odontochitina operculata* Zone include the nominate species, together with *Cribroperidinium edwardsii*, *Chlamydophorella nyei*, *Diconodinium* spp., and many unclassified chorate cysts (Evans, 1966b; Burger, 1968a, b). *Ascodinium parvum* is not present. The base of the *O. operculata* Zone is defined immediately above the final appearance of *Muderongia tetracantha* and the zone is correlated with palynological units K2b and K2c (Burger, 1973b). In the southern part of the Papuan Basin, it is topped by a regional unconformity (APC, 1961), but in Queensland sedimentation continued into the Cenomanian. However, most of these strata (the Winton Formation and its equivalents) are nonmarine, and the microplankton record finishes before the incoming of *Ascodinium parvum*.

Although the type areas of the *Ascodinium parvum* and *Odontochitina operculata* Zones are widely separated and no section through their contact has yet been studied, they nevertheless provide a useful vehicle for distinguishing late Albian assemblages from those of early Late Cretaceous age. In contrast with the *Odontochitina operculata* Zone in Queensland, the lower samples from Bathurst Island have a much more diverse microflora and mark the incoming of a large number of species. Contemporaneous microplankton floras which are considerably richer than those from Queensland are known from the Albian of Western Australia (chiefly from the work of Cookson & Eisenack, 1958, 1960a, 1962a; Eisenack & Cookson, 1960; Edgell, 1964), Europe, and North America (see p. 22 for a complete list of references). At present the zonation used here cannot be fully correlated with these other areas, but it seems that the earliest appearance of *Ascodinium parvum* is in the lowermost Cenomanian of Bathurst Island. Two further Bathurst Island species, *Palaeohystrichophora infusorioides* and *Prolixosphaeridium conulum*, are known from a slightly lower level (uppermost Albian or Vraconian) in Europe (Davey & Verdier, 1973). In addition, eight taxonomically new species occur prolifically throughout the succession, although further study in other areas may extend their downward range.

These are:

Tanyosphaeridium salpinx	*Valensiella griphus*
Adnatosphaeridium uncinatum	*Exochosphaeridium cenomaniense*
?*Ovoidinium fragile*	*E. brevispinum*
Membranosphaera granulata	*Cribroperidinium cooksonae*

The *Odontochitina operculata-costata* group occurs in both the late Albian and throughout the *Ascodinium parvum* Zone but undergoes a probably gradational change at the base of the latter. Thus in the Albian of Queensland the *O. operculata* end member predominates, whereas in the Bathurst Island samples the *O. costata* type (= *O. striatoperforata* of Cookson & Eisenack, 1962a) is much more abundant. There is no record of this change outside eastern Australia and Papua, so at present it cannot be used with confidence for stratigraphic purposes.

The lower of the two subzones provisionally recognizable in Bathurst Island, the *Diconodinium dispersum* partial range Subzone, is defined as the partial overlap between the range of the nominate species and that of *Ascodinium parvum.* Two abundant species, *Canninginopsis denticulata* and *Diconodinium dispersum*, have top ranges at the upper limit of the unit; and the highest occurrences of *Pseudoceratium ludbrookae* and *Prolixosphaeridium conulum* lie just below this level. All these forms have a previously documented Albian to Cenomanian record. The base of the subzone is taken at the incoming of *Ascodinium parvum* and thus could not be fully examined in this study. The unit is at present dated as early to late Cenomanian. The *Palaeostomocystis fragilis* partial range Subzone is defined as the interval between the final appearance of *Diconodinium dispersum* and *Canninginopsis denticulata* and the top ranges of *Ascodinium parvum* and *Palaeostomocystis fragilis.* It includes strata independently dated as late Cenomanian and early Turonian.

Many common species range right to the top of the Bathurst Island sections. Certain of these have not been recorded in strata younger than early Turonian, the most important being

Ascodinium parvum	*Gonyaulacysta cassidata*
Palaeostomocystis fragilis	*Cribroperidinium muderongensis*
Chlamydophorella nyei	*Hystrichosphaeridium difficile*
Psaligonyaulax deflandrei	*Cleistosphaeridium polypes*
Litosphaeridium siphoniphorum	*Cassiculosphaeridia reticulata*
	and several new species.

The upper range limits of these forms are provisionally used here to define the top of the *Ascodinium parvum* Zone. Also disappearing during the early Turonian in the Australian region is the *Odontochitina operculata-costata* group, although in Europe and North America it continues at least to the end of the Campanian (Wilson, 1971; Zaitzeff & Cross, 1970). *Cyclonephelium vannophorum* is restricted in Bathurst Island to the upper part of the section. However, in England it has been found only in uppermost Albian and lower Cenomanian strata (Davey, 1969a; Davey & Verdier, 1973).

By comparison with the early and mid-Cretaceous, relatively little is known about the stratigraphic ranges of Australian late Turonian to Senonian microplankton. In the Otway Basin, Evans' (1966a) *Ascodinium parvum* Zone is topped by an unclassified interval, which Dettmann & Playford (1969) tentatively dated as late Turonian to early Coniacian. Following this is a succession of units based upon the ranges of species of *Deflandrea* and its allies, beginning with Evans' *Deflandrea cretacea* Zone (late Coniacian to early Santonian according to Dettmann & Playford). These assemblages differ from that of mid-Cretaceous age in lacking many of the species described from Bathurst Island. New elements occurring in these units in southeastern and Western Australia include several species of *Dinogymnium* and *Deflandrea* (plus the related genera *Xenikoon*, *Nelsoniella*, and *Amphidiadema*), together with *Litosphaeridium striatoconus*, *Odontochitina cribropoda*, *O. porifera*, and *Hexagonifera vermiculata.* None of these forms is present in Bathurst Island, and the top of the section probably lies not far below the summit of the *Ascodinium parvum* Zone.

The relationships between the microplankton zonation utilized here and various other schemes of subdivision are shown in Figure 4. The *Ascodinium parvum* Zone equates with spore-pollen units K3a and K3b. The *Palaeostomocystis fragilis* Subzone includes unit K3b and the upper part of unit K3a. The nature of the spore-pollen units and their correlation with the palynological zonation of Dettmann & Playford are discussed in detail in the next chapter.

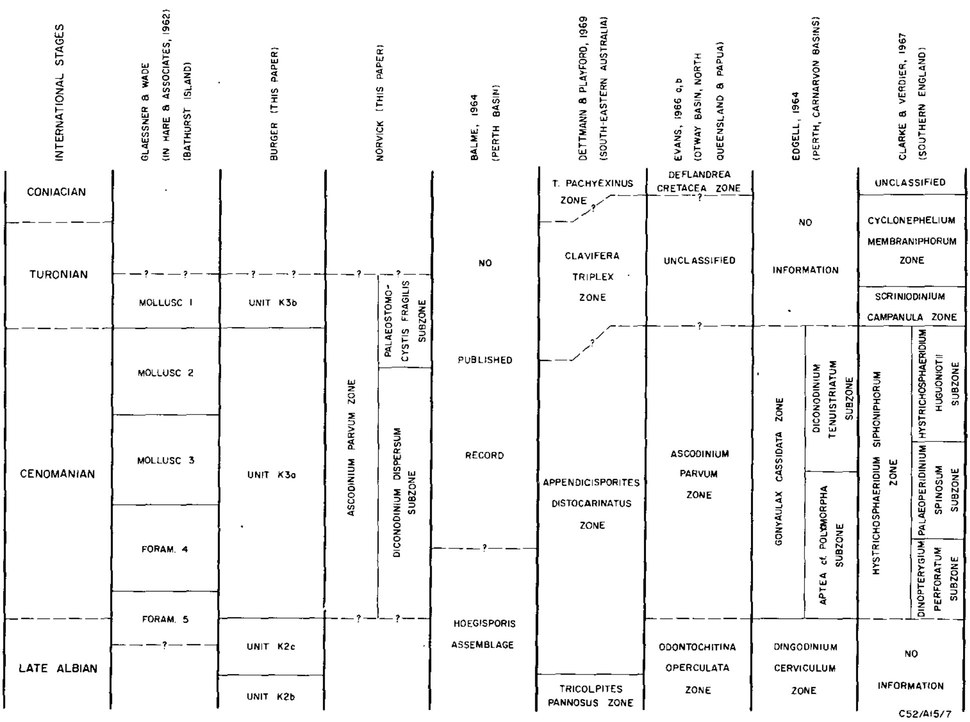

Figure 4. Correlation of Cretaceous microfloral zonations in Australia and England.

In their monographic series of papers on the Mesozoic microplankton of the Australian region, Cookson, Eisenack and Deflandre did not put forward any formal zonal systems (see p. 22 for a full set of references). They grouped their assemblages in terms of rock units which they related to the European stage nomenclature, using the correlations of McWhae et al., 1958 (Western Australia); Sprigg et al., *in* Glaessner & Parkin, 1958 (South Australia); Brunnschweiler, 1954, 1959 (South and Western Australia); Walkom, 1919 (Queensland); and others. Of the 54 previously described species occurring in the *Ascodinium parvum* Zone of Bathurst Island, 43 were recorded from upper Albian, Cenomanian, and lower Turonian strata from various parts of Australia. Much more work remains to be done before these assemblages can be fitted into a continent-wide stratigraphic framework. However, particularly comparable with those from Bathurst Island are the microplankton associations described from the Osborne Formation of the Perth Basin (probably Albian to Cenomanian); the upper part of the Gearle Siltstone in the Carnarvon Basin (Cenomanian to lower Turonian); and the lower part of the Madura Shale in the Eucla Basin (Albian-Cenomanian).

Edgell's (1964) microplankton zonation of Cretaceous strata in the Perth Basin also conforms with the present scheme in a general way. He dated his *Gonyaulax* *cassidata* Zone, which includes the whole of the Osborne Formation, as Cenomanian on foraminiferal evidence. Characteristic species for this zone are:

Gonyaulacysta cassidata
Cribroperidinium edwardsii
Trichodinium castanea
Codonia campanulata.

All except the last are common in Bathurst Island. In his lower division of the zone, the *Aptea* cf. *A. polymorpha* Subzone, he found, in addition to the nominate species:

Pterodinium cornutum
P. magnoserratum
Cyclonephelium membraniphorum.

Only *C. membraniphorum* occurs in Bathurst Island; it is common in nearly all samples (i.e. throughout most of the Cenomanian).

Characteristic species in Edgell's upper division, the *Diconodinium tenuistriatum* Subzone, included:

*Diconodinium tenuistriatum**
*D. inflatum**
Ascodinium acrophorum
Xiphophoridium alatum
Microdinium ornatum
Odontochitina striatoperforata (= *O. costata* in this study)
Pseudoceratium ludbrookae
Stephodinium australicum (= *S. coronatum*)*
*Ginginodinium spinulosum***
*Lecaniella margostriata***
*L. dictyota***
*Schizocystia rugosa***
*S. laevigata.***

(*cf. determination in Bathurst Island, **not present in Bathurst Island.)

His assemblages indicate that the *Gonyaulax cassidata* Zone is probably a correlate of the *Ascodinium parvum* Zone. However, his two subzonal associations are based on species which either range throughout the succession or are restricted to differing parts of the Bathurst Island sequence. Consequently they cannot be equated with our subzones.

Clarke & Verdier (1967) put forward a zonation of the southern English Late Cretaceous based on microplankton, which can be correlated in broad terms with eastern Australia. Their *Hystrichosphaeridium siphoniphorum* concurrent range Zone and *Scriniodinium campanula* assemblage Zone together probably equate with the *Ascodinium parvum* Zone on Bathurst Island. The earliest Cenomanian to ?Turonian *H. siphoniphorum* Zone was defined on the first occurrence of *Palaeohystrichophora infusorioides* and its top was marked by the disappearance of, among others, the nominate species, *Psaligonyaulax deflandrei* (= their *Gonyaulax extensa*) and *Hystrichosphaeridium huguoniotii* (a form very closely related to our *Cleistosphaeridium anchoriferum*). *Odontochitina costata* occurs for the first time just above the base. The succeeding ?Cenomanian to Turonian *Scriniodinium campanula* Zone includes several characteristic species also present in Bathurst Island, particularly *Xiphophoridium alatum, Cyclonephelium hughesii* (cf. determination in Bathurst Island) and *C. membraniphorum.* Unfortunately the subzones which Clarke & Verdier describe from within their *H. siphoniphorum* Zone cannot be positively identified in Australia.

Davey (1970) examined Cenomanian microplankton assemblages from a number of localities in Europe and North America and found that certain species have widely applicable stratigraphic limits. His investigations in southern England and northern France indicated that *Ovoidinium scabrosum, O. verrucosum, Gonyaulacysta fetchamensis,* and *Cleistosphaeridium polypes* var. *clavulum* did not occur above the lowermost Cenomanian, although all are known from older strata. None of these forms has been identified from Bathurst Island, and later work by Davey & Verdier (1973) suggests that this horizon is uppermost Albian (Vraconian) in age. Davey also agreed with Clarke & Verdier (1967) in that he was able to define the base of the Cenomanian on the first appearance of *Palaeohystrichophora infusorioides,* and its top on the final occurrence of *Cleistosphaeridium hugoniotii.* He noted that *Litosphaeridium siphoniphorum* occurred throughout the Cenomanian but was not present in his Albian or Turonian samples.

Recent work by Davey & Verdier (1971, 1973) has now altered and refined our knowledge of the stratigraphic limits of fossil microplankton at the Albian-Cenomanian boundary. They investigated Albian, uppermost Albian (Vraconian), and basal Cenomanian sections in France, which had been independently dated by means of ammonites and planktonic foraminifera. Their results showed that certain common Cenomanian forms found in Bathurst Island also occur in the late Albian. These include *Litosphaeridium siphoniphorum,* which had previously been thought to be restricted to the Cenomanian. In the latest Albian (Vraconian), species which appear for the first time and which are also known from Bathurst Island include *Exochosphaeridium pseudhystrichodinium, Palaeohystrichophora infusorioides, Cyclonephelium vannophorum, C. hughesii* (cf. in Bathurst Island), *Prolixosphaeridium conulum,* and *Odontochitina costata.* They noted the disappearance of *Astrocysta cretacea* during the Vraconian, but forms tentatively identified with this species also occur in the Bathurst Island samples. From these studies it is apparent that the Bathurst Island assemblages contain no European basal Cenomanian marker species. All our Cenomanian first appearances are either new taxa or are so far only known from Australia.

One very interesting point was raised by Davey (1970), when he compared assemblages from Europe and North America. He found that the microfloras from southern England, northern France, and Texas (USA) were all dominated by chorate cysts; whereas contemporaneous assemblages from Canada were dominated by species of *Deflandrea.* The two groups of localities had relatively few species in common, although all the Texan species were also known from Europe. Previous work showed that *Deflandrea*-dominated Cenomanian microfloras also occur in northern Germany, Arctic Canada, and eastern Australia (unspecified localities). Davey concluded that the *Deflandrea* assemblages were restricted to a cold-water, Boreal biogeographic province; while those dominated by chorate cysts only occurred in a warm-water, Tethyan province. He related the spinose morphology of the chorate cysts to decreased water density and correspondingly faster sinking rates in the warmer water of low palaeolatitudes. The Bathurst Island floras have a high proportion of chorate cysts, and members of the *Deflandrea* group are relatively rare. Using Davey's hypothesis, Bathurst Island was well within the boundaries of his warm-water province. In contrast, the assemblages described by Cookson & Eisenack (1970a, 1971) from the mid-Cretaceous of the Eucla Basin contain abundant *Deflandrea* and are possibly indicative of colder water conditions.

THE SPORE-POLLEN ZONATION

The palynological sequence, as compiled from well preserved and richly varied microfloral assemblages from Bathurst Island Nos. 1 and 2, includes 61 species of spores and pollen grains (Text-fig. 9, after p. 20) of stratigraphic value in the study of the mid-Cretaceous. The component species are described later. From the results of Senior & Hughes' (1973) work, it can be deduced that the parent vegetation lay farther to the north.

The sequence can be subdivided into two intervals, of which the boundaries are defined by limits of ranges of selected spore and pollen types. No formal nomenclature is yet proposed for these intervals, as it is not known if they will be recognized elsewhere. At present they are referred to as palynological units and symbolized according to Evans' (1966c) palynostratigraphic scheme, in which the Cretaceous units are defined by a prefix K, and numbered in stratigraphic succession (Evans, 1966a; Burger, 1968a, b; 1973a).

Burger (1973b) recognized in the upper Albian sediments of the Carpentaria Basin, Queensland, a spore interval, unit K2c, which represents a strongly transitional stage at the close of the Early Cretaceous, in that it contains the upper limits of the ranges of Aptian-Albian species, such as *Pilosisporites notensis, P. parvispinosus, P. grandis, Lycopodiumsporites circolumenus, Contignisporites cooksonae, C. fornicatus, Leptolepidites major, L. verrucatus, Trilites* cf. *T. tuberculiformis, Foraminisporis dailyi, Matonisporites cooksonae, Aequitriradites verrucosus, A. spinulosus, Triporoletes radiatus, Baculatisporites comaumensis, Osmundacidites wellmanii.* It also contains the earliest occurrence of Late Cretaceous forms, such as *Clavifera triplex, Crybelosporites* cf. *C. brenneri* (BMR species no. 1129), and *Liliacidites* cf. *L. kaitangataensis* ('*Dicolpopollis* sp.', BMR species no. 1121).

Of the 80 to 90 spore and pollen species regularly occurring in the late Albian of Queensland, only about 40 species were found in the Bathurst Island sequences. The occurrence of some significant species is shown in Text-figure 5. At the onset of the Cenomanian (within Zone F5), about 13 species enter the sequence. The transition from Albian to Cenomanian may regionally not be as pronounced as would seem from Figure 5, as the distribution of the dispersed pollen was probably geographically limited. However, gleichenaceous spores and angiospermous pollen grains, which are among the most common forms in the Bathurst Island sequence, have been observed to increase at the onset of the Late Cretaceous throughout eastern Australia, and in the coastal basins of Western Australia (Balme, 1964). It is clear that we have to do with a major change in the floristic record.

Those species regarded as the most important stratigraphic markers are:

Triporoletes laevigatus	*Antulsporites varizonatus*
Asteropollis asteroides	*Ornamentifera minima*
	Herkosporites proxistriatus.

The level of their first appearance is here taken as the lower limit of palynological unit K3a. The unit was identified in No. 1 well in the 243.8-61.0 m interval, and in No. 2 well in the 311.8-45.7 m interval; it coincides approximately with Zones F5 to M2, and is thus entirely of Cenomanian age.

Common species in the unit are:

Appendicisporites distocarinatus	*Cyathidites* spp.
Stoverisporites microverrucatus	*Microcachryidites antarcticus*
Perotrilites oepikii	*Camarozonosporites australiensis*
Clavifera triplex	*Laevigatosporites ovatus*
Gleicheniidites circinidites	*Stereisporites antiquasporites*
	Microfoveolatosporis canaliculatus.

The unit contains probably the last occurrence of *Crybelosporites striatus.*

In the upper part of the unit (Zone M2) a few forms such as *Senectotetradites fistulosus, Vallizonosporites* sp., *Ephedripites* spp., *Stereisporites* sp. appear, and also some isolated, unidentified forms assigned to the genus *Liliacidites*, whose geographical and stratigraphic distribution is not known.

The upper limit of unit K3a is characterized by the disappearance of *Perotrilites majus, Foraminisporis asymmetricus,* and *Trilobosporites trioreticulosus*. These species also disappear in the basal Upper Cretaceous of the Otway Basin, in Dettmann & Playford's (1969) *Appendicisporites distocarinatus* Zone. The upper limit of unit K3a seems to coincide with the tops of the ranges of *Ceratosporites equalis*, *Perotrilites jubatus*, *Clavatipollenites hughesii*, *Antulsporites varizonatus*, and some other less common species.

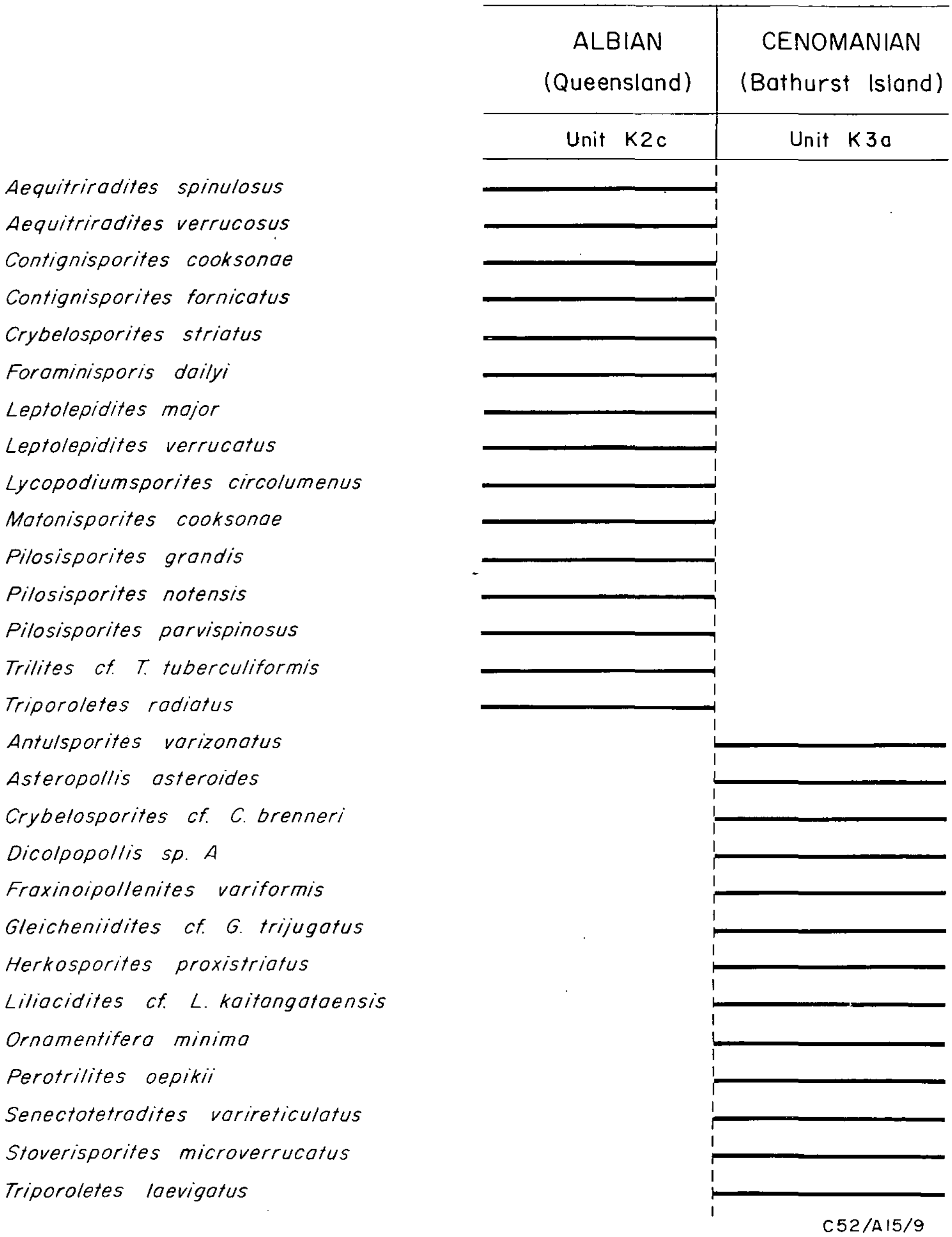

Figure 5. Approximate limits of ranges of spores and pollen species at the Albian-Cenomanian boundary in northern Australia.

The succeeding interval, unit K3b, is distinguished in No. 1 well at 30.5 m and in No. 2 well at 15.2 m. Its lower limit approximately coincides with that of Zone M1, and the unit is thus possibly of Turonian age. The presence of *Balmeisporites tridictyus* and *B. glenelgensis* is of uncertain significance, as the ranges of these species are poorly documented in northern Australia. *B. glenelgensis* occurs in the Late Cretaceous of Victoria (Cookson & Dettmann, 1958) and South Australia (Dettmann & Playford, 1969) and *B. tridictyus* in the Albian of those areas (Cookson & Dettmann, 1958a, b; Dettmann, 1963). Neither species is known from the Early Cretaceous of Queensland.

Unit K3b lacks *Classopollis* sp., *Ornamentifera minima*, and various other species mentioned above. At present the upper limit of the unit must remain undefined.

Table 2: Quantitative representation of major formgroups in spore-pollen assemblages (based on counts of 200 specimens per sample).

		1	2	3	4	5	6	7
Bathurst Island 1	core 1	30	2	22	13	20	4	9
	core 2	34	4	24	11	14	3	9
	core 3	30	5	30	16	9	4	6
	core 6	36	1	33	18	8	—	4
	core 8	36	3	40	10	7	1	3
Bathurst Island 2	core 1	39	5	17	11	17	2	9
	core 2	21	5	16	10	10	29	9
	core 3	30	7	21	21	9	7	5
	core 4	34	7	34	13	8	1	3
	core 5	34	2	35	20	5	1	3
	core 6	35	5	36	14	6	1	3
	core 7	39	1	29	19	6	2	4
	core 8	39	1	26	24	5	1	4
	core 9	40	1	33	23	2	—	1
	core 10	42	4	30	17	5	1	1
	core 11	42	5	27	3	10	10	3
	core 12	41	4	31	9	10	1	4

1 : Cyathidites-Gleicheniidites-Clavifera
2 : Appendicisporites-Cicatricosisporites
3 : Other trilete forms
4 : Monoletes
5 : Saccates-Hilates-Monosulcates-Inaperturates
6 : Classopollis
7 : Remainder of Angiosperms

In both qualitative and quantitative senses, the two well sections display closely comparable and rather monotonous developments (Table 2, fig. 6). The spore-pollen fraction in the strew mounts increases slightly from about 30% of the entire assemblages in the lower part of unit K3a to 50-60% in unit K3b. Within the spore-pollen fraction, taken at 100%, the group of *Cyathidites-Gleicheniidites* remains fairly constant between 30% and 45%. The Schizaeaceae are about 5% in the lower part of unit K3a, then dwindle to about 1% and increase up to 7% in the upper part of the unit and in unit K3b. The rest of the Triletes are 25-40% of the total spores and pollen in much of unit K3a, and are reduced at the upper limit of the unit and in unit K3b to 17-22%.

The Monoletes, of which *Laevigatosporites ovatus* is the most common form, increase rapidly from 4-9% in the lower part of unit K3a to about 20% in the middle part. In the upper part of the unit and in unit K3b, the group gradually decreases to 10-13%. The group of Saccates, Hilates, etc., of which *Microcachryidites antarcticus* forms the major component, gradually increases from 6-11% in unit K3a to 16-20% in unit K3b.

The *Classopollis* group fluctuates between 1 and 7 %, with a brief disappearance in the middle part of unit K3a (Zone M2), and displays two major oscillations in the sequence of No. 2 well, one in the lower part of unit K3a (at 275 m), reaching to 10% of the total assemblage, and one at the upper limit of the unit (at 45 m), reaching to not less than 39% of the total microflora. The first fluctuation takes place entirely at the expense of the Monoletes group; the other groups are not notably affected. The second fluctuation is much more intense and causes a brief relapse in the *Cyathidites-Gleicheniidites* graph.

Finally, the group of angiosperms (mainly Tricolpatae) gradually increases from 1-4% in the lower part of unit K3a to 9-10% in unit K3b.

No sudden oscillations of the *Classopollis* abundance are apparent in No. 1 well; here the sequence does not reach the stratigraphic level of the first oscillation in No. 2 well. The sampling in the upper part of unit K3a may have been insufficient to record a second oscillation, although the *Classopollis* graph shows a considerable increase in that part of the sequence.

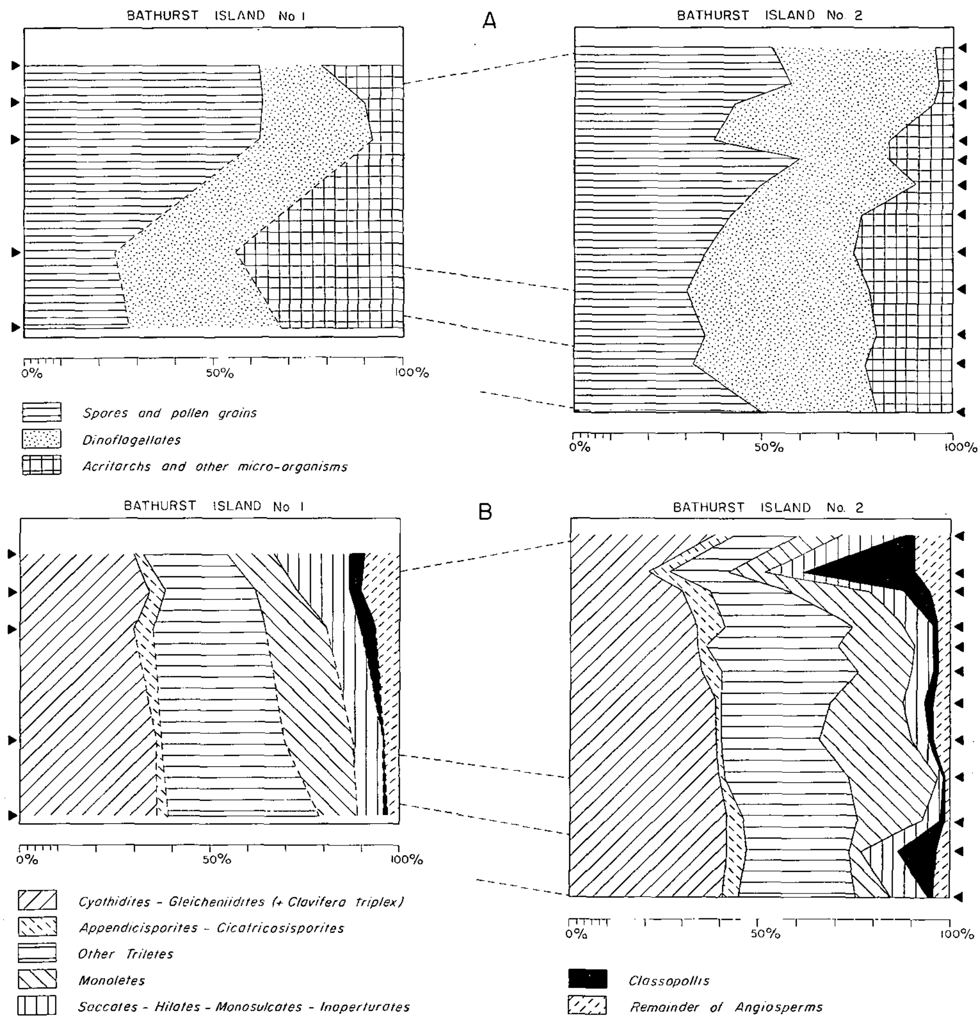

Figure 6(a). Overall composition of microfloral assemblages (based on count of 100 specimens per sample). (b). Quantitative representation of major formgroups in spore-pollen assemblages (based on count of 200 specimens per sample).

These fluctuations cannot yet be explained comprehensively. *Classopollis* is often considered to have been shed by abundantly pollen-producing lowland or coastal (arid?) plants (Pocock, 1962; Burger, 1966) with coniferous affinities, such as *Pagiophyllum connivens, Cheirolepsis muensteri, Brachyphyllum scotti,* and *B. expansum* (Reissinger, 1950; Couper, 1958; Pocock & Jansonius, 1961; Barnard, 1968). It is imaginable that, owing to shifting coast lines, coastal vegetation, in which these plants were well represented, temporarily established itself in the vicinity of the location of No. 2 well. Pollen sedimentation of *Classopollis* would then locally increase well beyond the proportion of abundance of the parent plant itself. This would be manifested as a peak in the *Classopollis* graph in a diagram of the type shown in Figure 6.

This explanation is based on the assumption that the diagrams reflect genuine mutations in time of the parent vegetation. It cannot be maintained if Burger's (p. 144) suspicion that *Classopollis* sp. (BMR species no. 337) is not a genuine component of the spore-pollen assemblages, but is of secondary origin, is correct. In that case this species should not be included in the *Classopollis* graph; the fluctuations of *C. simplex* would not exceed those of statistical variations.

On the whole, however, the graphs, which span an estimated five to ten million years, present a rather monotonous picture. The vegetation must have evolved without abrupt or major changes, and therefore, presumably, in a stable climate. The relative abundance and diversity of Gleicheniaceae and Schizaeaceae, and a gradual decrease of *Microcachryidites antarcticus* since the Neocomian and Aptian, indicates a climate decidedly mild in comparison with that during the Aptian (see Day, 1969; Dettmann & Playford, 1969). This is supported by examination of foraminifera from near total depth in the Bathurst Island wells, which by their affinity to the Tethys faunas indicate warm environments (M. Owen, pers. comm.).

COMPARISON OF PALYNOLOGICAL ZONATIONS IN AUSTRALIA

Dated Cenomanian deposits are at present known from Victoria, South Australia, Western Australia, and Papua New Guinea. Nonmarine Cenomanian complexes (Winton Formation, Eromanga Basin) are known from Queensland. Our knowledge of the palynology of this epoch is rapidly expanding. Dettmann (1973) studied Cenomanian and Turonian pollen from the eastern Australian region, including Bathurst and Melville Islands.

From Western Australia, Balme (1964) described a microflora (his *Hoegisporis* Assemblage) from the ?Albian-?Cenomanian Osborne Formation, Perth Basin. Characteristic is the presence of *Hoegisporis uniforma* and *Amosopollis cruciformis,* plus the abundance and diversity of the group of *Gleicheniidites.* Common forms are *Inaperturopollenites limbatus* and *Microcachryidites antarcticus; Cicatricosisporites australiensis* and *Perotrilites* spp. are scarce. *H. uniforma* occurs in upper Albian and Cenomanian strata of northern Australia. *A. cruciformis* has not been observed either in the Albian of the Great Artesian Basin, or in Bathurst Island.

Dettmann & Playford (1969) described from the mid-Cretaceous in southeastern Australia (Otway, Gippsland, and Great Artesian Basins), in ascending order, their *Tricolpites pannosus* Zone, *Appendicisporites distocarinatus* Zone, and *Clavifera triplex* Zone. In the Great Artesian Basin, Queensland, palynological unit K2b, of late Albian age, was recognized as the northern extension of the *Tricolpites pannosus* Zone (Burger, 1973b). The *Appendicisporites distocarinatus* Zone contains the nominate index species, and includes the final occurrence of *Trilobosporites trioreticulosus, Perotrilites majus,* and *Balmeisporites holodictyus.* The *Clavifera triplex* Zone contains, except for *C. triplex,* also *Phyllocladidites mawsonii,* and lacks *A. distocarinatus* (Dettmann & Playford, op. cit.).

Unfortunately, from the distribution of these species in Bathurst Island and in Queensland (Burger, 1973b) these zones cannot be recognized as such in northern Australia. Unit K2c contains *Clavifera triplex,* but cannot be compared with the *Clavifera triplex* Zone, as it includes many species which had disappeared in the Upper Cretaceous of eastern Australia before the start of the zone. Unit K2c can very probably be correlated with part of the *Appendicisporites distocarinatus* Zone (Fig. 7).

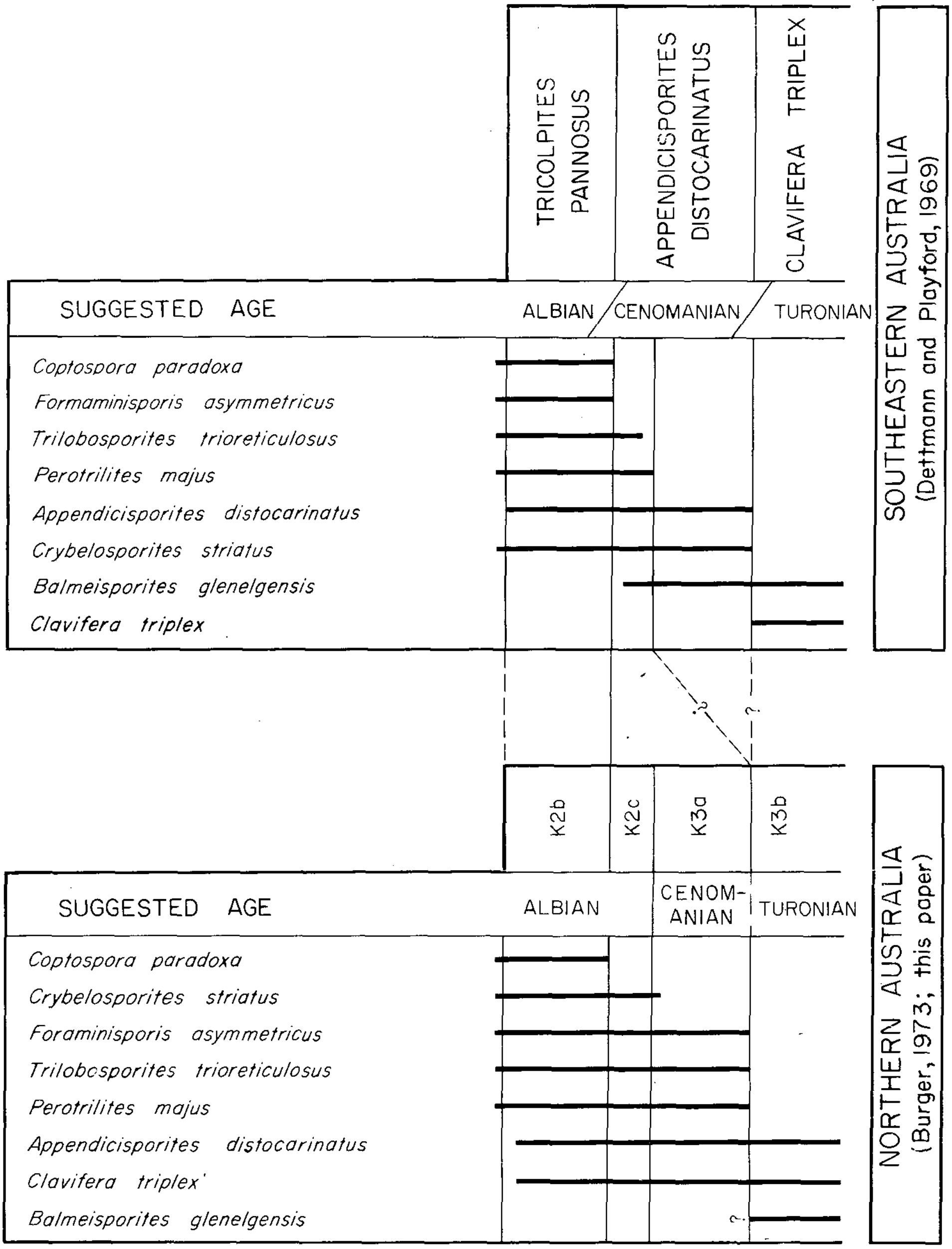

Figure 7. Comparison of documented ranges of key fossils in southeastern and northern Australia.

It is not certain whether microfloras equivalent to the *Clavifera triplex* Zone are present in the Bathurst Island sequence. Dettmann & Playford (1969) assumed a Turonian or possibly Cenomanian age for the lower limit of the zone. Species such as *Trilobosporites trioreticulosus* and *Perotrilites majus*, the tops of whose ranges lie within the *Appendicisporites distocarinatus* Zone (Dettmann & Playford, op. cit.), do not appear to extend into unit K3b in Bathurst Island. Species such as *Triorites minor, Stephanoporopollenites obscurus,* and *Phyllocladidites mawsonii* occur in the *Clavifera triplex* Zone in southeastern Australia, and Dettmann (1973) reported *T. minor* and other representatives of the genus from outcrop samples collected in Bathurst Island. However, none of these species has been observed in the Bathurst Island wells. This may indicate that the microfloras from unit K3b are slightly older than this zone. It seems likely, therefore, that units K2c and K3a represent the northern extension of the *Appendicisporites distocarinatus* Zone, and that unit K3b, in view of its geological age, represents an interval very near the lower limit of the *Clavifera triplex* Zone (Fig. 7).

CONCLUSIONS

Detailed comparison between the Bathurst Island microplankton assemblages and those described from overseas mid-Cretaceous reveals that of the 54 previously described dinoflagellate and acritarch species definitely identified, 12 appear to be exclusively Australian, and 42, i.e. 78 percent, are known from the mid-Cretaceous overseas. The bulk of these records are from Europe and North America, possibly because more detailed work has been done in these areas. Pre- and post-Cenomanian microplankton microfloras from Australia are probably also closely comparable with those from overseas. The conclusion reached is that in the Cretaceous oceans the dinoflagellate and acritarch populations were essentially the same world-wide, in many cases even down to specific level.

Of the 63 species documented and described in the spore-pollen assemblages from Bathurst Island, 60 occur in the Cenomanian (unit K3a). Of these, 48 species were found with sample frequency of more than 25 percent (i.e. occurring in more than 4 of 17 samples), which is here taken as a minimum limit of frequency to be of any value stratigraphically. In this group of 48 species, 16 (or 33%) are at present known only in Australia. In the group of (multi-aperturate) angiospermous species alone, of a total of 11 species 8 seem to be endemic according to the present record; this group thus appears rather restricted. The remainder of the Bathurst Island assemblages is more cosmopolitan. Of the total number of species, one-fifth is known concurrently from the mid-Cretaceous of North America, Europe, and the USSR (including Siberia). An additional 12 percent of the species are known from the Cretaceous of the USA and Canada alone.

The regional palaeogeographic picture is that of a very shallow regressive sea, with land towards the north and east (at the location of Cobourg Peninsula), covered by a lowland vegetation in a temperate to warm, possibly dry climate.

It is too early to seek analogies between the results of the present study and the fragmentary data so far collected from the nonmarine Cenomanian in Queensland. Differences in environment and evidence of diachronism with regard to the Winton Formation, Eromanga Basin, plus the common occurrence of reworked Lower Cretaceous pollen in the formation, present complications of which the full extent and nature need thorough study. Future scheduled work in the Cretaceous of the Darwin region is expected to bridge the geographical gap, and contribute towards a more cohesive history of the mid-Cretaceous of northern Australia.

Data on a larger scale can only be integrated at a future date, when results of Upper Cretaceous study in eastern Australia by Dr Mary E. Dettmann have been published.

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Oil Development N.L. granted permission to publish data on Bathurst Island Nos. 1 and 2 wells.

MID-CRETACEOUS MICROPLANKTON FROM BATHURST ISLAND

by

M. S. NORVICK

PREVIOUS WORK ON CRETACEOUS MICROPLANKTON

The earliest descriptions of fossil microplankton were published by Ehrenberg in 1838, on material from Upper Cretaceous flints from Denmark and north Germany. His technique of examining thin slivers of flint in transmitted light was followed by dinoflagellate research workers until the 1950s, when normal palynological maceration processes became more commonly used. Soon after publishing his account of the Baltic material, Ehrenberg visited England and presented a lecture at the Clapham Microscopical Society in London. Several members of the society, including Mantell, White, Reade, Deane, and Wilkinson, became interested in this work and began studying the microplankton from English flints of a similar age.

Interest in fossil microplankton lapsed for over eighty years until 1933, when O. Wetzel published descriptions and illustrations of Upper Cretaceous hystrichospherids from thin sections of flint from the Baltic area. Soon afterwards, Deflandre (1934, 1935, 1936a, b, 1937) began publishing his long series of monographic papers on Upper Cretaceous dinoflagellate cysts and acritarchs from northern France. Although Deflandre's specimens came from flint nodules and were not collected from in situ exposures, his work represents the first complete study of Upper Cretaceous assemblages and provided a valuable starting point for later workers.

Upper Cretaceous microplankton were first extracted from outcrop material by Firtion (1952). His samples came from the lower Cenomanian of northern France and contained dinoflagellate cysts, acritarchs, spores, and pollen grains. Many studies have been made in the subsequent two decades and the European literature has expanded at a considerable rate. From Germany, Eisenack (1958b) studied the Aptian, Gocht (1957, 1959) the Neocomian, and Alberti (1961) the Valanginian to Albian microplankton floras. Baltes (1963, 1965, 1967a, b) has described some Albian assemblages from Romania, and Gorka (1963) has studied the Upper Cretaceous microplankton of Poland. Studies on the English Cretaceous include those of Cookson & Hughes (1964) on the upper Albian and lower Cenomanian of Cambridgeshire, and Neal & Sarjeant (1962) on the Barremian and Hauterivian of Yorkshire.

In a recent series of papers, Davey (1969a, 1970) and Davey, Downie, Sarjeant, & Williams (1966a, see under individual authors) have described in detail dinoflagellate assemblages from the English Hauterivian, Barremian, Cenomanian, and lower Eocene strata and considerably revised their systematic nomenclature. Davey also studied material from the mid-Cretaceous of northern France, Canada, and the United States. Many of his species have also been found in Bathurst Island. An almost complete Upper Cretaceous (Cenomanian to Campanian) section from southern England was examined in detail by Clarke & Verdier (1967), primarily so as to establish a stratigraphic zonation based on the ranges of microplankton species (see p. 000). Their monograph appeared almost simultaneously with those of Davey et. al., and the resulting taxonomic duplications were dealt with in two publications; by Clarke, Davey, Sarjeant, & Verdier (1968) and Davey, Downie, Sarjeant, & Williams (1969).

The application of stratigraphic stage nomenclature, both locally and on an intercontinental scale, requires a thorough understanding of the fossils from the mainly European type sections. Consequently studies on the dinoflagellate floras from stratotype localities are of very great importance when Australian sections are correlated with the standard European stages. Five such investigations have been made: by Millioud (1967, 1969), on the stratotype Valanginian and Hauterivian of the Alps; by Wilson (1971), on the type sections of the Campanian, Maastrichtian and Danian in northern Europe; by Davey & Verdier (1971), on the Albian of the Paris Basin; and by Davey & Verdier (1973) on the Vraconian (uppermost Albian) of France.

Studies on Australian microplankton began with Deflandre & Cookson's papers (1954, 1955) on a number of Cretaceous and Tertiary assemblages. Their work has since been systematically revised by Verdier (1970). Between 1955 and the present time Cookson, usually in collaboration with Eisenack, has comprehensively described and illustrated the microplankton from many Australian Upper Mesozoic localities. Their assemblages came from the Oxfordian to probable Tithonian of the Canning Basin, the ?Callovian to Maastrichtian of the Carnarvon Basin, the Aptian to Senonian of the Perth Basin, the Albian or Cenomanian to Senonian of the Eucla Basin, the Senonian of the Otway Basin, the Lower Cretaceous (Aptian to Albian) of the Styx and Great Artesian Basins and the Upper Jurassic to Lower Cretaceous of the Papuan Basin (Cookson, 1956, 1965b; Cookson & Eisenack, 1958, 1960a, b, 1961, 1962a, b, 1968, 1969, 1970a, 1971; Eisenack & Cookson, 1960). They also examined the microplankton from a number of Tertiary localities, which do not directly concern this study. Other investigations, chiefly directed towards stratigraphic problems, include those of Evans (1966b), Burger (1968b, c, 1973a) and Haskell (1970), on the Lower Cretaceous of the Great Artesian and Papuan Basins; Douglas (1962) and Evans (1966a), on the Upper Cretaceous of the Otway Basin; Ingram (1968) on the Eucla Basin; and Edgell (1964) on the Perth Basin.

North American Cretaceous microplankton studies have been applied particularly to the problem of the Cretaceous-Tertiary boundary in the western half of the United States, and the early to mid-Cretaceous of the Canadian prairie provinces and the Canadian Arctic. In the first category are investigations on the uppermost Cretaceous and lowermost Tertiary of New Mexico (Anderson, 1960; subsequently revised by Sarjeant & Anderson, 1969), California (Drugg, 1967), South Dakota (Stanley, 1965), and the Gulf Coast (Leopold & Pakiser, 1964; Zaitzeff & Cross, 1970). The second group includes work by Pocock (1962), on the Upper Jurassic and Lower Cretaceous of the Canadian prairies; by Brideaux (1971) and Singh (1964, 1971), on the Lower Cretaceous of Alberta; and by Manum & Cookson (1964), on the mid-Cretaceous of Arctic Canada. Davey's (1969a, 1970) studies have been mentioned above. In addition Tasch, McClure, & Oftedahl (1964) described dinoflagellate cysts and acritarchs from the Albian of Kansas, Evitt (1961, 1967) figured a number of Upper Jurassic and Cretaceous forms from various localities, and Habib (1969, 1970) illustrated assemblages found in deep-sea cores from offshore of the United States eastern seaboard.

This is by no means a complete bibliography and additional references may be found in many of the above papers, particularly Davey (1969a, 1970), Davey et al., (1966a) and Clarke & Verdier (1967). Extensive bibliographies are also included in the species catalogues compiled by Norris & Sarjeant (1965), Downie & Sarjeant (1964), Eisenack & Klement (1964), Eisenack & Kjellström (1971), and Loeblich & Loeblich (1966, 1968, 1969, 1970).

CLASSIFICATION AND MORPHOLOGY

The fossil cysts of dinoflagellates have a well documented range from the Jurassic to the present day and are also known from marine sediments of Silurian and Permian age. Cysts and motile stages are abundant in modern seas and a few extant freshwater forms are also known. Until recently, studies on fossil and recent dinoflagellates were completely divorced from each other: neontologists have directed their efforts mainly to the motile stages and have built up a classification based on the cytological and morphological characters present in this part of the life cycle. One group, the order Peridiniales, includes most of the recognizable dinoflagellates known from the fossil record (excluding the acritarchs). In these, the biflagellate motile stage has a cell wall composed almost entirely of cellulose (Loeblich & Loeblich, 1966), which is seldom, if ever, preserved in the fossil state. Most of the Peridiniales pass through a encysted stage, resulting from poorly understood causes, such as the onset of unfavourable environmental conditions. The cyst wall usually is composed of a resistant organic material related to sporopollenin (a few forms with silica or calcite cysts are known), and this is the only part of the organism which the palaeontologist can study. Most of the known genera of dinoflagellates are now extinct and our knowledge of these forms is derived entirely from the fossilized cyst.

Consequently a quite separate classification has been developed by palaeontologists, using the morphological characters of the cyst. With a few notable exceptions (the genera *Spiniferites, Gonyaulax, Gonyaulacysta, Nematosphaeropsis,* and certain other forms), fossil species have been assigned to specially erected fossil genera, while extant species have received a quite different generic placing. It now seems probable that at least some of the fossil forms belong to the same biological taxon (be it at specific or generic level) as certain living dinoflagellates, and the present nomenclature differentiation is completely artificial. One point on which both phycologists and palaeontologists now agree is that dinoflagellates should be treated under the rules of the International Commission for Botanical Nomenclature.

At present there is no completely satisfactory suprageneric classification which includes both fossil cysts and recent motile stages. Eisenack (1961), Sarjeant & Downie (1966), and others have developed a formal taxonomy by which genera are grouped into families on cyst characters, particularly the presence or absence of processes and the form of the archaeopyle. The recent studies of Wall & Dale (1967, 1968, 1970) and Evitt (1967) have shown that certain modern species are heterosporous and conversely that the encysted stages of some other extant genera are so similar in morphology that they would not be distinguishable if discovered in a fossilized state. They independently concluded that the overall shape and the archaeopyle position provided taxonomically the most stable characters for classification at familial level; criteria which were not always given overriding importance by other palaeontologists. Wall & Dale (1968) put forward a scheme by which both fossil and extant genera belonging to the Peridiniales are grouped into a number of informal lineages. Additional information on the morphology of certain fossil genera (particularly the *Ascodinium, Odontochitina,* and *Hystrichosphaeridium* groups) suggests that some of their lineages should be either subdivided or merged.

A universally acceptable suprageneric taxonomy will undoubtedly be formulated in the near future and, rather than confuse the situation by introducing a new classification, the grouping put forward here is informal. The system used may be tabulated as follows:

Group 1:	Precingular archaeopyle. Proximate cysts.	
	Gonyaulacysta	*Psaligonyaulax*
	Cribroperidinium	*Apteodinium*
	Trichodinium	
Group 2:	Precingular archaeopyle. Proximochorate cysts with sutural-gonal ornament.	
	Spiniferites	*Achomosphaera*

Hystrichodinium *Heslertonia*
Dinopterygium

Group 3: Precingular archaeopyle. Chorate cysts.
Cordosphaeridium *Exochosphaeridium*
Coronifera

Group 4: Combination precingular apical archaeopyle. Chorate cysts.
Florentinia

Group 5: Apical archaeopyle. Proximate cysts.
Microdinium *Glyphanodinium*
Cassiculosphaeridia

Group 6: Apical archaeopyle. Proximochorate cysts with sutural-gonal ornament.
Xiphophoridium

Group 7: Apical archaeopyle. Chorate cyst.
Hystrichosphaeridium *Oligosphaeridium*
Litosphaeridium *Prolixosphaeridium*
Tanyosphaeridium *Cleistosphaeridium*

Group 8: Epitractal archaeopyle. Chorate cysts.
Callaiosphaeridium *Actinotheca*

Group 9: Apical archaeopyle. Dorsoventrally flattened, chorate or proximate, sometimes marginate cysts.
Cyclonephelium *Adnatosphaeridium*
Valensiella *Canninginopsis*

Group 10: Apical archaeopyle. Spherical proximate cysts without tabulation.
Chytroeisphaeridia *Membranosphaera*

Group 11: Intercalary archaeopyle. Proximate or proximochorate cysts.
Pyxidiella *Pareodinia*

Group 12: Intercalary archaeopyle. Cavate cysts with a peridinioid outline.
Deflandrea *Astrocysta*
Trithyrodinium *Wallodinium*

Group 13: Combination apical and intercalary archaeopyle. Cavate cysts.
Ascodinium *Ovoidinium*

Group 14: Apical archaeopyle. Cavate cysts and cysts with a debris envelope.
Odontochitina *Muderongia*
Pseudoceratium *Hexagonifera*
Kalyptea

Group 15: Precingular archaeopyle. Cavate or lamellate cysts.
Stephodinium *Disphaeria*

Group 16: Not classified.
Chlamydophorella *Diconodinium*
Palaeohystrichophora *Rhombodella*

Group 17: Genera with questionable dinoflagellate affinities.
Trigonopyxidia *Horologinella*
Palaeostomocystis

This scheme is by no means complete and includes only those genera encountered in the present study. In this paper the acritarchs are classified using the system proposed by Downie, Evitt, & Sarjeant (1963). Morphological terms applied to dinoflagellate cysts and cyst structures have been revised and expanded by Downie & Sarjeant (1966) and their terms are used here. Methods relating to the description and classification of archaeopyles are taken from the comprehensive discussion by Evitt (1967).

SYSTEMATIC DESCRIPTIONS

Class: DINOPHYCEAE Pascher

Order: PERIDINIALES Lindemann

GROUP 1: Precingular archaeopyle. Proximate cysts.

Genus GONYAULACYSTA Deflandre, 1964, emended Sarjeant, 1966

Type species: Gonyaulax jurassica Deflandre, 1938.

GONYAULACYSTA CASSIDATA (Eisenack & Cookson, 1960) Sarjeant, 1966.

(Pl. 1, figs. 4, 5)

1960 *Gonyaulax helicoidea* subsp. *cassidata* Eisenack & Cookson, 3, pl. 1, figs. 5, 6.
1962a *Gonyaulax cassidata* Eisenack & Cookson; Cookson & Eisenack, 486, pl. 2, figs. 11, 12.
1966a *Gonyaulacysta cassidata* (Eisenack & Cookson) Sarjeant, 125, pl. 14, figs. 3, 4, text-fig. 31.

BMR palynological species catalogue no.: 951.

Remarks: Little can be added to Sarjeant's (1966a) and Clarke & Verdier's (1967) descriptions of this species. They noted that the scattered verrucae on the plate areas may be densely or sparsely distributed and the sutural crests may be deeply or less deeply denticulate. This variation also occurs in the specimens from Bathurst Island. The antapical plate is bounded by higher crests than the other plate areas. An apical pericoel is always present and may be slightly constricted at the base. The pericoel includes the anterior portion of the precingular plate whorl, and, in some specimens, the precingular archaeopyle, formed by the loss of plate 3″, is separate in both the endophragm and the periphragm (i.e. archaeopyle formula P/P).

The specimens studied are identical with the holotype of Eisenack & Cookson 1960, which I have examined in the National Museum, Melbourne. They differ from *Gonyaulacysta axicerastes* Sarjeant, 1966a, from the Barremian of England, in their more elongate overall shape, their higher crests, and their larger apical pericoel. *Psaligonyaulax deflandrei* Sarjeant, 1966a, and *P. galeata* (Cookson & Eisenack, 1960a) may be distinguished by their possession of an antapical pericoel.

Occurrence: Gonyaulacysta cassidata was originally described from Albian strata in SANTOS Oodnadatta bore, Eromanga Basin, South Australia. Cookson & Eisenack (1962a, 1968) and Eisenack & Cookson (1960) noted it from other Australian localities, including the Aptian of the Carpentaria Basin, the Aptian to Cenomanian of the Perth Basin, and the Albian to Cenomanian of the Carnarvon Basin. Edgell (1964) found it to be characteristic of the Osborne Formation in the Perth Basin. He used it as the nominate species of his *G. cassidata* Zone, which he equated with the whole of the Cenomanian.

Davey (1969a) reported *G. cassidata* throughout the Cenomanian in a number of French and English localities, while Baltes (1967a, b) figured it from the Romanian Albian and Singh (1971) described it from the upper Albian or Cenomanian of northwestern Alberta. Cookson & Hughes (1964) found *G. cassidata* in the uppermost Albian and lower Cenomanian of England. Clarke & Verdier (1967) recorded *Gonyaulacysta cassidata* throughout the Cenomanian in their southern English section. They also quoted unpublished data indicating that the species occurs no earlier than the early Albian. Davey & Verdier (1971) recorded the species from the entire Albian of the Paris Basin, and the same authors (1973) also found it in the upper Albian and lower Cenomanian of France. Finally, Sarjeant (1967), in his worldwide compilation of dinoflagellate distributions, showed the form ranging from the base of the Barremian to the top of the Albian. There are no records of *G. cassidata* in strata younger than lower Turonian.

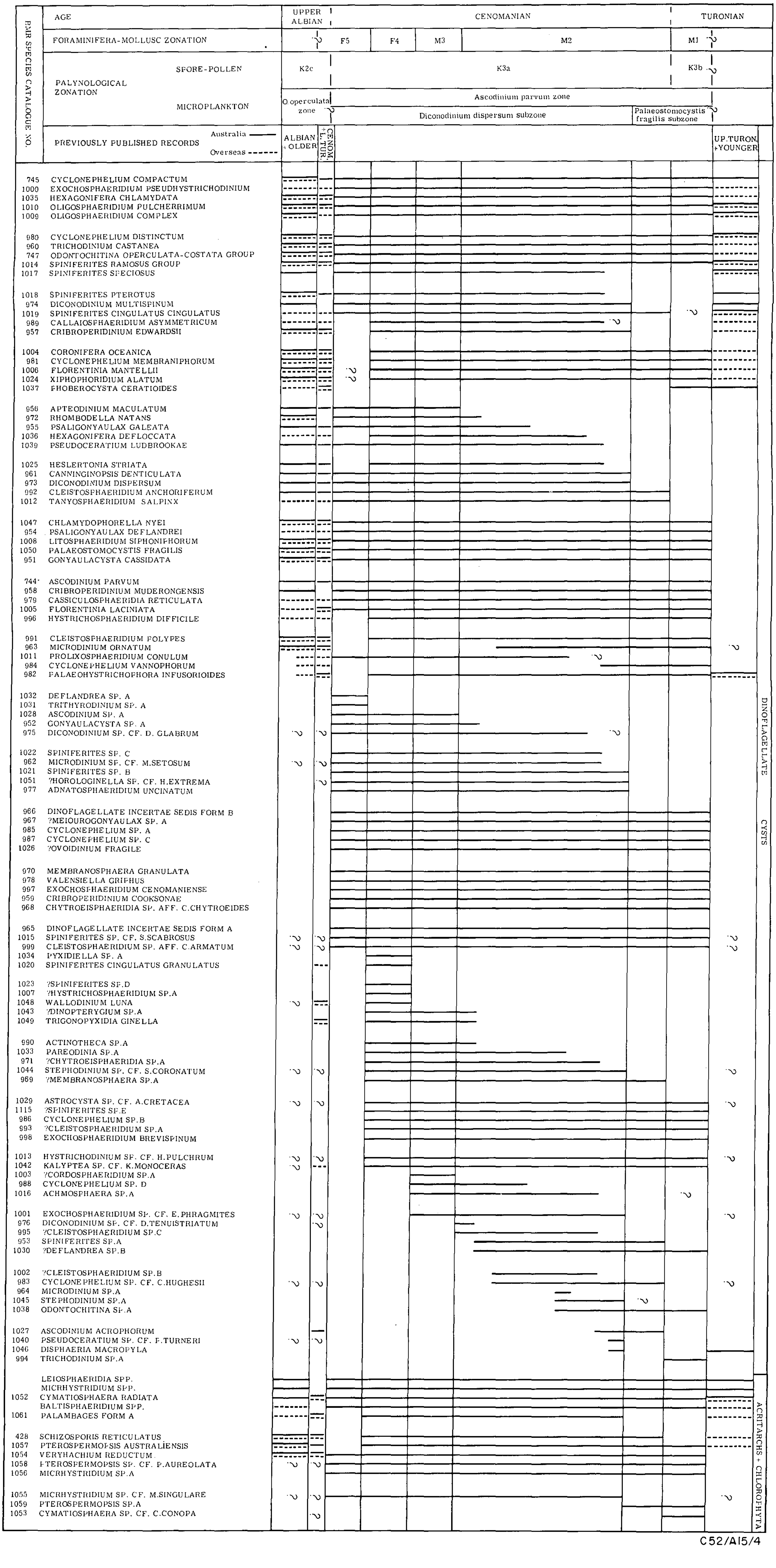
GONYAULACYSTA sp. A
(Pl. 2, fig. 4)

BMR palynological species catalogue no.: 952.

Description: Proximate, acavate, thick-walled cysts, with indistinct tabulation, a rhomboidal or oval dorsal outline, and a solid, tapering apical horn. A small antapical spine is also present in some specimens. A narrow, weakly helicoid cingulum separates the subequal hypotract and epitract. Tabulation is indistinctly picked out by weak granular sutural ridges, which are up to 1 μm in basal width and 1 μm in height. The details of tabulation could not be discerned owing to masking by dense, non-tabular ornamentation. The wall is covered by a dense ornament of low rounded grana, up to 0.5 μm in basal diameter and less than 0.5 μm apart. The archaeopyle is haplotabular and precingular in position. It forms a large arch with a straight base on the cingulum. No detached opercula have been positively identified. Wall thickness ranges from 0.5 to 1.0 μm.

Dimensions: The seven measured specimens range from 64 to 92 μm in length, with an average length of 82 μm.

Remarks: Samples from the lower part of both Bathurst Island wells have yielded nine specimens. Certain morphological features suggest an affinity between *Gonyaulacysta* sp. A and several species of *Cribroperidinium.* It resembles *C. orthoceras* (Eisenack), *C. edwardsii* (Cookson & Eisenack), and *C. cooksonae* sp. nov. in wall structure, rhomboidal shape, and precingular archaeopyle, and *C. intricatum* Davey in these features and in its granular ornamentation. However, accessory tabulation (see under *Cribroperidinium*) could not be identified. *Palaeoperidinium* cf. *P. ventriosum* (O. Wetzel) of Cookson & Eisenack, 1958, from the Aptian of the Carnarvon Basin (figured specimen examined in National Museum, Melbourne), has somewhat coarser granular ornament and a more inflated dorsal ambitus. *Gonyaulacysta hadra* Sarjeant, described from upper Barremian strata in northern England, differs in its greater wall thickness, dual wall structure, and varying density of surface granulation. *G. aichmetes* Sarjeant and *G. paraorthoceras* Davey, 1968, from the same level as *G. hadra,* have much better defined sutural crests. Fuller comparisons with all the forms mentioned are precluded by the indeterminate tabulation of the Bathurst Island specimens.



C52/A15/4

Figure 8. Vertical distribution of microplankton in Bathurst Island.

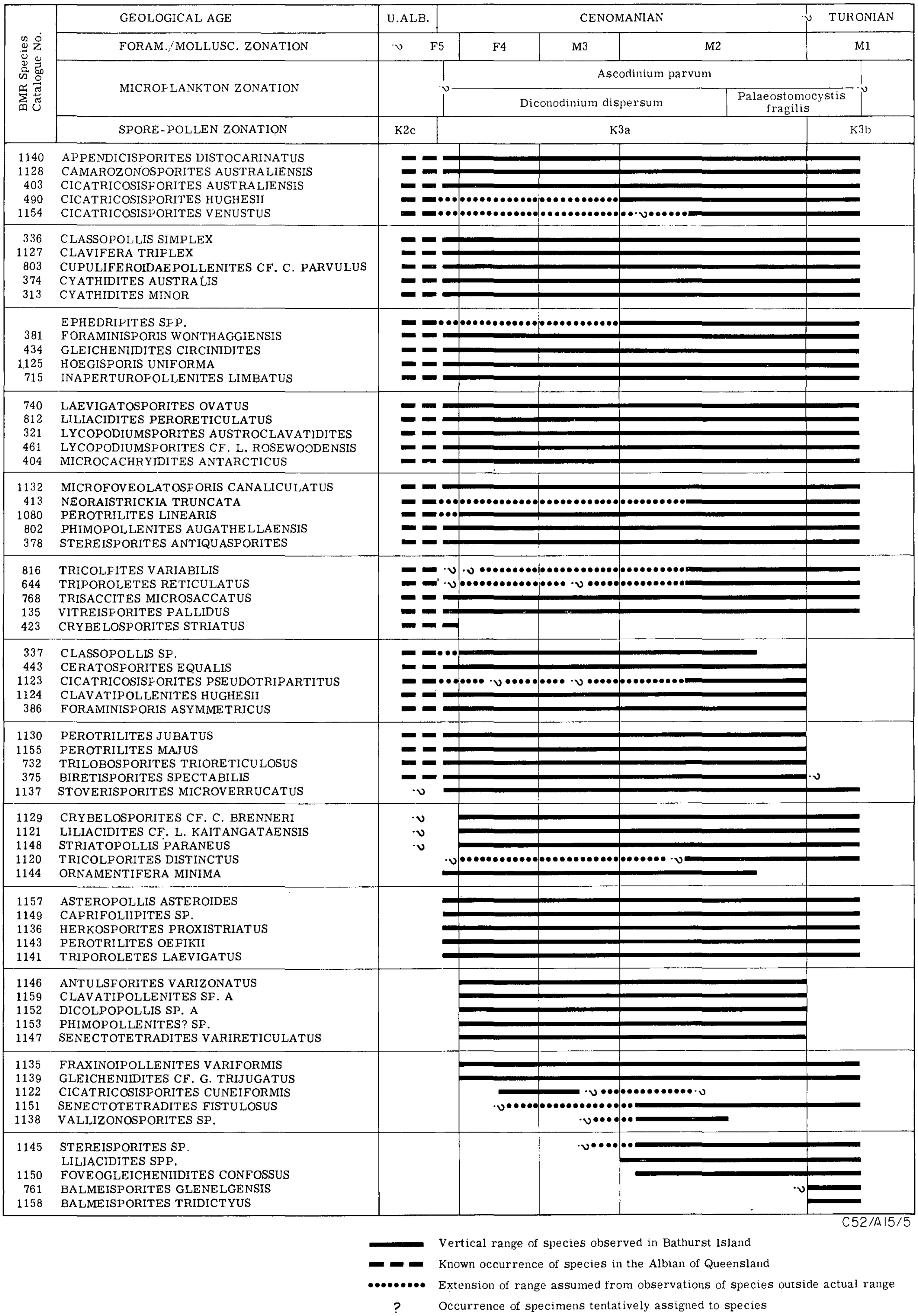


Figure 9. Vertical distribution of spore and pollen species in Bathurst Island.

Genus PSALIGONYAULAX Sarjeant, 1966

Type species: Psaligonyaulax deflandrei Sarjeant, 1966.

Remarks: Sarjeant (1966a) proposed the generic name *Psaligonyaulax* to include proximate cysts with a tabulation similar to that of *Gonyaulacysta,* a precingular archaeopyle formed by the loss of a single plate (3″), and apical and antapical pericoels. He separated his new genus from *Gonyaulacysta* on the presence of an antapical pericoel and from *Scriniodinium* (s.s.) on the constriction of the pericoel into apical and antapical portions.

The close morphological relationship between *Gonyaulacysta cassidata* (Eisenack & Cookson) and *Psaligonyaulax deflandrei* Sarjeant raises some doubt of the need for a generic taxon to accommodate bicavate cysts of this type. If taxonomic concepts are taken to their logical conclusion, species of *Gonyaulacysta* with an apical pericoel only (such as *Gonyaulacysta cassidata, G. axicerastes* Sarjeant, and the type species *G. jurassica* (Deflandre)) should perhaps be separated from truly acavate forms. The taxonomic importance of small pericoels is still uncertain, and apically cavate and acavate cysts are for the present included in the same genus (*Gonyaulacysta*). *Psaligonyaulax* is provisionally retained for cysts with two pericoels and its morphological variation is here slightly increased by the inclusion of *Psaligonyaulax galeata* (Cookson & Eisenack, 1960a). Further study may indicate the necessity for generically separating forms with and without an apical pericoel, but the present material is insufficiently well preserved or abundant to warrant such a step.

PSALIGONYAULAX DEFLANDREI Satjeant, 1966
(Pl. 1, fig. 6)

1964 *Gonyaulax cassidata* Eisenack & Cookson; Cookson & Hughes (pars.), 42, pl. 5, fig. 11 only.
1966a *Psaligonyaulax deflandrei* Sarjeant, 137, pl. 14, figs. 7, 8, text-fig. 35.
1967 *Gonyaulacysta extensa* Clarke & Verdier, 30, pl. 4, figs. 7-9, text-fig. 11.

BMR palynological species catalogue no.: 954.

Remarks: In the specimens from Bathurst Island, sutural crests are well marked but few are high. Some are weakly denticulate, especially in the cingular region. The antapical pericoel is well developed but the antapical plate (1‴′) is in some specimens perforate and surrounded by a serrate crest. Antapical perforations of this type have been described by Gocht (1970) in Middle Jurassic specimens of *Endoscrinium luridum* (Deflandre), *E. galeritum* (Deflandre), and *E. eisenackii* (Deflandre). The archaeopyle is separated by the pericoel at its anterior end and may be assigned the formula P/P under Evitt's scheme (1967).

The Bathurst Island specimens differ from *Gonyaulacysta cassidata* (Eisenack & Cookson) in their possession of a four-cornered antapical pericoel, a more tapered apical projection, lower lists, and a more fusiform overall shape. *G. cassidata* has an antapical plate bounded by a square arrangement of strong lists, but the endophragm and periphragm of this plate area are always closely in contact. *Psaligonyaulax galeata* (Cookson & Eisenack) differs in having a more nearly spherical inner body and much less distinct tabulation on its apical and antapical regions.

Occurrence: Sarjeant (1966a) described *P. deflandrei* from the English Cenomanian, and Davey (1970) recorded it throughout the Cenomanian of sections in both southern England and northern France. Davey & Verdier (1971, 1973) report it from upper Albian and lower Cenomanian strata in France. Clarke & Verdier (1967) found it throughout the Cenomanian in southern England and suggest a base in the upper Albian. The specimen of *P. deflandrei,* which was figured by Cookson & Hughes

(1964, pl. 5, fig. 11) as '*Gonyaulax cassidata*', came from the English lowermost Cenomanian. Thus *Psaligonyaulax deflandrei* ranges from the upper Albian to the top of the Cenomanian in Europe. The rare Bathurst Island specimens extend its geographical distribution to Australia.

PSALIGONYAULAX GALEATA (Cookson & Eisenack, 1960) Davey & Verdier, 1973 (Pl. 1, fig. 7)

1960a *Scriniodinium galeatum* Cookson & Eisenack, 3, pl. 1, figs. 16-18.
1973 *Psaligonyaulax galeatum* (Cookson & Eisenack) Davey & Verdier, 195.

BMR palynological species catalogue no.: 955.

Description: Cavate cysts, with the pericoel divided into an apical and an antapical portion by a broad zone of contact between endophragm and periphragm in the cingular region. The epitract has parallel or slightly tapering sides immediately above its contact with the capsule, and tapers abruptly into a short apical horn. The hypotract is parallel-sided near the cingulum and is flatly or obliquely truncate terminally. The inner body is spherical to slightly prolate and the widest diameter of the cyst is at the cingulum. Tabulation is discernible only on the periphragm, the endophragm being psilate. In the apical and antapical regions, tabulation is absent or represented by faint lines and folds. Lines of granules and short, low, proximally fenestrate lists outline some of the sutures in the cingular region. A full tabulation formula cannot be elucidated. The cingulum is strongly helicoid and six precingular plate areas can be distinguished. The truncate antapex indicates the probable presence of plate 1''''. Apart from the sutural elements, the periphragm is psilate. The archaeopyle is precingular and in one specimen it can be observed as separate semicircular arches in the periphragm and endophragm, with straight bases on the cingulum (i.e. archaeopyle formula P/P).

Remarks: Only three specimens of this form were found in the Bathurst Island material. Comparison with Cookson & Eisenack's holotype left no doubt as to their identity with *P. galeata.* The separation of the pericoel into two terminal portions and its close morphological relationship with the type species of *Psaligonyaulax* supports Davey & Verdier's (1973) transference of *P. galeata* from *Scriniodinium* to *Psaligonyaulax.* In *Scriniodinium* the pericoel is continuous around the cingulum. *Endoscrinium*, which might otherwise accommodate this species, lacks an antapical plate. However, the presence of a posterior intercalary plate, another diagnostic feature of *Psaligonyaulax* mentioned by Sarjeant (1966a), has not yet been identified in *P. galeata.*

P. apatela (Cookson & Eisenack, 1960b) has smaller, terminally more tapering pericoels than *P. galeata*, and apical and antapical tabulation. *P. apatela* was originally described under the genus *Scriniodinium* from the Upper Jurassic of West Australia, but Manum & Cookson (1964) also record it from the low Upper Cretaceous of Arctic Canada. *Psaligonyaulax deflandrei* possesses much more distinct sutural ornamentation and has smaller pericoels than *P. galeata.*

Occurrence: The three specimens found (two definitely identified and one poorly preserved) all came from the lower part of Bathurst Island No. 2 well. Cookson & Eisenack (1960a) originally described it from probable Cenomanian sediments in the Carnarvon Basin. They also recorded it (1960a, 1968) from Albian to Cenomanian strata in the Carnarvon Basin, the (?) upper Albian-Cenomanian of the Perth Basin and the mid-Cretaceous of the Perth Basin. Edgell (1964) mentions a questionable occurrence in the Lower Cretaceous of the Perth Basin (?Valanginian—his zone of *Deflandrea* sp.nov.).

Genus CRIBROPERIDINIUM Neale & Sarjeant, 1962, emended Davey, 1969

Type species: Cribroperidinium sepimentum Neale & Sarjeant, 1962.

Remarks: The genus *Cribroperidinium* was erected by Neale & Sarjeant (1962) to include proximate, crested cysts, similar to *Gonyaulacysta*, but with an unusually large number of reflected plate areas. They gave the tabulation formula 6′, 1-5a, 8″, 9‴, 1p, 1-2pv, 6-?7pc,0⁗. Davey (1969a) emended the genus and pointed out that some of these plates are not always identifiable. He also showed that many plate areas are unusual and irregular in shape, that some of the crests may vary in position in different specimens, and that detached opercula (precingular in original position) are consistently crossed by strong crests. He came to the conclusion that many of the crests are not sutural in position but are accessory, perhaps strengthening structures. To refer to these complex areas he used a system of numbering based on roman numerals, instead of the conventional arabic numeral notation. This method is employed in species description here. By removing the accessory crests he arrived at a tabulation fairly typical of *Gonyaulacysta* (see reconstruction in Text-fig. 10).

Davey (1969a) placed the following species in the emended genus (original generic names shown):

Cribroperidinium sepimentum Neale & Sarjeant, 1962
Gonyaulax orthoceras Eisenack, 1958
Gonyaulax edwardsii Cookson & Eisenack, 1958
Gonyaulax muderongensis Cookson & Eisenack, 1958
Cribroperidinium intricatum Davey, 1969;

and questionably included *Gonyaulax apionis* Cookson & Eisenack, 1958, and *G. diaphanis* Cookson & Eisenack, 1958.
Sarjeant (1967) also referred *Peridinium ventriosum* O. Wetzel, 1933, to *Cribroperidinium* with some doubt. According to Davey (1969a), the species definitely placed in *Cribroperidinium* have a combined range from Hauterivian to early Turonian; Sarjeant, however, showed *C. orthoceras* ranging into the late Valanginian and late Turonian. Wilson (1967) figured from the New Zealand Palaeocene what is clearly a species of *Cribroperidinium* and what he believed to be an autochthonous form as *Gonyaulacysta* aff. *orthoceras*. The youngest published record is that of Gocht (1969), who figured *Gonyaulacysta* aff. *orthoceras* from the German middle Oligocene.

The generic limits between *Gonyaulacysta* and *Cribroperidinium* do not appear to be adequately determinable on evidence of accessory crests alone. Several published Cretaceous forms must remain excluded from *Cribroperidinium* under Davey's diagnosis and yet have very similar thick-walled cysts, with serrate crestal structures, ovoid outlines, and conspicuous, solid apical horns. On one such species (*Gonyaulacysta fetchamensis*), Sarjeant (1966a, p. 130) described '. . . a broken line of "tubercles", like an embryonic crest, cross(ing) plate 5″ . . .' Thus in the future there may be a need to enlarge *Cribroperidinium* with reference to other morphological features. Davey's diagnosis (1969a) is followed for the purposes of this study.

Large, more or less heavily armoured, proximate dinoflagellate cysts, with accessory crests of the type discussed above, are well represented in the Bathurst Island material. They occur as broken fragments, detached opercula, and, more rarely, complete specimens. Three main groups could be differentiated, not on details of tabulation (determinable in only a few cases), but on the density and type of intratabular ornament and on wall thickness. The use of these criteria has the advantage that imperfect material could be identified. In a fourth less common group (*Gonyaulacysta* sp. A above) accessory crests could not be identified with certainty and, although an otherwise close morphological relationship with the definite *Cribroperidinium* species is indicated, they are left for the present in *Gonyaulacysta.*

From an examination of a number of Cookson & Eisenack's type specimens (1958), two of the Bathurst Island groups referable to *Cribroperidinium* are identified with two of their species (*C. edwardsii* and *C. muderongensis*). The third group of cysts have much thinner walls with correspondingly lower crests and ornament. They are thought sufficiently distinct from all published forms to warrant the erection of a new species (*C. cooksonae*).

The three groups show a considerable degree of morphological variation, both within and between species. The height of the crests, the depth of their serration, and the size and arrangement of intratabular verrucae may vary even on different parts of the same specimen. As a result the morphological limits between *C. muderongensis* and *C. edwardsii* are not completely clear and at present remain arbitrary. In addition to these problems the relationship between the Australian and European species is not certain. Two of the latter (*C. intricatum* Davey and *C. orthoceras* Eisenack) may well be conspecific with *C. edwardsii* or *C. muderongensis.* At the moment the type specimens of only the Australian forms have been examined and a fuller understanding of the group must be postponed.

CRIBROPERIDINIUM MUDERONGENSIS (Cookson & Eisenack, 1958) Davey, 1969

(Pl. 1, figs. 8, 9; Pl. 2, figs. 1, 2, 3; Test-figs. 10, 11)

1958 *Gonyaulax muderongensis* Cookson & Eisenack, 32, pl. 3, figs. 3, 4, text-fig. 15.
1966a *Gonyaulacysta muderongensis* (Cookson & Eisenack) Sarjeant, 131.
1969a *Cribroperidinium muderongensis* (Cookson & Eisenack) Davey, 128.

BMR palynological species catalogue no.: 958.

Description: The large acavate cyst has a thick tabulate wall and a prominent apical horn. The dorsal outline varies from circular or oval to polygonal. The solid apical horn is stout, tapering, sometimes shallowly divided at its distal termination and its sides bear serrate lists formed at the junction of the apical plates. Hypotract and epitract are more or less equal in size and are separated by a narrow, slightly laevo-rotatory cingulum.

A complex tabulation is picked out by strong, imperforate lists, which have a fibrous structure and are up to 5 μm in height and 2 μm in basal diameter. These tend to be higher in the apical, antapical, and cingular regions. The lists taper distally and although occasionally smooth are more commonly serrate, denticulate, or divided into truncate pillars. Some of the precingular and postcingular lists are only represented by lines of partly fused verrucae.

Tabulation studies indicate the apparent presence of a large number of plate areas, particularly in the precingular and postcingular whorls. Incomplete tabulation patterns are reproduced for three specimens (Text-figs. 11 a-f), using Davey's roman numeral notation (1969a). In the specimens studied no more than four apical plates and one anterior intercalary plate could be recognized (I-IV′ and Ia). Some of the precingular and postcingular plate areas are bounded by what appear to be accessory lists. In different specimens these have varying positions giving differently shaped areas for plates I-VIII″ and III-VIII‴. Plate I‴ is usually very small, elongate and difficult to distinguish from the sulcal plates (see however, Text-fig. 11a). Plates II‴, IX‴ and IX″ are relatively constant in shape and position. Plate II‴ is sometimes crossed by an incomplete accessory ridge (Text-fig. 11f). Plates I-VIII″ and III-VIII‴ are partly separated by incomplete stirrup-shaped ridges. If all these stirrup-shaped structures were fully developed a theoretical total of ten precingular and twelve postcingular areas would be present, some being semicircular and some L-shaped.

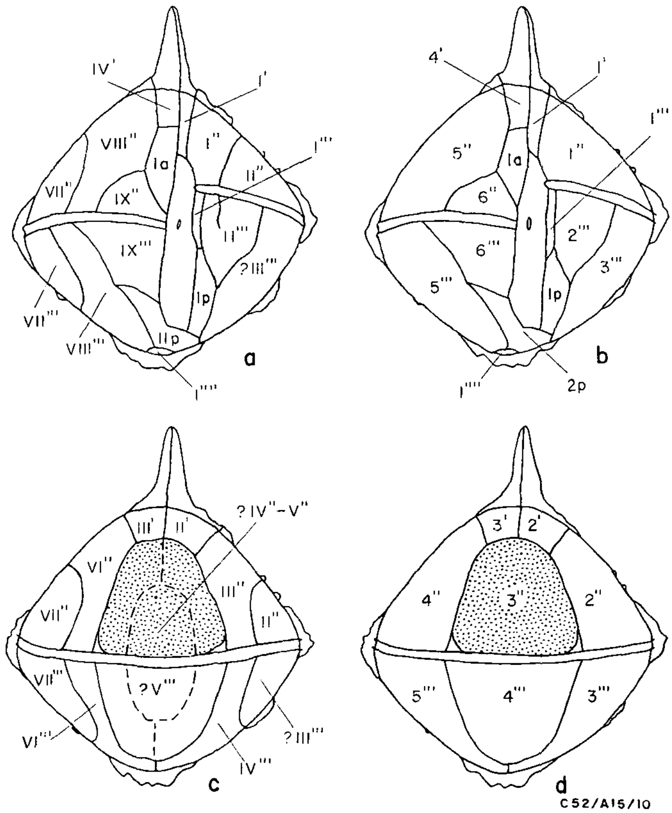


Figure 10. Reconstruction of tabulation in *Cribroperidinium muderongensis*. a, c: Sulcal and dorsal views of specimens with accessory lists and apparent tabulation. b, d: True tabulation revealed by the removal of the accessory tabulation.

L-shaped areas are illustrated in Text-figures 11a (plates VIII″ and III‴) and 11e (plate V-VI‴). Not all the stirrup-shaped accessory lists could be differentiated and no more than nine precingular and nine postcingular areas have been observed. Detached opercula, formed by the loss of a single precingular plate during archaeopyle formation, consistently bear a stirrup-shaped ridge (see Pl. 2, fig. 5). Two posterior intercalary and a variable number of sulcal plates could be differentiated. In some specimens, a small antapical plate can be identified but its presence is usually obstructed by clusters of high antapical lists. The cingulum is not divided by ridges.

The tabulation is reconstructed in Text-figures 10a and c, which were compiled from the observations described above. Following Davey's arguments (1969a), many of the precingular and postcingular lists are intratabular, and if these are removed the tabulation pattern shown in Text-figures 10b and d would result. The tabulation formula would then be 4′, la, 6″, 0c, 6‴, 2p, 1⁗.

The archaeopyle is formed by the loss of a single precingular plate (3″), and the detached opercula, described above, occur frequently. Enlarged archaeopyles (see Evitt, 1967; Brideaux, 1971) are not uncommon. In these, part of the cingulum and even part of the postcingular plates are incorporated into the archaeopyle by a curved suture.

The cyst wall varies from 1 to 2 μm in thickness. It is imperforate and has a fibrous structure similar to that of the lists. Areas between the lists are ornamented by scattered grana and verrucae of variable size and shape. These may be densely or

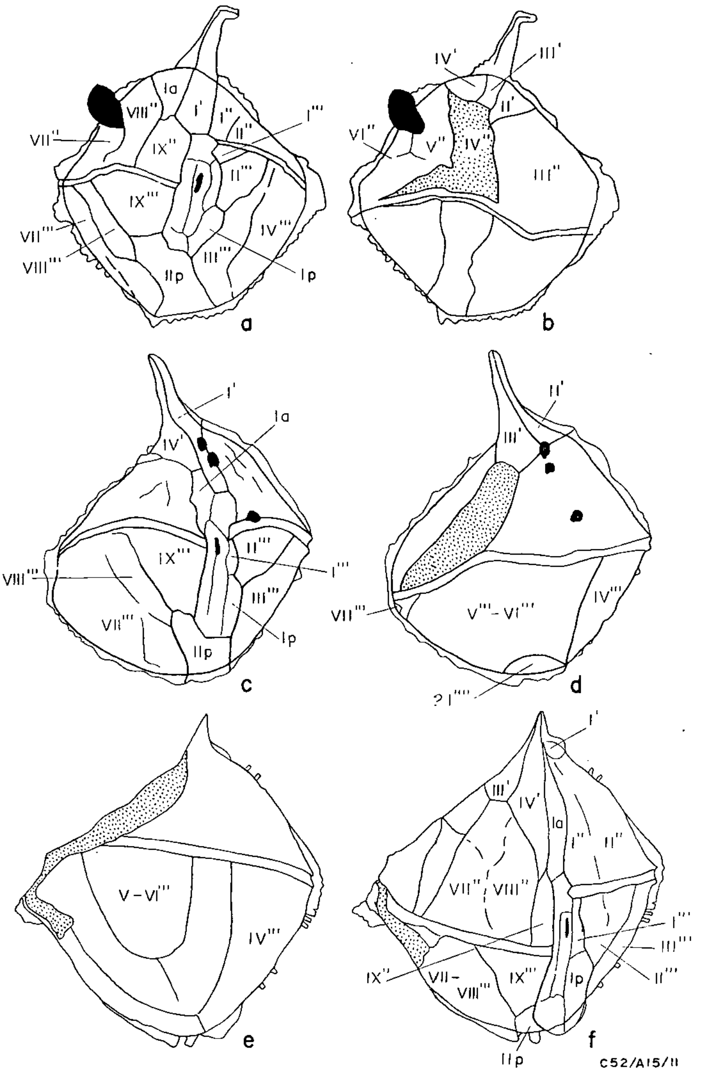


Figure 11. Tabulation of *Cribroperidinium muderongenis*, all × 500. a, b: Sulcal and dorsal views, No. 2 well, core 1, 15.3m, 50′0-6″. M.F.P. 4440:1:160:121 (CPC 12201). c, d: Sulcal and dorsal views No. 2 well, core 2, 48.8m, 150′0-6″. M.F.P. 4439:1:139:222 (CPC 12205). e, f: Dorsal and sulcal views No. 2 well, core 2, 48.8m, 150′0-6″. M.F.P. 4439:1:012:155 (CPC 12348).

sparsely distributed and are sometimes arranged in a linear fashion to form incomplete accessory lists.

Dimensions: The overall length of 10 measured specimens ranges from 75 to 139 μm, with an average of 113 μm.

Remarks: An examination of Cookson & Eisenack's (1958) holotype indicated the identity of the Bathurst Island specimens with *Gonyaulax muderongensis* and confirmed Davey's (1969a) reallocation of the species to *Cribroperidinium*. *Cribroperidinium edwardsii* (Cookson & Eisenack) differs from this species in its consistent lack of discrete verrucae or grana on the areas between the lists and in its possession of more than four apical plates. Both species have very similar crestal structures, although those of *C. edwardsii* are generally smoother and less dissected. An arbitrary limit between the two species is taken for the purposes of this study on the presence or absence of verrucae and grana. ?*Cribroperidinium diaphanis* (Cookson & Eisenack, 1958), from the Lower Cretaceous of the Perth Basin, may represent a morphological intermediate between the two forms. The holotype, examined in the National Museum, Melbourne, has deeply dissected, spiny lists and very fine grana between them. It is considerably thinner-walled than *C. muderongensis* and *C. edwardsii*, and is retained as a separate taxon until more specimens have been examined. The relationship of the two European species, *C. intricatum* Davey and *C. orthoceras* (Eisenack), with the Bathurst Island form cannot yet be determined. Davey (1969a) noted that *C. intricatum*, from the upper Albian and lower Cenomanian of England, and the Cenomanian of France and Canada, lacks the spines of *C. muderongensis* and its continuous lists are always perforate. *C. sepimentum* Neale & Sarjeant, 1962, from the Hauterivian of England, has a perforate cyst.

Occurrence: This form is common throughout the succession in both Bathurst Island wells. Cookson & Eisenack (1958) originally described it from Aptian strata in the Carnarvon Basin. Edgell (1964) found it in the South Perth Shale and Leaderville unit of the Perth Basin, which he dated as Hauterivian/Barremian and Aptian respectively. Ingram (1968) noted the species in a Neocomian-Aptian sample from the Eucla Basin.

CRIBROPERIDINIUM EDWARDSII (Cookson & Eisenack, 1958) Davey, 1969
(Pl. 2, fig. 5; Text-fig. 12)

1958 *Gonyaulax edwardsii* Cookson & Eisenack, 32, pl. 3, figs. 5, 6; text-fig. 7.
1958 *Gonyaulax apionis* Cookson & Eisenack, 36, pl. 3, fig. 7; text-figs. 3, 4.
1966a *Gonyaulacysta edwardsii* (Cookson & Eisenack) Sarjeant, 130.
1966a *Gonyaulacysta apionis* (Cookson & Eisenack) Sarjeant, 130.
1969a *Cribroperidinium edwardsii* (Cookson & Eisenack) Davey, 128.

BMR palynological species catalogue no.: 957.

Description: The cyst is large, acavate, thick-walled, and tabulate. A stout apical horn is present in most specimens. It is sometimes terminally divided and is longitudinally traversed by serrate crests, giving it an irregular outline. The body of the cyst is usually circular in dorsal ambitus; a few specimens are elongate polygonal, and a few are slightly oval owing to distortion. Apical compressions are circular. The epitract and hypotract are subequal in size and the cingulum is narrow, slightly helicoid, and laevorotatory.

Plate areas are numerous and are bounded by a complex arrangement of lists 1 or 2 μm in basal width and tapering to reach a height of up to 6 μm. The highest lists are concentrated around the cingulum, apex, and antapex. The lists have a very fine, densely stippled surface texture, which produces an OL-pattern under oil immersion and suggests a perforate or foveolate structure. The OL-pattern is tentatively interpreted as surface ornamentation, consisting of positive elements less than 0.2 μm in diameter which are partly fused to form a reticulum. Distally the lists are usually entire, although serrate and deeply divided crests are not uncommon.

The large number of lists, their varying position on different specimens, and the irregular shaped areas that they bound indicate that some do not follow the plate margins but are probably accessory sutures (as in *Cribroperidinium muderongensis*). Only an incomplete picture of the tabulation could be elucidated (see Text-figs. 2 a-e). However, the apparent tabulation, labelled here with roman numerals, seems to be closely comparable with that of *C. muderongensis*. At least five apical plates are present. On one specimen (Text-fig. 12e) there may be more, but the crests are less distinct in this area. Anterior intercalary plate areas could not be identified with certainty. Similarly the structure of the precingular and postcingular circlets is not clearly discernible on the material studied. Some areas are bounded by the stirrup-shaped ridges described earlier (see Text-fig. 12d, plates VI‴, VII‴, and VIII‴). Plate I‴, where present, is long and narrow (Text-fig. 12d). In many specimens Plate II is crossed by an incomplete ridge (Text-figs. 12b and d). Plates IX‴ and IX″ can usually be identified. Two posterior intercalary and a variable number of sulcal plates are present and an antapical plate is discernible on some specimens (Text-fig. 12b, plate I⁗). A full reconstruction is not warranted, but the stirrup-shaped ridges in precingular and postcingular whorls indicate that some of the areas figured are probably bounded by accessory lists. When these are removed the tentative tabulation can be represented by the formula (5-6′), (0-1a), ?6″, 0c, ?6‴, 2p, 1⁗. The archaeopyle is formed by the loss of a single precingular plate (3″). Detached opercula have a flat or slightly convex base, sloping sides and a rounded top. They bear a stirrup-shaped ridge and are difficult to distinguish from those of *C. muderongensis*. Text-figure 12c shows a specimen with a slightly enlarged archaeopyle (sensu Evitt, 1967), where narrow slivers of adjacent precingular and cingular areas are missing.

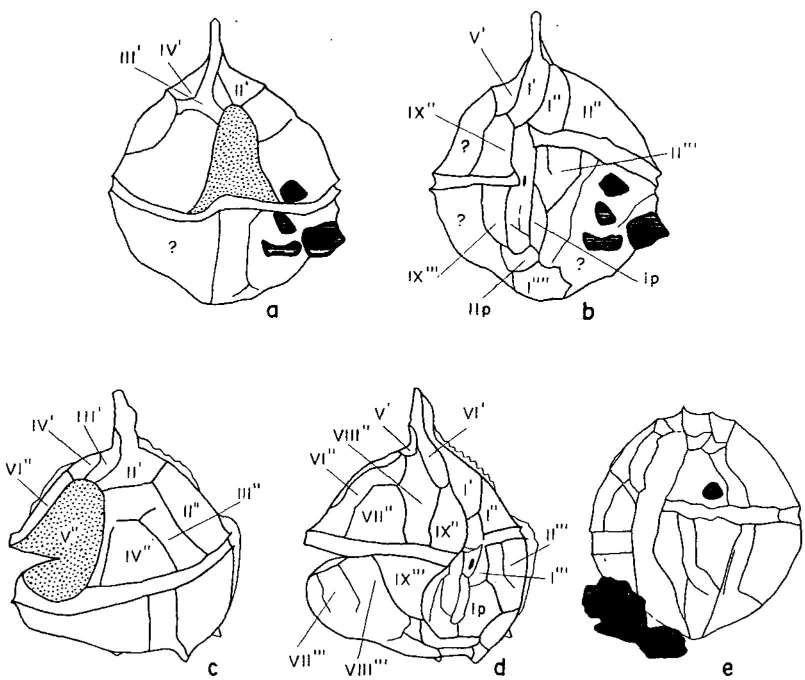


Figure 12. Tabulation of *Cribroperidinium edwardsii*, all × 500. a, b: Dorsal and sulcal views. No. 2 well, core 4, 91.5m, 298′6″-299′0″. M.F.P. 4437:1:173:1091 (CPC 12349). c, d: Dorsal and sulcal views. No. 2 well, core 3, 61.0m, 200′0-6″. M.F.P. 4438:1:079:206 (CPC 12350). e: Sulcal view. No. 2 well, core 10, 248.8m, 816′0-6″. M.F.P. 4431:1:181:194 (CPC 12351).

The cyst wall is 1 to 2 μm thick and has a structure similar to that of the lists, as described above. It has a densely stippled OL-pattern under oil immersion, which suggests that it is covered by very small and very closely set granules, fused into a fine reticulum. An alternative explanation is that it is composed of partly fused rods or fibres, set perpendicular to the surface in a matrix possessing different optical properties. Apart from this finely stippled pattern the periphragm between the lists is devoid of positive structures such as verrucae, grana, etc.

Dimensions: The nine measured specimens range from 68 to 109 μm in overall length and average 95 μm.

Remarks: Cribroperidinium edwardsii differs from *C. muderongensis* (Cookson & Eisenack), *C. intricatum* Davey, and *C. orthoceras* (Eisenack) in its lack of surface grana or verrucae. Its larger number of apical plates and more entire lists also differentiate it from *C. muderongensis* and ?*C. diaphanis* (Cookson & Eisenack). *Gonyaulacysta aichmetes* Sarjeant, 1966a (upper Barremian of northeast England) and *G. fetchamensis* Sarjeant, 1966a (Cenomanian of Southern England) both closely resemble *C. edwardsii* in crest structure and ornamentation, but neither bear accessory lists.

The holotypes of *Gonyaulax apionis* Cookson & Eisenack and *Gonyaulax edwardsii* have been examined in the National Museum, Melbourne. Both have a similar wall structure, lack intratabular verrucae, and bear stirrup-shaped accessory lists on precingular and postcingular plate areas. The main difference between the two specimens is one of outline. The holotype of *G. apionis* is elongate oval and probably slightly distorted. The elongate polygonal shape shown by Cookson & Eisenack (1958, pl. 3, fig. 7) is due to slight protruberances or shoulders visible only at a particular focus level. Specimens with a similar shape but otherwise indistinguishable from *C. edwardsii* have been noted in the Bathurst Island material. I believe, therefore, that the two forms are conspecific.

Occurrence: Cookson & Eisenack (1958) described *C. edwardsii* from the Albian of the Carnarvon Basin and *G. apionis* from the Albian of the Otway Basin. Their other occurrences include the Cenomanian/Lower Turonian and Albian of the Carnarvon Basin, the Cenomanian and Albian of the Perth Basin and the Albian of the Styx Basin. Cookson & Eisenack (1968, 1971) also figure specimens from the mid-Cretaceous of the Perth and Eucla Basins. Edgell (1964) recorded *C. edwardsii* from throughout his *Gonyaulax cassidata* Zone, which he equated with the Cenomanian in the Perth Basin. He also noted the occurrence of *C. edwardsii* and *G. apionis* in strata that he dates as Hauterivian-Barremian in the Perth Basin. Ingram (1968) recorded *C. edwardsii* and *Gonyaulax* sp. cf. *G. apionis* in Albian/Cenomanian samples from the Eucla Basin. The specimen figured by Evans (1966a, pl. 2, fig. 1) as 'Gonyaulacidae sp.' is conspecific with *C. edwardsii.* It came from his *Ascodinium parvum* Zone in the Otway Basin, which he regarded as Cenomanian but has been referred by Dettmann & Playford (1969) to the Cenomanian and early Turonian. Burger (1968b, c) found *C. edwardsii* in Lower Cretaceous marine strata in the Eromanga and Surat Basins. The lower parts of the Bathurst Island sections have yielded *C. edwardsii* in small numbers. On the above evidence the Australian range of the species is from strata dated as Aptian (and possibly late Neocomian) to early Turonian.

Overseas occurrences include Cookson & Hughes' (1964) record in upper Albian to lower Cenomanian strata from Cambridgeshire, England, that of Singh (1971) from the upper Albian of Alberta, that of Davey & Verdier (1971, 1973) from the lower Albian to lower Cenomanian of the Paris Basin and southeast France, and that of Corradini (1971) from the Upper Cretaceous of Italy. Clarke & Verdier (1967) found *C. edwardsii* in strata of early Cenomanian to late Campanian age in southern England. They also quote unpublished information extending its range to below the Cenomanian and to the top of the Maastrichtian.

CRIBROPERIDINIUM COOKSONAE sp. nov.
(Pl. 1, figs. 1, 2, 3; Text-fig. 13)

Holotype: Plate 1, fig. 2. Bathurst Island No. 2 well, core 10, 248.8 m, 816′0-6″. M.F.P. 4431-1:118:182 (CPC 12196). Width 67 μm, length 81 μm.

Derivation of name: The specific name is in honour of the late Dr Isabel Cookson, whose work on fossil dinoflagellates, particularly from Australasia, helped to lay the foundation for all later studies.

BMR palynological species catalogue no.: 959.

Diagnosis: Cysts very thin-walled, acavate and proximate. Dorsal outline circular, oval, or polygonal. Short, solid apical horn. Tabulation indistinct; defined by low, narrow sutural and accessory lists. Wall surface smooth between crests. Stirrup-shaped accessory lists present on precingular and postcingular plate areas. Cingulum broad, slightly helicoid and divided by faint crests. Sulcus well developed. Archaeopyle formed by loss of a single dorsal precingular plate (3″).

Description: Proximate, acavate cysts with a thin wall and indistinct tabulation. The apical region is topped by a short, stout, solid, tapering horn. In addition, a very short, narrow antapical spike up to 2 μm long may be present. The dorsal outline is circular, longitudinally oval, or polygonal, but the thin wall structure readily allows distortion by folding. A weakly helicoid, laevo-rotatory cingulum separates the subequal epitract and hypotract. The sulcus projects a short way into the epitract but is longer and broader in the hypotract. The surface is traversed by a complex system of low, sometimes indistinct crests. These attain a maximum height of 1 μm and a basal width of 1 μm. A few are true sutural lists but others represent irregular intratabular accessory ridges. The finest of the latter have meandrine courses and cannot be fitted into the system devised for *Cribroperidinium* by Davey (1969a). Only a very incomplete tabulation pattern could be elucidated and no tabulation formula is presented (see Text-figs. 13 a-d). Traces of five apical plates are identifiable. Plates I‴ and II‴ have shapes and positions similar to those of *C. edwardsii* and *C. muderongensis*. Text-figure 13b shows plate IX″ bearing an irregular comb-like complex of low ridges. Incomplete stirrup-shaped accessory lists could be identified on the precingular and postcingular whorls of a number of specimens (Text-fig. 13c, plates ?IV-V″, and the precingular plates on the far left of Text-fig. 13b). The cingulum is divided by low crests, but no anterior intercalary, posterior intercalary, sulcal or antapical plates could be differentiated. The archaeopyle is precingular in position and is formed by the loss of a single plate (3″). It has a straight base on the cingulum, sloping sides, and a straight or arched apex. No detached opercula have been observed but Text-figure 13c shows a complete specimen with its operculum still in position (plate ?IV-V″). The cyst wall is very thin (less than 0.5 μm) and frequently folded. Its surface is psilate between the sutural lists and accessory lists.

Dimensions: The overall length ranges between 58 and 95 μm for the 35 measured specimens (average 72 μm).

Remarks: This form differs from all described species of *Cribroperidinium* in its thin wall structure, the presence of cingular plates, and its very fine, irregular crests. *Gonyaulacusta episoma* Sarjeant, 1966a, (from the upper Barremian of northeast England) has higher membraneous lists, a granular surface, and no accessory lists. *Gonyaulacysta exilicristata* Davey, 1969a, a Cenomanian species from southern England, France, and Canada, is very similar in gross morphology, sutures, and traces of accessory tabulation. It differs from *C. cooksonae* in its considerably thicker wall structure and granulate surface. The German Kimmeridgian form *Gonyaula-*

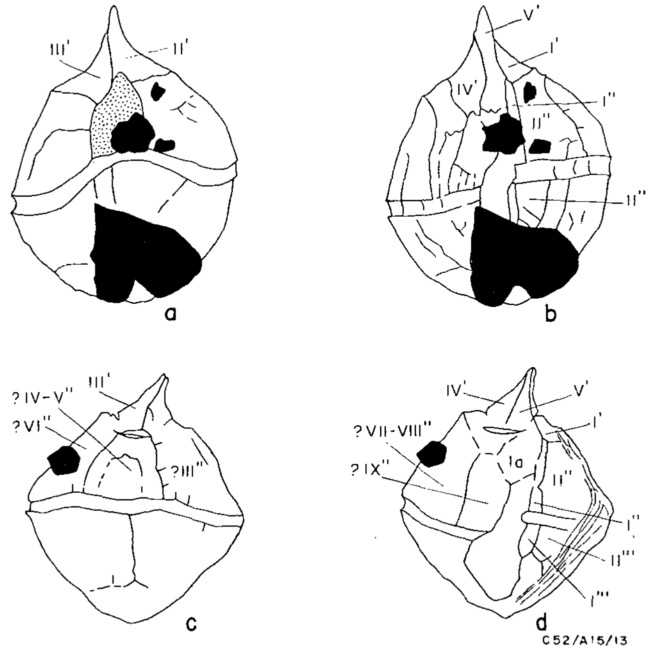


Figure 13. Tabulation of *Cribroperidinium cooksonae*, all × 500. a, b: Dorsal and ventral views of paratype. No. 2 well, core 2, 45.8m, 150′0-6″. M.F.P. 4439:1:029:077 (CPC 12197). c, d: Dorsal and ventral views of paratype. No. 2 well, core 1, 15.3m, 50′0-6″. M.F.P. 4440:1:013:168 (12195).

cysta granulata (Klement, 1960) has traces of stirrup-shaped accessory ridges but has a granulate surface and higher lists.

This species is referred to *Cribroperidinium* because it possesses clearly intratabular accessory lists, present as stirrup-shaped crests on certain precingular and post-cingular plate areas. *C. cooksonae* is a common constituent of the microflora throughout both Bathurst Island well sections.

Genus Apteodinium Eisenack, 1958

Type species: Apteodinium granulatum Eisenack, 1958.

Remarks: Apteodinium was erected by Eisenack (1958b) for proximate cysts with a large 'pylome', an apical horn, and a girdle, but with no tabulation. Several workers have demonstrated that the 'pylome' is in fact a precingular archaeopyle. Sarjeant & Downie (1966) placed it in the family Pareodiniaceae Gocht, together with *Spinidinium* Cookson & Eisenack, 1962a, *Trichodinium* Eisenack & Cookson, 1960, *Xenicodinium* Klement, 1960, and *Pareodinia* Deflandre, 1947. The basic difference in archaeopyle position (*Apteodinium* and *Trichodinium* are precingular, *Pareodinia*, *Spinidinium*, and possibly *Xenicodinium* are intercalary) suggests that they are not taxonomically related. Wall & Dale's (1968) grouping of *Apteodinium*, *Diconodinium* Eisenack & Cookson, 1960, *Trichodinium*, and *Xenicodinium* in their Apteodinioid lineage is also not accepted, as the archaeopyle of *Diconodinium* is distinct from that of the other three. As Davey (1969a) indicated, the precingular archaeopyle, cyst shape, and presence of faint plate boundaries suggest a close relationship between *Apteodinium* and *Gonyaulacysta* so that it is sometimes very difficult to distinguish them generically.

APTEODINIUM MACULATUM Eisenack & Cookson, 1960
(Pl. 2, fig. 9)

1960 *Apteodinium maculatum* Eisenack & Cookson, 4, pl. 2, figs. 1-3.

BMR palynological species catalogue no.: 956.

Remarks: The description of Eisenack & Cookson (1960) requires little amplification. The oval shape, stout apical horn, cingulum, and large precingular archaeopyle are characteristic for the genus. Tabulation is very faintly marked by sutural lines and its pattern is indeterminable on the material at hand. The most distinctive feature of the species is the verrucate ornament. This consists of randomly arranged, circular, thickened, more densely stained areas, each of which is surrounded by a clear annulus up to 5 μm in diameter. The areas between the verrucae are densely and finely granulate.

Verrucate ornament is absent in forms described as *A. maculatum* by Sarjeant (1966b, p. 205) (from the lower Barremian of northeast England) and by Habib (1970) (from the Cretaceous of the deep sea floor off the Bahamas). For this reason these occurrences are not included in the species synonymy list.

Occurrence: A. maculatum was originally described from Albian strata in the Eromanga Basin; it also occurs in the Albian of the Carnarvon Basin and the Aptian of the Carpentaria Basin. Cookson & Eisenack (1968) also figure it from the mid-Cretaceous of the Perth Basin. The occurrence of small numbers of *A. maculatum* in the lower samples of Bathurst Island No. 2 well extends its unequivocal range into Cenomanian strata.

Genus TRICHODINIUM Eisenack & Cookson, 1960, emended Clarke & Verdier, 1967

Type species: Trichodinium pellitum Eisenack & Cookson, 1960.

Remarks: Clarke & Verdier (1967) emended the concept of *Trichodinium* to bring attention to the precingular archaeopyle. It is further characterized by its covering of numerous short, non-tabular processes and by the differentiation of a cingulum. Clarke & Verdier interpreted the apical horn as being formed by the fusion of several processes. The presence of processes differentiates *Trichodinium* from *Apteodinium. Cometodinium* Deflandre & Courteville, 1939, lacks an apical horn and *Xenicodinium* Klement, 1960, has no apical horn or cingulum. Furthermore, Drugg (1970b) has described an intercalary archaeopyle on one Indonesian Neogene species of *Xenicodinium. Exochosphaeridium* Davey et al., 1966b, and *Cordosphaeridium* Eisenack, 1963b, have precingular archaeopyles but bear longer processes and lack a well defined cingulum.

TRICHODINIUM CASTANEA (Deflandre, 1935) Clarke & Verdier, 1967
(Pl. 3, figs. 1, 2)

1935 *Palaeoperidinium castanea* Deflandre, 228, pl. 5, fig. 8.
1960 *Trichodinium intermedium* Eisenack & Cookson, 6, pl. 2, figs. 5-6.
1967 *Trichodinium castanea* (Deflandre) Clarke & Verdier, 19, pl. 1, figs. 1-2 (see also for earlier references).
1969a *Trichodinium castaneum* (Deflandre) Davey, 131, pl. 11, figs. 1-3.

BMR palynological species catalogue no.: 960.

Remarks: Trichodinium castanea is characterized by its spherical to ovoid cyst, its short, irregular apical horn, its precingular archaeopyle and its ornament of short spines. The apical horn is usually quite small, distally divided and is formed by the fusion of a number of processes. A few specimens lack this feature. The spines are short, often irregular or divided distally, and cover the entire surface of the cyst. A wide cingulum is outlined by rows of spines. Occasionally, traces of precingular and postcingular tabulation are also outlined by linear arrangements of spines and by faint sutures. Overall length ranges from 48 to 88 μm (average 61 μm for 26 specimens).

The considerable range in the morphological variation, shown by the Bathurst Island material, supports the enlarged concept of *T. castanea* offered by Clarke & Verdier (1967). They placed *Apteodinium ciliatum* Gocht and *Trichodinium intermedium* Eisenack & Cookson in synonymy with *T. castanea.* However, Davey (pers. comm.), after discussing the former species with Gocht, considers that *T. ciliatum* can be distinguished from *T. castanea.* Davey (1969a) distinguishes *T. castanea* and *T. intermedium* on size. The latter appears to be somewhat larger and more densely spinose, but variation in the Bathurst Island specimens would include this form.

Occurrence: T. castanea was originally described from the Turonian and Senonian of France. European occurrences range from late Hauterivian to Senonian, although Clarke & Verdier (1967) show its top in the early Turonian. In Australia it has been described from the Aptian to the Cenomanian of the Perth and Carnarvon Basins (Cookson & Eisenack, 1962a; Eisenack & Cookson, 1960). Edgell (1964) noted it from throughout his *Gonyaulax cassidata* Zone in the Perth Basin, which he equated with the whole of the Cenomanian. It is common throughout both Bathurst Island sections.

TRICHODINIUM sp. A

(Pl. 6, figs. 2, 3)

BMR palynological species catalogue no.: 994.

Description: Chorate cyst, with a subspherical central body and numerous short similar processes (1 to 2 μm long). Tabulation criteria are completely absent (including cingulum and apical structures) and the processes are arranged randomly, probably more than five per plate area. The processes are solid, tapering, unbranched, and fibrous, with capitate or pointed distal extremities. The fibrils, which are about 0.2 μm thick, continue over the periphragm and join those radiating from adjacent process bases. The archaeopyle is smooth-margined and triangular, with two convex sides, one concave side, and acute corners. Such a shape would suggest that is is precingular in position and formed by the loss of one reflected plate area. The wall is thin (less than 0.5 μm).

Dimensions: The figured specimen has an overall diameter of 48 μm and a central body diameter of 46 μm.

Remarks: Only two specimens have been found and they differ from all related species in the shortness and number of their processes. They may be differentiated from *Trichodinium castanea* in having more regular processes and in their total lack of a cingulum or an apical horn.

GROUP 2. Precingular archaeopyle. Proximochorate custs with sutural/gonal processes or high lists.

Genus SPINIFERITES Mantell, 1850, emended Sarjeant, 1970

Type species: Xanthidium ramosum Ehrenberg, 1838.

Remarks: The genus *Hystrichosphaera* O. Wetzel, 1933, emended Deflandre, 1937, emended Davey & Williams, 1966a, (type species *Xanthidium ramosum* Ehrenberg,

1938) has been used for many years for proximochorate cysts with a precingular archaeopyle and sutural/gonal processes connected by sutural crests. Recently, Sarjeant (1964, 1970) and Loeblich & Loeblich (1966) demonstrated that Mantell (1850) had validly erected the genus *Spiniferites*, using as its type Ehrenberg's species *Xanthidium ramosum*. *Spiniferites* Mantell thus clearly has priority over the more widely used genus *Hystrichosphaera*. A full nomenclatural history for *Hystrichosphaera* may be found in Davey & Williams (1966a) and the discussion leading to its replacement by *Spiniferites* is summarized by Sarjeant (1970).

SPINIFERITES RAMOSUS (Ehrenberg, 1838) Mantell, 1854

(Pl. 3, figs. 3, 4)

1838 *Xanthidium ramosum* Ehrenberg, 109, pl. 1, fig. 15, nos. 1-5.
1838 *Xanthidium furcatum* Ehrenberg, 109, pl. 1, fig. 14.
1854 *Spiniferites ramosus* (Ehrenberg) Mantell, text-fig. 77, nos. 4, 6.
1933 *Hystrichosphaera ramosa* (Ehrenberg) O. Wetzel, 144.
1933 *Hystrichosphaera furcata* (Ehrenberg) O. Wetzel, 136.

BMR palynological species catalogue no.: 1014.

Remarks: Spiniferites ramosus (Ehrenberg) includes several rather diverse types of cyst, some of which were originally described under different specific names. Davey & Williams (1966a) showed that the distinctions between, among others, *S. ramosus* and *S. furcatus* (Ehrenberg) could not justify separation at specific level. Several other workers have experienced difficulty in distinguishing these two forms, and Clarke & Verdier (1967) also placed them in the same species. The presence of morphological intermediates between these and other types led Davey & Williams (1966a) to suggest that the whole group belonged to one large and variable species. They amplified this hypothesis by describing a number of varieties to illustrate the more distinct end members and united *S. ramosus* and *S. furcatus* under the nominate variety.

Studies on the Bathurst Island material lend support to the conclusions of Davey & Williams (1966a). Proximochorate cysts with solid, trifurcate, gonal processes are common and several types were originally distinguished. The most abundant has low intratabular lists, long stout processes, and an overall maximum diameter of 40 to 60 μm. Another form is somewhat smaller and has shorter, more slender processes. Other types of cyst have very slender processes and some bear high membranous lists. The forms with high lists resemble *Spiniferites membranaceus* (Rossignol, 1964), which Davey & Williams (1966a) included as one of their varieties of *S. ramosus*. A thin-walled type with slender processes is very similar to *S. ramosus* var. *gracilis* (Davey & Williams, 1966a).

Although end members of these different morphological types could be distinguished, so many intermediate specimens are present that accurate distinction becomes impossible. As none of the end members appears to show any stratigraphic restriction, the whole group has been united under *S. ramosus*.

Spiniferites ramosus, in the broad sense used here, has been found in sediments as old as Oxfordian (Deflandre, 1938; Sarjeant, 1960) and its continuous record stretches from Neocomian to Holocene. It has been found in deep-sea Pleistocene deposits (Wall, 1967) and in Holocene sediments dated at 950 B.C. from Wales (Harland, 1968). Wall & Dale (1970) germinated viable specimens of *S. ramosus* in vitro, to produce thecae of the *Gonyaulax spinifera* (Claparede & Lachmann) type.

SPINIFERITES sp. cf. S. SCABROSUS (Clarke & Verider, 1967) nov. comb.

(Pl. 3, fig. 13)

cf. 1967 *Hystrichosphaera scabrosa* Clarke & Verdier, 49, pl. 9, figs. 7-10; text-fig. 21.

BMR palynological species catalogue no.: 1015.

Remarks: A number of specimens from the Bathurst Island samples resemble Clarke & Verdier's (1967) figures of *Hystrichosphaera scabrosa*, which was originally described from the English Upper Cretaceous. The general morphology is very similar to that of *Spiniferites ramosus* (Ehrenberg), but the plate areas are ornamented with close set grana or, more rarely, with small distally truncate pillars, up to 0.5 μm high. Clarke et al. (1968) compared *S. scrabrosus* with *S. ramosus* var. *reticulatus* (Davey & Williams, 1966a) but point out that the latter has a reticulate not granulate sculpture. *S. ramosus* var. *granosus* (Davey & Williams, 1966a), from the English Eocene, also has granulate ornamentation but its processes are much more slender. Further study may show that the Bathurst Island specimens are merely another variant of *S. ramosus*, but the rare material at present available is sufficiently distinctive to warrant its retention as a separate taxon. The transference of *Hystrichosphaera scabrosa* to Mantell's (1850) genus *Spiniferites* is made here in accordance with the principles discussed by Sarjeant (1970).

SPINIFERITES SPECIOSUS (Deflandre, 1934) Sarjeant, 1970

(Pl. 3, fig. 12)

1934 *Hystrichosphaera speciosa* Deflandre, 967, fig. 4.
1970 *Spiniferites speciosus* (Deflandre) Sarjeant, 77.

BMR palynological species catalogue no.: 1017.

Remarks: The rare but well preserved specimens found in the Bathurst Island samples agree well with Deflandre's (1937) illustrations (from the French Upper Cretaceous) and with the specimens figured by Deflandre & Cookson (1955) (lodged in the National Museum, Melbourne). Deflandre & Cookson found this form in the Lower Cretaceous from the Great Artesian Basin, in a Palaeocene or lower Eocene sample from Victoria, and questionably in the Miocene of Victoria.

The Bathurst Island specimens have ovoid bodies, thin walls, and psilate plate areas. They may be distinguished from *Spiniferites ramosus* (Ehrenberg) by their short, stout gonal processes and prominent apical horn. The Tertiary species *Spiniferites cornutus* (Gerlach, 1961) is similar in body shape but has a much longer apical process.

SPINIFERITES PTEROTUS (Cookson & Eisenack, 1958) Sarjeant, 1970

(Pl. 3, fig. 5)

1958 *Cymatiosphaera pterota* Cookson & Eisenack, 50, pl. 11, fig. 7.
1966a *Hystrichosphaera pterota* (Cookson & Eisenack) Davey & Williams, 40.
1970 *Spiniferites pterotus* (Cookson & Eisenack) Sarjeant, 76.

BMR palynological species catalogue no.: 1018.

Remarks: A few specimens of *Spiniferites pterotus* occur in both Bathurst Island wells. They have distinctive high transparent intertabular lists, and the gonal processes (located at the intersections of lists) are reduced to narrow fibres. *S. crassimuratus* (Davey & Williams, 1966a) and the *S. cingulatus* group also have well developed lists but, unlike *S. pterotus*, their processes extend a short way beyond the crests and are generally furcate.

Cookson & Eisenack's (1958) holotype of *S. pterotus* has been examined in the National Museum, Melbourne. It is similar to the Bathurst Island material except that its lists are slightly higher and its processes may extend a short way beyond them as small spines. The presence of a cingulum and of clear tabulation leaves no doubt as to its correct placing with *Spiniferites*.

Occurrence: The type level is the (?) Albian of the Perth Basin. Cookson & Eisenack (1958) also record it from the Cenomanian or lower Turonian and from the Campanian or lower Maastrichtian of the Carnarvon Basin. Overseas occurrences include that from the Albian of Romania (Baltes, 1967b).

SPINIFERITES CINGULATUS (O. Wetzel, 1933) Sarjeant, 1970

1933 *Cymatiosphaera cingulata* O. Wetzel, 28, pl. 4, fig. 10.
1954 *Hystrichosphaera cingulata* (O. Wetzel) Deflandre, 258.
1970 *Spiniferites cingulatus* (O. Wetzel) Sarjeant, 76.

Remarks: Davey & Williams (1966a) and Clarke & Verdier (1967) re-examined *Spiniferites cingulatus* and independently subdivided this large and variable species into a number of varieties. The synonymous duplication of names was resolved by Clarke et al. (1968). Clarke & Verdier (1967) showed that, although the group as a whole ranges from the Cenomanian to the Pleistocene, some varieties have restricted stratigraphic distribution within the Upper Cretaceous.

SPINIFERITES CINGULATUS var. CINGULATUS (Clarke & Verdier, 1967) nov. comb.

(Pl. 3, fig. 11)

1967 *Hystrichosphaera cingulata* var. *cingulata* Clarke & Verdier, 45, pl. 8, figs. 9, 10.

BMR palynological species catalogue no.: 1019.

Remarks: This is the commonest variety of *Spiniferites cingulatus* and occurs in the lower and middle parts of both Bathurst Island wells. The Bathurst Island material agrees well with the published descriptions and figures and the specimens are characterized by their high lists, which extend almost to the tips of the processes. The processes are gonal in position and distally often bifurcate or trifurcate. *Spiniferites pterotus* (Cookson & Eisenack) also has high sutural lists, but the supporting processes are never distally divided and seldom project beyond the crests. Unlike other varieties of *S. cingulatus*, the nominate variety has completely unornamented plate areas.

Occurrence: In Australia, *S. cingulatus* var. *cingulatus* has been recorded previously only from the lower Eocene and middle Miocene of the Otway Basin (Deflandre & Cookson, 1955) and the Miocene of the Great Barrier Reef (Hill, Playford, & Woods, 1970). Overseas occurrences range from the Albian to the Maastrichtian. These include the Cenomanian to Campanian of southern England (Clarke & Verider, 1967), the Cenomanian of southern England and northern France (Davey, 1969a), the Albian of northern Canada (Singh, 1971), the middle Albian to lower Cenomanian of France (Davey & Verdier, 1971, 1973), the Senonian of Germany (O. Wetzel, 1933) and France (Deflandre-Rigaud, 1955), the Cenomanian and Maastrichtian of Poland (Gorka, 1963), and the Albian to Cenomanian of Romania (Baltes, 1963, 1965, 1967a, b).

SPINIFERITES CINGULATUS var. GRANULATUS (Clarke & Verdier, 1967) nov. comb.

(Pl. 3, fig. 6)

1967 *Hystrichosphaera cingulata* var. *granulata* Clarke & Verdier, 45, pl. 9, figs. 5, 6; text-fig. 18.

BMR palynological species catalogue no.: 1020.

Remarks: A single specimen, referable to Clarke & Verdier's (1967) variety, was found near the base of Bathurst Island no. 2 well. It has high membranous lists, beyond which the gonal processes do not protrude; and plate areas which are densely granulate. Clarke & Verdier (1967) found it only in the middle and upper Cenomanian of southern England.

SPINIFERITES sp. A

(Pl. 3, fig. 10)

BMR palynological species catalogue no.: 953.

Description: Cyst proximochorate and acavate, with a spherical or oblate central body. The tabulation is picked out by sutural ridges and consists of an indeterminate number of precingular and postcingular plates, separated by a broad, slightly helicoid cingulum, 5-6 μm wide. Short, solid, tapering gonal processes, 3 or 4 μm long, are linked by low sutural ridges, about 1 μm in height. Distally, the processes are entire or shallowly bifid. The archaeopyle is haplotabular and precingular in position; the central body is thin-walled (less than 0.5 μm), with a smooth or very finely granulate surface (elements up to 0.2 μm in diameter).

Dimensions: The figured specimen has a central body 41 μm long and 42 μm wide.

Remarks: The very short processes and low sutural ridges distinguish the three specimens collected from all other forms of *Achomosphaera* and *Spiniferites*. The small number of specimens precludes formation of a formal new species.

SPINIFERITES sp. B

(Pl. 5, fig. 5)

BMR palynological species catalogue no.: 1021.

Description: Proximochorate, acavate cyst, with a spherical central body. The cyst bears slender (1 to 1.5 μm), solid, slightly tapering processes, 9 to 12 μm long, which are gonal or more rarely sutural in position. These become trifurcate at about two-thirds of their length and terminally each branch is bifurcate (occasionally trifurcate) and pointed. The processes are linked by low ridges (1 μm high) and lists, some of which are higher at the poles, and which delimit the tabulation. The cingulum is slightly helicoid and about 7 μm wide. The archaeopyle is formed by the loss of a single reflected precingular plate area. The wall is less than 0.2 μm in thickness and is completely smooth.

Dimensions: The figured specimen has a central body 60 μm in diameter.

Remarks: The low sutural ridges, very slender processes, and absence of list buttresses at their bases distinguish this form from *Spiniferites cingulatus* var. *cingulatus* and from even the most extreme variants of *S. ramosus*. *S.* sp. A has much shorter processes.

SPINIFERITES sp. C

(Pl. 10, figs. 5, 6)

BMR palynological species catalogue no.: 1022.

Description: Acavate, proximochorate cyst, with a prolate central body. The subequal hypotract and epitract are separated by a broad, helicoid cingulum. Processes are gonal in position, 14 to 16 μm long and formed by the junction of the stout sutural lists. The lists are high, dense, sometimes proximally fenestrate and have a slightly wavy distal edge. Precingular and postcingular processes are trifurcate and show additional division at their terminations. Apical, antapical, and sulcal processes are unbranched or irregularly furcate; polar processes are longer and stouter. The archaeopyle is precingular and is formed by the loss of plate 3″. The plate areas are completely smooth and the wall is moderately thick (1 to 1.5 μm).

Dimensions: Overall length of figured specimen 81 μm, central body 51 μm long and 55 μm wide.

Remarks: This species resembles some variants of *Spiniferites ramosus*, particularly *S. ramosus* var. *membranaceus* (Rossignol, 1964). However, the thick wall and very stout processes serve to distinguish them. Four specimens have been recovered from the lower and middle parts of Bathurst Island no. 2 well.

?SPINIFERITES sp. D

(Pl. 3, fig. 7)

BMR palynological species catalogue no.: 1023.

Description: Cyst proximochorate and acavate, with a prolate central body and distally undulose sutural lists, 7-10 μm high. The lists reach about 0.5 μm in thickness and are sometimes slightly fenestrate (perhaps owing to corrosion). Processes are reduced to supporting structures at the gonal intersections of the lists and do not protrude beyond the lists. An archaeopyle has not been observed. The wall is 2 μm thick and unornamented.

Dimensions: The overall length of the figured specimen is 88 μm, length of central body is 60 μm, and width of central body is 43 μm.

Remarks: This species differs from the *Spiniferites cingulatus* group and from *S. pterotus* in having much thicker walls. The walls of *S. crassimuratus* (Davey & Williams, 1966a) are differentially thickened in the centres of the plate areas. *S. wetzelii* (Deflandre, 1935) bears processes, whose distal portions are irregularly branched and protrude beyond the sutural lists. Only two specimens have been found, both incomplete and both from the lower part of no. 2 well.

?SPINIFERITES sp. E

(Pl. 16, fig. 3)

BMR palynological species catalogue no.: 1115.

Description: Cyst proximochorate and acavate. The wall is thin (0.2 to 0.5 μm) and readily folded. It has a finely granulate surface and is traversed by a system of high lists. The lists also have a faintly granulate structure and reach a height of 5 to 15 μm. Distally they are deeply denticulate or even aculeate, the elements attaining lengths of 4 μm. The lists appear to be sutural in position but do not occur on all plate boundaries. Incomplete crests on the dorsal and ventral faces follow short straight or curved courses. A cingulum could not be identified. In the apical region, four lists with less deeply indented margins unite over a small lacuna. An archaeopyle is present in some specimens and its position is either intercalary or precingular.

Dimensions: Overall length of figured specimen 56 μm, overall width 54 μm, length of central body 35 μm.

Remarks: This species is questionably and very hesitantly placed in the genus *Spiniferites.* The incomplete data on the tabulation and archaeopyle precluded more accurate placing, which must await the examination of more material. It has been found in both boreholes and occurs rarely in the middle and upper parts of the succession.

Genus ACHOMOSPHAERA Evitt, 1963

Type species: Hystrichosphaeridium ramuliferum Deflandre, 1937.

ACHOMOSPHAERA sp. A

(Pl. 3, figs. 8, 9)

BMR palynological species catalogue no.: 1016.

Description: Proximochorate, tabulate, acavate cyst, with a very thick-walled prolate central body. The wall is 1 to 2 μm thick, composed of a thin transparent periphragm and a thicker, more densely coloured endophragm. Beneath the plate areas, the endophragm is pierced by closely spaced canals or punctae, up to 0.5 μm in diameter. These are filled with pigment or are mineralized, giving the wall a very dark coloration. Canals are absent along the sutural boundaries and the tabulation is defined by narrow zones of colourless endophragm. Lines of structural weakness are developed at the junctions between plate areas and distorted specimens frequently show partial breakage along the median line of these imperforate zones. The processes are gonal in position, terminally pointed, and twice branched in a trifurcate manner. They are short (7 to 13 μm) and narrow (1.5 to 3 μm), with slightly expanded bases. Sutural crests are either absent, or are represented by low thickenings, joining the bottom of the processes. The tabulation is similar to that shown by the genera *Spiniferites* and *Gonyaulacysta*, with a broad cingulum and a haplotabular precingular archaeopyle.

Dimensions: The overall diameter ranges from 61 to 68 μm (5 specimens) and the figured specimen has a central body 48 μm long and 40 μm wide.

Remarks: Infrequent specimens of *Achomosphaera* sp. A occur in samples from no. 2 well. They are very similar to *Spiniferites crassipellis* (Deflandre & Cookson, 1955) in their possession of a very thick, densely coloured wall. *S. crassipellis* was originally described from the lower Eocene of Victoria but Davey & Williams (1966a), Davey (1969a), and Clarke & Verdier (1967) also figured apparently identical forms from European Cenomanian to Santonian strata. Both the Tertiary and the Cretaceous specimens bear distinct sutural crests, a feature which is absent from the Bathurst Island form. A second European Upper Cretaceous species, *Achomosphaera sagena* Davey & Williams, 1966a (= *A. reticulata* of Clarke & Verdier, 1967), also resembles *Achomosphaera* sp. A in its very thick wall structure. The endophragmic canals are enlarged to form the lumina of a coarse reticulate pattern (1.5 μm in diameter) and the zones of colourless tissue along plate boundaries are absent.

Genus HYSTRICHODINIUM Deflandre, 1935, emended Clarke & Verdier, 1967

Type species: Hystrichodinium pulchrum Deflandre, 1935.

1961 *Heliodinium* Alberti, 33.

Remarks: Deflandre (1935) erected *Hystrichodinium* to include forms with long processes and a complete lack of tabulation on the central body. Alberti's (1961) original description of *Helodinium* differentiated it from *Hystrichodinium* on its presence of central body tabulation. Sarjeant (1966a) emended them, drawing attention to the precingular archaeopyle and traces of tabulation in *Hystrichodinium.* He distinguished them on process form; describing those of *Hystrichodinium* as 'long, hollow spines, rounded in cross-section and fairly stiff, and those of *Heliodinium* as '. . .flattened, dagger to ribbon-like, very flexible . . .'. Clarke & Verdier (1967) independently emended *Hystrichodinium* and placed *Heliodinium* in synonymy. Clarke et al. (1968) again reviewed them and stated 'since the type species of these genera are distinct, the name *Heliodinium* cannot be considered an objective synonym of *Hystrichodinium*: its retention or rejection remains a matter of opinion only, especially in absence of full knowledge of the tabulation of the latter genus'. In view of the close relationship between these two genera and their present differentiation being based only on process form, Clarke & Verdier's (1967) emendation is accepted here and *Heliodinium* is treated as a synonym of *Hystrichodinium.*

HYSTRICHODINIUM sp. cf. H. PULCHRUM Deflandre, 1935

(Pl. 7, fig. 2; Pl. 11, fig. 1; Pl. 17, fig. 1)

?1935 *Hystrichodinium pulchrum* Deflandre, 229, pl. 5, fig. 1; text-figs. 9-11.

BMR palynological species catalogue no.: 1013.

Remarks: A number of poorly preserved specimens of *Hystrichodinium*, from both wells, can questionably be referred to *H. pulchrum.* They have precingular archaeopyles and a variable number of hollow, unbranched gonal and possibly sutural spines. Sutural lists are either low or absent, with the result that the tabulation is very indistinct.

The specimens with more numerous spines resemble figures of *H. pulchrum* and some figures of *H. voigtii* (Alberti, 1961) (particularly those of Sarjeant, 1966b and Davey, 1969a). However, Alberti's type-figure of *Heliodinium voigtii* shows that it has high sutural lists, a feature not present in the Bathurst Island material. Specimens with fewer spines are similar to *Hystrichodinium oligacanthum* Deflandre & Cookson (1955), from the Lower Cretaceous of the Great Artesian Basin. The holotype, which was examined in the National Museum, Melbourne, is quite distinct from the specimens under discussion. *Hystrichodinium patriciae* (Neale & Sarjeant, 1962) has a thicker central body and much longer processes. Other published species are smaller than the Bathurst Island material (*Hystrichodinium? parvum* Alberti), have branched processes (*Hystrichodinium ramoides* Alberti and *H. furcatum* Alberti) or bear more numerous and shorter spines (*Hystrichodinium compactum* Alberti and *H. dasys* Davey).

Occurrence: H. pulchrum has a well documented range from the Valanginian to the Maastrichtian in Europe (see Clarke & Verdier, 1967, p. 39). It has also been recorded from the mid-Cretaceous of Arctic Canada (Manum & Cookson, 1964) and the Aptian of the Perth Basin (Edgell, 1964). A questionable determination has also been made from the Eocene of Romania (Baltes, 1969).

Genus HESLERTONIA Sarjeant, 1966

Type species: Gonyaulax heslertonense Neale & Sarjeant, 1962.

HESLERTONIA STRIATA (Eisenack & Cookson, 1960) nov. comb.

(Pl. 10, fig. 10)

1960 *Cymatiosphaera striata* Eisenack & Cookson, 9, pl. 3, figs. 10, 11.

BMR palynological species catalogue no.: 1025.

Remarks: Specimens referable to *Cymatiosphaera striata* Eisenack & Cookson occur in small numbers in both wells. They have very high, membranous, radially striate and folded ledges. These are sutural in position and, although a detailed tabulation cannot be elucidated, a cingulum with precingular and postcingular plate areas is distinguishable. A precingular, haplotabular archaeopyle is sometimes developed.

The presence of tabulation, the high sutural lists, and the precingular archaeopyle all indicate that this species should be transferred from the acritarch genus *Cymatiosphaera* to *Heslertonia.* The type species of *Heslertonia, H. heslertonensis* (Neale & Sarjeant, 1962) (Hauterivian and Barremian of England), differs slightly from the Australian species in having branched and non-striate lists. A future re-examination of the holotypes of the two species may show them to be conspecific. *H. pellucida* Gitmez, 1970, from the Kimmeridgian of Scotland, has completely smooth and somewhat lower lists. Some forms of *Gonyaulacysta, Spiniferites*, and *Pterodinium* bear high sutural lists but they are never as well developed as in *Heslertonia striata.*

Occurrence: Eisenack & Cookson (1960) recorded *H. striata* from the probable Cenomanian of the Carnarvon Basin, the ?upper Albian to Cenomanian of the Perth Basin, the Albian of the Eromanga and Perth Basins, and the Aptian of the Carpentaria Basin.

Genus DINOPTERYGIUM Deflandre, 1935

Type species: Dinopterygium cladoides Deflandre, 1935.

?DINOPTERYGIUM sp. A

(Pl. 11, fig. 4)

BMR palynological species catalogue no.: 1043.

Description: Proximochorate cysts, with a prolate or ovoid central body and an epitract which is considerably shorter than the hypotract. The sutures bear thin membranous lists, up to 12 μm in height. These are most strongly developed around the single antapical plate and at the cingulum. Archaeopyle formation is by the loss of a single precingular plate. The walls are thin and smooth or very finely granular.

Dimensions: The figured specimen is 61 μm long.

Remarks: Dinopterygium cladoides Deflandre differs from this species in having a much shorter epitract and a pterate test shape (i.e. the largest diameter is at the cingulum). *D. perforatum* Clarke & Verdier, 1967, has a similar shape but its sutural lists are perforate. The few, poorly preserved specimens of *?Dinopterygium* sp. A came from the lower part of Bathurst Island no. 2 and from the central part of the no. 1 well.

GROUP 3. Precingular archaeopyle. Chorate cysts.

Chorate dinoflagellate cysts with precingular archaeopyles are common in Lower Cretaceous to Holocene sediments and a large number of genera have been erected to accommodate the various known types. Many of the taxa were described over a relatively short period (1966-69), and some duplication of names was inevitable.

The least complex members of the group have simple processes and an archaeopyle formed by the loss of reflected precingular plate areas from one (e.g. *Cordosphaeridium* Eisenack, 1963b; *Operculodinium* Wall, 1967) to five (e.g. *Lingulodinium* Wall, 1967). A second, related group includes more complex cysts; some are cavate (e.g. *Triblastula* O. Wetzel, 1933; *Samlandia* Eisenack, 1954), others have modified processes which approximate to the shape of the plate areas (e.g. *Danea* Morgenroth, 1968; *Palmnickia* Eisenack, 1954). These are exclusively youngest Cretaceous to Palaeogene in age and will not be considered further here.

Cordosphaeridium was first described by Eisenack (1963b), when he separated certain species of chorate cyst from *Hystrichosphaeridium* on the fibrous structure of their processes. He did not comment on archaeopyle form, and his figures, although showing this feature, are so oriented that the archaeopyle position is indeterminate.

Morgenroth (1966) found, in the north German lower Eocene, a number of species which he considered to be morphologically intermediate between *Cordosphaeridium* Eisenack and *Coronifera* Cookson & Eisenack, 1958. The characteristic feature of these species was the presence of distinctive apical and/or antapical processes. To accommodate such forms he erected the genus *Lanternosphaeridium*. He also noted that the periphragm and processes may have a fibrous structure and his illustrations show a clearly precingular archaeopyle.

The first use of archaeopyle position as a classificatory criterion in chorate cysts was by Davey & Williams (1966b) and Davey et al. (1966b). However, owing to orientation difficulties Davey & Williams (1966b) incorrectly identified the archaeopyle of *Cordosphaeridium* as being apical, but correctly as formed by the loss of a single plate. Davey et al. (1966b) reallocated species of dinoflagellate cyst previously attributed to the acritarch genus *Baltisphaeridium* Eisenack on archaeopyle and process position. Their new genus *Exochosphaeridium* included forms from the Cretaceous with a precingular archaeopyle and a distinctive apical process. They found that the processes were either fibrous or solid, conical, terminally closed, and often pointed. In one specimen they noted process alignment on either side of the cingulum. Drugg (1967) and Clarke & Verdier (1967) placed similar Cretaceous forms in *Baltisphaeridium*.

Wall (1967) examined Quaternary material from the Caribbean deep-sea floor and erected a number of chorate and psilate cust genera on archaeopyle form. Under *Lingulodinium* he included chorate cysts with an archaeopyle formed by the loss of four or five reflected precingular plate areas. The archaeopyle of *Tectatodinium* is precingular and haplotabular but the cyst is completely devoid of processes or projections. In his diagnosis of *Operculodinium* Wall (1967) referred to the haplotabular precingular archaeopyle, the lack of polar structures, the microgranular or microreticulate periphragm, and the conical (or tapering) hollow processes, which have minutely striate bases and acicular or capitate terminations. Traces of a cingulum are sometimes present and the processes are intratabular, with more than one per plate area. As a type species Wall chose *Hystrichosphaeridium centrocarpum* Deflandre & Cookson, 1955, which ranges at least back into the Neogene (Miocene of Australia).

Working with viable recent material, Wall & Dale (1967, 1968) found that three 'cyst species' of *Operculodinium* (*O. centrocarpum*, *O. psilatum* Wall, 1967, and *O. israelianum* (Rossignol, 1962)) produced a single, 'gonyaulacean' species of motile dinoflagellate (*Protoceratium reticulatum* Claparede & Lachmann, 1859). As these 'cyst species' differ from one another in the length of their processes (*O. psilatum* has extremely short processes), it must be assumed that this character is of doubtful reliability as a criterion.

The correct use of archaeopyle characteristics was continued when Morgenroth (1968) for the first time identified a haplotabular precingular archaeopyle on northern European Danian specimens of *Cordosphaeridium*. Subsequently Gocht (1969) re-examined many Palaeogene species of *Cordosphaeridium* in detail, including the type species *Hystrichosphaeridium inodes* Klumpp, 1953, and he confirmed that the archaeopyle was formed by the loss of one reflected precingular plate area. He also re-examined *Lanternosphaeridium*, described its precingular archaeopyle, and noted a close morphological similarity with *Cordosphaeridium*. Although his *Cordosphaeridium* never bore true apical structures, the apical process was often somewhat larger than the others. In *Lanternosphaeridium*, however, he showed that the apical and sometimes also the antapical process had a different shape and was consistently larger than the other processes. He also found that whereas in *Cordosphaeridium* the cingular processes were intratabular, in *Lanternosphaeridium* they were aligned along the margins of the cingulum: i.e. they were sutural or gonal. The specimen which Gocht (1969) describes as *Operculodinium* cf. *hirsutum* (Ehrenberg) has a haplotabular precingular archaeopyle and reticulate periphragm. Its elongate apical process differentiates it from typical *Operculodinium*.

Davey (1969a) described several Cenomanian species of *Exochosphaeridium* in detail. He found that the archaeopyle was formed by the loss of two reflected precingular plate areas, that a differentiated apical process was present, and that the processes were fibrous, distally closed, and sometimes branched. Later Davey (1969c) erected the genus *Amphorosphaeridium* to include cysts with a precingular haplotabular archaeopyle, a fibrous periphragm, polar differentiation, and hollow fibrous processes. He separated it from *Exochosphaeridium* on its hollow and more complex processes and in the same publication emended *Cordosphaeridium* in the same terms as Morgenroth (1968) and Gocht (1969).

The use of archaeopyle type by Wall & Dale (1968) and Evitt (1967), as the character of maximum biological stability, is not questioned here. However, from the above observations it is evident that archaeopyle type is only of use in separating the more distinctive genera of chorate cyst. Thus *Lingulodinium* and *Trioperculodinium* Drugg, 1970a, may be satisfactorily differentiated from other chorate cysts with precingular archaeopyles in their possession of 4 to 5P and 3P archaeopyles respectively. *Exochosphaeridium* has an archaeopyle formed by the loss of one or two precingular plate areas, the only described chorate genus with a 2P archaeopyle. This variability seems to be valid at generic level in this case. Otherwise homogeneous populations of *Exochospaeridium* from Bathurst Island have either one or two precingular plate areas missing and no author has specifically limited any taxon to its possession of one type or the other.

Process form appears to be a more useful character for the division of cysts with haplotabular precingular archaeopyles. Some prudence must be observed in its use, especially as Wall & Dale (1968) found that process and horn length may vary within one biological species. However, work on Recent material has not yet found evidence for intra-specific variation with regard to the presence or absence of polar structures. The presence of differentiated apical or antapical processes may thus provide a useful criterion in fossil cysts.

Genera lacking distinctive polar structures include *Cordosphaeridium* and *Operculodinium*. Some features of their morphology suggest that they may be synonymous. Both may have a fibrous or reticulate periphragm and processes which are fibrous at least at their bases. Intratabular processes aligned with the cingulum are known from both genera. Some species of *Cordosphaeridium* (including the type species *C. inodes*) have only one process per reflected plate area, while *Operculodinium* was defined as having more than one. In his diagnosis Wall (1967) described the processes of *Operculodinium* as tapering, frequently small, and distally closed and sometimes capitate. On the other hand the processes of *Cordosphaeridium* are solid or hollow and distally open, more or less broad, and often terminally flared. Forms with broad processes appear rarely in the Cretaceous, reach an acme in the Palaeogene, and disappear in the Neogene. Species of *Cordosphaeridium* with narrow but flared processes (e.g. *C. gracilis* Eisenack, 1954, and *C. tiara* Klumpp, 1953) are on present evidence restricted to the Palaeogene. *Operculodinium* has a definite range only as far back as the upper Eocene, and is known in present-day seas. If, as the available morphological evidence would suggest, this were a relatively short ranging genus, the pre-upper Eocene citations of *Operculodinium* in the literature are incorrect and should be reallocated elsewhere. These include Davey's (1969b) *O. centrocarpum*, from the South African uppermost Cretaceous, Morgenroth's (1966) *Cordosphaeridium tiara* var. *centrocarpum* from the German lower Eocene, and Gocht's (1969) *Operculodinium* cf. *hirsutum*, also from the lower Eocene. In view of the extant occurrence of *Operculodinium*, the genus is here interpreted in its restricted sense and none of the Bathurst Island species are placed in it. One form with broad processes occurs in the material and is consequently placed in *Cordosphaeridium.*

Coronifera Cookson & Eisenack, 1958, is easily distinguished from all other genera with one or more differentiated polar structures. At present it contains two species (*C. oceanica* Cookson & Eisenack and *C. albertii* Millioud) and is the only genus with a tabular antapical process and a solid apical process. The remaining genera with polar structures are *Exochosphaeridium*, *Lanternosphaeridium*, and *Amphorosphaeridium. Exochosphaeridium* is distinguishable from the other two genera by its closed, usually solid, tapering pointed processes. *Lanternosphaeridium* and *Amphorosphaeridium* have hollow and open or solid and truncate processes. They both bear larger polar processes with a similar structure. Gocht (1969) and Drugg (1970a) describe *Lanternosphaeridium* with processes arranged along either side of the cingulum. Davey (1969c) did not mention this in his description of *Amphorosphaeridium*, but some of his illustrations show the same feature. Thus the two genera have identical characteristics and are considered synonymous, *Lanternosphaeridium* having priority.

Genus CORDOSPHAERIDIUM Eisenack, 1963, emended Morgenroth, 1968

Type species: Hystrichosphaeridium inodes Klumpp, 1953.

?CORDOSPHAERIDIUM sp. A

(Pl. 7, fig. 4)

BMR palynological species catalogue no.: 1003.

Description: Chorate cyst, with a central body composed of a smooth endophragm and a smooth periphragm in close contact. The periphragm gives rise to numerous, slender, similar, solid processes which are 12 to 16 μm long and arranged apparently randomly (probably more than one per reflected plate area). Process bases are slightly expanded, 1 to 3 μm in diameter, and sometimes buttressed. Distally the processes are smooth, unbranched, and taper to capitate terminations, about 0.5 μm in diameter. The wall is 0.5 μm thick and the archaeopyle is not determinable.

Dimensions: The figured specimen has an overall diameter of 82 μm, a central body diameter of 60 μm and processes 12 to 16 μm long.

Remarks: The single specimen differs from all the other species of *Cordosphaeridium*, *Exochosphaeridium*, and *Cleistosphaeridium* found in its smooth periphragm and slender capitate processes. It is placed, with some hesitancy, in *Cordosphaeridium* by virtue of its solid processes. The smooth periphragm and very narrow processes are somewhat atypical of that genus. Its exclusion from the genus *Operculodinium* rests on the solid nature of the processes, but as the archaeopyle is indeterminate its true generic placing must remain uncertain.

Genus EXOCHOSPHAERIDIUM Davey, Downie, Sarjeant, & Williams, 1966

Type species: Exochosphaeridium phragmites Davey et al., 1966.

EXOCHOSPHAERIDIUM sp. cf. E. PHRAGMITES Davey et al., 1966

(Pl. 7, fig. 5)

cf. 1966b *Exochosphaeridium phragmites* Davey, Downie, Sarjeant, & Williams, 165, pl. 2, figs. 8-10.

BMR palynological species catalogue no.: 1001.

Remarks: A number of specimens from Bathurst Island no. 2 resemble *Exochosphaeridium phragmites* in their proximally joined blade-like processes, granular (not reticulate) periphragm, large apical process, and precingular archaeopyle. The published descriptions and figures have more numerous, narrower processes and a larger size; and *E. pseudhystrichodinium* (Deflandre) has thinner and more granular wall structure and broader processes.

Occurrence: Davey et al. (1966b) and Davey (1969a) record *E. phragmites* from the Cenomanian of southern England and northern France. Davey & Verdier (1971, 1973) also found it in the Albian and lower Cenomanian of southeast France and the Paris Basin. Cookson & Eisenack's (1970a) illustration of *?E. phragmites*, from the Senonian and Albian-Cenomanian of the Eucla Basin, is very similar to the Bathurst Island specimens.

EXOCHOSPHAERIDIUM PSEUDHYSTRICHODINIUM (Deflandre, 1937) Davey, Downie, Sarjeant, & Williams, 1966

(Pl. 4, figs. 7, 11)

1937 *Hystrichosphaeridium pseudhystrichodinium* Deflandre, 25, pl. 15, figs. 3-4.
1963 *Baltisphaeridium pseudhystrichodinium* (Deflandre) Downie & Sarjeant, 92.
1966b *?Exochosphaeridium pseudhystrichodinium* (Deflandre) Davey et al., 166.
1969a *Exochosphaeridium pseudhystrichodinium* (Deflandre) Davey, 163, pl. 11, figs. 4, 5.

BMR palynological species catalogue no.: 1000.

Remarks: This form is one of the commonest chorate cysts in both Bathurst Island wells. The granular periphragm and numerous branched, pointed processes are identical with those shown in the published illustrations. Some specimens have an enlarged apical process and a type P or 2P archaeopyle. As mentioned by Davey (1969a), the morphologically closest form to this species is the '*Baltisphaeridium hirsutum* (Ehrenberg) group', which, however, has a fibrous periphragm.

Occurrence: E. pseudhystrichodinium was first described by Deflandre (1937) from French Senonian flints. It has also been recorded from the Campanian and Maastrichtian of Poland (Gorka, 1963), the Maastrichtian of Holland (de Wit, 1943, 1944), the Maastrichtian of Belgium (Lejeune-Carpentier, 1941), the Upper Cretaceous of Italy (Corradini, 1971), the Danian of Germany (W. Wetzel, 1952) and California

(Drugg, 1967), the Eocene of Belgium (Pastiels, 1948), the uppermost Albian of the Paris Basin (Davey & Verdier, 1973), the Albian of Romania (Baltes, 1967a), and the Cenomanian and Turonian of England (Davey, 1969a).

EXOCHOSPHAERIDIUM CENOMANIENSE sp. nov.

(Pl. 4, figs. 4, 8)

1958 *Hystrichosphaeridium* cf. *H. hirsutum* Ehrenberg, 1838; Cookson & Eisenack, 44, pl. 11, figs. 5, 6.

Holotype: Pl. 4, fig. 4. Bathurst Island no. 1 well, core 1, 30.5 m, 100′0-6″. M.F.P. 4450-1:176:054 (CPC 12222). Overall length 73 μm, diameter central body 60 μm, process length 7-12 μm.

Derivation of name: After the Cenomanian stage, in which it occurs.

BMR palynological species catalogue no.: 997.

Diagnosis: Cyst chorate. Central body prolate or spherical. Processes tapering, solid or fibrous, medium to long. Processes are striate proximally, pointed or minutely capitate distally. Periphragm fibrous, coarsely and irregularly reticulate. Process arrangement random, at least three per plate area. Apical process distinct, often foliate. Archaeopyle precingular, composed of either one or two discrete plates.

Description: Chorate cyst with a spherical to prolate central body and medium to long tapering processes. The processes reach 18 μm in length, with a solid or fibrous structure and pointed or minutely capitate distal extremities. The process bases are up to 5 μm broad and, where coarsely fibrous, are sometimes perforate proximally. Fibrils radiate over the periphragm from the process bases and anastomose into a coarse and completely irregular periphragmic network. Fibrils are 0.5 μm to 1 μm thick and lumina up to 1 μm in diameter. The processes are arranged randomly, three or more per plate area. No trace of cingular alignment could be identified in the population studied, but the apical process is usually longer than the others and it is often distally foliate. The archaeopyle may be formed by the loss of one or two reflected precingular plate areas. The wall is 1-1.5 μm thick.

Dimensions: Overall diameter ranges between 51 and 97 μm (average 74 μm for 24 specimens).

Remarks: This form is a member of the '*Baltisphaeridium hirsutum* (Ehrenberg) group' of Davey et al. (1966b) and Davey (1969a). It constitutes a plexus of species of *Exochosphaeridium*, characterized by the possession of a striate, reticulate, or fibrous periphragm. *Exochosphaeridium striolatum* (Deflandre, 1937) (Senonian of France) differs from *E. cenomaniense* in that its periphragm is divided into fields by conspicuous ridges linking the process bases. Not all the upper Albian to Upper Cretaceous records of *E. striolatum* show these fields and some may need transference from that taxon. *E. striolatum* var. *truncatum* (Davey, 1969a) has distally truncate processes, which resemble some of the Bathurst Island specimens. However, Davey's illustrations show a form with fewer and longer processes than those under study. *Baltisphaeridium bifidum* Clarke & Verdier, 1967, also differs in the form of its processes. In this case they are bifid at their tips. Cookson & Hughes' (1964) figure of *Baltisphaeridium hirsutum* (Ehrenberg) is similar to *Exochosphaeridium cenomaniense* in its surface sculpture but has narrower processes. *E. scitulum* Singh, 1971, also has rather narrower processes and its central body wall is somewhat thinner than that of *E. cenomaniense*.

In the Bathurst Island wells this species is known from throughout the section.

The specimens figured by Cookson & Eisenack (1958) as *Hystrichosphaeridium* cf. *hirsutum* from the Albian of the Carnarvon Basin have been examined at the National Museum, Melbourne, and are conspecific with *E. cenomaniense*. They also recorded it from the Albian of the Perth Basin and the Aptian-Albian of the Papuan Basin.

EXOCHOSPHAERIDIUM BREVISPINUM sp. nov.

(Pl. 4, figs. 5, 6)

Holotype: Pl. 4, figs. 5, 6. Bathurst Island no. 2 well, core 4, 91.5m, 298′6-11″. M.F.P. 4437-1:033:053 (CPC 12224). Overall diameter 62 μm, diameter central body 52 μm, process length 5-8 μm.

Derivation of name: The specific name refers to the short processes.

BMR palynological species catalogue no.: 998.

Diagnosis: Cyst chorate. Central body spherical. Processes short and numerous, three or more per plate area, arrangement random. Processes tapering, solid or finely fibrous, striate proximally and pointed distally. Apical process rarely distinct and longer than the others. Periphragm fibrous, finely and densely reticulate. Archaeopyle precingular, composed of one or more commonly two discrete plates.

Description: Chorate cysts with a near-spherical central body and numerous short processes. The latter are solid or fibrous and taper from their slightly expanded bases (1-3 μm in diameter) to pointed extremities. At their bases the fibrils anastomose into a fine and dense periphragmic reticulation. Fibres and lumina are up to 0.5 μm in diameter and the wall is 0.5 to 1 μm thick. At least three processes occur per reflected plate area; they show no trace of alignment. A larger apical process is occasionally developed. The archaeopyle is precingular in position and formed by the loss of one, or more commonly two reflected plate areas.

Dimensions: The overall diameter ranges from 54 to 81 μm, with an average of 63 μm for 15 specimens.

Remarks: The form is related to *Exochosphaeridium cenomaniense* sp. nov. but differs in its thinner wall, shorter and narrower processes, and finer periphragmic network. The two forms show no intergradation. *E. brevispinum* has not been found in the lowermost samples of either Bathurst Island well but becomes common in the middle and upper parts of the sections.

Genus CORONIFERA Cookson & Eisenack, 1958

Type species: Coronifera oceanica Cookson & Eisenack, 1958

CORONIFERA OCEANICA Cookson & Eisenack, 1958

(Pl. 10, figs. 1, 2)

1958 *Coronifera oceanica* Cookson & Eisenack, 45, pl. 12, figs. 5, 6.

BMR palynological species catalogue no.: 1004.

Remarks: There is some controversy regarding the morphology of *C. oceanica*, in particular over the archaeopyle position. Cookson & Eisenack (1958), in their original description, did not actually specify the location of the archaeopyle. In the holotype, which was examined in the National Museum, Melbourne, the archaeopyle is partly obscured, but it is questionably precingular in position. The type figure

(Cookson & Eisenack, 1958; pl. 12, fig. 6) is undoubtedly oriented wrongly and the large tubular process with its denticulate margin should be antapical. The apical process is solid, closed, and foliate, but all other processes are much more slender and most are bifid or trifid near their sharp terminations. Cookson & Eisenack's other figured specimen (pl. 12, fig. 5) has a clearly precingular, haplotabular archaeopyle, but the area around the apical horn is also partly broken away. Whether this represents an accidental breakage or a true apical plus precingular archaeopyle is uncertain. Evitt (1967) described archaeopyles similar to this (type Aa +P) in '*Hystrichokolpoma*' *ferox*, where a precingular plate (possibly 3″) is missing and the apical plates remain attached. The paratype of *C. oceanica* has an apical horn but no tubular antapical process, although the rest of the processes are identical with those of the holotype.

Eisenack (1958b) also recorded *C. oceanica* from the German Aptian. He did not discuss the archaeopyle or 'pylome' position, but his figure (pl. 25, fig. 1) shows a precingular archaeopyle on a specimen oriented upside down.

Neither Cookson & Hughes (1964) nor Clarke & Verdier (1967) described the archaeopyle in their material. Their figures show somewhat crumpled specimens, in which the archaeopyle is not determinable. All show the characteristic tubular antapical process with a denticulate margin. Cookson & Hughes (1964) also described the pointed, branched processes and reticulate periphragm.

Cookson & Eisenack (1968) identified an archaeopyle in the apical position. However, their illustration clearly shows a precingular haplotabular archaeopyle; but this may be due to oblique compression of the specimen. Davey (1969a) also described an apical archaeopyle and emended the genus to accommodate this. In addition he noted that his specimens, unlike the holotype, had a periphragm which was reticulate and processes which were sometimes joined by membranes.

Diphyes appendicularis Cookson & Eisenack, 1970a, also has an apical archaeopyle. In other characters it is very similar to *Coronifera oceanica*, with its tubular antapical process and pointed lateral processes. The type illustration shows an apical orifice, but the nature of its margin is unclear.

The Bathurst Island material shows a confusing degree of variation. The periphragm may be granular or reticulate. In the latter case, fibrils radiating from the base of the processes unite with those from other processes to give an anastomosing star-like pattern. The processes may be slightly fibrous at their base, but are usually solid and smooth distally. Some are entire and pointed and some capitate. Other specimens have distally bifid or trifid processes, the branches of which are at obtuse angles to each other, sometimes recurved and usually pointed. An apical horn or process is usually but not always present. The tubular antapical process is a constant feature. In well preserved specimens the archaeopyle is precingular and haplotabular. Other specimens have a large indented precingular archaeopyle, probably of type 2P. Still others have a large, rather ragged apical orifice, which may represent an apical or even an epitractal archaeopyle.

It is difficult to correlate these observations with the present concept of a single specific taxon. If Evitt's (1967) conclusions are correct, the forms with different archaeopyle types should be allocated to different species and genera. However, the observed range of variation in characters other than the archaeopyle and the complete lack of linkage between this variation and the different archaeopyle types make Evitt's theories hard to apply. The other possibility is that all the apparently different archaeopyle types are really preservational manifestations of one form of structurally weak, compound archaeopyle. Such a type was mentioned above for '*Hystrichosphaeridium*' *ferox* (type $\bar{A}a$ + P) and is also known in the genus *Florentinia* Davey & Verdier, 1973. Type $\bar{A}a$ + Pa archaeopyles have been described by Evitt (1967) in a number of specimens of *Sirmiodinium*. If cysts with this pattern of dehiscence were preserved in any but the most perfect manner, they might readily form one or more of the types known from Bathurst Island. The sulcal tongue, which joins the apical plate areas to the body of the cyst in $\bar{A}$a archaeopyles, is a very weak piece of tissue and would be readily severed. If a dehisced cyst with an archaeopyle of type Aa + 2P or A + 6P (epitractal and composed of 7 or more discrete plates) was well preserved it might only show a haplotabular precingular archaeopyle.

Progressively rougher treatment would cause the weakly adherent plates to separate and its appearance would approach some of the observed and published multitabular archaeopyles of *C. oceanica.*

Occurrence: Whatever the taxonomic standing of *C. oceanica*, the species in its broad sense has a restricted range. It was originally described from the Albian of the Perth and Carnarvon Basins. Edgell (1964) recorded but did not figure it from the Neocomian of the Perth Basin. Cookson & Eisenack (1968) figure it from the mid-Cretaceous of the Perth Basin. If Cookson & Eisenack's (1970a) record of *Diphyes appendicularus* belongs here, it considerably extends the range upwards, as it was found in the Senonian of the Eucla Basin. Overseas occurrences include the upper Hauterivian to lower Aptian of the Alps (Millioud, 1969); the upper Albian and basal Cenomanian of central England (Cookson & Hughes, 1964); the Cenomanian of southern England and northern France, Albian of England and Saskatchewan (Davey, 1969a); the middle Albian to lower Cenomanian of France (Davey & Verdier, 1971, 1973); the Cenomanian to basal Coniacian of southern England (Clarke & Verdier, 1967); and the upper Aptian of Germany (Eisenack, 1958b). Its worldwide range is thus at present Neocomian to Coniacian. It occurs uncommonly in both wells at Bathurst Island.

GROUP 4: Combination precingular apical archaeopyle. Chorate cysts.

Genus FLORENTINIA Davey & Verdier, 1973

Type species: Florentinia laciniata Davey & Verdier, 1973.

FLORENTINIA LACINIATA Davey & Verdier 1973

(Pl. 6, figs. 11, 12)

1971 *Hystrichokolpoma ferox* Singh, 326, pl. 51, figs. 1-5 (*non* Deflandre, 1937).
1973 *Florentinia laciniata* Davey & Verdier, pl. 2, figs. 1, 3, 4, 6, 7, 9 (Synonymy).

BMR palynological species catalogue no.: 1005.

Remarks: The Bathurst Island material agrees fairly closely with Davey & Verdier's type description and illustrations, but usually has a more heavily granulate body wall. Most of the specimens are somewhat fragmented, but with good preservation the characteristic combination precingular apical archaeopyle could be identified (formula $\bar{A}$+P or $\bar{A}$a+P). The overall diameter of the cyst ranges from 47 to 85 μm (average 66 μm for 16 specimens) and processes are usually shorter (about a third of the overall diameter) than in the type figures. The apical, precingular, and postcingular processes are large and hollow, with a granular or faintly fibrous structure. At their distal extremities they divide into a number of tubules, most of which are closed at the end. Davey & Verdier mention that the process reflecting plate 5''' is larger than all the others, but this is not so in our specimens. They use the presence of a larger, open, antapical process both as a generic and a specific criterion, but in the Bathurst Island material this process is not notably different from the others. However, the morphology of the archaeopyle and processes is otherwise so similar and distinctive that these deviations are only thought to represent variation within the species.

There is a close resemblance between *F. laciniata* and '*Hystrichokolpoma*' *ferox* (Deflandre, 1937), which was originally described from the Senonian of France. Indeed Davey & Verdier (1973) were able to transfer several published records of '*H.*' *ferox* to this species. Evitt (1967) has described an archaeopyle formed by the complete loss of plate 3'' and the partial loss of the apical whorl (formula $\overline{A}a+P$) in typical '*H.*' *ferox*. It has been differentiated generically from *Florentinia* in its lack of a large, distinctive antapical process; and from *F. laciniata* in having acicular rather than tubular process terminations.

The Bathurst Island material is also similar to Cookson & Eisenack's (1960a) figure of *Hystrichosphaeridium flosculus* (Deflandre), from the Senonian of the Carnarvon Basin. However, the spine-like projections on the larger processes in the latter are more elongate and pointed—similar to those of '*H.*' *ferox*. In addition, Cookson & Eisenack's figure shows a distinctive, distally rounded process, which is more reminiscent of those of ?*Spiniferites* sp. E than of *F. laciniata*. Deflandre's (1937) type illustrations of *H. flosculus*, from the Senonian of France, show large, distally spinose processes, which are markedly flared. They are quite different from the processes of the Bathurst Island specimens.

Singh's (1971) illustrations of *H. ferox* show specimens with an elongate antapical process and characteristic tubules at the distal ends of the other major processes. Two of his figures (pl. 51, figs. 1 and 3) also show a precingular archaeopyle, and his record is here transferred to *F. laciniata*. As noted by Davey & Verdier (1973), Cookson & Eisenack (1968) figured a form conspecific with *F. laciniata* as *Cordosphaeridium chimaera*, presumably from the mid-Cretaceous of the Perth Basin. Unfortunately they did not describe or even mention it in the text and it consequently remained a nomen nudum.

Occurrence: *F. laciniata* was originally described from the upper Albian and lower Cenomanian of France (Paris Basin and French Alps). On the basis of Davey & Verdier's (1973) synonymy list, and taking into consideration their usage of previous records of '*Hystrichokolpoma*' *ferox*, *F. laciniata* has a total range at least from the Aptian to the Cenomanian and possibly into the Senonian. Published occurrences include the Aptian of Germany (Eisenack, 1958b), the ?uppermost Albian to Santonian of England (Cookson & Hughes, 1964; Clarke & Verdier, 1967; Davey, 1969a) and Germany (Alberti, 1961), the Albian of northwestern Alberta (Singh, 1971), and the Albian to Cenomanian of the Perth and Carnarvon Basins (Cookson & Eisenack, 1962a, 1968). It occurs throughout the succession in Bathurst Island.

FLORENTINIA MANTELLII (Davey & Williams, 1966) Davey & Verdier, 1973

(Pl. 7, fig. 3)

1962a *Hystrichosphaeridium stellatum* Cookson & Eisenack, 492, pl. 4, fig. 14 (*non* Maier, 1959).
1966b *Hystrichosphaeridium mantelli* Davey & Williams, 66, pl. 6, fig. 6.
1968 *Hystrichosphaeridium stellatum* Cookson & Eisenack, 119, fig. 6J (*non* Maier, 1959).
1971 *Hystrichosphaeridium stellatum* Singh, 331, pl. 53, figs. 1-3 (*non* Maier, 1959).
1971 *Hystrichosphaeridium stellatum* Brideaux, 26, pl. 26, fig. 68; pl. 27, fig . 73 (*non* Maier, 1959).
1973 *Florentinia mantelli* (Davey & Williams) Davey & Verdier, pl. 1, figs. 1, 4, 7; pl. 4, figs. 1, 3.

BMR palynological species catalogue no.: 1006.

Remarks: *F. mantellii* resembles *Florentinia deanei* (Davey & Williams, 1966b), from the middle Cenomanian to Turonian of southern England, in its combination precingular apical archaeopyle and its process arrangement. The latter differs in having more expanded, lagenate processes, which are broader than those of *F.*

mantellii at their bases. The Bathurst Island specimens have processes characteristic of *F. mantellii* and in one a precingular archaeopyle could be identified (pl. 7, fig. 3). Several Cretaceous records of the German Oligocene and Miocene species *Hystrichosphaeridium stellatum* Maier, 1959, are now considered to be referable to *Florentinia mantellii* on the basis of archaeopyle position and process morphology. Typical *H. stellatum* differs in its apical archaeopyle and more cylindrical major processes.

Occurrence: Davey & Williams (1966b) described *F. mantellii* from the lower Cenomanian of southern England. It has also been found in the Cenomanian of northern France, the Turonian of England (Davey, 1969a) and the upper Albian to lower Cenomanian of France (Davey & Verdier, 1973). Cretaceous records of *H. stellatum*, now transferred to *F. mantellii*, include occurrences from the Albian to Cenomanian of the Perth and Carnarvon Basins (Cookson & Eisenack, 1962a, 1968) and the Albian of Alberta (Brideaux, 1971; Singh, 1971). Thus on published data *F. mantellii* has a range from Albian to Turonian. In Bathurst Island it occurs in small numbers throughout the succession.

GROUP 5. Apical archaeopyle. Proximate cysts.

Genus MICRODINIUM Cookson & Eisenack, 1960, emended Sarjeant, 1966

Type species: Microdinium ornatum Cookson & Eisenack, 1960.

MICRODINIUM ORNATUM Cookson & Eisenack, 1960

(Pl. 2, figs. 7, 8)

1960a *Microdinium ornatum* Cookson & Eisenack, 6, pl. 2, figs. 3-8; text-figs. 2-4.

BMR palynological species catalogue no.: 963.

Remarks: The rare specimens found in the Bathurst Island material agree with the type specimen in their shape and in the character of their plate boundaries. A small epitract and a large hypotract appear to be characteristic of the genus. The sutures are marked by lists which are perforate proximally. The pillars left by these lumina are regular in size and oval or rectangular in cross section. Sarjeant (1966a) and Davey (1969a) related some English and French Cenomanian—Turonian specimens to *M. ornatum*. They found that their material and that of Clarke & Verdier (1967) (from the English Cenomanian to Santonian) had distally divided sutural lists and lacked one plate at the ventral side of the cingulum. This plate was also missing on the one specimen from Bathurst Island upon which tabulation could be elucidated. The European *M.* cf. *ornatum* may only represent a geographical variant.

Occurrence: M. ornatum was originally described by Cookson & Eisenack from the ?upper Albian or Cenomanian of the Perth Basin. They also found it in Albian to lower Turonian strata from the Carnarvon Basin and (Cookson & Eisenack, 1971) the mid-Cretaceous of the Eucla Basin. Edgell (1964) recorded but did not figure it from his *Wetzeliella*? *neocomica* Zone in the Perth Basin, which he dated as Hauterivian to Barremian. (This is stratigraphically considerably older than all other published records of *M. ornatum* and is treated with some reservation.) He also listed it as one of the fossils characteristic of his *Diconodinium tenuistriatum* Subzone, which he equated with the Upper Osborne Formation (?u. Cenomanian) of the Perth Basin. Manum & Cookson (1964) found *M. ornatum* in the Upper Cretaceous of Arctic Canada, Baltes (1967a) figured it from the Romanian Albian, and Davey & Verdier (1973) recorded it from the uppermost Albian (Vraconian) of the Paris Basin.

MICRODINIUM sp. cf. M. SETOSUM Sarjeant, 1966

(Pl. 13, fig. 2; Pl. 17, fig. 2)

cf. 1966a *Microdinium setosum* Sarjeant, 151, pl. 16, figs. 9, 10; text-fig. 39.
cf. 1967 *Microdinium echinatum* Clarke & Verdier, 64, pl. 1, figs. 9, 10; text-fig. 26.

BMR palynological species catalogue no.: 962.

Remarks: Three specimens from Bathurst Island no. 2 well are similar to Sarjeant's species (1966a) in having spiny lists and a small epitract. However, they differ in their smooth plate areas, and their nomenclature is left open pending the examination of more material.

Occurrence: Davey (1969a) and Davey & Verdier (1971, 1973) found *M. setosum* in Albian to Cenomanian strata from southern England and France. *M. echinatum*, which Clarke et al. (1968) showed to be a junior synonym of *M. setosum*, was reported by Clarke & Verdier (1967) from throughout the southern English Cenomanian. They also note its occurrence in unspecified pre-Cenomanian strata.

MICRODINIUM sp. A

(Pl. 2, fig. 6)

BMR palynological species catalogue no.: 964.

Description: Proximate, acavate cyst, with a prolate body consisting of a small epitract and a much larger hypotract. The cingulum is broad and very slightly helicoid. Plate areas are limited by finely and irregularly beaded sutural lists, 0.5 μm to 1 μm in width, and up to 1 μm high. The full tabulation is indeterminable but the precingular plate areas are considerably smaller than the postcingular ones. An apical archaeopyle and an indistinct sulcus are present. The wall is thin and the plate areas are ornamented by an irregular reticulum. Muri are less than 0.2 μm high, 0.5 to 1 μm wide, while the lumina are 0.5 to 2 μm in diameter.

Dimensions: The figured specimen is 36 μm long and 30 μm wide.

Remarks: The single specimen found differs from all described species of *Microdinium* in its reticulate ornamentation. The small epitract, apical archaeopyle, and small size support the generic allocation.

Genus MEIOUROGONYAULAX Sarjeant, 1966

Type species: Meiourogonyaulax valensii Sarjeant, 1966.

?MEIOUROGONYAULAX sp. A

(Pl. 6, fig. 6)

BMR palynological species catalogue no.: 967.

Description: Acavate proximate cyst, oval in outline, with a subequal epitract and hypotract, or in some cases with a reduced epitract. The cingulum is narrow and very slightly helicoid; the sulcus is indistinct. Sutures are marked by zones of irregular rugulae 2 to 3 μm wide. The rugulae are 0.5 μm high, 0.5 to 2 μm long, and sometimes fused into beaded, irregular ridges. Tabulation is indistinct but five precingular and six postcingular plate areas are present. The archaeopyle is apical and formed by the loss of what appears to be a single plate. The wall is thin and smooth except near the sutures.

Dimensions: The figured specimen is 65 μm long and 69 μm wide.

Remarks: The presence of an apical archaeopyle and five precingular plate areas in the rare specimens available suggests an affinity with the genus *Glyphanodinium*. They are quite distinct from the heavily crested Upper Jurassic species of *Meiourogonyaulax*, including the type species *M. valensii* Sarjeant, 1966a. One specimen (figured) has an operculum still attached to the archaeopyle and this seems to be haplotabular. However, dehisced specimens have a somewhat zig-zag archaeopyle margin, indicating that a tetratabular operculum may once have been present.

Genus CASSICULOSPHAERIDIA Davey, 1969

Type species: Cassiculosphaeridia reticulata Davey, 1969.

CASSICULOSPHAERIDIA RETICULATA Davey, 1969

(Pl. 9, figs. 11, 12)

1969a *Cassiculosphaeridia reticulata* Davey, 142, pl. 3, fig. 7; pl. 4, fig. 3.

BMR palynological species catalogue no.: 979.

Remarks: The Bathurst Island specimens, which occur throughout both sections, are identical with Davey's (1969a) type figures and description. In certain cases the disposition of the reticulum in the equatorial region suggests the presence of a cingulum. These resemble *Dictyopyxidia circulata* Clarke & Verdier, 1967, but do not appear to be cavate.

Occurrence: Davey (1969a) recorded this species from the upper Cenomanian of southern England and from throughout the Cenomanian of northern France. Davey & Verdier (1971) also found it throughout the Albian of the Paris Basin.

GROUP 6. Apical archaeopyle. Proximochorate cysts.

Genus XIPHOPHORIDIUM Sarjeant, 1966

Type species: Hystrichodinium alatum Cookson & Eisenack, 1962.

1967 *Pyramidium* Clarke & Verdier, 39.

XIPHOPHORIDIUM ALATUM (Cookson & Eisenack, 1962) Sarjeant, 1966

(Pl. 10, fig. 11)

1962a *Hystrichodinium alatum* Cookson & Eisenack, 487, pl. 2, figs. 1-4.
1966a *Xiphophoridium alatum* (Cookson & Eisenack) Sarjeant, 147, pl. 16, fig. 11.
1967 *Pyramidium alatum* (Cookson & Eisenack) Clarke & Verdier, 40, pl. 6, figs. 5, 6.

BMR palynological species catalogue no.: 1024.

Remarks: Cookson & Eisenack's holotype (1962a) has been examined in the National Museum, Melbourne, and appears to have a precingular archaeopyle. Unfortunately the paratypes could not be studied, but in view of the apical archeopyle described by Clarke & Verdier (1967), Sarjeant (1966a), and Davey (1970), and its consistent presence in the well preserved Bathurst Island material, the feature developed on the holotype is thought to be due to coincidental breakage. In all other characters the specimens under study agree with the published data.

Occurrence: Cookson & Eisenack (1962a) described *X. alatum* from the Albian of the Carnarvon Basin and the ?upper Albian to Cenomanian of the Perth Basin. Edgell (1964) noted it in the upper Cenomanian of the Perth Basin. It has also been recorded from the upper Albian and lower Cenomanian of central England (Cookson & Hughes, 1964) and the Cenomanian of southern England and northern France (Davey, 1970). Clarke & Verdier (1967) found it in the Cenomanian and lower Turonian of southern England and Davey & Verdier (1971) reported it in upper Albian strata from the Paris Basin. Finally Brideaux (1971) illustrated a cyst from the Albian of Canada as *Meiourogonyaulax* ? sp.A, which should probably belong in *Xiphophoridium alatum.*

GROUP 7. Apical archaeopyle. Chorate cysts.

Genus HYSTRICHOSPHAERIDIUM Deflandre, 1937, emended Davey & Williams, 1966

Type species: Xanthidium tubiferum Ehrenberg, 1838.

HYSTRICHOSPHAERIDIUM DIFFICILE Manum & Cookson, 1964

(Pl. 4, figs. 1, 2, 3)

1964 *Hystrichosphaeridium difficile* Manum & Cookson, 12, pl. 3, figs. 1-3, 7.
1966b ?*Cordosphaeridium difficile* (Manum & Cookson) Davey & Williams, 91 (nomen nudum).

BMR palynological species catalogue no.: 996.

Remarks: The material studied differs slightly from the type illustrations in lacking a low apical horn. The broad processes are very similar and serve to distinguish it from *Cordosphaeridium eoinodes* (Eisenack, 1958b). In addition, the Bathurst Island specimens have a clearly apical archaeopyle with a notched border, whereas that of *C. eoinodes* is precingular in position. The form illustrated by Baltes (1969), as *H.* cf. *difficile*, from the Oligocene of Romania, is not the same as the Bathurst Island specimens.

Occurrence: This species occurs sporadically in no. 2 well, being commonest near the top. It was described from the Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964). Davey (1969a) also recorded it from the Albian and Cenomanian of Saskatchewan.

?HYSTRICHOSPHAERIDIUM sp. A

(Pl. 7, fig. 8)

BMR palynological species catalogue no.: 1007.

Description: A chorate cyst, in which the psilate endophragm and periphragm are in close contact over most of the surface. The periphragm gives rise to between 40 and 50 similar short hollow processes. Proximally the processes are cylindrical, but distally they are flared and open, with an entire and sometimes slightly recurved margin. The central body wall is very thin (less than 0.2 μm). No trace of tabulation or reflected tabulation has been found and the position of the archaeopyle is indeterminable.

Dimensions: The overall diameter ranges between 20 and 30 μm. The figured specimen has an overall diameter of 25 μm, a central body diameter of 20 μm, and processes 2 to 3 μm long.

Remarks: The form is considerably smaller than *Hystrichosphaeridium arundum* Eisenack & Cookson, 1960, and lacks narrow, differentiated sulcal and cingular processes. The larger processes of *H. arundum* are more cylindrical in shape and do not bear broadly flared or recurved distal margins. ?*H.* sp.A occurs very rarely in the lower part of both sections.

Genus OLIGOSPHAERIDIUM Davey & Williams, 1966

Type species: Xanthidium tubiferum complex White, 1842.

OLIGOSPHAERIDIUM COMPLEX (White, 1842) Davey & Williams, 1966

(Pl. 7, fig. 1)

1842 *Xanthidium tubiferum complex* White, 39, pl. 4, div. 3, fig. 11.
1848 *Xanthidium complexum* (White) Bronn, 1375.
1940 *Hystrichosphaeridium elegantulum* Lejeune-Carpentier, 22, text-figs. 11, 12.
1946 *Hystrichosphaeridium complex* (White) Deflandre, 11.
1966b *Oligosphaeridium complex* (White) Davey & Williams, 71, pl. 7, figs. 1, 2; pl. 10, fig. 3; text-fig. 14 (see also for earlier references).

BMR palynological species catalogue no.: 1009.

Remarks: The species is characterized by its thin wall, its long narrow similar intratabular processes with deeply branched terminations, its apical archaeopyle, and its lack of cingular processes. Detached opercula with three and four processes have been found. The process terminations are non-fenestrate, in contrast with those of *O. pulcherrimum* (Deflandre & Cookson, 1955), but are divided into branched and recurved aculei.

Occurrence: Davey & Williams (1966b), Clarke & Verdier (1967) and Davey (1969a) listed the published occurrences of *O. complex* and found that it had a worldwide range from the Neocomian to the Palaeogene. The oldest well documented occurrence is that described by Millioud (1967, 1969), who found it in stratotype Hauterivian rocks of the Alps but not in the stratotype Valanginian or Berriasian. It has also been recorded from the Neocomian to the Aptian of the Perth Basin (Edgell, 1964), the Danian of California (Drugg, 1967), the Albian to lower Cenomanian of France (Davey & Verdier, 1971, 1973), the Upper Cretaceous of northern Italy (Corradini, 1971), and the middle to upper Albian of Canada (Brideaux, 1971; Singh, 1971). It is a common constituent of the flora at Bathurst Island, throughout the succession.

OLIGOSPHAERIDIUM PULCHERRIMUM (Deflandre & Cookson, 1955) Davey & Williams, 1966

(Pl. 5, figs. 1-4)

1955 *Hystrichosphaeridium pulcherrimum* Deflandre & Cookson, 270, pl. 1, fig. 8; text-figs. 21, 22.
1966b *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey & Williams, 75, pl. 10, fig. 9; pl. 11, fig. 5.

BMR palynological species catalogue no.: 1010.

Remarks: The apical archaeopyle and the absence of cingular processes are typical of the genus. The processes are variable and may be moderately stout or, more commonly, very slender. Distally they broaden or become markedly flared. They have fenestrate terminations; the polygonal lumina are separated by thin, narrow strips of periphragm. The distal margin is always aculeate, although the spines may be fairly widely spaced.

The morphology of the processes distinguishes *Oligosphaeridium pulcherrimum* from all other species. *O. complex* (White) has aculeate but non-fenestrate processes. *O. reticulatum* Davey & Williams, 1966, *O. vaseformum* (Neale & Sarjeant, 1962) and *O. macrotubulum* (Neale & Sarjeant, 1962) all bear non-fenestrate processes and have a pitted or reticulate central body. Both *Areosphaeridium dictyoplokus* (Klumpp, 1953) and *Oligosphaeridium perforatum* (Gocht, 1959) have fenestrate processes, but the complete termination consists of a flat, table-like structure. The perforations tend to be more rounded than in *O. pulcherrimum* and the distal margin is entire, rather than spinose. In *O. anthophorum* (Cookson & Eisenack, 1958) the processes also have an entire distal margin but the perforations begin well down on the stem. *O. reniforme* (Tasch, McClure, & Oftedahl, 1964) has perforate, distally aculeate processes but the marginal spines are considerably fewer and more sparsely distributed than in *O. pulcherrimum.*

Occurrence: Oligosphaeridium pulcherrimum was originally described by Deflandre & Cookson (1955) from the Lower Cretaceous of the Eromanga Basin. It has also been recorded from the mid-Cretaceous and Senonian of the Eucla Basin (Cookson & Eisenack, 1970a, 1971) and the lowest Campanian or Santonian of the Perth Basin (Cookson & Eisenack, 1968). Other occurrences include those of Delcourt & Sprumont (1957, 1959a,b), from the 'Wealden' of Belgium; Valensi (1955b), from the Cretaceous of France; Davey & Williams (1966b), from the lower Eocene of England; Clarke & Verdier (1967), from the Cenomanian to Coniacian of England; Singh (1971), from the middle and upper Albian of Alberta; Heisecke (1970), from the Danian of Argentina; and Leopold & Pakiser (1964), from the Upper Cretaceous of Alabama. Brideaux (1971) compared a specimen from the Albian of Alberta with *O. pulcherrimum.* It occurs throughout the succession in Bathurst Island.

Genus LITOSPHAERIDIUM Davey & Williams, 1966

Type species: Hystrichosphaeridium siphoniphorum Cookson & Eisenack, 1958.

LITOSPHAERIDIUM SIPHONIPHORUM (Cookson & Eisenack, 1958) Davey & Williams, 1966

(Pl. 10, figs. 3, 4)

1958 *Hystrichosphaeridium siphoniphorum* Cookson & Eisenack, 44, pl. 11, figs. 8-10.
1966b *Litosphaeridium siphoniphorum* (Cookson & Eisenack) Davey & Williams, 80, pl. 7, figs. 7, 8; text-figs. 16, 17 (see also for earlier references).

BMR palynological species catalogue no.: 1008.

Remarks: The holotype and paratypes of *Litosphaeridium siphoniphorum* have been examined in the National Museum, Melbourne, and the Bathurst Island material agrees with them in all respects except size. The Bathurst Island specimens are slightly smaller; but Davey (1969a) found considerable size variation in his assemblages from the English Cenomanian. The archaeopyle is apical and detached opercula bearing three and four processes have been identified.

Occurrence: Cookson & Eisenack (1958) described *L. siphoniphorum* from the Albian of the Carnarvon Basin and the Albian and ?Cenomanian of the Perth Basin. It is also known from the Albian of Romania (Baltes, 1963, 1967b), the upper Albian and lower Cenomanian of eastern England (Cookson & Hughes, 1964), the mid-Cretaceous of the Perth Basin (Cookson & Eisenack, 1968), the Albian to Cenomanian of England and Canada, the Cenomanian of northern France (Davey, 1969a), the upper Albian of the Paris Basin and southeast France (Davey & Verdier, 1973), and the Cenomanian of southern England (Clarke & Verdier, 1967). It is abundant throughout the Bathurst Island sections.

Genus PROLIXOSPHAERIDIUM Davey, Downie, Sarjeant, & Williams, 1966

Type species: Prolixosphaeridium deirense Davey et al., 1966b.

PROLIXOSPHAERIDIUM CONULUM Davey, 1969

(Pl. 6, fig. 10)

1969a *Prolixosphaeridium conulum* Davey, 160, pl. 8, figs. 5, 6.

BMR palynological species catalogue no.: 1011.

Remarks: The Bathurst Island specimens, which are found only in the lower part of both sections, agree with Davey's (1969a) figures and description regarding their granular ornamentation and process length. *Prolixosphaeridium granulosum* (Deflandre, 1937) differs in having longer processes with coarser ornamentation on the central body. A related form, *Prolixosphaeridium parvispinum* (Deflandre, 1937), has more numerous shorter processes with fine spines between the processes. The specimens figured by Cookson & Eisenack (1958) as *Hystrichosphaeridium parvispinum*, from the Aptian of the Eromanga and Papuan Basins, have been examined in the National Museum, Melbourne. The specimen figured on plate 8, figure 12 has more processes and a more finely granulate periphragm than the Bathurst Island material. This specimen is similar to Deflandre's (1937) original figure of *H. xanthiopyxides* var. *parvispinum*. The form illustrated on plate 8, figure 11 is quite different and has fewer and stouter processes. It remains distinct from the material under study in that the periphragm is densely spinulate between the processes. The Bathurst Island specimens have a granulate, not an echinate periphragm.

Occurrence: Davey (1969a) found this species restricted to the upper Cenomanian of southern England and northern France, but it has since been recorded from the uppermost Albian (Vraconian) of the Paris Basin (Davey & Verdier, 1973).

Genus TANYOSPHAERIDIUM Davey & Williams, 1966

Type species: Tanyosphaeridium variecalamum Davey & Williams, 1966b.

TANYOSPHAERIDIUM SALPINX sp. nov.

(Pl. 9, fig. 10)

1971 *Tanyosphaeridium* sp. Singh, 344, pl. 57, fig. 7.

Holotype: Plate 9, fig. 10. Bathurst Island no. 2 well, core 6, 126.5 m, 418′0-6″. M.F.P. 4435-2:130:036 (CPC 12269). Overall length (dehisced) 39 μm, overall width 44 μm, length central body 30 μm, width central body 22 μm, process length 9-13 μm.

Derivation of name: The specific name is the Greek *salpinx*, a trumpet, noun in apposition; with reference to the trumpet-like process terminations.

BMR palynological species catalogue no.: 1012.

Diagnosis: Cyst chorate, central body elongate. Processes intratabular, one per plate area and up to 30 in number. Sulcal processes slightly smaller than the others. Process terminations open, flared, and entire. Central body wall thin, sparsely granulate. Reflected tabulation formula 4′, 6″, 6c, 6‴, ?1p, 1-4⁗, 1-3s. Archaeopyle apical, tetratabular, with a notched margin.

Description: Chorate cyst, with a markedly elongate central body and up to 30 slender processes. The processes are intratabular in position, arranged one per plate area and reflect a tabulation formula 4′, 6″, 6c, 6‴, ?1p, 1-4⁗ and 1-3s. All major whorls have similar sized processes but the variable number of sulcal processes are slightly smaller. The major processes are hollow, smooth, distally open, and form a circle where they leave the central body. Over most of their length they are cylindrical (1-2 μm wide) or become slightly narrower. Distally they expand to an open trumpet-shaped termination, having an entire or finely serrate margin. The central body is sometimes sparsely granulate but it is uncertain whether the periphragm or the endophragm bears this ornament. The two membranes are very thin and are usually under 0.5 μm in total thickness. The archaeopyle is apical in position, jagged or notched in outline, and is probably formed by the loss of four reflected plate areas.

Dimensions: The overall length varies from 37 to 51 μm with an average of 43 μm for 10 measured specimens.

Remarks: This form differs from all previously described species of *Tanyosphaeridium* in its distally flared processes. The holotype of *T. isocalamus* (Deflandre & Cookson, 1955), from the Lower Cretaceous of the Eromanga Basin, has processes which are cylindrical for the whole of their length and do not bear the cone-like expansions typical of *T. salpinx*. *T. variecalamum* Davey & Williams, 1966b, from the English Cenomanian, has distally cylindrical or tapering processes. The form illustrated as *Tanyosphaeridium* sp. by Singh (1971), from the middle and upper Albian of Alberta, has distally flared processes and is probably conspecific with the Bathurst Island specimens. *T. salpinx* is common in the lower parts of both Bathurst Island wells.

Genus CLEISTOSPHAERIDIUM Davey, Downie, Sarjeant, & Williams, 1966

Type species: Cleistosphaeridium diversispinosum Davey et. al., 1966b.

CLEISTOSPHAERIDIUM POLYPES (Cookson & Eisenack, 1962) Davey, 1969

(Pl. 6, fig. 7)

1962a *Hystrichosphaeridium recurvatum* subsp. *polypes* Cookson & Eisenack, 491, pl. 4, figs. 11-13.
1966b ?*Polysphaeridium polypes* (Cookson & Eisenack) Davey & Williams, 99 (nomen nudum).
1969a *Cleistosphaeridium polypes* (Cookson & Eisenack) Davey, 154, pl. 6, figs. 7, 8.

BMR palynological species catalogue no.: 991.

Remarks: The Bathurst Island specimens agree with Cookson & Eisenack's (1962a) type illustrations and with Davey's (1969a) figures. Some specimens have a notched, probably apical archaeopyle. They differ from *C. polypes* var. *clavulum* Davey, 1969a (figured by Cookson & Hughes, 1964, as *Hystrichosphaeridium recurvatum* var. *polypes*), in having distally open processes with aculeate, sometimes recurved margins. The variety *clavulum* has capitate process terminations.

Occurrence: This form occurs irregularly in both wells. It has been recorded from the Aptian to Cenomanian of the Perth Basin, the Albian and ?Cenomanian of the Carnarvon Basin, and the Aptian of the Carpentaria Basin (Cookson & Eisenack, 1962a). Davey (1969a) described it from the middle and upper Cenomanian of southern England and northern France, the upper Cenomanian of Texas and the Albian/Cenomanian of Saskatchewan. It is also known from the middle and upper Albian of Alberta (Singh, 1971) and from the lower and middle Albian of the Paris Basin (Davey & Verdier, 1971).

CLEISTOSPHAERIDIUM ANCHORIFERUM (Cookson & Eisenack, 1960), Davey, Downie, Sarjeant, & Williams, 1966

(Pl. 6, fig. 8)

1960a *Hystrichosphaeridium anchoriferum* Cookson & Eisenack, 8, pl. 2, fig. 11.
1966b *Cleistosphaeridium anchoriferum* (Cookson & Eisenack) Davey et al., 167.

BMR palynological species catalogue no.: 992.

Remarks: Davey (1969a) and Clarke & Verdier (1967) considered *Cleistosphaeridium anchoriferum* to be a junior synonym of *C. huguoniotii* (Valensi, 1955a). Davey (1969a) also included Cookson & Hughes' (1964) record of *Chlamydophorella nyei* (from the English upper Albian and lower Cenomanian) in *Cleistosphaeridium huguoniotii*. He further described a variant of *C. huguoniotii* with septate processes (var. *pertusum*). However, Cookson & Eisenack (1968, 1969) considered the Australian specimens to differ in process structure from certain of those from Europe. If they are distinct, the Australian material should remain in *C. anchoriferum*. Until a more thorough examination of the type specimens has been completed the Australian and European citations are kept as separate species.

The holotype of *C. anchoriferum* has been examined and agrees in all respects with the Bathurst Island specimens. Some of the latter have well preserved apical archaeopyles. This species is quite distinct from *Chlamydophorella nyei*, which has much smaller and more slender processes joined by a more or less complete distal membrane.

Occurrence: *C. anchoriferum* occurs sporadically in both wells but is absent from the uppermost samples. Its published Australian occurrences include the Albian to Cenomanian of the Perth and Carnarvon Basins (Cookson & Eisenack, 1960a, 1969) and the mid-Cretaceous of the Perth Basin (Cookson & Eisenack, 1968).

CLEISTOSPHAERIDIUM sp. aff. C. ARMATUM (Deflandre, 1937) Davey, 1969

(Pl. 4, figs. 9, 10: Pl. 7, figs. 6, 7)

cf. 1937 *Hystrichosphaeridium armatum* Deflandre, 28, pl. 16, figs. 6, 7.
cf. 1963 *Baltisphaeridium armatum* (Deflandre) Downie & Sarjeant, 91.
cf. 1969a *Cleistosphaeridium armatum* (Deflandre) Davey, 153, pl. 8, figs. 1, 2, 12.

BMR palynological species catalogue no.: 999.

Remarks: In the Bathurst Island wells *Cleistosphaeridium* aff. *C. armatum* is abundant throughout the section. It has numerous similar hollow tapering and distally pointed processes. It is a small form (overall diameter not exceeding 47 μm) and the surface of the central body is densely but finely granulate. An apical archaeopyle is sometimes developed (Pl. 7, fig. 7). In certain specimens the archaeopyle is smaller and resembles the precingular archaeopyle of *Cordosphaeridium* (Pl. 7, fig. 6). Unfortunately the processes show no polar differention or cingular alignment, so that it is very difficult to ascertain the correct orientation.

Deflandre (1937), Clarke & Verdier (1967), and Davey (1969a) all describe minute but characteristic hair-like baculae or elongate granulations covering the central body of *Cleistosphaeridium armatum*. This feature is not present on any of the material from Bathurst Island, although it agrees with the published descriptions in all other features. The erection of a new taxon based on this criterion alone is not considered wise at this time and the material under study is related to rather than identified with Deflandre's species.

Occurrence: True *C. armatum* is known from the Albian to the Campanian from various localities in Europe, and from the Cenomanian of Texas (Davey, 1969a).

?CLEISTOSPHAERIDIUM sp. A

(Pl. 11, fig. 12)

BMR palynological species catalogue no.: 993.

Description: Chorate cyst, with a spherical or slightly prolate central body. Over the central body the cyst wall is very thin (less than 0.2 μm), completely smooth, and easily crumpled. More than 50 similar, hollow, very slender processes (11 to 16 μm long) are distributed without apparent alignment or pattern. They arise from slightly expanded bases and then taper from about 1 to 0.5 μm in diameter. Distally they are closed and may be pointed, minutely capitate (terminal button less than 0.5 μm in diameter) or bear two recurved aculei. All three types are known to occur on the same specimen. An archaeopyle is sometimes developed and appears to be apical in position.

Dimensions: The overall size varies between 47 and 61 μm (average 53 μm for 14 specimens). The figured specimen has an overall diameter of 60 μm and a central body 38 μm in diameter.

Remarks: The lack of orientational structures and the easily deformable nature of the cyst wall make the identification of archaeopyle position uncertain. As a result, the generic placing must remain questionable. This form differs from all described species of *Cleistosphaeridium* and from similar species of *Exochosphaeridium*, *Cordosphaeridium* etc., in its very thin wall structure and very slender processes. It is morphologically closest to *Cleistosphaeridium polypes* (Cookson & Eisenack). *?C.* sp.A occurs rarely in both wells.

?CLEISTOSPHAERIDIUM sp.B

(Pl. 6, fig. 5)

BMR palynological species catalogue no.: 1002.

Description: Chorate cyst, 50 to 54 μm in diameter, with a spherical central body. The completely smooth wall (0.5 μm thick) gives rise to more than 50 similar solid processes. These are 0.2-0.5 μm in diameter, sinuous, and relatively short (7 and 11 μm long). Some processes branch dichotomously for the final quarter of their length and some branch a second time. All branched and unbranched processes have minute capitate terminations. An archaeopyle is possibly present on two specimens but its position is open to question. There is no apparent pattern in the distribution of the processes.

Dimensions: The figured specimen has an overall diameter of 54 μm and a central body diameter of 42 μm.

Remarks: This form differs from *?Cleistosphaeridium* sp.A in having shorter, branching processes and a thicker wall. The various types of *Baltisphaeridium* known from Bathurst Island have much more numerous and more slender processes. *?Cleistosphaeridium* sp.B occurs very rarely in two samples from Bathurst Island no. 2 well.

?CLEISTOSPHAERIDIUM sp.C

(Pl. 6, fig. 4)

BMR palynological species catalogue no.: 995.

Description: Chorate cyst with a slightly oblate central body whose wall is less than 0.5 μm thick. Similar, solid, numerous processes (8 to 10 μm long) almost obscure the faintly granulate surface of the central body. The processes have a slightly fibrous structure, are about 0.5 to 1 μm in thickness and are straight or sinuous. They are often proximally united, and distally may be finely branched, aculeate or (more commonly) simple and truncate. They are not arranged in any definable pattern and show no alignment. An apical archaeopyle is present.

Dimensions: The figured specimen is 59 μm in overall diameter and its central body is 40 μm across.

Remarks: The rare specimens from no. 2 well differ from *Hystrichosphaeridium difficile* Manum & Cookson, 1964, in having much more numerous and narrower processes. *Exochosphaeridium phragmites* and *E. pseudhystrichodinium* have pointed, not truncate, process terminations. *Cleistosphaeridium* sp.C may be further differentiated in its possession of an apical instead of a precingular archaeopyle.

GROUP 8. Epitractal archaeopyle. Chorate cysts.

Genus CALLAIOSPHAERIDIUM Davey & Williams, 1966

Type species: Hystrichosphaeridium asymmetricum Deflandre & Courteville, 1939.

1967 *Hexasphaera* Clarke & Verdier, 42.

CALLAIOSPHAERIDIUM ASYMMETRICUM (Deflandre & Courteville, 1939) Davey & Williams, 1966

(Pl. 6, fig. 1)

1939 *Hystrichosphaeridium asymmetricum* Deflandre & Courteville, 100, pl. 4, figs. 1, 2.
1966b *Callaiosphaeridium asymmetricum* (Deflandre & Courteville) Davey & Williams, 104, pl. 8, figs. 9, 10; pl. 9, fig. 2.
1967 *Hexasphaera asymmetrica* (Deflandre & Courteville) Clarke & Verdier, 43, pl. 7, figs. 1-3; text-fig. 17.

BMR palynological species catalogue no.: 989.

Remarks: The genera *Callaiosphaeridium* Davey & Williams, 1966b, and *Hexasphaera* Clarke & Verdier, 1967, were erected within a year of each other using the same type species. Clarke et al. (1968) showed that *Callaiosphaeridium* has priority. The Bathurst Island material agrees with the published illustrations in most respects. The specimen figured confirms the presence of an epitractal archaeopyle. Evitt (1967) described a type AP archaeopyle on specimens from the Upper Cretaceous of France. The presence of notches between the large cingular processes indicate that these are intratabular in position.

Occurrence: Callaiosphaeridium asymmetricum has been recorded from the French Turonian to Senonian (Deflandre & Courteville, 1939), from the Albian of Alberta (Brideaux, 1971), from the French Albian to Cenomanian and the English upper Albian to lower Turonian (Davey, 1969a; Davey & Verdier, 1971, 1973). Clarke & Verdier (1967) found it in English Cenomanian to mid-Santonian strata (they also note unspecified pre-Cenomanian records) and used its final appearance to mark the top of their *'Hexasphaera' asymmetrica* concurrent range Subzone. Davey & Williams (1966b) recorded it from the English Neocomian and Cenomanian. Zaitzeff & Cross (1970) figured a form to which they attached a cf. determination from the lower Maastrichtian of Texas. It occurs in the lower parts of both Bathurst Island wells: the first Australian record of the species.

Genus ACTINOTHECA Cookson & Eisenack, 1960, emended Cookson & Eisenack, 1961

Type species: Actinotheca aphroditae Cookson & Eisenack, 1960.

ACTINOTHECA sp.A

(Pl. 6, fig. 9)

BMR palynological species catalogue no.: 990.

Description: Cyst chorate and pterate. Central body circular or oval in polar view with a smooth or very faintly granulate wall less than 0.5 μm thick. Six or seven broad processes are arranged around the periphery, presumably in cingular positions. They have parallel or slightly divergent sides and are 8 to 10 μm wide and 10 to 15 μm long. They are flattened or rhomboidal in section and distally are open, with finely serrate margins. The processes are linked laterally by two very thin membranes. The only traces of tabulation on the central body are the tangential lines where the membranes arise and these circumscribe two large polygonal bare polar areas. The archaeopyle is apparently epitractal in position and is formed by the loss of the whole of the cysts above the large processes.

Dimensions: In the figured specimen the overall diameter is 78 μm, central body diameter 51 μm.

Remarks: The specimens are placed in *Actinotheca* because of their double peripheral membrane and the restriction of processes to the cingulum. *H. aproditae* Cookson & Eisenack, 1960a (Turonian, Carnarvon Basin) lacks such processes but has two similar peripheral (or cingular) membranes. *A. ornata* Cookson & Eisenack, 1970a, from the Senonian of the Eucla Basin, has much broader processes. Evitt (1967) commented on a probable epitractal archaeopyle in *A. aphroditae*, a feature which is questionably present on one of the Bathurst Island specimens. 'Object A, genus and species indeterminate' of Cookson & Eisenack (1970a) (Albian-Cenomanian of Eucla Basin), is also very similar to *Actinotheca* sp.A. However, 'Object A' has a tangential breakage, which may represent an apical archaeopyle. If this is correct its affinities would more correctly lie with the *Cyclonephelium* group than with *Actinotheca*. *A.*sp.A occurs very rarely in the lower samples of Bathurst Island no. 1 well.

GROUP 9. Apical archaeopyle. Dorsoventrally flattened, chorate or proximate, sometimes marginate cysts.

Genus CYCLONEPHELIUM Deflandre & Cookson, 1955,
emended Williams & Downie, 1966

Type species: Cyclonephelium compactum Deflandre & Cookson, 1955.

CYCLONEPHELIUM COMPACTUM Deflandre & Cookson, 1955

(Pl. 9, figs. 5, 6)

1955 *Cyclonephelium compactum* Deflandre & Cookson, 285, pl. 2, figs. 11-13.

BMR palynological species catalogue no.: 745.

Remarks: The occasional specimens from Bathurst Island have been compared with the holotype in the National Museum, Melbourne. The specific limits between *Cyclonephelium compactum*, *C. distinctum* Deflandre & Cookson, and *C. membraniphorum* Cookson & Eisenack are not clear-cut. *C. compactum* appears to be intermediate between the other two species on process morphology (see Text-fig. 14). In *C. compactum* the processes are restricted to the margin of the cyst. They are broader than those of *C. distinctum* and are fibrous in structure, not membranous as in *C. membraniphorum*. One of Cookson & Eisenack's (1962a) figures of *C. compactum* (pl. 5, fig. 3) would be placed on present concepts in *C. membraniphorum*. *C. hughesii* Clarke & Verdier is similar to *C. compactum* in having relatively broad processes, but the processes are much thicker and denser.

Occurrence: *Cyclonephelium compactum* was first described from the Lower Cretaceous of the Eromanga Basin. It is also known from the Upper Cretaceous of the Perth Basin (Deflandre & Cookson, 1955) and Aptian to Cenomanian sediments of the Perth Basin (Cookson & Eisenack, 1958, 1962a). Edgell (1964) found it in the Aptian of the Perth Basin and Brideaux (1971) figured it from the Albian of Alberta.

CYCLONEPHELIUM DISTINCTUM Deflandre & Cookson, 1955

(Pl. 8, figs. 1-3)

1955 *Cyclonephelium distinctum* Deflandre & Cookson, 285, pl. 2, fig. 14.
1961 *Circulodinium deflandrei* Alberti, 29, pl. 4, figs. 7-13.

BMR palynological species catalogue no.: 980.

Remarks: Several authors have commented on the variability of *Cyclonephelium distinctum*, including Deflandre & Cookson (1955), Cookson & Eisenack (1962a), Davey (1969a) and Gocht (1959). Cookson & Eisenack (1962a) and Manum & Cookson (1964) described variation which they thought was stratigraphically correlated. They found that in older formations their specimens had more numerous processes, which covered larger parts of the dorsal and ventral areas of the cyst. *C. distinctum* is common throughout the succession in the Bathurst Island wells and is sometimes the dominant species of the assemblage. A large range of variation is present and attempts at subdivision failed for lack of clear-cut non-gradational morphological changes. Even the differences linked with stratigraphic position could not be supported, as all the variants with the features mentioned by the above authors occurred together in the same assemblages. The conclusion was reached that this is an inherently very variable and complex species plexus.

The main lines of variation are shown diagrammatically in Figure 14. Some of them, when logically extrapolated, reach separate specific status and even in these cases specific limits are not always well defined. Typical *C. distinctum* (i.e. forms identical with the holotype) are characterized by short, narrow processes, confined to the margin of the cyst. These may intergrade with forms in which the processes are longer and thicker, or longer and narrower. Those with broader processes begin to resemble *C. compactum*, for which no clear limits could be identified. The Bathurst Island specimens of *C.* cf. *hughesii* also have broader, thicker processes but are a quite distinct species. There is a considerable range of variation in the extent to which the processes encroach upon the dorsal and ventral bald areas. Alberti (1961) illustrated specimens in which these areas are completely covered and gave them a new generic and specific name (*Circulodinium deflandrei*). Identical specimens are here included in the expanded *C. distinctum.* A further variant is represented by forms in which the processes cover the whole cyst but are much reduced in length. These are considered specifically distinct and are placed in *C. vannophorum* Davey, 1969a. Forms without dorsal and ventral unornamented areas also resemble ?*C. attadalicum* Cookson & Eisenack, 1962a. However, the well marked cingulum and sulcus which characterizes that species is absent in all the Bathurst Island material. The relationship between the *'Circulodinium deflandrei'* variants and certain species of *Tenua* with long processes is at present problematical. A third line of variation is by a reduction in the number of processes. This results in forms such as that illustrated in Plate 8, figure 3, where very few processes are present. However, no specimens referable to *Cyclonephelium paucispinum* Davey, 1969a, have been identified.

Occurrence: *C. distinctum* has a world-wide documented range from the late Berriasian to the Danian. In Australia it has been recorded from the Albian to the middle Senonian of the Perth Basin (Deflandre & Cookson, 1955; Cookson & Eisenack,

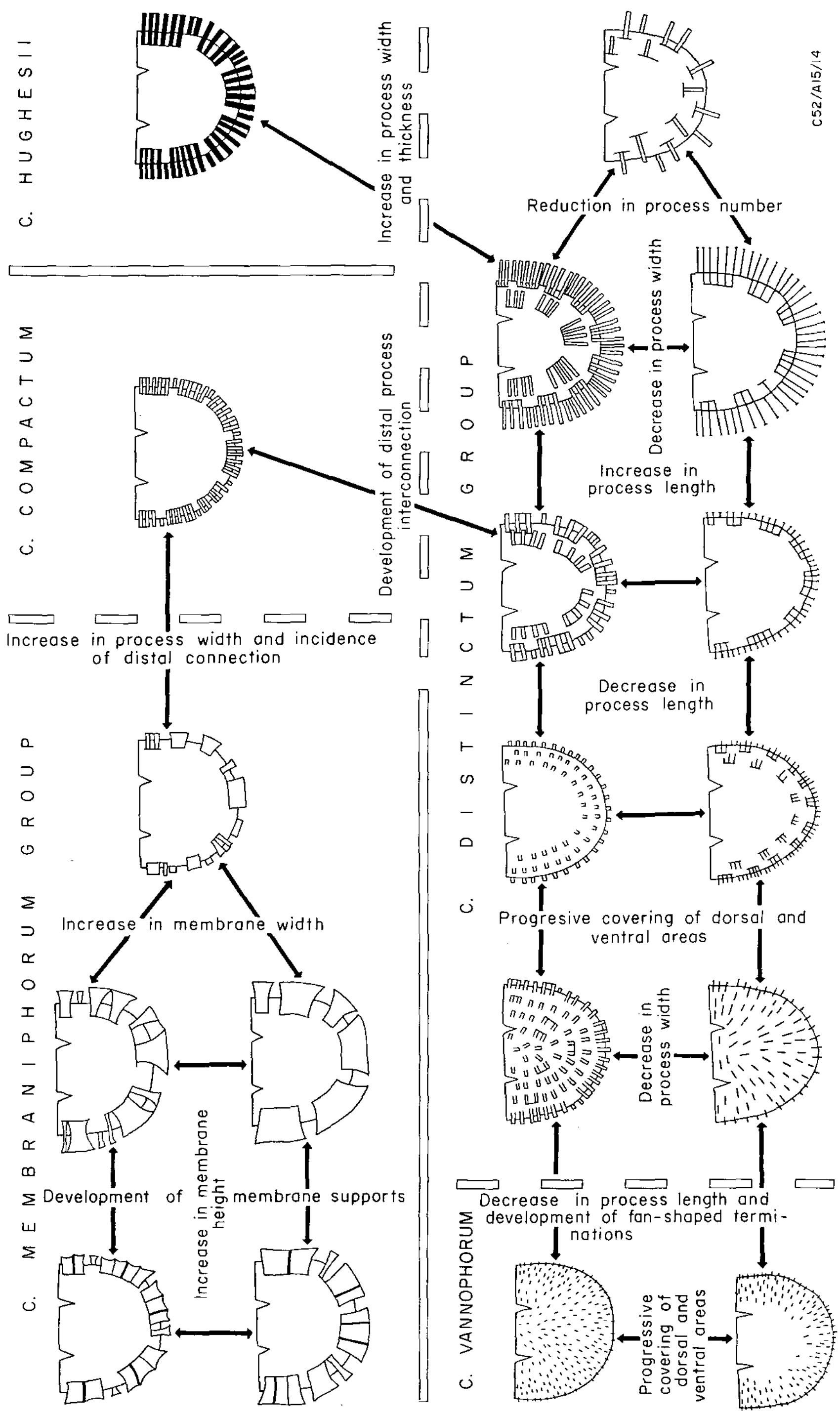


Figure 14. Development of intra- and interspecific variation in species of *Cyclonephelium*. Broken lines indicate transitional specific boundaries.

1962a, 1968); the Albian of the Carnarvon Basin (Cookson & Eisenack, 1962a); and the mid-Cretaceous of the Eucla Basin (Cookson & Eisenack, 1971). It is known questionably from the lowermost Aptian of the Surat Basin in Queensland (*Foraminisporis asymmetricus* Subzone of Burger, 1973). North American occurrences include the Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964) the Cenomanian/Albian of Saskatchewan (Davey, 1969a) and the Albian of Alberta (Singh, 1971) (also possibly *Cyclonephelium* sp.A of Brideaux, 1971). Drugg's (1967) figure, from the Danian of California, differs slightly from other published illustrations. In Europe it has been found in the stratotype upper Berriasian to Aptian of the Alps (Millioud, 1967, 1969), the upper Valanginian to Aptian (and possibly Albian) of Germany (Gocht, 1959; Alberti, 1961), the Albian of Romania (Baltes, 1967b) and France (Davey & Verdier, 1971, 1973), the Cenomanian to upper Campanian of England (Clarke & Verdier, 1967), and the Cenomanian of England and France (Davey, 1969a).

CYCLONEPHELIUM MEMBRANIPHORUM Cookson & Eisenack, 1962

(Pl. 8, figs. 4, 5)

1958 *Cyclonephelium compactum* Deflandre & Cookson; Cookson & Eisenack, 48, pl. 12, fig. 8 only.
1962a *Cyclonephelium membraniphorum* Cookson & Eisenack, 495, pl. 6, figs. 8-14.
1962a *Cyclonephelium compactum* Deflandre & Cookson; Cookson & Eisenack, 494, pl. 5, fig. 3 only.

BMR palynological species catalogue no.: 981.

Remarks: The range of variation in *Cyclonephelium membraniphorum* was very adequately illustrated by Cookson & Eisenack (1962a). A number of forms which they had previously included in *C. compactum* are here placed in *C. membraniphorum*. This is justified by virtue of the complete variation in the height of the membranous connections between the processes and in the relative thickness of the latter. There are, in addition, intermediates between the variant of *C. membraniphorum* with low membranes and stout processes and with typical *C. compactum* (see Text-fig. 14). In the Bathurst Island samples, forms with lower membranes are more common than the variant with high membranes and reduced supporting fibres.

Occurrence: C. membraniphorum is common throughout the succession in the Bathurst Island wells. It has previously been described from the Albian to Cenomanian of the Perth, Carnarvon, and Eucla Basins (Cookson & Eisenack, 1958, 1962a, 1968, 1971). Edgell (1964) found that it was a characteristic microfossil in the lower Cenomanian of the Perth Basin. Overseas occurrences are from the lower Cenomanian of central England (Cookson & Hughes, 1964), the Turonian and lowermost Coniacian of southern England (Clarke & Verdier, 1967), the Cenomanian of southern England and northern France (Davey, 1969a) and the upper Albian of France (Davey & Verdier, 1971, 1973).

CYCLONEPHELIUM sp. cf. C. HUGHESII Clarke & Verdier, 1967

(Pl. 9, fig. 3)

cf. 1960b *Cyclonephelium densebarbatum* Cookson & Eisenack, 253, pl. 38, fig. 9 only (*non* fig. 10).
cf. 1964 *Cyclonephelium* cf. *densebarbatum* Cookson & Eisenack; Cookson & Hughes, 44, pl. 10, fig. 10.
cf. 1967 *Cyclonephelium hughesii* Clarke & Verdier, 21, pl. 2, fig. 6; text-fig. 8.

BMR palynological species catalogue no.: 983.

Remarks: A small number of specimens from both Bathurst Island wells resemble Clarke & Verdier's species in having broad, rather short processes. The Bathurst Island specimens are somewhat larger than Clarke & Verdier's form (although within the limits of variation) but have thicker, considerably denser processes. *Cyclonephelium membraniphorum* and *C. compactum* both have processes with much thinner and membranous or fibrous walls. *C. distinctum* has narrower processes than either Clarke & Verdier's species or its Bathurst Island variant. *C. densebarbatum* was considered by Clarke & Verdier (1967) to differ from *C. hughesii* in its narrower processes.

Occurrence: Clarke & Verdier found *C. hughesii* in the Cenomanian and lower Turonian of southern England. Cookson & Eisenack's (1960b) specimen came from the Canning Basin Upper Jurassic, and those of Cookson & Hughes (1964) from the uppermost Albian or lowermost Cenomanian of central England. It has also been recorded from uppermost Albian (Vraconian) strata in the Paris Basin and the French Alps (Davey & Verdier, 1973).

CYCLONEPHELIUM VANNOPHORUM Davey, 1969

(Pl. 9, figs. 1, 2)

1969a *Cyclonephelium vannophorum* Davey, 168, pl. 9, fig. 3; pl. 11, figs. 11, 12; text-fig. 16E.

BMR palynological species catalogue no.: 984.

Remarks: *C. vannophorum* shows considerable variation in the distribution and form of its processes (see Text-fig. 14). They are typically flared distally and fan-shaped, but in some specimens they may be reduced to small cylindrical, distally truncate structures, a few micrometres in height. In some specimens they cover the whole of the dorsal and ventral faces; in others they are more restricted, leaving bald central areas. A poorly developed antapical horn is occasionally present but cingular and sulcal structures have not been observed. The archaeopyle is apical in position and has a straight, slightly zig-zag, or notched margin.

Davey's type description includes reference to the wide variation in process form, and the Bathurst Island material falls within this range. Specimens with fan-shaped processes are very similar to his type illustration. The limits between *Cyclonephelium vannophorum* and *C. distinctum* are hard to define and are principally based on process shape. There are intermediate forms, especially among specimens where the dorsal and ventral process-free areas are small or absent. ?*C. attadalicum* Cookson & Eisenack, 1962a, is another related species. This has longer processes and much clearer traces of the cingulum and sulcus (Davey noted these features on some of his specimens of *C. vannophorum*). *C. vannophorum* appears to occupy an intermediate position between the genera *Tenua* and *Cyclonephelium*. Sarjeant (1968) revised a number of Late Jurassic species of *Tenua*, and his *T. pilosa* (Ehrenberg), *T. rioulti* Sarjeant, and *T. villersense* Sarjeant are difficult to distinguish from some variants of *Cyclonephelium vannophorum*. However, the Bathurst Island specimens are significantly larger than any of Sarjeant's forms.

Occurrence: Davey (1969a) described *C. vannophorum* from the English lower Cenomanian and thought that it was possibly a recycled form. Since then Davey & Verdier (1973) have recorded it from uppermost Albian (Vraconian) strata in south-east France. It is restricted to the upper part of the section in both Bathurst Island wells.

CYCLONEPHELIUM sp. A

(Pl. 8, fig. 10)

BMR palynological species catalogue no.: 985.

Description: Proximochorate marginate cysts, with a dorsoventrally flattened central body. An apical protuberance and either one or two antapical bulges are developed in some specimens, but traces of tabulation, cingulum, or sulcus are completely lacking. The cyst wall is faintly granulate and other ornament is restricted to a peripheral zone, leaving circular dorsal and ventral bald areas. The periphery is traversed by low granulate ridges (1 μm high and 1 to 2 μm wide), which follow tangential and radial paths and result in a triangulate or box-like peripheral pattern. At their intersections some of the ridges coalesce into solid verrucae up to 3 μm in height. The archaeopyle is apical, with a slightly indented margin.

Dimensions: The overall width varies from 54 to 65 μm. Overall length of figured specimen 62 μm, overall width 62 μm.

Remarks: The peripheral pattern of ridges and verrucae differentiates this form from all described species of *Cyclonephelium.* Rare specimens were found in Bathurst Island no. 2 well, where it occurs throughout the section.

CYCLONEPHELIUM sp. B

(Pl. 8, fig. 8)

BMR palynological species catalogue no.: 986.

Description: Marginate proximochorate cysts, with a dorsoventrally flattened central body. Either one or two low antapical protuberances may be present. The central body wall is less than 0.5 μm thick and bears a faint granulate or microreticulate ornament. Heavier ornament is present around the periphery and on the faces of the cyst but is absent in centrodorsal and centroventral areas. The periphery and a broad zone within it are covered by short, winding, branching ridges. These are up to 3 μm in height, 1 μm in basal thickness, and in section they are distally bifid, expanded, or even flat-topped. They circumscribe an incomplete reticulate pattern, whose lumina are 3 to 5 μm in diameter. Sometimes a few short processes up to 4 μm long arise from the reticulum. Cingulum and sulcus are absent. The archaeopyle is apical, with a deeply notched margin.

Dimensions: Overall width 61 to 85 μm. Overall width of figured specimen 63 μm, overall length (dehisced) 55 μm.

Remarks: Cyclonephelium paucispinum Davey, 1969a, may bear a peripheral reticulum. It is associated with relatively high processes, which are not developed or are considerably smaller in *C.* sp.B. A reticulum is also present in *C. eisenackii* Davey, 1969a, but it is more complete and has much broader lumina than in this form. In addition the ambitus of *C. eisenackii* is characteristically polygonal, with more accentuated apical and antapical horns. The reticulum in *C.* sp.A is considerably coarser than in the species described here and has distinct triangular lumina. *C.* sp.B occurs in small numbers in both well sections.

CYCLONEPHELIUM sp. C

(Pl. 8, fig. 9; Pl. 12, fig. 1)

BMR palynological species catalogue no.: 987.

Description: Proximochorate marginate cyst, with a dorsoventrally flattened central body and large-scale ornamentation restricted to the peripheral region. The peripheral ornament consists of homogeneous to slightly fibrous perforate to reticulate membranes up to 5 μm in height. These are arranged either as two peripheral membranes (usually joined by crossing membranes) or as very broad, distally open processes. The wall of the central body is less than 0.5 μm thick and faintly granulate. An apical archaeopyle with a zig-zag and notched margin is usually present.

Dimensions: The overall width is between 51 and 75 μm.

Remarks: The reticulate nature of the peripheral membranes serves to distinguish this species from *C. membraniphorum*. The perforations are not believed to be due to fungal corrosion and no intermediate forms with *C. membraniphorum* have been located. *C. areolatum* Cookson & Eisenack, 1960b, from the Upper Jurassic of the Canning Basin, bears much more finely reticulate peripheral membranes and has a well marked cingulum. Rare specimens of *C.* sp.C occur in both the top and bottom of Bathurst Island no. 2 well.

CYCLONEPHELIUM sp.D

(Pl. 11, fig. 11)

BMR palynological species catalogue no.: 988.

Description: Marginate proximate cysts, with a dorsoventrally flattened body. A low, asymmetrically placed protuberance is present at the antapex. The central parts of the dorsal and ventral faces are devoid of ornament and the wall is thin and psilate. The periphery and adjacent parts of the dorsal and ventral sides bear low irregular verrucae and short, stout, distally expanded processes. These are sometimes joined to form incomplete ridges. The archaeopyle is apical and has a notched margin.

Dimensions: Length of figured specimen (dehisced) 56 μm, width 58 μm.

Remarks: This form somewhat resembles *Cyclonephelium* sp.B, but the latter has more complete ridges and a thicker wall; they may merely represent two variants of the same species. Only two specimens of *C.* sp.D have been found, both in Bathurst Island no. 2 well, and for the present they are retained as a separate taxon.

Genus ADNATOSPHAERIDIUM Williams & Downie, 1966

Type species: Adnatosphaeridium vittatum Williams & Downie, 1966.

ADNATOSPHAERIDIUM UNCINATUM sp.nov.

(Pl. 8, figs. 11, 12)

Holotype: Plate 8, fig. 11. Bathurst Island no. 2 well, core 9, 213.4 m, 700′0-6″. M.F.P. 4432-1:215:043 (CPC 12259). Overall length 58 μm, overall width 65 μm, width of central body 54 μm.

Derivation of name: From the Latin *uncinus*, a hook or barb; with reference to the hook-like appearance of the processes.

BMR palynological species catalogue no.: 977.

Diagnosis: Cyst chorate, dorsoventrally flattened. Central body thin walled, outline circular or with either one or two low antapical protuberances. Processes numerous, short, solid, narrow, and parallel-sided. Processes divide distally into narrow, flattened, smooth, unbranched aculei, which unite with those from adjacent processes. Processes similar or slightly longer at the antapex. Tabulation and cingulum absent. Archaeopyle apical, tetratabular, with a zig-zag or notched margin.

Description: Dorsoventrally flattened chorate cyst, with a central body whose outline is circular or subcircular, sometimes with one or two unequal antapical protuberances. The wall is thin (less than 0.5 μm) and its surface is smooth or faintly granulate. The central body bears numerous straight, parallel-sided, solid processes with slightly expanded bases, about 3 to 5 μm apart. They are 0.5 to 1 μm in diameter (most are about 1 μm) and 5 to 10 μm in length. Distally they divide into ribbon-like aculei (0.5 to 1 μm wide), which become recurved and connect with those from adjacent processes. The aculei bear no spines and are seldom branched. The overall appearance of the processes is of a series of simple loops standing out from the central body wall. They are variably arranged but appear to be more closely set around the periphery. They are slightly longer at the antapex. The dorsal and ventral faces sometimes bear slightly smaller processes, arranged in soleate and linear complexes. No tabulation pattern could be elucidated. The archaeopyle is apical in position, with a zig-zag and sometimes notched margin. Detached tetratabular, six-sided opercula are common.

Dimensions: The overall width is 51 μm (61 μm) 71 μm for 28 examples.

Remarks: The network of aculei joining the process terminations is typical of the genus *Adnatosphaeridium* but the dorsoventral flattening of the cyst and the presence of zones of smaller processes indicates a relationship with *Areoligera* Lejeune-Carpentier, 1938, or *Cyclonephelium* Deflandre & Cookson, 1955. *A. uncinatum* differs from all previously described species of *Adnatosphaeridium* in having much shorter processes and a compressed central body. *Cyclonephelium distinctum* has processes of similar length but they are not joined in the same way by distal aculei. Certain Eocene species of *Cyclonephelium* have distally confluent processes (e.g. *C. divaricatum* Williams & Downie, 1966, and *C. pastielsi* Deflandre & Cookson, 1955) but they lack processes on the dorsal and ventral faces. *A. uncinatum* is common in the lower parts of both wells.

Genus VALENSIELLA Eisenack, 1963

Type species: Membranilarnax ovulum Deflandre, 1947.

VALENSIELLA GRIPHUS sp.nov.

(Pl. 8, figs. 6, 7; Pl. 10, figs. 7, 8, 9)

Holotype: Plate 10, figs. 7, 8. Bathurst Island no. 2 well, core 12, 311.9 m, 1023′0-6″. M.F.P. 4429-2:157:060 (CPC 12274). Overall length 58 μm, overall width 49 μm.

Derivation of name: From the Latin *griphus*, noun in apposition; a fishing net or basket.

BMR palynological species catalogue no.: 978.

Diagnosis: Cyst proximate, acavate, spherical or subspherical. Wall thin, covered by a coarse, non-tabulate reticulum of low, solid ridges. Lumina rarely interconnected. Ridges support a thin, fragile, finely reticulate, non-tabulate, distal membrane, which encloses the entire tract. Tabulation and cingulum absent. Archaeopyle apical, tetratabular, with a notched margin.

Description: Proximate acavate cyst, with a spherical or subspherical tract. Some examples are dorsoventrally flattened, probably because of secondary distortion. The cyst wall is less than 0.5 μm thick and its surface is traversed by a network of solid ridges. The ridges or muri are 1 to 1.5 μ, in thickness and are distally expanded, so that in optical section they have the appearance of short, stout processes. They are 2 to 3 μm in height, and form a reticulum whose lumina are occasionally interconnected and are about 5 to 10 μm in diameter. Free-standing processes and unattached ridges are rare. The network of ridges supports a very thin and fragile reticulate membrane over the whole surface of the cyst. The reticulum consists of circular or polygonal perforations 0.5 to 1 μm in diameter, leaving strands 0.5 to 1 μm in width. Neither the proximal (coarse) nor the distal (fine) reticula reflect any trace of tabulation. The archaeopyle is apical and in one specimen is attached by a sulcal neck. In dehisced specimens the archaeopyle margin is slightly zig-zag and often notched.

Dimensions: The overall width ranges between 47 and 71 μm with an average of 56 μm for 16 specimens.

Remarks: Valensiella griphus differs from all previously described species of *Valensiella* in the perforate nature of the outer membrane. The perforations are of constant size and shape and are therefore most unlikely to be due to corrosion. Gocht (1970) differentiated three species of *Valensiella* on the type of support ridges. *V. griphus* has ridges similar to those of *V. ovula*, where they are arranged in a practically complete network. In *V. ampulla* Gocht and *V. vermiculata* Gocht they are reduced to various types of winding ridges, rugulae or isolated pillars. All three forms have entire, albeit very delicate, distal membranes and their shape is fairly uniformly prolate (rather than sperical as in *V. griphus*). Both *Cassiculosphaeridia reticulata* Davey, 1969a, and *Canningia reticulata* Cookson & Eisenack, 1960b, from the Canning Basin Upper Jurassic and the English Cenomanian (Clarke & Verdier, 1967) have reticulate ornament; but it is developed upon the cyst wall, and distal reticula are lacking. *C. senonica* Clarke & Verdier, 1967, from the English Santonian, has processes which anastomose into a distal reticulum. They are not united into ridges and they support the outer membrane at a much higher level than in *V. griphus*. All three species usually have low antapical horns which are typical of *Canningia* but have not been observed in *Valensiella*.

All but one of the published citations of *Valensiella* have been from Upper Jurassic strata. Clarke & Verdier (1967) recorded *V. ovula* from the Cenomanian to Santonian of southern England. It is not possible to determine the nature of the distal membrane from their illustrations. They show specimens whose shape and proximal reticulum are otherwise very similar to *V. griphus*. *V. griphus* occurs throughout both Bathurst Island well sections.

Genus CANNINGINOPSIS Cookson & Eisenack, 1962

Type species: Canninginopsis denticulata Cookson & Eisenack, 1962

CANNINGINOPSIS DENTICULATA Cookson & Eisenack, 1962

(Pl. 11, fig. 2)

1962a *Canninginopsis denticulata* Cookson & Eisenack, 488, pl. 1, figs. 16-19; text-figs. 2a, b.

BMR palynological species catalogue no.: 961.

Remarks: The holotype of *C. denticulata* has been examined in the National Museum, Melbourne. It is similar to the Bathurst Island specimens in all respects, except that it is somewhat larger and has correspondingly coarser granules (Cookson & Eisenack's size range 95-125 μm wide; Bathurst Island material 54-75 μm wide). This discrepancy may be due to differences in processing technique.

Occurrence: In the Bathurst Island wells, *Canninginopsis denticulata* occurs in all but the uppermost samples. It has been described from Aptian to Cenomanian strata of the Perth Basin, the Albian of the Eromanga Basin, and the Cenomanian of the Carnarvon Basin (Cookson & Eisenack, 1962a, 1968).

GROUP 10: Apical archaeopyle. Spherical, proximate cysts without tabulation.

Remarks: Non-tabulate cysts with smooth to baculate ornamentation are known from Upper Jurassic to Holocene sediments and are present in modern seas. They may be spherical or cup-shaped and forms have been described with apical, precingular, and intercalary archaeopyles. The simplicity of their organization (i.e. small number of potential distinguishing characteristics) and the lack of orientational structures make their study very difficult. Evitt (1967) figured most of the theoretical permutations of this kind of cyst but unfortunately did not name them. His illustrations include spherical, unornamented cysts with archaeopyle types $\bar{A}$a (formae L, M, N); I (the unnamed cyst in pl. 3, fig. 8); 3I (Forma Q); P (Forma R), and 2P (Forma Z). Wall (1967) described the genus *Tectatodinium* for cysts with a precingular (type P) archaeopyle. *Chytroeisphaeridia* Sarjeant, 1962, *Batiacasphaera* Drugg, 1970, and *Membranosphaera* Samoilovitch, 1961 all have apical archaeopyles and in some respects their diagnoses overlap. No genera have yet been named to include the cysts with intercalary or 2P archaeopyles. All the spherical or subspherical cysts of this type found in the Bathurst Island samples have apical archaeopyles.

Chytroeisphaeridia Sarjeant, 1962 was originally described as a subgenus of *Leiosphaeridia*. Downie, Evitt, & Sarjeant (1963) later recognized its apical archaeopyle and raised it to generic rank within the dinoflagellates. Since then several authors (Sarjeant, 1965, 1968; Davey, 1969a; Gitmez, 1970; Gocht, 1970) have illustrated detached or attached apical opercula on two Late Jurassic (*C. chytroeides*, *C. pocockii*) and one Cenomanian (*C. euteiches*) species. Wall (1965, 1967) described two Quaternary and extant cyst species, which he attributed to *Chytroeisphaeridia* (*C. cariacoensis* and *C. simplicia*). Later Wall & Dale (1968) incubated the living Peridinioid dinoflagellate *Peridinium avellana* (Meunier) from *C. cariacoensis*, and related *C. simplicia* to *Peridinium conicoides* Paulsen. Both cyst species have intercalary archaeopyles and thus should not have been placed in *Chytroeisphaeridia*.

Membranosphaera Samoilovitch, 1961, as emended by Drugg (1967), includes cysts in which the apical operculum is typically attached by a sulcal tongue. Non-tabular ornamentation is present in the form of small spines and grana, and these occasionally support a fragile outer membrane. The presence of this structure seems to indicate some relationship with *Chlamydophorella nyei*, in which both the membrane and its supporting structures are more substantial. Cysts with a similar shape, ornamentation, and archaeopyle to the type species of *Membranosphaera* (*M. maastrichtica*) occur in Bathurst Island, although they uniformly lack any trace of the fragile outer membrane. Such a delicate membrane would probably only be preserved under exceptional conditions and it is thus not used as a criterion for generic differentiation.

The third genus with a comparable type of cyst is *Batiacasphaera* Drugg, 1970. This has a spherical or cup-shaped tract and a surface ornamentation of baculae. The baculae may be randomly arranged, or aligned and partly fused in a reticulate pattern. The archaeopyle is apical and Drugg described species which lack all trace of a sulcal tongue.

The generic significance of an attached as against an unattached apical operculum is theoretically sound but sometimes difficult to apply. In imperfectly preserved material there is uncertainty whether the absence of a sulcal tongue or isthmus is due to accidental breakage of a relatively fragile structure or to the fact that it was never developed. This problem applies to the Bathurst Island specimens of *Chytroeisphaeridia* aff. *C. chytroeides* and *Membranosphaera granulata*, in which only well preserved cysts have opercula joined to the tract by a sulcal tongue.

Drugg's (1967 and 1970a) diagnoses for *Membranosphaera* and *Batiacasphaera* appear to partly overlap. The principal differences are the occasional presence of a thin outer membrane in *Membranosphaera* (it never occurs in *Batiacasphaera*), and the reticulate ornament exclusive to one species of *Batiacasphaera*. Neither of these characteristics were included as being obligatory. However, Drugg (pers. comm.) has pointed out that the overall dimensions of both species of *Batiacasphaera* are considerably larger than those of *Membranosphaera*. More important, the archaeopyle of the latter is characteristically of the Āa type, while *Batiacasphaera* has a completely detached apical operculum. For this reason, with the reservations mentioned above, the two genera are considered distinct.

Genus CHYTROEISPHAERIDIA Sarjeant, 1962, emended Downie, Evitt, & Sarjeant, 1963.

Type species: Leiosphaeridia (Chytroeisphaeridia) chytroeides Sarjeant, 1962.

CHYTROEISPHAERIDIA sp. aff. C. CHYTROEIDES (Sarjeant, 1962) Downie, Evitt, & Sarjeant, 1963.

(Pl. 9, figs. 4, 7)

aff. 1962 *Leiosphaeridia (Chytroeisphaeridia) chytroeides* Sarjeant, 493, pl. 70, figs. 13, 16; text-figs. 11, 12.
aff. 1963 *Chytroeisphaeridia chytroeides* (Sarjeant) Downie, Evitt, & Sarjeant, 9.

BMR palynological species catalogue no.: 968.

Remarks: The Bathurst Island material has a spherical or cup-shaped cyst, a thin, completely smooth wall and an apical archaeopyle. The operculum is attached to the rest of the cyst by a sulcal tongue of variable width, although some inevitable breakage occurs. The variation in the width of the sulcal tongue was noted by Evitt (1967), who attributed it to the elongation of either one (plate 1′) or two (plates 1′ and 4′) apical plate areas. Well preserved specimens from Bathurst Island show both of these situations but no taxonomic distinction was attempted on this character.

Typical *Chytroeisphaeridia chytroeides* has a smooth, thin wall structure and a subspherical ambitus similar to the Bathurst Island specimens. All the published figures show a form lacking an attached operculum, and for this reason the Bathurst Island specimens are compared, rather than identified, with Sarjeant's species. In cysts with an otherwise identical structure this feature is considered too liable to breakage to justify a new species. *C. euteiches* Davey, 1969, from the French Cenomanian, may also have an attached operculum but differs in its much thicker wall. *C. pocockii* Sarjeant, 1968, from the Upper Jurassic of France and Canada, has a granulate or baculate wall. Of the specimens figured by Evitt (1967), formae L and N (Upper Cretaceous of Alabama and Lower Cretaceous of California respectively) resemble *C.* aff. *C. chytroeides*. Both formae seem to be faintly granulate in his illustrations and are probably referable to *Membranosphaera*. Several species of *Canningia* are similar to *Chytroeisphaeridia* aff. *C. chytroeides*, particularly *Canningia ringnesii* Manum & Cookson, 1964, and *C. colliveri* Cookson & Eisenack, 1960. However, unlike the genus *Canningia*, none of the Bathurst Island specimens has apical or antapical horns.

Occurrence: C. chytroeides has been previously described from the Upper Jurassic of France (Sarjeant, 1965, 1968), England (Sarjeant, 1962), Scotland (Gitmez, 1970), and Canada (Pocock, 1972). Gocht (1970) also recorded it from the Bathonian of Germany. *C.* aff. *C. chytroeides* occurs throughout both Bathurst Island wells.

?CHYTROEISPHAERIDIA sp. A

(Pl. 9, fig. 8)

BMR palynological species catalogue no.: 971.

Description: Cyst proximate, unornamented, non-tabulate and spherical or cup-shaped. The wall is thin (less than 1 μm) and its surface is completely smooth. The apical archaeopyle is formed by the loss of two to four discrete, unattached opercular pieces (archaeopyle formula 2A or 4A) and has a notched margin. Most of the specimens are undehisced and the archaeopyle is marked by narrow (1 μm wide) grooves or lines of weakness.

Dimensions: The width of the cyst ranges from 46 to 58 μm (5 specimens); that of the figured specimen is 54 μm.

Remarks: The archaeopyle type distinguishes the rare specimens from previously described taxa. It has only been found in the middle part of Bathurst Island No. 2 well.

Genus MEMBRANOSPHAERA Samoilovitch, 1961, ex Norris & Sarjeant, 1965, emended Drugg, 1967.

Type species: Membranosphaera maastrichtica Samoilovitch (*in* Samoilovitch et al., 1961)

Remarks: Membranosphaera is characterized by its spherical or slightly prolate tract; its lack of tabulation; its ornament of grana, bacula, clavae or echinae; and its apical archaeopyle. A fragile outer membrane is occasionally preserved and the operculum is typically attached to the rest of the cyst by a sulcal tongue. Evitt (1967, text-figs. 33, 34) described and figured two types of sulcal tongue, and both types are known to occur in *Membranosphaera. Chytroeisphaeridia* also has an attached apical archaeopyle, but most species have a completely psilate wall. *Batiacasphaera* Drugg, 1970, has granulate to baculate ornament, but the archaeopyle lacks a sulcal tongue and the operculum is completely unattached.
The following previously described forms are included within *Membranosphaera*:

Membranosphaera maastrichtica Samoilovitch (*in* Samoilovitch et al., 1961, 252, Pl. 83, figs. 1a-d. Samoilovitch erected it as the type species of his 'new group' (a nomen nudum). It was later validated by Norris & Sarjeant (1965), who placed it in the acritarchs. Drugg (1967) drew attention to its dinoflagellate affinities. It was originally described from the Santonian, Maastrichtian, and Palaeocene of Siberia. Drugg found it in the Maastrichtian and Danian of California.

Membranosphaera sp. Drugg, 1967, p. 30, pl. 5, fig. 11. From the Danian of California.

Formae L, M, N. Evitt, 1967, pl. 1, figs. 15, 16 and 17 respectively. From the Upper Cretaceous of Alabama, the Upper Cretaceous of California and the Lower Cretaceous of California. Forma M is possibly conspecific with *M. granulata* sp. nov. (see below). The other two formae have considerably finer and more sparsely distributed grana.

MEMBRANOSPHAERA GRANULATA sp. nov.

(Pl. 11, fig. 9; Pl. 12, fig. 3)

Holotype: Plate 11, fig. 9. Bathurst Island No. 2 well, core 4, 91.5 m, 298′6-11″. M.F.P. 4437-1:096:049 (CPC 12286). Width 31 μm, length without operculum 33 μm.

Derivation of name: From the Latin *granulum*, a small grain; with reference to the nature of the surface ornament.

BMR palynological species catalogue no.: 970.

Diagnosis: Cyst spherical or subspherical, proximate, acavate, and non-tabulate. Wall thin, with a variable and dense ornament of small grana, bacula, or clavae. Distal reticulum absent. Archaeopyle apical, with an entire or notched margin. Operculum attached by a sulcal tongue.

Description: Proximate, acavate and non-tabulate cysts, with a spherical or subspherical shape. The wall is thin (less than 0.5 μm) and ornamented by small grana, bacula, or clavae of variable shape and spacing. The grana may be as small as 0.5 μm in diameter and up to 1 μm apart. Where the ornament consists of bacula or clavae they reach 1 μm in length and are more closely spaced. The archaeopyle is apical, with an operculum attached by a sulcal neck. The margin of the archaeopyle is sometimes notched and the sulcal neck may be broad or narrow. Common specimens occur in which the sulcal neck is completely severed and the operculum is detached.

Dimensions: Width 27 μm (36 μm) 44 μm for 13 specimens.

Remarks: Batiacasphaera compta Drugg, 1970, from the upper Eocene of the American Gulf Coast, differs from *M. granulata* in having bacula which are arranged in a reticulate pattern, sometimes partly fused to form muri. *B. baculata* Drugg, 1970, also from the Gulf Coast upper Eocene, has randomly arranged bacula, but they are considerably larger than those of the Bathurst Island specimens. Neither of Drugg's species was described as having attached opercula, and both are larger than *M. granulata. M. maastrichtica* Samoilovitch of Drugg (1967) has bacula that occasionally bear a thin outer membrane. The clavate members of *M. granulata* approach this condition, but an outer membrane could not be positively identified in any of the available material. Some of the specimens resemble Forma M of Evitt (1967), from the Upper Cretaceous of California, which probably falls within the range of variation of *M. granulata. Chytroeisphaeridia pocockii* Sarjeant, 1968, from the Upper Jurassic of England, France, and Scotland, is granulate like *M. granulata.* However, it is somewhat larger and has never been figured with an attached operculum. In the Bathurst Island wells *M granulata* occurs fairly commonly throughout the succession.

?MEMBRANOSPHAERA sp. A

(Pl. 9, fig. 9)

BMR palynological species catalogue no.: 969.

Description: Cyst proximate, acavate, spherical or subspherical, and non-tabulate. The wall is thin (less than 0.5 μm) and easily folded. It has a smooth or very finely granulate surface, the grana being less than 0.5 μm across and closely spaced. The archaeopyle is apical and formed from four discrete subequal plates, each of which remains attached, independently, to its adjacent precingular plate margin (archaeopyle formula 4Aa).

Dimensions: The 11 specimens measured are 36 μm (46 μm) 56 μm in width; the figured specimen is 55 μm high and 55 μm broad.

Remarks: The peculiar mode of archaeopyle formation serves to distinguish this cyst from all previously published species. Its inclusion in the genus *Membranosphaera* is left uncertain pending the study of more specimens, when the erection of a new genus may be necessary. All but one questionable specimen came from Bathurst Island No. 2 well, where it occurs rarely in the middle part of the section.

GROUP 11. Intercalary archaeopyle. Proximate or proximochorate, acavate cysts.

Genus PYXIDIELLA Cookson & Eisenack, 1958

Type species: Pyxidiella pandora Cookson & Eisenack, 1958.

PYXIDIELLA sp.A

(Pl. 12, fig. 8)

BMR palynological species catalogue no.: 1034.

Description: Proximochorate acavate cyst, with an elongate central body and a rounded apex and antapex. The central body has a dense covering of short, solid, distally pointed processes, 2-3 μm long and about 1 μm in basal width. Between the processes the cyst surface is smooth. The processes are completely random in arrangement and no trace of cingulum or sulcus is present. A haplotabular archaeopyle is formed by the loss of a single intercalary reflected plate area. It is situated just below the apex and has four angular corners.

Dimensions: The figured specimen is 49 μm long and 35 μm wide.

Remarks: A single well preserved specimen was found near the base of Bathurst Island no. 2 well. It differs from *Pyxidiella pandora* Cookson & Eisenack, 1958 (Upper Jurassic of the Carnarvon and Papuan Basins) and *P. scrobiculata* Deflandre & Cookson, 1955 (Upper Cretaceous-Tertiary of the Otway and Perth Basins) in having a spinose instead of a granulate ornament. An intercalary archaeopyle and spinose ornament have been described on *Xenicodinium hispidum* Drugg, 1970b, from the Neogene of Sumatra, but it has a more inflated outline than in *Pyxidiella* sp.A. The type species of *Xenicodinium* (*X. densispinosum* Klement, 1960, from the German Upper Jurassic) differs in having a probably precingular archaeopyle.

Genus PAREODINIA Deflandre, 1947, emended Gocht, 1970

Type species: Pareodinia ceratophora Deflandre, 1947.

PAREODINIA sp.A

(Pl. 15, fig. 2)

BMR palynological species catalogue no.: 1033.

Description: Proximate acavate cyst, with a prolate central body. The apex is drawn out into a long (about 30 μm in figured specimen), narrow, tapering, terminally rounded horn. The cyst wall is very thin (less than 0.5 μm), easily folded and completely lacking in ornament or processes. Cingulum, sulcus, and other traces of tabulation are absent. A broad, low archaeopyle lies immediately below the apical horn and is formed by the loss of two intercalary plates.

Dimensions: The figured specimen is 72 μm long and 31 μm wide.

Remarks: The very rare specimens from Bathurst Island differ from other species of *Pareodinia* in their long apical horn. *P. aphelia* Cookson & Eisenack, 1958, from the Upper Jurassic to Aptian of the Perth and Carnarvon Basins, has a much shorter horn and a granular, more fusiform body. *P. ceratophora* Deflandre, 1947 also has a shorter horn with a broader base, while *Pareodinia* sp. of Evitt (1961; 1967) bears numerous spine-like processes.

GROUP 12. Intercalary archaeopyle. Cavate cysts with a peridinioid outline.

Genus DEFLANDREA Eisenack, 1938, emended Williams & Downie, 1966

Type species: Deflandrea phosphoritica Eisenack, 1938.

DEFLANDREA sp. A

(Pl. 13, fig. 14)

BMR palynological species catalogue no.: 1032.

Description: Cavate cyst, with a very thin faintly granulate periphragm and a slightly thicker, but still less than 0.5 μm, smooth endophragm. The tract is drop-shaped, with a gently tapering epitract and a much shorter, antapically flat hypotract. The widest part of the cyst is at the cingulum (38 μm in the figured specimen). The two membranes have about the same shape and are separated by a narrow pericoel, widest at the apex (6 μm) and very narrow (about 1 μm) or non-existent beneath the cingulum and hypotract. The only form of tabulation present is fine folds which delimit a broad, slightly helicoid cingulum and a wide, indistinct sulcus. The archaeopyle is formed in both membranes by the loss of one anterior intercalary plate.

Dimensions: The figured specimen is 63 μm long and 38 μm wide.

Remarks: The single specimen, from the lowest sample of Bathurst Island no. 2 well, differs from published species of *Deflandrea* in its very narrow pericoel and its overall shape. Its generic allocation is supported by its cavate structure and its haplotabular intercalary archaeopyle.

?DEFLANDREA sp. B

(Pl. 13, fig. 13)

BMR palynological species catalogue no.: 1030.

Description: Cyst probably cavate, with a thin faintly granular periphragm and an extremely thin endophragm. The subequal hypotract and epitract are separated by a narrow, slightly helicoid cingulum at the point of greatest width. The epitract has sloping sides and a rounded apex. The hypotract also has sloping sides but is antapically truncate, sometimes with a short horn, about 5 μm in length, at one corner. The endocoel has a similar shape to the ambitus and the two membranes are separated by a pericoel of fairly constant width (about 5 μm). No archaeopyle has been observed, but faint ridges on one specimen outline an intercalary plate area. This may represent an undehisced archaeopyle.

Dimensions: Overall dimensions of the figured specimen are length 70 μm, width 52 μm.

Remarks: The somewhat enigmatic morphology of the three available specimens renders confident generic placing impossible. If the wall is composed of only a single membrane or if the cyst dehisced by the dissolution of the entire wall then no known genus can accommodate it.

Genus ASTROCYSTA Davey, 1970

Type species: Palaeoperidinium cretaceum Pocock, 1962.

Astrocysta sp.cf. A. cretacea (Pocock, 1962) Davey, 1970

(Pl. 15, fig. 9)

cf. 1936b *Palaeoperidinium* sp. Deflandre, 31, pl. 4, fig. 7.
cf. 1962 *Palaeoperidinium cretaceum* Pocock, 80, pl. 14, figs. 219-221.
cf. 1964 *Palaeoperidinium* cf. *cretaceum* Pocock; Manum & Cookson, 20, pl. 3, figs. 11, 12.
cf. 1970 *Astrocysta cretacea* (Pocock) Davey, 359, pl. 2, fig. 4.
cf. 1971 *Lejeunia*? *cretacea* (Pocock) Brideaux, 86, pl. 24, figs. 46-47.

BMR palynological species catalogue no.: 1029.

Remarks: A few specimens from both wells are similar to but not identical with Pocock's species. The Bathurst Island material has shorter horns and a more rounded ambitus in the region of the cingulum. Davey (1970) described specimens which lacked an archaeopyle, but which had a series of fine ridges around an anterior intercalary plate. Norris & Hedlund (1972) identified a transapical archaeopyle in the holotype of *Astrocysta cretacea*, in which dehiscence took place along a suture separating the epitract into dorsal and ventral parts. In one of the Bathurst Island specimens (Pl. 15, fig. 9) a fracture partly removes the apex and one intercalary plate as a single piece. It is uncertain whether this is a true archaeopyle or an accidental breakage. In common with all the published illustrations of *A. cretacea* and *A.*cf. *A. cretacea* the Bathurst Island material has a wall structure composed of two membranes. These are in contact over most of the cyst but are occasionally separated in the horns, leaving small pericoels. *A. kozlowskii* (Gorka, 1963), from the Maastrichtian of Poland, and *A. tricuspis* (O. Wetzel, 1933), from the Baltic Upper Cretaceous, both have more accentuated horns. '*Peridinium*' *basilium* Drugg, 1967, from the Californian Maastrichtian-Danian, has a similar outline with short horns. However, its tabulation is distinct and a spherical endocoel is present in some specimens.

Occurrence: A. cretacea was described by Pocock (1962) from the Lower Cretaceous of western Canada. It is also known from the French Senonian (Deflandre, 1936b), the Albian of Saskatchewan (Davey, 1970), the Lower Cretaceous of Alberta (Singh, 1964, 1971), the Albian of France (Davey & Verdier, 1971, 1973), and possibly the Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964). Brideaux (1971) records it from the middle to upper Albian of Alberta and the Barremian to Campanian of Maryland.

Genus Trithyrodinium Drugg, 1967

Type species: Trithyrodinium evittii Drugg, 1967.

Trithyrodinium sp.A

(Pl. 13, figs. 15, 16)

BMR palynological species catalogue no.: 1031.

Description: Cyst cavate, composed of two thin, faintly granulate membranes (both less than 0.2 μm in thickness). The periphragm extends to form a short antapical and a slightly larger apical horn. A second antapical protuberance is usually present, giving the antapex a truncate appearance. The pericoel is narrow and the endophragm reaches into the base of the horns. Apart from a faint cingulum, surface ornamentation and signs of tabulation are absent. The archaeopyle is formed by the loss of three intercalary plates in both the endophragm and periphragm (type 3I/3I). Detached opercula have not been observed.

Dimensions: The length of the cyst ranges between 54 and 58 μm in four specimens.

Remarks: This rare species is placed in the genus *Trithyrodinium* Drugg because of its cavate cyst and 3I archaeopyle. Drugg (1967) restricted the genus to include only forms with 3I archaeopyles, in which the operculum remains a single unit. This cannot be ascertained in the Bathurst Island material. The type species, *T. evittii*, from the Danian of California, has a more inflated subspherical endocoel and a laterally less extended archaeopyle. Certain of the Late Cretaceous forms redescribed by Evitt (1967), such as *Deflandrea granulifera* Manum, 1963, and *D. thomasii* Cookson & Eisenack, 1961, have archaeopyles which are haplotabular intercalary in the periphragm and composed of three discrete intercalary plates in the endophragm. They further differ from *Trithyrodinium* sp.A in having more spherical, heavily granulate inner bodies and larger terminal pericoels. '*Hexagonifera*' *suspecta* Manum & Cookson, 1964 has a tripartite intercalary archaeopyle composed of separate plates in the endophragm and lacks any opening in the periphragm.

Genus WALLODINIUM Loeblich & Loeblich, 1968

Type species: Diplotesta glaessneri Cookson & Eisenack, 1960a.

WALLODINIUM LUNA (Cookson & Eisenack, 1960) nov.comb.

(Pl. 16, fig. 10; Pl. 17, fig. 12)

1960a *Diplotesta luna* Cookson & Eisenack, 10, pl. 3, fig. 21.

BMR palynological species catalogue no.: 1048.

Remarks: The two specimens found, both from the same sample low in Bathurst Island no. 2 well (core 11, 274.4 m, 900′0-6″), are very similar to the holotype, examined in the National Museum, Melbourne. The periphragm of all three is ruptured in an intercalary position. Certain other species, particularly *Wallodinium inflatum* Habib, 1969 and *W. glaessneri* (Cookson & Eisenack, 1960b) appear to have an archaeopyle which includes the apical region as well as an intercalary reflected plate area. In either case this genus is a true dinoflagellate and is related morphologically to *Deflandrea, Ovoidinium*, etc. Loeblich & Loeblich (1968) erected the genus *Wallodinium* to replace the preoccupied *Diplotesta*, and *D. luna* is here transferred to their genus.

The main difference between *Wallodinium luna* and *W. inflatum*, from the mid-Cretaceous of the Atlantic deep sea floor, is that the latter has a much larger endocoel. Habib's (1969, 1970) figures show an inner capsule which almost entirely fills the pericoel. *W. glaessneri*, which Cookson & Eisenack (1960b) described from the Upper Jurassic of the Canning Basin and the Lower Cretaceous (Neocomian or Aptian) of the Eromanga and Carnarvon Basins, has less pointed apices. In addition, *W. glaessneri* sometimes has a striate periphragm. The type figure of *W. krutzschii* Alberti, 1961 (Hauterivian to upper Barremian of Germany) is similar to the Bathurst Island material but the two other illustrations show specimens with much smaller inner capsules. Manum & Cookson (1964) described *W. bidigitatum* (Upper Cretaceous of Arctic Canada and the Perth Basin), in which the inner capsule is produced into an apical and an antapical horn. A similar feature was noted in *W. luna* by Cookson & Eisenack (1962a), but it could not be identified on either of the specimens from Bathurst Island. Finally, the English upper Albian and lower Cenomanian species *W. anglicum* Cookson & Hughes, 1964 differs in its small inner body and its very narrow terminal horns.

Occurrence: Wallodinium luna was described originally from the upper Albian to Cenomanian of the Perth Basin (Cookson & Eisenack, 1960a, 1962a). Other records include the Albian or Cenomanian of the Perth Basin (Cookson & Eisenack, 1969) and the Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964).

GROUP 13. Combination apical and intercalary archaeopyle. Cavate cysts.

Genus ASCODINIUM Cookson & Eisenack, 1960

Type species: Ascodinium acrophorum Cookson & Eisenack, 1960

ASCODINIUM ACROPHORUM Cookson & Eisenack, 1960

(Pl. 13, fig. 11; Pl. 17, fig. 8)

1960a *Ascodinium acrophorum* Cookson & Eisenack, 5, pl. 1, figs. 19, 20.

BMR palynological species catalogue no.: 1027.

Remarks: The two Bathurst Island specimens (both from no. 2 borehole) conform to Cookson & Eisenack's (1960a) figures and description in all respects except that they are somewhat smaller. *Ascodinium parvum* (Cookson & Eisenack, 1958) is distinct in having a rhomboidal rather than subspherical outline and endocoel. *A. serratum* Cookson & Eisenack, 1960 has a finely serrate antapical region and lacks the short apical horn of *A. acrophorum.*

In the specimens of *A. acrophorum* from Bathurst Island, the archaeopyle has an undulose margin. An operculum is still in place in the figured specimen and consists of a combination apical-intercalary unit. The dorsal portion, correlated with a single intercalary plate area, is relatively small, and it shows a rounded re-entrant at its junction with the apical circlet. Comparable morphology is visible in both endophragm and periphragm, suggesting an archaeopyle type $\overline{\mathrm{AI}}/\overline{\mathrm{AI}}$ (see Text-fig. 15a). This interpretation results in the same archaeopyle morphology as was tentatively proposed by Evitt (1967).

Occurrence: A. acrophorum has been previously recorded from (?) upper Albian and Cenomanian strata in the Perth Basin (Cookson & Eisenack, 1960a, 1968; Edgell, 1964).

ASCODINIUM PARVUM (Cookson & Eisenack, 1958) Cookson & Eisenack, 1960

(Pl. 13, figs. 3, 6; Pl. 17, fig. 9)

1958 *Deflandrea parva* Cookson & Eisenack, 28, pl. 4, figs. 12-13.
1960a *Ascodinium parvum* (Cookson & Eisenack) Cookson & Eisenack, 5, pl. 1, figs. 23-25.

BMR palynological species catalogue no.: 744.

Remarks: Cookson & Eisenack's (1960a) neotype has been examined in the National Museum, Melbourne, and is similar to the Bathurst Island material in all respects except that it is longer. Many Cookson & Eisenack species have size ranges larger than those of otherwise identical material from Bathurst Island; these discrepancies are believed to be due to differences in processing technique. The archaeopyle in both the neotype and in certain Bathurst Island specimens is clearly identifiable as type $\overline{\mathrm{AI}}/\overline{\mathrm{AI}}$ of Evitt (1967) (see Text-fig. 15b and d). The rhomboidal shape, typical of *A. parvum,* is only present in some specimens. Variation is towards a more oval outline, similar to that of *A. ovalis* Cookson & Eisenack, 1970a, from the Albian to Cenomanian of the Eucla Basin. The latter species was erected on a single specimen, and later study may show it to be conspecific with *A. parvum.* The periphragm is consistently smooth but the endophragm may be sparsely or densely granulate. It is never completely smooth, as in *Ascodinium* sp.A (see below).

Occurrence: A. parvum was originally described from the ?Albian of the Perth Basin and the Cenomanian or lower Turonian of the Carnarvon Basin (Cookson & Eisenack, 1958). Cookson & Eisenack (1960a, 1968) also recorded it from the Albian to Cenomanian of the Perth and Carnarvon Basins. Evans (1966a, unpubl.) found *A. parvum* restricted to his zone of the same name in the Otway Basin. He correlated the limits of this zone with those of the Cenomanian stage, but Dettmann & Playford (1969) thought that it includes the Cenomanian and part of the lower Turonian. *A. parvum* is a common microfossil throughout both Bathurst Island wells. It occurs in the uppermost samples, which had tentatively been dated as Turonian on ammonite evidence.

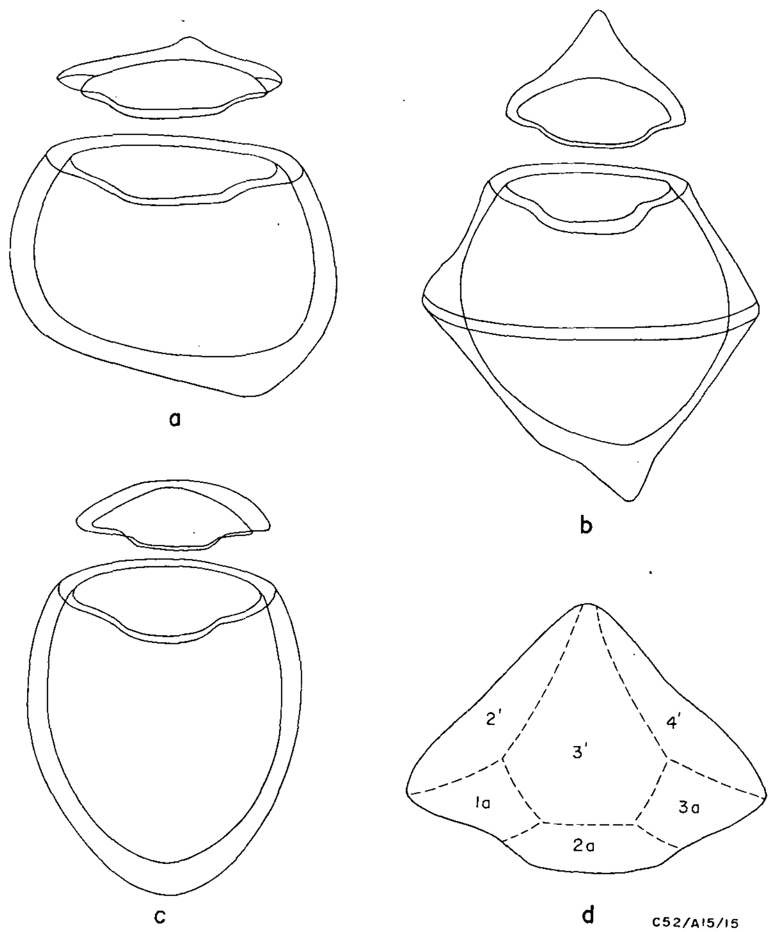


Figure 15. Reconstruction of morphology in selected species of *Ascodinium*, showing combination apical-intercalary archaeopyles (type A1/A1).

ASCODINIUM sp.A

(Pl. 13, figs. 9, 10; Pl. 17, figs. 5, 6)

BMR palynological species catalogue no.: 1028.

Description: Cyst cavate, with a completely smooth endophragm and periphragm, both less than 0.2 μm thick. The tract is prolate, usually with a smooth oval outline, devoid of horns. The pericoel is narrow and the inner and outer bodies have similar shapes. Traces of tabulation are absent. The archaeopyle operculum consists of a combination of the apex and a broad dorsal tongue. All angles and re-entrants are rounded, but the archaeopyle can be confidently interpreted as having formed by the loss of the apical plates and one intercalary plate as a single unit in each membrane (i.e. type $\overline{\mathrm{AI}}/\overline{\mathrm{AI}}$) (see Text-fig. 15c).

Dimensions: The 4 specimens measured range from 45 to 75 μm in length.

Remarks: Typical *Ascodinium parvum* differs from *Ascodinium* sp.A in having a rhomboidal rather than oval outline. Some variants of *A. parvum* have a slightly inflated ambitus, but all bear a granulate endophragm. The complete absence of ornamentation and the ovoid shape distinguishes this species from all other described forms. A few specimens have been found in the lower samples of no. 2 well.

Genus OVOIDINIUM Davey, 1970, emended

Type species: Ascodinium verrucosum Cookson & Hughes, 1964.

1972 *Evittia* Pocock, 93.

Emended diagnosis: Bicavate dinoflagellate cysts with a peridinioid shape. Central capsule spherical to subspherical, in contact with the periphragm in a broad zone around the equator. Periphragm bears an apical horn and either one or two antapical horns. Cingulum present. Archaeopyle formed by the loss of the apical whorl and one or more intercalary plates as a single unit in both membranes (formula AI/AI).

Remarks: The diagnosis of *Ovoidinium* is here emended to bring attention to the characteristic combination apical intercalary archaeopyle. In addition, a subrectangular ventral opening is sometimes also present in the posterior periphragm. Davey (1970) erroneously interpreted the archaeopyle as being apical. Evitt (1967) was able to demonstrate convincingly that a form very similar to the type species has a combination archaeopyle which includes the apical whorl and three intercalary plates (type A3I/A3I). A similar archaeopyle can also be seen in some published illustrations of *Ovoidinium*, particularly Davey's (1970) figures of *O. scabrosum* (pl. 4, fig. 4) and the holotype of *O. ostium* (pl. 4, fig. 5).

The identification of this type of archaeopyle in several species of *Ascodinium* removes one of the criteria for differentiating that genus from *Ovoidinium*. The two may still be distinguished by the lateral constriction of the pericoel around the cingulum in *Ovoidinium*, as this feature does not occur in *Ascodinium*.

Pocock (1972) erected the genus *Evittia* for bicavate cysts with a peridinioid outline and a combination apical intercalary archaeopyle. The holotype of his type species, *Deflandrea cincta* Cookson & Eisenack, 1958, has been examined in the National Museum, Melbourne; it has an archaeopyle with the operculum still partly in place. This consists of the apical whorl and at least one anterior intercalary plate in a single unit in both endophragm and periphragm (type $\overline{\mathrm{AI}}/\overline{\mathrm{AI}}$). It thus has a similar morphology to *Ovoidinium*, and indeed Davey (1970, p. 354) had previously reallocated it as *O. cinctum*. As a result of these observations *Ovoidinium* and *Evittia* are thought to be synonymous, the former having priority.

The following species is here transferred to *Ovoidinium*:

Ovoidinium waltonii (Pocock, 1972) Norvick *comb. nov.* = *Evittia waltonii* Pocock, 1972, 93, pl. 22, figs. 13, 14 (Jurassic of western Canada).

?OVOIDINIUM FRAGILE sp.nov.

(Pl. 13, figs. 1, 8; Pl. 17, fig. 7)

Holotype: Plate 13, fig. 1; Plate 17, fig. 7. Bathurst Island no. 1 well, core 8, 243.8 m, 800'0-6". M.F.P. 4445-1:166:187 (CPC 12302). Length 63 μm, width 49 μm.

Derivation of name: Refers to the thin endophragm.

BMR palynological species catalogue no.: 1026.

Diagnosis: Cyst bicavate, pericoel interrupted at a broad cingulum. Cyst shape peridinioid, with one apical and either one or two dissimilar antapical horns. Inner capsule subspherical. Endophragm and periphragm extremely thin and readily folded, smooth or very faintly granulate. Archaeopyle an irregular apical opening in both membranes, lower at one side of the cyst than at the other.

Description: Cavate cyst, composed of two extremely thin, smooth or very faintly granulate membranes. The endophragm and periphragm are in close contact in the cingular region but diverge to form apical and antapical pericoels. A tapering apical horn and one or two, dissimilar, tapering antapical horns are present. One of the antapical horns is often much reduced; where it is absent, the remaining horn is offset from the median line. The cingulum is broad (about 5 μm wide) and is sometimes interrupted by a shallow sulcus. Most specimens examined are undehisced, but a small number are truncated by a somewhat irregular opening, which removes the apex of both membranes and is lower at one side of the cyst than at the other. It is questionably interpreted as a combination apical-intercalary archaeopyle.

Dimensions: The overall length of 30 measured specimens is in the range 41 μm (60 μ) 75 μm.

Remarks: The equivocal nature of the archaeopyle position precludes confident generic allocation. *Palaeohystrichophora infusorioides* Deflandre resembles this form in the rarity and irregular nature of its archaeopyle. Evitt (1967) thought that *P. infusorioides* dehisced by the complete breakdown of the whole cyst wall, and this could be the case with ?*Ovoidinium fragile*. Specimens of ?*O. fragile* with a reduced second antapical horn resemble *P. infusorioides* in general shape but they may be differentiated by the absence of processes in the former. The variants with one antapical horn are also similar to '*Deflandrea*' *pontis-mariae* (Deflandre, 1936b), another form in which an archaeopyle has not yet been observed. *D. pontis-mariae* has longer, more gently tapering horns and a relatively smaller central body. Several other species of *Deflandrea* have a comparable dorsal ambitus but differ from ?*O. fragile* in having an intercalary archaeopyle. *O. fragile* may be differentiated from other described members of the genus in its much thinner and poorly ornamented endophragm. *O. scabrosum* (Cookson & Hughes, 1964) is perhaps morphologically the closest form to ?*O. fragile*. However, *O. scabrosum* has a densely granulate endophragm and a hyaline periphragm; whereas in ?*O. fragile* both membranes have similar ornament, being either smooth or very sparsely granulate. ?*O. fragile* is a common form in most samples and ranges throughout the succession in Bathurst Island.

GROUP 14. Apical archaeopyle. Cavate cysts and cysts with a debris envelope.

Genus ODONTOCHITINA Deflandre, 1935, emended Davey, 1970

Type species: Ceratium (Euceratium) operculatum O. Wetzel, 1933.

ODONTOCHITINA OPERCULATA (O. Wetzel, 1933)—O. COSTATA Alberti, 1961 group

(Pl. 14, figs. 1-4)

O. operculata:
1933 *Ceratium (Euceratium) operculatum* O. Wetzel, 170, pl. 11, figs. 21-22.
1935 *Odontochitina silicorum* Deflandre, 234, pl. 10, figs. 8-10.
1955 *Odontochitina operculata* (O. Wetzel) Deflandre & Cookson, 291, pl. 3, figs. 5, 6.
1966b *Odontochitina operculata* (O. Wetzel); Sarjeant, 208, pl. 21, fig. 2 (see also for synonymy).
O. costata:
1961 *Odontochitina costata* Alberti, 31, pl. 6, figs. 10-13.
1962a *Odontochitina striatoperforata* Cookson & Eisenack, 490, pl. 3, figs. 14-19.
1967 *Odontochitina costata* Alberti; Clarke & Verdier, 58, pl. 13, figs. 4-6 (see also for synonymy).

BMR palynological species catalogue no.: 747.

Remarks: Samples from throughout the Bathurst Island sections have yielded examples of a variable group of species, referable to *Odontochitina operculata* and *O. costata*. These and certain other species of *Odontochitina* have stratigraphic limits which have been used both within Australia and overseas for correlative purposes. Because these stratigraphic ranges apparently differ geographically and some of the species exhibit gradational interspecific limits, the material from Bathurst Island has been examined with particular caution and the relationship between species has been reappraised.

Odontochitina operculata is characterized morphologically by the presence of accentuated periphragmic horns, one apical and two antapical. The cyst is cavate and both cyst membranes are completely smooth. Neither a girdle, a sulcal groove, nor any trace of tabulation sutures are present. The elongate horns led early authors to place this species in the extant genus *Ceratium*. However, although the species has undoubted dinoflagellate affinities, the presence of an apical archaeopyle shows that *O. operculata* is really a resting cyst and not the theca of a motile form. Its morphological similarity with *Ceratium* (both have three very long horns and a relatively small central body) may be misleading, because *Odontochitina* has not been found in sediments younger than Cretaceous whereas *Ceratium* and its allies have no fossil record.

Odontochitina costata was originally described by Alberti (1961) and has a similar shaped cyst to *O. operculata*. It differs in bearing lines of perforations on the horns separated by longitudinal ribs or costae. Cookson & Eisenack (1962a) erected *O. striatoperforata* for Australian Cretaceous cysts with an identical morphology. Clarke & Verdier (1967) discussed its relationship with Alberti's species and concluded that the two were synonymous, *O. costata* being the prior name.

The specimens from Bathurst Island and material from the Great Artesian Basin, Queensland (Burger, pers. comm.) include morphologically intermediate forms between typical *O. operculata*, with an entire periphragm; and typical *O costata*, with well developed ribbing and perforations. For this reason the specific limits between the two species are considered to be gradational and in this discussion they are treated as a single plexus.

Within the *Odontochitina* assemblages examined there are two major variables: test shape and the development of periphragmic ornament (see Text-fig. 16). There is a complete intermediate series of specimens between forms with broad-based horns and forms with narrow horns. In the former, the central capsule or endophragm is commonly in contact with the periphragm only at a few points between the horn bases (as in Pl. 14, fig. 1). The two membranes are indistinguishable over most of the central body in specimens with narrow horns and the central body has a rounded ambitus between the horn bases. The two types are present in roughly equal quantities among the Bathurst Island specimens, but in the Lower Cretaceous of the Eromanga and Surat Basins *Odontochitina* with narrow horns predominates.

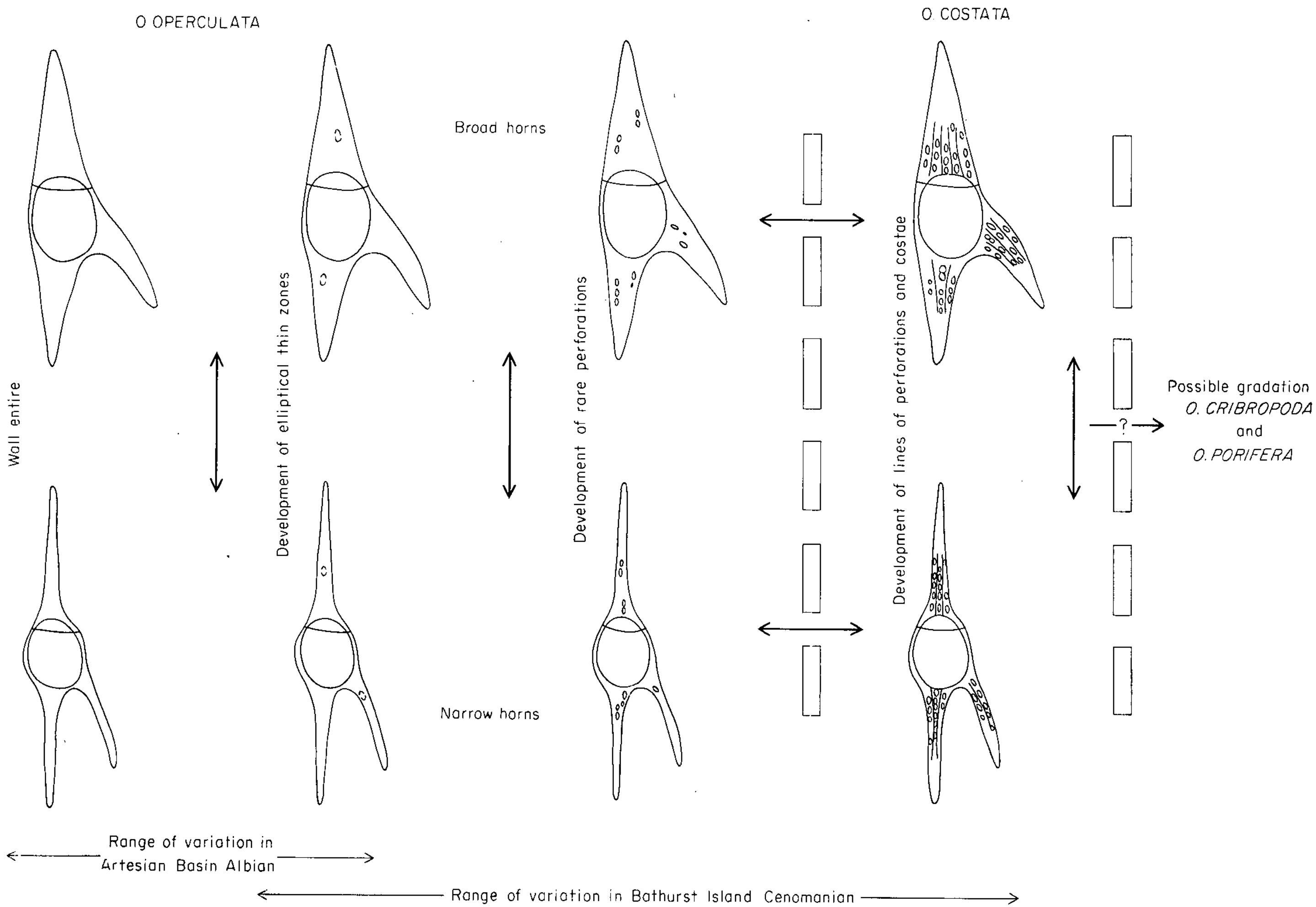


Figure 16. Variation in cyst shape and wall structure in *Odontochitina operculata* and *O. costata*.

Specimens identical with the holotype of *O. striatoperforata* (examined in the National Museum, Melbourne) and with Alberti's (1961) type illustrations of *O. costata* have well developed ribs and perforations on one or more horns. There are five or six ribs, which consist of sharp or blunt-crested longitudinal thickenings of the periphragm (see Text-figs. 16 and 17). In some specimens they occur over the whole length of the horn (Pl. 14, fig. 2); in others they are restricted to its proximal portion. They are invariably absent on the central body and on the endophragm. Longitudinal rows of oval or rounded, smooth-margined or partly coalescent holes occur in the thinner periphragm between the ribs. The rows are of variable length and are generally restricted to the proximal part of the horn (Clarke & Verdier, 1967, also found perforations concentrated at the distal end of the horn in some of their specimens). Some of the *Odontochitina* specimens from Bathurst Island—mostly those with broad-based horns—lack the longitudinal costae but retain more or less well developed perforations. Specimens without costae may have long (Pl. 14, fig. 3) or short (Pl. 14, fig. 1) rows of perforations. Some have only rare, scattered holes and these are thought to represent intermediates with *O. operculata*. No examples with an entire periphragm were found in the Bathurst Island samples. Albian and Aptian material from the Great Artesian Basin includes cysts with imperforate horns and others with rare, irregularly distributed, smooth-sided holes. The latter could have been formed by microbial activity, but their rounded outline suggests that they are original structures, representing thin zones in the periphragm (Text-fig. 17). Their variable development could have been caused by differences in maceration procedure. A more convincing example of probable fungal or bacterial activity in a detached *Odontochitina* operculum is shown in Plate 14, figure 4. The resulting perforations are much smaller and more irregular than in the strutures described above. They affect both membranes of the central body, as well as the periphragm of the apical horn.

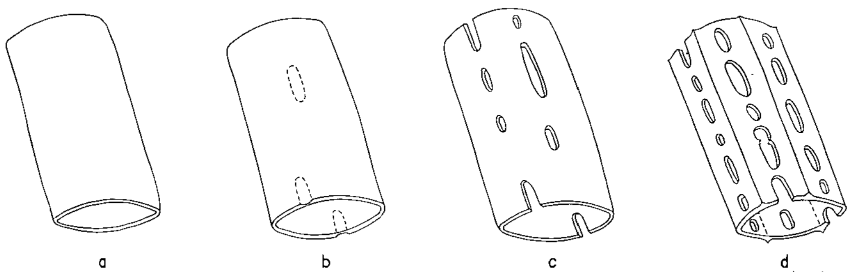


Figure 17. The progressive development of perforations and longitudinal striae in the periphragmic horns of *Odontochitina operculata* **and** *O. costata.*

Most specimens of *Odontochitina* have smoothly ovoid or spherical endocoels (as in Text-fig. 18a). In a few examples, both from Bathurst Island and from the Aptian-Albian of the Great Artesian Basin, the endophragm protrudes a short way into the base of the apical horn (Text-figs. 18b, c). A more extreme case was

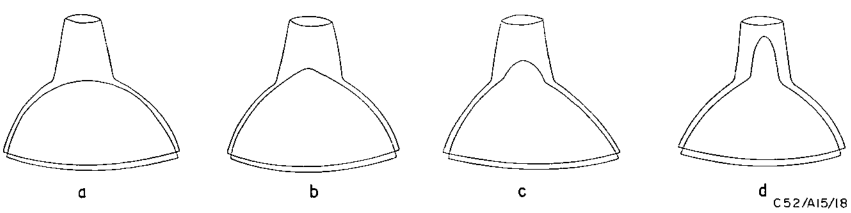


Figure 18. Variation in the development of endophragmatic extensions or protuberances into the base of apical horns in *Odontochitina costata* **(fig. d after Davey, 1970).**

illustrated by Davey (1970) (shown diagrammatically here in Text-fig. 18d) and he noted occasional endophragmic protrusions into the antapical horns as well. Capsule extensions are developed in both *O. costata* and *O. operculata*, but they are of doubtful taxonomic significance.

Occurrence: In Europe *O. operculata* has a well documented total range from the latest Hauterivian to the end of the Campanian (see Text-fig. 19). In addition, there is a possible record from the Maastrichtian of Poland (Alberti, 1961) and questionable occurrences in the Palaeocene of Germany (Alberti, 1961) and the Upper Jurassic of Canada (Pocock, 1962). Uppermost Hauterivian occurrences include those of Gocht (1959) from Germany; and of Millioud (1969), from the stratotype section in the Alps (also Barremian to lower Aptian of the same area). Other European references are from the Barremian to Coniacian (also possibly Hauterivian) of Germany (Alberti, 1961); the English Barremian (Sarjeant, 1966b); the north German Aptian (Eisenack, 1958b); the Romanian Albian (Baltes, 1963, 1967a, b); Baltic (O. Wetzel, 1933) and French (Deflandre, 1935, 1937; Deflandre & Courteville, 1939; Deflandre-Rigaud, 1955; Valensi, 1955b) Upper Cretaceous flints; the Albian to lower Cenomanian of France (Davey & Verdier, 1971, 1973); the Cenomanian of France and England (Firtion, 1952; Davey, 1970); and the Upper Cretaceous (Cenomanian to Campanian) of England (Clarke & Verdier, 1967), Poland (Gorka, 1963), and northern Italy (Corradini, 1971). In a well argued paper on the Upper Cretaceous and lowest Palaeocene microplankton from Denmark, Sweden, Holland, Belgium, and southwest France (including stratotype Campanian, Maastrichtian, and Danian), Wilson (1971) found *O. operculata* up to the top of the Campanian but not in lower Maastrichtian or higher samples. North American records include those of Pocock (1962), from the Barremian to Aptian of Canada; Singh (1964, 1971), from the Aptian to upper Albian of Alberta; Brideaux (1971), from the Albian of Alberta; and Davey (1970), from the upper Cenomanian of Texas and the Albian to Cenomanian of Saskatchewan.

Australian occurrences of *O. operculata* range in age from latest Neocomian to Cenomanian and possibly early Turonian. Deflandre & Cookson (1955) and Cookson & Eisenack (1958) record it from the Lower Cretaceous of the Papuan Basin; the Albian of the Eromanga, Styx, Perth, Carnarvon, and Papuan Basins; and the Cenomanian or lower Turonian of the Carnarvon Basin. Recent biostratigraphic work in the Great Artesian Basin by Haskell (1970) and BMR (Evans, 1966b; Burger, 1963), and northern Italy (Corradini, 1971). In a well argued paper on the Late probable upper Neocomian strata. In this area both top and bottom of the sequence are marked by changes into non-marine strata. Environmental conditions may thus explain the discrepancy between the total range in the Great Artesian Basin and the total range elsewhere.

O. costata (including *O. striatoperforata*) has a total documented range from the Albian to the early Maastrichtian, with the most frequent references from Albian and Cenomanian strata (see Text-fig. 19). Wilson (1971) found *O.* aff. *O. striatoperforata* up to the top of the Campanian but no higher in several European localities. Zaitzeff & Cross (1970) figure it from the lower Maastrichtian of Texas. Australian occurrences include the Albian of the Carnarvon and Eromanga Basins, the Albian to Cenomanian of the Eucla (cf. determination) and the ?upper Albian or Cenomanian and the upper Cenomanian of the Perth Basin (Cookson & Eisenack, 1962a, 1970; Edgell, 1964). Overseas records include those of Alberti (1961), from the German Cenomanian and Turonian; Clarke & Verdier (1967), from the lower Cenomanian to upper Campanian of southern England; Davey (1970), from the Cenomanian of England and France, and the upper Albian to lower Cenomanian of Saskatchewan; Corradini (1971), from the north Italian Upper Cretaceous; Cookson & Hughes

(1964), from the upper Albian and lower Cenomanian of eastern England (cf. determination); Manum & Cookson (1964), from the mid-Cretaceous of Arctic Canada; Evitt (1961, pl. 6, figs. 14, 15, 16; *Odontochitina* sp.), from the Albian of Venequela and the Senonian of Pakistan; Singh (1971), from the middle to upper Albian of

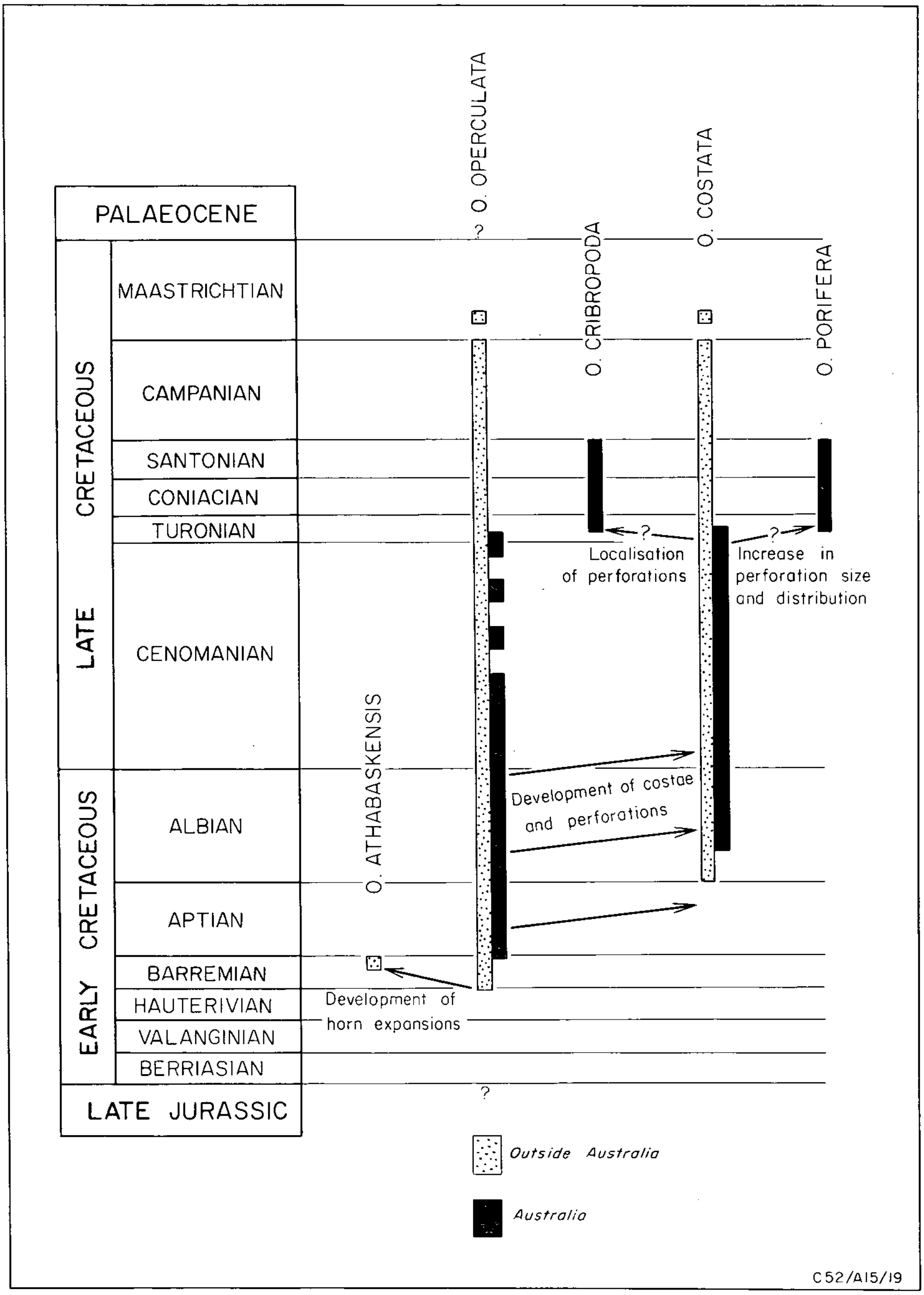


Figure 19. Published Australian and overseas stratigraphic ranges of some species of *Odontochitina*.

north-western Alberta; and Davey & Verdier (1973), from the uppermost Albian (Vraconian) to lower Cenomanian of France.

Conclusions: The available morphological and stratigraphic information enables us to suggest a tentative phylogenetic scheme for *Odontochitina*. *O. operculata* is the morphologically simplest species and it first appeared in the Early Cretaceous. The development of distal expansions of the horns gave rise to *O. athabaskensis*, which is so far only known from the upper Barremian of Canada (Pocock, 1962). Perforate and ribbed species made their initial appearance in the Albian with *O. costata*. The path by which they evolved is still uncertain, as the eastern Australian Albian assemblages are incomplete and lack the typical *O. costata* end members. However, the Bathurst Island material shows that a complete series of intermediate morphotypes still existed in the Cenomanian. In the Great Artesian Basin the Aptian and Albian assemblages are dominated by the *O. operculata* end members, but by Cenomanian time at Bathurst Island these have declined and the *O. costata* group has taken its place. At our present state of knowledge the Australian record of both species finished in the Turonian. However, elsewhere they each continue to the late Campanian and early Maastrichtian. Two further species could possibly have developed from the *O. costata* stock during the Turonian. These are *O. cribropoda* Deflandre & Cookson, 1955, which has enlarged perforations restricted to the distal parts of the horns; and *O. porifera* Cookson, 1956, in which the large holes are rectangular in outline and arranged to form a regular network.

ODONTOCHITINA sp. A

(Pl. 14, fig. 5)

BMR palynological species catalogue no.: 1038.

Description: Only two detached apical opercula have been found. They are derived from a cavate cyst, in which the thin (less than 0.2 μm), completely smooth membranes are separate only in the horns. The endophragm protrudes a short way into the base of the horn. The apical horn is long and relatively narrow (2 to 5 μm) both proximally and distally. In its central region it expands to about 9 μm, to form a smoothly rounded, elongate bulge. Here the periphragm is perforated by longitudinal rows of smooth-edged round or oval holes. In one specimen these partly coalesce and in another they are closely spaced, leaving a rectangular reticulum.

Dimensions: Length of detached apical operculum in figured specimen 74 μm.

Remarks: Both specimens came from Bathurst Island No. 2 well. The peculiar shape of the apical horn distinguishes this form from previously published species. A perforate expansion of this type in the apical horn has never been observed in the *Odontochitina operculata-costata* group.

O. athabaskensis Pocock, 1962 has horns with expanded portions. These may be situated near the roots or near the tips of the horns, but they are never perforate. Two other Australian Late Cretaceous species of *Odontochitina* have perforate horns. *O. cribropoda* Deflandre & Cookson, 1955 has club-shaped horns, with perforations restricted to the distal regions. *O. porifera* Cookson, 1956 has more regularly tapering horns, which are densely fenestrate for most of their length. In neither of these are the perforations restricted to the central parts of the horn.

Genus PHOBEROCYSTA Millioud, 1969

Type species: ?*Wetzeliella neocomica* Gocht, 1957.

1969 *Xenascus* Cookson & Eisenack, 7.

PHOBEROCYSTA CERATIOIDES (Deflandre,1937) Millioud, 1969

(Pl. 14, figs. 6, 7)

1937 *Hystrichosphaera ceratioides* Deflandre, 66, pl. 12, figs. 7, 8.
1950 *Ceratium operculatum* O. Wetzel, 169, pl. 13, fig. 6 (*non* O. Wetzel, 1933).
1961 Forma H Evitt, 400, pl. 6, fig. 9.
1966 *Pseudoceratium ceratioides* (Deflandre) Deflandre, 6.
1967 *Endoceratium perforatum* Vozzhennikova, 188, pl. 112, figs. 1-3; pl. 113, fig. 1.
1969 *Phoberocysta ceratioides* (Deflandre) Millioud, 432.
1969 *Xenascus australense* Cookson & Eisenack, 7, pl. 1, figs. I-K.
1970 Forma C sp. 1 Zaitzeff & Cross, pl. 5, figs. 48, 51.
1970 *Odontochitina blastema* Davey, 356, pl. 5, figs. 4, 5.

BMR palynological species catalogue no.: 1037.

Remarks: Three specimens, all from the uppermost sample in No. 2 well, are identified with *Phoberocysta ceratioides* on the basis of their processes, apical archaeopyle, and well developed horns. Two of the cysts are very similar to the published illustrations of *Odontochitina blastema* Davey, 1970, which Davey & Verdier (1971) subsequently transferred to *P. ceratioides.* They have a single lateral horn and the central body bears a number of narrow, irregular processes. The processes are joined proximally by low, incomplete ridges, which partially outline the cingular, precingular, and postcingular plate areas. Proximal portions of the horns also occasionally bear short processes and distally the horns are perforate. In the third specimen (Pl. 14, fig. 6) two lateral horns are present and the central body again has sparse, irregular processes.

P. ceratioides is a very variable species and the Bathurst Island material represents the extreme form with long, narrow horns. Other variants, such as those figured as *Pseudoceratium ceratioides* by Clarke & Verdier (1967) and as *Xenascus australense* by Cookson & Eisenack (1969), have more numerous processes and much wider, more irregular horns.

Occurrence: P. ceratioides has a published range from the middle Albian to the Maastrichtian. In Australia it has previously been recorded from the Albian or Cenomanian of the Perth Basin (Cookson & Eisenack, 1969). Other occurrences include the middle Albian to lower Cenomanian of France (Davey & Verdier, 1971, 1973), the upper Cenomanian of southern England and northern France (Davey, 1970), the Cenomanian to Campanian of southern England (Clarke & Verdier, 1967), the Senonian of France (Deflandre, 1937), Germany (O. Wetzel, 1950), and Pakistan (Evitt, 1961), the Upper Cretaceous of the USSR, (Vozzhennikova, 1967), and the Maastrichtian of Texas (Zaitzeff & Cross, 1970).

Genus PSEUDOCERATIUM Gocht, 1957

Type species: Pseudoceratium pelliferum Gocht, 1957.

PSEUDOCERATIUM LUDBROOKAE (Cookson & Eisenack, 1958) Eisenack, 1961

(Pl. 15, fig. 3)

1958 *Ceratocystidiopsis ludbrooki* Cookson & Eisenack, 52, pl. 5, figs. 7, 8.
1961 *Pseudoceratium ludbrooki* (Cookson & Eisenack) Eisenack, 299, pl. 36, fig. 1.

BMR palynological species catalogue no.: 1039.

Remarks: The well preserved material from Bathurst Island has been compared with the holotype in the National Museum, Melbourne. The tabulation traces are fainter than in the figure of Eisenack & Cookson (1960) and the two membranes are separated by broad supporting ridges, as in the paratype of Cookson & Eisenack (1958). In some specimens these are concentrated around the cingulum. Three periphragmic horns are present in all undehisced specimens, the lateral horn commonly having a geniculate shape. Sometimes a second lateral horn is weakly developed as a low lump on the cingulum. The archaeopyle is apical in both membranes and has a zig-zag margin sloping down towards the larger lateral horn. Neale & Sarjeant (1962) described tabulation in the English Neocomian species *Pseudoceratium* (*Eopseudoceratium*) *gochtii*. They showed that the 'lateral' horn was really dorsal and cingular in position (junction of plates 3″ 4″ 3‴ and 4‴) and that the sulcus runs along the opposite edge of the cyst. They suggested that the archaeopyle was formed by the removal of all the cyst above the precingular whorl, which would include six apical and five anterior intercalary plate areas. A similar shaped archaeopyle is present in *P. ludbrookae*, but there is insufficient evidence regarding the tabulation of the operculum to decide whether it consists of apical plates alone or a combination of apical and intercalary circlets.

P. ludbrookae differs from *P. gochtii* Neale & Sarjeant, 1962 and *P. pelliferum* Gocht, 1957 in having a smooth periphragm lacking processes. *P. nudum* Gocht, 1957 and *P. gochtii* Pocock, 1962 (erected as a separate taxon to Neale & Sarjeant's species) have a much more elongate shape with more accentuated horns. *P. turneri* Cookson & Eisenack, 1958 has a reticulate periphragm, while *P. dettmannae* Cookson & Hughes, 1964 has a pitted cingular region and a more rhomboidal shape than *P. ludbrookae*. *P. expolitum* Brideaux, 1971 has a similar shaped cyst and archaeopyle to *P. ludbrookae*, but from the type illustrations it appears to be acavate.

Occurrence: This distinctive species is very common in the lower parts of both Bathurst Island wells. It has previously been recorded from Albian strata in the Perth, Carnarvon, and Eromanga Basins (Cookson & Eisenack, 1958; Eisenack & Cookson, 1960). In addition, Edgell (1964) found it in the upper Cenomanian, and Cookson & Eisenack (1968) noted it from the mid-Cretaceous of the Perth Basin.

PSEUDOCERATIUM sp. cf. P. TURNERI Cookson & Eisenack, 1958

(Pl. 12, figs. 5, 6)

cf. 1958 *Pseudoceratium turneri* Cookson & Eisenack, 55, pl. 5, figs. 2-6.

BMR palynological species catalogue no.: 1040.

Remarks: A single dehisced specimen from the upper part of Bathurst Island No. 2 well has an ornament of ridges and processes, supporting an incomplete fenestrate membrane. It has one antapical horn, one lateral horn, and an apical archaeopyle. It closely resembles the published illustrations of *Pseudoceratium turneri*, but since only one poorly preserved specimen has been found it is compared rather than identified with Cookson & Eisenack's species.

Occurrence: P. turneri is known from the Aptian of the Carpentaria Basin and the Albian of the Styx, Eromanga, Carnarvon, Perth, and Papuan Basins (Cookson & Eisenack, 1958). Cookson & Hughes (1964) also noted it from the lowermost Cenomanian of England, and Davey & Verdier (1973) recorded it from the upper Albian of the Paris Basin. Edgell (1964) found *P. turneri* in Albian and Neocomian samples from the Perth Basin.

Genus HEXAGONIFERA Cookson & Eisenack, 1961, emended Cookson & Eisenack, 1962

Type species: Hexagonifera glabra Cookson & Eisenack, 1961.

HEXAGONIFERA CHLAMYDATA Cookson & Eisenack, 1962

(Pl. 12, figs. 13, 14)

1962a *Hexagonifera chlamydata* Cookson & Eisenack, 496, pl. 7, figs. 1-3, 5-8.

BMR palynological species catalogue no.: 1035.

Remarks: This common species shows considerable variation in surface ornament. Most specimens have finer granulate and verrucate ornament than present in the type illustrations. Those with coarser ornament also have a thicker endophragm. The endophragm is never vermiculate or reticulate, as in *Hexagonifera vermiculata* Cookson & Eisenack, 1961. The membranous periphragm is not always preserved and only occasionally are the blunt apical and antapical horns observable.

Occurrence: H. chlamydata has been described from Albian and Cenomanian deposits in the Carnarvon and Perth Basins (Cookson & Eisenack, 1962a, 1968). In Europe, Cookson & Hughes (1964) recorded it from the English upper Albian and lower Cenomanian, and Baltes (1967a) figured it from the Romanian Albian. Davey (1970) found it throughout the Cenomanian of southern England and northern France and in the lower Cenomanian of Saskatchewan, Canada. Clarke & Verdier (1967) recorded it from the lower Cenomanian to the upper Santonian of England. Other records include those of Singh (1971), from the middle to upper Albian of north-western Alberta; and Davey & Verdier (1971, 1973) from the French upper Albian and lower Cenomanian. It occurs throughout the succession in the Bathurst Island wells.

HEXAGONIFERA DEFLOCCATA Davey & Verdier, 1973

(Pl. 13, fig. 12)

1973 *Hexagonifera defloccata* Davey & Verdier, 198, pl. 3, figs. 6, 8.

BMR palynological species catalogue no.: 1036.

Remarks: Hexagonifera defloccata is distinguished from *H. chlamydata* Cookson & Eisenack by its psilate or punctate endophragm. The specific limits between the two species are difficult to define and intermediate forms probably occur. Some authors (Clarke & Verdier, 1967) describe wide variation in *H. chlamydata* but none have found a completely smooth variant. *H. glabra* Cookson & Eisenack, 1961, from the Upper Cretaceous of the Otway Basin, has a smooth or sparsely perforate endophragm which is considerably thicker than that of *H. defloccata*. *'Hexagonifera' suspecta* Manum & Cookson, 1964 differs from all other described species in its tripartite intercalary archaeopyle and does not belong in this genus.

Occurrence: Davey & Verdier described *H. defloccata* from the French upper Albian and lower Cenomanian. It occurs sporadically in the lower parts of both Bathurst Island wells.

Genus KALYPTEA Cookson & Eisenack, 1960

Type species: Kalyptea diceras Cookson & Eisenack, 1960.

KALYPTEA sp. cf. K. MONOCERAS Cookson & Eisenack, 1960

(Pl. 12, fig. 2)

cf. 1960b *Kalyptea monoceras* Cookson & Eisenack, 257, pl. 39, figs. 2, 3.
1964 *Kalyptea* cf. *monoceras* Cookson & Eisenack; Manum & Cookson, 28, pl. 6, fig. 13.

BMR palynological species catalogue no.: 1042.

Remarks: The rare specimens from Bathurst Island have more in common with Manum & Cookson's (1964) illustration of *K.* cf. *K. monoceras* than with Cookson & Eisenack's (1960b) type figure. Typical *K. monoceras* has a longer, more tapering apical horn than the Bathurst Island material. The cyst is surrounded by irregular pieces of what appears to be flocculated fine sediment. This feature has been variously described on a number of other species and genera as a 'diaphanous veil' or 'kalyptra'. Its morphological and taxonomic significance is still under discussion. Gocht (1970) described a 'kalyptra' on Middle Jurassic specimens of *Pareodinia ceratophora* Deflandre and questionably placed *Kalyptea monoceras* in its synonymy. *Kalyptea* sp. of Davey & Verdier (1971, 1973), from the Albian to lower Cenomanian of France, is very similar to the Bathurst Island specimens in cyst shape and, like Gocht's (1970) Jurassic form has an intercalary archaeopyle. Direct comparison is hampered because the position of the archaeopyle could not be determined with certainty in the Bathurst Island material.

Occurrence: Kalyptea monoceras was described from the Upper Jurassic of the Canning and Papuan Basins (Cookson & Eisenack, 1960b). A similar form was figured by Cookson & Hughes (1964) from the English lowermost Cenomanian, which differs from the Bathurst Island specimens for the same reason as the type figures. Manum & Cookson's (1964) *K.* cf. *K. monoceras* came from the mid-Cretaceous of Arctic Canada.

GROUP 15. Precingular archaeopyle. Cavate or lamellate cysts.

Genus Stephodinium Deflandre, 1936, emended Davey, 1970

Type species: Stephodinium coronatum Deflandre, 1936.

Stephodinium sp. cf. S. coronatum Deflandre, 1936

(Pl. 15, fig. 4)

cf. 1936a *Stephodinium coronatum* Deflandre, 59, text-fig. 104.
cf. 1962a *Stephodinium australicum* Cookson & Eisenack, 491, pl. 2, figs. 5-10.
cf. 1964 *Stephodinium europaicum* Cookson & Hughes, 50, pl. 8, figs. 9-17.

BMR palynological species catalogue no.: 1044.

Remarks: I agree with Clarke & Verdier (1967) in considering *Stephodinium coronatum*, *S. australicum*, and *S. europaicum* to be conspecific. The holotype of *S. australicum* has been examined in the National Museum, Melbourne, and has a cavate cyst in which the maximum separation of endophragm and periphragm is attained at the cingulum. The archaeopyle is precingular in position, as observed by Davey (1970), and is separate in the two membranes.

A number of specimens from both Bathurst Island wells are compared with this species. They have a small central body and a large pericoel expanded in the equatorial plane. The standard of preservation is poor and the fragile wall structure has led to extensive crumpling. Some show the intertabular ridges figured on all the published illustrations but none has a recognizable archaeopyle.

Occurrence: In Australia *S. coronatum* is known from the ?upper Albian or Cenomanian of the Perth Basin and the Cenomanian of the Carnarvon Basin (Cookson & Eisenack, 1962a). Overseas occurrences include the Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964), the English upper Albian and Cenomanian (Cookson & Hughes, 1964; Clarke & Verdier, 1967; Davey, 1970), the Romanian Albian (Baltes, 1967a), and the middle Albian, Cenomanian, Turonian, and possibly

Santonian of France (Deflandre, 1936a,b; Davey, 1970; Davey & Verdier, 1971, 1973).

STEPHODINIUM sp. A

(Pl. 12, fig. 7)

BMR palynological species catalogue no.: 1045.

Description: Equatorially expanded (or pterate) cavate cyst, in which the small, subspherical central body is attached to the periphragm at the apex, antapex, and dorsal side only. The two membranes are most widely separated around the cingulum and sulcus. Precingular and postcingular plates are picked out by narrow ridges, 0.5 μm wide. The cingulum is bounded above and below by smooth-surfaced lists, up to 8 μm high and with denticulate distal margins. Both the endophragm and periphragm are thin (less than 0.5 μm) and smooth or faintly granulate. No recognizable archaeopyle is present.

Dimensions: The dimensions of the figured specimen are width 86 μm, dorsoventral width 74 μm, maximum diameter of central body 39 μm.

Remarks: Two specimens from Bathurst Island No. 2 well differ from *Stephodinium* cf. *S. coronatum* and *S. coronatum* Deflandre in bearing denticulate lists at the margins of the cingulum, a more rectangular outline in apical view, and a smaller central body.

Genus DISPHAERIA Cookson & Eisenack, 1960, emended Norvick, 1973

Type species: Disphaeria macropyla Cookson & Eisenack, 1960a.

1960 *Thalassiphora* Eisenack & Gocht, 512.

Remarks: The genus *Disphaeria* was emended by Norvick (1973) and attention was drawn to its dinoflagellate affinities. The type species (redescribed below) has a double-walled lamellate cyst, with cingular folds and a possible archaeopyle. It was previously placed in the Acritarcha by Downie, Evitt, & Sarjeant (1963), who erected the morphological subgroup Disphaeromorphitae to accommodate it. The emendation rendered *Disphaeria* and *Thalassiphora* Eisenack & Gocht, 1960, synonymous, the former having priority by a few months. Four North American and European Tertiary species were transferred to *Disphaeria*. Two further species have since been described and are here placed in *Disphaeria*:

Disphaeria balcanica (Baltes, 1971) Norvick comb. nov. = *Thalassiphora balcanica* Baltes, 1971, 6, pl. 3, figs. 3-7 (Pliocene of Romania).

Disphaeria munda (Davey & Verdier, 1973) Norvick comb. nov. = *Thalassiphora munda* Davey & Verdier, 1973, 38, pl. 3, figs. 5, 7, 10 (uppermost Albian and lower Cenomanian of the Paris Basin and southeast France).

DISPHAERIA MACROPYLA Cookson & Eisenack, 1960, emended

(Pl. 15, fig. 1)

1960a *Disphaeria macropyla* Cookson & Eisenack, 11, pl. 3, figs. 13-14.

BMR palynological species catalogue no.: 1046.

Emended description: The holotype (examined in the National Museum, Melbourne) is a double-walled cyst, with a small subspherical central capsule and a circular bowl-shaped lamellar periphragm. The periphragm is crossed by a series of short, rather irregular folds, which mark the cingulum or girdle. The two membranes are only attached to each other at a small centrodorsal area, situated at the middle of the cingulum. The distal margin of the lamellar periphragm is infolded twice (see Text-fig. 20). Both membranes are very faintly granulate and no archaeopyle could be identified.

Another specimen on the same slide as the holotype (not Cookson & Eisenack's (1960a) figured paratype) has a similar structure. It differs in having a large triangular opening on the dorsal surface of the periphragm, which may represent a precingular archaeopyle. The infolded distal margin of the lamellar periphragm is slightly thickened and bears a row of blunt, well spaced denticles.

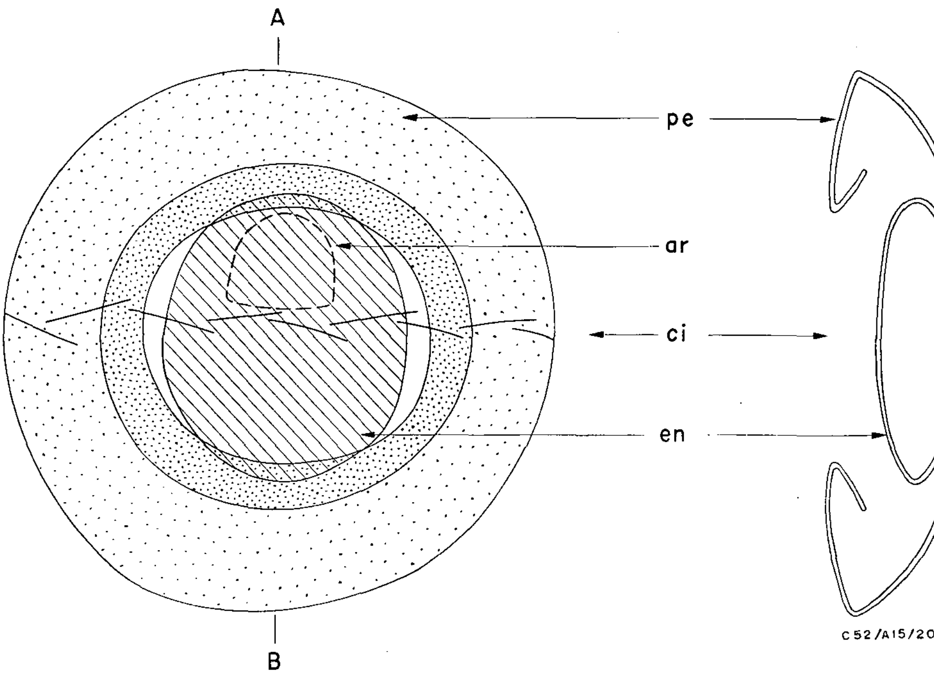


Figure 20. Diagrammatic reconstruction of the morphology of *Disphaeria macropyla* and longitudinal section along A-B (pe—lamellar periphragm; en—endophragm of central capsule (shaded); ar—archaeopyle; ci—position of cingulum; light stipple—area of wing lamella infolded once; heavy stipple—double-folded wing lamella).

Remarks: Two specimens have been recovered from a single core in Bathurst Island No. 2 well (c. 3, 61.0 m, 200′0-6″). They agree with the holotype and with the other specimen described above in their structural organization, the presence of a cingulum, and the development of marginal denticulation on the wing lamella. A smooth-sided rupture in one or both membranes probably represents an archaeopyle, but it is partly obscured by folding and its position relative to the cingulum cannot be determined with certainty. Cookson & Eisenack (1968, fig. 1M) provide an illustration of *D. macropyla* with a much better preserved archaeopyle. Their figure shows an arch-like opening in the endophragm, immediately anterior to the girdle, in a precingular position.

D. macropyla differs from previously described species in its very thin, entire periphragm, and its lack of sutural ridges. *D. pelagica* (Eisenack & Gocht, 1960), from various European Tertiary localities, has a much more robust cyst and folds marking plate boundaries. *D. delicata* (Williams & Downie, 1966), an English lower Eocene form, has a similar very thin wall structure to *D. macropyla*. However, both of its membranes are psilate and the marginal denticles on the periphragm are not present. *D. munda* (Davey & Verdier, 1973), from the French uppermost Albian (Vraconian) and lower Cenomanian, has processes separating the two membranes—structures which are absent in *D. macropyla.*

Occurrence: D. macropyla has been previously recorded from Turonian to lower Campanian strata of the Perth and Carnarvon Basins (Cookson & Eisenack, 1962a, 1968). The Bathurst Island Cenomanian specimens thus represent the earliest occurrence to date.

GROUP 16. Not classified.

Genus CHLAMYDOPHORELLA Cookson & Eisenack, 1958, emended Davey, 1970

Type species: Chlamydophorella nyei Cookson & Eisenack, 1958.

CHLAMYDOPHORELLA NYEI Cookson & Eisenack, 1958

(Pl. 11, fig. 8)

1958 *Chlamydophorella nyei* Cookson & Eisenack, 56, pl. 11, figs. 1-3.

BMR palynological species catalogue no.: 1047.

Remarks: Several species of *Chlamydophorella* have previously been distinguished on relatively minor differences of outline. *C. urna* Cookson & Eisenack, 1960, from the Albian & Cenomanian of the Carnarvon and Perth Basins, and *C. discreta* Clarke & Verdier, 1967, from the English Cenomanian to Santonian, are particularly difficult to separate from *C. nyei.* The holotype of *C. nyei*, re-examined in the National Museum, is very similar to the Bathurst Island specimens except that it has slightly more robust processes and a more complete ectophragmic membrane. Process thickness is a very variable character in the material studied and forms with stouter processes have much in common with the *Cleistosphaeridium anchoriferum-huguoniotii* group.

Occurrence: C. nyei is known from Aptian to lower Turonian strata in Australia. Cookson & Eisenack (1958) recorded it from the Aptian of the Carpentaria, Papuan (?), and Perth (?) Basins; the Albian of the Perth, Carnarvon, and Eromanga Basins; the Cenomanian of the Perth Basin, and the Cenomanian-lower Turonian of the Carnarvon Basin. Other Australian records include those of Cookson & Eisenack (1962a, 1968, 1971), from the mid-Cretaceous of the Eucla and Perth Basins. Burger (1973a) found *C. nyei* in uppermost Neocomian to Albian strata from the Great Artesian Basin. Overseas occurrences have been noted by Manum & Cookson (1964), from the low Upper Cretaceous of Arctic Canada; Davey (1970), from the Albian and Cenomanian of Saskatchewan; Singh (1971) and Brideaux (1971), from the Albian of Alberta; and Baltes (1967b), from the Albian of Romania. It is common in both Bathurst Island wells and occurs throughout the succession.

Genus DICONODINIUM Eisenack & Cookson, 1960

Type species: Palaeohystrichophora multispina Deflandre & Cookson, 1955.

Remarks: The position of the archaeopyle in *Diconodinium* remains problematical. Cookson & Eisenack (1962a) figure an opening in *D. dispersum* and *D. glabrum.* Similar apertures occur in a very few Bathurst Island specimens of *D. multispinum* and *D. dispersum.* The aperture is long and narrow, running from just below the apex to the cingulum. This would suggest that it is either precingular or sulcal in position. As sulcal archaeopyles have never been observed in either fossil or extant genera, it seems more likely that the archaeopyle of *Diconodinium* is dorsal precingular in position and formed by the loss of a single, very narrow, elongate reflected plate area (perhaps 3″ or 4″).

DICONODINIUM MULTISPINUM (Deflandre & Cookson, 1955) Eisenack & Cookson, 1960

(Pl. 11, fig. 6)

1955 *Palaeohystrichophora multispina* Deflandre & Cookson, 257, pl. 1, fig. 5.
1960 *Diconodinium multispinum* (Deflandre & Cookson) Eisenack & Cookson, 3.

BMR palynological species catalogue no.: 974.

Remarks: Diconodinium multispinum is characterized by having an ornament of small solid spines. The size and density of the spines is highly variable and in some specimens, such as the holotype, they consist of relatively few but long echinae. Others, including the specimen figured in Cookson & Eisenack, (1958, pl. 10, fig. 13), have a surface ornament which is restricted to small granules. These processes are never tubiform or distally truncate, as are those of *D. dispersum.* Another variable feature is the intensity of the surface folds, which delimit an indistinct tabulation. The wall is relatively thin and the height of the folds is a function of the cyst inflation. The Bathurst Island material shows similar broad variability. However, at no stage do the specimens show intermediate characteristics with *D. dispersum.*

Occurrence: At the moment the geological record of *D. multispinum* is restricted to Australia. It was described from the Senonian of the Perth Basin (Deflandre & Cookson, 1955; Edgell, 1964) and is also known from the Albian of the Eromanga, Carpentaria, and Carnarvon Basins (Cookson & Eisenack, 1958; Evans, 1966b). It occurs in both Bathurst Island wells in moderate numbers but has not been identified in the uppermost samples.

DICONODINIUM DISPERSUM (Cookson & Eisenack, 1958) Eisenack & Cookson, 1960

(Pl. 12, fig. 10)

1958 *Palaeohystrichophora dispersa* Cookson & Eisenack; 39, pl. 10, figs. 12, 14.
1960 *Diconodinium dispersum* (Cookson & Eisenack) Eisenack & Cookson, 3.

BMR palynological species catalogue no.: 973.

Remarks: The material studied shows considerable variation in the size of the processes. They are always cylindrical proximally and truncate distally, and thus differ from the tapering spines of *D. multispinum. D. pelliferum* (Cookson & Eisenack, 1958) was originally separated from *D. dispersum* on the smaller size of its spines. The holotypes of both forms have been re-examined and do not differ significantly in process shape. Consequently the two species are probably conspecific.

Occurrence: Diconodinium dispersum and *D. multispinum* have a very similar distribution in the Bathurst Island material, though *D. dispersum* is much more abundant in the lower and middle parts of the succession. It is known from various Albian to Cenomanian formations in the Perth Basin (Cookson & Eisenack, 1958, 1962a, 1968; Eisenack & Cookson, 1960). Edgell (1964) also recorded it from the Aptian and questionably upper Neocomian of the Perth Basin.

DICONODINIUM sp. cf. D. GLABRUM Eisenack & Cookson, 1960

(Pl. 11, fig. 3)

cf. 1960 *Diconodinium glabrum* Eisenack & Cookson; 3, pl. 1, fig. 11.

BMR palynological species catalogue no.: 975.

Remarks: A few specimens from the lower and middle parts of both Bathurst Island wells have completely smooth walls, a moderately inflated shape, an apical horn and a slightly offset antapical horn. They differ from typical *Diconodinium glabrum* in outline and in lacking sutural folds. This deficit may be due to the flexibility of the wall, but in view of their different ambiti the Bathurst Island specimens are left in open nomenclature. The outline never approaches the extreme inflation of *D. inflatum* Eisenack & Cookson, 1960 (?upper Albian or Cenomanian of the Perth Basin). The specific distinction between *D. glabrum* and another closely related species, *D. articum* Manum & Cookson, 1964, from the Upper Cretaceous of Arctic Canada, is not fully understood.

Occurrence: *D. glabrum* is known from the ?upper Albian or Cenomanian of the Perth Basin; the Albian of the Eromanga, Perth, and Carnarvon Basins; and the mid-Cretaceous of the Perth Basin (Eisenack & Cookson, 1960; Cookson & Eisenack, 1968).

DICONODINIUM sp. cf. D. TENUISTRIATUM Eisenack & Cookson, 1960

(Pl. 11, fig. 7)

cf. 1960 *Diconodinium tenuistriatum* Eisenack & Cookson, 4, pl. 1, figs. 14-16.

BMR palynologcial species catalogue no.: 976.

Remarks: A few fragmentary and crushed specimens from both wells are questionably referred to Eisenack & Cookson's species. They have solid apical and antapical horns, a longitudinally striate surface and traces of a cingulum.

Occurrence: Eisenack & Cookson's (1960) specimens were from the ?upper Albian and the Cenomanian of the Perth and Carnarvon Basins. Edgell (1964) found *D. tenuistriatum* to be characteristic of the upper part of the Cenomanian in the Perth Basin.

Genus PALAEOHYSTRICHOPHORA Deflandre, 1935, emended Deflandre & Cookson, 1955

Type species: *Palaeohystrichophora infusorioides* Deflandre, 1935.

PALAEOHYSTRICHOPHORA INFUSORIOIDES Deflandre, 1935

(Pl. 13, fig. 4; Pl. 17, fig. 4)

1934 *Palaeohystrichophora infusorioides* Deflandre, 967, fig. 8 (nomen nudum).
1935 *Palaeohystrichophora infusorioides* Deflandre; Deflandre, 230, pl. 8, fig. 4.

BMR palynological species catalogue no.: 982.

Remarks: *Palaeohystrichophora infusorioides* is a very variable species. It is specifically characterized by its peridinioid shape (one or two antapical horns and a single apical horn are present), cavate structure, and ornament of slender tapering processes. Features which vary within the species include the size, the thickness of the wall, and the length, width, and density of the processes. The specimens from Bathurst Island have particularly slender processes and a very thin wall, so that photography has proved unusually difficult. No archaeopyle has been identified. Many authors have found their material in a similar condition, although Davey (1970) reported seeing a precingular archaeopyle in very rare cases. Evitt (1967) supported the theory that excystment in *P. infusorioides* may have been by destruction of the whole cyst wall.

Occurrence: Davey (1970) and Clarke & Verdier (1967) mention the stratigraphic importance of *P. infusorioides*. They show that, with the exception of a single specimen in the middle Albian (Alberti, 1961), *P. infusorioides* occurs only in lower Cenomanian to Senonian strata. Since then its lower range has been extended very slightly by its discovery by Davey & Verdier (1973) in French uppermost Albian (Vraconian) strata. A full list of overseas occurrences may be found in Clarke & Verdier (1967) and need not be repeated here. Additional records are those of Davey (1970), from the Cenomanian of England, France, Texas, and Saskatchewan; Leopold & Pakiser (1964), from the low Upper Cretaceous of Alabama; and Zaitzeff & Cross (1970), from the lower Maastrichtian of Texas. In Australia it has been noted from the Cenomanian to lower Turonian and from the Campanian of the Carnarvon Basin (Cookson & Eisenack, 1958; 1960a); the mid-Cretaceous and upper Turonian to mid-Senonian (?Santonian) of the Perth Basin (Cookson & Eisenack, 1960a, 1969; Edgell, 1964), and from the Upper Cretaceous (to upper Senonian) of the Eucla Basin (Cookson & Eisenack, 1970a; Ingram, 1968). It occurs infrequently in both Bathurst Island wells but is absent from the lowermost sample of No. 2 well.

Genus RHOMBODELLA Cookson & Eisenack, 1962

Type species: Rhombodella natans Cookson & Eisenack, 1962.

RHOMBODELLA NATANS Cookson & Eisenack, 1962

(Pl. 11, fig. 5)

1962a *Rhombodella natans* Cookson & Eisenack, 496, pl. 7, figs. 12-13.

BMR palynological species catalogue no.: 972.

Remarks: A few specimens from Bathurst Island compare well with Cookson & Eisenack's figures. They described an opening, perhaps an apical archaeopyle, where one corner of the rhomboidal cyst was removed. All the Bathurst Island specimens are unruptured and the presumably apical corner is well rounded. It is the only angle that lacks processes, which are somewhat longer than those figured by Cookson & Eisenack.

Occurrence: Cookson & Eisenack (1962a) described this form from the ?Albian or Aptian of the Perth Basin. It is also known from the middle and upper Albian of France (Davey & Verdier, 1971, 1973) and Baltes (1967b) figured a smaller type (*Rhombodella* sp.; pl. 3, fig. 10) from the Albian of Romania.

Genus INDETERMINATE

DINOFLAGELLATE INCERTAE SEDIS FORM A

(Pl. 16, figs. 1, 2)

BMR palynological species catalogue no.: 965.

Description: Cyst proximate, acavate, and rounded rhomboidal to oval in outline; wall thin (less than 0.5 μm) and easily folded. The surface of the cyst is traversed either by zones of granules or by low lists; these outline a tabulation and are concentrated at the apex and antapex. The cingulum is helicoid and is interrupted by two elongate zones without lists. The ventral area probably represents the sulcus, but the dorsal area (below the archaeopyle) is of problematical position. The tabulation cannot be determined in detail, but at least one apical, four or five precingular, four postcingular, and one antapical plates are present. The archaeopyle is large, haplotabular, and trapezoid. Its position is either precingular or intercalary.

Dimensions: Overall length 47 μm (58 μm) 65 μm for 17 specimens.

Remarks: The enigmatic tabulation and the uncertain position of the archaeopyle preclude generic allocation. The variation in ornament and the differences in tabulation may necessitate further specific subdivision. It is moderately common in both wells and occurs throughout the succession.

DINOFLAGELLATE INCERTAE SEDIS FORM B

(Pl. 12, fig. 4)

BMR palynological species catalogue no.: 966.

Description: Acavate and proximate cyst, with a rhomboidal or pentagonal outline and a tabulate surface. The sutures bear lists, which may be granulate or smooth, thin or thick. Distally they are entire or slightly frilled. The tabulation pattern is not determinable in detail. The cingulum is marked by a prominent list and is divided into two parts, ventrally by the sulcus and dorsally by a smooth area of unknown position. Precingular and postcingular reflected plate areas are similarly interrupted. A questionable archaeopyle is haplotabular and situated in a precingular or intercalary position.

Dimensions: Overall length is 49 μm, width 58 μm, in the figured specimen.

Remarks: This species has a comparable and similarly ambiguous structure to that of Dinoflagellate Incertae Sedis form A. Both have a cingulum divided into two parts and an archaeopyle in a precingular or intercalary position. Form B may be differentiated by its higher lists. It occurs rarely in both wells.

GROUP 17. Genera with questionable dinoflagellate affinities.

Genus TRIGONOPYXIDIA Cookson & Eisenack, 1961

Type species: Trigonopyxis ginella Cookson & Eisenack, 1960.

1960a *Trigonopyxis* Cookson & Eisenack, 11.

TRIGONOPYXIDIA GINELLA (Cookson & Eisenack, 1960) Manum & Cookson, 1964

(Pl. 11, fig. 10; Pl. 17, fig. 3)

1960a *Trigonopyxis ginella* Cookson & Eisenack, 11, pl. 3, figs. 18-20.
1964 *Trigonopyxidia ginella* (Cookson & Eisenack) Manum & Cookson, 26, pl. 6, fig. 6.

BMR palynological species catalogue no.: 1049.

Remarks: The rare specimens from No. 1 well agree in all characters with the published figures. The holotype has been re-examined in the National Museum, Melbourne, but the slide has deteriorated and an archaeopyle could not be identified.

The outer membrane of one of the Bathurst Island specimens has a rupture in an apical position. Similar apical ruptures occur on most of the published illustrations but it is uncertain whether or not they represent archaeopyles.

Occurrence: Trigonopyxidia ginella was first noted in ?upper Albian or Cenomanian strata in the Perth Basin (Cookson & Eisenack, 1960a). It has also been reported from the low Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964) and the lowermost Cenomanian of central England (Cookson & Hughes, 1964).

Genus HOROLOGINELLA Cookson & Eisenack, 1962

Type species: Hologinella lineata Cookson & Eisenack, 1962.

?HOROLOGINELLA sp. cf. H. EXTREMA Cookson & Eisenack, 1962

(Pl. 16, fig. 6)

cf. 1962b *Horologinella? extrema* Cookson & Eisenack, 272, pl. 37, fig. 10.

BMR palynological species catalogue no.: 1051.

Remarks: The rare specimens from Bathurst Island differ from the type figure in having less concave sides and thus a more rectangular shape. Cookson & Eisenack did not mention a double wall structure, but their illustration shows a duplication of the double Y-fold (one on the inner and one on the outer membrane). They did not describe any aperture and none has been observed on the Bathurst Island material. Cookson & Eisenack (1962b) described an apical opening in some other species *H. lineata* and *H. apiculata*). A related genus (*Schizocystia* Cookson & Eisenack, 1962) opens by splitting into halves across the neck. One species of *Horologinella* (*H. lineata*) has polygonal fields reminiscent of dinoflagellate tabulation, but Cookson & Eisenack preferred not to designate biological affinities for the group. However, they did draw attention to the similarity between some of their forms and certain algal aplanospores described by Churchill (1960).

Occurrence: Cookson & Eisenack (1962b) reported ?*H. extrema* from the Cenomanian of the Carnarvon Basin.

Genus PALAEOSTOMOCYSTIS Deflandre, 1935

Type species: Palaeostomocystis reticulata Deflandre, 1935.

PALAEOSTOMOCYSTIS FRAGILIS Cookson & Eisenack, 1962

(Pl. 13, figs. 5, 7)

1962a *Palaeostomocystis fragilis* Cookson & Eisenack, 496, pl. 7, figs. 10-11.

BMR palynological species catalogue no.: 1050.

Remarks: Three different types of *Palaeostomocystis fragilis* occur in Bathurst Island, all of which are believed to be compressional variants of the same species. One type is a simple ovoid sac, with an aperture at one end and a strong fold bisecting the sac along its minor axis; this is identical with the holotype. A second type is the same as that figured in Cookson & Eisenack (1962a, pl. 7, fig. 10), where a major fold bisects the ovoid cyst parallel to its long axis. The transverse fold and terminal opening are also present, as they are in the third type. The latter has a more rhomboidal outline and the wall is plicated by four peripheral, longitudinally arranged folds (see Pl. 13, fig. 5). The aperture is more rectangular than in other members of the species.

■ Species positively identified

□ Species tentatively identified

		8. 243.8m 800'0-6"	7. 229.6m 750'0-6"	6. 182.9m 600'0-6"	5. 152.4m 500'0-6"	4. 121.1m 400'0-6"	3. 91.4m 300'0-6"	2. 61.0m 200'0-6"	1. 30.5m 100'	
	FORAMINIFERAL-MOLLUSCAN ZONES	F4	M3	?		M2		?	M1?	ZONATION
	MICROPLANKTON ZONES	Ascodinium parvum zone								
		Diconodinium dispersum subzone						Palaeostomocystis fragilis subzone		
B.M.R. SPECIES CATALOGUE NO.	M.F.P. BMR Sample catalogue number	4445	4446	4447	4456	4448	4455	4449	4450	BATHURST ISLAND 1 (CORE / M.F.P.)
990	ACTINOTHECA SP. A	■	Very poor recovery	■	Very poor recovery	Very poor recovery				DINOFLAGELLATE CYSTS
977	ADNATOSPHAERIDIUM UNCINATUM	■		■				■		
744	ASCODINIUM PARVUM			■			■	■	■	
1029	ASTROCYSTA SP. CF. A. CRETACEA							■		
989	CALLAIOSPHAERIDIUM ASYMMETRICUM			■						
961	CANNINGINOPSIS DENTICULATA	■		■			■			
979	CASSICULOSPHAERIDIA RETICULATA	■		■			■	■		
1047	CHLAMYDOPHORELLA NYEI	■		■			■	■	■	
968	CHYTROEISPHAERIDIA SP. CF. C. CHYTROEIDES			■				□	■	
992	CLEISTOSPHAERIDIUM ANCHORIFERUM	■		■			■	■		
999	CLEISTOSPHAERIDIUM SP. AFF. C. ARMATUM	■		■			■	■	■	
991	CLEISTOSPHAERIDIUM POLYPES	■					■	■		
993	?CLEISTOSPHAERIDIUM SP. A.			■				■		
995	?CLEISTOSPHAERIDIUM SP. C						■			
1004	CORONIFERA OCEANICA	■		■						
959	CRIBROPERIDINIUM COOKSONAE	■		■			■		■	
957	CRIBROPERIDINIUM EDWARDSII	■		■			■			
958	CRIBROPERIDINIUM MUDERONGENSIS	■		■			■	■	■	
980	CYCLONEPHELIUM DISTINCTUM	■		■			■	■		
983	CYCLONEPHELIUM SP. CF. C. HUGHESII						■	■		
981	CYCLONEPHELIUM MEMBRANIPHORUM	■		■				■		
984	CYCLONEPHELIUM VANNOPHORUM							■		
986	CYCLONEPHELIUM SP. B	■		■				■		
987	CYCLONEPHELIUM SP.C			■						
1030	?DEFLANDREA SP. B			■						
973	DICONODINIUM DISPERSUM	■		■			■			
975	DICONODINIUM SP. CF. D. GLABRUM			■						
974	DICONODINIUM MULTISPINUM	■		■			■			
976	DICONODINIUM SP. CF. D. TENUISTRIATUM			■						
965	DINOFLAGELLATE INCERTAE SEDIS FORM A						■	■	■	
966	DINOFLAGELLATE INCERTAE SEDIS FORM B	■		■					■	
1043	?DINOPTERYGIUM SP. A			□						
998	EXOCHOSPHAERIDIUM BREVISPINUM			■					■	
997	EXOCHOSPHAERIDIUM CENOMANIENSE	■					■	■	■	
1001	EXOCHOSPHAERIDIUM SP. CF. E. PHRAGMITES			□						
1000	EXOCHOSPHAERIDIUM PSEUDHYSTRICHODINIUM	■		■			■	■	■	
1005	FLORENTINIA LACINIATA	■		■					■	
1006	FLORENTINIA MANTELLII			■			■		■	
951	GONYAULACYSTA CASSIDATA								■	
952	GONYAULACYSTA SP. A	■		■						
1025	HESLERTONIA STRIATA	■					■			
1035	HEXAGONIFERA CHLAMYDATA	■		■			■	■		
1036	HEXAGONIFERA DEFLOCCATA			■						
1051	?HOROLOGINELLA SP. CF. H. EXTREMA	□								
1013	HYSTRICHODINIUM SP. CF. H. PULCHRUM			■				■		
996	HYSTRICHOSPHAERIDIUM DIFFICILE						■			
1007	?HYSTRICHOSPHAERIDIUM SP. A	■								
1042	KALYPTEA SP. CF. K. MONOCERAS	■		■						
1008	LITOSPHAERIDIUM SIPHONIPHORUM	■					■	■		
967	?MEIOUROGONYAULAX SP. A.							■	■	
970	MEMBRANOSPHAERA GRANULATA	■		■				■	■	
969	?MEMBRANOSPHAERA SP. A			□						
963	MICRODINIUM ORNATUM						■	■		
747	ODONTOCHITINA OPERCULATA-COSTATA GROUP	■		■			■	■		
1009	OLIGOSPHAERIDIUM COMPLEX	■		■			■	■		
1010	OLIGOSPHAERIDIUM PULCHERRIMUM	■		■			■	■		
1026	?OVOIDINIUM FRAGILE	■		■			■		■	
982	PALAEOHYSTRICHOPHORA INFUSORIOIDES	■					■		■	
1050	PALAEOSTOMOCYSTIS FRAGILIS	■		■			■	■	■	
1033	PAREODINIA SP. A			■						
1011	PROLIXOSPHAERIDIUM CONULUM	■		■						
954	PSALIGONYAULAX DEFLANDREI	■		■					■	
1039	PSEUDOCERATIUM LUDBROOKAE			■			■			
972	RHOMBODELLA NATANS			■						
1019	SPINIFERITES CINGULATUS VAR. CINGULATUS	■		■			■	■	□	
1018	SPINIFERITES PTEROTUS						■			
1014	SPINIFERITES RAMOSUS GROUP	■		■			■	■	■	
1015	SPINIFERITES SP. CF. S. SCABROSUS	■		■			■	■	■	
1017	SPINIFERITES SPECIOSUS						■			
953	SPINIFERITES SP. A			■						
1021	SPINIFERITES SP. B			■						
1115	?SPINIFERITES SP. E			■					■	
1044	STEPHODINIUM SP. CF. S. CORONATUM			■						
1012	TANYOSPHAERIDIUM SALPINX	■		■				■		
960	TRICHODINIUM CASTANEA	■		■			■	■	□	
1049	TRIGONOPYXIDIA GINELLA	■		■						
978	VALENSIELLA GRIPHUS	■		■			■	■	■	
1024	XIPHOPHORIDIUM ALATUM	■		■			■	■	■	
	BALTISPHAERIDIUM SPP.	■		■					■	ACRITARCHS
1052	CYMATIOSPHAERA RADIATA	■		■			■			
	LEIOSPHAERIDIA SPP.	■		■			■	■	■	
1055	MICRHYSTRIDIUM SP. CF. M. SINGULARE	■		■			■			
1056	MICRHYSTRIDIUM SP. A.	■		■					■	
	MICRHYSTRIDIUM SPP.	■		■				■	■	
1058	PTEROSPERMOPSIS SP. CF. P. AUREOLATA								■	
1057	PTEROSPERMOPSIS AUSTRALIENSIS	■		■						
1054	VERYHACHIUM REDUCTUM	■		■			■	■	■	
1061	PALAMBAGES FORM A			■			■			CHLOROPHYTA

C52/A15/21

Figure 21. Microplankton distribution chart for Bathurst Island No. 1.

Figure 24 Microplankton distribution chart for Bathurst Island No. 2.

■ Species positively identified
□ Species tentatively identified
M.F.P. BMR Sample catalogue number

B.M.R. SPECIES CATALOGUE NO.	SPECIES	4429	4430	4431	4432	4433	4434	4435	4436	4437	4438	4439	4440	
	FORAMINIFERAL-MOLLUSCAN ZONES	F5	F4	M3		M2							M1 ?	ZONATION
	MICROPLANKTON ZONES	Ascodinium parvum zone												
		Diconodinium dispersum subzone									Palaeostomocystis fragilis subzone			
	CORE	12 311.9m 1023'0-6"	11 274.4m 900'0-6"	10 248.8m 816'0-6"	9 213.4m 700'0-6"	8 182.8m 599'6-11"	7 152.3m 499'6-11"	6 126.5m 418'0-6"	5 106.4m 349'0-6"	4 91.5m 298'6-11"	3 61.0m 200'0-6"	2 45.8m 150'0-6"	1 15.3m 50'0-6"	CORE
	M.F.P.	4429	4430	4431	4432	4433	4434	4435	4436	4437	4438	4439	4440	BATHURST ISLAND 2
1016	ACHMOSPHAERA SP. A			■	■					■			□	DINOFLAGELLATE CYSTS
977	ADNATOSPHAERIDIUM UNCINATUM	■		■	■	■		■	■	■				
956	APTEODINIUM MACULATUM	■	■	■										
1027	ASCODINIUM ACROPHORUM									■		■		
744	ASCODINIUM PARVUM	■	■	■	■	■	■	■	■	■	■	■	■	
1028	ASCODINIUM SP. A	■	■	■										
1029	ASTROCYSTA SP. CF. A. CRETACEA		■										■	
989	CALLAIOSPHAERIDIUM ASYMMETRICUM		■	□	■	■	□	■		■	□			
961	CANNINGINOPSIS DENTICULATA	■	■	■	■	■	■	■	■	■	■			
979	CASSICULOSPHAERIDIA RETICULATA	■		■	■	■				■	■		■	
1047	CHLAMYDOPHORELLA NYEI	■	■	■	■	■	■	■	■	■	■			
968	CHYTROEISPHAERIDIA SP. CF. C. CHYTROEIDES	■	■	■	■	■			■	■	■		■	
971	?CHYTROEISPHAERIDIA SP. A		■			■	■			■				
992	CLEISTOSPHAERIDIUM ANCHORIFERUM	■	■	■				■	■		■			
999	CLEISTOSPHAERIDIUM SP. AFF. C. ARMATUM	■	■	■	■		■	■	■	□	■	■	■	
991	CLEISTOSPHAERIDIUM POLYPES		■	■				■		■			■	
993	?CLEISTOSPHAERIDIUM SP. A		■	■	■	■			■	■			■	
1002	?CLEISTOSPHAERIDIUM SP. B					■				■				
995	?CLEISTOSPHAERIDIUM SP. C				■	■		■						
1003	?CORDOSPHAERIDIUM SP. A			■										
1004	CORONIFERA OCEANICA		■		■	■			■	■			■	
959	CRIBROPERIDINIUM COOKSONAE	■	■	■	■	■	■		■	■	■	■	■	
957	CRIBROPERIDINIUM EDWARDSII			■	■	■				■	■			
958	CRIBROPERIDINIUM MUDERONGENSIS	■	■	■	■	■	■	■	■	■	■	■	■	
745	CYCLONEPHELIUM COMPACTUM	■	■						■				■	
980	CYCLONEPHELIUM DISTINCTUM	■		■	■	■	■	■	■	■	■	■	■	
983	CYCLONEPHELIUM SP. CF. C. HUGHESII					■				■				
981	CYCLONEPHELIUM MEMBRANIPHORUM		■	■	■			■	■	■	■		■	
984	CYCLONEPHELIUM VANNOPHORUM									■	■	■	■	
985	CYCLONEPHELIUM SP. A	■			■				■				■	
986	CYCLONEPHELIUM SP. B				■	■			■	■	■		■	
987	CYCLONEPHELIUM SP. C	■	■								■		■	
988	CYCLONEPHELIUM SP. D			■			■							
1032	DEFLANDREA SP. A	■												
1030	?DEFLANDREA SP. B												■	
973	DICONODINIUM DISPERSUM	■	■	■	■	■	■	■	■	■	■			
975	DICONODINIUM SP. CF. D. GLABRUM	■	■	■	■	■	■		■		□			
974	DICONODINIUM MULTISPINUM	■	■	■	■	■	■	■	■	■	■			
976	DICONODINIUM SP. CF. D. TENUISTRIATUM				■									
965	DINOFLAGELLATE INCERTAE SEDIS FORM A	■	■	■	□				■	■		■	■	
966	DINOFLAGELLATE INCERTAE SEDIS FORM B	■			■			■						
1043	?DINOPTERYGIUM SP. A		■	■										
1046	DISPHAERIA MACROPYLA										■			
998	EXOCHOSPHAERIDIUM BREVISPINUM		■	■					■		■		■	
997	EXOCHOSPHAERIDIUM CENOMANIENSE	■	■	■			■	□	□	■	■	■	■	
1001	EXOCHOSPHAERIDIUM SP. CF. E. PHRAGMITES			■	■				■		■			
1000	EXOCHOSPHAERIDIUM PSEUDHYSTRICHODINIUM	■	■		■	■	■	■	■	■	■	■	■	
1005	FLORENTINIA LACINIATA	■	■	■	■	■		■		■	■	■		
1006	FLORENTINIA MANTELLII	□	■	■	■	■	■	■	■	■	■	■	■	
951	GONYAULACYSTA CASSIDATA	■			■	■		■	■	■	■		■	
952	GONYAULACYSTA SP. A	■	■											
1025	HESLERTONIA STRIATA		■											
1035	HEXAGONIFERA CHLAMYDATA	■	■	■	■	■	■	■	■	■	■	■	■	
1036	HEXAGONIFERA DEFLOCCATA		■			■		■	■					
1051	?HOROLOGINELLA SP. CF. H. EXTREMA	■				■		■			■			
1013	HYSTRICHODINIUM SP. CF. H. PULCHRUM		■	■	■				■		■		■	
996	HYSTRICHOSPHAERIDIUM DIFFICILE		■			■				■	■	■	■	
1007	?HYSTRICHOSPHAERIDIUM SP. A		■											
1042	KALYPTEA SP. CF. K. MONOCERAS		■		■								■	
1008	LITOSPHAERIDIUM SIPHONIPHORUM	■	■	■	■	■		■	■	■	■	■	■	
967	?MEIOUROGONYAULAX SP. A	■								■				
970	MEMBRANOSPHAERA GRANULATA	■	■	■	■	■	■	■	■	■	■			
969	?MEMBRANOSPHAERA SP. A		■	□				■		■		■		
963	MICRODINIUM ORNATUM					■		■					■	
962	MICRODINIUM SP. CF. M. SETOSUM	■								■				
964	MICRODINIUM SP. A							■						
747	ODONTOCHITINA OPERCULATA-COSTATA GROUP	■	■	■	■	■	■	■	■	■	■	■	■	
1038	ODONTOCHITINA SP. A							■					■	
1009	OLIGOSPHAERIDIUM COMPLEX	■	■	■	■	■		■	■		■	■	■	
1010	OLIGOSPHAERIDIUM PULCHERRIMUM	■	■	■	■				■	■	■		■	
1026	?OVOIDINIUM FRAGILE	■	■	■	■	■	■	■	■	■	■			
982	PALAEOHYSTRICHOPHORA INFUSORIOIDES					■					■	■		
1050	PALAEOSTOMOCYSTIS FRAGILIS	■	■	■	■	■		■	■	■	■	■	■	
1033	PAREODINIA SP. A		■					■						
1037	PHOBEROCYSTA CERATIOIDES												■	
1011	PROLIXOSPHAERIDIUM CONULUM	■	■	■		■	■	■		□				
954	PSALIGONYAULAX DEFLANDREI	■		■		■	■	■	■	■	■			
955	PSALIGONYAULAX GALEATA	■				□	■							
1039	PSEUDOCERATIUM LUDBROOKAE	■	■		■	■		■	■	■				
1040	PSEUDOCERATIUM SP. CF. P. TURNERI										■			
1034	PYXIDIELLA SP. A		■											
972	RHOMBODELLA NATANS	■	■											
1019	SPINIFERITES CINGULATUS VAR. CINGULATUS	■	■	■		■		■						
1020	SPINIFERITES CINGULATUS VAR. GRANULATUS		■											
1018	SPINIFERITES PTEROTUS	■	■	■			■	■						
1014	SPINIFERITES RAMOSUS GROUP	■	■	■	■	■	■	■	■	■	■	■	■	
1015	SPINIFERITES SP. CF. S. SCABROSUS	■			■	■	■	■		■				
1017	SPINIFERITES SPECIOSUS	■	■											
953	SPINIFERITES SP. A									■		■		
1021	SPINIFERITES SP. B	■			■					■	■			
1022	SPINIFERITES SP. C	■					■	■		■				
1023	?SPINIFERITES SP. D		■											
1115	?SPINIFERITES SP. E		■				■		■		■	■	■	
1044	STEPHODINIUM SP. CF. S. CORONATUM		■		■	■		■	■		■			
1045	STEPHODINIUM SP. A							■			■	□		
1012	TANYOSPHAERIDIUM SALPINX	■	■	■	■	■	■	■						
960	TRICHODINIUM CASTANEA	■	■	■	■	■	■	■	■	■	■	■	■	
994	TRICHODINIUM SP. A												■	
1031	TRITHYRODINIUM SP. A	■												
978	VALENSIELLA GRIPHUS	■	■	■		■		■		■			■	
1048	WALLODINIUM LUNA		■											
1024	XIPHOPHORIDIUM ALATUM	□		■	■		■	■	■		■	■	■	
	BALTISPHAERIDIUM SPP.	■		■	■			■	■	■	■			ACRITARCHS
1053	CYMATIOSPHAERA SP. CF. C. CONOPA												■	
1052	CYMATIOSPHAERA RADIATA	■	■	■	■	■	■	■	■	■	■	■	■	
	LEIOSPHAERIDIA SPP.	■	■	■	■	■	■	■	■	■			■	
1055	MICRHYSTRIDIUM SP. CF. M. SINGULARE	■	■	■		■		■	■	■	■			
1056	MICRHYSTRIDIUM SP. A	■		■	■	■		■		■				
	MICRHYSTRIDIUM SPP.	■	■	■	■	■	■	■		■	■	■	■	
1058	PTEROSPERMOPSIS SP. CF. P. AUREOLATA	■		■		■			■			■	■	
1057	PTEROSPERMOPSIS AUSTRALIENSIS						■						■	
1059	PTEROSPERMOPSIS SP. A											■	■	
1054	VERYHACHIUM REDUCTUM	■	■	■	■	■	■	■	■	■	■	■	■	
1061	PALAMBAGES FORM A		■					■	■	□	■			CHLOROPHYTA
428	SCHIZOSPORIS RETICULATUS		■	■								■		

C52/A15/22

about 0.5 μm in basal diameter, and taper distally to a point. A dehiscent rupture is sometimes present and consists of a split which almost completely separates the central body into two subequal hemispheres.

Dimensions: The overall diameter varies in the range 10 μm (19 μm) 24 μm for 10 specimens.

Remarks: Davey (1970) described and figured a selection of *Micrhystridium* species from the Cenomanian of Europe and North America. Some of his illustrations resemble the Bathurst Island specimens, but specific identifications could not be confirmed without recourse to his original specimens. Small numbers of *Micrhystridium* sp. A occur throughout the succession in both Bathurst Island wells.

Genus BALTISPHAERIDIUM Eisenack 1958, emended Downie & Sarjeant, 1963

Type species: Hystrichosphaeridium longispinosum Eisenack, 1931.

Remarks: A number of chorate specimens are provisionally referred to the acritarch genus *Baltisphaeridium* on the basis of their lack of archaeopyle and other dinoflagellate characters. Individual forms are very rare and none could be identified with described species. Their distribution is shown on the range charts only as a group.

BALTISPHAERIDIUM sp. A

(Pl. 16, fig. 5)

BMR palynological species catalogue no.: 1116.

Description: Chorate acritarch, with a subspherical or spherical central body and a smooth, extremely thin wall (less than 0.2 μm). The very large number of densely arranged, extremely slender processes (3 to 5 μm in length) are winding and occasionally branched, with bases about 0.5 μm in diameter. They rapidly taper to about 0.2 μm and are distally pointed. No dehiscence ruptures are visible. Dimensions of figured specimen are overall diameter 44 μm, diameter of central body 36 μm.

BALTISPHAERIDIUM sp. B

(Pl. 16, fig. 4)

BMR palynological species catalogue no.: 1117.

Description: Chorate acritarch, central body very thin-walled and with a smooth surface. More than 50 ribbon-like processes 8-16 μm long are present. They are very thin, unbranched, about 1 μm in basal width, and taper to a point. Their fragility results in irregular folding and bending, giving the acritarch a ragged appearance. No rupture or other dehiscence structure has been observed. The overall diameter of the figured specimen is 58 μm, central body diameter 22 μm.

BALTISPHAERIDIUM sp. C

(Pl. 16, fig. 9)

BMR palynological species catalogue no.: 1118.

Description: Chorate acritarch with a large number (over 50) of short processes (2 to 5 μm long) on a thin-walled, granulate, subspherical central body. The processes are 0.2 to 0.5 μm in basal diameter and are distally pointed. They are randomly arranged and have a curved or sinuous, unbranched shape. An irregular opening is

Palaeostomocystis appears to be a polyphyletic taxon, some of whose members are probably not dinoflagellates at all. However, the transverse fold of *P. fragilis* quite probably represents a dinoflagellate cingular structure. It is more difficult to relate the terminal opening to a dinoflagellate archaeopyle, as it has a smooth margin and lacks traces of tabulation. A similar structure, which may also be an archaeopyle, is known in *Fromea amphora* (Cookson & Eisenack, 1958). The two species are closely related and *F. amphora* is distinguished by its thicker wall.

Occurrence: P. fragilis is common in both Bathurst Island wells and occurs throughout the succession. In Australia Cookson & Eisenack (1962a) have recorded *P. fragilis* from the Aptian to the Cenomanian of the Perth Basin. It has also been described from the low Upper Cretaceous of Arctic Canada (Manum & Cookson, 1964), the upper Albian of Alberta (Brideaux, 1971; Singh, 1971) and the Albian or lower Cenomanian of the Atlantic ocean floor (Habib, 1969, 1970).

Group ACRITARCHA Evitt, 1963

Subgroup ACANTHOMORPHITAE Downie, Evitt, & Sarjeant, 1963

Genus MICRHYSTRIDIUM Deflandre, 1937, emended Downie & Sarjeant, 1963

Type species: Hystrichosphaera inconspicua Deflandre, 1935.

Remarks: Species of *Micrhystridium* are abundant in the Bathurst Island material and occur in nearly every sample. Several forms are present but all except two are very rare, usually only represented by individual specimens. For this reason only the two common species are described here. In the range charts the distribution of the rare species is not shown separately.

MICRHYSTRIDIUM sp. cf. M. SINGULARE Firtion, 1952

(Pl. 15, fig. 8)

cf. 1952 *Micrhystridium singulare* Firtion; 160, pl. 8, figs. 1-2.

BMR palynological species catalogue no.: 1055.

Remarks: This form is similar to Firtion's (1952) species in shape but is considerably larger. The Bathurst Island specimens have an overall diameter of 34 to 71 μm and most have nine hollow tapering horns. They are thus large for inclusion in the genus *Micrhystridium.* They might be allocated to *Veryhachium*, but the presence of nine horns is not typical of the latter genus. The forms figured by Davey (1970) as *Veryhachium* sp. B (Cenomanian of England and France), by Clarke & Verdier (1967) as *Veryhachium* sp. (Santonian of England) and by Cookson & Eisenack (1970a) as *Veryhachium* sp. (Senonian of the Eucla Basin) are all very similar to the Bathurst Island material. *M.* cf. *singulare* occurs rarely in both Bathurst Island wells and has been found in the lower and middle parts of the succession.

MICRHYSTRIDIUM sp. A

(Pl. 12, fig. 9)

BMR palynological species catalogue no.: 1056.

Description: Chorate acritarch, with a spherical or subspherical central body whose wall is single-layered and about 0.5 μm thick. About 20 randomly arranged processes arise abruptly from the completely psilate central body. They are 3 to 5 μm long, present in the figured specimen but it is probably a fortuitous rupture. The figured specimen has an overall diameter of 32 μm, central body diameter 26 μm.

Remarks: This form is similar to *Baltisphaeridium* sp. A but has much thicker and less numerous processes.

BALTISPHAERIDIUM sp. D

(Pl. 16, fig. 8)

BMR palynological species catalogue no.: 1119.

Description: Chorate acritarch, with a thin-walled central body (thickness less than 0.5 μm). The central body bears over 100 short, solid processes, 2 to 5 μm in length. These have slightly expanded bases about 1 μm in diameter, which rapidly taper to about 0.2 μm. They follow a slightly sinuous course and are terminally pointed. One specimen has a broad protuberance at one end of the central body, but dehiscence structures could not be positively identified. Dimensions of figured specimen are overall diameter 47 μm, diameter of central body 43 μm.

Remarks: Baltisphaeridium sp. D differs from *B.* spp. A and C in having a thicker wall and stouter processes.

Subgroup POLYGONOMORPHITAE Downie, Evitt, & Sarjeant, 1963

Genus VERYHACHIUM Deunff, 1958, emended Downie & Sarjeant, 1963

Type species: Veryhachium trisulcum Deunff, 1958.

VERYHACHIUM REDUCTUM Deunff, 1958

(Pl. 15, figs. 5, 6, 7)

1958 *Veryhachium trisulcum* var. *reductum* Deunff, 27, pl. 1, figs. 1, 3, 8, 10-12, 14, 15, 17, 22, 23.
1961 *Veryhachium reductum* Deunff; de Jekhowski, 210, pl. 2, figs. 33-37.

BMR palynological species catalogue no.: 1054.

Remarks: Davey (1970) distinguished a number of species of *Veryhachium* from the European and North American Cenomanian on horn number and shape. In the present study forms with three, four, and five horns (including *V. hyalodermum* Cookson, 1956; *V. metum* Davey, 1970) are all placed in *V. reductum.* It seems very likely that the two-horned type, figured by Davey (1970) as *Leiofusa* cf. *jurassica* Cookson & Eisenack, 1958, is also a variant of *V. reductum.* Two-horned specimens from Bathurst Island (see Pl. 15, fig. 5) have more in common with *V. reductum* than with Cookson & Eisenack's species and are thus included with the former. *V. reductum* is ubiquitous in the Bathurst Island wells and occurs in small numbers throughout the succession.

Occurrence: V. reductum was originally described from the Ordovician of France (Deunff, 1958). It is also known from the Silurian, Permian, Triassic, Jurassic, and Cretaceous in various parts of the world. Australian occurrences include the (?)Aptian-Albian and Cenomanian of the Perth and Carnarvon Basins (Cookson & Eisenack, 1962a, 1968) and the Albian-Cenomanian of the Eucla Basin (Cookson & Eisenack, 1970a).

Subgroup SPHAEROMORPHITAE Downie, Evitt & Sarjeant, 1963

Genus LEIOSPHAERIDIA Eisenack, 1958, emended Downie & Sarjeant, 1963

Type species: Leiosphaeridia baltica Eisenack, 1958a.

Remarks: A number of small, completely smooth-walled types of sphaeromorph acritarch occur more or less commonly in all the samples from Bathurst Island. They are about 20 to 30 μm in diameter, have walls 0.2 μm thick and do not take up safranin stain. Their morphology has most in common with the small types included by some authors in *Protoleiosphaeridium* Timofeyev, 1959. Larger forms (up to 300 μm), which Wall (1962) related to the Recent green Pracinophycean alga *Halosphaera* Ostenfeld, have not been encountered. The biological affinities of these small Leiospheres are not known with certainty. Members of the Cyanophyceae and Chlorophyceae produce resting spores of this type, but the extreme simplicity of their morphology precludes more detailed comparison.

Subgroup HERKOMORPHITAE Downie, Evitt, & Sarjeant, 1963

Genus CYMATIOSPHAERA O. Wetzel, 1933, emended Deflandre, 1954

Type species: Cymatiosphaera radiata O. Wetzel, 1933.

CYMATIOSPHAERA RADIATA O. Wetzel, 1933

(Pl. 16, fig. 7)

1933 *Cymatiosphaera radiata* O. Wetzel, 27, pl. 4, fig. 8.

BMR palynological species catalogue no.: 1052.

Remarks: The Bathurst Island specimens are characterized by their narrow lumina and high membranes, resulting in structures which resemble broad processes in broken specimens. *Adnatosphaeridium chonetum* (see Cookson & Eisenack, 1962a) has broad, close-set processes with a superficial similarity to the membranes of *Cymatiosphaera radiata*, but it is considerably larger; Cookson & Eisenack give its overall diameter as 65 to 90 μm, whereas the Bathurst Island specimens of *C. radiata* are 27 to 37 μm in diameter.

Occurrence: Australian occurrences of *Cymatiosphaera radiata* include the Albian to Cenomanian of the Perth and Carnarvon Basins (Cookson & Eisenack, 1960a) and the Senonian of the Eucla Basin (Cookson & Eisenack, 1970a). O. Wetzel (1933) originally described it from the Upper Cretaceous of Germany, Zaitzeff & Cross (1970) figured it from the Maastrichtian of Texas, and Davey (1970) recorded it from the Cenomanian of southern England and northern France. It is common in both Bathurst Island wells and occurs throughout the succession.

CYMATIOSPHAERA sp. cf. C. CONOPA Davey, 1970

(Pl. 12, figs. 11, 12)

cf. 1970 *Cymatiosphaera conopa* Davey, 380, pl. 9, figs. 4, 5.

BMR palynological species catalogue no.: 1053.

Remarks: A single well preserved specimen, from the top of No. 2 well, is tentatively identified with Davey's species. It is 24 μm in diameter and has a thick wall bearing a regular polygonal network of ridges. Short hollow spines arise at the intersections of the muri and appear as very small lumina in optical section. The main lumina are smooth-floored and lack pores or spines. Davey's material came from the Cenomanian of Saskatchewan, Canada, and bears more numerous polygons than the Bathurst Island specimen. *Cymatiosphaera tremaphora* Cookson & Eisenack, 1971, from the mid-Cretaceous of the Eucla Basin, has similar small unthickened areas at the flange junctions. The muri are more sinuous and the major lumina slightly smaller than in *C. conopa* but variation studies on a larger number of specimens than at present available may show that the two are conspecific.

Subgroup PTEROMORPHITAE Downie, Evitt & Sarjeant, 1963

Genus PTEROSPERMOPSIS W. Wetzel, 1952

Type species: Pterospermopsis danica W. Wetzel, 1952.

PTEROSPERMOPSIS AUSTRALIENSIS Deflandre & Cookson, 1955

(Pl. 16, fig. 11)

1955 *Pterospermopsis australiensis* Deflandre & Cookson, 286, pl. 3, fig. 4; text-figs. 52, 53.

BMR palynological species catalogue no.: 1057.

Remarks: The rare, poorly preserved specimens from Bathurst Island have been compared with Deflandre & Cookson's holotype. They have slightly larger central bodies but the undulose equatorial flange is very similar. None have as relatively large a central body as *P. ginginensis* Deflandre & Cookson, 1955.

Occurrence: P. australiensis was originally described from the Lower Cretaceous of the Eromanga Basin (Deflandre & Cookson, 1955). Burger (1973a) found *P. australiensis* in lowermost Aptian or uppermost Neocomian strata from the Great Artesian Basin, Queensland. Other occurrences include the Albian of Romania (Baltes, 1967b), the Upper Jurassic of southern England and northern France (Gitmez, 1970), the lower Palaeocene of South Dakota (Stanley, 1965), the middle to upper Albian of Alberta (Brideaux, 1971; Singh, 1971) and the mid-Cretaceous of the Eucla Basin (Cookson & Eisenack, 1971).

PTEROSPERMOPSIS sp. cf. P. AUREOLATA Cookson & Eisenack, 1958

(Pl. 16, fig. 13; Pl. 17, fig. 10)

cf. 1958 *Pterospermopsis aureolata* Cookson & Eisenack, 49, pl. 9, figs. 10-12.

BMR palynological species catalogue no.: 1058.

Remarks: Specimens from Bathurst Island have a relatively small central body, a thin equatorial flange, whose roots are completely unpleated, and an overall diameter of 58 to 99 μm. A circular pylome is sometimes present on the central body. Cookson & Eisenack (1958) did not describe a pylome and their specimens were considerably larger (109-208 μm in diameter). It is recognized that specific differentation on size alone is of rather uncertain value, and so these specimens are compared with *Pterospermopsis aureolata. P. eurypteris* Cookson & Eisenack, 1958, from the Lower Cretaceous of the Eromanga, Perth, and Carnarvon Basins, differs from this form in its smaller body and relatively wider flange.

Occurrence: P. aureolata was reported by Cookson & Eisenack (1958, 1971) from the Cenomanian to the lower Turonian of the Carnarvon Basin, the Aptian of the Carnarvon, Eromanga, and Carpentaria Basins, the upper Neocomian or lower Aptian of the Carnarvon Basin, and the mid-Cretaceous of the Eucla Basin. It is also known from the middle and upper Albian of northwestern Alberta (Singh, 1971). *P.* cf. *P. aureolata* occurs in small numbers throughout the section in the Bathurst Island wells.

PTEROSPERMOPSIS sp. A

(Pl. 16, fig. 12; Pl. 17, fig. 11)

BMR palynological species catalogue no.: 1059.

Description: Pterate acritarch with a large circular central body, whose wall is 2.5 to 3 μm thick, homogeneous, and smooth-surfaced. The flange is attached equatorially and has no pleats at its roots. It is very thin and completely smooth. In the figured specimen part of the flange has a double structure. A pylome or other type of dehiscence rupture has not been observed.

Dimensions: The figured specimen has a central body 58 μm in diameter and an overall diameter of 74 μm.

Remarks: This species has a larger central body than either *Pterospermopsis aureolata*, *P.* cf. *P. aureolata*, or *P. eurypteris*. It has a similar wing/body ratio to that of *P. ginginensis* Deflandre & Cookson, 1955, from the Senonian of the Perth Basin, and *P. microptera* Deflandre & Cookson, 1955, from the Tertiary of the Otway Basin and Western Australia. However, it is much larger than either and its flange roots are never undulose or pleated. *Pterospermopsis* sp. A occurs very rarely in the top part of Bathurst Island No. 2 well.

Phylum ?CHLOROPHYTA

Genus SCHIZOSPORIS Cookson & Dettmann, 1959

Type species: Schizosporis reticulatus Cookson & Dettmann, 1959.

SCHIZOSPORIS RETICULATUS Cookson & Dettmann, 1959

(Pl. 15, fig. 10)

1959 . *Schizosporis reticulatus* Cookson & Dettmann, 213, pl. 1, figs. 1-4.

BMR palynological species catalogue no.: 428.

Remarks: A few specimens from Bathurst Island No. 2 well have the characteristic reticulate pattern of membranes and the equatorial mode of rupture of *Schizosporis reticulatus*. The biological affinities of the genus are still in doubt. *Schizosporis* and the related genera *Lecaniella*, *Paralecaniella*, and *Peltacystia* are characterized by their equatorial mode of rupture, by which two similar hemispheres are produced. Cookson & Dettmann (1959) compared *Schizosporis* with certain angiospermous pollen grains. However, an angiosperm origin is considered unlikely in view of the Permian occurrences of *Schizosporis* and *Peltacystia* (Segroves, 1967; Balme & Segroves, 1966). Segroves (1967) avoided the question of biological affinities by placing them in the Acritarcha. He erected a new subgroup to include forms which dehisced by an equatorial rupture: the Schizomorphitae. This move is not followed here because the Acritarcha have been found almost exclusively in strata deposited under marine environments (the exceptions are some Quaternary forms). The *Schizosporis* group, though occurring in many localities in association with marine organisms, also have an extensive record of non-marine occurrence. Resemblances between *Peltacystia* and some members of the Chlorococcales have been noted by Segroves (1967). Cookson & Eisenack (1970b) also favour an affinity between *Paralecaniella* and the Volvocales. In either case a Chlorophycean origin for the group seems likely.

Occurrence: Cookson & Dettmann (1959) and Dettmann (1963) found *S. reticulatus* in Neocomian to ?Cenomanian strata in the Otway, Gippsland, Eromanga, Murray, and Styx Basins. Burger (1973) found it in strata of Neocomian and Aptian age in the Great Artesian Basin, Queensland. Overseas occurrences indicate a total range from the Berriasian to the Cenomanian. They include those of Pocock (1962) and Singh (1964, 1971, see also for earlier references), from the Lower Cretaceous of Canada; Leopold & Pakiser (1964), from the lower Upper Cretaceous of Alabama; Brenner (1963), from the Cretaceous of Maryland; Hedlund (1966), from the Oklahoma Cenomanian; Kemp (1970), from the English Aptian; and possibly Deák & Combaz (1967), from the French upper Albian to lower Cenomanian.

Genus PALAMBAGES O. Wetzel, 1961

Type species: Palambages morulosa O. Wetzel, 1961.

PALAMBAGES FORM A Manum & Cookson, 1964

(Pl. 16, fig. 14)

1964 *Palambages* Form A Manum & Cookson, 24, pl. 7, figs. 3-6.

BMR palynological species catalogue no.: 1061.

Remarks: Clusters of small, thin-walled spheres occur rarely in many of the Bathurst Island samples and are identified with Manum & Cookson's (1964) *Palambages* form A (Upper Cretaceous of Arctic Canada). Manum & Cookson provided an excellent description of their morphology and concluded that they are Chlorophycean algal colonies. Related forms have been recorded from the European Cretaceous (O. Wetzel, 1933, 1961; Gorka, 1963), the North American Cretaceous (Davey, 1970; Drugg, 1967; Zaitzeff & Cross, 1970; Singh, 1971), and the Argentinian Danian (Heisecke, 1970). Australian records include the mid-Cretaceous of the Eucla Basin (Cookson & Eisenack, 1971), the Albian of the Eromanga Basin, and the Upper Cretaceous of the Otway Basin (Cookson, 1965b).

CENOMANIAN SPORES AND POLLEN GRAINS FROM BATHURST ISLAND, NORTHERN TERRITORY, AUSTRALIA

by
D. Burger

CLASSIFICATION OF FOSSIL SPORES AND POLLEN GRAINS

The problem of classifying fossil dispersed spores and pollen grains into a hierarchy of taxa of ascending rank has been approached in different ways (van der Hammen, 1956; Pierce, 1961; Potonié, 1956, 1960a, 1966, 1970; Potonié & Kremp, 1955; and many others). For various reasons these schemes are unsatisfactory, although they are based on identical diagnostic morphological parameters, mentioned below. In selecting a system on the basis of artificial taxa (here preferred above natural or seminatural classifications) a model was sought in which the ranks of the hierarchy are defined and subdivided by different aspects of aperture, exine structure, and exine sculpture, in this order of importance. This principle is very close to the scheme developed by Potonié & Kremp (1955) and further extended by Potonié (1958, 1966, 1970), which is now widely applied in systematic literature.

The main disadvantage of Potonié & Kremp's system was discussed by Dettmann (1963), who criticized the application of different morphological criteria to subdivisions of equal rank, which results in overlapping definitions of various taxa. In her systematic study of Australian Early Cretaceous pollen and spores, Dettmann outlined a modified scheme, in which each rank in the hierarchy was defined by only one diagnostic character. Thus she constructed a system of mutually exclusive categories, which are based, in descending order, on aperture type, exine stratification, equatorial exine features, and sculpture (Dettmann, pp. 12-16, Table II).

Dettmann's system has been used by Dr P. R. Evans and myself, and is represented in Table 3. Certain groups of acavate trilete spores (Auriculati, Cingulati, Tricrassati, Patinati-Capsulati) are here upgraded to the rank of subturma, as they are typified by exine features. This is a slight modification of Dettmann's scheme, in which these groups were ranked as infraturma categories under subturma Zonotriletes Waltz. In the present scheme the rank of infraturma is restricted to sculptural subdivisions.

A similar procedure is provisionally adopted for the classification of Pollenites Potonié, 1931. Here also Dettmann's principle of mutually exclusive taxa is followed. The scheme applied is presented in Table 3. As in Sporites, the classification is based primarily on aperture. So that the system does not become too cumbersome, no attempt is made to distinguish turma categories on the basis of elaborate aperture classifications, such as were outlined in Erdtman (1952, 1969) for modern pollen grains. The following basic types of apertures are distinguished: colpi sensu lato, elongated, unbranched (including colpi, sulci, sulculi, rugae); sulci, elongated, branched (such as occur in trichotomosulcate, etc., forms); pori sensu lato, approximately equidimensional (including pori, 'ulci', foramina); and plicae, elongated (applied by Erdtman (1952) for 'sulcoid' grooves, such as occur in *Ephedra* type pollen and some Recent angiosperms). The categories distinguished on the basis of this subdivision are in essence synonymous to the familiar pollen classes of Erdtman (1945) and Iversen & Troels-Smith (1950) (see Faegri & Iversen, 1964, p. 171, pls. 6-8). In Table 3 only those categories are listed which accommodate the pollen types occurring in the Bathurst Island preparations.

The place of certain pollen groups, the so-called '*Verlegenheitsgruppen*', in the scheme is uncertain. One of these is Saccites Erdtman, 1947, which Potonié (1966,

1970) classified as a turma category. This is inconsistent with the hierarchy of the present scheme. The application of the principle of the scheme to the Saccites requires a better understanding of the aperture mechanics in this type of fossil pollen. At present no attempt is made to subdivide the group; it is incorporated in Table 3 as a 'division' without defined rank.

Table 3: Scheme of classification of SPORITES H. Potonié, based on Dettmann, 1963, and POLLENITES R. Potonié, based on Potonié, 1966, 1970 (revised).

<table>
<tr><td>rank</td><td>diagnostic feature</td><td colspan="17">spore-pollen group</td></tr>
<tr><td>Anteturma</td><td></td><td colspan="8">SPORITES</td><td>?</td><td colspan="8">POLLENITES</td></tr>
<tr><td>Turma</td><td>Aperture</td><td colspan="6">TRILETES</td><td>MONOLETES</td><td>HILATES</td><td>ALETES, INAPERTURATES</td><td>POLYPLICATES</td><td>TRICHOTOMOSULCATES</td><td>MONOCOLPATES</td><td>DICOLPATES</td><td>TRICOLPATES</td><td>TRICOLPORATES</td><td>MONOPORATES</td><td rowspan="4">Division SACCATES, not further differentiated</td></tr>
<tr><td>Suprasubturma</td><td>Exine stratification</td><td colspan="5">Acavatitriletes</td><td>Perinotriletes</td><td>Acavatomonoletes</td><td></td><td>Acavati</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Acavati</td></tr>
<tr><td>Subturma</td><td>Exine differentiation</td><td>Azonati</td><td>Cingulati</td><td>Auriculati</td><td>Tricrassati</td><td>Patinati - Capsulati</td><td></td><td>Azonomonoletes</td><td></td><td>Azonaletes</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Infraturma</td><td>Sculpture</td><td colspan="16">Three divisions are envisaged for each of the subturma categories: 1. Psilote forms 2. Apiculate forms 3. Murornate forms</td></tr>
</table>

M(P)464

Table 4: Occurrence of secondary (recycled) spores and pollen grains in the Bathurst Island well sections.

Species	Range	Bathurst Island 1	Bathurst Island 2
Balmeisporites holodictyus	Early Cretaceous		core 3
Callialasporites dampieri	Jurassic-Albian	core 3	core 3
Callialasporites trilobatus	Jurassic-?Albian	core 3	
Coptospora paradoxa	Albian		core 5
Coptospora striata	Aptian-Albian		core 1
Contignisporites cooksonae	Jurassic-Albian	cores 3, 8	
Stoverisporites lunaris	Early Cretaceous		core 3
Densoisporites velatus	Early Cretaceous	core 1	core 4
Osmundacidites wellmanii	Jurassic-Albian		core 10
Pilosisporites notensis	Aptian-Albian	core 1	
Pilosisporites parvispinosus	?Aptian-Albian		core 3
Tricolpites georgensis	Albian	core 6	

Secondary (recycled) palynomorphs

Some of the Bathurst Island preparations contain certain species (frequently single specimens) regarded as (recycled) contaminants on the evidence of their ranges in the upper Mesozoic of Queensland and Victoria (Table 4). The source of the contaminants is unknown, but in view of the regional palaeogeography during the late Albian (Day, 1969) and Cenomanian (this Bulletin, p. 5) the source rocks might have occurred farther north.

The following species are illustrated: *Pilosisporites notensis* (Pl. 18, fig. 17), *Stoverisporites lunaris* (Pl. 19, fig. 2), and *Tricolpites georgensis* (Pl. 33, fig. 16).

Systematic Descriptions

The nomenclature of the described species is in accordance with the binomial system and follows the rules of the International Botanical Code. Morphological terminology is derived from Erdtman (1952), Iversen & Troels-Smith (1950), Dettmann (1963), and Faegri & Iversen (1964). A list of species found in the Bathurst Island assemblages is given on pp. 168-9.

Anteturma SPORITES H. Potonié, 1893

Turma TRILETES Reinsch, 1881, emend. Dettmann, 1963

Suprasubturma ACAVATITRILETES Dettmann, 1963

Subturma AZONATI Luber, 1935, emend. Dettmann, 1963

Infraturma LAEVIGATI Bennie & Kidston, 1886, emend. Potonié, 1956

Genus CYATHIDITES Couper, 1953

Type species (by original designation): *Cyathidites australis* Couper, 1953, from the Jurassic of New Zealand.

Remarks: One of the most common elements in the microfloras from Bathurst Island Nos. 1 and 2. *Cyathidites australis* Couper (Pl. 18, figs. 3-5) is notably less abundant than *C. minor* Couper, 1953 (Pl. 18, figs. 6, 7); its size range seldom exceeds 65 μm, so that it is comparable with *C. australis rimalis* Balme, 1957, but it does not show the conspicuous grooves of commissure of Balme's form. Specimens similar to *C. minor* but smaller, ranging from 15 μm to 25 μm, occur in some of the preparations. Burger (1966) described identical types from the late Mesozoic in Europe as *Deltoidospora rafaeli*; elsewhere similar types have been described as *Concavisporites* spp., *Leiotriletes* spp., and so forth. This group of spores belongs very probably in the genus *Cyathidites*, where they merge with the group of *C. minor*, without sharp boundary. A list of selected synonymy for both species is given in Dettmann (1963, pp. 22-23).

Genus BIRETISPORITES Delcourt & Sprumont, 1955, emend. Delcourt, Dettmann, & Hughes, 1963.

Type species (by original designation): *Biretisporites potoniaei* Delcourt & Sprumont, 1955, from the mid-Cretaceous of Belgium.

BIRETISPORITES SPECTABILIS Dettmann

(Pl. 18, figs. 1, 2)

1963 *Biretisporites spectabilis* Dettmann, p. 26, pl. 2, figs. 3, 4.

Description: Trilete, azonate spores. Amb concavely triangular with rounded apices. Exine single-layered, 2-4 μm thick, smooth. Trilete laesurae straight, reaching to amb, bordered by thin, membranous, usually conspicuous lips.

Dimensions: Equatorial (4 specimens) 65-77 μm.

Occurrence: A rare species in most assemblages of Bathurst Island Nos. 1 and 2, not restricted to any interval. The species occurs in relatively larger numbers in the Early Cretaceous of eastern Australia (Dettmann, 1963; Burger, 1973a).

Remarks: The Bathurst Island specimens have a slightly thinner exine than those from southeastern Australia (Dettmann, 1963), but they are still easily distinguished from *Cyathidites australis* by their sturdier appearance. Similar spores have been described from the Cretaceous and Tertiary of Europe as *Leiotriletes*, *Concavisporites*, *Triplanosporites* (Thomson & Pflug, 1953; Krutzsch, 1963; Kedves, 1969; and others).

Infraturma APICULATI Bennie & Kidston, 1886, emend. Potonié, 1956

Genus NEORAISTRICKIA Potonié, 1956

Type species (by original designation): *Neoraistrickia* (al. *Triletes*) *truncatus* (Cookson) Potonié, 1956, from the Cretaceous of South Australia.

NEORAISTRICKIA TRUNCATA (Cookson) Potonié

(Pl. 18, figs. 8-10)

1953 *Trilites truncatus* Cookson, p. 471, pl. 2, fig. 36.
1956 *Neoraistrickia truncatus* (Cookson) Potonié, p. 34.
1957 *Baculatisporites truncatus* (Cookson) Balme, p. 18, pl. 1, figs. 20-22.

Occurrence: A rare species in some of the Bathurst Island assemblages, restricted to the upper part of palynological unit K3a. On the mainland it is frequently found in the Late Jurassic and Early Cretaceous (Balme, 1957; Dettmann, 1963; Burger, 1968a; 1973a).

Genus CERATOSPORITES Cookson & Dettmann, 1958

Type species (by original designation): *Ceratosporites equalis* Cookson & Dettmann, 1958, from the Early Cretaceous of southeastern Australia.

CERATOSPORITES EQUALIS Cookson & Dettmann

(Pl. 18, figs. 11, 12)

1958a *Ceratosporites equalis* Cookson & Dettmann, p. 101, pl. 14, figs. 17-19.

Occurrence: A rare species in most assemblages from Bathurst Island Nos. 1 and 2, not present in unit K3b. The species is common in the Early Cretaceous of the mainland (Cookson & Dettmann, 1958a; Dettmann, 1963; Burger, 1973a).

Remarks: The species is distinguished from *Neoraistrickia truncata* mainly by its more slender spinose ornament, but there is no sharp division between the two species in this respect. *N. truncata* may have reduced sculpture at the outer margin of its proximal face, whereas *C. equalis* is proximally psilate, but the Bathurst Island microfloras contain many intermediate specimens assignable to either species. The same phenomenon has been observed in the Aptian and Albian of the Great Artesian Basin in Queensland, so that the genera *Neoraistrickia* and *Ceratosporites* should perhaps be placed into synonymy.

Genus HERKOSPORITES Stover, *in* Stover & Partridge, 1973

Type species (by original designation): *Herkosporites elliottii* Stover, *in* Stover and Partridge, 1973, from the Tertiary of Victoria.

HERKOSPORITES PROXISTRIATUS sp. nov.

(Pl. 18, figs. 13-16)

Holotype: Bathurst Island No. 2, core 1, depth 15.3 m, MFP 4440-2; coord. 424/1022. Cenomanian (Pl. 18, fig. 15; CPC 12931).

Derivation of name: Based on the ornamentation of the proximal surface.

Description: Small, trilete, azonate spores. Amb rounded triangular to circular. Exine one-layered, about 1 μm, occasionally up to 1.5 μm thick, excluding sculpture. Trilete laesurae more or less distinct, simple, sometimes bordered by low narrow lips, and reaching to equator. Distal face showing densely spaced echinae and some bacula, spaced 0.5-3 μm apart, 0.5-1 μm thick, 1-(2-3)-4 μm high, occasionally branching at the tops. Elements reduced in size often occur at outer margin of proximal face. Here the exine is smooth, except for a narrow zone in each interradial area, more or less alongside laesurae, semicircular, in which short, sharp grooves or striae (or spines?) are aligned normal to adjoining laesurae.

Dimensions: Equatorial (23 specimens) 22-(28)-34 μm.
Occurrence: A rare to moderately common species in the Bathurst Island assemblages; not restricted to any interval. The species has not been observed in the Early Cretaceous of the Great Artesian Basin in Queensland.

Remarks: The species is similar to *Ceratosporites equalis*, except for its proximal ornament. It differs from the type species *H. elliottii* in its smaller dimensions, and also from *Neoraistrickia truncata* (sensu stricto) in the more slender and more densely crowded sculptural elements.

Genus STOVERISPORITES nov.

Diagnosis: Azonate to initially cingulate trilete miospores with granulate or verrucate exine distally, and smooth, granulate, or verrucate exine proximally. Additional distal, and sometimes also proximal, low exine walls entirely or partly enclose large circular psilate to granulate exine areas.

Remarks: The genus differs from *Kuylisporites* Potonié, 1956, by the absence of equatorial, interradial exine inflations, and the presence of low exine walls enclosing shallow, large pits. It differs from *Craterisporites* De Jersey, 1970, from the Triassic of Queensland, in having a sculptured proximal exine, larger pits, and an initial cingulum. The genus is named in honour of Dr L. E. Stover, of Esso Production Research Company, Houston, Texas.

Type species (here designated): *Stoverisporites microverrucatus* sp. nov., from the Cenomanian of Bathurst Island, Northern Territory.

STOVERISPORITES LUNARIS (Cookson & Dettmann) nov. comb.

(Pl. 19, fig. 2)

1958a *Kuylisporites lunaris* Cookson & Dettmann, p. 103, pl. 14, figs. 22, 23.

Occurrence: Restricted to Bathurst Island No. 1, core 2, and No. 2, core 3, in the upper part of palynological unit K3a. It was not encountered in the preceding samples, but it is common in the Early Cretaceous of eastern Australia, so that the Bathurst Island specimens are possibly of secondary (recycled) origin.

STOVERISPORITES MICROVERRUCATUS sp. nov.

(Pl. 19, figs, 3, 4)

Holotype: Bathurst Island no. 1, core 8, depth 243.9 m, MFP 4445-2; coord. 419/1152. Cenomanian (Pl. 2, fig. 4, CPC 12937).

Derivation of name: Based on the small sculptural elements on proximal and distal exine.

Description: Small to medium-sized, trilete, azonate spores. Amb rounded triangular, circular or oval. Exine one-layered, 1-3 μm thick at equator, possibly slightly thinner at proximal and distal side. Trilete mark weakly visible, laesurae reaching to equator. Broad, shallow pits occur on distal face, bordered by low exine walls, which encircle areas of 4-7 μm diameter, and are not closed near the equator. Proximal face with some small verrucae of 0.5-2 μm diameter, irregularly distributed, close together, and slightly larger in polar area and alongside laesurae. Small verrucae often occur sparsely on distal face in the areas between the lumina and the polar region.

Dimensions: Equatorial (15 specimens) 24-43 μm.

Occurrence: Present in low numbers in microfloras from Bathurst Island Nos. 1 and 2; not restricted to a specific interval. The species is probably conspecific with '*Kuyli-sporites* sp.' (BMR species 1131), which occurs in the Albian of the Carpentaria Basin, Queensland (Burger, 1973b).

Remarks: The species differs from *S. lunaris* in its verrucate sculpture. Except for the large shallow pits, *S. lunaris* has a smooth to weakly granulate exine. *S. micro-verrucatus* is possibly slightly thickened at the equator, suggesting the presence of a cingulum, but this is difficult to establish without dissecting the spores. Dettmann (1963) described *S. lunaris* likewise as 'weakly thickened equatorially'.

Infraturma MURORNATI Potonié & Kremp, 1955

Genus LYCOPODIUMSPORITES Thiergart, 1938, ex Delcourt & Sprumont, 1955

Type species (designated by Delcourt & Sprumont, 1955): *Lycopodiumsporites* (al. *Sporites*) *agathoecus* (Potonié, 1934) Thiergart, 1938, from the Early Tertiary of Germany.

LYCOPODIUMSPORITES AUSTROCLAVATIDITES (Cookson) Potonié

(Pl. 19, fig. 1)

1953 *Lycopodium austroclavatidites* Cookson, p. 469, pl. 2, fig. 35.
1956 *Lycopodiumsporites austroclavatidites* (Cookson) Potonié, p. 46 (for more complete synonymy see Dettmann, 1963, p. 44).

Occurrence: Rare to moderately common species in Bathurst Island Nos. 1 and 2; also common in Jurassic and Cretaceous sediments of Australia and overseas.

LYCOPODIUMSPORITES cf. L. ROSEWOODENSIS (De Jersey) De Jersey

(Pl. 19, fig. 6)

cf. 1959 *Lycopodium rosewoodensis* De Jersey, p. 3, pl. 1, figs. 5, 6.
cf. 1963 *Lycopodiumsporites rosewoodensis* (De Jersey) De Jersey, p. 4, pl. 2, fig. 3.

Occurrence: Sporadically in a number of microfloras from Bathurst Island Nos. 1 and 2; not restricted to any interval.

Remarks: The specimens conform to De Jersey's description of the species, but the muri of the (distal) reticulum are slightly more pronounced, although lower than those of *L. austroclavatidites.*

Genus CICATRICOSISPORITES Potonié & Gelletich, 1933

Type species (by monotypy): *Cicatricosisporites dorogensis* Potonié & Gelletich, 1933, from the earliest Tertiary of Hungary.

CICATRICOSISPORITES AUSTRALIENSIS (Cookson) Potonié

(Pl. 19, fig. 13; Text-fig. 23)

1953 *Mohrioisporites australiensis* Cookson, p. 470, pl. 2, figs. 29-34.
1956 *Cicatricosisporites australiensis* (Cookson) Potonié, p. 48.

Occurrence: Rare species in most of the Bathurst Island Nos. 1 and 2 microfloras; not restricted to any interval. Common in the Early Cretaceous of Australia and Papua New Guinea. Dettmann & Playford (1969) gave a Turonian to Coniacian age for the upper limit of its range, within their *Clavifera triplex* Zone, Otway Basin. The species is also well known from the Cretaceous in other parts of the world.

CICATRICOSISPORITES CUNEIFORMIS Pocock

(Pl. 19, fig. 7; Text-fig. 23)

1964 *Cicatricosisporites cuneiformis* Pocock, p. 158, pl. 2, fig. 17.

Occurrence: Uncommon in the lower part of the sequence in Bathurst Island Nos. 1 and 2, in the basal part of palynological unit K3a. Specimens close to, but not positively identified as belonging to, the species occur in unit K3a of Bathurst Island No. 1 and in the upper part of that unit in Bathurst Island No. 2. Pocock (1964) described *C. cuneiformis* from the Albian of Saskatchewan, Canada. Dettmann & Playford (1968) reported the species from the late Albian and early Late Cretaceous of eastern Australia; it does not seem to occur in the Albian of the Great Artesian Basin in Queensland.

Remarks: The species is not described here, for lack of sufficiently well preserved specimens; the following notes are based on examination of a few specimens only. Equatorial dimensions of two grains were 40 μm and 51 μm, within the size range given by Dettmann & Playford. Striae are relatively wide, sometimes with slightly knobby or serrated edges. A set of four ribs and adjacent grooves spans 7-14 μm in width, as measured at the distal face. Striae are about twice as wide as grooves. Trilete laesurae are indistinct. The arrangement of striae at the distal and proximal faces is not unlike that in *C. dorogensis.* The species is slightly larger than *C. venustus*; the arrangement of striae is more irregular, in that the ribs in one set are not exactly parallel to one another, as in *C. venustus.* Pocock's (1964) and Dettmann & Playford's (1968) illustrations of *C. cuneiformis* show that the proximal striae in each interradial area are oriented parallel to one of the adjoining commissures (Text-fig. 23). In *C. venustus* the striae are straight and run parallel to the bisector of the angle between laesurae in each proximal interradial area (see also Deák, 1963, pl. 1, fig. 1).

Cicatricosisporites hughesii Dettmann

(Pl. 20, figs. 4, 5)

1963 *Cicatricosisporites hughesii* Dettmann, p. 55, pl. 10, figs. 6-8.

Occurrence: Sporadically in units K3a and K3b of Bathurst Island No. 1, and unit K3b of Bathurst Island No. 2; probably not restricted to a specific interval. The species is common in the Early Cretaceous of eastern Australia (Dettmann, 1963; Burger, 1968c, 1973a, b), and occurs in the Late Cretaceous of North America (Drugg, 1967; Groot et al., 1961).

Cicatricosisporites pseudotripartitus (Bolchovitina) Dettmann

(Pl. 20, figs. 1, 6)

1961 *Anemia pseudotripartita* Bolchovitina, p. 53, pl. 15, figs. 3a-c.
1963 *Cicatricosisporites pseudotripartitus* (Bolchovitina) Dettmann, p. 54, pl. 10, figs. 1-5.

Description: Medium-sized, trilete, azonate spores. Amb rounded triangular with convex or straight sides. Exine one-layered, about 3-4 μm thick, striate. Distal face provided with ribs oriented parallel to adjacent sides of amb, arranged approximately in a pattern of concentric triangles. In polar area, ribs may merge into smooth, triangular exine thickening. At proximal face, two or three striae in each area between laesurae, oriented parallel to adjacent side. Striae at distal face low, 2.5-4 μm wide, intervening grooves 0.5-2 μm, striae at proximal face equally wide or slightly narrower. Trilete laesurae indistinct, inconspicuously lipped, reaching three-quarters of the distance to the equator.

Dimensions: Equatorial (3 specimens) 42-44 μm.

Occurrence: A rare species in the upper part of palynological unit K3a of Bathurst Island Nos. 1 and 2. Specimens probably assignable to the species also occur in the same unit of Bathurst Island No. 2. The species is a rare component of late Albian microfloras in the Great Artesian Basin in Queensland. Dettmann & Playford (1969) reported the species from the Albian to the Turonian-Coniacian in southeastern Australia. Hedlund & Norris (1968) and Singh (1971) reported the species from the Albian of the U.S.A. and Canada.

Cicatricosisporites venustus Deák

(Pl. 19, figs. 8-12; Text-fig. 23)

1963 *Cicatricosisporites venustus* Deák, p. 252, pl. 2, figs. 12, 13.
1963 *Cicatricosisporites furcatus* Deák, p. 254, pl. 2, figs. 6, 7.

Description: Medium-sized, trilete, azonate spores. Amb triangular with rounded to moderately acute corners and straight to convex sides. Trilete mark indistinct, laesurae often split open, bordered by narrow (2 μm) exine thickenings. Exine one-layered, 1-1.5 μm thick. Distal face striate, ribs more or less arranged in three sets, in each set parallel to one of polar symmetry planes, thereby crossing the equator at right angles, and sometimes branching. At proximal face, striae in each interradial region parallel to bisector of angle between two laesurae. Striae thin, as wide as intervening grooves; a set of four ribs and grooves at distal face is 6-9 μm in width.

Dimensions: Equatorial (10 specimens) 36-40 μm.

Occurrence: Uncommon to common in the upper part of unit K3a of Bathurst Island Nos. 1 and 2. The species also occurs in the (late) Albian of the Eromanga Basin, Queensland (uncommunicated information). Outside Australia, the species occurs in the Aptian of Hungary (Deák, 1963, 1965), the Aptian and Albian of the U.K. (Kemp, 1970), the Cenomanian of France (Azema et al., 1972), the Late Cretaceous of Alabama, USA (Leopold & Pakiser, 1964), the Albian of Canada (Singh, 1971), and the mid-Cretaceous of Spain (Amerom, 1965). Identical forms have also been reported from the Aptian and Albian of Maryland, USA, as *Cicatricosisporites hallei* (see Brenner, 1963), and the Cenomanian of Oklahoma, as *C. dorogensis* (see Hedlund, 1966). Bratzeva (1969) reported similar forms from the Maastrichtian of eastern Siberia.

Remarks: The species is easily distinguished by its delicate appearance and the straight narrow ribs. Many of the Bathurst Island specimens were ruptured and it was difficult to locate specimens suitable for illustration. The Australian specimens are slightly larger than those from Hungary, for which Deák gave a size range of 25-40 μm. The species differs from *C. coconinoensis* Agasie, 1969, in having a thinner exine and narrower striae.

The arrangement of distal and proximal ribs in *C. venustus* is schematically illustrated in Text-figure 23.

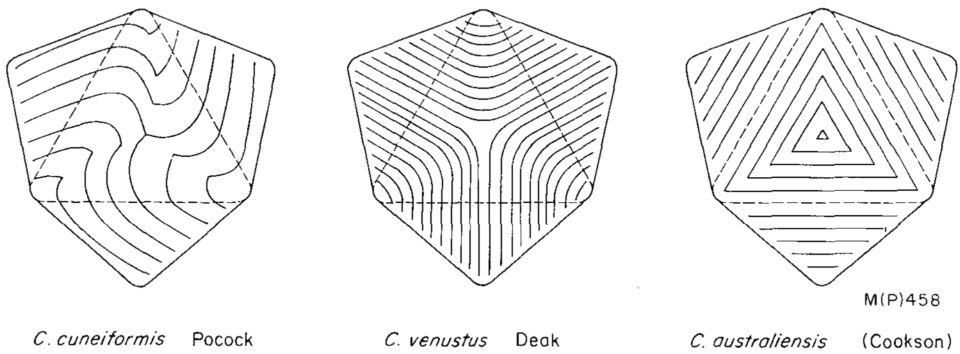


Figure 23. Configuration of striae in some species of *Cicatricosisporites*.

Genus BALMEISPORITES Cookson & Dettmann, 1958

Type species (by original designation): *Balmeisporites holodictyus* Cookson & Dettmann, 1958 (see Cookson & Dettmann, 1958b), from the Early Cretaceous of South Australia.

BALMEISPORITES HOLODICTYUS Cookson & Dettmann

1958b *Balmeisporites holodictyus* Cookson & Dettmann, p. 42, pl. 2, fig. 1.

Occurrence: Dettmann (1963) reported the species from the Early Cretaceous of southeastern Australia. Single specimens of the species also occur in the Rolling Downs Group (Albian) of the Great Artesian Basin in Queensland. Dettmann & Playford (1969) indicated that the species ranges from the Aptian to the Cenomanian. One entire specimen, badly corroded and unsuitable for illustration, was found in Bathurst Island No. 2, core 3 (unit K3a).

Remarks: The specimen from Bathurst Island is probably of secondary (recycled) origin, regarding its decayed appearance. The spore cavity measures 80 μm. The exine, excluding sculpture, is 3 μm thick, reticulum indistinct, muri thin, about 6 μm high. Equatorial growths not distinct. Proximal extension projects upwards about 60 μm.

BALMEISPORITES GLENELGENSIS Cookson & Dettmann, 1958

(Pl. 26, fig. 3)

1958b *Balmeisporites glenelgensis* Cookson & Dettmann, p. 43, pl. 2, fig. 9.

Occurrence: Only one entire specimen was found in Bathurst Island No. 1, core 1 (unit K3b). Fragments of specimens, possibly of the same species, occur in other microfloras of Bathurst Island No. 2, but it is not possible to establish a local stratigraphic record of the species from these occurrences. The species has not been encountered in the Aptian and Albian of the Great Artesian Basin, Queensland. Cookson & Dettmann reported the species from the Late Cretaceous of Victoria. Dettmann & Playford (1969) gave a range from Cenomanian to Santonian for the species in South Australia.

Remarks: The specimen from Bathurst Island No. 1 has a central cavity measuring 160 μm. The exine is 6 μm thick, excluding the height of the muri, and is probably multilayered. The outer layer is granulate. A coarse reticulum covers the entire surface of the spores, muri are 4 μm high, hollow or double-layered, equatorial growths reach a height of up to 35 μm, proximal extensions not well developed, probably damaged. Lumina of reticulum polyangular to irregular and 6-10 μm, occasionally up to 15 μm across.

BALMEISPORITES TRIDICTYUS Cookson & Dettmann, 1958

(Pl. 27, figs. 1, 2)

1958b *Balmeisporites tridictyus* Cookson & Dettmann, p. 42, pl. 2, fig. 7.

Occurrence: Two entire specimens were found in Bathurst Island No. 1, core 1 (unit K3b). Cookson & Dettmann (1958b) and Dettmann (1963) reported the species from the Albian of southeastern Australia. It has until now not been found in Lower Cretaceous sediments of the Great Artesian Basin in Queensland.

Remarks: The following notes are based on examination of two specimens. Central cavity measures 65 and 75 μm. Exine probably multi-layered, about 4 μm thick. Outer layer extremely thin, minutely wrinkled, granulate. Equatorial growths attain heights of 26 μm, the proximal extremities project up to 40 μm. A trilete scar is not visible.

The specimens conform in size and general appearance to *Balmeisporites tridictyus*. They differ from *B. glenelgensis* in their smaller dimensions and absence of a reticulum. They can probably be regarded as autochthonous, as they are preserved without damage to the delicate exine projections.

Subturma AURICULATI Schopf emend. Dettmann, 1963

Infraturma—Apiculate forms

Genus TRILOBOSPORITES Pant, 1954, ex Potonié, 1956

Type species (designated by Potonié, 1956); *Trilobosporites* (al. *Concavisporites*) *hannonicus* (Delcourt & Sprumont, 1955) Potonié, 1956, from the mid-Cretaceous of Belgium.

TRILOBOSPORITES TRIORETICULOSUS Cookson & Dettmann, 1958

(Pl. 19, fig. 5)

1958a *Trilobosporites trioreticulosus* Cookson & Dettmann, p. 109, pl. 17, figs. 1-3.

Occurrence: In low abundance, often single specimens, in many of the Bathurst Island Nos. 1 and 2 microfloras; restricted to palynological unit K3a. The species occurs throughout the Albian of eastern Australia (Dettmann, 1963; Burger, 1968b, c; Terpstra & Burger, 1969). Dettmann & Playford (1969) and the present report indicate that the species ranges upwards into the Cenomanian of eastern and northern Australia. Pocock (1964) and Singh (1971) reported the species from the Albian of Canada.

Infraturma—Murornate forms.

Genus APPENDICISPORITES Weyland & Krieger, 1953

Type species (by original designation): *Appendicisporites tricuspidatus* Weyland & Greifeld, 1953, from the Late Cretaceous of Germany.

1949 *Plicatella* Maliavkina (pars); nom. nud., p. 60.
1960 *Plicatella* Maliavkina ex Potonié, p. 50.

Remarks: The history of the names *Plicatella* and *Appendicisporites* is recounted by Dettmann & Playford (1968, pp. 74-75). I adhere to their opinion that the two genera should not be separated solely on different character of appendices, as was proposed by Potonié (1956).

Outside *Appendicisporites distocarinatus*, described below, a small number of spores assignable to the genus occurred in the Bathurst Island microfloras, mostly single specimens, which do not match the description of *distocarinatus*. Some of them are illustrated in Plates 20 and 21. One specimen of *A.* cf. *A. erdtmanii* Pocock, 1964, was found in Bathurst Island No. 1, core 3 (Pl. 21, fig. 7). A form resembling *A. grandis* Pocock, 1964, was found in the same well, core 1 (Pl. 21, fig. 5). A specimen not unlike *A. irregularis* Pocock, 1964, and *A. problematicus* (Burger, 1966) occurs in Bathurst Island No. 2, core 2 (Pl. 20, fig. 8).

APPENDICISPORITES DISTOCARINATUS Dettmann & Playford, 1968

(Pl. 20, fig. 7; Pl. 21, figs. 1, 4)

1968 *Appendicisporites distocarinatus* Dettmann & Playford, p. 75, pl. 6, figs. 16-18.

Description: Large to medium-sized, trilete, striate spores. Amb triangular with rounded to straight sides and acute corners with extended projections. Exine 1-2.5 μm thick, except in apical equatorial areas, where opposite ribs coalesce and form fin-like extensions by merging with adjacent sets of distal ribs. Extensions project up to 20 μm from spore cavity and continue distally about two-thirds of distance towards polar area, with reduced height. Ribs both distally and proximally arranged in sets of triangles with sides parallel to amb, and absent in proximal polar region. Four ribs and adjacent grooves at distal face measure 9-(13-16)-23 μm in width; grooves about half as wide as ribs. Trilete laesurae often indistinct, with thin and 2-3 μm high lips in the polar region, and reaching almost to equator.

Dimensions: Equatorial (35 specimens) 38-(56)-82 μm.

Occurrence: Rare to common in the microfloras from Bathurst Island Nos. 1 and 2. The species is regularly found in the late Albian of eastern Australia; Dettmann & Playford (1969) reported it also from the early Late Cretaceous (Cenomanian) of the southeastern part of the continent.

Remarks: These spores are almost similar to those from the Neocomian of the Netherlands (Burger, 1966), which have a size range of 45-60 μm. It is not certain whether they, and the Australian specimens, are conspecific with *A. tricornitatus*;

Weyland & Krieger selected a specimen of 35 μm diameter as type for the species. Also Dettmann & Playford (1968) mentioned the difficulty in comparing the Australian specimens with *A. tricornitatus*, as the morphology of the appendices in this species is not accurately known.

Subturma TRICRASSATI Dettmann, 1963

Infraturma—Psilate forms

Genus GLEICHENIIDITES Ross, 1949 ex Delcourt & Sprumont, 1955, emend. Dettmann, 1963

1949 *Gleicheniidites* Ross, nom. nud., p. 31.
1955 *Gleicheniidites* Ross ex Delcourt & Sprumont, p. 61.
1963 *Gleicheniidites* Ross ex Delcourt & Sprumont, emend. Dettmann, p. 64 (for further synonymy see Dettmann, 1963, p. 64).

Type species (designated by Delcourt & Sprumont, 1955): *Gleicheniidites senonicus* Ross, 1949, from the Late Cretaceous of Sweden.

GLEICHENIIDITES CIRCINIDITES (Cookson) Dettman

(Pl. 22, figs. 3-7)

1953 *Gleichenia circinidites* Cookson, p. 464, pl. 1, figs. 5-6.
1963 *Gleicheniidites cercinidites* (Cookson) Dettmann, p. 65, pl. 13, figs. 6-10.

Occurrence: Common in the Bathurst Island Nos. 1 and 2 microfloras. Also common in the Early Cretaceous and latest Jurassic of Australia (Balme, 1957; Dettmann, 1963; Burger, 1973a,b). Similar forms have been reported on a world-wide scale in the Late Mesozoic and Tertiary.

Remarks: The difference between this species and *G. senonicus*, and to some extent also *G. feronensis* (Delcourt & Sprumont, 1955), are gradational, and specimens comparable to all three species were present in Bathurst Island. The species may perhaps be synonymous and the associated specimens could probably represent the group in various stages of maturity.

GLEICHENIIDITES cf. G. TRIJUGATUS (Pierce) nov. comb.

(Pl. 22, figs. 13-16, 19)

cf. 1961 *Cingutriletes trijugatus* Pierce, p. 26, pl. 1, fig. 4.

Description: Medium-sized, trilete, tricrassate spores. Amb rounded triangular with rounded apices and straight, occasionally concave, sides. Trilete mark distinct, laesurae straight, with low, inconspicuous lips, and reaching to amb. Exine psilate, proximally and distally thin, equatorially in interradial regions extended into three crassitudes, 5-6 μm thick, which diminish near apices to 2-4 μm, sometimes with slight invaginations of amb. Occasionally a thin, spongeous, outermost layer is preserved.

Dimensions: Equatorial (13 specimens) 27-52 μm.

Occurrence: Rare in most microfloras of palynological unit K3a in Bathurst Island No. 2. Pierce (1961) described the species from the early Late Cretaceous (Cenomanian) of Minnesota, U.S.A.

Remarks: The genus *Cingutriletes* Pierce, 1961, is typified by a zonate spore (*C. congruens* Pierce, p. 25), whereas the species *trijugatus* includes tricrassate spores.

The Bathurst Island specimens are identical with Pierce's species, except for the absence of triradiate ridges. They differ from *Gleicheniidites carinatus* (Bolchovitina, 1953) Bolchovitina, 1968, by their smaller equatorial dimensions and more concavely triangular amb. They also differ from *G. circinidites* primarily in having broader crassitudes extending almost to, and sometimes encroaching on, the apices. They are similar to forms which Krutzsch (1962) described from the Tertiary of Europe as *Neogenisporis plicatoides*. Spores similar in morphology but with verrucate ornament were found in the Aptian and Albian of Germany and described as *Asbeckiasporites wirthi* by Brelie (1964). Döring (1965) reported similar forms (*Gleicheniidites latifolius*) from the Early Cretaceous of northwest Germany.

Genus CLAVIFERA Bolchovitina, 1966

Type species (by original designation): *Clavifera* (al. *Gleichenia*) *triplex* (Bolchovitina, 1953) Bolchovitina, 1966, from the Cretaceous of the USSR.

CLAVIFERA TRIPLEX (Bolchovitina) Bolchovitina

(Pl. 22, figs. 11, 12)

1953 *Gleichenia triplex* Bolchovitina, p. 54, pl. 8, figs. 10-13.
1966 *Clavifera triplex* (Bolchovitina) Bolchovitina, p. 68, pl. 1, figs. 6a-c.

Description: Medium-sized, trilete, tricrassate spores. Amb triangular with straight to almost straight, often serrated or sinuous sides, and acute corners. Trilete laesurae straight, lipped, reaching to amb. Exine psilate, distally and proximally thin, equatorially in interradial regions thickened into crassitudes 3-9 μm broad, and slightly thickened at apices (orifices). Three distal exine folds, not always distinct, concave towards pole, with ends joining in apical regions, occur in most specimens.

Dimensions: Equatorial (22 specimens) 32-(36)-50 μm.

Occurrence: Rare to common in all but the uppermost samples of Bathurst Island Nos. 1 and 2. Rare in the late Albian of the Carpentaria Basin, Queensland (Burger, 1973b). Dettmann & Playford (1968) described the species also from the Late Cretaceous in southeastern Australia. In Europe the species occurs in the Neocomian of Germany (Döring, 1965), and the Aptian-Albian of Britain (Kemp, 1970). It also occurs in the Aptian to earliest Tertiary (Palaeocene) of Russia and Siberia (Bolchovitina, 1953, 1966). Agasie (1969) reported a very probably synonymous form from the Late Cretaceous of Arizona, USA, as *Trilobozonosporites arizonaensis*.

Remarks: For comparison with morphologically similar species see Dettmann & Playford (1968). The species cannot be strictly separated from *Gleicheniidites circinidites*; many intermediate specimens occurred in the Bathurst Island microfloras. The two species might perhaps be regarded as congeneric, in which case the genus *Clavifera* would be a junior synonym of *Gleicheniidites*.

Infraturma—Apiculate forms

Genus ORNAMENTIFERA Bolchovitina, 1966

Type species (by original designation): *Ornamentifera* (al. *Gleichenia*) *echinata* (Bolchovitina, 1953) Bolchovitina, 1966, from the Albian of Kazakhstan, USSR.

ORNAMENTIFERA MINIMA sp. nov.

(Pl. 23, figs. 1, 2)

Holotype: Bathurst Island No. 2, core 10, depth 248.8 m, MFP 4431-1; coord. 368/1058. Cenomanian (Pl. 23, fig. 1; CPC 12985).

Derivation of name: Based on the relatively small equatorial dimensions.

Description: Medium-sized, trilete, tricrassate, verrucate-baculate spores. Amb triangular with straight to slightly curved sides and acute corners. Trilete mark indistinct, laesurae straight, with inconspicuous lips, and bordered by flat, irregular, narrow exine elevations. Exine about 2 μm thick, at equator developed into three 4-10 μm wide crassitudes, often obscured by distal sculptural elements. Crassitudes thickest at centres of interradial areas and thin rapidly towards apices. Proximal face psilate or granulate to microverrucate, without clearly defined sculptural elements. Distal face predominantly baculate, with elements 2-3 μm high, irregular in cross-section, isolated or confluent, with diameter of 2-4 μm. Elements at equator projecting beyond periphery, sometimes reduced to absent in a narrow area near equator along the crassitudes.

Dimensions: Equatorial (13 specimens) 28-45 μm.

Occurrence: A rare species in unit K3a of Bathurst Island Nos. 1 and 2. The species has not been observed in the Albian of the Great Artesian Basin.

Remarks: The specimens differ from *O. sentosa* Dettmann & Playford, 1968, in having less prominent proximal sculpture and apparently more closely distributed distal elements (Dettmann, pers. comm.).

Infraturma—Murornate forms

Genus FOVEOGLEICHENIIDITES nov.

Diagnosis: The genus *Foveogleicheniidites* incorporates tricrassate microspores which resemble those of *Gleicheniidites*, but which are psilate or foveolate proximally, and foveolate distally.

Remarks: The genus differs from *Trubasporites* Vavrdova, 1964, in that the type species of *Trubasporites* (by original designation) is a zonate form *Polypodiaceoisporites* (al. *Cingulatisporites*) *foveolatus* (Couper, 1958) Kemp, 1970.

Type species (here designated): *Foveogleicheniidites* (al. *Gleicheniidites*) *confossus* (Hedlund, 1966) nov. comb., from the Cenomanian of Oklahoma, USA.

FOVEOGLEICHENIIDITES CONFOSSUS (Hedlund) nov. comb.

(Pl. 22, figs. 20-22)

1966 *Gleicheniidites confossus* Hedlund, p. 17, pl. 1, fig. 8b.

Description: Small to medium sized, trilete, tricrassate spores. Amb triangular with straight to slightly curved sides and bluntly acute corners. Trilete laesurae often indistinct, straight, reaching to equator and bordered by low, membranous lips. Exine thin, about 1 μm thick, except for equatorial interradial regions, where crassitudes about 6 μm wide are developed. Foveolae on both faces of spore, diameter 0.5-1 μm, separated 1-5 μm, slightly funnel-shaped, giving spores a crenulated outline in polar view. Distal face with three exine folds, not always distinct, curving towards distal pole, and joining in apical regions.

Dimensions: Equatorial (29 specimens) 25-(30)-46 μm.

Occurrence: Rare species in the upper part of unit K3a and unit K3b of Bathurst Island Nos. 1 and 2. Also sporadically in the Albian of the Great Artesian Basin in Queensland. Outside Australia, as far as I know, the species has been reported only from the Cenomanian of Oklahoma, USA (Hedlund, 1966). From the early Late Cretaceous of New Jersey, USA, Kimyai (1966) reported more or less similar forms as *Gleicheniidites orientalis* (Bolchovitina, 1953) and *G. raritanianus* Kimyai.

Genus CAMAROZONOSPORITES Pant, 1954, ex Potonié, 1956, emend. Klaus, 1960

Type species (designated by Potonié, 1956): *Camarozonosporites* (al. *Rotaspora*) *cretaceus* (Weyland & Krieger, 1953) Potonié, 1956, from the Late Cretaceous of Germany.

CAMAROZONOSPORITES AUSTRALIENSIS sp. nov.

(Pl. 23, figs. 5-9)

Holotype: Bathurst Island No. 2, core 3, depth 61.0 m, MFP 4438-2; coord. 349/1106 (Pl. 23, fig. 8; CPC 12992).

Derivation of name: Taken from its occurrence in Australia.

Description: Large to medium-sized, trilete, tricrassate spores. Amb rounded triangular to circular. Trilete mark distinct, laesurae simple, straight, reaching almost to equator. Exine two-layered, at proximal face 1-2 μm thick, contact area smooth to finely wrinkled, remainder of proximal face showing low, sinuous exine elevations, mostly in radial orientation. Distal face medium to coarsely rugulate, individual rugulae 2-4 μm wide, varying in length, often reduced to absent near equator between apices, and separated by 2 μm-wide grooves, or by irregular more or less equidimensional 'lumina' 2-6 μm in diameter. Exine thickness at distal side not determined, at equator near apices 2-4 μm, increasing in interradial areas to 2-7 μm.

Dimensions: Equatorial (34 specimens) 28-(38)-57 μm.

Occurrence: Common species in the microfloras of Bathurst Island Nos. 1 and 2; not restricted to any interval. Similar specimens were also reported as *Camarozonosporites* cf. *C. amplus* from the Albian of the Great Artesian Basin in Queensland (Burger, 1973b).

Remarks: A distinct species, which differs from *Camarozonosporites amplus* (Stanley, 1965) Dettmann & Playford, 1968, by its smaller equatorial diameter and the absence of coarse granula in the distal polar region. *Camarozonosporites wilsnackensis* Krutzsch, 1963 has narrower distal rugulae and is weakly verrucate proximally. *Staplinisporites regularis* Burger, 1966 has a finer distal sculpture and is granulate in the distal polar area; also, it has a narrow, inconspicuous circumpolar ring at distal face, where the exine is thickened. *Camarozonosporites hammenii* Amerom, 1965 has a finer distal sculpture and is proximally psilate. *Camarozonosporites rudis* (Leschik) Klaus, 1960 has considerable exine thickenings along laesurae.

Camarozonosporites australiensis sp. nov. resembles *Camarozonosporites insignis* Norris, 1967, but has coarser proximal ornament and heavier crassitudes. It also resembles *Camarozonosporites dakotaensis* Agasie, 1969, but has narrower crassitudes.

Subturma CINGULATI Potonié & Klaus, 1954 emend. Dettmann, 1963

Remarks: This subturma includes, according to Dettmann's definition (1963), trilete spores with various types of equatorial exine thickenings. These types are not accommodated in different subturmae, as they cannot be sharply divided. Dettmann distinguished (1) cingulate forms, in which the extension is wedge-shaped in cross-section; (2) zonate forms, with membranous extensions, and (3) cinguli-zonate forms, where the extension is intermediate in cross-section, and membranous towards the periphery.

To these three groups a fourth can be added, which includes trilete forms with equatorial extensions which, in cross-section, are constricted at the roots (Text-fig. 24). This uncommon type of flange occurs in *Cingulatisporites levispeciosus* Pflug and was described by Pocock (1961) in his discussion of the genus *Cingulatisporites* Thomson (*in* Thomson & Pflug, 1953). A fifth group could perhaps be distinguished, containing spores such as *Reinschospora* Schopf, Wilson, & Bentall, *Lepidozonotriletes* Luber emend. Potonié, and *Tenellisporites* Potonié, which have equatorially located bands, hairs or spines ('capilli') rather than an uninterrupted flange.

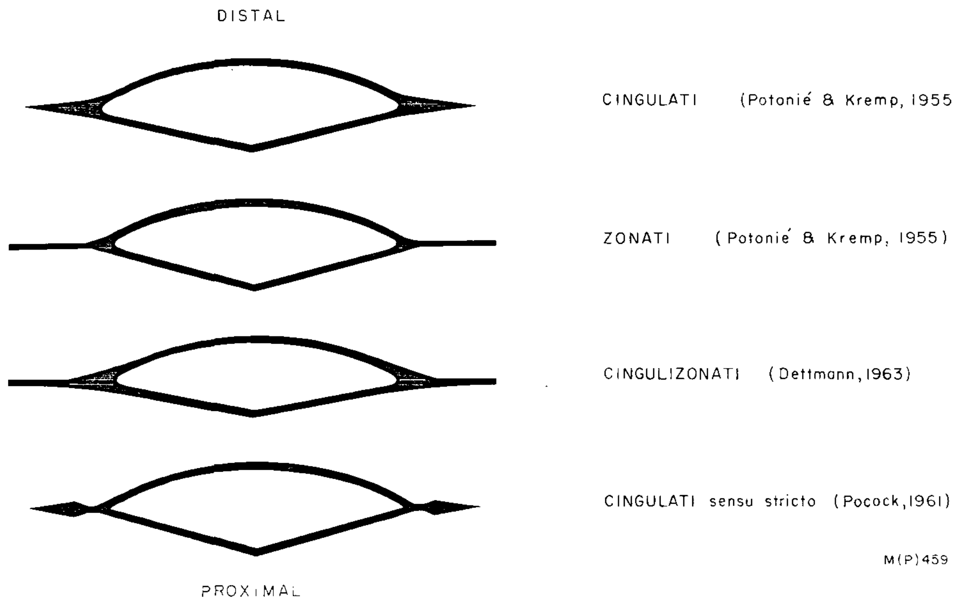


Figure 24. Schematic cross-sections of acavate trilete spores with various types of equatorial exine extensions.

Infraturma—Psilate zonate forms (sensu lato)

Genus STEREISPORITES Thomson & Pflug, 1953

Type species (designated by Thomson & Pflug, 1953): *Stereisporites* (al. *Sphagnumsporites*) *stereoides* (Potonié & Venitz, 1934) Pflug *in* Thomson & Pflug, 1953, from the Tertiary of Germany.

STEREISPORITES ANTIQUASPORITES (Wilson & Webster) Dettmann, 1963

(Pl. 24, figs. 9-11)

1946 *Sphagnum antiquasporites* Wilson & Webster, p. 273, fig. 2.
1963 *Stereisporites antiquasporites* (Wilson & Webster) Dettmann, p. 25, pl. 1, figs. 20,21.

Occurrence: Common in the microfloras from Bathurst Island Nos. 1 and 2. Also common in the Late Mesozoic of Australia and overseas.

Remarks: Dettmann (1963) noted the presence of weak equatorial exine thickenings in the Australian representatives of the species and suggested that the species be assigned to the Auriculati. However, the specimens found in the Bathurst Island microfloras and in the Jurassic and Lower Cretaceous of the Great Artesian Basin in Queensland are cingulate, with little variation in width of the cingulum in each specimen.

STEREISPORITES sp.

(Pl. 24, figs. 7, 8)

Description: Large, trilete, zonate spores. Amb rounded triangular to circular, amb central body triangular with convex sides and acute corners. Exine two-layered, exine central body 2 μm thick, psilate. Trilete laesurae distinct, reaching almost to amb central body and bordered by inconspicuous low exine thickenings. Outer exine layer zonate, thin, psilate. Zona 4-6 μm wide, narrower near apices, and with an uninterrupted cavate outer part 2-5 μm wide.

Dimensions: Equatorial (3 specimens) central body 36-44 μm, entire grain 44-62 μm.

Occurrence: Sporadically in palynological unit K3a of Bathurst Island No. 2.

Remarks: The spores are distinguished by their transparency and zonal features. They have some affinity to *Psilatriletes radiatus* Brenner from the mid-Cretaceous of Maryland and Delaware, USA (Brenner, 1963, 1967). The material examined was not sufficient to warrant the erection of a new species.

Infraturma—Apiculate forms

Genus FORAMINISPORIS Krutzsch, 1959

Type species (by original designation): *Foraminisporis foraminis* Krutzsch, 1959 (see Krutzsch, 1959a), from the Tertiary of Germany.

FORAMINISPORIS ASYMMETRICUS (Cookson & Dettmann) Dettmann, 1963

(Pl. 24, fig. 14)

1958a *Apiculatisporites asymmetricus* Cookson & Dettmann, p. 100, pl. 14, figs. 11, 12.
1963 *Foraminisporis asymmetricus* (Cookson & Dettmann) Dettmann, p. 72, pl. 16, figs. 15-19.

Occurrence: Rare in most samples of Bathurst Island No. 2, and in the upper part of unit K3a in Bathurst Island No. 1; not restricted to any interval. The species occurs also in the Aptian and Albian of eastern Australia (Dettmann, 1963; Burger, 1973a,b). Dettmann & Playford (1969) placed the final appearance of the species in the earliest Late Cretaceous.

Remarks: Specimens are frequently laterally compressed or otherwise deformed. The equatorial dimensions range from 36 μm to 50 μm; maximum diameter of verrucae is 1-2 μm, slightly smaller than in the Aptian and Albian specimens.

FORAMINISPORIS WONTHAGGIENSIS (Cookson & Dettmann) Dettmann, 1963

(Pl. 24, fig. 13)

1958a *Apiculatisporites wonthaggiensis* Cookson & Dettmann, p. 100, pl. 14, figs. 7-10.
1963 *Foraminisporis wonthaggiensis* (Cookson & Dettmann) Dettmann, p. 71, pl. 14, figs. 19-23.

Occurrence: Rare to common in most samples from Bathurst Island No. 2. Common in the Neocomian, Aptian, and Albian of eastern Australia (Dettmann, 1963; Burger, 1973a,b); and in the mid-Cretaceous of North America (Singh, 1964, 1971; Norris, 1967).

Remarks: The Bathurst Island specimens are similar to the Early Cretaceous specimens found in the Great Artesian Basin, Queensland, but they have slightly thicker echinae, often with broadened bases, whereas the Early Cretaceous spores have small, slender spines. The species differs from *Saxosporis gracilis* Krutzsch, 1963 by the presence of a cingulum. It also differs from *S. brandenburgensis* Krutzsch, 1967 by its larger dimensions and the presence of a cingulum.

Genus ANTULSPORITES Archangelsky & Gamerro, 1966

Heliosporites Archangelsky & Gamerro, 1966a, p. 203 (non *Heliosporites* Schulz, 1962, p. 311).

Type species (by original designation): *Antulsporites* (al. *Heliosporites*) *baculatus* (Archangelsky & Gamerro) Archangelsky & Gamerro, 1966b, from the Early Cretaceous of Argentina.

Other species:
Antulsporites (al. *Cingulatisporites*) *saevus* (Balme, 1957) Archangelsky & Gamerro, 1966.
Antulsporites (al. *Cingulatisporites*) *granulatus* (De Jersey, 1959) Archangelsky & Gamerro, 1966.

Remarks: Archangelsky & Gamerro erected the genus *Antulsporites* to accommodate trilete spores, smooth to finely sculptured proximally and verrucate, baculate or echinate distally, with a zona displaying radial striation. They did not mention lamellation of the exine in their generic diagnosis, but they described the type species as having a two-layered exine. The genus resembles *Verrucingulatisporites* Kedves, 1961, which was reported as having a pseudocingulum with proximal and distal verrucate-corrugate ornament. The genus *Savitrisporites* Bhardwai, 1955, is different in that its type species has a differentiated cingulum. *Antulsporites* resembles *Perotrilites* Erdtman ex Couper, 1953, emend. Evans, 1970, and *Kraeuselisporites* Leschik, 1955, emend. Jansonius, 1962, which incorporate trilete zonate spores with a two-layered acavate exine. In *Perotrilites* the zona is 'wide in proportion to diameter of intexinal body' (Evans, 1970, p. 66); Evans did not mention the presence of radial lineation. The type species *P. granulatus* Couper, 1953, emend. Evans, 1970, thus seems to differ from *Antulsporites baculatus* in having a relatively finer distal sculpture, and a zona which is wider in regard to the diameter of the central cavity, without radial striation. This striation also lacks in *Kraeuselisporites*.

ANTULSPORITES VARIZONATUS sp. nov.

(Pl. 24, fig. 6)

Holotype: Bathurst Island No. 2, core 9, depth 213.4 m, MFP 4432-2; coord. 446/1094, Cenomanian (Pl. 24, fig. 6; CPC 13001).

Derivation of name: Based on the slightly uneven width of the zona per specimen.

Description: Small to medium-sized, trilete, zonate spores. Amb central cavity triangular with rounded acute corners and straight to slightly curved sides. Amb entire spore rounded triangular. Trilete laesurae weak, almost reaching to base of zona. Exine 1-2 μm thick, thinner at proximal side, possibly two-layered. Proximal face smooth, but small verrucae occur alongside laesurae. Distal face verrucate-baculate, individual elements closely spaced, occasionally fused, 2-4 μm high, maximum diameter 2-4 μm. Zone smooth, thin, 3-7 μm wide, often slightly narrower at apices, some displaying faint radial striping.

Dimensions: Equatorially, central cavity (11 specimens) 23-34 μm; entire spore (11 specimens) 28-40 μm.

Occurrence: Rare species in unit K3a of Bathurst Island Nos. 1 and 2.

Remarks: The species resembles *Antulsporites baculatus* (Archangelsky & Gamerro) but has a virtually smooth proximal exine, while the zona of many specimens is not uniform in width. It also resembles *Labiacoronisporites minor* Danzé-Corsin & Laveine (*in* Briche, Danzé-Corsin, & Laveine, 1963) but lacks the wide, low lips bordering the laesurae, and also has different distal sculpture. More or less similar spores occur in the Eocene of Hungary (*Polypodiaceoisporites bagolyhegyi* Kedves & Rakosy, 1965).

Genus PEROTRILITES Erdtman ex Couper, 1953, emend. Evans, 1970

Type species (designated by Couper, 1953): *Perotrilites granulatus* Couper, 1953, emend. Evans, 1970, from the Late Jurassic of New Zealand.

Remarks: Couper (1953) initially described the type species as having a loosely fitting, very thin perispore. This was subsequently questioned by various authors. Examination of the holotype of the species (illustrated in Couper, 1953, pl. 3, fig. 28; also in Evans, 1970, pl. 10, fig. 3) by Evans and Burger disclosed the specimen to be zonate, with no evidence that the zona is double-layered (Text-fig. 25). Evans revised the definition of the genus accordingly. He considered the possibility of, but did not formally propose, synonymy with *Kraeuselisporites* Leschik, 1955 emend. Jansonius, 1962, which incorporates zonate, acavate, trilete spores with a two-layered exine, proximally smooth and distally with varying types of sculpture from granulate to echinate (Jansonius, 1962, p. 46). It is not possible to decide upon the synonymy of the two genera until the types have been closely compared. Evans' emended diagnosis of *Perotrilites* is here accepted for the accommodation of the species described below.

Playford & Helby (1968) regarded the genus *Indotriradites* Tiwari, 1964, as synonymous with *Kraeuselisporites*, but according to Tiwari's interpretation, *Indotriradites* is equatorially and distally cavate (Text-fig. 25). *Gondisporites* Bhardwai, 1962, is close to *Kraeuselisporites*, but is also cavate distally and equatorially. The genus *Densosporites* (Berry, 1937) emend. Bhardwai & Venkatachala, 1962, incorporates patinate spore types with a single-layered exine. *Hymenozonotriletes polyacanthus* Naumova, 1953, type species for the genus, is distally echinate, but reportedly with 'membranous perispore' (Naumova, 1953, p. 41). The presence of

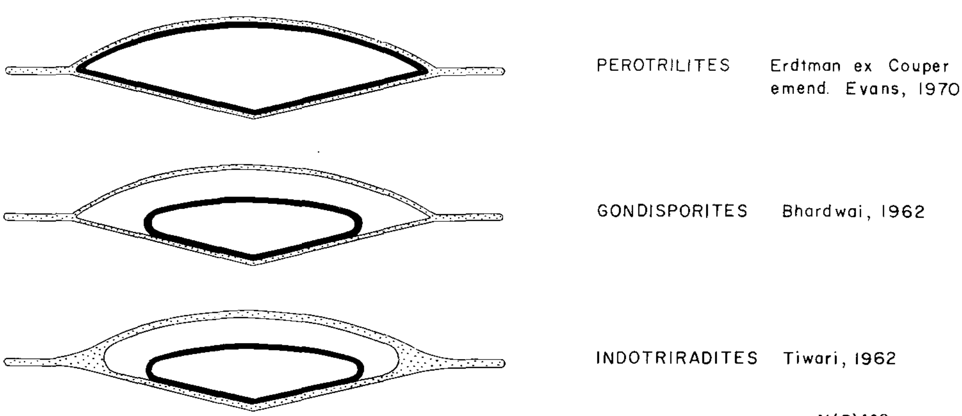


Figure 25. Details of exine lamellation in some trilete zonate spores.

a perispore was confirmed also for other species of the genus (Taugourdeau-Lantz, 1962). The genus *Ancyrospora* Richardson, 1960, emend. Richardson, 1962, includes spores with a thicker flange and with spines bifurcating at the tips (see also Owens, 1971).

PEROTRILITES MAJUS (Cookson & Dettmann) Evans, 1970

(Pl. 25, figs. 5-7)

1958a *Styxisporites majus* Cookson & Dettmann, p. 115, pl. 19, fig. 10.
1963 *Kraeuselisporites majus* (Cookson & Dettmann) Dettmann, p. 78, pl. 17, figs. 5, 6.
1970 *Perotrilites majus* (Cookson & Dettmann) Evans, pp. 67-68.

Description: Large, trilete, zonate spores. Amb central cavity rounded triangular to subcircular, amb spore approximately circular. Trilete laesurae distinct, extending onto outer margin of zona, bordered by 3-8 μm high membranous lips, reducing in height towards inner margin of zona. Exine very thin, inconspicuously two-layered, proximally smooth, distally covered with thin, 2-4 μm-high echinae, often aligned into groups of 2 to 4 with confluent, narrow bases, forming an imperfect reticulum with open lumina. Zona thin, distally sparsely granulate or micro-echinate, and 7-12 μm wide.

Dimensions: Equatorial, central cavity (9 specimens) 36-45 μm, entire spore (6 specimens) 50-64 μm.

Occurrence: Scarce in palynological unit K3a of Bathurst Island No. 1 and in most samples of Bathurst Island No. 2; apparently not present in unit K3b. The species occurs also in the Albian to Cenomanian of southeastern Australia (Dettmann, 1963; Dettmann & Playford, 1969) and in the Aptian of the Great Artesian Basin in Queensland (Burger, 1973a).

PEROTRILITES JUBATUS (Dettmann & Playford) Evans, 1970

(Pl. 25, figs. 8, 9; Pl. 26, figs. 1, 2; Text-fig. 26)

1968 *Kraeuselisporites jubatus* Dettmann & Playford, p. 81, pl. 7, figs. 10, 11.
1970 *Perotrilites jubatus* (Dettmann & Playford) Evans, 1970, p. 68.

Description: Large, trilete, zonate spores. Amb central body rounded triangular, amb entire spore circular to triangular or irregularly oval. Trilete mark distinct, laesurae extending onto outer margin of zona, bordered by membranous lips, which are up to 22 μm high near proximal pole and reduce rapidly towards periphery of spore. Exine 0.5-2.5 μm thick, indistinctly lamellated, proximally smooth, distally on central body provided with muri, less than 1 μm thick and up to 8 μm high, with serrated to echinate crests. Muri mostly short, branching, enclosing lumina of varying size in polar region, not extending onto zona. Most specimens have one set of muri, longer, sometimes joined in apical regions and running approximately parallel to amb body, at varying distances of distal pole (Text-fig. 26). Zona broad, hyaline, very thin, distally with tiny granules or sparsely distributed, thin spines, up to 3 μm high.

Dimensions: Equatorial, central body (25 specimens) 38-(44)-50 μm; entire grain (14 specimens) 60-90 μm.

Occurrence: Rare in many samples of Bathurst Island Nos. 1 and 2. Also sporadic in the late Albian of the Carpentaria Basin, Queensland (Burger, 1973b). Dettmann & Playford (1969) gave a range for the species which extends from the late Albian to the early Late Cretaceous.

Remarks: A distinct species, which is larger than *Perotrilites majus* and has higher laesurate lips and more prominent murornate sculpture. Because of its fragile structure it was not possible to examine a sufficient number of well preserved spores; certain details need more scrutiny. In many specimens the inner exine layer seems to be detached from the zona in the equatorial, interradial regions, giving the spores a pseudo-tricrassate appearance in polar view. This is also discernible in some specimens of *P. majus*. The species may be identical with *Kraeuselisporites laceratus* Norris, 1968, from the (Lower Cretaceous) Hawks Crag Breccia in New Zealand.

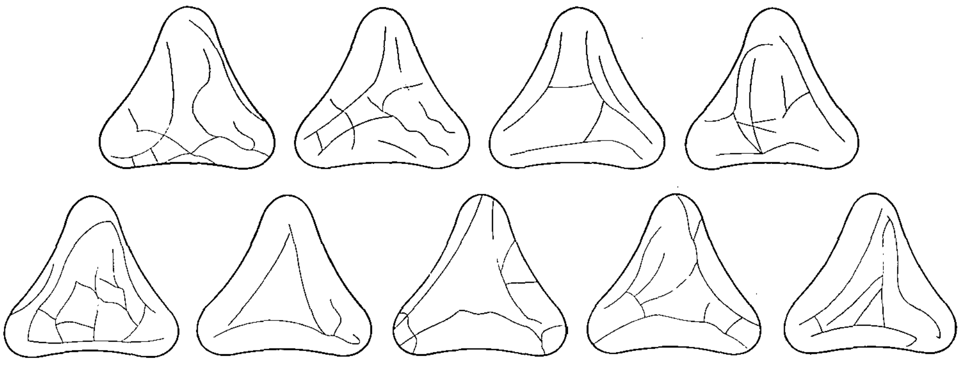


Figure 26. Variations in arrangement of 'pseudomuri' on distal exine surface in *Perotrilites jubatus* (Dettmann & Playford).

PEROTRILITES OEPIKII sp. nov.

(Pl. 24, fig. 12)

Holotype: Bathurst Island No. 1, core 3, depth 91.5 m, MFP 4455-2; coord. 363/1187, Cenomanian (Pl. 24, fig. 12; CPC 13006).

Derivation of name: In honour of Dr A. A. Öpik, Bureau of Mineral Resources, Canberra.

Description: Small, trilete, zonate spores. Amb rounded triangular to circular. Exine 1-2 μm thick, number of layers not determined. Proximal face psilate, trilete mark simple, extending to amb central body. Distal face echinate, echinae 1-2 μm in basal diameter, 2-3 μm high, spaced 2-5 μm apart, tops pointed or blunt. Remainder of exine psilate. Zona membranous, narrow, slightly broadening in between apices, sometimes partly missing (because of poor preservation); outer rim often minutely crenulate and distally often with tiny, sparsely scattered spinules.

Dimensions: Equatorial, central body (14 specimens) 20-26 μm; entire spore ([illegible]1 specimens) 24-29 μm.

Occurrence: Rare to common species in most samples of Bathurst Island No. 2, and in the upper part of unit K3a of Bathurst Island No. 1. The species has not been observed in the late Albian of the Carpentaria Basin in Queensland.

Remarks: The species cannot be assigned to the genus *Antulsporites*, as the zona lacks radial striping. Neither can it be placed in *Hymenozonotriletes* Naumova, as it is acavate, or in *Acanthotriletes* (Naumova) ex Potonié & Kremp, 1955, as it is zonate.

PEROTRILITES LINEARIS (Cookson & Dettmann) Evans, 1970

(Pl. 25, figs. 1-3)

1958a *Styxisporites linearis* Cookson & Dettmann, p. 114, pl. 19, figs. 3, 4, 8, 9.
1970 *Perotrilites linearis* (Cookson & Dettmann) Evans, p. 67.

Description: Medium-sized, trilete, zonate spores. Amb rounded triangular to circular. Proximal face flattened, distal face characteristically hemispherical. Trilete mark distinct, laesurae straight, reaching to amb, bordered by narrow, low lips. Exine 2 μm thick, excluding sculpture, lamellation not observed. Proximal face smooth, distal face echinate, sculpture elements 1-3 μm wide at roots, with straight parallel to tapering sides and blunt or pointed, occasionally widened tops. Height 2-6 μm; single elements spaced 2-4 μm apart, occasionally aligned by two or three, with confluent bases built up into low ridges. Membranous zona in fragments present in some specimens, fragments seen up to 5 μm wide, without ornament.

Dimensions: Equatorial (10 specimens) excluding zona 34-48 μm.

Occurrence: Rare to common in most samples of Bathurst Island No. 2, and in the lower part of unit K3a of Bathurst Island No. 1; apparently not restricted to a specific interval. Also in the Early Cretaceous of eastern Australia (Dettmann, 1963; Burger, 1973a).

Remarks: The species differs from *P. oepikii* sp. nov. by its larger dimensions and coarser sculpture. *Santonisporites radiatus* Deák & Combaz, 1967 has a thicker exine and radially arranged ridges rather than isolated spines.

Genus VALLIZONOSPORITES Döring, 1965

Type species (by original designation): *Vallizonosporites vallifoveatus* Döring, 1965, from the Early Cretaceous ('Wealden') of Germany.

Remarks: Vallizonosporites differs from *Sestrosporites* Dettmann, 1963, in being zonate instead of tricrassate. It resembles *Polypodiaceoisporites* Potonié, 1956 (*non* 1951), but it is foveolate rather than reticulate, with additional spines and bacula. The genus *Hymenozonotriletes* (Naumova) ex Naumova, 1953 incorporates species with entirely apiculate sculpture. *Foveosporites* Balme, 1957 has a superficial resemblance but is azonate.

VALLIZONOSPORITES sp.

(Pl. 25, fig. 4)

Description: Large, zonate, trilete spores. Amb rounded triangular with rounded to acute corners. Trilete laesurae distinct, straight, reaching almost to amb central body. Proximal and distal exine foveolate, 3-6 μm thick, at equator extending into a very thin, smooth zona 5-7 μm wide, with shallow foveolae near its inner margin. Foveolae on central body deep, slightly funnel-shaped, diameter at surface 1-1.5 μm, spaced about 1-2 μm apart.

Dimensions: Equatorial (2 specimens), entire spore 62, 64 μm; central body 46, 48 μm.

Occurrence: In low abundance, mostly single specimens, in palynological unit K3a of Bathurst Island Nos. 1 and 2. The species is not known from the Early Cretaceous of the Great Artesian Basin in Queensland.

Remarks: Specimens of the species have a dome-shaped distal side, which shows the characteristically deep foveolae. The species is distinguished from other Australian trilete foveolate forms by its size, thickness of exine, and wide zona. *Foveosporites cyclicus* Stanley, 1965 has a narrower zona and thinner exine. The type species *V. vallifoveatus* has a thinner exine and additional apiculate sculptural elements.

Suprasubturma PERINOTRILITES Erdtman, 1947, emend. Dettmann, 1963

Remarks: Dettmann (1963) observed that this group incorporates some species in which the spores have an uniformly thick sclerine, whereas in other species the sclerine may be thickened equatorially. However, she refrained from subdividing the group, as in many of the incorporated genera the details of exine differentiation are not clear.

Genus CRYBELOSPORITES Dettmann, 1963

Type species (by original designation): *Crybelosporites* (al. *Perotrilites*) *striatus* (Cookson & Dettmann, 1958) Dettmann, 1963, from the Early Cretaceous of south-eastern Australia.

CRYBELOSPORITES STRIATUS (Cookson & Dettmann) Dettmann, 1963

(Pl. 23, fig. 10)

1958b *Perotrilites striatus* Cookson & Dettmann, p. 43, pl. 1, figs. 8, 9.
1963 *Crybelosporites striatus* (Cookson & Dettmann) Dettmann, p. 81, pl. 18, figs. 8-12.

Occurrence: Several specimens occur in Bathurst Island No. 2, core 12, in the lower part of unit K3a. Rare to common species in the Albian of eastern Australia (Dettmann, 1963; Burger, 1973b). Dettmann & Playford (1969) extended the range of the species in the Otway Basin into the early Late Cretaceous.

CRYBELOSPORITES cf. C. BRENNERI Playford, 1971

(Pl. 24, figs. 1-5)

cf. 1971 *Crybelosporites brennerii* Playford, p. 550, pl. 105, fig. 18.

Description: Medium-sized, trilete spores with a multi-layered, cavate sclerine. Body of spore spherical, proximal side often collapsed, whereby the trilete laesurae have opened. Sclerine 2-3 μm thick, apparently two layers present. Inner layer smooth, about 0.5 μm thick, outer layer distally and equatorially in close contact, proximally detached, uniformly reticulate except on gula. Muri of reticulum thin, low, lumina closed, circular to irregular, equidimensional, with a diameter of 0.5-1 μm. Rudimentary gula often present, projecting 6-16 μm from proximal surface of spore body, transparent, ragged, with a crumpled, psilate to punctate surface.

Dimensions: Central body (24 specimens) 30-(35)-45 μm.

Occurrence: Rare to moderately common species in most samples of Bathurst Island Nos. 1 and 2. Also sporadically in the latest Albian of the Carpentaria Basin in Queensland (Burger, 1973b). Playford (1971) described the species from the Albian of Saskatchewan and Manitoba, Canada.

Remarks: This species resembles *Crybelosporites striatus*, but has a thinner sclerine and a distinctly finer, more uniform surface reticulum. In *C. striatus* the gula is better developed, with a striate surface. There is no sign of the presence of an inner sculptine layer, which is clearly visible in *C. striatus*. The species may be conspecific with *C. brenneri*, although according to Playford the surface sculpture in *brenneri* is scabrate to microrugulate, rather than reticulate.

Turma MONOLETES Ibrahim, 1933

Suprasubturma ACAVATOMONOLETES Dettmann, 1963

Subturma AZONOMONOLETES Luber, 1955

Infraturma LAEVIGATOMONOLETI Dybova & Jachowicz, 1957

Genus LAEVIGATOSPORITES Ibrahim, 1933

Type species (by monotypy): *Laevigatosporites* (al. *Sporonites*) *vulgaris* (Ibrahim, *in* Potonié, Ibrahim, & Loose, 1932) Ibrahim, 1933, from the Late Carboniferous of Germany.

LAEVIGATOSPORITES OVATUS Wilson & Webster, 1946

(Pl. 27, figs. 3, 4)

1946 *Laevigatosporites ovatus* Wilson & Webster, p. 273, fig. 5.

Occurrence: Common species in Bathurst Island Nos. 1 and 2; also common in the Albian of the Australian region.

Remarks: Polar diameter (6 specimens) measures 13-20 μm, maximum equatorial dimension (12 specimens) is 22-30 μm. These spores are smaller than those recorded from the Albian of southeastern Australia (Dettmann, 1963); they are slightly smaller than the specimens from the Early Cretaceous of Queensland. *Laevigatosporites major* (Cookson, 1947) Krutzsch, 1959 (see Krutzsch, 1959a), which Dettmann & Playford (1968) reported from the Late Cretaceous and Tertiary of southern Australia, is considerably larger.

Infraturma MURORNATOMONOLETI cat. nov.

Remarks: This infraturma differs from the Sculptatomonoleti Dybova & Jachowicz, 1957, in that it is restricted to azonate, monolete, murornate forms, apiculate forms excluded. Thus, the group includes foveo-reticulate types such as *Microfoveolatosporis* Krutzsch, 1959 (i.e. Krutzsch, 1959a), rugulate forms such as *Undulatosporites* Leschik, 1955, and striate forms such as *Striatosporites* Bhardwai, 1954, and *Schizaeoisporites* Potonié, 1951, emend. Potonié, 1960 (i.e. Potonié, 1960a).

Genus MICROFOVEOLATOSPORIS Krutzsch, 1959, emend. Potonié, 1966

Type species (by original designation): *Microfoveolatosporis pseudodentatus* Krutzsch, 1959 (see Krutzsch, 1959a), from the earliest Tertiary of Germany.

MICROFOVEOLATOSPORIS CANALICULATUS Dettmann, 1963

(Pl. 27, figs. 5-8)

1963 *Microfoveolatosporis canaliculatus* Dettmann, p. 87, pl. 19, figs. 15, 16.

Description: Spores small, monolete, oval in polar view, bean-shaped to semicircular in side view. Monolete mark distinct, measuring two-thirds to three-quarters of length of spore, bordered by thin, low lips. Exine 1.5-2 μm thick, foveolate, pits shallow, often funnel-shaped, so that rims are almost in contact, diameter 0.5-2 μm, centres of pits separated 1-4 μm. Foveolae along laesurate margin smaller and spaced farther apart.

Dimensions: Polar (12 specimens) 17-22 μm, equatorial length (18 specimens) 26-34 μm.

Occurrence: Rare in the samples of Bathurst Island Nos. 1 and 2. Rare to moderately common in the late Albian of the Great Artesian Basin (Dettmann, 1963; Burger, 1968b,c; 1973b).

Turma HILATES Dettmann, 1963

Remarks: Dettmann (1963) proposed this turma category for spore types with a modification of the exine in the distal or proximal polar regions, which often resulted in a breakdown of the exine (hilum). She thus broadened Erdtman's (1952) definition of a hilum as an indistinctly delimited, approximately circular proximal aperture, in order to accommodate forms such as *Coptospora paradoxa* (Cookson & Dettmann), *Cooksonites variabilis* Pocock, and species of *Aequitriradites* Delcourt & Sprumont, emend. Cookson & Dettmann, in which the exine is fractured and often missing in the distal polar area. In some genera a proximal tetrad mark is visible.

Genus TRIPOROLETES Mtchedlishvili, 1960, emend. Playford, 1971

Type species (by monotypy): *Triporoletes singularis* Mtchedlishvili, in Mtchedlishvili & Samoilovich, 1960, from the Cretaceous of the USSR.

Remarks: This genus incorporates zonate, cavate spores, with a faint to distinct trilete mark.

TRIPOROLETES RETICULATUS (Pocock) Playford, 1971

(Pl. 27, figs. 9, 10)

1962 *Rouseisporites reticulatus* Pocock, p. 53, pl. 7, fig. 101.
1971 *Triporoletes reticulatus* (Pocock) Playford, p. 552.

Occurrence: Single specimens occur in samples from the upper part of palynological unit K3a of Bathurst Island Nos. 1 and 2. Comparable specimens occur in samples from deeper parts of the well sections. The species also occurs in the Early Cretaceous of Australia (Dettmann, 1963; Burger, 1973a) and Canada (Pocock, 1962).

Remarks: The Bathurst Island specimens have a faint, proximal trilete mark. They are not well preserved, in comparison with other spores with which they occur; they could therefore be of secondary (recycled) origin.

TRIPOROLETES LAEVIGATUS (Pocock) Playford, 1971

(Pl. 28, figs. 2-5)

1962 *Rouseisporites laevigatus* Pocock, p. 53, pl. 7, figs. 106-109.
1971 *Triporoletes laevigatus* (Pocock) Playford, p. 552.

Description: Medium-sized, distally hilate, cavate, zonate spores. Amb rounded triangular to circular. Sclerine two-layered, inner layer 1-2.5 μm thick, in a number of specimens probably thickened at equator, faintly punctate, often slightly invaginated in equatorial apical regions. Narrowly enveloping outer layer thin, hyaline, smooth, often extending beyond margin of inner body in apical equatorial regions. Sclerine proximally with few low folds, faint trilete mark frequently present, distally with sinuous folds without particular orientation and not reaching entirely towards amb; sometimes finer secondary folds occur. Sclerine sometimes fractured along folds, but no hilum observed.

Dimensions: Equatorial (18 specimens) 35-(43)-66 μm.

Occurrence: Rare to moderately common species in many microfloras from Bathurst Island; not restricted to a particular interval. The species has not been observed in the Albian of the Great Artesian Basin in Queensland. Outside Australia, the species has been reported from the Aptian and Albian of Canada (Pocock, 1962; Singh, 1964).

Remarks: The species differs from *Triporoletes radiatus* (Dettmann, 1963) Playford, 1971, and *T. simplex* (Cookson & Dettmann, 1958) Playford, 1971, by the absence of radially oriented distal muroid ridges and the presence of an apparently azonate outer sclerine layer. It resembles *Retitriletes cenomanianus* Agasie, 1969, from the Cenomanian of Arizona, USA, but the description of that species does not mention a cavate sclerine. *Retitriletes dorogensis* Kedves, 1965, from the Eocene of Hungary, has a more pronounced trilete mark and more distinct distal reticulum. *Zlivisporites blanensis* Pacltová, 1961, from the Late Cretaceous of Czechoslovakia, and from the Jurassic in Tunisia (Reyre, 1965) shows some similarity but has a regular distal reticulum.

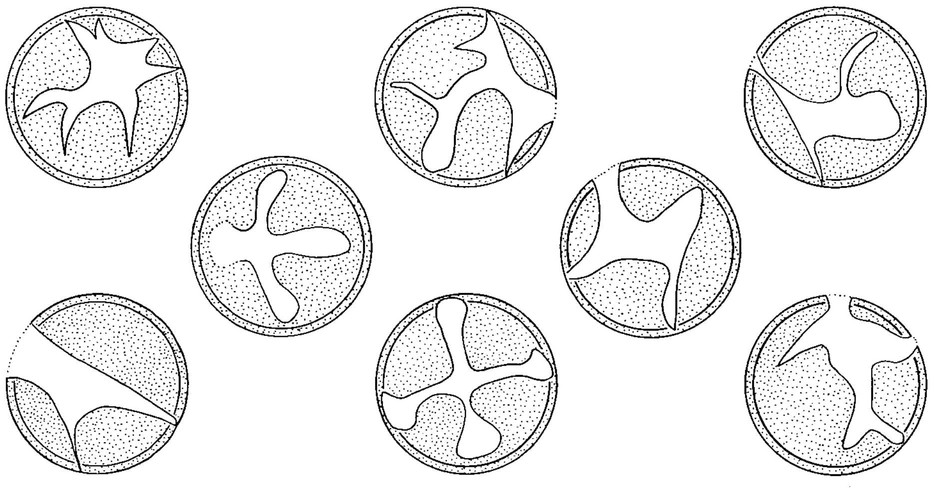


Figure 27. Modifications of aperture observed in *Asteropollis asteroides* (Hedlund & Norris).

Anteturma POLLENITES Potonié, 1931

Division SACCITES Erdtman, 1947

Remarks: Saccate pollen grains are relatively rare in the Bathurst Island microfloras. Single specimens of *Callialasporites dampieri* (Balme) and *C. trilobatus* (Balme) were found but are very probably of secondary origin. Single specimens assignable to *Podocarpidites* Cookson, 1947 emend. Potonié, 1958, occur in most samples, but no attempt was made to identify them at specific level, as too few specimens were available for closer examination. Specimens close to *Podocarpidites ellipticus* Cookson, 1947, were identified in some preparations (Pl. 28, fig. 13).

Genus RUGUBIVESICULITES Pierce, 1961

Type species (by original designation): *Rugubivesiculites convolutus* Pierce, 1961, from the early Late Cretaceous of Minnesota, USA.

Remarks: Specimens with a minutely rugulate proximal cap and two almost spherical sacs occur in Bathurst Island No. 2, core 2 (Pl. 28, fig. 14). These specimens have finer ornament than those that Pierce described from Minnesota. Similar spores were also occasionally found in the late Albian of the Great Artesian Basin in Queensland.

Genus VITREISPORITES Leschik, 1955, emend. Jansonius, 1962

Type species (by original designation): *Vitreisporites signatus* Leschik, 1955, from the Triassic of Switzerland.

VITREISPORITES PALLIDUS (Reissinger) Nilsson, 1958

(Pl. 28, figs. 6, 7)

1950 *Pityopollenites pallidus* Reissinger, p. 109, pl. 15, figs. 1-5.
1958 *Caytonipollenites pallidus* (Reissinger) Couper, p. 150, pl. 26, figs. 7, 8.
1958 *Vitreisporites pallidus* (Reissinger) Nilsson, p. 78, pl. 7, figs. 12-14.

Occurrence: Rare to moderately common species in most of the Bathurst Island microfloras. Common in the Mesozoic of Australia and other parts of the world.

Remarks: The Cenomanian specimens are similar to those from the Jurassic and Early Cretaceous of Queensland, but tend to be larger, some specimens measuring 45 μm. Nilsson gave a size range for the Early Jurassic specimens of 25-30 μm; Couper (1958) measured for the British Jurassic and Early Cretaceous specimens a size range of 20-38 μm. For this reason it appears unnecessary to include the larger specimens from Bathurst Island in a separate species.

Genus ALISPORITES (Daugherty, 1941) Somers, 1968, emend. Potonié, 1970

Type species (by monotypy): *Alisporites opii* Daugherty, 1941, from the Triassic of Arizona, USA.

Remarks: Specimens assignable to *Alisporites* occur in moderate numbers in many of the Bathurst Island samples. The material was not sufficiently abundant for a closer systematic study, but it includes forms which do not occur in the Early Cretaceous of Queensland and differ from *Alisporites similis* (Balme, 1957) Dettmann, 1963, in the shape of the sulcus (or leptoma, see Erdtman, 1949) and the relative size of the sacci in relation to the central corpus (Pl. 28, figs. 8, 12). Poorly preserved specimens similar to *A. similis* and *Alisporites grandis* (Cookson, 1953) Dettmann, 1963, were present in some of the samples.

Genus MICROCACHRYIDITES Cookson, 1947, ex Couper, 1953

Type species (designated by Couper, 1953): *Microcachryidites antarcticus* Cookson, 1947, from the Tertiary of Kerguelen Archipelago.

MICROCACHRYIDITES ANTARCTICUS Cookson, 1947

(Pl. 28, fig. 9)

1947 *Microcachryidites antarcticus* Cookson, p. 132, pl. 14, fig. 19.

Occurrence: Common in the Bathurst Island samples. Also common in the Early Cretaceous of Australia (Balme, 1957; Dettmann, 1963), occasionally also in the latest Jurassic of the Great Artesian Basin, Queensland (Burger, 1973a).

Remarks: Trisaccate forms vaguely resembling *M. antarcticus* have been reported from the Early Jurassic in the Surat Basin, Queensland (Reiser & Williams, 1969).

Genus TRISACCITES Cookson & Pike, 1954

Type species (by monotypy): *Trisaccites* (al. *Dacrydium*) *microsaccatus* (Couper, 1953) Couper, 1960, from the Late Cretaceous of New Zealand.

Remarks: Couper (1960) placed the type species *Trisaccites micropterus* Cookson & Pike into synonymy with *T.* (al. *Dacrydium*) *microsaccatus* (Couper).

TRISACCITES MICROSACCATUS (Couper) Couper, 1960

(Pl. 11, figs. 10, 11)

1953 *Dacrydium microsaccatum* Couper, p. 35, pl. 4, fig. 38.
1954 *Trisaccites micropterus* Cookson & Pike, p. 64, pl. 2, figs. 21-29.
1960 *Trisaccites microsaccatus* (Couper) Couper, p. 46, pl. 104, figs. 12, 13. (for more complete synonymy see Haskell, 1968, p. 234).

Occurrence: A rare component of many of the Bathurst Island microfloras, not restricted to any specific interval. Also present in the Aptian and Albian of the Great Artesian Basin, the late Jurassic to Aptian in Western Australia (Balme, 1957), and the Early Cretaceous and Tertiary of southeastern Australia (Dettmann, 1963; Cookson & Pike, 1954). Couper (1953, 1960) reported the species from the Late Cretaceous of New Zealand.

Remarks: Dettmann (1963) transferred the species to the genus *Podosporites*, but Sah & Jain (1965), after having re-examined type slides of *Podosporites*, argued against synonymy of this genus and *Trisaccites* and re-assigned the species to *Trisaccites.*

Turma ALETES, KRYPTAPERTURATES

Remarks: Aletes Ibrahim, 1933, includes spores with no or hardly observable tetrad mark; Kryptaperturates refers to forms with other, vaguely visible germinal apertures (Potonié, 1970) and is as such close to Inaperturates Iversen & Troels-Smith (1950). Kryptaperturate (inaperturate), acavate forms are *Hoegisporis* and *Inaperturopollenites*, described below.

Subturma AZONALETES (Luber, 1935) Potonié & Kremp, 1955

Infraturma—Apiculate forms (sensu lato)

Genus HOEGISPORIS Cookson, 1961

Type species (by original designation): *Hoegisporis lenticulifera* Cookson, 1961, from the mid-Cretaceous of Western Australia.

HOEGISPORIS UNIFORMA Cookson, 1965

(Pl. 28, figs. 16-18)

1965 *Hoegisporis uniforma* Cookson, p. 39, pl. 9, fig. 2.

Description: Large, flattened, inaperturate pollen grains. Amb circular to oval. Exine about 2 μm thick, densely granulate, near equator at distal side provided with 6-11 hemispherical massive thickenings, almost equal distances apart, occasionally occurring in pairs, with diameter 5-9 μm. Exine thinner and often ruptured or absent in a large, approximately circular, not distinctly delimited area in the distal polar region.

Dimensions: Equatorial (23 specimens) 41-(51)-68 μm.

Occurrence: Rare to moderately common species in the Bathurst Island microfloras. Also occurring in the late Albian of the Great Artesian Basin, Queensland (Burger, 1973b). Cookson (1965) reported the species from probably Aptian-Albian sediments in South Australia and Western Australia.

Genus INAPERTUROPOLLENITES (Pflug ex Thomson & Pflug, 1953) emend. Potonié, 1958

Type species (by original designation): *Inaperturopollenites* (al. *Pollenites magnus dubius*) *dubius* (Potonié & Venitz, 1934) Thomson & Pflug, 1953, from the Late Tertiary of Germany.

INAPERTUROPOLLENITES LIMBATUS Balme

(Pl. 29, figs. 1-4)

1957 *Inaperturopollenites limbatus* Balme, p. 31, pl. 7, fig. 83.

Description: See Balme, 1957.

Dimensions: Equatorial (20 specimens) 33-(51)-60 μm.

Occurrence: Moderately common to sporadic species in many of the Bathurst Island microfloras; not restricted to any interval. Also rare to common in the Jurassic and Early Cretaceous of the Australian region.

Turma MONOPORINES Naumova, 1939

Suprasubturma: Acavate forms

Genus CLASSOPOLLIS Pflug, 1953, emend. Pocock & Jansonius, 1961

Type species (by original designation): *Classopollis classoides* Pflug, 1953, emend. Pocock & Jansonius, 1961, from the Early Jurassic (Lias) of Germany.

CLASSOPOLLIS SIMPLEX (Danzé-Corsin & Laveine) Reiser & Williams, 1969

(Pl. 13, figs. 1, 2; Text-fig. 28)

1963 *Classopollenites simplex* Danzé-Corsin & Laveine, in Briche, Danzé-Corsin & Laveine, p. 106, pl. 11, figs. 7, 8 (invalid genus).
1964 *Classopollis simplex* De Jersey & Paten, p. 12, pl. 7, figs. 4-6.
1969 *Classopollis simplex* (Danzé-Corsin & Laveine) Reiser & Williams, p. 16, pl. 6, fig. 15.

Occurrence: Rare to moderately common species in most of the Bathurst Island microfloras. Common in the Jurassic and Early Cretaceous of the Great Artesian Basin, Queensland (De Jersey & Paten, 1964; Reiser & Williams, 1969; also uncommunicated information from the Eromanga and Carpentaria Basins).

Remarks: This species has a distinctly tectate, psilate to finely granulate exine (Text-fig. 28), conspicuous rimula, and more or less differentiated proximal polar region. Dimensions (8 specimens) lie in the 25-29 μm range, in accordance with De Jersey & Paten's (1964) and Reiser & Williams' (1969) observations.

CLASSOPOLLIS sp.

(Pl. 30, figs. 3-8)

Description: Grains medium-sized, anisopolar, considerably compressed in polar direction; amb circular, oval to rounded triangular. Exine 1-1.5 μm thick, two-layered, with slight folding at right angles to equator. Nexine about as thick as sexine, probably slightly thicker near margin of pore, without ornament. Sexine

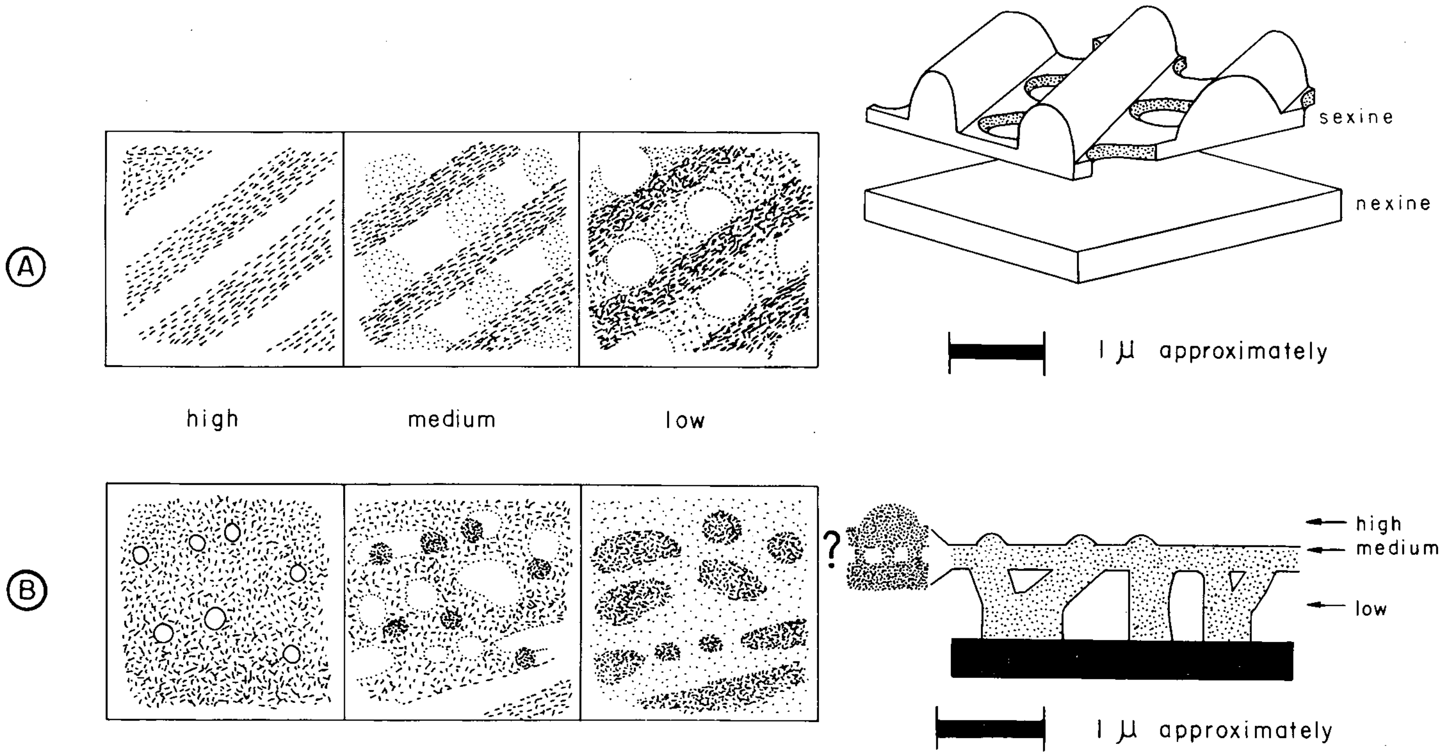


Figure 28. Exine structure of *Striatopollis paraneus* (Norris) (A), and *Classopollis simplex* (Danzé-Corsin & Laveine) (B), according to LO-analysis.

M(P)463

sometimes detached from nexine in proximal and distal equatorial region, in which case it is often more intensively folded. It consists of regularly distributed, minute grana supporting a thin, uninterrupted tectum, with extremely small grana and spines. Subsurface grana in equatorial region more or less distinctly arranged in rows, which are parallel to equator and spaced 0.5 μm apart. Rimula not observed. Proximal polar area not visibly differentiated, distal pole characterized by the presence of a circular pore 8-11 μm in diameter.

Dimensions: Equatorial (22 specimens) 30-(35)-40 μm.

Occurrence: Rare to common—in one sample (Bathurst Island No. 2, core 2) even abundant—in unit K3a of Bathurst Island No. 2 and in core 3, Bathurst Island No. 1. Occasionally observed in Lower Cretaceous sediments of the Great Artesian Basin, Queensland.

Remarks: Owing to flattening, the grains are settled in the microscope preparations with the polar axis pointed towards the observer, so that I could not measure polar dimensions, or examine the pore in detail. The species is readily distinguished from other *Classopollis* forms; it differs from *C. simplex* by its larger equatorial dimensions, thinner exine with broad, radial folding, and absence of a conspicuous rimula. It also differs from *C. pflugii* Pocock & Jansonius, 1961, by the presence of a distinct pore, the absence of a rimula, and virtually psilate exine. *Classoides glandis* Amerom, 1965 lacks circumequatorial striation of the exine.

However, no formal name is yet proposed for the species. In a large number of specimens the exine layers are partly separated; also, in contrast with the general appearance of the other fossils in the preparations, exine details, such as the rim of the pore, are relatively poorly delineated. This seems to be a preservational deterioration, and it is assumed that the specimens were not derived from the same source as the other components of the spore-pollen assemblages. Therefore, although there is no other positive evidence, I suspect that *Classopollis* sp. could be a foreign (recycled?) element in the sequence.

Turma POLYPLICATES Erdtman, 1952

Genus Ephedripites Bolchovitina, 1953

Type species (by original designation): *Ephedripites mediolobatus* Bolchovitina, 1953, from the Cretaceous of Central USSR.

Remarks: Representatives of this genus occur sporadically in the upper part of unit K3a in Bathurst Island Nos. 1 and 2. Some of the specimens are illustrated in Plate 29, figures 5-8. The number of specimens found was not sufficient for a closer systematic examination of the group. The genus *Steevesipollenites* Stover, 1964, includes ephedroid forms, but these have conspicuously modified poles. The genus *Striainaperturites* Pierce, 1961, is a junior synonym of *Ephedripites*.

Turma TRI(TETRA)CHOTOMOSULCATES Erdtman, 1945

Genus Asteropollis Hedlund & Norris, 1968

Type species (by original designation): *Asteropollis asteroides* Hedlund & Norris, 1968, from the Albian of Oklahoma, USA.

Asteropollis asteroides Hedlund & Norris

(Pl. 30, figs. 10-15; Pl. 31, figs. 1-3; Text-fig. 27)

1968 *Asteropollis asteroides* Hedlund & Norris, p. 153, pl. 7, fig. 2.

Description: Pollen grains spherical, medium-sized, heteropolar, tri-, tetra-, or pentachotomosulcate. Nexinal aperture often opened; the branches sometimes bifurcating, in many specimens of unequal length, and spanning across distal hemisphere. Exine two-layered, semitectate, nexine 1-1.5 μm thick, sexine consists of closely spaced clavae, 0.5-1 μm high, capita connected by muri forming a minute, even reticulum with meshes of 0.5 μm diameter. Clavae alongside aperture coarser and further apart, reticulum at location of unopened aperture sometimes uninterrupted, with a mesh of about 1 μm diameter.

Dimensions: (20 specimens) 20-(24)-28 μm.

Occurrence: Rare to common species in the Bathurst Island microfloras; also observed from strata elsewhere on the island, and sporadically in the ?Cenomanian-Turonian of the Otway Basin, Victoria (Dettmann, 1973).

Remarks: Various aspects of the aperture are illustrated in Text-figure 27; most specimens are tetrachotomosulcate. The species resembles minutely clavate forms which Groot & Groot (1962) described as *Apiculatisporites vulgaris*, from the mid-Cretaceous of Portugal. It also resembles *Liliacidites trichotomosulcates* Singh, 1971, from the Albian of Canada.

Turma MONOSULCATES, MONOCOLPATES, etc.

Remarks: This group includes pollen grains with one elongated germinal aperture (furrow). According to the terminology developed by Erdtman (1952) these can be either colpi, situated equatorially and oriented meridionally, or sulci, passing across the distal pole. The Bathurst Island specimens incorporated in this turma are commonly regarded as monosulcate.

Genus CLAVATIPOLLENITES Couper, 1958

Type species (by original designation): *Clavatipollenites hughesii* Couper, 1958, from the Early Cretaceous (Wealden) of Britain.

CLAVATIPOLLENITES HUGHESII Couper, 1958

(Pl. 29, figs. 14-16)

1958 *Clavatipollenites hughesii* Couper, p. 159, pl. 31, figs. 21, 22.

Description: Small monosulcate grains, ellipsoidal to almost spherical. Sulcus (in nexine) usually gaping, sometimes with ragged edges, almost spanning long axis of grain. Exine two-layered, semitectate, 1.5-2 μm thick, nexine and sexine approximately of equal thickness. Nexine smooth, sexine consists of closely and evenly spaced clavae, thin, 0.5-1 μm high, capita connected by muri, which form a minute regular network with lumina 0.5 μm across.

Dimensions: Equatorial (9 specimens) 19-25 μm, polar (6 specimens) 16-25 μm.

Occurrence: Rare species in units K3a and K3b of Bathurst Island Nos. 1 and 2. Also rare in the Albian of the Great Artesian Basin in Queensland. The species has been reported from the (mid-) Cretaceous in North America, Europe, and USSR. Dettmann (1973) reported similar pollen grains from Bathurst and Melville Islands, as well as from the ?Cenomanian-Turonian of the Otway Basin, Victoria.

Remarks: Angiospermous affinity of the species, suggested by Couper (1958) and Kemp (1970), in view of the structure of the exine, was doubted by Brenner (1963), who pointed out that similar types of exine also occur in some gymnosperms, and thought that now extinct gymnosperms could have produced pollen with similar exine structures. I do not regard the species as of truly angiospermous affinity. In Queensland and Northern Territory the first appearance of the species (early Albian) precedes that of the group of tricolpate forms (late Albian), which constitutes the earliest distinct angiospermous element in the Australian microfloral record.

CLAVATIPOLLENITES sp. A

(Pl. 29, fig. 20)

Description: Grains monosulcate, ellipsoidal. Sulcus (in nexine) long and straight, with frequently ragged margins. Exine two-layered, 1-1.5 μm thick. Nexine smooth, sexine consists of bacula 0.5 μm high, of which the tops are bridged by muri forming a minute, regular network with polygonal, oval or circular lumina of 0.5-3 μm diameter.

Dimensions: Equatorial (3 specimens) 23-26 μm; polar (2 specimens) 18, 20 μm.

Occurrence: Occasionally in unit K3a of Bathurst Island No. 1.

Remarks: This form has not been examined in sufficient detail to justify erection of a new species. It differs from *C. hughesii* in having more widely spaced sexinous bacula and a coarser surface reticulum. It is smaller than *C. rotundus* Kemp, 1968 (dimensions 25-30 μm), has no thickenings or exine infoldings along the sulcus, and no tendency for the sexine to separate.

Genus LILIACIDITES Couper, 1953

Type species (by original designation): *Liliacidites kaitangataensis* Couper, 1953, from the Late Cretaceous of New Zealand.

Remarks: Except for the species described below only single grains of *Liliacidites* spp. occur in a few of the Bathurst Island microfloras. The material available was not sufficiently rich for a more detailed study. One specimen with exine folds along the sulcus is illustrated in Plate 29, figure 21. Other specimens with affinity to *Liliacidites* are shown in Plate 29, figures 17, 18.

LILIACIDITES PERORETICULATUS (Brenner) Singh, 1971

(Pl. 29, figs. 9-13)

1963 *Peromonolites peroreticulatus* Brenner, p. 94, pl. 41, fig. 1.
1971 *Liliacidites peroreticulatus* (Brenner) Singh, p. 188, pl. 28, figs. 6-11.

Description: Small, monosulcate, ellipsoidal pollen grains. Nexinal sulcus distinct, often slightly gaping, spanning long axis of grain. Exine double-layered, nexine 0.5 μm thick, smooth. Sexine consists of thin bacula or clavae, 1-2 μm high, spaced 1-4 μm apart, outer extremities bridged by smooth or granulate muri, which encircle polygonal to circular lumina 1-3 μm wide, and often continue across location of sulcus.

Dimensions: Entire grain (13 specimens) 16-22 μm; polar (15 specimens) 12-18 μm.

Occurrence: Uncommon in many Bathurst Island microfloras, not restricted to a specific interval. Also in the Albian of the Great Artesian Basin in Queensland (Terpstra & Burger, 1969; Burger, 1968b, c, 1973b). The species has been observed in the late Neocomian to Albian of Maryland, USA (Brenner, 1963), the early Late Cretaceous (Cenomanian) of Arizona, USA (Agasie, 1969), the Albian of Peru

(Brenner, 1969), the Albian of Canada (Pocock, 1962; Singh, 1971), and the Cenomanian of France (Azema et al., 1972).

LILIACIDITES cf. L. KAITANGATAENSIS Couper, 1953

(Pl. 31, figs. 4-9; Pl. 32, figs. 1, 2)

cf. 1953 *Liliacidites kaitangataensis* Couper, p. 56, pl. 7, fig. 97.

Description: See Dettmann, 1973, pp. 9-10. Dimensions of the Bathurst Island grains: polar (21 specimens) 23-(33)-42 μm; equatorial (29 specimens) 35-(47)-65 μm.

Occurrence: Rare to moderately common in most samples from Bathurst Island Nos. 1 and 2. Single specimens were also found in the latest Albian of the Carpentaria Basin, Queensland (Burger, 1973b). Dettmann (1973) reported the species from Bathurst and Melville Islands.

Remarks: Frequent rupturing of the ?proximal exine gives the Bathurst Island specimens a pseudo-dicolpate character; however, from observation of similar forms from Bathurst Island with the scanning electron microscope, Dettmann (1973) came to the conclusion that one of the exine furrows (?proximally) was caused by rupturing of an initial oblong weakening of the exine, with no genuine germinal function.

Turma DISULCATES, DICOLPATES, etc.

Remarks: Erdtman (1947) erected the form-group *Dicolpites* for sporae dispersae with two colpi (sensu Erdtman, 1952); this group is not a genus under the rules of the International Code of Botanical Nomenclature. Pflanzl (1956) erected the form-genus *Dicolpopollis* to incorporate dispersed pollen with two opposite sulci, from the Tertiary of Germany, but no type species was established. Potonié (1960b) reinstated Dicolpates Erdtman, 1947, as a suprageneric taxon for pollen grains with two furrows (sensu lato), and validated *Disulcites* Erdtman, 1945, by designating *D. kalewensis* Potonié, 1960, as its type. He subsequently (1966) transferred this species to the genus *Dicolpopollis*, *Disulcites* being its junior synonym, and established *Dicolpopollis kockeli* Pflanzl, 1956, as the type species.

Genus DICOLPOPOLLIS Pflanzl, 1956, emend. Potonié, 1966

Type species (designated by Potonié, 1966): *Dicolpopollis kockeli* Pflanzl, 1956, from the ?Miocene of Germany.

Remarks: Very few reports exist of this type of pollen in the Cretaceous. Drugg (1967) described a *Disulcites* sp. from the Danian of California, USA. Gruas-Cavagnetto (1968) described *Disulcites luteticus* from the Tertiary of France. Judging by the illustration, this is an intectate form with very short sulci ('sillons') and reticulate surface ornament. *Dicolpopollis* sp. A is described below; single specimens of other presumably dicolpate forms, not described here, are illustrated in Plate 32, figures 6, 10.

DICOLPOPOLLIS sp. A

(Pl. 32, figs. 8, 9)

Description: Small to medium-sized, ovoid, ?disulcate grains. Sulculi long, straight, presumably in equatorial plane. Exine indistinctly semitectate, 1-2 μm thick. Nexine inconspicuous, sexine about 0.5-1 μm thick, surface reticulum in polar area with lumina of about 0.5 μm diameter, reduced towards sulculi and absent in the apical regions.

Dimensions: (5 specimens) polar 12-22 μm, equatorial 18-36 μm.

Occurrence: Inconspicuous and rare species in some microfloras from unit K3a in Bathurst Island Nos. 1 and 2; not observed in the Early Cretaceous of the Great Artesian Basin, Queensland.

Remarks: The furrows are at present taken to be germinal apertures, but the pollen type needs further examination as new material becomes available. Its stratigraphic significance is doubtful in view of its rarity.

Turma TRICOLPATES Iversen & Troels-Smith, 1950

Infraturma—Psilate forms

Genus CUPULIFEROIDAEPOLLENITES Potonié, Thomson, & Thiergart, 1950

Type species (by original designation): *Cupuliferoidaepollenites liblarensis* Potonié, Thomson & Thiergart, 1950, from the Miocene of Germany.

Synonym: Psilatricolpites van der Hammen, 1956 ex Pierce, 1961.

CUPULIFEROIDAEPOLLENITES cf. C. PARVULUS (Groot & Penny) Dettmann, 1973

(Pl. 33, figs. 1-4)

1960 *Tricolpopollenites parvulus* Groot & Penny, p. 232, figs. 8, 9.
1970 *Psilatricolpites* (al. *Tricolpites*) *pannosus* (Dettmann & Playford, 1968) Burger, p. 6, pl. 1, figs. 2, 3, 6.
1973 *Cupuliferoidaepollenites parvulus* (Groot & Penny) Dettmann, p. 12, pl. 2, figs. 11-15.

Description: See Groot & Penny, 1960; Burger, 1970; Dettmann, 1973. Dimensions of the Bathurst Island specimens: polar (11 specimens) 13-23 μm; equatorial (14 specimens) 9-17 μm.

Occurrence: Infrequently in the Bathurst Island microfloras; also infrequently in the late Albian of Queensland, from where Burger (1970) reported the species as *Psilatricolpites pannosus.* Dettmann (1973) reported the species from the mid-Cretaceous of Bathurst, Melville, and Mornington Islands. Groot & Penny (1960) described *parvulus* from the mid-Cretaceous of Maryland and Delaware, USA. Azema, Durand & Médus (1972) reported it from the Cenomanian of France. More or less similar specimens (*Tricolpites psilascabratus* Norton, *in* Norton & Hall, 1969) have been reported from the earliest Tertiary of Montana, USA. Jardiné & Magloire (1965) described similar types from the Late Crecaceous of Senegal and Ivory Coast.

Infraturma—Apiculate forms

Genus FRAXINOIPOLLENITES Potonié, 1951

Type species (by original designation): *Fraxinoipollenites* (al. *Pollenites confinis pudicus*) *pudicus* (Potonié, 1934) Potonié, 1951, from the Eocene of Germany.

Remarks: This genus incorporates tricolpate, prolate pollen grains with a granulate to reticulate exine. The genus *Scabratricolpites* (van der Hammen, 1956; Guzmán, 1967) ex Potonié, 1970, is possibly a younger synonym of *Fraxinoipollenites.* The genus *Perforotricolpites* Guzmán, 1967, includes species with tectate-perforate, psilate to scabrate exine. The Bathurst Island specimens described below are approximately spherical to prolate, intectate, with a granulate-scabrate to irregularly roughened exine surface. They should therefore be assigned to *Fraxinoipollenites.*

The following species are here transferred to *Fraxinoipollenites*:

F. (al. *Tricolpites*) *abatus* (Oltz, 1969, p. 147, pl. 41, fig. 132) nov. comb.
F. (al. *Tricolpopollenites*) *crassimurus* (Groot & Penny, 1960, p. 232, pl. 2, figs. 4, 5) nov. comb.
F. (al. *Tricolpopollenites*) *irregularis* (Oltz, 1969, p. 151, pl. 42, fig. 141) nov. comb.
F. (al. *Tricolpopollenites*) *micropunctatus* (Groot, Penny & Groot, 1961, p. 133, pl. 26, fig. 9) nov. comb.
F. (al. *Tricolpites*) *parvigranulatus* (Oltz, 1969, p. 149, pl. 41, fig. 132) nov. comb.
F. (al. *Tricolpopollenites*) *pumilis* (Groot, Penny & Groot, 1961, p. 132, pl. 26, fig. 7) nov. comb.

FRAXINOIPOLLENITES VARIFORMIS sp. nov.

(Pl. 33, figs. 5-10)

Holotype: Bathurst Island No. 2, core 1, depth 15.3 m, MFP 4440-1; coord. 325/1017. Possibly early Turonian (Pl. 33, fig. 10; CPC 13118).

Derivation of name: Based on the variable shape and sculpture of the species.

Description: Small to medium-sized, spherical to prolate pollen grains; tricolpate, isopolar. Colpi distinct, relatively short, often gaping owing to compression of the specimens. Pores not observed. Exine 1-1.5 μm thick, two-layered, intectate. Nexine approximately as thick as sexine, probably psilate. Sexine granulate, occasionally microverrucate, or with low, small, irregular elevations, giving the exine surface a roughened, corroded appearance.

Dimensions: Polar (3 specimens) 20-28 μm; equatorial (8 specimens) 19-24 μm.

Occurrence: Sporadic to common in some of the Bathurst Island microfloras from units K3a and K3b; not known from the Early Cretaceous of Queensland.

Remarks: The species resembles *Nyssapollenites squamosus* Dettmann, 1973, from the mid-Cretaceous of Bathurst Island, but is slightly larger and lacks distinct pores. *Nyssapollenites lanosus* Dettmann, 1973, is smaller. *F. variformis* sp. nov. differs from *F. parvigranulatus* (Oltz) nov. comb., by the thicker exine and larger dimensions. It slightly resembles *Oacolpopollenites variabilis* Elsik, *in* Stover, Elsik, & Fairchild, 1966, but has a less complex exine structure. It also differs from *Tricolpites lillei* Couper, 1953, by the absence of papillae and its smaller equatorial dimensions.

Infraturma—Murornate forms

Genus PHIMOPOLLENITES Dettmann, 1973

Type species (by original designation): *Phimopollenites* (al. *Tricolpites*) *pannosus* (Dettmann & Playford, 1968) Dettmann, 1973, from the mid-Cretaceous of South Australia.

PHIMOPOLLENITES AUGATHELLAENSIS (Burger) Dettmann, 1973

(Pl. 33, figs. 17, 18)

1970 *Tricolpites augathellaensis* Burger, p. 7, pl. 2, fig. 2.
1973 *Phimopollenites augathellaensis* (Burger) Dettmann, p. 17, pl. 3, figs. 12-17.

Description: See Burger, 1970, and Dettmann, 1973. Polar dimensions (7 specimens) 25-34 μm, equatorial dimensions (10 specimens) 18-26 μm.

Occurrence: Uncommon in most of the Bathurst Island microfloras. Also moderately common in the late Albian of the Great Artesian Basin, Queensland (Burger, 1970). Dettmann (1973) reported the species from the mid-Cretaceous of Bathurst and Mornington Islands, and from South Australia.

Remarks: The species is smaller than *Tricolpites gigantoreticulatus* Jardiné & Magloire, 1965, from the Late Cretaceous of Senegal, Africa. It is similar to *T. wilsonii* Kimyai, 1966, but has a thicker exine. In Kimyai's species (Kimyai, pl. 2, fig. 18) the colpi are bordered by an almost smooth margin, which is not the case in *Phimopollenites augathellaensis.*

cf. PHIMOPOLLENITES sp.

(Pl. 33, figs. 11, 12)

Description: Small to medium-sized, tricolpate pollen grains. Colpi distinct, long, straight, often gaping. Operculoid membranes frequently torn, with ragged margins. Exine semitectate, 1.5-2 μm thick. Nexine as thick as, or thicker than, sexine. Sexine consists of very thin, extremely closely spaced pila, which are near the limit of visibility under oil immersion. In top view a minute network is seen (OL-pattern), of which the lumina are 0.1 μm or less in diameter.

Dimensions: Polar (3 specimens) 25 μm; equatorial (3 specimens) 18-26 μm.

Occurrence: Rare in unit K3a of Bathurst Island Nos. 1 and 2.

Remarks: This form is distinguished by its extremely minute exine structure. Its affinity to *Phimopollenites* is therefore not certain.

Genus TRICOLPITES Cookson ex Couper, 1953 emend. Belsky, Boltenhagen, & Potonié, 1965

Type species (designated by Couper, 1953): *Tricolpites reticulatus* Cookson, 1947, from the Tertiary of Kerguelen Archipelago.

TRICOLPITES VARIABILIS Burger, 1970

(Pl. 33, figs. 13-15)

1970 *Tricolpites variabilis* Burger, p. 8, pl. 1, fig. 1.

Description: see Burger, 1970. Dimensions of the Bathurst Island specimens: polar (7 specimens) 14-23 μm, equatorial (10 specimens) 11-19 μm.

Occurrence: Uncommon in the Bathurst Island microfloras. Also observed in the late Albian to ?Cenomanian of the Great Artesian Basin in Queensland.

Remarks: Dettmann (1973) thought that this species might be synonymous with *Phimopollenites pannosus* (Dettmann & Playford, 1968) Dettmann, 1973, which differs from species of *Tricolpites* in that it has nexine colpoids, partly or completely covered by operculoid sexinous membranes, with freestanding, interlocked columellae. Re-examination of the holotype and other specimens of *T. variabilis* show, however, that the colpi occur in nexine and sexine, and are simple, straight-edged, without a sign of the presence of an operculoid membrane. The species is therefore probably unrelated to *Phimopollenites*. I believe that it is closer to *Tricolpites* sp., which Dettmann (op. cit.) described from the late Albian-Cenomanian of the Great Artesian and Otway Basins, as well as from Bathurst Island. The two species are similar in dimensions and exine features; notably, the tops of the columellate heads are slightly higher than the connecting bridge-like muri; this is not the case in *P. pannosus* (compare Dettmann, 1973, pl. 3, fig. 10, and pl. 4, fig. 12). Future scanning electron microscope examination of the Queensland and Bathurst Island material kept in the Bureau of Mineral Resources will probably give more conclusive evidence of possible synonymy of the two species.

Genus SENECTOTETRADITES Dettmann, 1973

Type species (by original designation): *Senectotetradites varireticulatus* Dettmann, 1973, from the Cenomanian of Mornington Island.

SENECTOTETRADITES FISTULOSUS Dettmann

(Pl. 32, figs. 3-5, 7)

1972 *Senectotetradites fistulosus* Dettmann, p. 22, pl. 6, fig. 8.

Description: See Dettmann, 1973. Overall dimensions of the Bathurst Island tetrads (6 specimens) 40-46 μm.

Occurrence: Rare in unit K3a of Bathurst Island Nos. 1 and 2. Not observed in the Albian of the Great Artesian Basin in Queensland. Dettmann (1973) reported the species from the mid-Cretaceous of Bathurst, Melville, and Mornington Islands.

Remarks: The colpi are extremely short and were difficult to observe in the tetrads; Dettmann's illustrations show the colpi much clearer. After examination of some specimens in strew mounts from Bathurst Island No. 2 Dettmann (pers. comm.) agreed that they are very probably conspecific with *fistulosus*.

SENECTOTETRADITES VARIRETICULATUS Dettmann, 1973

(Pl. 33, fig. 19; Pl. 34, figs. 1-3)

1973 *Senectotetradites varireticulatus* Dettmann, pp. 21-22, pl. 6, fig. 13.

Description: See Dettmann, 1973. Dimensions of single grains (in tetrad): polar (4 specimens) 27-38 μm, equatorial (6 specimens) 25-36 μm.

Occurrence: Rare species in some of the microfloras from Bathurst Island Nos. 1 and 2; apparently restricted to spore unit K3a. Not known from the Albian of the Great Artesian Basin in Queensland. Dettmann (1973) reported the species from the mid-Cretaceous of Melville and Bathurst Islands, the Otway Basin in South Australia, and Mornington Island, Queensland.

Remarks: The species resembles a form which Brenner (1963) described from the Albian of Maryland, USA, as *Retitricolpites geranioides* (Couper) nov. comb. Those specimens have a prolate to oblate shape, comparatively thick exine, and typically reduced surface reticulum in the polar regions. It also resembles *Artiopollis indivisus* Agasie, 1969, from the Cenomanian of Arizona, USA, but has a coarser surface reticulum. *Tricolpites densifoveatus* McIntyre, 1968, from the Miocene of New Zealand, is also closely similar, but is slightly smaller, with a finer reticulum. However, in none of these species were the grains reported as being united in tetrads.

Genus STRIATOPOLLIS Krutzsch, 1959b

Type species (by original designation): *Striatopollis sarstedtensis* Krutzsch, 1959 (see Krutzsch, 1959b), from the ?Palaeocene of Germany.

Remarks: This genus differs from *Ailanthipites* Wodehouse, 1933, in that it incorporates tricolpate pollen, without pores. The genus *Dactylopollis* Muller, 1968, differs by the additional presence of closed lumina in the intercolpate regions. *Hexaporotricolpites* Boltenhagen, 1967, incorporates tricolpate pollen with one pore at the extremities of each colpus (Boltenhagen, 1967, 1969). *Cranwellia* Srivastava, 1966 emend. Srivastava, 1969, incorporates pollen with intectate exine and striae consisting of granules in linear arrangement. The genus *Striatricolpites* (van der Hammen) Guzmán, 1967, has until now not been typified properly for application in fossil pollen systematics, as the (nomenclatorial) type assigned by van der Hammen (1956) was a Recent pollen grain of *Acer platanoides* L. (for a wider discussion on the subject see Srivastava, 1969, and Dettmann, 1973).

Other species here transferred to *Striatopollis* are:

S. (al. *Tricolpites*) *bacustriatus* (Norton, *in* Norton & Hall, 1969, p. 44, pl. 6, fig. 13) nov. comb.

S. (al. *Striopollenites*) *dubius* (Jardiné & Magloire, 1965, p. 214, pl. 10, fig. 50) nov. comb.

S. (al. *Tricolpites*) *microstriatus* (Jardiné & Magloire, 1965, p. 214, pl. 10, fig. 53) nov. comb.

S. (al. *Tricolpites*) *synstriatus* (Jardiné & Magloire, 1965, p. 215, pl. 10, fig. 56) nov. comb.

The group of striate, tricolpate forms which occurs in the Bathurst Island preparations probably includes more than one form-species. However, as various types are morphologically quite similar, and *S. paraneus* constitutes the large majority of the group, no attempt is made to describe and identify the other forms.

STRIATOPOLLIS PARANEUS (Norris) Singh, 1971

(Pl. 34, figs. 4-9; Text-fig. 24)

1967 *Retitricolpites paraneus* Norris, p. 109, pl. 18, figs. 15-20.
1971 *Striatopollis paraneus* (Norris) Singh, p. 206, text-fig. 42, pl. 32, figs. 1-3.

Description: Small, isopolar, tricolpate pollen grains. Shape prolate to subspherical. Colpi long, straight, usually indistinct. Exine 1-1.5 μm thick, nexine thin, 0.5 μm or less, occasionally detached from sexine. Sexine apparently consists of a perforated stratum supporting sets of parallel-oriented ribs. Perforations or lumina are linearly arranged, closely spaced, and absent alongside colpi; they are circular, diameter about 0.5 μm. Striae and intervening grooves 0.5 μm wide; striae alternate with rows of lumina and are often curved in a thumbprint pattern.

Dimensions: Polar (16 specimens) 14-(19)-24 μm, equatorial (17 specimens) 11-(13)-16 μm.

Occurrence: Rare to moderately common species in units K3a and K3b of Bathurst Island Nos. 1 and 2; unknown in the Albian of the Great Artesian Basin in Queensland. Dettmann (1973) described and reported similar pollen grains as *Striatopollis* cf. *S. paraneus* (Norris) from Bathurst and Mornington Islands. Norris (1967), Hedlünd & Norris (1968), and Singh (1971) reported the species from the Albian of Canada and the USA.

Remarks: The exine structure, as apparent from LO-analysis, is schematically illustrated in Text-figure 28. Dettmann's (1973) beautiful scanning electron microscope illustrations reveals minute cross-ribbing on the surfaces of the striae, which are not well visible under the light microscope. The species differs from *Aesculiidites circumstriatus* (Fairchild) Elsik, 1968, from the Palaeocene of Texas, USA, which is transversely circumstriate. *Tricolpites tectostriatus* Oltz, 1969 (Maastrichtian, Montana, USA) is less smoothly striate. *Striatopollis sarstedtensis* Krutzsch, 1959 (see Krutzsch, 1959b), from the Tertiary and, according to Groot & Groot (1962), also the Late Cretaceous of Europe, is more or less similar to *S. paraneus*. Jardiné & Magloire (1965) reported a more or less similar species (*Striopollenites dubius*) from the Albian and Cenomanian of Senegal and Ivory Coast.

Turma TRICOLPORATES Iversen & Troels-Smith, 1950

Infraturma—Psilate forms

Genus TRICOLPORITES Cookson, 1947 emend. Srivastava, 1972

Type species (by monotypy): *Tricolporites prolata* Cookson, 1947, from the Tertiary of Kerguelen Archipelago.

Remarks: This genus differs from *Nyssoidites* Potonié, Thomson, & Thiergart, 1950, and *Nyssapollenites* Thiergart, 1937, by its different shape and absence of costae colpi. It also differs from *Cupuliferoipollenites* Potonié, 1951, by the absence of colpi equatoriales. *Rhoipites* Wodehouse, 1933, incorporates forms with pitted, microreticulate exine sculpture. The genus *Tricolporopollenites* Thomson & Pflug, 1953 contains forms with various apiculate and murornate exine ornament. *Tricolpopollenites* Thomson & Pflug, 1953 may be synonymous with *Tricolporites*, if Krutzsch (1959b) claims correctly that the type species *Tricolpopollenites parmularius* is tricolporate.

TRICOLPORITES DISTINCTUS (Groot & Penny) nov. comb.

(Pl. 34, figs. 10-14)

1960 *Tricolporopollenites distinctus* Groot & Penny, p. 234, pl. 2, fig. 10.

Description: Small, prolate to subspherical, isopolar, tricolporate grains. Colpi distinct, straight; nexinal pores indistinct, small meridionally elongated. Exine between 0.5 μm and 1 μm thick, two-layered, intectate; both layers smooth.

Dimensions: Polar (9 specimens) 12-17 μm, equatorial (9 specimens) 18-14 μm.

Occurrence: Uncommon in the Bathurst Island assemblages; not known in the Albian of the Great Artesian Basin in Queensland. Groot & Penny (1960) described the species from the mid-Cretaceous of Delaware, USA.

Remarks: The species is slightly larger than *Tricolporites traversi* Anderson, 1960, from the latest Cretaceous of New Mexico, USA. It is smaller than *Tricolpopollenites parmularius* (Potonié, 1934) Thomson & Pflug, 1953 emend. Krutzsch, 1959 (see Krutzsch, 1959b), from the Eocene of Germany. It resembles *Tricolporopollenites* sp. Jardiné & Magloire, 1965 (p. 216, pl. 11, figs. 11-15) from the Late Cretaceous of Senegal.

Infraturma: Murornate forms

Genus CAPRIFOLIIPITES Wodehouse, 1933

Type species (by monotypy): *Caprifoliipites viridifluminis* Wodehouse, 1933, from the Eocene of Colorado, USA.

Remarks: The genus differs from *Vitipites* Wodehouse, 1933 emend. Potonié, 1960, and *Araliaceoipollenites* Potonié, 1951, by the absence of polar exine thickenings. It also differs from the genus *Horniella* Traverse, 1955, by the absence of equatorial colpi. *Rhoipites* Wodehouse, 1933, is similar except for a much more minute exine structure.

CAPRIFOLIIPITES sp.

(Pl. 34, figs. 15-17)

Description: Small to medium-sized, isopolar, tricolporate, subprolate to spherical pollen grains. Colpi distinct, relatively short. Some specimens show an indication of the presence of a (nexinal?) pore. Exine 1.5-2 μm thick, two-layered, intectate. Nexine and sexine equal in thickness, sexine consists of a minute reticulum with irregular mesh, maximum diameter 0.5-2 μm, in some specimens reduced or absent in polar regions; muri about 0.5 μm thick, massive, 0.5-1 μm high.

Dimensions: Polar (3 specimens) 18-29 μm, equatorial (6 specimens) 16-24 μm.

Occurrence: Rare in some of the Bathurst Island microfloras; not tied to a specific interval. Not known from the Early Cretaceous of the Great Artesian Basin, Queensland.

Remarks: The species is similar to *Tricolpites anguloluminosus* Anderson, 1960, from near the Cretaceous-Tertiary boundary of New Mexico, USA, but has additional pores. More or less similar specimens were reported (*Tricolpites* sp. 1) from the late Albian of Britain (Kemp, 1968). Elsik (1968) described identical specimens from the Cretaceous-Palaeocene of Texas as *Tricolporopollenites kruschi* (Potonié) Thomson & Pflug, 1953.

BATHURST ISLAND 1									
ZONATION		M1 K3b	? K3a	M2 K3a	M2 K3a	M2 K3a	M2 K3a	? M3 K3a	F4 K3a
CORE SAMPLE FEET		100'0-6"	200'0-6"	300'0-6"	400'0-6"	500'0-6"	600'0-6"	750'0-6"	800'0-6"
CORE SAMPLE METRES		30.4	60.9	91.4	121.9	152.4	182.8	228.6	243.8
MFP		4450	4449	4455	4448	4456	4447	4446	4445
TRILETES, Acavatitriletes, Azonati	BIRETISPORITES SPECTABILIS		●	●	very poor recovery	very poor recovery	●	very poor recovery	●
	CYATHIDITES AUSTRALIS	●	●	●			●		●
	CYATHIDITES MINOR	●	●	●			●		●
	CERATOSPORITES EQUALIS			●			●		●
	HERKOSPORITES PROXISTRIATUS	●	●	●			●		●
	STOVERISPORITES MICROVERRUCATUS	●	○	●			●		●
	NEORAISTRICKIA TRUNCATA			●			●		
	BALMEISPORITES GLENELGENSIS	●							
	BALMEISPORITES TRIDICTYUS	●							
	CICATRICOSISPORITES AUSTRALIENSIS	●	●	●			●		○
	CICATRICOSISPORITES CUNEIFORMIS			○			○		○
	CICATRICOSISPORITES HUGHESII	●	●	●			●		○
	CICATRICOSISPORITES PSEUDOTRIPARTITUS			●					
	CICATRICOSISPORITES VENUSTUS		●	●					
	LYCOPODIUMSPORITES AUSTROCLAVATIDITES	●	●	●			●		●
	LYCOPODIUMSPORITES cf. L. ROSEWOODENSIS		●						○
TRILETES, Acavatitriletes, Auriculati	APPENDICISPORITES DISTOCARINATUS	●	●	●			●		●
	APPENDICISPORITES SPP.	●	●						
	TRILOBOSPORITES TRIORETICULOSUS		●				●		
TRILETES, Acavatitriletes, Tricrassati	CLAVIFERA TRIPLEX		●	●			●		●
	GLEICHENIIDITES CIRCINIDITES	●	●	●			●		●
	ORNAMENTIFERA MINIMA						●		●
	CAMAROZONOSPORITES AUSTRALIENSIS	●	●	●			●		●
	FOVEOGLEICHENIIDITES CONFOSSUS	●		●					
TRILETES, Acavatitriletes, Cingulati	STEREISPORITES ANTIQUASPORITES	●	●	●			●		●
	ANTULSPORITES VARIZONATUS						●		●
	FORAMINISPORIS ASYMMETRICUS			●					
	FORAMINISPORIS WONTHAGGIENSIS	●					○		
	PEROTRILITES JUBATUS			●					●
	PEROTRILITES MAJUS			●					●
	PEROTRILITES OEPIKII		●	●					
	PEROTRILITES LINEARIS			○					●
	VALLIZONOSPORITES SP.						○		
TRILETES, Perinotrilites	CRYBELOSPORITES cf. C. BRENNERI	●	●	●			●		●
MONOLETES, Acavatomonoletes	LAEVIGATOSPORITES OVATUS	●	●				●		●
	MICROFOVEOLATOSPORIS CANALICULATUS	●	●	●			●		●
HILATES	TRIPOROLETES LAEVIGATUS	●	●	○					●
	TRIPOROLETES RETICULATUS	○	●	○					
ALETES	INAPERTUROPOLLENITES LIMBATUS	●					●		●
	HOEGISPORIS UNIFORMA	●		●			●		●
SACCATES	ALISPORITES SPP.	●	●	●					●
	PODOCARPIDITES SPP.	●		●			●		
	VITREISPORITES PALLIDUS	●		●			●		●
	MICROCACHRYIDITES ANTARCTICUS	●	●	●			●		●
	TRISACCITES MICROSACCATUS	●	●	●			●		
MONOPORAT.	CLASSOPOLLIS SIMPLEX	●	●	●			●		●
	CLASSOPOLLIS SP.			●					
POLYPLIC. TRICHOT.	EPHEDRIPITES SPP.		●	○					
	ASTEROPOLLIS ASTEROIDES	●	●	●			●		●
MONOCOLPATES	CLAVATIPOLLENITES HUGHESII	●	○				●		●
	LILIACIDITES PERORETICULATUS	●	●	●			●		
	CLAVATIPOLLENITES SP. A		●	○			●		●
	LILIACIDITES cf. L. KAITANGATAENSIS	●	●	●			●		●
	LILIACIDITES SPP.	●							
DICOLP.	DICOLPOPOLLIS SP. A		●						●
TRICOLPATES	CUPULIFEROIDAEPOLLENITES cf. C. PARVULUS	●	○	●			●		
	FRAXINOIPOLLENITES VARIFORMIS	●	●						●
	PHIMOPOLLENITES AUGATHELLAENSIS	●		●					●
	TRICOLPITES VARIABILIS	●	●	●					
	PHIMOPOLLENITES SP.		●	●					●
	SENECTOTETRADITES VARIRETICULATUS								●
	SENECTOTETRADITES FISTULOSUS			●					○
	STRIATOPOLLIS PARANEUS	●	●	●			●		
TRICOLPOR	TRICOLPORITES DISTINCTUS	●	●	●					
	CAPRIFOLIIPITES SP.	●					●		

● species positively identified
○ species tentatively identified
MFP BMR Sample Catalogue number

M(P)560

Figure 29. Occurrence of spores and pollen grains, Bathurst Island No. 1.

Figure 30. Occurrence of spores and pollen grains, Bathurst Island No. 2.

BATHURST ISLAND 2

		4429	4430	4431	4432	4433	4434	4435	4436	4437	4438	4439	4440
ZONATION		F5	F4	M3				M2					M1 ?
						K3a							K3b
CORE SAMPLE FEET		1023'0-6"	900'0-6"	816'0-6"	700'0-6"	599'6-11"	499'6-11"	418'0-6"	349'0-6"	298'6-11"	200'0-6"	150'0-6"	50'0-6"
CORE SAMPLE METRES		305.7	274.3	248.7	216.1	182.5	152.1	127.4	106.3	91.1	60.9	45.7	15.2
MFP		4429	4430	4431	4432	4433	4434	4435	4436	4437	4438	4439	4440
TRILETES – Acavatitriletes – Azonati	BIRETISPORITES SPECTABILIS		●		●			●		○	●	●	○
	CYATHIDITES AUSTRALIS	●	●	●		●		●	●		●	●	●
	CYATHIDITES MINOR	●	●	●	●	●	●	●	●		●	●	●
	CERATOSPORITES EQUALIS	●	●	●	●	●		●	●	●	●		
	HERKOSPORITES PROXISTRIATUS	●		●	●	●	●	●	●	●	●	●	●
	STOVERISPORITES MICROVERRUCATUS	●	●	●	●	●	○	●	●	●	●	●	
	NEORAISTRICKIA TRUNCATA							●	○			○	●
	BALMEISPORITES GLENELGENSIS										○		
	CICATRICOSISPORITES AUSTRALIENSIS	●	●	○	●	○		●	●	●	●		
	CICATRICOSISPORITES CUNEIFORMIS		●	●			○	○				○	
	CICATRICOSISPORITES HUGHESII	○		○				●	●		○		
	CICATRICOSISPORITES PSEUDOTRIPARTITUS		○	○						●	●	●	
	CICATRICOSISPORITES VENUSTUS				○						●	●	●
	LYCOPODIUMSPORITES AUSTROCLAVATIDITES	●	○	●	●	●	●	●	●	●	●	●	
	LYCOPODIUMSPORITES cf. L. ROSEWOODENSIS	●		●							●		●
TRILETES – Acavatitriletes – Auriculati		●	●	●	●	●		●	●	●	●	●	
		●	●	●	●	●	●	●	●	●	●	●	●
			●	●	●		●		●	●	●	●	
TRILETES – Acavatitriletes – Tricrassati	CLAVIFERA TRIPLEX	●	●	●	●	●	●	●	●	●	●		○
	GLEICHENIIDITES cf. G. TRIJUGATUS		●	●	●	●	●	○	●	●	○		●
	GLEICHENIIDITES CIRCINIDITES	●	●	●	●	●	●	●	●	●	●	●	●
	ORNAMENTIFERA MINIMA	●	●	●	●	○	●	●	●				
	CAMAROZONOSPORITES AUSTRALIENSIS	●	●	●	●	●	●	●	●	●	●	●	●
	FOVEOGLEICHENIIDITES CONFOSSUS								●	●			
TRILETES – Acavatitriletes – Cingulati	STEREISPORITES ANTIQUASPORITES	●	●	●	●	●		●	●	●	●	●	
	STEREISPORITES SP.			○	○	●							●
	ANTULSPORITES VARIZONATUS			●	●	○	●	●	●	●	●		
	FORAMINISPORIS ASYMMETRICUS	●	●		○	●	●	●	●		●	●	
	FORAMINISPORIS WONTHAGGIENSIS	●	●	●		●	○				●	○	●
	PEROTRILITES JUBATUS		●	●		○	○	○	●	●	●	●	
	PEROTRILITES MAJUS	●	●	●	●	●		●	●	○		●	
	PEROTRILITES OEPIKII	●		●	●	●	●		●		●		●
	PEROTRILITES LINEARIS		●	○	●	●	○		●	●	○		●
	VALLIZONOSPORITES SP.			○	●	●		○	●				
TRILETES – Perinotrilites	CRYBELOSPORITES STRIATUS	●											
	CRYBELOSPORITES cf. C. BRENNERI		●	●	●	●	●	●	●	●	●	●	
MONOLETES – Acavatomonoletes	LAEVIGATOSPORITES OVATUS	●	●	●	●	●	●	●	●	●	●	●	●
	MICROFOVEOLATOSPORIS CANALICULATUS	●	●	●	●	●	●	●	●		●	●	●
HILATES	TRIPOROLETES LAEVIGATUS	●	●			●		●	●		●	●	
	TRIPOROLETES RETICULATUS	○		○							●	●	
ALETES	INAPERTUROPOLLENITES LIMBATUS	●	●	●	●	●	●	●	●		●	●	○
	HOEGISPORIS UNIFORMA	●	●	●	●	●	●	●	●		●	●	●
SACCATES	ALISPORITES SPP.	●	●		●			●			●	●	
	PODOCARPIDITES SPP.	●					●	●	●	●		●	●
	VITREISPORITES PALLIDUS	●	●	●		●		●	●	●	●	●	
	MICROCACHRYIDITES ANTARCTICUS	●	●	●	●	●	●	●	●	●	●	●	●
	TRISACCITES MICROSACCATUS	●	●		●	●	●	●			●	●	
MONOPORAT.	CLASSOPOLLIS SIMPLEX	●	●	●	●	●	●	●	●	●	●	●	●
	CLASSOPOLLIS SP.		●	○		●	●	●					
POLYPLIC. TRICHOT.	EPHEDRIPITES SPP.									●	●	●	○
	ASTEROPOLLIS ASTEROIDES	●	●	●	○	●	●	●	●	●	●	●	●
MONOCOLPATES	CLAVATIPOLLENITES HUGHESII				○	●		○	●		○		
	LILIACIDITES PERORETICULATUS	●	●		●			●	●	●	●		●
	LILIACIDITES cf. L. KAITANGATAENSIS		●	●	○		○	●	●	●	●	●	●
	LILIACIDITES SPP.	●			●				○		○	●	
DICOLP.	DICOLPOPOLLIS SP. A											●	
TRICOLPATES	CUPULIFEROIDAEPOLLENITES cf. C. PARVULUS		●	●	●			●		○	●	●	
	FRAXINOIPOLLENITES VARIFORMIS									●			●
	PHIMOPOLLENITES AUGATHELLAENSIS			●	●		●	●	●	●	●		
	TRICOLPITES VARIABILIS	○	○						●		●		
	PHIMOPOLLENITES? SP.		○					●	●				
	SENECTOTETRADITES VARIRETICULATUS			○	●						●		
	SENECTOTETRADITES FISTULOSUS				●			○			●	●	
	STRIATOPOLLIS PARANEUS		●		●	○	○	●	●		●	●	
TRICOLPOR.	TRICOLPORITES DISTINCTUS	○						○		●	●		●
	CAPRIFOLIIPITES SP.	●		○								●	

● species positively identified
○ species tentatively identified
MFP BMR Sample Catalogue number

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REFERENCES

AGASIE, J. M., 1969—Late Cretaceous palynomorphs from northeastern Arizona. *Micropaleontology*, 15(1), 13-30.

ALBERTI, G., 1961—Zur Kenntnis Mesozoischer und Alttertiärer Dinoflagellaten und Hystrichosphaerideen von Nord- und Mitteldeutschland sowie einigen anderen Europäischen Gebieten. *Palaeontographica A*, 116(1-4), 1-58.

AMEROM, H. W. J. van, 1965—Upper Cretaceous pollen and spore assemblages from the so-called "Wealden" of the province of Leon (northern Spain). *Pollen et Spores*, 7(1), 93-133.

ANDERSON, R. Y., 1960—Cretaceous-Tertiary palynology, eastern side of the San Juan Basin, New Mexico. *State Bur. Mines Min. Resour. New Mex. Inst. Mining Techn. Camp. Stat., Socorro, Mem.* 6, 58 pp.

APC (Australasian Petroleum Company), 1961—Geological results of petroleum exploration in western Papua, 1937-1961. *J. geol. Soc. Aust.*, 8(1).

ARCHANGELSKY, S. & GAMERRO, J. C., 1966a—Estudio palinológico de la Formación Baqueró (Cretácico), Provincia de Santa Cruz. II. *Ameghiniana*, 4(6), 201-9.

ARCHANGELSKY, S. & GAMERRO, J. C., 1966b—Estudio palinológico de la Formación Baqueró (Cretácico), Provincia de Santa Cruz, IV. *Ibid.*, 4(10), 363-70.

*ARCO LIMITED, 1969—Well completion report Lacrosse No. 1 (unpubl.).

*ARCO LIMITED & A.A.P. PTY LTD, 1969—Well completion report Petrel No. 1 (unpubl.).

AZEMA, C., DURAND, S. & MÉDUS, J., 1972—Des miospores du Cénomanien Moyen. *Paléobiol., Continent., Montpell.*, 3(4), 1-54.

BALME, B. E., 1957—Spores and pollen grains from the Mesozoic of Western Australia. *CSIRO Coal Res. Sect., tech. Comm.* 25.

BALME, B. E., 1964—The palynological record of Australian pre-Tertiary floras; *in ANCIENT PACIFIC FLORAS—THE POLLEN STORY*, 49-80. *Univ. Hawaii Press.*

BALME, B. E., & SEGROVES, K. L., 1966—*Peltacystia* gen. nov.: a microfossil of uncertain affinities from the Permian of Western Australia. *J. Roy. Soc. W. Aust.*, 49(1), 26-31.

BALTES, N., 1963—Dinoflagellate şi Hystrichosphaeride cretacice din Platforma moezica. *Petrol si Gaze, Bucharest*, 14(12), 581-97.

BALTES, N., 1965—Observatii asupra microflorei cretacice inferioare din zona R. Bicaz. *Ibid.* 16(1), 3-17.

BALTES, N., 1967a—Albian microplankton from the Moesic Platform, Rumania. *Micropaleontology*, 13(3), 327-36.

BALTES, N., 1967b—The microflora of the Albian "Green Sands" in the Moesic Platform (Rumania). *Rev. Palaeobot. Palyn.*, 5(14), 183-97.

BALTES, N., 1969—Distribution stratigraphique des Dinoflagellés et des Acritarches tertiares en Roumanie. *Proc. I int. Conf. planktonic Microfossils*, 1, 26-45.

BALTES, N., 1971—Pliocene Dinoflagellata and Acritarcha in Romania. *Proc. II int. Conf. planktonic Microfossils*, 1, 1-16.

BARNARD, P. D. W., 1968—A new species of *Masculostrobus* Seward producing *Classopollis* pollen from the Jurassic of Iran. *Proc. Linn. Soc.*, 61(384), 167-78.

BHARDWAI, D. C., 1954—Einige neue Sporengattungen des Saarkarbons. *Mh. N. Jb Geol. Paläont.*, 11, 512-25.

BHARDWAI, D. C., 1955—The spore genera from the Upper Carboniferous coals of the Saar and their value in stratigraphical studies. *Palaeobotanist*, 4, 119-50.

BHARDWAI, D. C., 1962—The microspore genera in the coals of Raniganj State (Upper Permian), India. *Ibid.*, 10(1-2), 68-106.

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

BOLCHOVITINA, N. A., 1953—Spores and pollen characteristic of Cretaceous deposits of central regions of U.S.S.R. *Trud. Inst. geol. Nauk Mosk.* 145 (geol. Ser. 61), 1-184 (in Russian).

BOLCHOVITINA, N. A., 1961—Fossil and Recent spores of the Schizaeaceae. *Ibid.*, 40 (in Russian).

BOLCHOVITINA, N. A., 1966—The fossil spores of the ferns of the family Gleicheniaceae, *in THE IMPORTANCE OF PALYNOLOGICAL ANALYSIS FOR STRATIGRAPHIC AND PALAEOFLORISTIC INVESTIGATIONS. NAUKA, MOSCOW* (in Russian).

BOLCHOVITINA, N. A., 1968—The spores of the family Gleicheniaceae ferns and their importance for stratigraphy. *Trud. Inst. geol. Akad. Nauk SSSR*, 186, 1-116 (in Russian).

BOLTENHAGEN, E., 1967—Spores et pollen du Crétacé supérieur du Gabon. *Pollen et Spores*, 9(2), 335-56.

BOLTENHAGEN, E., 1969—*Hexaporotricolpites potoniei*, espèce nouvelle d'un pollen hexaporotricolpe du Crétacé Supérieur du Gabon. *Grana Palyn.*, 9(1-3), 169-73.

BRATZEVA, G. M., 1969—Palynological studies of Upper Cretaceous and Paleogene of the Far East. *Trud. Akad. Sci. SSSR* 207 (in Russian).

BRELIE, G. von der, 1964—Eine unterkretazische Mikroflora aus dem nördlichen Sauerland. *Fortschr. Geol. Rheinld Westf.*, 12, 117-68.

BRENNER, G. J., 1963—The spores and pollen of the Potomac Group of Maryland. *Bull. Maryld Dep. Geol. Mines*, 27, 215 pp.

BRENNER, G. J., 1967—Early angiosperm pollen differentiation in the Albian to Cenomanian deposits of Delaware (U.S.A.). *Rev. Palaeobot. Palyn.*, 1, 219-27.

*Copies of reports deposited in the Bureau of Mineral Resources, Canberra.

BRENNER, G. J., 1968—Middle Cretaceous spores and pollen from northeastern Peru. *Pollen et Spores*, 10(2), 341-83.
BRICHE, P., DANZÉ-CORSIN, P., & LAVEINE, J. P., 1963—Flore infraliasique du Boulonnais (Macro- et microflore). *Mém. Soc. géol. Nord* 13, 7-143.
BRIDEAUX, W. W., 1971— Palynology of the Lower Colorado Group, Central Alberta, Canada. I. Introductory remarks, geology, and microplankton studies. *Palaeontographica B*, 135(3-6), 53-114.
BRONN, H. G., 1848—HANDBUCH EINER GESCHICHTE DER NATUR. Vol. 3. *Index palaeontologicus, Stuttgart.*
BROWN, H. Y. L., 1906—Explorations made by the Government Geologist and staff during 1905. *S. Aust. parl. Pap.* 55.
BRUNNSCHWEILER, R. O., 1954—Mesozoic stratigraphy and history of the Canning Desert and Fitzroy Valley, Western Australia. *J. geol. Soc. Aust.*, 1, 35-54.
BRUNNSCHWEILER, R. O., 1959—New Aconeceratinae (Ammonoidea) from the Albian and Aptian of Australia. *Bur. Miner. Resour. Aust. Bull.* 54.
BURGER, D., 1966—Palynology of uppermost Jurassic and lowermost Cretaceous strata in the eastern Netherlands. *Leidse geol. Meded.*, 35, 209-76.
BURGER, D., 1968a—Stratigraphy and palynology of Upper Mesozoic sections in some deep wells in the Surat Basin, Queensland. *Bur. Miner. Resour. Aust. Rec.* 1968/24 (unpubl.).
BURGER, D., 1968b—Palynology of marine Lower Cretaceous strata in the northern and eastern Eromanga Basin, Queensland. *Ibid.*, 1968/62 (unpubl.).
BURGER, D., 1968c—Relationship of palynology to stratigraphy in the Lower Cretaceous of the Surat Basin in Queensland. *Ibid.*, 1968/125 (unpubl.).
BURGER, D., 1970—Early Cretaceous angiospermous pollen grains from Queensland. *Bur. Miner. Resour. Aust. Bull.* 116, 1-15.
BURGER, D., 1973a—Palynological zonation and sedimentary history of the Neocomian in the Great Artesian Basin, Queensland. *Geol. Soc. Aust. spec. Publ.* 4, 87-118.
BURGER, D., 1973b—Palynological observations in the Carpentaria Basin, Queensland. *Bur. Miner. Resour. Aust. Bull.* 140, 27-44.

CAYE, J. P., 1968—The Timor Sea—Sahul Shelf area. *APEA J.*, 8(2), 35-41.
CHALLINOR, A., 1970—The geology of the off-shore Canning Basin, Western Australia. *APEA J.*, 10(2), 78-90.
CHURCHILL, D. M., 1960—Living and fossil unicellular Algae and Aplanospores. *Nature*, 186 (4723), 493-4.
CLAPARÈDE, E., & LACHMANN, J., 1859—Etudes sur les infusoires et les rhizopodes. *Inst. nat. genev. Mém.* 6 (1858), 261-482.
CLARKE, R. F. A., & VERDIER, J. P., 1967—An investigation of microplankton assemblages from the Chalk of the Isle of Wight, England. *Verh. K. ned. Akad. Wetensch., Afd. Natuurk., le Reeks* 24(3), 1-96.
CLARKE, R. F. A., DAVEY, R. J., SARJEANT, W. A. S., & VERDIER, J. P., 1968—A note on the nomenclature of some Upper Cretaceous and Eocene dinoflagellate taxa. *Taxon*, 17, 181-3.
COOKSON, Isabel, C., 1947—Plant microfossils from the lignites of Kerguelen Archipelago. *B.A.N.Z.A.R. Exp. 1929-1931*, Rep. A-2, 127-42.
COOKSON, Isabel C., 1953—Difference in microspore composition of some samples from a bore at Comaum, South Australia. *Aust. J. Bot.*, 1, 462-73.
COOKSON, Isabel C., 1956—Additional microplankton from Australian late Mesozoic and Tertiary sediments. *Aust. J. mar. freshw. Res.*, 7(1), 183-91.
COOKSON, Isabel C., 1961—*Hoegisporis*, a new Australian Cretaceous form genus. *Palaeontology*, 3(4), 485-6.
COOKSON, Isabel C., 1965a—On a new species of *Hoegisporis* Cookson. *Ibid.*, 8(1), 39-40.
COOKSON, Isabel C., 1965b—Cretaceous and Tertiary microplankton from southeastern Australia. *Proc. Roy. Soc. Vic.*, 78(1), 85-93.
COOKSON, Isabel C. & DETTMANN, Mary E., 1958a—Some trilete spores from Upper Mesozoic deposits in the eastern Australian region. *Proc. Roy. Soc. Vic.*, 70, 95-128.
COOKSON, Isabel C., & DETTMANN, Mary E., 1958b—Cretaceous "megaspores" and a closely associated microspore from the Australian region. *Micropaleontology*, 4(1), 39-49.
COOKSON, Isabel C., & DETTMANN, M. E., 1959—On *Schizosporis*, a new form genus from Australian Cretaceous deposits. *Ibid.*, 5(2), 213-6.
COOKSON, Isabel C., & EISENACK, A., 1958—Microplankton from Australian and New Guinea Upper Mesozoic sediments. *Proc. Roy. Soc. Vic.*, 70(1), 19-79.
COOKSON, Isabel C., & EISENACK, A., 1960a—Microplankton from Australian Cretaceous sediments. *Micropaleontology*, 6(1), 1-18.
COOKSON, Isabel C., & EISENACK, A., 1960b—Upper Mesozoic microplankton from Australia and New Guinea. *Palaeontology*, 2(2), 243-61.
COOKSON, Isabel C., & EISENACK, A., 1961—Upper Cretaceous microplankton from the Belfast No. 4 bore, south-western Australia. *Proc. Roy. Soc. Vic.*, 74(1), 69-76.
COOKSON, Isabel C., & EISENACK, A., 1962a—Additional microplankton from Australian Cretaceous sediments. *Micropaleontology*, 8(4), 485-507.
COOKSON, Isabel C., & EISENACK, A., 1962b—Some Cretaceous and Tertiary microfossils from Western Australia. *Proc. Roy. Soc. Vic.*, 75(2), 269-73.
COOKSON, Isabel C., & EISENACK, A., 1968—Microplankton from two samples from Gingin Brook no. 4 borehole, Western Australia. *J. Roy. Soc. W. Aust.*, 51(4), 110-22.
COOKSON, Isabel C., & EISENACK, A., 1969—Some microplankton from two bores at Balcatta, Western Australia. *Ibid.*, 52(1), 3-8.

COOKSON, Isabel C., & EISENACK, A., 1970a—Cretaceous microplankton from the Eucla Basin, Western Australia. *Proc. Roy. Soc. Vic.*, 83(2), 137-58.
COOKSON, Isabel C., & EISENACK, A., 1970b—Die Familie der Lecaniellaceae n. fam.—Fossile Chlorophyta, Volvocales? *Mh. N. Jb. Geol. Paläont.*, 6, 321-25.
COOKSON, Isabel C., & EISENACK, A., 1971—Cretaceous microplankton from Eyre No. 1 bore, core 20, Western Australia. *Proc. Roy. Soc. Vic.*, 84(2), 217-26.
COOKSON, Isabel C., & HUGHES, N. F., 1964—Microplankton from the Cambridge Greensand (Mid-Cretaceous). *Palaeontology*, 7(1), 37-59.
COOKSON, Isabel C., & PIKE, Kathleen M., 1954—The fossil occurrence of *Phyllocladus* and two other podocarpaceous types in Australia. *Aust. J. Bot.*, 2, 60-8.
CORRADINI, D., 1971—Preliminary reports on the study of non-calcareous microplankton assemblages from the Upper Cretaceous of the Northern Apennines. *Proc. II int. Conf. planktonic Microfossils*, 1, 321-9.
COUPER, R. A., 1953—Upper Mesozoic and Cainozic spores and pollen grains from New Zealand. *N.Z. geol. Surv. palaeont. Bull.* 22, 1-77.
COUPER, R. A., 1958—British Mesozoic microspores and pollen grains. *Palaeontographica B*, 103, 75-179.
COUPER, R. A., 1960—New Zealand Mesozoic and Cainozoic plant microfossils. *N.Z. geol. Surv. palaeont. Bull.* 32, 1-87.

*DAILY, B., 1955—Geological observations on Melville and Bathurst Islands, Northern Territory. *Univ. of Adelaide* (unpubl.).
DAUGHERTY, L. H., 1941—The Upper Triassic flora of Arizona. *Carnegie Instn. Wash. Publ.* 526.
DAVEY, R. J., 1968—*Gonyaulacysta parorthoceras*, a new species of dinoflagellate cyst. *Palaeont. Afr., Johannesburg*, 11, 1.
DAVEY, R. J., 1969a—Non-calcareous microplankton from the Cenomanian of England, Northern France and North America; Part I. *Bull. Br. Mus. nat. Hist. (Geol.)*, 17(3), 105-80.
DAVEY, R. J., 1969b—Some dinoflagellate cysts from the Upper Cretaceous of Northern Natal, South Africa. *Palaeont. Afr., Johannesburg*, 12, 1-23.
DAVEY, R. J., 1969c—The evolution of certain Upper Cretaceous hystrichospheres from South Africa. *Ibid.*, 12, 25-51.
DAVEY, R. J., 1970—Non-calcareous microplankton from the Cenomanian of England, northern France and North America: Part II. *Bull. Br. Mus. nat. Hist. (Geol.)*, 18(8), 335-97.
DAVEY, R. J., & VERDIER, J. P., 1971—An investigation of microplankton assemblages from the Albian of the Paris Basin. *Verh. K. ned. Akad. Wetensch., Afd. Natuurk., le Reeks* 26(2), 58.
DAVEY, R. J. & VERDIER, J. P., 1973—An investigation of microplankton assemblages from latest Albian (Vraconian) sediments. *Rev. Española Micropal.*, 5(2), 173-212.
DAVEY, R. J., & WILLIAMS, G. L., 1966a—The genera *Hystrichosphaera* and *Achomosphaera*. *Bull. Br. Mus. nat. Hist. (Geol.), Suppl.* 3, 28-52.
DAVEY, R. J., & WILLIAMS, G. L., 1966b—The genus *Hystrichosphaeridium* and its allies. *Ibid*, 53-105.
DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L., 1966a—Studies on Mesozoic and Cainozoic dinoflagellate cysts. *Bull. Br. Mus. nat. Hist. (Geol.), Suppl.* 3.
DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L., 1966b—Fossil dinoflagellate cysts attributed to *Baltisphaeridium*. *Ibid.*, 157-75.
DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L., 1969—Appendix to "Studies on Mesozoic and Cainozoic dinoflagellate cysts". *Bull. Br. Mus. nat. Hist. (Geol.), Appendix to Suppl.* 3.
DAVIES, H. L., NORVICK, M., RYBURN, R. J., HUTCHINSON, D. S., & SWEET, I. P., 1972—Tectonics of the Western Central Ranges of Papua and New Guinea. *Abstr. Joint Spec. Gr. Meet., Canb.*, 1972, *Geol. Soc. Aust. I.*, 15-6.
DAY, R. W., 1969—The Lower Cretaceous of the Great Artesian Basin. *In* CAMPBELL, K. S. W., Ed.—*STRATIGRAPHY AND PALAEONTOLOGY—ESSAYS IN HONOUR OF DOROTHY HILL*, 140-73. *Canberra, A.N.U. Press.*
DEÁK, Marguerite H., 1963—Quelques spores striées de l'étage Aptien. *Rev. Micropaléont.*, 5(4), 251-6.
DEÁK, Marguerite H., 1965—Recherches palynologiques des dépôts Aptiens de la Montagne Centrale de Transdanubie. *Geol. Hungar., Ser. Palaeont.*, 29, 9-105.
DEÁK, Marguerite H., & COMBAZ, A., 1967—"Microfossiles organiques" du Wéaldien et du Cénomanien dans un sondage de Charente-Maritime. *Rev. Micropaléont.*, 10(2), 69-96.
DEFLANDRE, G., 1934—Sur les microfossiles d'origine planctonique conservés à l'état de matière organique dans les silex de la craie. *C. R. Acad. Sci. Paris*, 199, 966-8.
DEFLANDRE, G., 1935—Considérations biologiques sur les micro-organismes d'origine planctonique conservés dans les silex de la craie. *Bull. Biol. Fr. Belg., Paris*, 69, 213-44.
DEFLANDRE, G., 1936a—Les flagellés fossiles. Aperçu biologique et paléontologique. Rôle géologique. *Actual. scient. et ind., Paris*, 335.
DEFLANDRE, G., 1936b—Microfossiles des silex crétacés. I. Généralités. Flagellés. *Ann. Paléont., Paris*, 25, 151-91.
DEFLANDRE, G., 1937—Microfossiles des silex crétacés. II. Flagellés incertae sedis. Hystrichosphaeridées. Sarcodinés. Organismes divers. *Ibid.*, 26, 51-103.
DEFLANDRE, G., 1938—Microplancton des mers jurassiques conservé dans les marnes de Villers-sur-Mer (Calvados). *Trav. Stat. Zool. Wimereux, Paris*, 13 (*Vol. jubilaire M. Caullery*), 147-200.
DEFLANDRE, G., 1946—Hystrichosphaeridées II. Espèces du Secondaire et du Tertiaire. *Fichier micropaléont. (6) Arch. orig. Serv. Docum. C.N.R.S.*, 235(1-5), cards 860-1019.

*Copy of report deposited in the Bureau of Mineral Resources, Canberra.

DEFLANDRE, G., 1947—Sur quelques micro-organismes planctoniques des silex jurassiques. *Bull. Inst. Océanogr. Monaco*, 921, 1-10.
DEFLANDRE, G., 1954—Systématique des Hystrichosphaeridées: sur l'acception du genre *Cymatiosphaera* O. Wetzel. *C.R. Soc. géol. Fr.*, 12, 257-8.
DEFLANDRE, G., 1964—Quelques observations sur la systématique et la nomenclature des dinoflagellés fossiles. *Multicop. E.P.H.E. et illustration C.N.R.S.*, 1-8.
DEFLANDRE, G., 1966—Addendum à mon mémoire. *Cah. Micropaléont.*, sér. 1, 2. *Arch. orig. Centre de Documentation C.N.R.S.* 419, 1-9.
DEFLANDRE, G., & COOKSON, Isabel C., 1954—Sur le microplancton fossile conservé dans diverses roches sédimentaires australiennes s'étageant du Crétacé inférieur au Miocène supérieur. *C.R. Acad. Sc., Paris*, 239(19), 1235-8.
DEFLANDRE, G., & COOKSON, Isabel C., 1955—Fossil microplankton from Australian late Mesozoic and Tertiary sediments. *Aust. J. mar. freshw. Res.*, 6(2), 242-313.
DEFLANDRE, G., & COURTEVILLE, H., 1939—Note préliminaire sur les microfossiles des silex crétacés du Cambrésis. *Bull. Soc. franc. Microsc.*, 8, 95-106.
DEFLANDRE-RIGAUD, M., 1955—Microfossiles des silex sénoniens du Tréport (Seine-Maritime). *C. R. Somm. Soc. Géol. Fr.*, 1-2, 19-20.
DE JEKHOWSKY, B., 1961—Sur quelques hystrichosphères permo-triassiques d'Europe et d'Afrique. *Rev. Micropaléont.*, 3(4), 207-12.
DE JERSEY, N. J., 1959—Jurassic spores and pollen grains from the Rosewood Coalfield. *Qld Govt Min. J.*, 60(691), 346-66 (also 1960: *Geol. Surv. Qld Publ.* 294).
DE JERSEY, N. J., 1963—Jurassic spores and pollen grains from the Marburg Sandstone. *Geol. Surv. Qld Publ.* 313.
DE JERSEY, N. J., 1970—Triassic miospores from the Blackstone Formation, Aberdare Conglomerate and Raceview Formation. *Ibid.*, 348, *palaeont. Pap.* 22.
DE JERSEY, N. J. & PATEN, R. J., 1964—Jurassic spores and pollen grains from the Surat Basin. *Ibid.*, 322.
DELCOURT, A. F., & SPRUMONT, G., 1955—Les spores et grains de pollen du Wéaldien du Hainaut. *Mém. Soc. Belg. Géol. N.S.* 4, 1-73.
DELCOURT, A. & SPRUMONT, G., 1957—Quelques microfossiles du Wéaldien de Féron-Glageon. *Bull. Soc. géol. Belg.*, 6(1), 57-68.
DELCOURT, A. & SPRUMONT, G., 1959a—Curieuse association de microfossiles dans le Wéaldien de Féron-Glageon (France). *Bull. Soc. belg. Géol. Paléont. et Hydrol.*, 68, 122-5.
DELCOURT, A. & SPRUMONT, G., 1959b—Spores, grains de pollen, Hystrichosphères et Péridiniens dans le Wéaldien de Féron-Glageon. *Ann. Soc. géol. Nord*, 79, 29-64.
DELCOURT, A. F., DETTMANN, Mary E. & HUGHES, N. F., 1963—Revision of some Lower Cretaceous microspores from Belgium. *Palaeontology*, 6(2), 282-92.
DETTMANN, Mary E., 1963—Upper Mesozoic microfloras from southeastern Australia. *Proc. Roy. Soc. Vic.*, 77(1), 1-148.
DETTMANN, Mary E., 1973—Angiospermous pollen from Albian to Turonian sediments of eastern Australia. *Spec. Publ. geol. Soc. Aust.*, 4, 3-34.
DETTMANN, Mary E., & PLAYFORD, G., 1968—Taxonomy of some Cretaceous spores and pollen grains from eastern Australia. *Proc. Roy. Soc. Vic.*, 81(2), 69-94.
DETTMANN, Mary E., & PLAYFORD, G., 1969—Palynology of the Australian Cretaceous: a review. *in* CAMPBELL, K. S. W. ed.—*Stratigraphy and Palaeontology—Essays in honour of Dorothy Hill*, 174-210. *Canberra, A.N.U. Press.*
DEUNFF, J., 1958—Micro-organismes planctoniques du Primaire armoricain. I. Ordovicien du Veryhac'h (Prequ'île de Crozon). *Bull. Soc. Géol. Min. Bretagne*, n.s. 2, 1-41.
DE WIT, R., 1943—Hystrichosphaeridae in Limburgsche Vuursten. *Verh. geol. mijnb. Gen.*, 13, 363-92.
DE WIT, R., 1944—Micro-organismen in Limburgsche Vuursten. *Natuurh. Maandbl.*, 7-8, 52-4.
DÖRING, H., 1965—Die sporenpaläontologische Gliederung des Wealden in Westmecklenburg (Struktur Werle). *Geologie*, 14(47), 1-118.
DOUGLAS, J. G., 1962—Microplankton of the Deflandreidae group in Western District sediments. *Min. Geol. J. Melbourne*, 6(4), 17-32.
DOUGLAS, R. G., 1969—Upper Cretaceous biostratigraphy of northern California. *1 int. Conf. planktonic Microfossils Proc. 2*, 126-52.
DOWNIE, C. & SARJEANT, W. A. S., 1963—On the interpretation and status of some Hystrichosphere genera. *Palaeontology*, 6(1), 83-96.
DOWNIE, C., & SARJEANT, W. A. S., 1964—Bibliography and index of fossil dinoflagellates and acritarchs. *Geol. Soc. Am. Mem.* 94.
DOWNIE, C., & SARJEANT, W. A. S., 1966—The morphology, terminology and classification of fossil dinoflagellate cysts. *Bull. Br. Mus. nat. Hist. (Geol.), Suppl.* 3, 10-7.
DOWNIE, C., EVITT, W. R., & SARJEANT, W. A. S., 1963—Dinoflagellates, Hystrichospheres and the classification of the Acritarchs. *Stanford Univ. Publ., geol. Sci.* 7(3) 1-16.
DRUGG, W. S., 1967—Palynology of the Upper Moreno Formation (Late Cretaceous - Paleocene) Escarpado Canyon, California. *Palaeontographica*, B 120, 1-71.
DRUGG, W. S., 1970a—Some new genera, species and combinations of phytoplankton from the Lower Tertiary of the Gulf Coast, U.S.A. *Proc. N. Am. Paleont. Convention, Sept. 1969, Part G*, 809-43.
DRUGG, W. S., 1970b—Two new Neogene species of *Tuberculodinium* and one of *Xenicodinium* (Pyrrhophyta). *Proc. biol. Soc. Wash.* 83, 115-22.
DYBOVA, S., & JACHOWICZ, A., 1957—Das Alter des Zwickau-Luganer Bogheads auf Grund der palynologischen Analyse. *Geologie*, 6, 674-97.

EDGELL, H. S., 1964—The correlative value of microplankton in the Cretaceous of the Perth Basin, W.A. *Min. Dep. W.Aust. ann. Rep.* 1963, 100-5.
EHRENBERG, C. G., 1838—Über das Massenverhältnis der jetzt lebenden Kiesel-infusorien und über ein neues Infusorien-Conglomerat als Polierschiefer von Jastraba in Ungarn. *Akad. Wiss. Berlin Abh.* 1836, 1, 109-35.
EISENACK, A., 1931—Neue Mikrofossilien des baltischen Silurs. I. *Paläont. Z.*, 13, 74-118.
EISENACK, A., 1938—Die Phosphoritknollen der Bernsteinformation als Überlieferer tertiären Planktons. *Schr. phys.-ökon. Ges. Königsberg*, 70(2), 181-8.
EISENACK, A., 1954—Mikrofossilien aus Phosphoriten des samländischen Unteroligozäns und über die Einheitlichkeit der Hystrichosphaerideen. *Palaeontographica A*, 105(3-6), 49-95.
EISENACK, A., 1958a—*Tasmanites* Newton 1875 und *Leiosphaeridia* n.g. als Gattungen der Hystrichosphaeridia. *Ibid.*, 110, 1-19.
EISENACK, A., 1958b—Mikroplankton aus dem norddeutschen Apt, nebst einigen Bemerkungen über fossile Dinoflagellaten. *Abh. N. Jb. Geol. Paläont.* 106(3), 383-422.
EISENACK, A., 1961—Einige Erörterungen über fossile Dinoflagellaten nebst Übersicht über die zur Zeit bekannten Gattungen. *Ibid.*, 112(3), 281-324.
EISENACK, A., 1963a—Zur *Membranilarnas*-Frage. *Mh. N. Jb. Geol. Paläont.*, 1963(2), 98-103.
EISENACK, A., 1963b—*Cordosphaeridium* n.g., ex *Hystrichosphaeridium*, Hystrichosphaeridea. *Abh. N. Jb. Geol. Paläont.* 118, 260-5.
EISENACK, A., & COOKSON, Isabel C., 1960—Microplankton from Australian Lower Cretaceous sediments. *Proc. Roy. Soc. Vic.*, 72(1), 1-11)
EISENACK, A., & GOCHT, H., 1960—Neue Namen für einige Hystrichosphären der Bernsteinformation Ostpreussens. *Mh. N. Jb. Geol. Paläont.*, 1960(11), 511-8.
EISENACK, A., & KJELLSTROM, G., 1971—*KATALOG DER FOSSILEN DINOFLAGELLATEN, HYSTRICHOSPHAREN UND VERWANDTEN MIKROFOSSILIEN. II: DINOFLAGELLATEN. Stuttgart, Schweizerbart.*
EISENACK, A., & KLEMENT, K. W., 1964—*KATALOG DER FOSSILEN DINOFLAGELLATEN, HYSTRICHOSPHAREN UND VERWANDTEN MIKROFOSSILIEN. I: DINOFLAGELLATEN. Stuttgart, Schweizerbart* (with revisions to 1967).
ELSIK, W. C., 1968—Palynology of a Paleocene Rockdale Lignite, Milam County, Texas. II. Morphology and taxonomy. *Pollen et Spores*, 10(3), 599-664.
ERDTMAN, G., 1945—Pollen morphology and plant taxonomy. III. *Morina* L. *Svensk bot. Tidskr.*, 39, 188-91.
ERDTMAN, G., 1947—Suggestions for the classification of fossil and Recent pollen grains and spores. *Ibid.*, 41(1), 104-14.
ERDTMAN, G., 1952—POLLEN MORPHOLOGY AND PLANT TAXONOMY. ANGIOSPERMS. *Stockholm, Almqvist & Wiksell.*
ERDTMAN, G., 1969—HANDBOOK OF PALYNOLOGY. An introduction to the study of pollen grains and spores. *New York, Hafner.*
ETHERIDGE, R., Jnr. 1907—The Cretaceous fossils of Maclear Creek, Cape Gambier, Melville Island. *S. Aust. parl. Pap. 1906, Suppl.* 55.
EVANS, P. R., 1966a—Mesozoic stratigraphic palynology of the Otway Basin. *Bur. Miner. Resour. Aust. Rec.* 1966/69 (unpubl.).
EVANS, P. R., 1966b—Contribution to the palynology of northern Queensland and Papua. *Ibid.*, 1966/198 (unpubl.).
EVANS, P. R., 1966c—Mesozoic stratigraphic palynology in Australia. *Aust. Oil Gas J.*, 12(6), 58-63.
EVANS, P. R., 1970—Revision of the miospore genera *Perotrilites* Erdtman ex Couper,1953 and *Diaphanospora* Balme & Hassell, 1962. *Bur. Miner. Resour. Aust. Bull.* 116, 65-74.
EVITT, W. R., 1961—Observations on the morphology of fossil dinoflagellates. *Micropaleontology*, 7(4), 385-420.
EVITT, W. R., 1963—A discussion and proposals concerning fossil dinoflagellates, hystrichospheres, and acritarchs. *Proc. nat. Acad. Sci.*, 49(2), 158-64, 298-302.
EVITT, W. R., 1967—Dinoflagellate studies. II. The archeopyle. *Stanford Univ. Publ. geol. Sci.*, 10(3), 1-82.

FAEGRI, K. & IVERSEN, J., 1964—TEXTBOOK OF POLLEN ANALYSIS. *Oxford, Blackwell* (2nd ed.).
FIRTION, F., 1952—Le Cénomanien inférieur du Nouvion-en-Thiérache: examen micropaléontologique. *Ann. Soc. géol. Nord* 72, 150-64.

GERLACH, E., 1961—Mikrofossilien aus dem Oligozän und Miozän Nordwestdeutschlands, unter besonderer Berücksichtigung der Hystrichosphaerideen und Dinoflagellaten. *Abh. N. Jb. Geol. Paläont.*, 112(2), 143-228.
GITMEZ, G. U., 1970—Dinoflagellate cysts and acritarchs from the basal Kimmeridgian (Upper Jurassic) of England, Scotland and France. *Bull. Br. Mus. nat. Hist. (Geol.)*, 18(7), 233-331.
GLAESSNER, M. F., & PARKIN, L. W., 1958—The geology of South Australia. *J. geol. Soc. Aust.*, 5.
GOCHT, H., 1957—Mikroplankton aus dem nordwestdeutschen Neokom (Teil I). *Paläont. Z.*, 31(3-4), 163-85.
GOCHT, H., 1959—Mikroplankton aus dem nordwestdeutschen Neokom (Teil II). *Ibid.*, 33(1-2), 50-89.
GOCHT, H., 1969—Formengemeinschaften alttertiären Mikroplanktons aus Bohrproben des Erdölfeldes Meckelfeld bei Hamburg. *Palaeontographica, B*, 126(1-3), 1-100.
GOCHT, H., 1970—Dinoflagellaten-Zysten aus dem Bathonium des Erdölfeldes Aldorf (NW-Deutschland). *Ibid.*, 129(4-6), 125-65.

GORKA, H., 1963—Coccolithophoridés, dinoflagellés, hystrichosphaeridés et microfossiles incertae sedis du Crétacé supérieur de Pologne. *Acta palaeont. polon.*, 8(1), 3-90.
GROOT, J. J., & GROOT, Catharina R., 1962—Plant microfossils from Aptian, Albian and Cenomanian deposits of Portugal. *Comm. Serv. geol. Portugal*, 46, 133-71.
GROOT, J. J., & PENNY, J. S., 1960—Plant microfossils and age of nonmarine Cretaceous sediments of Maryland and Delaware. *Micropaleontology*, 6(2), 225-36.
GROOT, J. J., PENNY, J. S., & GROOT, Catharina R., 1961—Plant microfossils and age of the Raritan, Tuscaloosa and Magothy Formations of the eastern United States. *Palaeontographica B*, 108(3-6), 121-40.
GRUAS-CAVAGNETTO, Carla, 1968—Quelques nouvelles espèces sparnaciennes de pollens et spores. *Bull. Soc. géol. France. Sér.* 7, 9(1), 57-62.
GUZMÁN, A. E. G., 1967—A PALYNOLOGICAL STUDY OF THE UPPER LOS CUERVOS AND MIRADOR FORMATIONS (LOWER AND MIDDLE EOCENE, TIBU AREA, COLOMBIA). *Leiden, E. J. Brill.*

HABIB, D., 1969—Middle Cretaceous palynomorphs in a deep-sea core from the seismic reflector horizon A outcrop area. *Micropaleontology*, 15(1), 85-101.
HABIB, D., 1970—Middle Cretaceous palynomorph assemblages from clays near the horizon beta deep-sea outcrop. *Ibid.*, 16(3), 345-79.
HALSE, J. W., & HAYES, J. D., 1971—The geological and structural framework of the offshore Kimberley Block (Browse Basin) area, Western Australia. *APEA J.*, 11(1), 64-70.
HAMMEN, T. van der, 1956—A palynological systematic nomenclature. *Bol. geol. Bogotá*, 4(2-3), 63-101.
HAMMEN, T. van der, & WYMSTRA, T. A., 1964—A palynological study on the Tertiary and Upper Cretaceous of British Guyana. *Leidse geol. Meded.*, 30, 183-241.
*HARE, R., & ASSOCIATES, 1961—Oil Development N.L. Well Completion Report Bathurst Island Well No. One (unpubl.).
*HARE, R., & ASSOCIATES, 1962—Oil Development N.L. Well Completion Report Bathurst Island Well No. 2 (unpubl.).
HARLAND, R., 1968—A microplankton assemblage from the Post-Pleistocene of Wales. *Grana Palyn.*, 8(2-3), 536-54.
HASKELL, T. R., 1968—Saccate pollen grains from the Lower Cretaceous of the Great Artesian Basin, Australia. *Univ. Qld Pap. Dep. Geol.*, 6(8), 211-43.
HASKELL, T. R., 1970—Dinoflagellate species *Dingodinium cerviculum*, *Odontochitina operculata* and *Muderongia tetracantha* in Lower Cretaceous strata of the Great Artesian Basin, Australia. *Proc. Roy. Soc. Qld*, 81, 57-68.
HEDLUND, R. W., 1966—Palynology of the Red Branch Member of the Woodbine Formation (Cenomanian), Bryan County, Oklahoma. *Bull. Okl. geol. Surv.* 112.
HEDLUND, R. W., & NORRIS, G., 1968—Spores and pollen grains from Fredericksburgian (Albian) strata, Marshall County, Oklahoma. *Ibid.*, 10(1), 129-59.
HEISECKE, A. M., 1970—Microplancton de la Formación Roca de la Prov. de Neuquén. *Ameghiniana*, 7(3), 225-63.
HILL, D., PLAYFORD, G., & WOODS, J. T., (Eds.) 1970—Cainozoic fossils of Queensland. *Qld palaeontogr. Soc.*
HUGHES, R. J., & SENIOR, B. R., 1973—New stratigraphic names for Cretaceous and Cainozoic units of Bathurst and Melville Islands and Cobourg Peninsula, Northern Territory. *Aust. Oil Gas*, 1974, 10-17.

IBRAHIM, A. C., 1933—Sporenformen des Aegirhorizonts des Ruhr-Reviers. *Diss. techn. Hochsch. Berlin, Würzburg.*
INGRAM, B. S., 1968—Stratigraphic palynology of Cretaceous rocks from bores in the Eucla Basin, Western Australia. *Min. Dep. W. Aust. Ann. Rep.* 1967, 102-5.
IVERSEN, J., & TROELS-SMITH, J., 1950—Pollenmorfologiske Definitioner og Typer. *Danm. geol. Unders.* 4 RK, 3(8), 1-54.

JANSONIUS, J., 1962—Palynology of Permian and Triassic sediments, Peace River area, Western Canada, *Palaeontographica B*, 110(1), 35-98.
JARDINÉ, S., & MAGLOIRE, L., 1965—Palynologie et stratigraphie du Crétacé des bassins du Sénégal et Côte d'Ivoire. *Mém. Bur. Rech. Géol. Min.*, 32, 187-245.

KAYE, P., EDMOND, G. M., & CHALLINOR, A., 1972—The Rankin Trend, Northwest Shelf, Western Australia. *APEA J.*, 12(1), 3-8.
KEDVES, M., 1961—Etudes palynologiques dans le bassin de Dorog. II. *Pollen et Spores*, 3(1), 101-53.
KEDVES, M., 1965—Ein neuer reticulater Sporen-Typ aus dem Eozän des Braunkohlenbeckens von Dorog (Ungarn). *Paläont. Z.*, 39(3-4), 188-92.
KEDVES, M., 1969—PALYNOLOGICAL STUDIES ON HUNGARIAN EARLY TERTIARY DEPOSITS. *Budapest. Akadémiai Kiado.*
KEDVES, M., & RAKOSY, J., 1965—Zonotrilete microspores from the Eocene bauxite layers of Gánt in Hungary. *Acta Biol. Univ. Szeged, N.S.* 11(3-4), 233-44.
KEMP, Elizabeth M., 1968—Probable angiosperm pollen from the British Barremian to Albian strata. *Palaeontology*, 11(3), 421-34.
KEMP, Elizabeth M., 1970—Aptian and Albian miospores from southern England. *Palaeontographica B*, 131, 73-143.

*Copies of reports deposited in the Bureau of Mineral Resources, Canberra.

KENNEDY, W. J., 1971—Cenomanian ammonites from southern England. *Palaeontology, spec. Pap.* 8.
KIMYAI, A., 1966—New plant microfossils from the Raritan Formation (Cretaceous) in New Jersey. *Micropaleontology*, 12(4), 461-76.
KLAUS, W., 1960—Sporen der Karnischen Stufe der ostalpinen Trias. *Jb. geol. Bundesamt*, 5, 107-83.
KLEMENT, K. W., 1960—Dinoflagellaten und Hystrichosphaerideen aus dem unteren und mittleren Malm Südwestdeutschlands. *Palaeontographica A*, 114(1-4), 1-104.
KLUMPP, B., 1953—Beitrag zur Kenntnis der Mikrofossilien des Mittleren und Oberen Eozän. *Palaeontographica A*, 103(5-6), 377-406.
KRUTZSCH, W., 1959a—Mikropaläontologische (sporenpaläontologische) Untersuchungen in der Braunkohle des Geiseltales. *Geologie*, 8 (*Beih.* 21-22), 1-425.
KRUTZSCH, W., 1959b—Einige neue Formgattungen und -Arten von Sporen und Pollen aus der mitteleuropäischen Oberkreide und dem Tertiär. *Palaeontographica B*, 105(5-6), 125-57.
KRUTZSCH, W., 1962-1967—Atlas der mittel- und jungtertiären dispersen Sporen- und Pollen- sowie der Mikroplanktonformen des nördlichen Mitteleuropas. I. 1962—*VEB Deutscher Verlag Wissensch., Berlin*. II-III 1963—*Ibid.* IV-V. 1967—*VEG Gustav Fischer Verlag, Jena.*

LEFFINGWELL, H. A., 1966—Palynology of the Lance (Late Cretaceous) and Fort Union (Paleocene) Formations of the type Lance area, Wyoming. *Geol. Soc. Am. spec. Pap.* 127, 1-64.
LEJEUNE-CARPENTIER, M., 1938—L'étude microscopique des silex (6ième note). *Areoligera*; nouveau genre d'Hystrichosphaeridée. *Ann. Soc. géol. Belg.*, 62(3), 163-74.
LEJEUNE-CARPENTIER, M., 1940—L'étude microscopique des silex (8ième note). Systématique et morphologie des "Tubifères". Ibid., 63(5), 216-36.
LEJEUNE-CARPENTIER, M., 1941—L'étude microscopique des silex (9ième note). Sur *Hystrichosphaeridium hirsutum* (Ehrenberg) et quelques formes voisines. *Ibid.*, 64(3), 71-92.
LEOPOLD, Estella B., & PAKISER, Helen M., 1964—A preliminary report on the pollen and spores of the pre-Selma Upper Cretaceous strata of western Alabama. *Bull. U.S. geol. Surv.* 1160-E, 71-95.
LESCHIK, G., 1955—Die Keuperflora von Neuewelt bei Basel. II. Die Iso- und Mikrosporen. *Schweiz. palaeont. Abh.*, 72, 5-70.
LOEBLICH, A. R., Jr, & LOEBLICH, A. R., III, 1966—Index to the genera, subgenera and sections of the Pyrrhophyta. *Stud. trop. Oceanogr., Miami*, 3, 1-94.
LOEBLICH, A. R., Jr, & LOEBLICH, A. R., III, 1968—Index to the genera, subgenera and sections of the Pyrrhophyta, II. *J. Paleont.*, 42(1), 210-3.
LOEBLICH, A. R., Jr, & LOEBLICH, A. R., III, 1969—Index to the genera, subgenera and sections of the Pyrrhophyta, III. *Ibid.*, 43(1), 193-8.
LOEBLICH, A. R., Jr, & LOEBLICH, A. R., III, 1970—Index to the genera, subgenera and sections of the Pyrrhophyta, IV. *Ibid.*, 44(3), 536-43.
LOEBLICH, A. R., & TAPPAN, Helen, 1961—Cretaceous planktonic foraminifera: Part 1—Cenomanian. *Micropaleontology*, 7(3), 257-304.

MAIER, D., 1959—Planktonuntersuchungen in tertiären und quartären marinen Sedimenten. *Abh. N. Jb. Geol. Paläont.* 107(3), 278-340.
MALIAVKINA, V. S., 1949—Identification of spores and pollen. Jurassic-Cretaceous. *Trud. Vsesosh. Neft. Nauchno-Issl. Geol.—Razhv. Inst. (VNIGRI)*, 33, 138 pp. (in Russian).
MANTELL, G. A., 1850—*A PICTORIAL ATLAS OF FOSSIL REMAINS, CONSISTING OF COLOURED ILLUSTRATIONS SELECTED FROM PARKINSON'S "ORGANIC REMAINS OF A FORMER WORLD" AND ARTIS'S "ANTEDILUVIAN PHYTOLOGY". London, Bohn.*
MANTELL, G. A., 1854—*THE MEDICALS OF CREATION: OR, FIRST LESSONS IN GEOLOGY AND THE STUDY OF ORGANIC REMAINS.* 2nd edn, *London*, 2 vols.
MANUM, S., 1963—Some new species of *Deflandrea* and their probable affinity with *Peridinium*. *Årbok norsk Polarinst., Oslo*, 1962, 55-67.
MANUM, S., & COOKSON, Isabel C., 1964—Cretaceous microplankton in a sample from Graham Island, Arctic Canada, collected during the second "Fram" Expedition (1898-1902), with notes on the microplankton from the Hassel Formation, Ellef Ringnes Island. *Skr. norsk. Vid.-Akad. Oslo, mat.—naturv. Kl.*, (n.s.) 17, 1-36.
MCINTYRE, D. J., 1968—Further new pollen species from New Zealand Tertiary and uppermost Cretaceous deposits. *N.Z. J. Bot.*, 6(2), 177-204.
MCWHAE, J. R. H., PLAYFORD, P. E., LINDNER, A. W., GLENISTER, B. F., & BALME, B. E., 1958—The stratigraphy of Western Australia. *J. geol. Soc. Aust.*, 4(2).
MILLIOUD, M. E., 1967—Palynological study of the type localities at Valangin and Hauterive. *Rev. Palaeobot. Palyn.*, 5(1-4), 155-67.
MILLIOUD, M. E., 1969—Dinoflagellates and acritarchs from some Western European Lower Cretaceous type localities. *Proc. I int. Conf. Planktonic Microfossils*, 2, 420-34.
MORGENROTH, P., 1966—Mikrofossilien und Konkretionen des nordwesteuropäischen Untereozäns. *Palaeontographica B*, 119(1-3), 1-53.
MORGENROTH, P., 1968—Zur Kenntnis der Dinoflagellaten und Hystrichosphaeridien des Danien. *Geol. Jb.*, 86, 533-78.
MTCHEDLISHVILI, N. D., & SAMOILOVICH, S. R., 1960—New species of angiosperms. *in New species of plants and invertebrates of U.S.S.R.* part I. Moscow (in Russian).
MULLER, J., 1968—Palynology of the Pedawan and Plateau Sandstone Formations (Cretaceous-Eocene) in Sarawak, Malaysia. *Micropaleontology*, 14(1), 1-37.

NAUMOVA, S. N., 1939—Spores and pollen of the coals of the USSR. *17th int. geol. Cong., USSR*, 1937 *Abstr.*, 60-1.

NAUMOVA, S. N., 1953—Spore-pollen assemblages of Upper Devonian of the Russian Platform and their significance for stratigraphy. *Trud. Inst. geol. Nauk Akad. Nauk SSSR*, 143, *geol. Ser.* 60 (in Russian).
NEALE, J. W., & SARJEANT, W. A. S., 1962—Microplankton from the Speeton Clay of Yorkshire. *Geol. Mag.*, 99(5), 439-58.
NICOL, G. N., 1970—Exploration and geology of the Arafura Sea. *APEA J.*, 10(2), 56-61.
NILSSON, T., 1958—Über das Vorkommen eines mesozoischen Sapropelgesteins in Schonen. *Lunds Univ. Årsskr. N.F., Ard.* 2, 54, 112 pp.
NORRIS, G., 1967—Spores and pollen from the Lower Colorado Group (Albian-?Cenomanian) of Central Alberta. *Palaeontographica B*, 120 (1-4), 72-115.
NORRIS, G., 1968—Plant microfossils from the Hawks Crag Breccia, south-west Nelson, New Zealand. *N.Z. J. Geol. Geophys.*, 11(2), 312-44.
NORRIS, G., & HEDLUND, R. W., 1972—Transapical sutures in dinoflagellate cysts. *Geoscience and Man*, 4, 49-56.
NORRIS, G., & SARJEANT, W. A. S., 1965—A descriptive index of genera of fossil Dinophyceae and Acritarcha. *N.Z. geol. Surv. palaeont. Bull.*, 40, 1-72.
NORTON, N. J., & HALL, J. W., 1969—Palynology of the Upper Cretaceous and Lower Tertiary in the type locality of the Hell Creek Formation, Montana, U.S.A. *Palaeontographica B*, 125(1-3), 1-64.
NORVICK, M. S., 1973—The microplankton genus *Disphaeria* Cookson & Eisenack emend. *Bur. Miner. Resour. Aust. Bull.* 140, 45-6.

OLTZ, D. F., 1969—Numerical analyses of palynological data from Cretaceous and early Tertiary sediments in east central Montana. *Palaeontographica B*, 128(3-6), 90-166.
OWENS, B., 1971—Miospores from the Middle and early Upper Devonian rocks of the western Queen Elizabeth Islands, Arctic Archipelago. *Geol. Surv. Can. Pap.* 70-38, 157 pp.

PACLTOVÁ, B., 1961—On some plant microfossils from fresh-water sediments of the Upper Cretaceous (Senonian) in the South-Bohemian Basins. *Sborn. Ust. Ustav. Geol. Paleont.*, 26, 47-102.
PANT, D. D., 1954—Suggestions for the classification and nomenclature of fossil spores and pollen grains. *Bot. Rev.*, 20, 33-60.
PASTIELS, A., 1948—Contributions à l'étude des microfossiles de l'Éocène belge. *Mém. Mus. Roy. Hist. nat. Belg.*, 109, 1-77.
*PEMBERTON, R. L., 1971—Well Completion Report Tinganoo Bay No. 1 Diamond Drill-hole; Flinders Petroleum N.L. and Pexa Oil N.L. (unpubl.).
PESSAGNO, E. A., 1967—Upper Cretaceous planktonic foraminifera from the western Gulf coastal plain. *Paleont. am.*, 5(37), 243-445.
PFLANZL, G., 1956—Das Alter der Braunkohlen des Meissners, der Flöze 2 und 3 des Hirschberges und eines benachbarten Kohlenlagers bei Laudenbach. *Notizbl. hess. Landesamt Bodenförsch.*, 48, 232-44.
PFLUG, H. D., 1953—Zur Entstehung und Entwicklung des angiospermiden Pollens in der Erdgeschichte. *Palaeontographica B.*, 95(4-6), 60-171.
PIERCE, R. L., 1961—Lower Upper Cretaceous plant microfossils from Minnesota. *Bull. Minn. geol. Surv.* 42.
PLAYFORD, G., 1971—Palynology of Lower Cretaceous (Swan River) strata of Saskatchewan and Manitoba. *Palaeontology*, 14(4), 535-65.
PLAYFORD, G., & HELBY, R., 1968—Spores from a Carboniferous section in the Hunter Valley, New South Wales. *J. geol. Soc. Aust.*, 15(1), 103-19.
POCOCK, S. A. J., 1961—The microspore genus *Cingulatisporites* Thomson 1953. *J. Paleont.* 35(6), 1234-6.
POCOCK, S. A. J., 1962—Microfloral analysis and age determination of strata at the Jurassic-Cretaceous boundary in the western Canada plains. *Palaeontographica B*, 111, 1-95.
POCOCK, S. A. J., 1964—Pollen and spores of the Chlamydospermidae and Schizaeaceae from upper Mannville strata of the Saskatoon area of Saskatchewan. *Grana Palyn.*, 5(2), 129-209.
POCOCK, S. A. J., 1972—Palynology of the Jurassic sediments of western Canada. Part 2, marine species. *Palaeontographica B*, 137(4-6), 85-153.
POCOCK, S. A. J., & JANSONIUS, J., 1961—The pollen genus *Classopollis* Pflug, 1953. *Micropaleontology*, 7(4), 439-49.
POTONIÉ, R., 1934—Zur Mikrobotanik des eozänen Humodils des Geiseltals. *Arb. Inst. Paläobot. Petrogr. Brennst.*, 4, 25-125.
POTONIÉ, R., 1951—Revision stratigraphisch wichtiger Sporomorphen des mitteleuropäischen Tertiärs. *Palaeontographica B*, 91, 131-51.
POTONIÉ, R., 1956-1970—Synopsis der Gattungen der Sporae disperae. I. 1956—*Beih. Geol. Jb.*, 23. II. 1958—*Ibid.*, 31. III. 1960a—*Ibid.*, 39. IV. 1966—*Ibid.*, 72. V. 1970—*Ibid.*, 87.
POTONIÉ, R., 1960b—Sporologie der eozänen Kohle von Kalewa in Burma. *Senckenb. Leth.*, 41(1-6), 451-81.
POTONIÉ, R., & GELLETICH, J., 1933—Über Pteridophyten-Sporen einer eozänen Braunkohle aus Dorog in Ungarn. *Sber. Ges. Nat. Freunde* (1932), 517-28.
POTONIÉ, R., & KLAUS, W., 1954—Einige Sporengattungen des alpinen Salzgebirges. *Geol. Jb.*, 68, 517-44.
POTONIÉ, R., & KREMP, G. O. W., 1955—Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie. *Geol. Jb.*, 69, 111-94.
POTONIÉ, R., & VENITZ, A., 1934—Zur Mikrobotanik des miozänen Humodils der niederrheinischen Bucht. *Arb. Inst. Paläobot. Petrogr. Brennst.*, 5, 1-54.
POTONIÉ, R., IBRAHIM, A., & LOOSE, F., 1932—Sporenformen aus den Flözen Ägir und Bismarck des Ruhrgebietes. *N. Jb. Miner. Petrol. Paläont.*, 67B, 438-54.

*Copy of report deposited in the Bureau of Mineral Resources, Canberra.

POTONIÉ, R., THOMSON, R. W., & THIERGART, F., 1950—Zur Nomenklatur und Klassifikation der neogenen Sporomorphae (Pollen und Sporen). *Geol. Jb.*, 65, 35-70.

REISER, R. F., & WILLIAMS, A. J., 1969—Palynology of the Lower Jurassic sediments of the northern Surat Basin, Queensland. *Geol. Surv. Qld. Publ.* 339, *palaeont. Pap.* 15.

REISSINGER, A., 1950—Die "Pollenanalyse" ausgedehnt auf alle Sedimentgesteine der geologischen Vergangenheit. *Palaeontographica B*, 90, 99-126.

REYRE, Y., 1965—Description de quelques spores et pollens de séries attribuées au Jurassique Supérieur dans le Sahara Tunisien. *Rev. Micropaléont.*, 7(4), 257-64.

RICHARDSON, J. B., 1960—Spores from the Middle Old Red Sandstone of Cromarty, Scotland. *Palaeontology*, 3(1), 45-63.

RICHARDSON, J. B., 1962—Spores with bifurcate processes from the Middle Old Red Sandstone of Scotland. *Ibid.*, 5(2), 171-94.

ROSS, N. E., 1949—On a Cretaceous pollen and spore bearing clay deposit of Scania (a preliminary report). *Bull. Soc. geol. Inst. Univ. Uppsala*, 34, 25-42.

ROSSIGNOL, M., 1962—Analyse pollinique de sédiments marins Quaternaires en Israël II. Sédiments Pleistocènes. *Pollen et Spores*, 4(1), 121-48.

ROSSIGNOL, M., 1964—Hystrichosphères du Quaternaire en Mediterranée orientale, dans les sédiments Pleistocènes et les boues marines actuelles. *Rev. Micropaléont.*, 7(2), 83-99.

SAH, S. C. D., & JAIN, K. P., 1965—Jurassic spores and pollen grains from the Rajmahal Hills, Bihar, India; with a discussion on the age of the Rajmahal Intertrappean Beds. *Palaeobotanist*, 13(3), 264-90.

SAMOILOVITCH, S. R., & MTCHEDLISHVILI, N. D., (Eds.) 1961—Pyl'tsa i spory zapadnoy Sibiri; Yura-Paleotsen (Pollen and spores of western Siberia; Jurassic-Palaeocene). *Trudy vses. neft. nauchno-issled. geol. razv. Inst.* (VNIGRI), 177.

SARJEANT, W. A. S., 1960—New hystrichospheres from the Upper Jurassic of Dorset. *Geol. Mag.*, 97(2), 137-44.

SARJEANT, W. A. S., 1962—Microplankton from the Ampthill Clay of Melton, South Yorkshire. *Palaeontology*, 5(3), 478-97.

SARJEANT, W. A. S., 1964—Taxonomic notes on hystrichospheres and acritarchs. *J. Paleont.*, 38(1), 173-7.

SARJEANT, W. A. S., 1965—Microplankton from the Callovian (*S. calloviense* Zone) of Normandy. *Rev. Micropaléont.* 8(3), 175-84.

SARJEANT, W. A. S., 1966a—Dinoflagellate cysts with *Gonyaulax*-type tabulation. *Bull. Br. Mus. nat. Hist. (Geol.), Suppl.* 3, 107-56.

SARJEANT, W. A. S., 1966b—Further dinoflagellate cysts from the Speeton Clay (Lower Cretaceous). *Ibid.*, 199-214.

SARJEANT, W. A. S., 1967—The stratigraphic distribution of fossil dinoflagellates. *Rev. Palaeobot. Palyn.*, 1(1-4), 323-43.

SARJEANT, W. A. S., 1968—Microplankton from the Upper Callovian and Lower Oxfordian of Normandy. *Rev. Micropaléont.*, 10(4), 221-42.

SARJEANT, W. A. S., 1970—The genus *Spiniferites* Mantell, 1850 (Dinophyceae). *Grana*, 10(1), 74-8.

SARJEANT, W. A. S., & ANDERSON, R. Y., 1969—A re-examination of some dinoflagellate cysts from the uppermost Lewis Shale (Late Cretaceous), New Mexico (U.S.A.). *Rev. Palaeobot. Palyn.*, 9(3-4), 229-37.

SARJEANT, W. A. S., & DOWNIE, C., 1966—The classification of dinoflagellate cysts above generic level. *Grana Palyn.*, 6(3), 503-27.

SCHULZ, E., 1962—Sporenpaläontologische Untersuchungen zur Rhät-Lias-Grenze in Thüringen und der Altmark. *Geologie* 11(3), 308-19.

SEGROVES, K. L., 1967—Cutinized microfossils of probable nonvascular origin from the Permian of Western Australia. *Micropaleontology*, 13(3), 289-305.

SENIOR, B. R., & HUGHES, R. J., 1973—Progress report on the geology of the Bathurst Island, Melville Island, Cobourg Peninsula and Fog Bay 1:250 000 Sheet areas, Northern Territory. *Bur. Miner. Resour. Aust. Rec.* 1973/52 (unpubl.).

SINGH, C., 1964—Microflora of the Lower Cretaceous Mannville Group, east-central Alberta. *Res. Ccl Alb. Bull.* 15, 239 pp.

SINGH, C., 1971—Lower Cretaceous microfloras of the Peace River area, Northwestern Alberta. *Ibid.*, 28, 542 pp.

SKWARKO, S. K., 1966—Cretaceous stratigraphy and palaeontology of the Northern Territory. *Bur. Miner. Resour. Aust. Bull.* 73.

SOMERS, Y., 1968—Spores disaccates du Westphalien A. *Bull. Soc. Roy. Sci. Liège*, 37(5-8), 350-7.

SRIVASTAVA, S. K., 1966—Upper Cretaceous microflora (Maastrichtian) from Scollard, Alberta, Canada. *Pollen et Spores*, 8, 497-552.

SRIVASTAVA, S. K., 1969—Some angiosperm pollen from the Edmonton Formation (Maastrichtian), Alberta, Canada. *in* J. Sen Mem. Volume. Ed. H. Santapau et al., *Calcutta, Eka Press*, 47-68.

SRIVASTAVA, S. K., 1972—Taxonomic notes on pollen genera *Callistopollenites*, *Tricolporites* and *Carpinipites. Canad. J. Bot.*, 50(1), 9-12.

STANLEY, E. A., 1965— Upper Cretaceous and Paleocene plant microfossils and Paleocene dinoflagellates and hystrichosphaerids from northwestern South Dakota. *Bull. Am. Paleont.*, 49(222), 175-384.

STOVER, L. E., 1962—*Taurocusporites*, a new trilete spore genus from the Lower Cretaceous of Maryland. *Micropaleontology*, 8(1), 55-9.

STOVER, L. E., 1964—Cretaceous ephedroid pollen from West Africa. *Ibid.*, 10(2), 145-56.

STOVER, L. E., & PARTRIDGE, A. D., 1973—Tertiary and late Cretaceous spores and pollen from the Gippsland Basin, southeastern Australia. *Proc. Roy. Soc. Vic.*, 85(2), 237-86.

STOVER, L. E., ELSIK, W. C., & FAIRCHILD, W. W., 1966—New genera and species of early Tertiary palynomorphs from Gulf Coast. *Paleont. Contrib. Univ. Kansas, Pap.* 5.

TASCH, P., MCCLURE, K., & OFTEDAHL, O., 1964—Biostratigraphy and taxonomy of a hystrichosphere-dinoflagellate assemblage from the Cretaceous of Kansas. *Micropaleontology*, 10(2), 189-206.
TAUDOURDEAU-LANTZ, Josette, 1962—Remarque sur la structure du genre *Hymenozonotriletes* (Naoumova 1937? 1939) ex Naoumova 1953. *Rev. Micropaléont.*, 5(1), 51-3.
TERPSTRA, G. R. J., & BURGER, D., 1969—Micropalaeontology and palynology of samples from BMR Bulloo No. 1 Scout Hole, Queensland. *Bur. Miner. Resour. Aust. Rec.* 1969/39 (unpubl.).
THIERGART, F., 1938—Die Pollenflora der Niederlausitzer Braunkohle. *Jb. preuss. geol. Landesamt*, 58 (1937), 282-351.
THOMSON, P. W., & PFLUG, H. D., 1953—Pollen und Sporen des mitteleuropäischen Tertiärs. *Palaeontographica B*, 94(1-4), 1-138.
TIMOFEYEV, B. V., 1959—The ancient flora of the Baltic Regions and its stratigraphic significance. *Trudy vses. neft. nauchno-issl. geol. razv. Inst. (VNIGRI)*, 129 (in Russian).
TIWARI, R. S., 1964—New miospore genera in the coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist*, 12(3), 250-9.
TRAVERSE, A., 1955—Pollen analysis of the Brandon Lignite of Vermont. *U.S. Bur. Min. Rep. Invest.* 5151.

VALENSI, L., 1955a—Sur quelques micro-organismes des silex crétacés du Magdalénien de Saint-Amand (Cher). *Bull. Soc. géol. Fr., ser.* 6, 5, 35-40.
VALENSI, L., 1955b—Étude micropaléontologique des silex du Magdalénien de Saint-Amand (Cher). *Bull. Soc. préhist. Fr.*, 52(9-10), 584-96.
VAVRDOVA, M., 1964—*Trubasporites*, n. f.g. and some other sporomorphs from Carpathian Lower Cretaceous. *Casops. Prague Narodni Muz.*, 133, 37-40.
VERDIER, J. P., 1970—Addendum au Mémoire de G. Deflandre et I. C. Cookson, microplancton fossile de sédiments du Mésozoique supérieur et du Tertaire d'Australie. *Cah. Micropaléont. sér. 2. Arch. orig. Centre Doc. CNRS*, 469, 1-54.
VINE, R. R., & DAY, R. W., 1965—Nomenclature of the Rolling Downs Group, northern Eromanga Basin, Queensland. *Qld Govt Min. J.*, 66(767), 417-21.
VISSER, W. A., & HERMES, J. J., 1962—Geological results of the exploration for oil in Netherlands New Guinea. *Holland. Staatsdrukkerij- en Uitgeversbedrijf.* 265 pp.
VOZZHENNIKOVA, T. F., 1967—Iskopaemya peridinei yurskikh melovykhi paleogenovykh otlozheniy SSSR (Fossil peridinians of the Jurassic, Cretaceous and Palaeogene deposits of the USSR). *Sibirsk. Otdel. Inst. Geol. Geofiz., Moscow, Akad. Nauk. SSSR*, 347 pp. (in Russian).

WALKOM, A. B., 1919—Mesozoic floras of Queensland: Parts III and IV. The floras of the Burrum and Styx River Series. *Geol. Surv. Qld Publ.* 263, 7-78.
WALL, D., 1962—Evidence from recent plankton regarding the biological affinities of *Tasmanites* Newton 1875 and *Leiosphaeridia* Eisenack 1958. *Geol. Mag.*, 99(4), 353-62.
WALL, D., 1965—Modern hystrichospheres and dinoflagellate cysts from the Woods Hole region. *Grana Palyn.*, 6(2), 297-314.
WALL, D., 1967—Fossil microplankton in deep-sea cores from the Caribbean Sea. *Palaeontology*, 10(1), 95-123.
WALL, D., & DALE, B., 1967—The resting cysts of modern marine dinoflagellates and their palaeontological significance. *Rev. Palaeobot. Palyn.*, 2(2), 349-54.
WALL, D., & DALE, B., 1968—Modern dinoflagellate cysts and evolution of the Peridiniales. *Micropaleontology*, 14(3), 265-304.
WALL, D., & DALE, B., 1970—Living hystrichosphaerid dinoflagellate spores from Bermuda and Puerto Rico. *Ibid.*, 16(1), 47-58.
WETZEL, O., 1933—Die in organischer Substanz erhaltenen Mikro-fossilien des Baltischen Kreide-Feuersteins. *Palaeontographica*, 77, 141-88; 78, 1-110.
WETZEL, O., 1950—Deutungsversuche an ausgewählten Gruppen von Mikrofossilien und Mikrostrukturen im baltischen Geschiebefeuerstein und einigen anderen Gesteinen der Kreidezeit. *Abh. N. Jb. Mineral.*, 91(2), 161-92.
WETZEL, O., 1961—New microfossils from Baltic Cretaceous flintstones. *Micropaleontology*, 7(3), 337-50.
WETZEL, W., 1952—Beitrag zur Kenntnis des dan-zeitlichen Meeresplanktons. *Geol. Jb.* (1950), 66, 391-419.
WEYLAND, H., & GREIFELD, G., 1953—Uber strukturbietende Blätter und pflanzliche Mikrofossilien aus den untersenonen Tonen der Gegend von Quedlinburg. *Palaeontographica B*, 95(1-3), 30-52.
WEYLAND, H., & KRIEGER, W., 1953—Die Sporen und Pollen der Aachener Kreide und ihre Bedeutung für die Charakterisierung des Mittleren Senons. *Ibid.*, 95, 6-29.
WHITE, H. H., 1842—On fossil Xanthidia. *Microsc. J., London*, 11, 35-40.
WILLIAMS, G. L., & DOWNIE, C., 1966—Further dinoflagellate cysts from the London Clay. *Bull. Br. Mus. nat. Hist. (Geol.), Suppl.* 3, 215-36.
WILSON, G. J., 1967—Microplankton from the Garden Cove Formation. Campbell Island. *N.Z. J. Bot.*, 5(2), 223-40.
WILSON, G. J., 1971—Observations on European late Cretaceous dinoflagellate cysts. *II int. Conf. Planktonic Microfossils Proc.* 2, 1259-75.
WILSON, R. L., & WEBSTER, R. M., 1946—Plant microfossils from a Fort Union Coal of Montana. *Am. J. Bot.*, 33, 271-8.

WODEHOUSE, R. P., 1933—The oil shales of the Eocene Green River Formation. *Bull. Torr. bot. Club*, 1, 479-524.
WRIGHT, C. W., 1963—Cretaceous ammonites from Bathurst Island, northern Australia. *Palaeontology*, 6(4), 597-614.

ZAITZEFF, J. B., & CROSS, A. T., 1970—The use of dinoflagellates and acritarchs for zonation and correlation of the Navarro Group (Maastrichtian) of Texas. *Geol. Soc. Am., spec. Pap.* 127, 341-77.

SPECIES INDEX OF FOSSIL MICROPLANKTON

BMR Species No.	*DINOFLAGELLATES*	Page
1016	*Achomosphaera* sp.A.	45
990	*Actinotheca* sp.A.	67
977	*Adnatosphaeridium uncinatum* sp.nov.	74
956	*Apteodinium maculatum* Eisenack & Cookson, 1960.	38
1027	*Ascodinium acrophorum* Cookson & Eisenack, 1960a.	85
744	*Ascodinium (al. Deflandrea) parvum* (Cookson & Eisenack, 1958) Cookson & Eisenack, 1960a.	85
1028	*Ascodinium* sp.A.	86
1029	*Astrocysta* sp.cf.*A* (al. *Palaeoperidinium*) *cretacea* (Pocock, 1962) Davey, 1970.	83
989	*Callaiosphaeridium* (al. *Hystrichosphaeridium*) *asymmetricum* (Deflandre & Courteville, 1939) Davey & Williams, 1966b.	67
961	*Canninginopsis denticulata* Cookson & Eisenack, 1962a.	76
979	*Cassiculosphaeridia reticulata* Davey, 1969a.	59
1047	*Chlamydophorella nyei* Cookson & Eisenack, 1958.	101
968	*Chytroeisphaeridia* sp.aff. *C.* (al. *Leiosphaeridia*) *chytroeides* (Sarjeant, 1962) Downie, Evitt & Sarjeant, 1963.	78
971	?*Chytroeisphaeridia* sp.A.	79
992	*Cleistophaeridium* (al. *Hystrichosphaeridium*) *anchoriferum* (Cookson & Eisenack, 1960a) Davey et al., 1966b.	64
999	*Cleistosphaeridium* sp.aff.*C.*(al. *Hystrichosphaeridium*) *armatum* (Deflandre, 1937) Davey, 1969a.	65
991	*Cleistosphaeridium* (al. *Hystrichosphaeridium*) *polypes* (Cookson & Eisenack, 1962a) Davey, 1969a.	64
993	?*Cleistosphaeridium* sp.A.	65
1002	?*Cleistosphaeridium* sp.B.	66
995	?*Cleistosphaeridium* sp.C.	66
1003	?*Cordosphaeridium* sp.A.	50
1004	*Coronifera oceanica* Cookson & Eisenack, 1958.	53
959	*Cribroperidinium cooksonae* sp.nov.	36
957	*Cribroperidinium* (al. *Gonyaulax*) *edwardsii* (Cookson & Eisenack, 1958) Davey, 1969a.	33
958	*Cribroperidinium* (al. *Gonyaulax*) *muderongensis* (Cookson & Eisenack, 1958) Davey, 1969a.	30
745	*Cyclonephelium compactum* Deflandre & Cookson, 1955.	68
980	*Cyclonephelium distinctum* Deflandre & Cookson, 1955.	69
983	*Cyclonephelium* sp.cf.*C.hughesii* Clarke & Verdier, 1967.	71
981	*Cyclonephelium membraniphorum* Cookson & Eisenack, 1962a.	71
984	*Cyclonephelium vannophorum* Davey, 1969a.	72
985	*Cyclonephelium* sp.A.	72
986	*Cyclonephelium* sp.B.	73
987	*Cyclonephelium* sp.C.	73
988	*Cyclonephelium* sp.D.	74
1032	*Deflandrea* sp.A.	82
1030	?*Deflandrea* sp.B.	82
973	*Diconodinium* (al. *Palaeohystrichophora*) *dispersum* (Cookson & Eisenack, 1958) Eisenack & Cookson, 1960.	102
975	*Diconodinium* sp.cf.*D. glabrum* Eisenack & Cookson, 1960.	103
974	*Diconodinium* (al. *Palaeohystrichophora*) *multispinum* (Deflandre & Cookson, 1955) Eisenack & Cookson, 1960.	102
976	*Diconodinium* sp.cf.*D. tenuistriatum* Eisenack & Cookson, 1960.	103
965	Dinoflagellate Incertae Sedis form A.	104
966	Dinoflagellate Incertae Sedis form B.	104
1043	?*Dinopterygium* sp.A.	47
1046	*Disphaeria macropyla* Cookson & Eisenack, 1960a.	99
998	*Exochosphaeridium brevispinum* sp. nov.	53
997	*Exochosphaeridium cenomaniense* sp. nov.	52
1001	*Exochosphaeridium* sp.cf.*E. phragmites* Davey et al., 1966b.	51
1000	*Exochosphaeridium* (al. *Hystrichosphaeridium*) *pseudhystrichodinium* (Deflandre, 1937) Davey et al., 1966b.	51
1005	*Florentinia laciniata* Davey & Verdier, 1973.	55
1006	*Florentinia* (al. *Hystrichosphaeridium*) *mantellii* (Davey & Williams, 1966b) Davey & Verdier, 1973.	56
951	*Gonyaulacysta* (al. *Gonyaulax*) *cassidata* (Eisenack & Cookson, 1960) Sarjeant, 1966a.	25
952	*Gonyaulacysta* sp.A.	26

BMR Species No.		Page
1025	*Heslertonia* (al. *Cymatiosphaera*) *striata* (Eisenack & Cookson, 1960) nov. comb.	47
1035	*Hexagonifera chlamydata* Cookson & Eisenack, 1962a.	97
1036	*Hexagonifera defloccata* Davey & Verdier, 1973.	97
1051	?*Horologinella* sp.cf.*H. extrema* Cookson & Eisenack, 1962b.	106
1013	*Hystrichodinium* sp.cf.*H. pulchrum* Deflandre, 1935.	46
996	*Hystrichosphaeridium difficile* Manum & Cookson, 1964.	60
1007	?*Hystrichosphaeridium* sp.A.	60
1042	*Kalyptea* sp.cf.*K. monoceras* Cookson & Eisenack, 1960b.	97
1008	*Litosphaeridium* (al. *Hystrichosphaeridium*) *siphoniphorum* (Cookson & Eisenack, 1958) Davey & Williams, 1966b.	62
967	?*Meiourogonyaulax* sp.A.	58
970	*Membranosphaera granulata* sp.nov.	79
969	?*Membranosphaera* sp.A.	80
963	*Microdinium ornatum* Cookson & Eisenack, 1960a.	57
962	*Microdinium* sp.cf.*M. setosum* Sarjeant, 1966a.	58
964	*Microdinium* sp.A.	58
747	*Odontochitina* (al. *Ceratium*) *operculata* (O. Wetzel, 1933) *costata* Alberti, 1961, group.	89
1038	*Odontochitina* sp.A.	94
1009	*Oligosphaeridium* (al. *Xanthidium*) *complex* (White, 1842) Davey & Williams, 1966b.	61
1010	*Oligosphaeridium* (al. *Hystrichosphaeridium*) *pulcherrimum* (Deflandre & Cookson, 1955) Davey & Williams, 1966b.	61
1026	?*Ovoidinium fragile* sp.nov.	88
982	*Palaeohystrichophora infusorioides* Deflandre, 1935.	103
1050	*Palaeostomocystis fragilis* Cookson & Eisenack, 1962a.	106
1033	*Pareodinia* sp.A.	81
1037	*Phoberocysta* (al. *Hystrichosphaera*) *ceratioides* (Deflandre, 1937) Millioud, 1969.	95
1011	*Prolixosphaeridium conulum* Davey, 1969a.	62
954	*Psaligonyaulax deflandrei* Sarjeant, 1966a.	27
955	*Psaligonyaulax* (al. *Scriniodinium*) *galeata* (Cookson & Eisenack, 1960a) Davey & Verdier, 1973.	28
1039	*Pseudoceratium* (al. *Ceratocystidiopsis*) *ludbrookae* (Cookson & Eisenack, 1958) Eisenack, 1961.	95
1040	*Pseudoceratium* sp.cf.*P. turneri* Cookson & Eisenack, 1958.	96
1034	*Pyxidiella* sp.A.	81
972	*Rhombodella natans* Cookson & Eisenack, 1962a.	104
1019	*Spiniferites* (al. *Hystrichosphaera*) *cingulatus* var. *cingulatus* (Clarke & Verdier, 1967) nov. comb.	42
1020	*Spiniferites* (al. *Hystrichosphaera*) *cingulatus* var. *granulatus* (Clarke & Verdier, 1967) nov. comb.	43
1018	*Spiniferites* (al. *Cymatiosphaera*) *pterotus* (Cookson & Eisenack, 1958) Sarjeant, 1970.	41
1014	*Spiniferites* (al. *Xanthidium*) *ramosus* (Ehrenberg, 1838) Mantell, 1854.	40
1015	*Spiniferites* sp.cf.*S.* (al. *Hystrichosphaera*) *scabrosus* (Clarke & Verdier, 1967) nov. comb.	41
1017	*Spiniferites* (al. *Hystrichosphaera*) *speciosus* (Deflandre, 1934) Sarjeant, 1970.	41
953	*Spiniferites* sp.A.	43
1021	*Spiniferites* sp.B.	43
1022	*Spiniferites* sp.C.	44
1023	?*Spiniferites* sp.D.	44
1115	?*Spiniferites* sp.E.	44
1044	*Stephodinium* sp.cf.*S. coronatum* Deflandre, 1936a.	98
1045	*Stephodinium* sp.A.	99
1012	*Tanyosphaeridium salpinx* sp.nov.	63
960	*Trichodinium* (al. *Palaeoperidinium*) *castanea* (Deflandre, 1935) Clarke & Verdier, 1967.	38
994	*Trichodinium* sp.A.	39
1049	*Trigonopyxidia* (al. *Trigonopyxis*) *ginella* (Cookson & Eisenack, 1960a) Manum & Cookson, 1964.	105
1031	*Trithyrodinium* sp.A.	83
978	*Valensiella griphus* sp.nov.	75
1048	*Wallodinium* (al. *Diplotesta*) *luna* (Cookson & Eisenack, 1960a) nov. comb.	84
1024	*Xiphophoridium* (al. *Hystrichodinium*) *alatum* (Cookson & Eisenack, 1962a) Sarjeant, 1966a.	59

BMR Species No.		Page
	ACRITARCHS and CHLOROPHYTA	
1116	*Baltisphaeridium* sp.A.	108
1117	*Baltisphaeridium* sp.B.	108
1118	*Baltisphaeridium* sp.C.	108
1119	*Baltisphaeridium* sp.D.	109
1053	*Cymatiosphaera* sp.cf.*C. conopa* Davey, 1970.	110
1052	*Cymatiosphaera radiata* O. Wetzel, 1933.	110
——	*Leiosphaeridia* spp.	110
1055	*Micrhystridium* sp.cf.*M. singulare* Firtion, 1952.	107
1056	*Micrhystridium* sp.A.	107
——	*Micrhystridium* spp.	107
1061	*Palambages* form A Manum & Cookson, 1964.	113
1058	*Pterospermopsis* sp.cf.*P. aureolata* Cookson & Eisenack, 1958.	111
1057	*Pterospermopsis australiensis* Deflandre & Cookson, 1955.	111
1059	*Pterospermopsis* sp.A.	112
428	*Schizosporis reticulatus* Cookson & Dettmann, 1959.	112
1054	*Veryhachium reductum* Deunff, 1958.	109

INDEX OF FOSSIL SPORES AND POLLEN GRAINS

——	*Alisporites* sp.	140
1146	*Antulsporites varizonatus* sp. nov.	131
1140	*Appendicisporites distocarinatus* Dettmann & Playford, 1968.	124
1157	*Asteropollis asteroides* Hedlund & Norris, 1968.	144
761	*Balmeisporites glenelgensis* Cookson & Dettmann, 1958.	123
1158	*Balmeisporites tridictyus* Cookson & Dettmann, 1958.	123
375	*Biretisporites spectabilis* Dettmann, 1963.	116
1128	*Camarozonosporites australiensis* sp. nov.	128
1149	*Caprifoliipites* sp.	154
443	*Ceratosporites equalis* Cookson & Dettmann, 1958.	117
403	*Cicatricosisporites* (al. *Mohrioisporites*) *australiensis* (Cookson, 1953) Potonié, 1956.	120
1122	*Cicatricosisporites cuneiformis* Pocock, 1966.	120
490	*Cicatricosisporites hughesii* Dettmann, 1963.	121
1123	*Cicatricosisporites* (al. *Anemia*) *pseudotripartitus* (Bolchovitina, 1961) Dettmann, 1963.	121
1154	*Cicatricosisporites venustus* Deák, 1963.	121
336	*Classopollis simplex* (Danzé-Corsin & Laveine, 1963) Reiser & Williams, 1969.	142
337	*Classopollis* sp.	142
1124	*Clavatipollenites hughesii* Couper, 1958.	145
1159	*Clavatipollenites* sp.A.	146
1127	*Clavifera* (al. *Gleichenia*) *triplex* (Bolchovitina, 1953) Bolchovitina, 1966.	126
1129	*Crybelosporites* cf.*C. brenneri* Playford, 1971.	136
423	*Crybelosporites* (al. *Perotrilites*) *striatus* (Cookson & Dettmann, 1958) Dettmann, 1963.	136
803	*Cupuliferoidaepollenites* cf. *C.* (al. *Tricolpopollenites*) *parvulus* (Groot & Penny, 1960) Dettmann, 1963.	148
374	*Cyathidites australis* Couper, 1953.	116
313	*Cyathidites minor* Couper, 1953.	116
1152	*Dicolpopollis* sp.A.	147
——	*Ephedripites* spp. indet.	144
386	*Foraminisporis* (al. *Apiculatisporites*) *asymmetricus* (Cookson & Dettmann, 1958) Dettmann, 1963.	130
381	*Foraminisporis* (al. *Apiculatisporites*) *wonthaggiensis* (Cookson & Dettmann, 1958) Dettmann, 1963.	130
1150	*Foveogleicheniidites* (al. *Gleicheniidites*) *confossus* (Hedlund, 1966) nov. comb.	127
1135	*Fraxinoipollenites variformis* sp. nov.	149
434	*Gleicheniidites* (al. *Gleichenia*) *circinidites* (Cookson, 1953) Dettmann, 1963.	125
1139	*Gleicheniidites* cf.*G.* (al. *Cingutriletes*) *trijugatus* (Pierce, 1961) nov. comb.	125
1136	*Herkosporites proxistriatus* sp. nov.	118
1125	*Hoegisporis uniforma* Cookson, 1965.	141
715	*Inaperturopollenites limbatus* Balme, 1957.	142
740	*Laevigatosporites ovatus* Wilson & Webster, 1946.	137
1121	*Liliacidites* cf.*L. kaitangataensis* Couper, 1953.	147
812	*Liliacidites* (al. *Peromonolites*) *peroreticulatus* (Brenner, 1963) Singh, 1971.	146

BMR Species No.		Page
321	*Lycopodiumsporites* (al. *Lycopodium*) *austroclavatidites* (Cookson, 1953) Potonié, 1956.	119
461	*Lycopodiumsporites* cf. *L.* (al. *Lycopodium*) *rosewoodensis* (De Jersey, 1959) De Jersey, 1963.	119
404	*Microcachryidites antarcticus* Cookson, 1947.	140
1132	*Microfoveolatosporis canaliculatus* Dettmann, 1963.	137
413	*Neoraistrickia* (al. *Trilites*) *truncata* (Cookson, 1953) Potonié, 1956.	117
1144	*Ornamentifera minima* sp. nov.	126
1130	*Perotrilites* (al. *Kraeuselisporites*) *jubatus* (Dettmann & Playford, 1968) Evans, 1970.	133
1080	*Perotrilites* (al. *Styxisporites*) *linearis* (Cookson & Dettmann, 1958) Evans, 1970.	134
1155	*Perotrilites* (al. *Styxisporites*) *majus* (Cookson & Dettmann, 1958) Evans, 1970.	133
1143	*Perotrilites oepikii* sp. nov.	134
802	*Phimopollenites* (al. *Tricolpites*) *augathellaensis* (Burger, 1970) Dettmann, 1973.	149
1153	cf. *Phimopollenites* sp.	150
1151	*Senectotetradites fistulosus* Dettmann, 1973.	151
1147	*Senectotetradites varireticulatus* Dettmann, 1973.	151
378	*Stereisporites* (al. *Sphagnum*) *antiquasporites* (Wilson & Webster, 1946) Dettmann, 1963.	129
1145	*Stereisporites* sp.	130
1137	*Stoverisporites microverrucatus* sp. nov.	119
1148	*Striatopollis paraneus* (Norris, 1967) Singh, 1971.	152
816	*Tricolpites variabilis* Burger, 1970.	150
1120	*Tricolporites* (al. *Tricolporopollenites*) *distinctus* (Groot & Penny, 1960) nov. comb.	153
732	*Trilobosporites trioreticulosus* Cookson & Dettmann, 1958.	123
1141	*Triporoletes* (al. *Rouseisporites*) *laevigatus* (Pocock, 1962) Playford, 1971.	138
664	*Triporoletes* (al. *Rouseisporites*) *reticulatus* (Pocock, 1962) Playford, 1971.	138
768	*Trisaccites* (al. *Dacrydium*) *microsaccatus* (Couper, 1953) Couper, 1960.	141
1138	*Vallizonosporites* sp.	135
135	*Vitreisporites* (al. *Pityopollenites*) *pallidus* (Reissinger, 1950) Nilsson, 1958.	140

PLATE 1.

		Page
Figs. 1–3	*Cribroperidinium cooksonae*, sp. nov.	
	1. Paratype. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:013:168 (CPC 12195).	36
	2. **Holotype.** × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431 :1 : 118 : 182 (CPC 12196).	
	3. Paratype. × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:029:077 (CPC 12197).	
Figs. 4, 5.	*Gonyaulacysta cassidata* (Eisenack & Cookson)	
	4. Dorsal side. × 700. No. 2 well, core 9, 213.4 m., 700′ 0–6″. M.F.P. 4432:1:117:074 (CPC 12198).	25
	5. Ventral side, same specimen.	
Fig. 6.	*Psaligonyaulax deflandrei* Sarjeant	
	Lateral view, archaeopyle on right. × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:106:086 (CPC 12199).	27
Fig. 7	*Psaligonyaulax galeata* (Cookson & Eisenack)	
	Lateral view, archaeopyle on right. × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:110:150 (CPC 12200).	28
Figs. 8, 9.	*Cribroperidinium muderongensis* (Cookson & Eisenack)	
	8. Ventral view. × 500. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:160:121 (CPC 12201).	30
	9. Dorsal view, same specimen.	

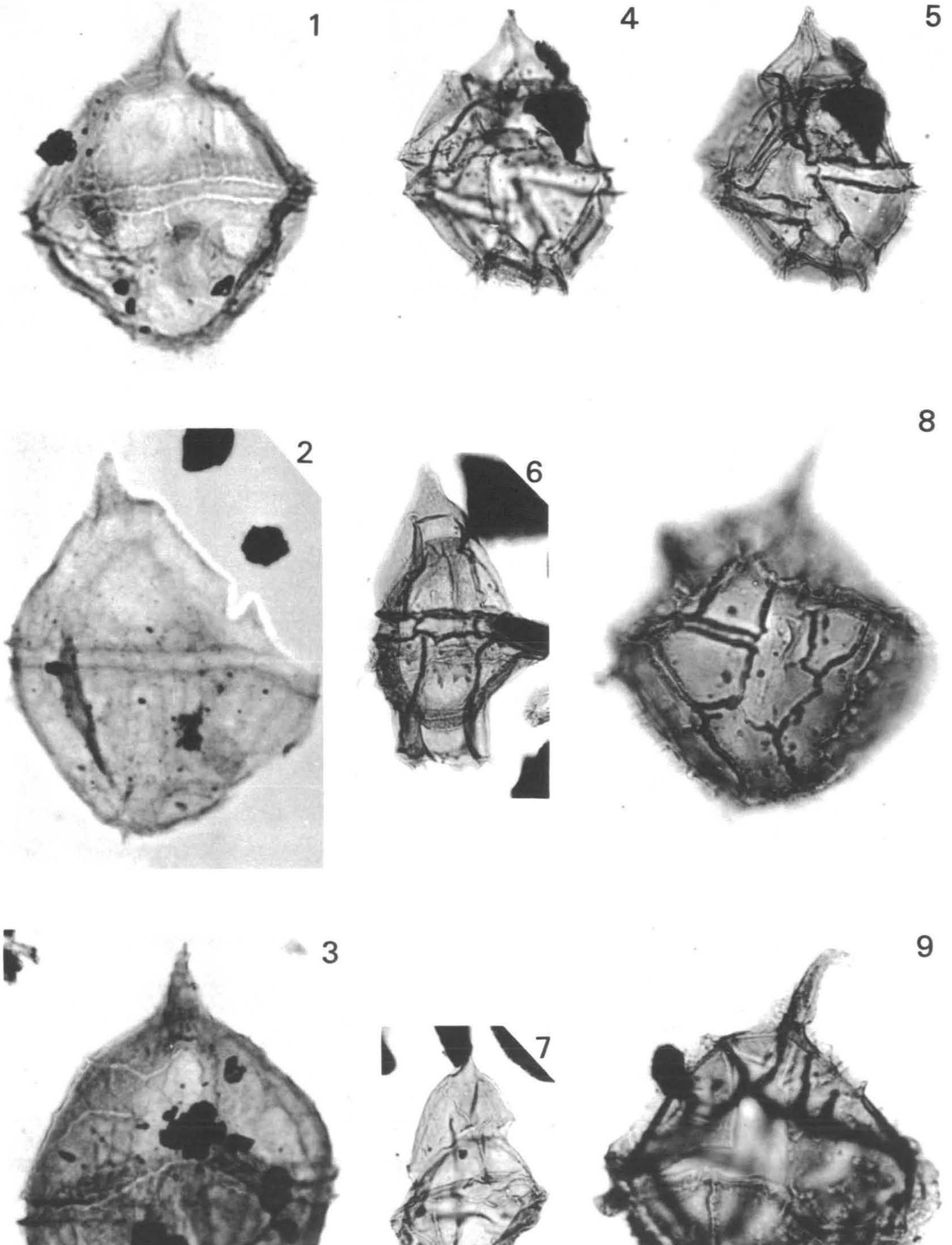
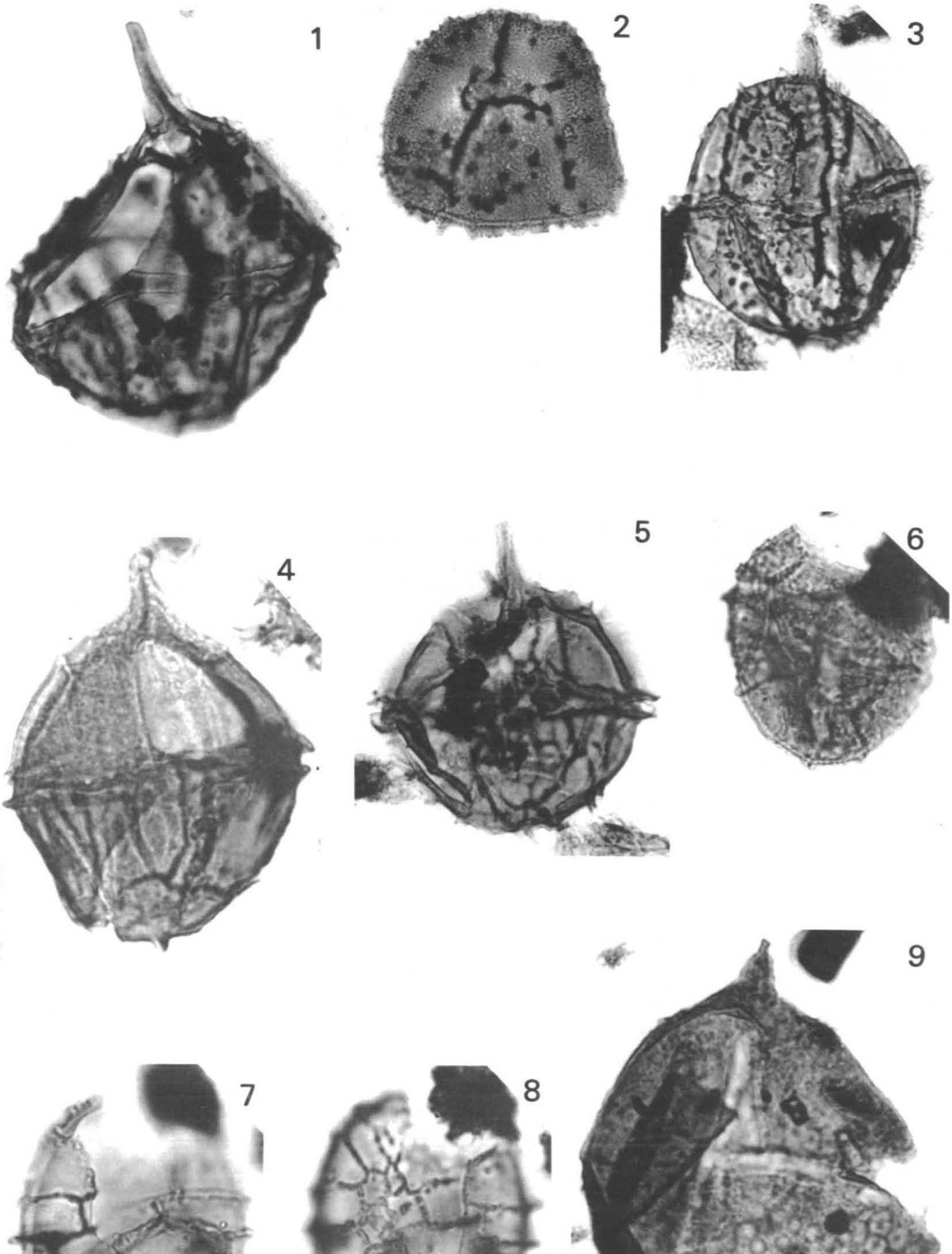

1
4
5
2
6
8
3
7
9

PLATE 2.

		Page
Figs. 1–3.	*Cribroperidinium muderongensis* (Cookson & Eisenack) 1. × 500. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:139:222 (CPC 12205). 2. Detached operculum. × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:192:209 (CPC 12206). 3. × 500. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:148:059 (CPC 12204).	30
Fig. 4.	*Gonyaulacysta* sp. A. × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:207:063 (CPC 12203).	26
Fig. 5.	*Cribroperidinium edwardsii* (Cookson & Eisenack) × 500. No. 2 well, core 9, 213.4 m., 700′ 0–6″. M.F.P. 4432:1:053:103 (CPC 12207).	33
Fig. 6.	*Microdinium* sp. A. × 1000. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:056:153 (CPC 12208).	58
Figs. 7, 8.	*Microdinium ornatum* Cookson & Eisenack 7. Dorsal view. × 1000. No. 2 well, core 6, 216.5 m., 418′ 0–6″. M.F.P. 4435:2:106:058. (CPC 12209). 8. Ventral view, same specimen.	57
Fig. 9.	*Apteodinium maculatum* Eisenack & Cookson × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:096:087 (CPC 12202).	38


1
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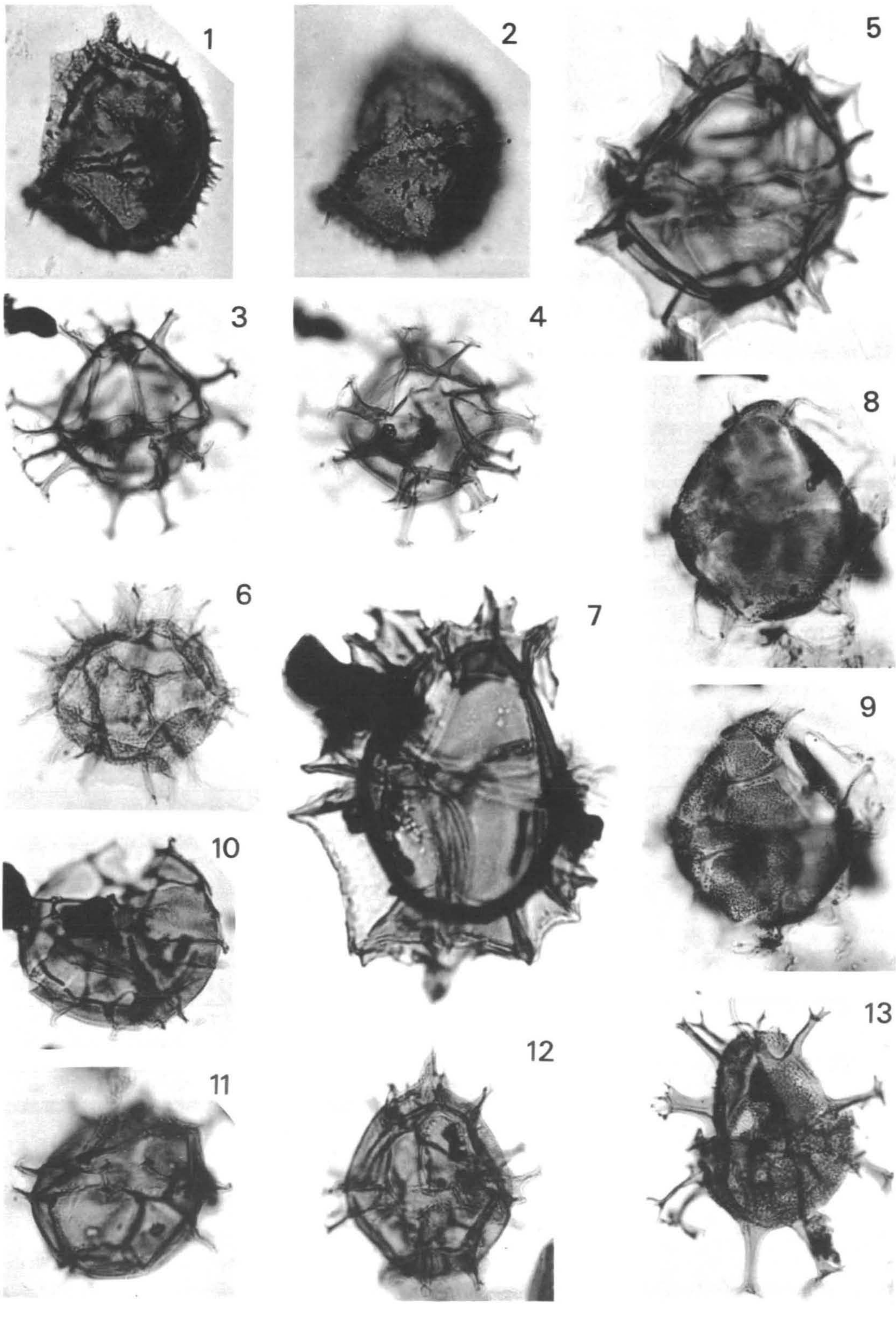
4
5
6
7
8
9

PLATE 3

		Page
Figs. 1, 2	*Trichodinium castanea* (Deflandre) 1. Upper surface. × 700. No. 2 well, core 1, 15.3m., 50′ 0–6″. M.F.P. 4440:1:206:101 (CPC 12210). 2. Lower surface, same specimen.	38
Figs. 3, 4	*Spiniferites ramosus* (Ehrenberg) 3. Dorsal side × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:214:033 (CPC 12211). 4. Ventral side, same specimen.	40
Fig. 5	*Spiniferites pterotus* (Cookson & Eisenack) × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:107:105 (CPC 12212).	41
Fig. 6	*Spiniferites cingulatus granulatus* (Clarke & Verdier) × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:123:003 (CPC 12213).	43
Fig. 7	?*Spiniferites* sp. D. × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:204:212 (CPC 12214).	44
Figs. 8, 9	*Achomosphaera* sp. A 8. Optical section × 700. No. 2 well, core 9, 213.4m., 700′ 0–6″. M.F.P. 4432:1:028:114 (CPC 12215). 9. Lateral surface, same specimen.	45
Fig. 10	*Spiniferites* sp. A × 700. No. 2 well, core 2, 45.8m., 150′ 0–6″. M.F.P. 4439:1:118:075 (CPC 12216).	43
Fig. 11	*Spiniferites cingulatus cingulatus* (Clarke & Verdier) × 700. No. 2 well, core 12, 311.9m., 1023′ 0–6″. M.F.P. 4429:2:213:195 (CPC 12217).	42
Fig. 12	*Spiniferites speciosus* (Deflandre) × 700. No. 2 well, core 12, 311.9m., 1023′ 0–6″. M.F.P. 4429:2:058:034 (CPC 12218).	41
Fig. 13	*Spiniferites* sp. cf. *S. scabrosus* (Clarke & Verdier) × 700. No. 2 well, core 7, 152.3m., 499′ 6–11″. M.F.P. 4434:1:221:159 (CPC 12219).	41


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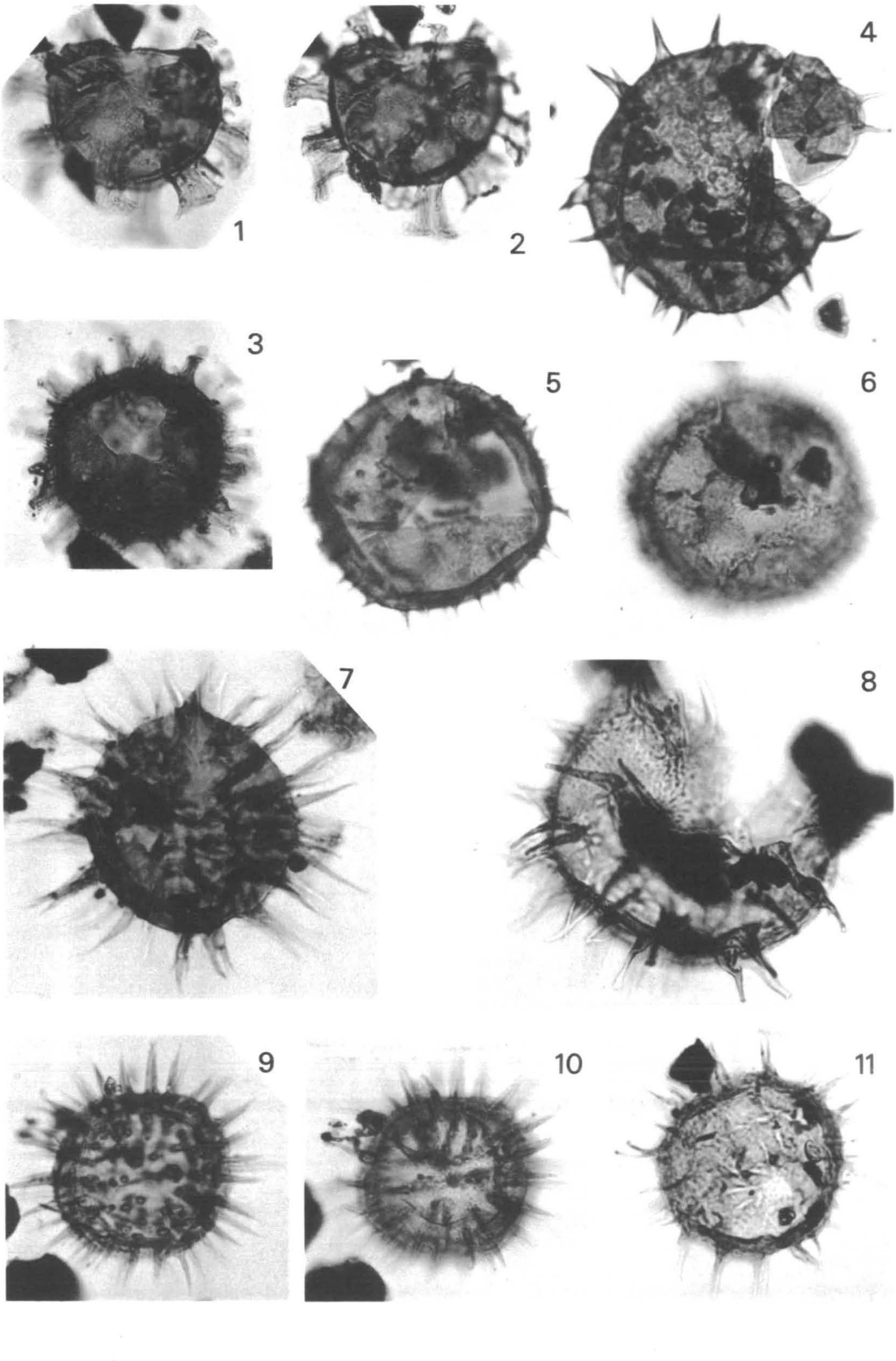
3
4
8
6
7
9
10
13
12
11

PLATE 4

		Page
Figs. 1, 3	*Hystrichosphaeridium difficile* (Manum & Cookson) 1. Upper surface and archaeopyle. × 700. No. 2 well, core 3, 61.0m., 200′ 0–6″. M.F.P. 4438:1:225:056 (CPC 12220). 2. Lower surface, same specimen. 3. Oblique apical view of archaeopyle. × 700. No. 2 well, core 8, 182.8m., 599′ 6–11″. M.F.P. 4433:1:186:034 (CPC 12221).	60
Figs. 4, 8	*Exochosphaeridium cenomaniense* sp. nov. 4. **Holotype** showing 2P archaeopyle. × 700. No. 1 well, core 1, 30.5m., 100′ 0–6″. M.F.P. 4450:1:176:054 (CPC 12222). 8. Paratype. × 700. No. 2 well, core 3, 61.0m., 200′ 0–6″. M.F.P. 4438:1:034:183 (CPC 12223).	52
Figs. 5, 6	*Exochosphaeridium brevispinum* sp. nov. 5. **Holotype.** Lower surface and archaeopyle. × 700. No. 2 well, core 4, 91.5m., 298′ 6–11″. M.F.P. 4437:1:033:053 (CPC 12224). 6. Upper surface, same specimen.	53
Figs. 7, 11	*Exochosphaeridium pseudhystrichodinium* (Deflandre) 7. × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:069:035 (CPC 12225). 11. Apical view, seen from below. × 700. No. 2 well, core 8, 182.8m., 599′ 6–11″. M.F.P. 4433:1:042:031 (CPC 12226).	51
Figs. 9, 10	*Cleistosphaeridium* sp. aff. *C. armatum* (Deflandre) 9. Optical section. × 700. No. 2 well, core 2, 45.8m., 150′ 0–6″. M.F.P. 4439:1:162:092 (CPC 12227). 10. Upper surface, same specimen.	65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2
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4
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6
7
8
9
10
11

PLATE 5

		Page
Figs. 1–4	*Oligosphaeridium pulcherrimum* (Deflandre & Cookson) 1. Lateral surface view. × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:068:113 (CPC 12228). 2. Lateral optical section, same specimen. 3. × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:186:025 (CPC 12229). 4. Detail of same specimen, showing process terminations. × 1000.	61
Fig. 5	*Spiniferites* sp. B Lateral view showing archaeopyle and detached operculum inside cyst. × 700. No. 2 well, core 4, 91.5m., 298′ 6–11″. M.F.P. 4437:1:079:116 (CPC 12230).	43

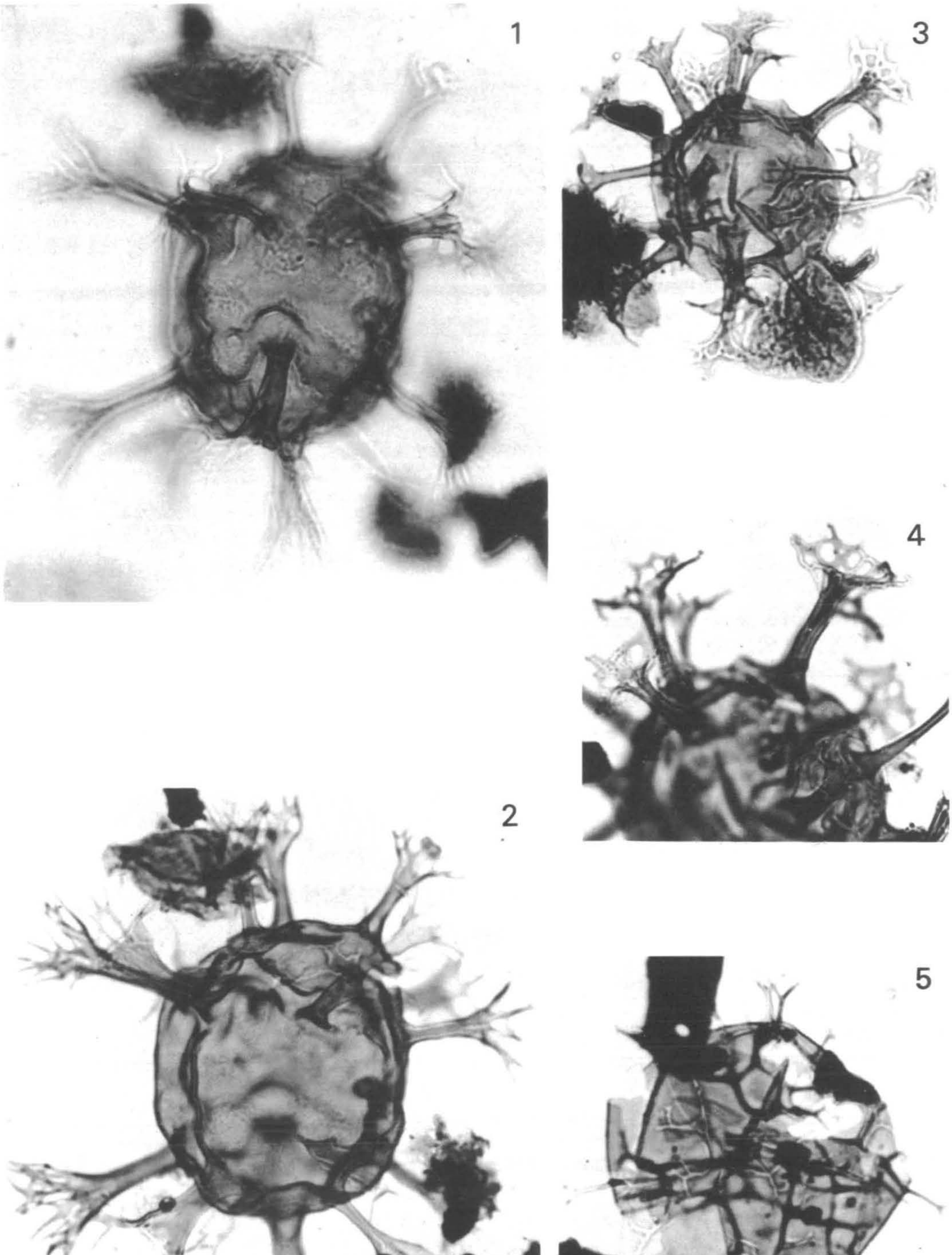
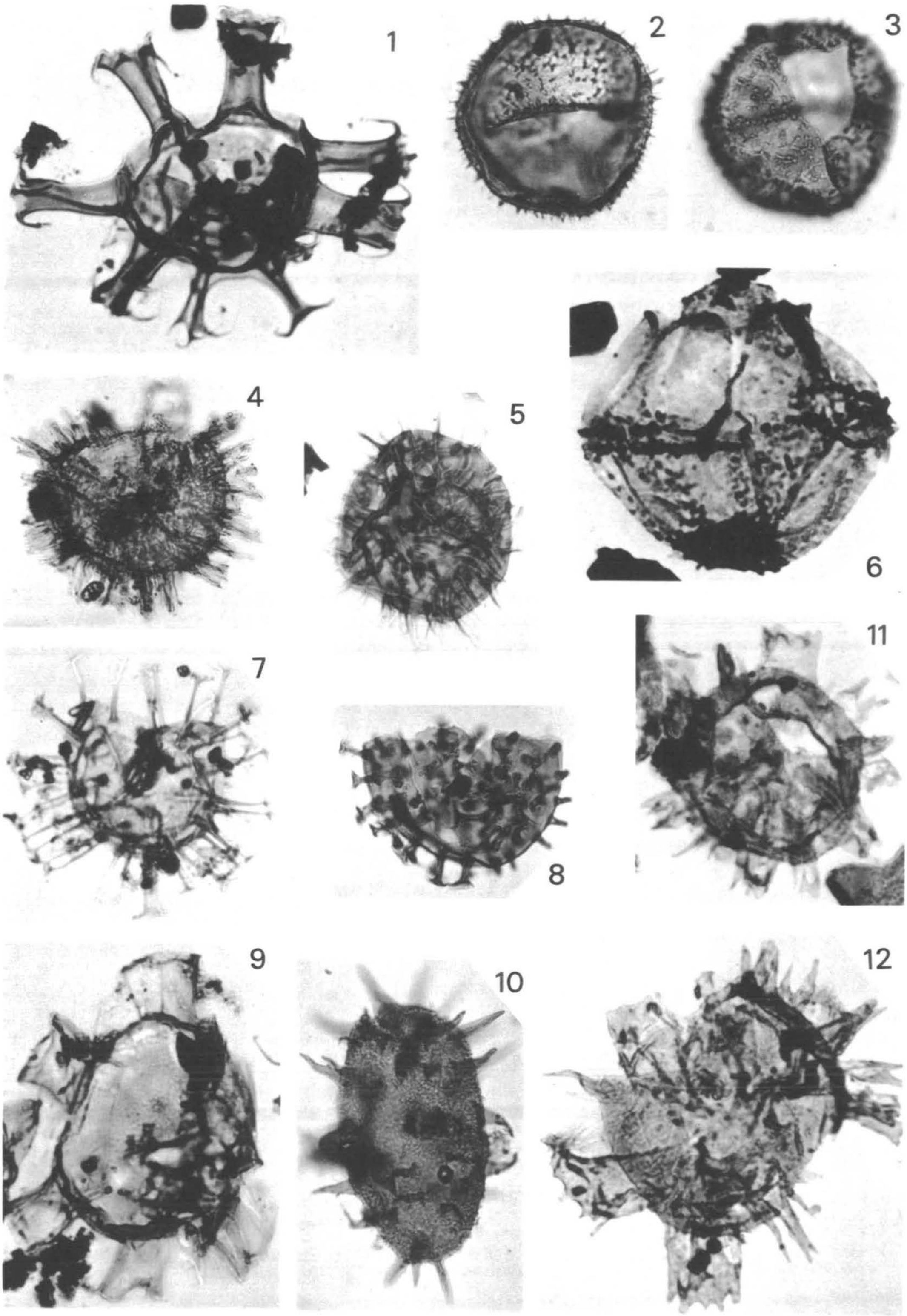

1
3
4
2
5

PLATE 6

		Page
Fig. 1	*Callaiosphaeridium asymmetricum* (Deflandre & Courteville) × 700. No. 2 well, core 6, 126.5m., 418′ 0–6″. M.F.P. 4435:2:216:053 (CPC 12231).	67
Figs. 2, 3	*Trichodinium* sp. A. 2. Optical section. × 700. No. 2 well, core 1, 15.3m., 50′ 0–6″. M.F.P. 4440:1:028:032 (CPC 12232). 3. Surface and archaeopyle of same specimen.	39
Fig. 4	?*Cleistosphaeridium* sp. C Lateral view. × 700. No. 2 well, core 8, 182.8m., 599′ 6–11″. M.F.P. 4433:1:063:197 (CPC 12233).	66
Fig. 5	?*Cleistosphaeridium* sp. B × 700. No. 2 well, core 8, 182.8m., 599′ 6–11″. M.F.P. 4433:1:051:160 (CPC 12234).	66
Fig. 6	?*Meiourogonyaulax* sp. A Lateral view showing apical archaeopyle with operculum still in place. × 700. No. 2 well, core 12, 311.9m., 1023′ 0–6″. M.F.P. 4429:2:196:167 (CPC 12235).	58
Fig. 7	*Cleistosphaeridium polypes* (Cookson & Eisenack) × 700. No. 2 well, core 4, 91.5m., 298′ 6–11″. M.F.P. 4437:1:068:046 (CPC 12236).	64
Fig. 8	*Cleistosphaeridium anchoriferum* (Cookson & Eisenack) × 700. No. 2 well, core 6, 126.5m., 418′ 0–6″. M.F.P. 4435:2:233:092 (CPC 12237).	64
Fig. 9.	*Actinotheca* sp. A × 700. No. 1 well, core 8, 243.8m., 800′ 0–6″. M.F.P. 4445:1:236:216 (CPC 12238).	67
Fig. 10.	*Prolixosphaeridium conulum* Davey Lateral view showing apical archaeopyle with operculum still in place. × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:043:196 (CPC 12239).	62
Figs. 11, 12.	*Florentinia laciniata* Davey & Verdier 11. × 700. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:040:105 (CPC 12240). 12. × 700. No. 2 well, core 8, 182.8m., 599′ 6–11″. M.F.P. 4433:1:190:075 (CPC 12241).	55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3
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5
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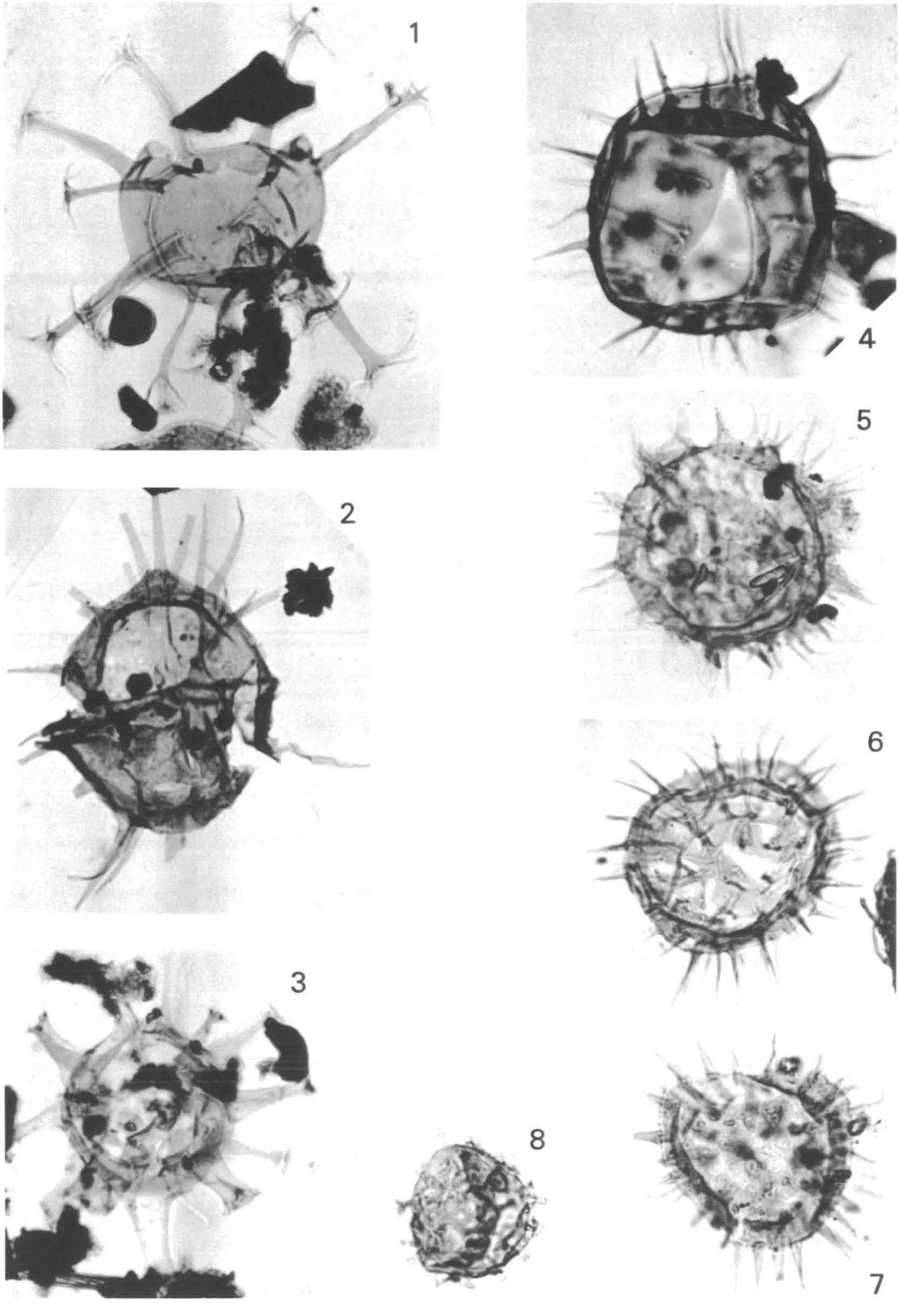
7
8
9
10
11
12

PLATE 7

		Page
Fig. 1.	*Oligosphaeridium complex* (White) × 700. No. 2 well, core 6, 126.5m., 418′ 0–6″. M.F.P. 4435:2:038:078 (CPC 12242).	61
Fig. 2.	*Hystrichodinium* sp. cf. *H. pulchrum* (Deflandre) Dorsal view of variant with broad processes. × 700. No. 2 well, core 3, 61.0m., 200′ 0–6″. M.F.P. 4438:1:182:156 (CPC 12243).	46
Fig. 3.	*Florentinia mantellii* (Davey & Williams) × 700. No. 2 well, core 6, 126.5m., 418′ 0–6″. M.F.P. 4435:2:129:160 (CPC 12244).	56
Fig. 4.	?*Cordosphaeridium* sp. A × 700. No. 2 well, core 10, 248.8m., 816′ 0–6″. M.F.P. 4431:1:137:217 (CPC 12245).	50
Fig. 5.	*Exochosphaeridium* sp. cf. *E. phragmites* (Davey, *et al.*) × 700. No. 2 well, core 3, 61.0m., 200′ 0–6″. M.F.P. 4438:1:221:198 (CPC 12246).	51
Figs. 6, 7.	*Cleistosphaeridium* sp. aff. *C. armatum* (Deflandre) 6. Shows partially detached archaeopyle. × 700. No. 2 well, core 12, 311.9m., 1023′ 0–6″. M.F.P. 4429:2:071:174 (CPC 12247). 7. Lateral view showing apical archaeopyle. × 700. No. 2 well, core 10, 248.8m., 816′ 0–6″. M.F.P. 4431:1:048:195 (CPC 12248).	65
Fig. 8.	?*Hystrichosphaeridium* sp. A × 1000. No. 2 well, core 11, 274.4m., 900′ 0–6″. M.F.P. 4430:2:121:011 (CPC 12249).	60


1
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3
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5
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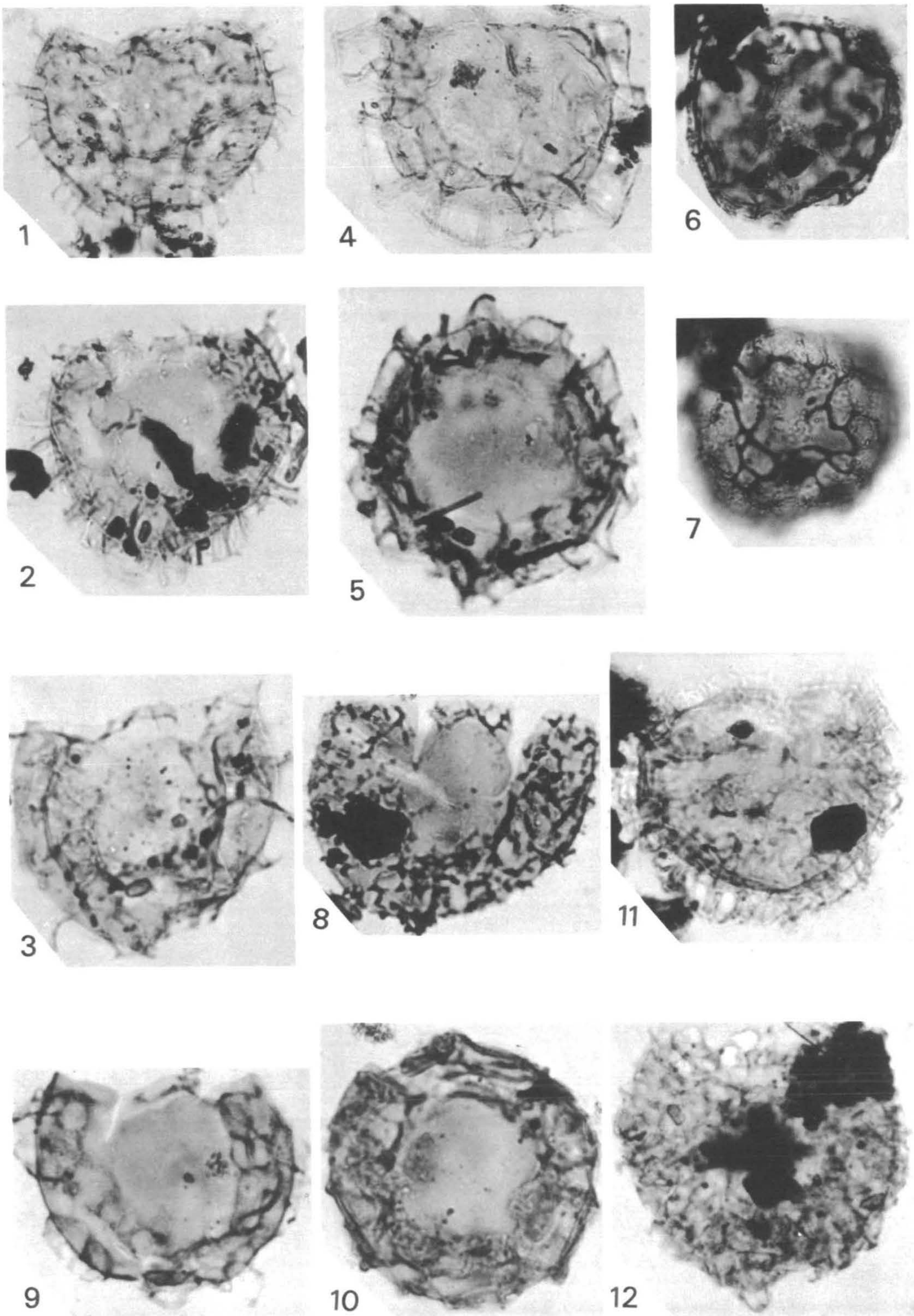
7
8

PLATE 8

		Page
Figs. 1–3.	*Cyclonephelium distinctum* Deflandre & Cookson 1. × 700. No. 2 well, core 9, 213.4m., 700′ 0–6″. M.F.P. 4432:1:212:154 (CPC 12250). 2. × 700. No. 2 well, core 3, 61.0m., 200′ 0–6″. M.F.P. 4438:1:155:205 (CPC 12251). 3. × 700. No. 2 well, core 1, 15.3m., 50′ 0–6″. M.F.P. 4440:1:171:181 (CPC 12252).	69
Figs. 4, 5.	*Cyclonephelium membraniphorum* Cookson & Eisenack 4. × 700. No. 2 well, core 9, 213.4m., 700′ 0–6″. M.F.P. 4432:1:054:085 (CPC 12253). 5. × 700. No. 2 well, core 1, 15.3m., 50′ 0–6″. M.F.P. 4440:1:205:030 (CPC 12254).	71
Figs. 6, 7.	*Valensiella griphus* sp. nov. 6. Paratype, optical section. × 700. No. 2 well, core 1, 15.3m., 50′ 0–6″. M.F.P. 4440:1:119:116 (CPC 12255). 7. Surface of same specimen.	75
Fig. 8.	*Cyclonephelium* sp. B × 700. No. 1 well, core 2, 61.0 m., 200′ 0–6″. M.F.P. 4449:2:224:187 (CPC 12256).	73
Fig. 9.	*Cyclonephelium* sp. C × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:2:065:086 (CPC 12257).	73
Fig. 10.	*Cyclonephelium* sp. A × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:219:195 (CPC 12258).	72
Figs. 11, 12.	*Adnatosphaeridium uncinatum* sp. nov. 11. **Holotype.** × 700. No. 2 well, core 9, 213.4 m., 700′ 0–6″. M.F.P. 4432 : 1 : 215 : 043 (CPC 12259). 12. Paratype. × 700. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:063:067 (CPC 12260).	74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6
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5
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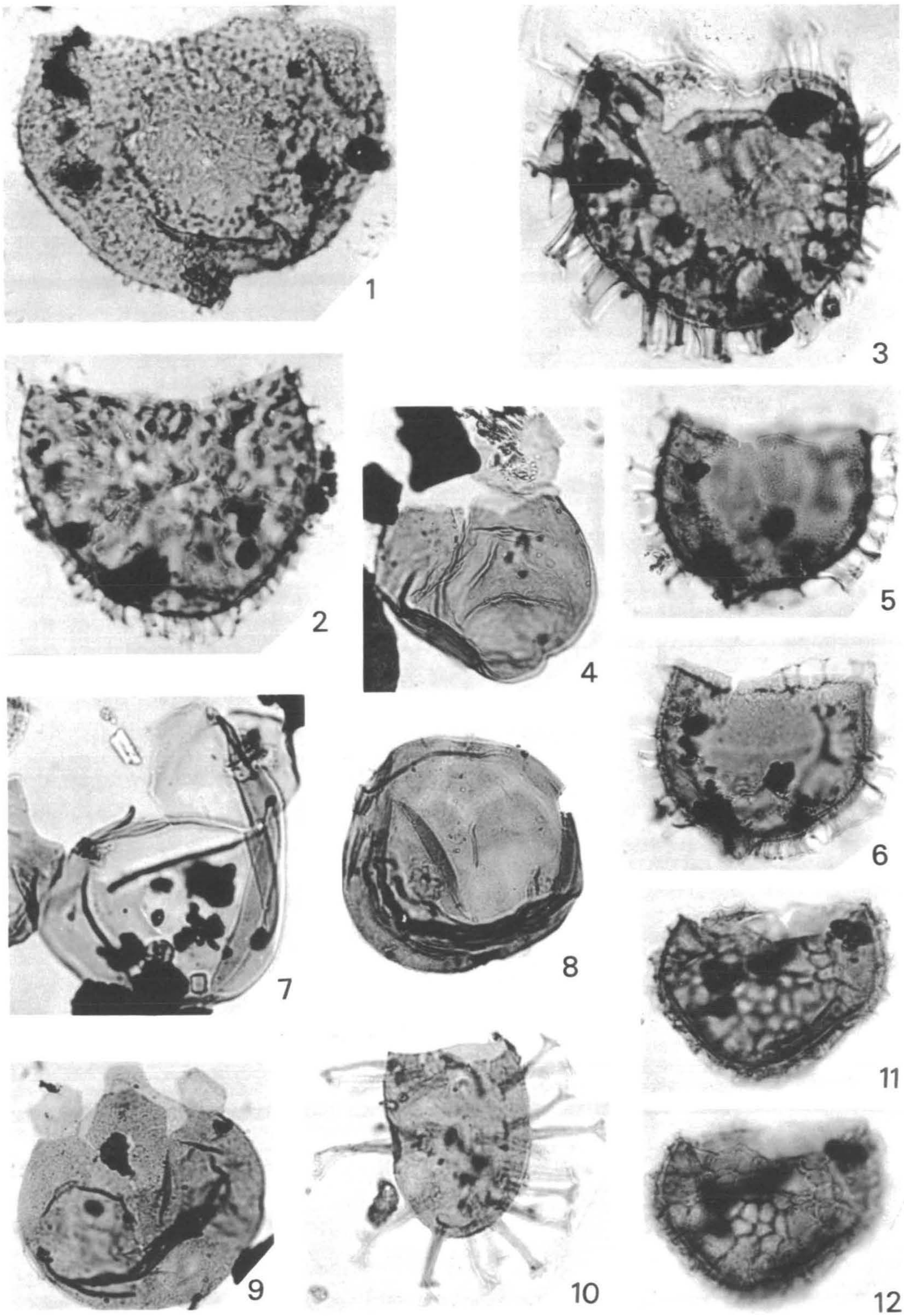
3
8
11
9
10
12

PLATE 9

		Page
Figs. 1, 2.	*Cyclonephelium vannophorum* Davey 1. × 700. No. 1 well, core 2, 61.0 m., 200′ 0–6″. M.F.P. 4449:2:165:164 (CPC 12261). 2. × 700. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:203:208 (CPC 12262).	72
Fig. 3.	*Cyclonephelium* sp. cf. *C. hughesii* Clarke & Verdier × 700. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:031:015 (CPC 12263).	71
Figs. 4, 7.	*Chytroeisphaeridia* sp. aff. *C. chytroeides* (Sarjeant) 4. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:158:112 (CPC 12264). 7. × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:049:160 (CPC 12265).	78
Figs. 5, 6.	*Cyclonephelium compactum* Deflandre & Cookson 5. Ventral (sulcal) surface. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:135:213 (CPC 12266). 6. Dorsal surface of same specimen.	68
Fig. 8.	?*Chytroeisphaeridia* sp. A × 700. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:166:180 (CPC 12267).	79
Fig. 9.	?*Membranosphaera* sp. A × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:093:125 (CPC 12268).	80
Fig. 10	*Tanyosophaeridium salpinx* sp. nov. **Holotype.** × 700. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:130:036 (CPC 12269).	63
Figs. 11, 12.	*Cassiculosphaeridia reticulata* Davey 11. Optical section. × 1000. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:151:215 (CPC 12270). 12. Upper surface of same specimen.	59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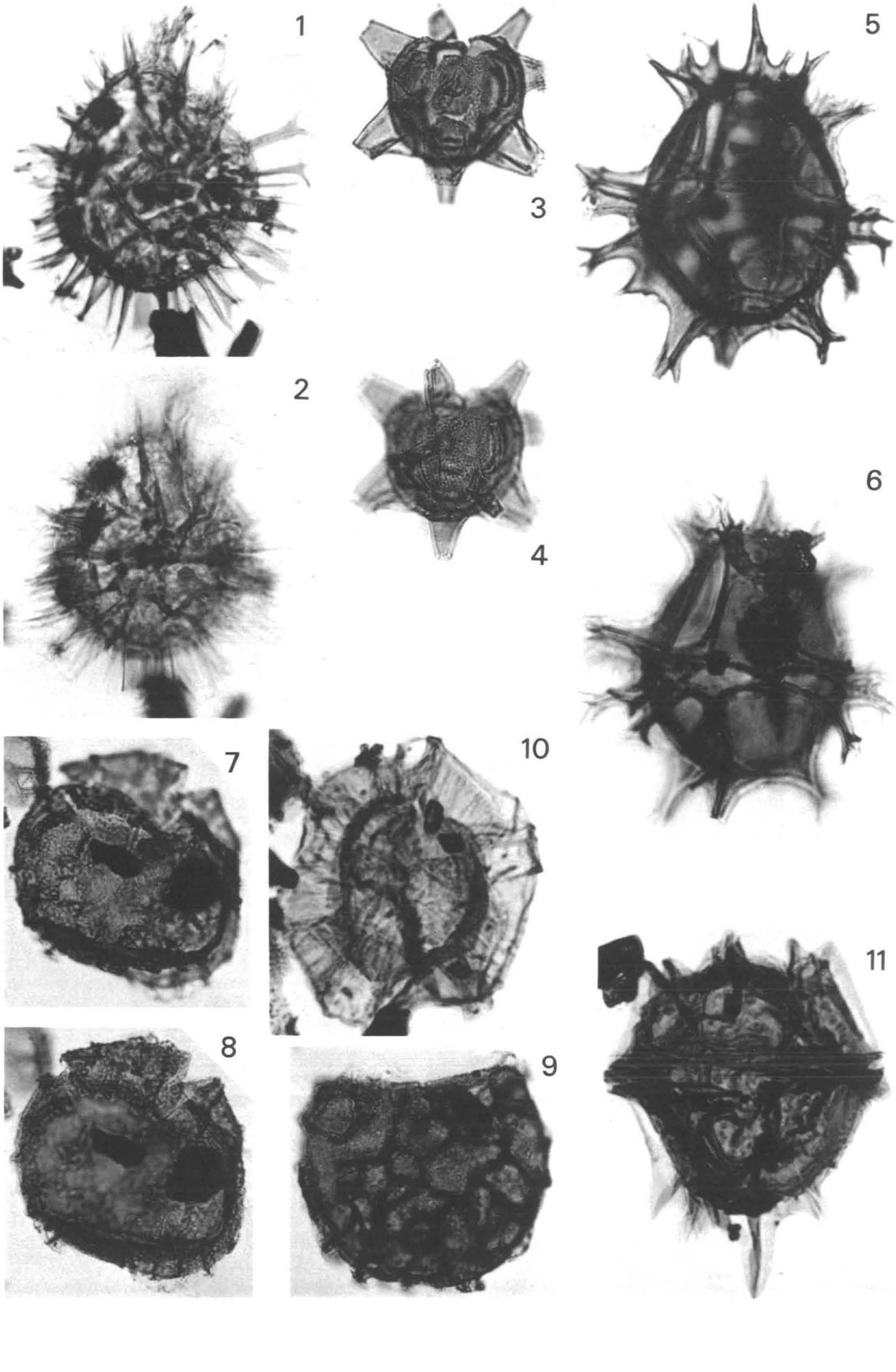
6
7
8
11
9
10
12

PLATE 10

		Page
Figs. 1, 2.	*Coronifera oceanica* Cookson & Eisenack 1. Optical section. × 700. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:161:040 (CPC 12271). 2. Upper surface of same specimen.	53
Figs. 3, 4.	*Litosphaeridium siphoniphorum* (Cookson & Eisenack) 3. Lower surface and archaeopyle. × 700. No. 2 well, core 4, 91.5 m., 298′6–11″. M.F.P. 4437:1:054:017 (CPC 12272). 4. Upper surface of same specimen.	62
Figs. 5, 6.	*Spiniferites* sp. C 5. Optical section. × 700. No. 2 well, core 7, 152.3 m., 499′ 6–11″. M.F.P. 4434:1:102:019 (CPC 12273). 6. Upper surface of same specimen.	44
Figs. 7–9.	*Valensiella griphus* sp. nov. 7. Upper surface of **holotype.** × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:157:060 (CPC 12274). 8. Optical section of same specimen. 9. Paratype. × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:078:119 (CPC 12275).	75
Fig. 10.	*Heslertonia striata* (Eisenack & Cookson) × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:120:113 (CPC 12276).	47
Fig. 11.	*Xiphophoridium alatum* (Cookson & Eisenack) × 700. No. 1 well, core 1, 30.5 m., 100′ 0–6″. M.F.P. 4450:1:155:030 (CPC 12277).	59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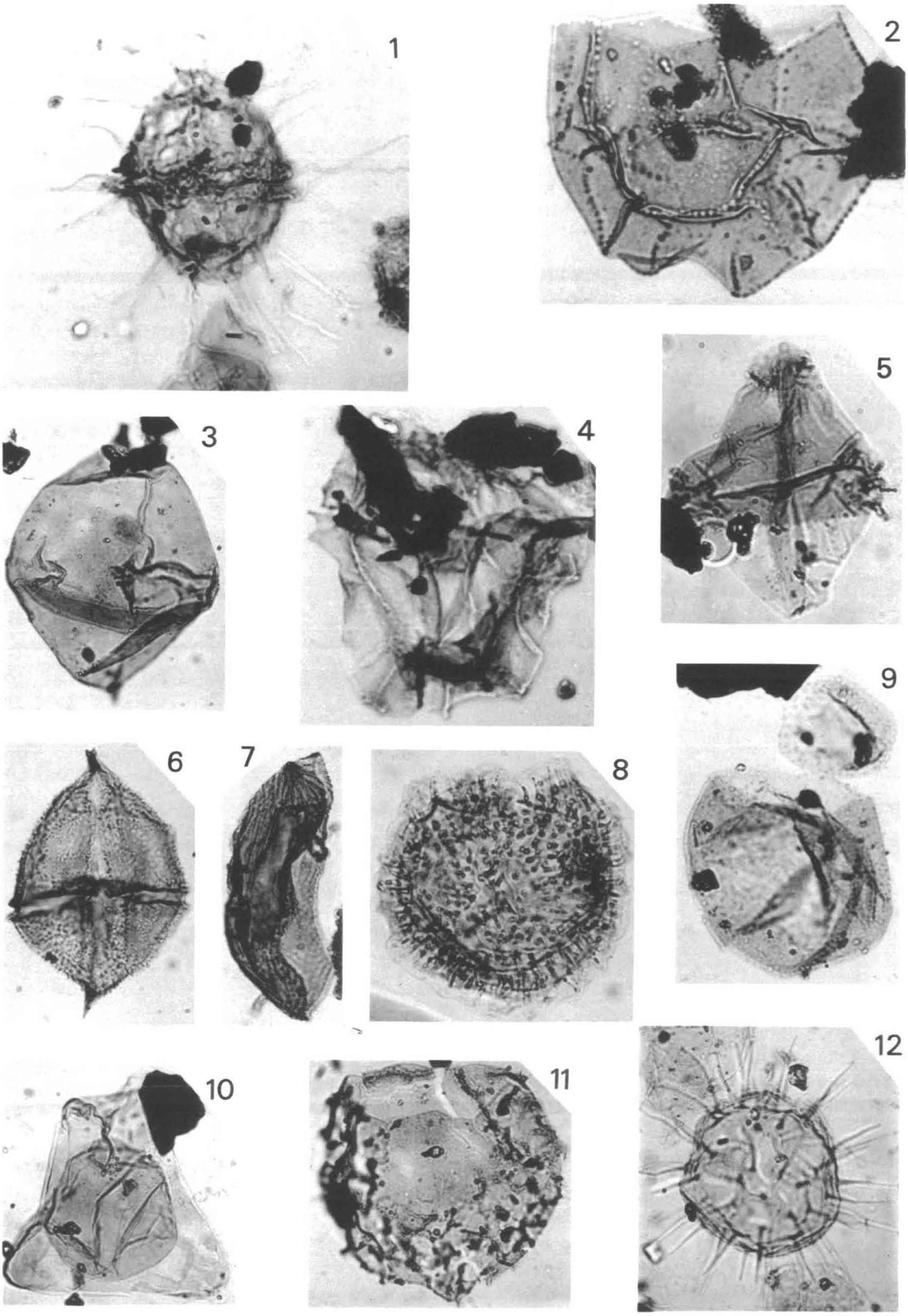
9
10
11

PLATE 11

		Page
Fig. 1.	*Hystrichodinium* sp. cf. *H. pulchrum* Deflandre Variant with narrow processes. × 700. No. 1 well, core 6, 182.9 m., 600′ 0–6″. M.F.P. 4447:2:080:089 (CPC 12278).	46
Fig. 2.	*Canninginopsis denticulata* Cookson & Eisenack × 700. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:042:113 (CPC 12279).	76
Fig. 3.	*Diconodinium* sp. cf. *D. glabrum* Eisenack & Cookson × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:200:137 (CPC 12280).	103
Fig. 4.	?*Dinopterygium* sp. A × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431:1:067:187 (CPC 12281).	47
Fig. 5.	*Rhombodella natans* Cookson & Eisenack × 1000. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:138:220 (CPC 12282).	104
Fig. 6.	*Diconodinium multispinum* (Deflandre & Cookson) × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431:1:035:204 (CPC 12283).	102
Fig. 7.	*Diconodinium* sp. cf. *D. tenuistriatum* Eisenack & Cookson × 700. No. 2 well, core 9, 213.4 m., 700′ 0–6″. M.F.P. 4432:1:158:009 (CPC 12284).	103
Fig. 8.	*Chlamydophorella nyei* Cookson & Eisenack × 1000. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:096:176 (CPC 12285).	101
Fig. 9.	*Membranosphaera granulata* sp. nov. **Holotype.** × 1000. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:096:049 (CPC 12286).	79
Fig. 10.	*Trigonopyxidia ginella* (Cookson & Eisenack) × 700. No. 1 well, core 6, 182.9 m., 600′ 0–6″. M.F.P. 4447:2:128:091 (CPC 12287).	105
Fig. 11	*Cyclonephelium* sp. D × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431:1:228:180 (CPC 12288).	74
Fig. 12.	?*Cleistosphaeridium* sp. A × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431:1:060:169 (CPC 12289).	65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9
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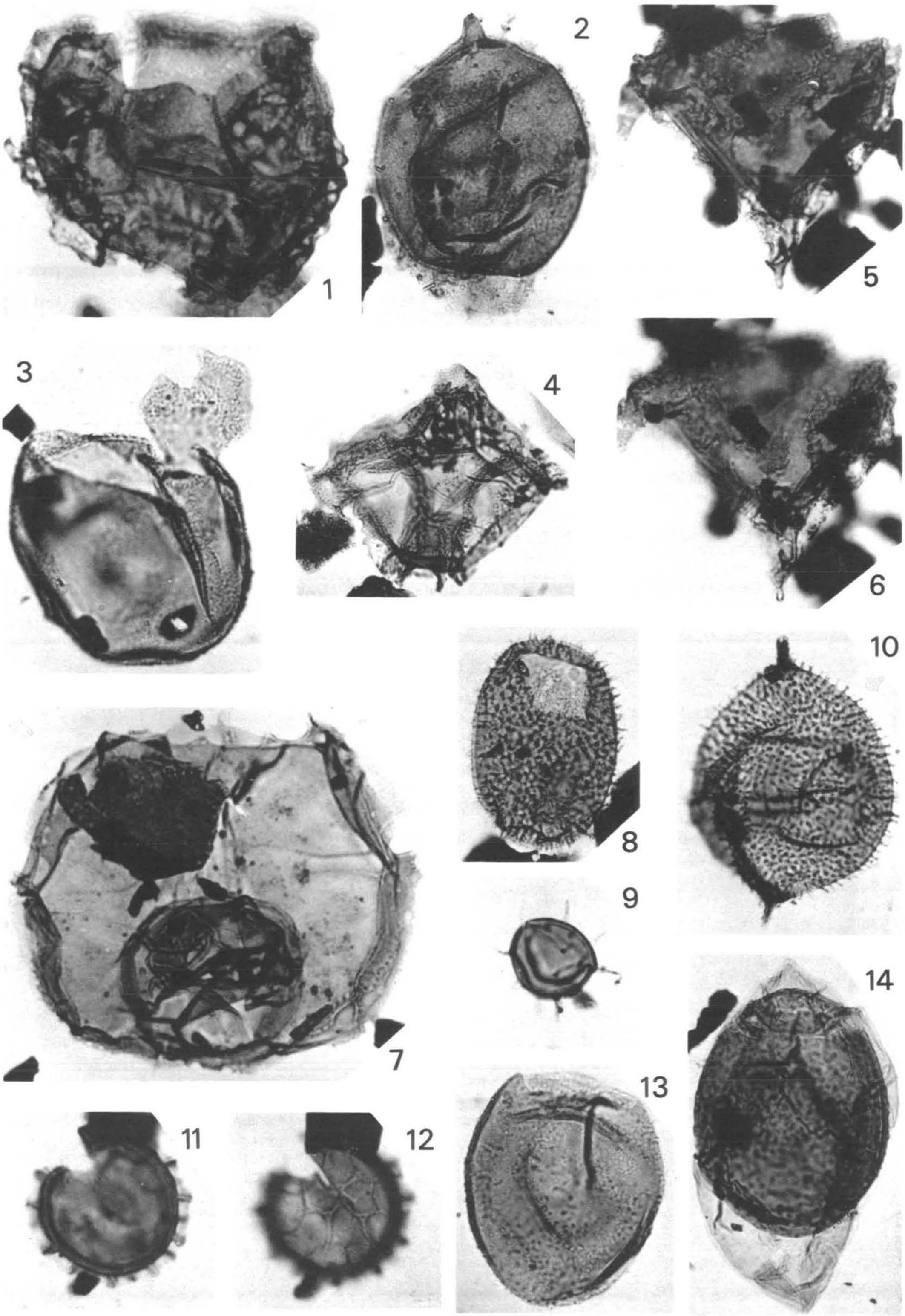
11
12

PLATE 12

		Page
Fig. 1.	*Cyclonephelium* sp. C × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:055:181 (CPC 12290).	73
Fig. 2.	*Kalyptea* sp. cf. *K. monoceras* Cookson & Eisenack × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:127:105 (CPC 12291).	97
Fig. 3.	*Membranosphaera granulata* sp. nov. Paratype. × 1000. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:203:189 CPC 12292).	79
Fig. 4.	Dinoflagellate Incertae Sedis form B × 700. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:048:111 (CPC 12293).	105
Figs. 5, 6.	*Pseudoceratium* sp. cf. *P. turneri* Cookson & Eisenack 5. Optical section. × 500. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:209:136 (CPC 12294). 6. Upper surface of same specimen.	96
Fig. 7.	*Stephodinium* sp. A Apical view. × 700. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:076:142 (CPC 12295).	99
Fig. 8.	*Pyxidiella* sp. A × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:129:089 (CPC 12296).	81
Fig. 9.	*Micrhystridium* sp. A × 1000. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:211:221 (CPC 12297).	107
Fig. 10.	*Diconodinium dispersum* (Cookson & Eisenack) × 700. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:133:209 (CPC 12298).	102
Figs. 11, 12.	*Cymatiosphaera* sp. cf. *C. conopa* Davey 11. Optical section. × 1000. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:2:081:123 (CPC 12299). 12. Upper surface of same specimen.	110
Figs. 13, 14.	*Hexagonifera chlamydata* Cookson & Eisenack 13. Inner capsule only, with fine endophragmic ornament. × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431:1:209:007 (CPC 12300). 14. Complete specimen of more coarsely granulate variant, with archaeopyle still in place. × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:203:197 (CPC 12301).	97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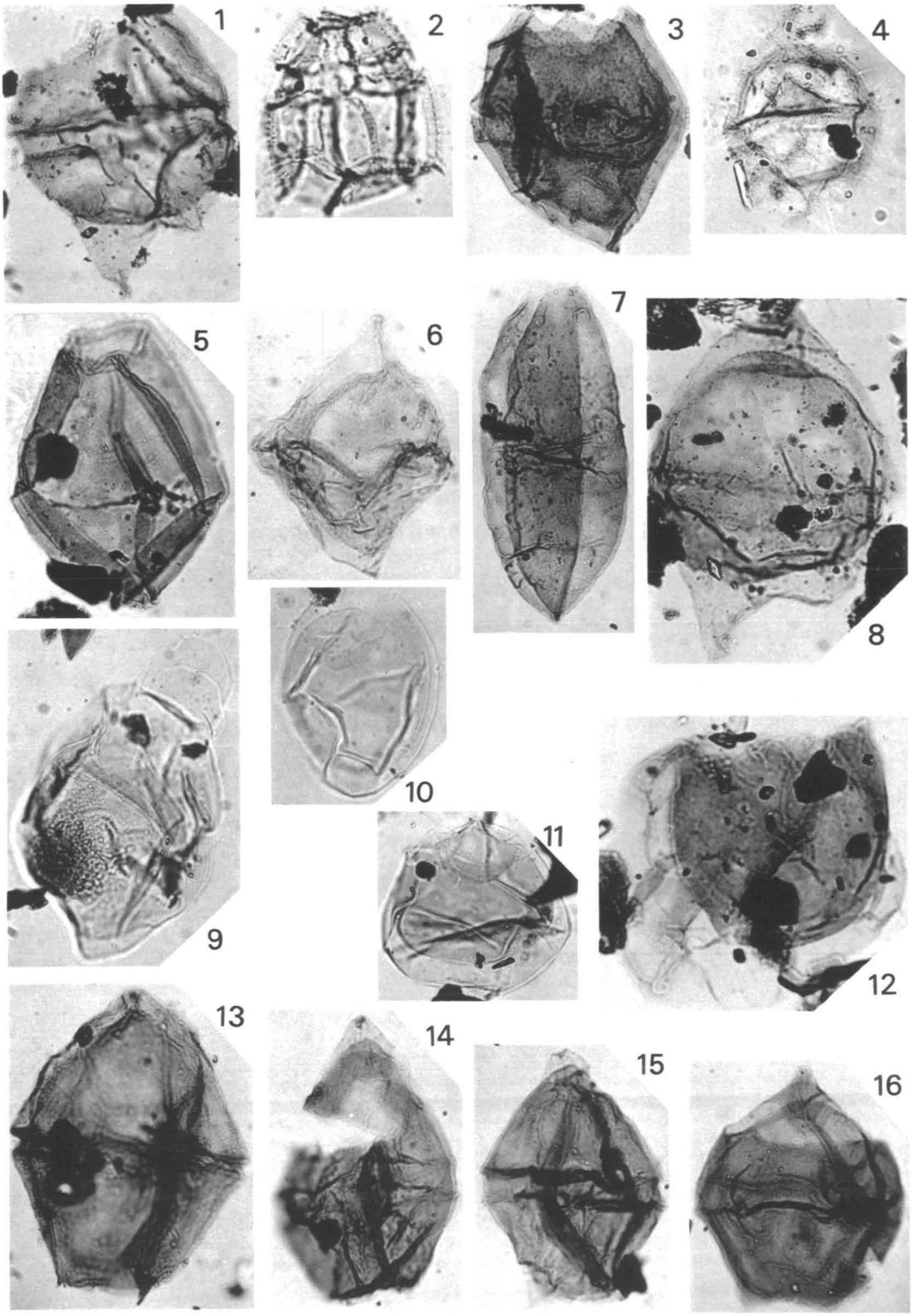
14
7
13
11
12

PLATE 13

		Page
Figs. 1, 8.	?*Ovoidinium fragile* sp. nov. 1. **Holotype.** × 700. No. 1 well, core 8, 243.8 m., 800′ 0–6″. M.F.P. 4445:1:166:187 (CPC 12302). 8. Paratype. × 700. No. 1 well, core 8, 243.8 m., 800′ 0–6″. M.F.P. 4445:1:128:079 (CPC 12303).	88
Figs. 3, 6.	*Ascodinium parvum* (Cookson & Eisenack) 3. Dehisced specimen showing archaeopyle. × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:119:038 (CPC 12304). 6. Complete specimen. × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:190:023 (CPC 12305).	85
Fig. 2.	*Microdinium* sp. cf. *M. setosum* Sarjeant × 1000. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:109:210 (CPC 12306).	58
Fig. 4.	*Palaeohystrichophora infusorioides* Deflandre × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:118:155 (CPC 12307).	103
Figs. 5, 7.	*Palaeostomocystis fragilis* Cookson & Eisenack 5. Rhomboidally folded form. × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:043:098 (CPC 12308). 7. Longitudinally folded form. × 700. No. 2 well, core 9, 213.4 m., 700′ 0–6″. M.F.P. 4432:1:168:109 (CPC 12309).	106
Figs. 9, 10.	*Ascodinium* sp. A 9. Specimen with operculum still partially attached. × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:179:090 (CPC 12310). 10. Dehisced specimen. × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:162:030 (CPC 12311).	86
Fig. 11.	*Ascodinium acrophorum* Cookson & Eisenack × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:101:185 (CPC 12312).	85
Fig. 12.	*Hexagonifera defloccata* Davey & Verdier × 700. No. 1 well, core 6, 182.9 m., 600′ 0–6″. M.F.P. 4447:2:105:120 (CPC 12313).	97
Fig. 13.	?*Deflandrea* sp. B × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:075:121 (CPC 12314).	82
Fig. 14.	*Deflandrea* sp. A × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:172:065 (CPC 12315).	82
Figs. 15, 16.	*Trithyrodinium* sp. A 15. Unruptured specimen. × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:065:074 (CPC 12316). 16. Dehisced specimen with a 3I archaeopyle. × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:181:105 (CPC 12317).	83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16

PLATE 14

		Page
Figs. 1-4.	*Odontochitina operculata—striatoperforata* group 1. Variant with broad horns and few perforations. × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:076:197 (CPC 12318). 2. Detached apical operculum with heavy ridges and common perforations. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:163:091 (CPC 12319). 3. Dehisced specimen with numerous perforations. × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:159:175 (CPC 12320). 4. Corroded operculum. × 700. No. 2 well, core 12. 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:058:202 (CPC 12321).	89
Fig. 5.	*Odontochitina* sp. A Detached operculum. × 700. No. 2 well, core 6, 126.5 m., 418′ 0–6″. M.F.P. 4435:2:047:213 (CPC 12322).	94
Figs. 6, 7.	*Phoberocysta ceratioides* (Deflandre) 6. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:046:169 (CPC 12323). 7. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:2:080:020 (CPC 12324).	95

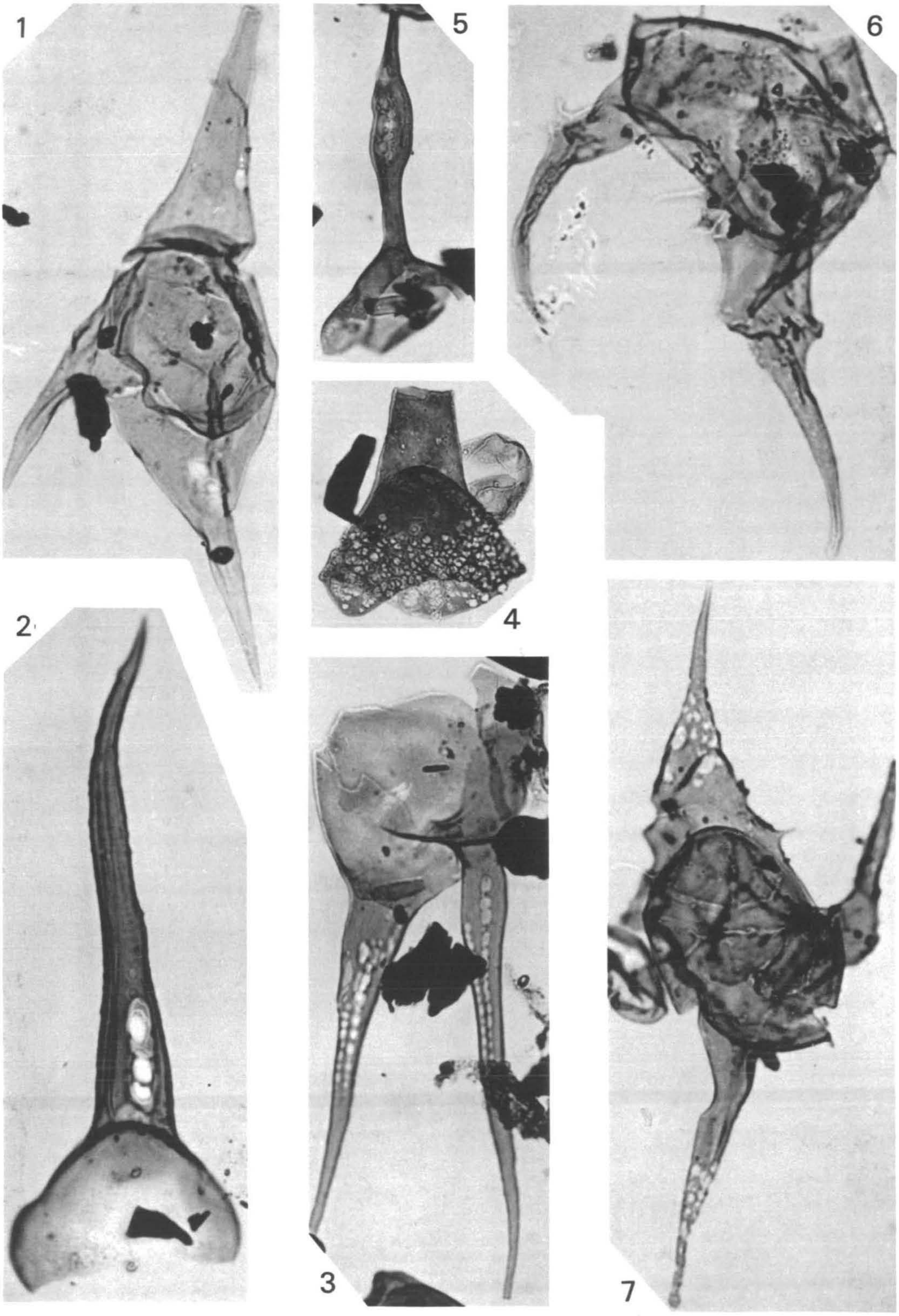
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PLATE 15

		Page
Fig. 1.	*Disphaeria macropyla* Cookson & Eisenack × 700. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:046:166 (CPC 12325).	99
Fig. 2.	*Pareodinia* sp. A × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:055:183 (CPC 12326).	81
Fig. 3.	*Pseudoceratium ludbrookae* Cookson & Eisenack × 500. No. 2 well, core 9, 213.4 m., 700′ 0–6″. M.F.P. 4432:1:066:034 (CPC 12327).	95
Fig. 4.	*Stephodinium* sp. cf. *S. coronatum* Deflandre × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:113:065 (CPC 12328).	98
Figs. 5, 6, 7.	*Veryhachium reductum* Deunff 5. Two horned variant. × 1000. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:192:117 (CPC 12331). 6. Type with four horns. × 1000. No. 2 well. core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:096:202 (CPC 12332). 7. Form with three horns. × 1000. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:195:190 (CPC 12333).	109
Fig. 8.	*Michrystridium* sp. cf. *M. singulare* Firtion × 1000. No. 2 well, core 4, 91.5 m., 298′ 6–11″. M.F.P. 4437:1:075:031 (CPC 12330).	107
Fig. 9.	*Astrocysta* sp. cf. *A. cretacea* (Pocock) × 700. No. 1 well, core 2, 61.0 m., 200′ 0–6″. M.F.P. 4449:2:037:152 (CPC 13521).	83
Fig. 10.	*Schizosporis reticulatus* Cookson & Dettmann × 500. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:110:208 (CPC 12335).	112

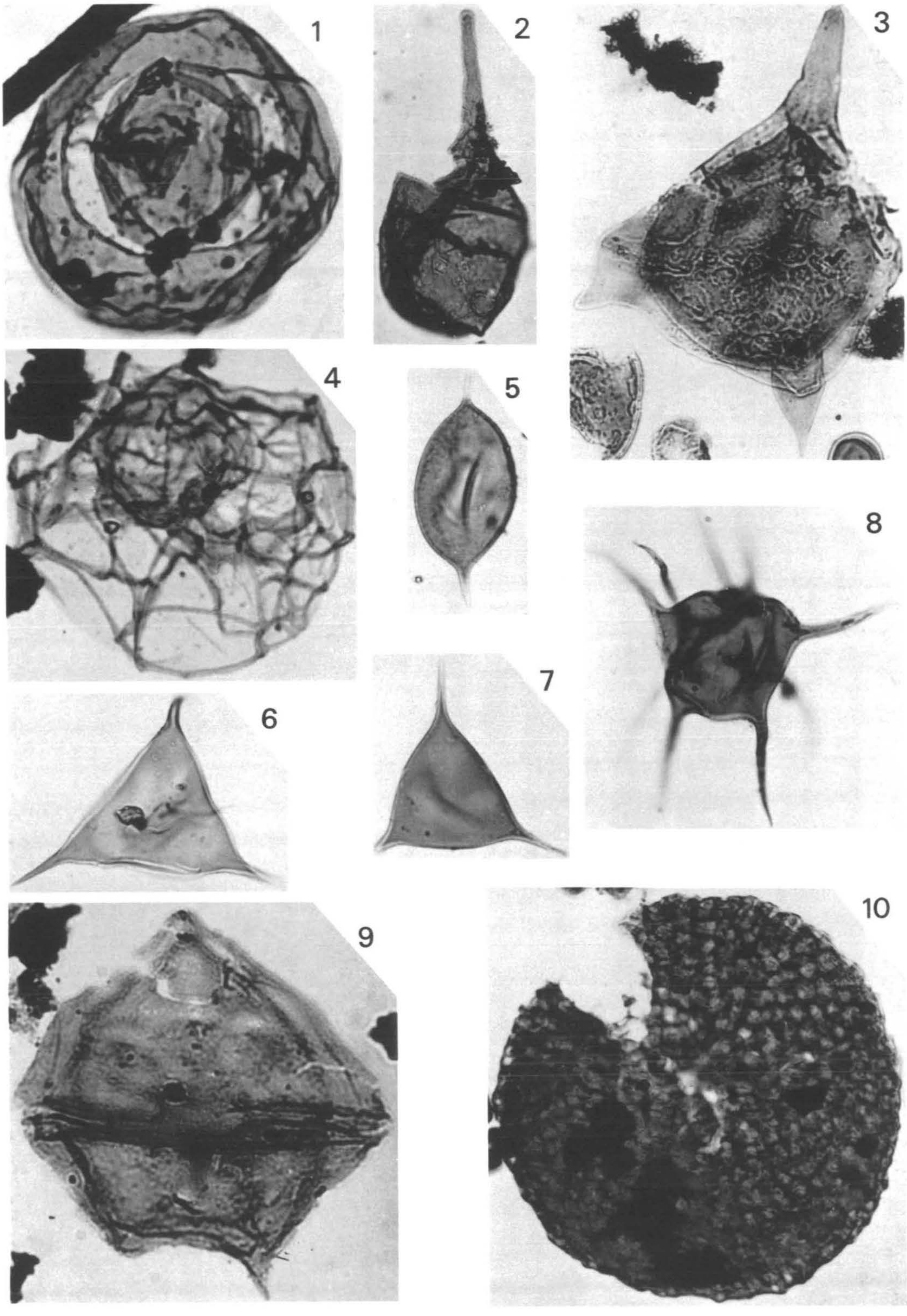
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PLATE 16

		Page
Figs. 1, 2.	Dinoflagellate Incertae Sedis form A 1. × 700. No. 2 well, core 10, 248.8 m., 816′ 0–6″. M.F.P. 4431:1:176:157 (CPC 12336). 2. × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:118:175 (CPC 12337).	104
Fig. 3.	?*Spiniferites* sp. E × 700. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:119:213 (CPC 12338).	44
Fig. 4.	*Baltisphaeridium* sp. B × 700. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:189:215 (CPC 12339).	108
Fig. 5.	*Baltisphaeridium* sp. A × 700. No. 2 well, core 5, 106.4 m., 349′ 0–6″. M.F.P. 4436:1:088:193 (CPC 12340).	108
Fig. 6.	?*Hologinella* sp. cf. *H. extrema* Cookson & Eisenack × 1000. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:027:058 (CPC 12334).	106
Fig. 7.	*Cymatiosphaera radiata* O. Wetzel × 1000. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:029:069 (CPC 12341).	110
Fig. 8.	*Baltisphaeridium* sp. D × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:225:190 (CPC 12342).	109
Fig. 9.	*Baltisphaeridium* sp. C × 1000. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:120:198 (CPC 12343).	108
Fig. 10.	*Wallodinium luna* (Cookson & Eisenack) × 700. No. 2 well, core 12, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:152:097 (CPC 12345).	84
Fig. 11.	*Pterospermopsis australiensis* Deflandre & Cookson × 1000 No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:157:139 (CPC 12329).	111
Fig. 12.	*Pterospermopsis* sp. *A*. × 700 No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:074:167 (CPC 12344).	112
Fig. 13.	*Pterospermopsis* cf. *P. aureolata* Cookson & Eisenack. × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:128:163 (CPC 12346).	111
Fig. 14.	*Palambages* Form A. Manum & Cookson × 500. No. 2 well, core 3, 61.0 m., 200′ 0–6″. M.F.P. 4438:1:209:187 (CPC 12347).	113

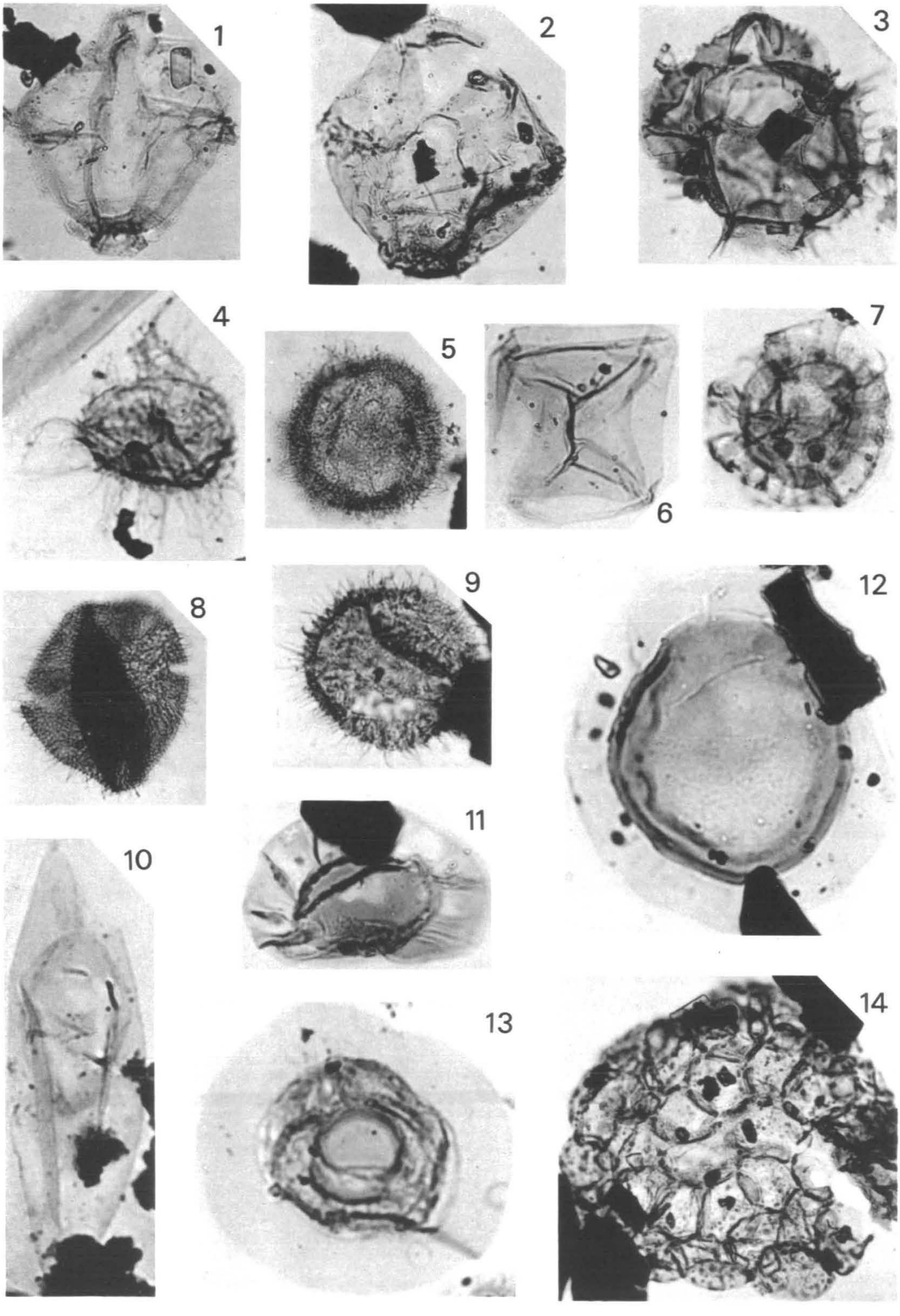
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PLATE 17
All phase contrast

		Page
Fig. 1.	*Hystrichodinium* sp. cf. *H. pulchrum* Deflandre Variant with narrow processes. × 700. No. 1 well, core 6, 182.9 m., 600′ 0–6″. M.F.P. 4447:2:080:089 (CPC 12278).	46
Fig. 2.	*Microdinium* sp. cf. *M. setosum* Sarjeant × 1000. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:109:210 (CPC 12306).	58
Fig. 3.	*Trigonopyxidia ginella* (Cookson & Eisenack) × 700. No. 1 well, core 6, 182.9 m., 600′ 0–6″. M.F.P. 4447:2:128:091 (CPC 12287).	105
Fig. 4.	*Palaeohystrichophora infusorioides* Deflandre × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:118:155 (CPC 12307).	103
Figs. 5, 6.	*Ascodinium* sp. A 5. Dehisced specimen. × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:162:030 (CPC 12311). 6. Specimen with operculum still partially attached. × 700. No. 2 well, core 12, 311.9 m., 1023′ 0–6″. M.F.P. 4429:2:179:090 (CPC 12310).	86
Fig. 7.	?*Ovoidinium fragile* sp. nov. Holotype. × 700. No. 1 well, core 8, 243.8 m., 800′ 0–6″. M.F.P. 4445:1:166:187 (CPC 12302).	88
Fig. 8.	*Ascodinium acrophorum* Cookson & Eisenack × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:101:185 (CPC 12312).	85
Fig. 9.	*Ascodinium parvum* (Cookson & Eisenack) × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:190:023 (CPC 12305).	85
Fig. 10.	*Pterospermopsis* sp. cf. *P. aureolata* Cookson & Eisenack × 700. No. 2 well, core 1, 15.3 m., 50′ 0–6″. M.F.P. 4440:1:128:163 (CPC 12346).	111
Fig. 11.	*Pterospermopsis* sp. A × 700. No. 2 well, core 2, 45.8 m., 150′ 0–6″. M.F.P. 4439:1:074:167 (CPC 12344).	112
Fig. 12.	*Wallodinium luna* (Cookson & Eisenack) × 700. No. 2 well, core 11, 274.4 m., 900′ 0–6″. M.F.P. 4430:2:152:097 (CPC 12345).	84

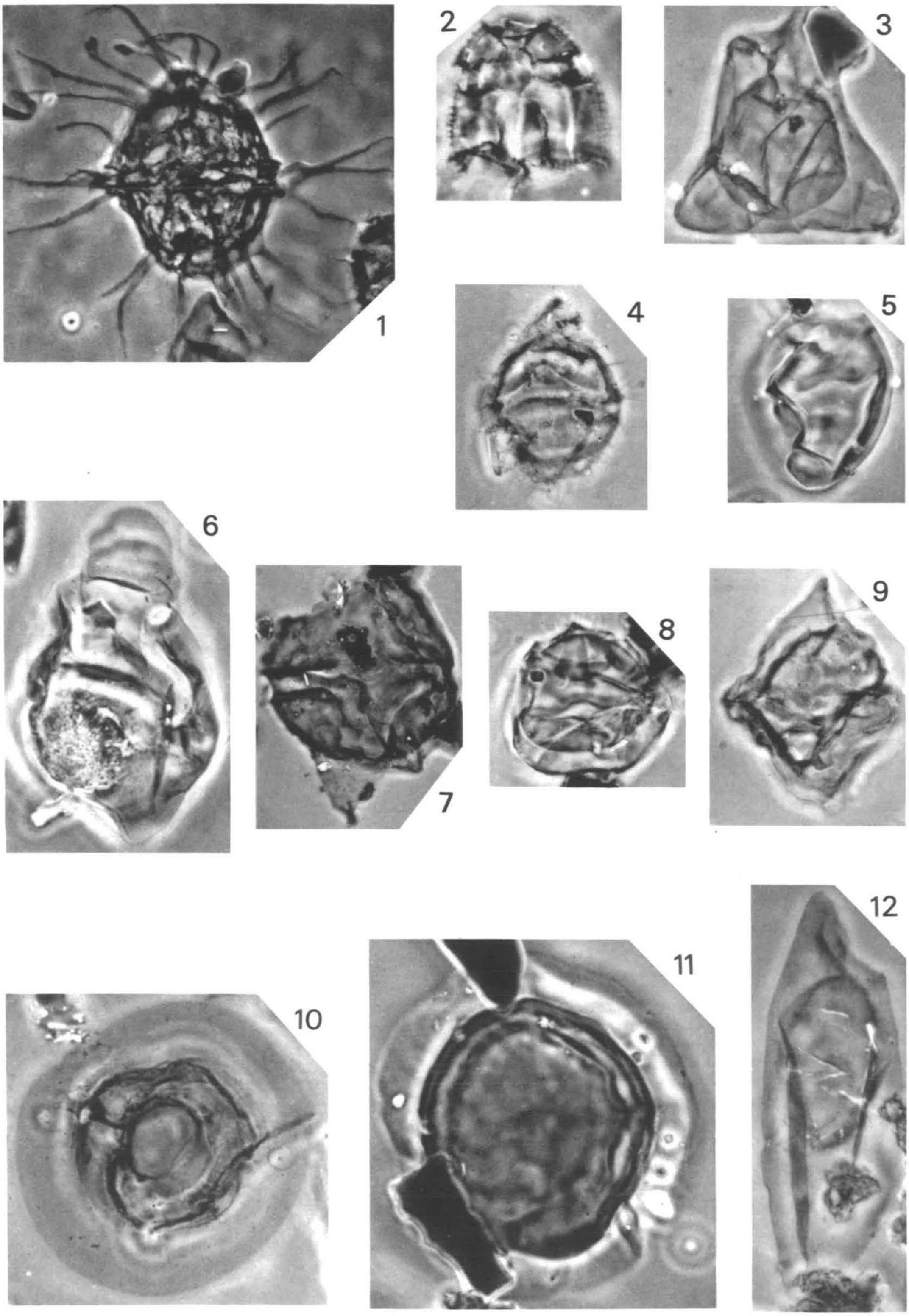
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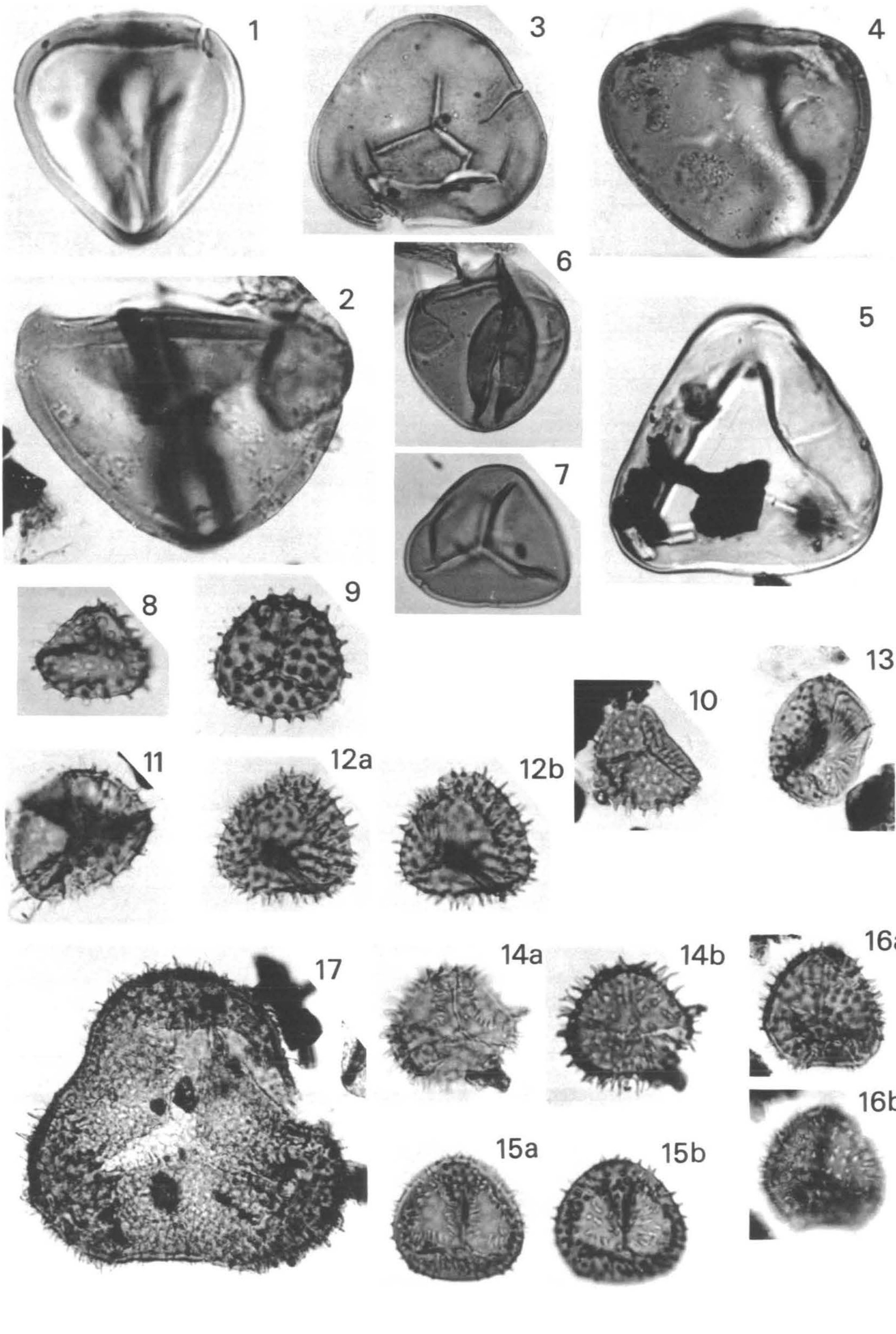
PLATE 18

All figures × 750

		Page
Figs. 1–2.	*Biretisporites spectabilis* Dettmann.	116
	1. Bathurst Island No. 2; 700′ 0–6″, 213.4 m. M.F.P. 4432–2; coord. 251/1062 (CPC 12917).	
	2. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–2; coord. 323/1084 (CPC 12918).	
Figs. 3–5.	*Cyathidites australis* Couper.	116
	3. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 350/1190 (CPC 12919).	
	4. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 298/1050 (CPC 12920).	
	5. Bathurst Island No. 2, 816′ 0–6″, 248.8 m. M.F.P. 4431–1; coord. 412/1004 (CPC 12921).	
Figs. 6–7.	*Cyathidites minor* Couper.	116
	6. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 245/1120 (CPC 12922).	
	7. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 269/1034 (CPC 12923).	
Figs. 8–10.	*Neoraistrickia truncata* (Cookson).	117
	8. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 419/1077 (CPC 12924).	
	9. Bathurst Island No. 2; 150′ 6″, 45.8 m. M.F.P. 4439–1; coord. 418/1211 (CPC 12925).	
	10. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 353/1073 (CPC 12926).	
Figs. 11–12.	*Ceratosporites equalis* Cookson & Dettmann.	117
	11. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–2; coord. 441/1104 (CPC 12927).	
	12. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–2; coord. 300/1063 (CPC 12928). *a*. distal view, *b*. proximal aspect, showing psilate contact area.	
Figs. 13–16.	*Herkosporites proxistriatus* sp. nov.	118
	13. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 300/1098 (CPC 12929). Lateral aspect, showing proximal ornament, proximal pole to the right.	
	14. Bathurst Island No. 2; 499′ 6–11″, 152.3 m. M.F.P. 4434–1; coord. 373/1062 (CPC 12930). *a*. proximal face, *b*. distal-equatorial aspect.	
	15. **Holotype.** *a*. proximal face, *b*. distal face.	
	16. Bathurst Island No. 1; 800′, 243.8 m. M.F.P. 4445–2; coord. 373/1200 (CPC 12932). *a*. proximo-equatorial focus, *b*. distal focus.	
Fig. 17.	*Pilosisporites notensis* Cookson & Dettmann. Not described, probably of secondary origin. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 420/1077 (CPC 12933).	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16b
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PLATE 19

All figures × 750 except fig. 3b

Page

Fig. 1. *Lycopodiumsporites austroclavatidites* (Cookson) 119
Bathurst Island No. 1; 600', 182.9 m. M.F.P. 4447–1; coord. 281/1131 (CPC 12934).

Fig. 2. *Stoverisporites lunaris* (Cookson & Dettmann). 118
Bathurst Island No. 1; 200', 60.9 m. M.F.P. 4449–1; coord. 322/1102 (CPC 12935).
a. proximal face, *b*. distal face.

Figs. 3–4. *Stoverisporites microverrucatus* sp. nov. 119

3. Bathurst Island No. 2; 1023' 0–6", 311.9 m. M.F.P. 4429–2; coord. 378/1163 (CPC 12936). *a*. slightly damaged, showing microverrucate sculpture and distinct pits, *b*. same specimen × 1150.
4. **Holotype.** *a*. proximal face, trilete mark indistinct, verrucae bordering laesurae, *b*. distal face.

Fig. 5. *Trilobosporites trioreticulosus* Cookson & Dettmann. 123
Bathurst Island No. 1; 200', 60.9 m. M.F.P. 4449–1; coord. 422/1097 (CPC 12938).
a. proximal face, *b*. distal face.

Fig. 6. *Lycopodiumsporites* cf. *L. rosewoodensis* (De Jersey). 119
Bathurst Island No. 1; 200', 60.9 m. M.F.P. 4449–1; coord. 389/1105 (CPC 12939).
a. proximo-equatorial aspect, *b*. distal face, showing low, thin muri and large, regular reticulum.

Fig. 7. *Cicatricosisporites cuneiformis* Pocock. 120
Bathurst Island No. 1; 100', 30.5 m. M.F.P. 4450–1; coord. 425/1053 (CPC 12940).
a. proximal face, slightly deflated, showing relatively large psilate contact area, *b*. distal face.

Figs. 8–12. *Cicatricosisporites venustus* Deák. 121

8. Bathurst Island No. 2; 200' 0–6", 61.0 m. M.F.P. 4438–2; coord. 416/1021 (CPC 12941). *a*. proximal face, showing ribs oriented normal to amb. *b*. distal face.
9. Bathurst Island No. 1; 300', 91.4 m. M.F.P. 455–1; coord. 405/1012 (CPC 12942).
10. Bathurst Island No. 2; 150' 0–6", 45.8 m. M.F.P. 4439–1; coord. 386/1139 (CPC 12943). Proximal face, showing arrangement of striae normal to amb.
11. Bathurst Island No. 2; 50' 0–6", 15.3 m. M.F.P. 4440–2; coord. 367/1139 (CPC 12944). Lateral view, *b*. showing exine thickening alongside laesurae.
12. Bathurst Island No. 2; 150' 0–6", 45.8 m. M.F.P. 4439–1; coord. 275/1056 (CPC 12945). Lateral view.

Fig. 13. *Cicatricosisporites australiensis* (Cookson). 120
Bathurst Island No. 2; 900' 0–6", 274.4 m. M.F.P. 4430–2; coord. 293/1184 (CPC 12946). Lateral view.

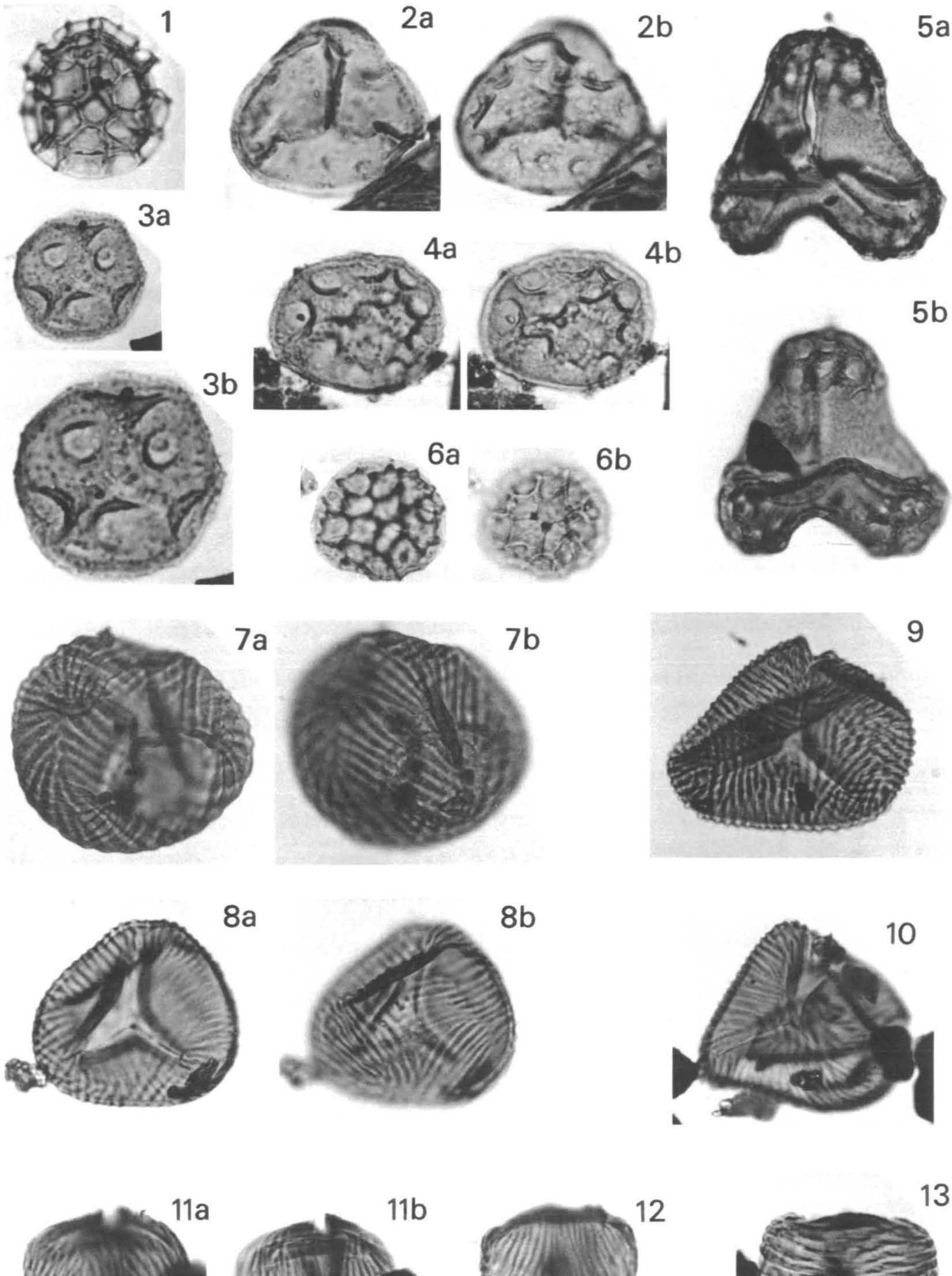
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PLATE 20

All figures × 750

		Page
Figs. 1, 6.	*Cicatricosisporites pseudotripartitus* (Bolchovitina). 1. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 407/1063 (CPC 12947). *a.* proximo-equatorial view, *b.* distal view. 6. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 241/1016 (CPC 12952). *a.* proximal face, *b.* distal face, showing broad, flat ribs characteristic of the species.	121
Fig. 2.	*Cicatricosisporites* cf. *C. hughesii* Dettmann. Bathurst Island No. 2, 816′ 0–6″, 248.8 m. M.F.P. 4431–1; coord. 355/1083 (CPC 12948). Lateral view.	
Fig. 3.	*Cicatricosisporites* sp. Not described. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 432/1070 (CPC 12949). Lateral view, showing pseudofoveolate distal apical areas; characteristic spore in the Upper Albian of Queensland.	
Figs. 4, 5.	*Cicatricosisporites hughesii* Dettmann. 4. Bathurst Island No. 2; 816′ 0–6″, 248.8 m. M.F.P. 4431–1; coord. 329/1093 (CPC 12950). *a.* proximal view, *b.* distal view. 5. (photographed through red filter). Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 296/1112 (CPC 12951). *a.* proximal face, slightly irregular pattern of ribs characteristic, *b.* showing typically indented apical outline.	121
Fig. 7.	*Appendicisporites distocarinatus* Dettmann & Playford. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–1; coord. 264/1122 (CPC 12953). *a.* focus on apical appendices, *b.* distal aspect, showing triangular orientation of ribs.	124
Fig. 8.	*Appendicisporites* cf. *A. problematicus* (Burger). Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 280/1160 (CPC 12954). *a.* equatorial focus, *b.* focus on distal ribs, characteristically sinuous, arranged in an irregular triangular pattern.	
Fig. 9.	*Appendicisporites* cf. *A. distocarinatus* Dettmann & Playford. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 431/1158 (CPC 12955). *a.* distal face, showing triangular arrangement of ribs and continuation of appendices onto distal side of spore, *b.* proximal face (partly ruptured).	

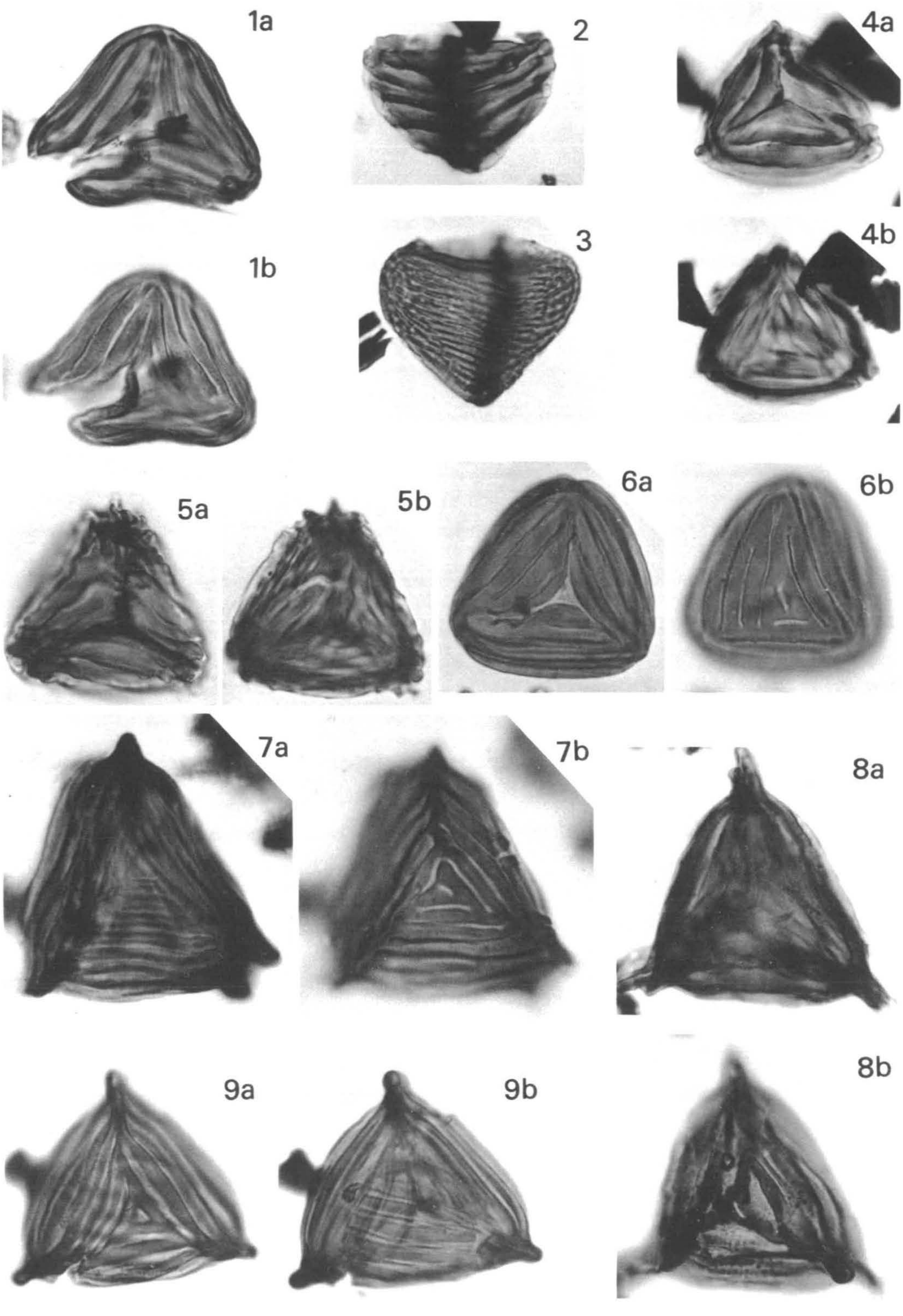
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PLATE 21

All figures × 750

		Page
Figs. 1, 4.	*Appendicisporites distocarinatus* Dettmann & Playford. 1. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 398/1164 (CPC 12956). *a.* focus on amb, *b.* distal aspect, showing triangular arrangement of striae. 4. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 398/1085 (CPC 12959). Lateral view, showing fin-like appendices in apical equatorial and distal regions.	124
Fig. 2.	*Appendicisporites* cf. *A. cristatus* (Markova) Pocock, 1964. Not described. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 266/1066 (CPC 12957). Oblique view. *a.* proximal face, *b.* distal face, showing lobed appearance of equatorial apical and distal appendices.	
Fig. 3.	*Appendicisporites* sp. Not described. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 330/1174 (CPC 12958). Spore fractured and torn. Upper part represents side view of appendices, continuing onto distal face. Lower part shows appendices in top view, formed by coalescence of opposite pairs of equatorial and distal ribs.	
Fig. 5.	*Appendicisporites* cf *A. grandis* Pocock Not described. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 396/1079 (CPC 12960). *a.* proximal face, ribs arranged in triangular pattern, *b.* distal face, ribs arranged parallel to nearest margin.	
Fig. 6.	*Appendicisporites* sp. Not described. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 340/1018 (CPC 12961). *a.* proximal face, ribs crossing equator at low angles, *b.* distal face, showing ribs in an irregular (not triangular) arrangement.	
Fig. 7.	*Appendicisporites* cf. *A. erdtmanii* Pocock Not described. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 413/1097 (CPC 12962). *a.* proximal face, with lipped trilete laesurae and relatively large contact area, *b.* distal face, ribs arranged in concentric triangles.	

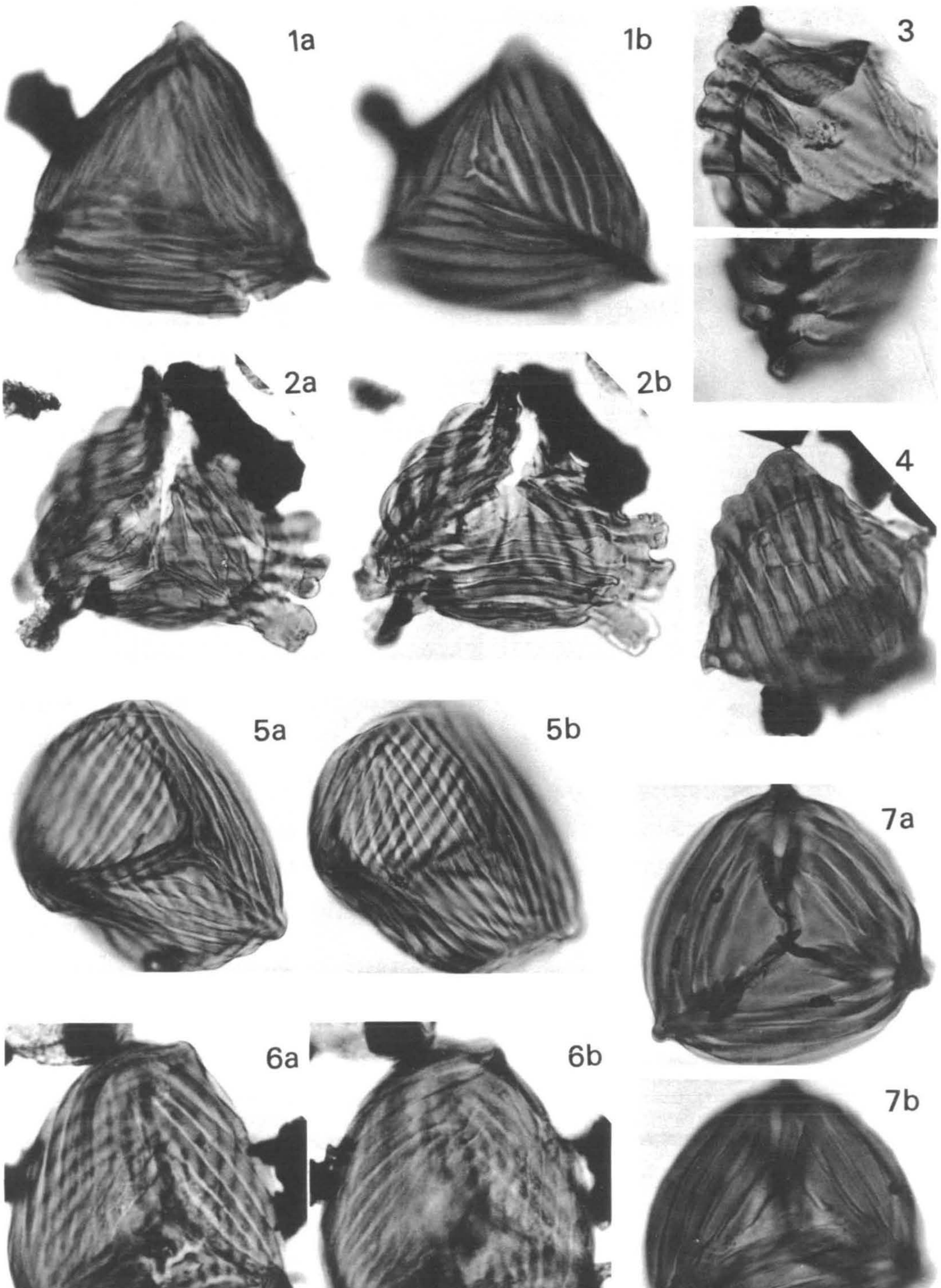
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PLATE 22

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Fig. 1. *Gleicheniidites* sp. cf. *G. feronensis* (Delcourt & Sprumont).
Not described. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 434/1156 (CPC 12963). *a.* proximo-equatorial aspect, showing characteristically broad crassitudes, *b.* distal face, with prominent concave exine foldings.

Figs. 2, 8. *Gleicheniidites* cf. *G. circinidites* (Cookson)
2. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–2; coord. 275/1153 (CPC 12964).
8. Bathurst Island No. 1; 200′, 50.9 m. M.F.P. 4449–1; coord. 314/1010 (CPC 12970).

Figs. 3-7. *Gleicheniidites circinidites* (Cookson) 125
3. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 307/1065 (CPC 12965).
4. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P., 4439–2; coord. 317/1163 (CPC 12966).
5. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 290/1151 (CPC 12967).
6. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–1; coord. 301/1171 (CPC 12968).
7. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4440–1; coord. 319/1011 (CPC 12969).

Figs. 9, 10. *Gleicheniidites*? *Clavifera*? Already showing the wavy outline typical of *Clavifera triplex*.
9. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 265/1189 (CPC 12971).
10. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 272/1155 (CPC 12972).

Figs. 11, 12. *Clavifera triplex* (Bolkhovitina) 126
11. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–2; coord. 405/1117 (CPC 12973).
12. Bathurst Island No. 2; 499′ 6–11″, 152.3 m. M.F.P. 4434–1; coord. 332/1022 (CPC 12974). Typically broad crassitudes and sinuous outline. Orifices not conspicuous; distal exine not folded.

Figs. 13–16, 19. *Gleicheniidites* cf. *G. trijugatus* (Pierce). 125
13. Bathurst Island No. 2; 599′ 6–11″, 182.8 m. M.F.P. 4433–1; coord. 282/1078 (CPC 12975).
14. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–2; coord. 373/1160 (CPC 12976).
15. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 359/1182 (CPC 12977).
16. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 386/1058 (CPC 12978). Distal folds or "triradiate ridges" faintly developed.
19. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 252/1064 (CPC 12981). Specimen with spongeous perinous layer preserved.

Figs. 17, 18. *Gleicheniidites* sp. Showing irregular amb and not clearly delimited crassitudes. Not described.
17. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 324/1137 (CPC 12979).
18. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 430/1109 12980).

Figs. 20–22. *Foveogleicheniidites confussus* (Hedlund) 127
20. Bathurst Island No. 2; 1023′ 0–6″, 311.9 m. M.F.P. 4429–2; coord. 304/1126 (CPC 12982). Foveolae distinct, distal exine folds weakly developed.
21. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 399/1140 (CPC 12983). *a.* proximal face, *b.* distal face, exine folds and foveolae conspicuous.
22. Bathurst Island No. 2; 150′ 0–6″; 45.8 m. M.F.P. 4439–2; coord. 350/1010 (CPC 12984). Damaged specimen, foveolae not distinct.

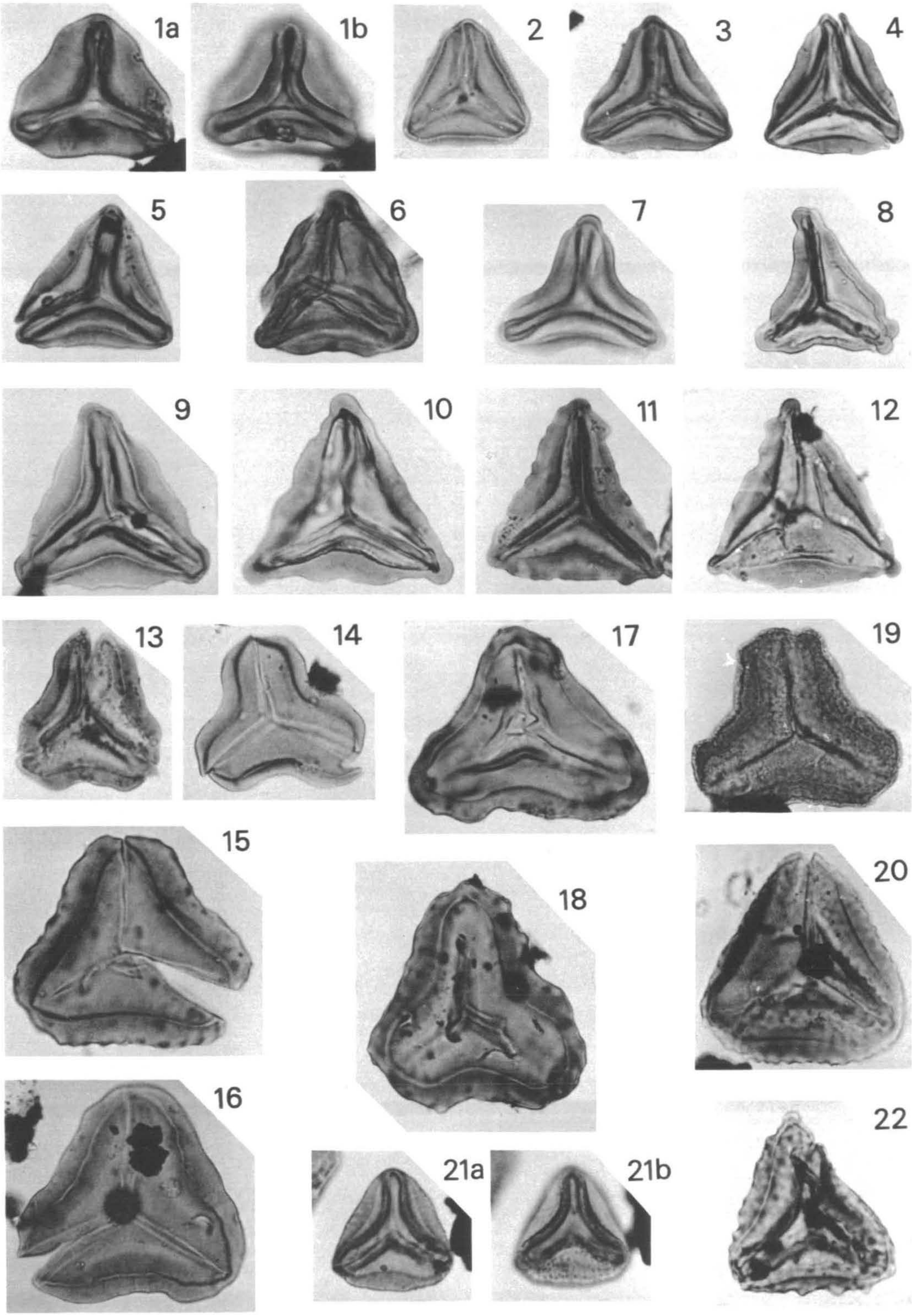
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PLATE 23

All figures × 750

		Page
Figs. 1, 2.	*Ornamentifera minima* sp. nov. 1. **Holotype.** *a*. proximal face, no distinct sculptural elements present, *b*. distal face 2. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–1; coord. 265/1187 (CPC 12986). *a*. proximal face, crassitudes visible, *b*. distal face.	126
Fig. 3.	*Ornamentifera* cf. *O. sentosa* Dettmann & Playford Not described. Bathurst Island No. 1; 800′, 243.8 m. M.F.P. 4445–1; coord. 278/1061 (CPC 12987). *a*. proximal view, crassitudes visible, *b*. distal view, sculptural elements less prominent than in *O. minima*.	
Fig. 4.	*Camarozonosporites* sp. Not described. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–2; coord. 321/1047 (CPC 12988). Typically minute rugulate sculpture.	
Figs. 5–8.	*Camarozonosporites australiensis* sp. nov. 5. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 360/1090 (CPC 12989). Small specimen. *a*. proximal face, *b*. distal face, relatively small sculptural elements. 6. Same sample. M.F.P. 4438–1; coord. 378/1103 (CPC 12990). *a*. proximal face, minute rugulae radially oriented, *b*. distal face, sculpture coarse. 7. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 253/1054 (CPC 12991). Large specimen. *a*. proximal face, minute sculptural elements visible, *b*. distal face, sculpture very coarse. 8. **Holotype.** *a*. proximal face, *b*. distal face, medium sculpture, no differentiation in polar region. 9. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 394/1132 (CPC 12993). *a*. proximal face, *b*. distal face, relatively small rugulae.	128
Fig. 10.	*Crybelosporites striatus* (Cookson & Dettmann) Bathurst Island No. 2; 1023′ 0–6″, 311.9 m. M.F.P. 4429–2; coord. 302/1006 (CPC 12994). *a*. focus on irregular reticulate pattern of outer sclerine layer, *b*. inner body, proximal side ruptured, small gula present.	136
Fig. 11.	*Crybelosporites* cf. *C. striatus* (Cookson & Dettmann) Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 291/1028 (CPC 12995). *a*. focus on outer reticulum, *b*. shows thick sclerine, inner body proximally slightly damaged; gula not present (recycled specimen?).	136

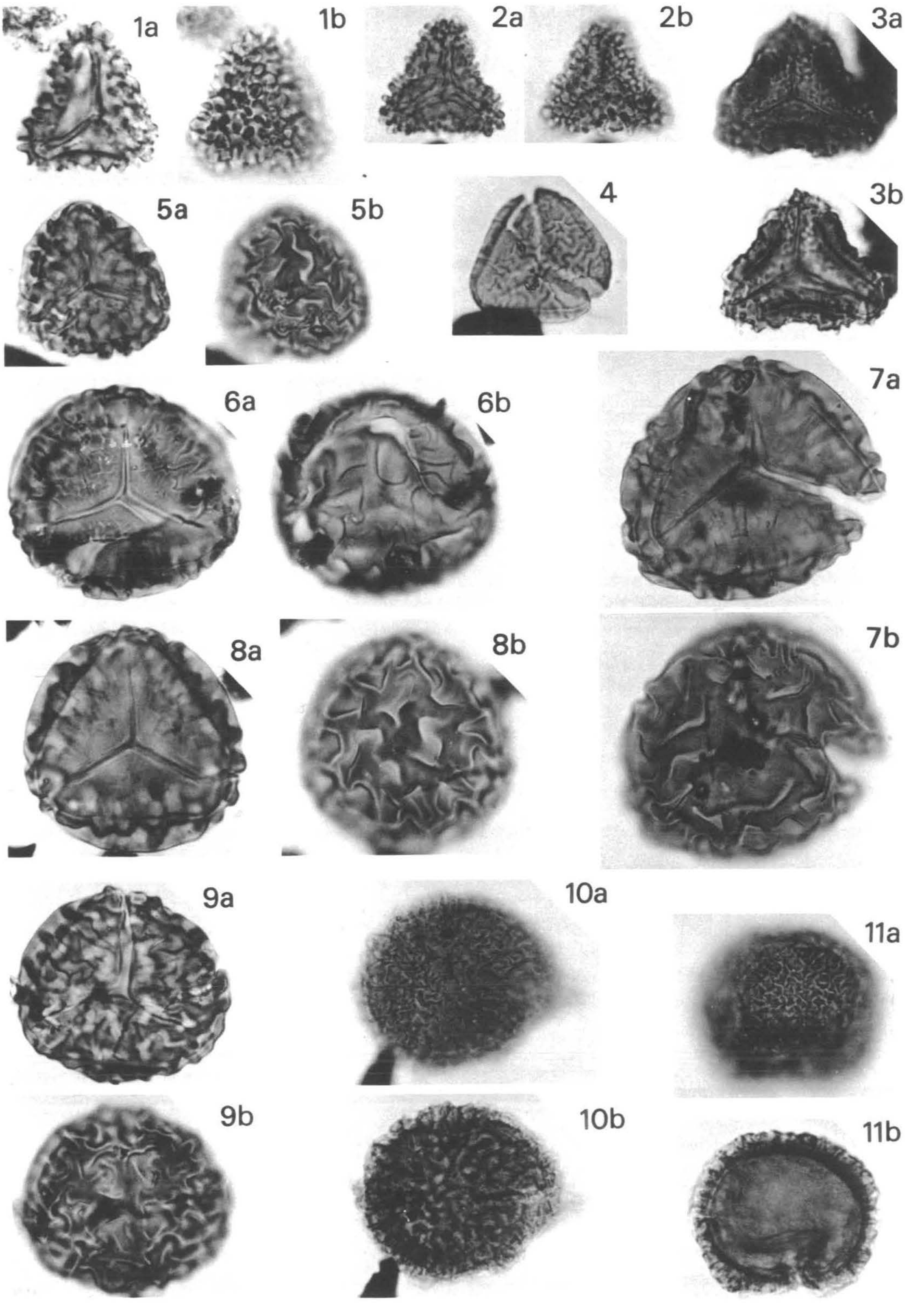
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PLATE 24

All figures × 750, except fig. 1c.

		Page
Figs. 1–5.	*Crybelosporites* cf. *C. brenneri* Playford 1. Bathurst Island No. 2; 599′ 6–11″, 182.8 m. M.F.P. 4433–1; coord. 445/1183 (CPC 12996). *a*. showing minute, regular reticulum and ragged gula, *b*. showing inner body and relatively thin sclerine, *c*. same specimen, about × 1700. 2. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 434/1144 (CPC 12997). Proximal side upwards (ragged gula developed); trilete mark visible. 3. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 428/1098 (CPC 12998). In figs 3–5 thin inner body proximally collapsed. 4. Same sample. M.F.P. 4455–1; coord. 251/1152 (CPC 12999). 5. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–2; coord. 320/1135 (CPC 13000). Showing typically thin sclerine, primitive gula and regular microreticulum.	136
Fig. 6.	*Antulsporites varizonatus* sp. nov. **Holotype.** *a*. proximal face, verrucae alongside laesurae and inconstant width of zona distinct, *b*. distal face, showing crowded sculptural elements.	131
Figs. 7–8.	*Stereisporites* sp. Cavate part of zona distinct. 7. Bathurst Island No. 2; 599′ 6–11″, 182.8 m. M.F.P. 4433–2; coord. 280/1076 (CPC 13002). 8. Same sample. M.F.P. 4433–1; coord. 291/1079 (CPC 13003).	130
Figs. 9–11.	*Stereisporites antiquasporites* (Wilson & Webster) 9. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–2; coord. 340/1105 (CPC 13146). 10. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–2; coord. 397/1162 (CPC 13004). 11. Bathurst Island No. 2; 1023′ 0–6″, 311.9 m. M.F.P. 4429–2; coord. 405/1121 (CPC 13005).	129
Fig. 12.	*Perotrilites oepikii* sp. nov. **Holotype.** *a*. proximal face, *b*. distal face, focus on echinae/bacula.	134
Fig. 13.	*Foraminisporis wonthaggiensis* (Cookson & Dettmann) Bathurst Island No. 2; 1023′ 0–6″, 311.9 m. M.F.P. 4429–2; coord. 358/1069 (CPC 13007). *a*. proximal face, *b*. distal face.	130
Fig. 14.	*Foraminisporis asymmetricus* (Cookson & Dettmann) Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 290/1137 (CPC 13008).	130
Fig. 15.	*Lycopodiacidites* cf. *L. intraverrucatus* Brenner, 1963 Not described. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 330/1063 (CPC 13009). *a*. proximal face, verrucae and laesurate margins similar as in some species of *Taurocusporites* Stover, 1962, *b*. distal face, with broad, flat verrucae.	

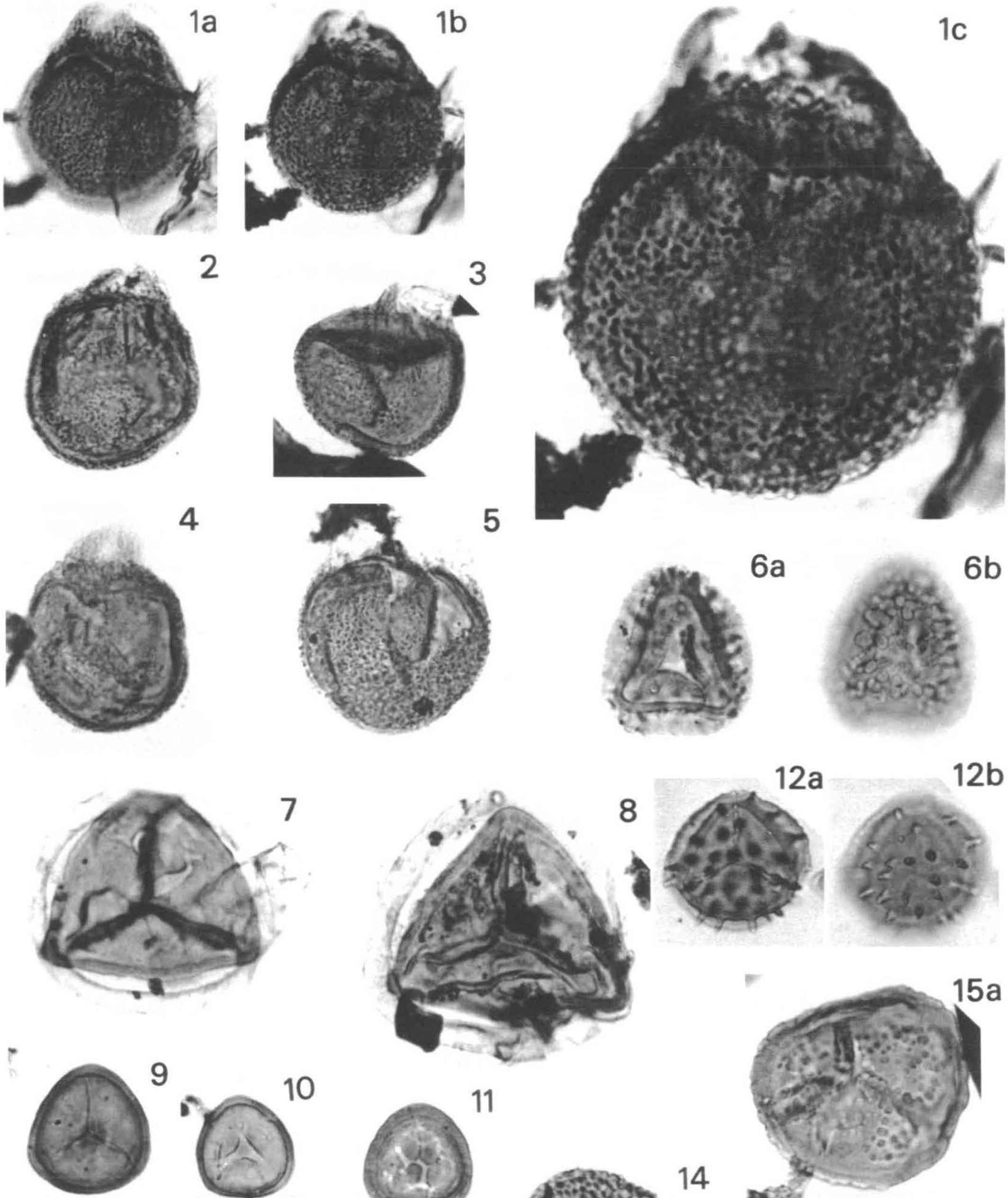
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PLATE 25

All figures $\times$ 750

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Figs. 1–3.	*Perotrilites linearis* (Cookson & Dettmann) 1. Bathurst Island No. 1; 800′, 243 m. M.F.P. 4445–1; coord. 397/1190 (CPC 13010). *a*. proximal face, *b*. equatorial plane, zona not preserved, *c*. distal face, showing typical sculpture. 2. Bathurst Island No. 2; 298′ 6–11″, 91.5 m. M.F.P. 4437–2; coord. 410/1181 (CPC 13011). Fragments of zona preserved, visible at lower margin. 3. Bathurst Island No. 2; 298′ 6–11″, 91.5 m. M.F.P. 4437–2; coord. 310/1070 (CPC 13012). Focus on equatorial plane, fragments of zona visible at left and lower margin.	134
Fig. 4.	*Vallizonosporites* sp. Bathurst Island No. 2; 349′ 0–6″, 106.4 m. M.F.P. 4436–2; coord. 300/1105 (CPC 13013). Showing thick exine and densely spaced foveolae.	135
Figs. 5-7.	*Perotrilites majus* (Cookson & Dettmann) 5. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 378/1102 (CPC 13014). 6. Bathurst Island No. 2, 900′ 0–6″, 274.4 m. M.F.P. 4430–2; coord. 362/1072 (CPC 13015). *a*. proximal face, showing lipped laesurae, *b*. equatorial-distal aspect. 7. Bathurst Island No. 2; 700′ 0–6″, 213.4 m. M.F.P. 4432–2; coord. 330/1129 (CPC 13016).	133
Figs. 8–9.	*Perotrilites jubatus* (Dettman & Playford) 8. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 363/1042 (CPC 13017). Corroded specimen. 9. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 295/1096 (CPC 13018). Showing high laesurate lips and projection of "muri" on distal face.	133

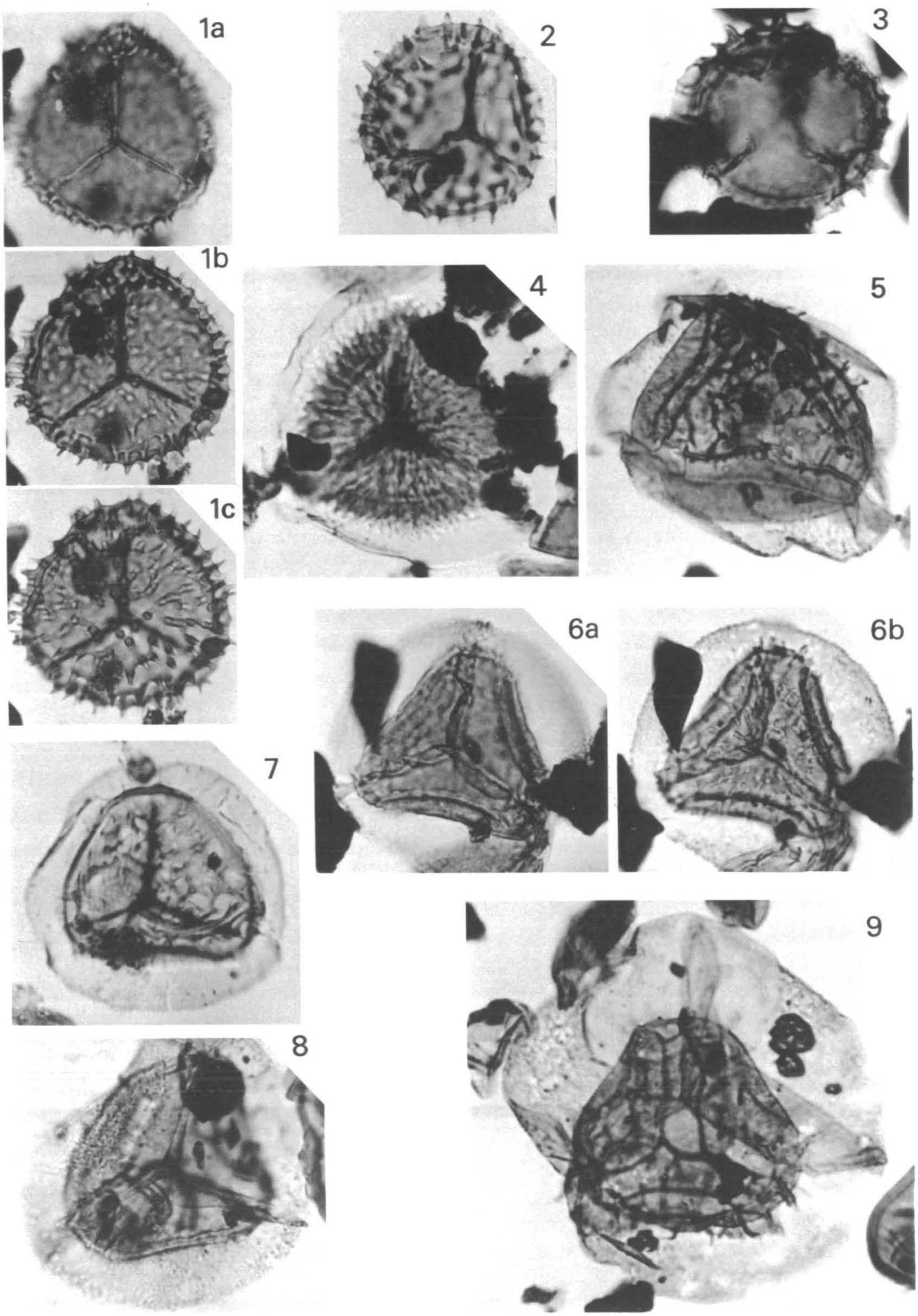
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PLATE 26

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Figs. 1, 2.	*Perotrilites jubatus* (Dettmann & Playford) 1. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 368/1047 (CPC 13019), × 750. Oblique view, spore compressed laterally. *a*. showing trilete mark, lips not distinct, *b*. pattern of distal "muri". 2. Same sample. M.F.P. 4438–1; coord. 389/992 (CPC 13020). *a*. specimen folded, lateral view, showing distal sculpture and laesurate lips; × 750, *b*. detail of *a*, showing root of zona, exine not visibly lamellated, about × 1900.	133
Fig. 3.	*Balmeisporites glenelgensis* Cookson & Dettmann Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 413/1077 (CPC 13021), × 400. Lateral view, proximal side upwards; left side showing equatorial and proximal exine extensions, right side (same specimen) showing surface reticulum.	123

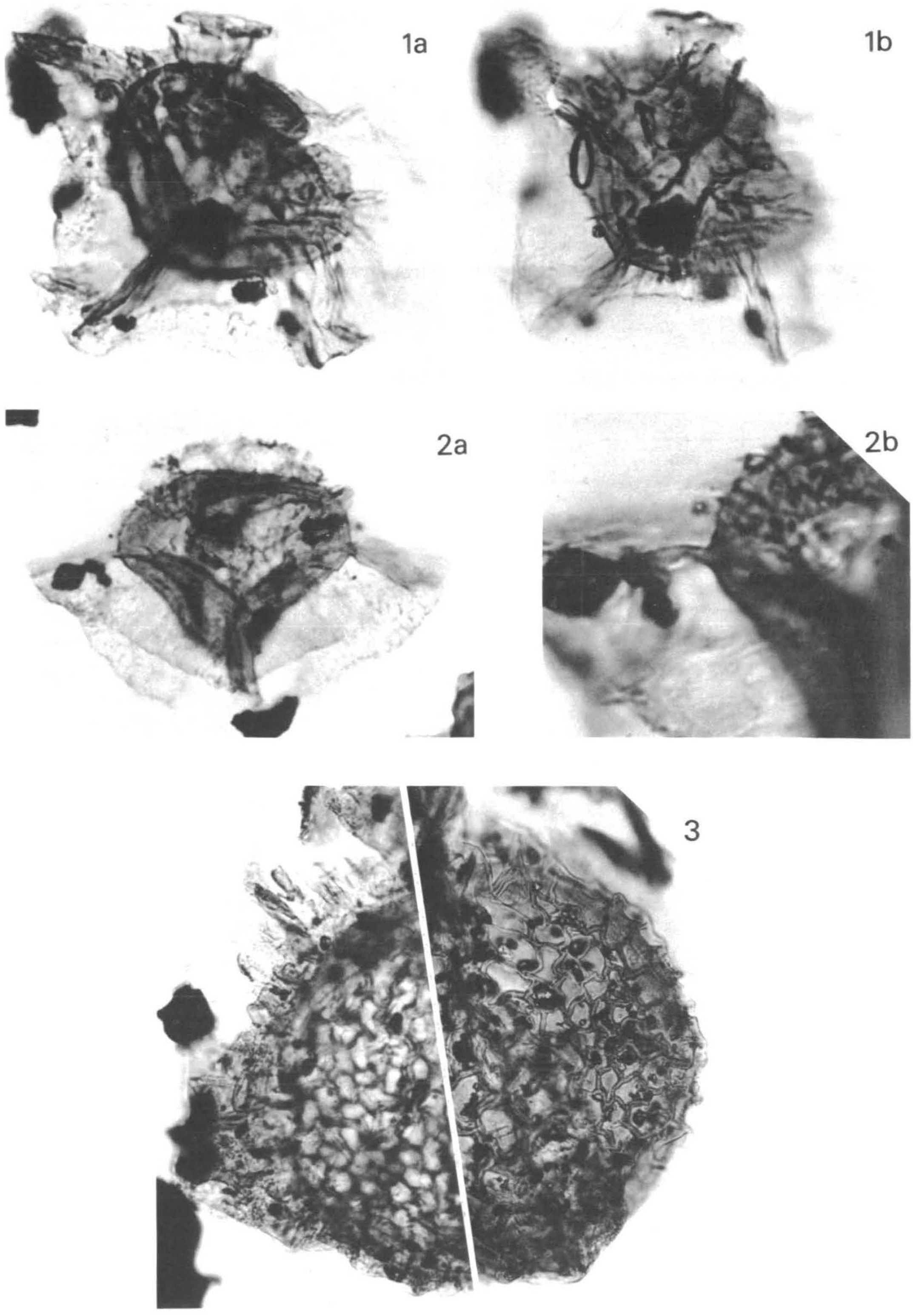
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PLATE 27

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Figs. 1, 2.	*Balmeisporites tridictyus* Cookson & Dettmann 1. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 353/1158 (CPC 13022); × 400. Specimen in polar view. *a*. focus on proximal exine projections, *b*. focus on equatorial growths. 2. Same sample. M.F.P. 4450–1; coord. 386/1202 (CPC 13023); × 400. Specimen in lateral view. *a*. focus on equatorial exine projections, *b*. showing almost smooth, multilayered exine.	123
Figs. 3, 4.	*Laevigatosporites ovatus* Wilson & Webster 3. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 265/1086 (CPC 13024). 4. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 315/1045 (CPC 13025).	137
Figs. 5–8.	*Microfoveolatosporis canaliculatus* Dettmann 5. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 302/1175 (CPC 13026). Equatorial view. 6. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 281/1051 (CPC 13027). Equatorial view. 7. Same sample. M.F.P. 4438–2; coord. 400/1193 (CPC 13028). Equatorial view. 8. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–1; coord. 294/1175 (CPC 13029). Polar view.	137
Figs. 9, 10.	*Triporoletes reticulatus* (Pocock) 9. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 286/1010 (CPC 13030). 10. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 413/1151 (CPC 13031).	138
Fig. 11.	*Triporoletes* sp. Not described. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 337/1067 (CPC 13032).	
Fig. 12.	*Triporoletes* cf. *T. simplex* (Cookson & Dettmann) Not described. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 419/1090 (CPC 13033). Specimen possibly secondary, introduced by recycling of older sediments.	

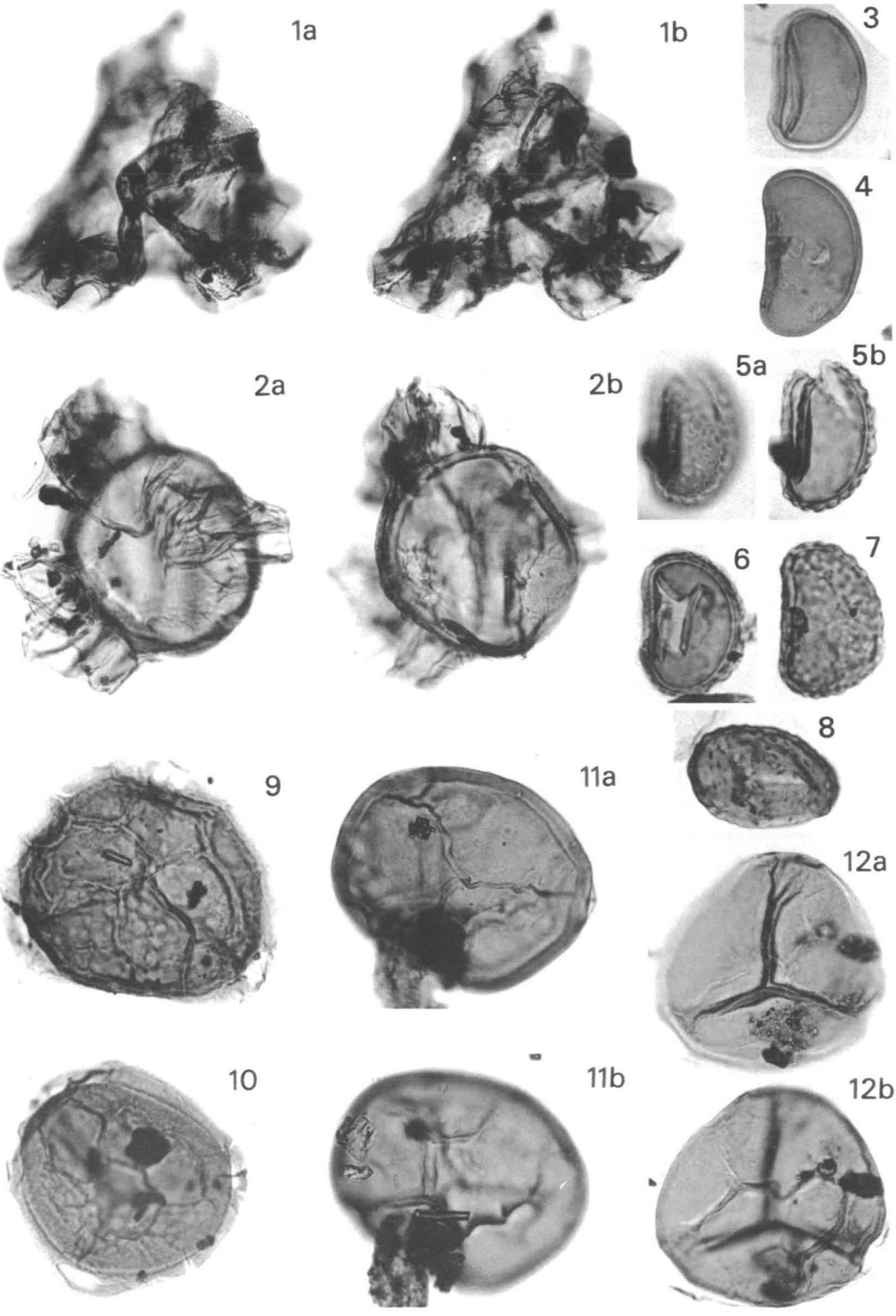
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PLATE 28

All figures × 750

Page

Fig. 1. *Triporoletes* cf. *T. laevigatus* (Pocock)
Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 379/1116 (CPC 13034).

Figs. 2–5. *Triporoletes laevigatus* (Pocock) 138
2. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 370/1169 (CPC 13035).
3. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 409/1148 (CPC 13036). Trilete mark distinct. Typically erratic sclerine folding at distal face.
4. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 229/1042 (CPC 13037). Faint indication of laesurae, sclerine without ornament.
5. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 378/1079 (CPC 13038). *a*. distal face, *b*. proximal face; part of outer sclerine layer disappeared, trilete mark faintly visible.

Figs. 6, 7. *Vitreisporites pallidus* (Reissinger) 140
6. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 340/1040 (CPC 13039).
7. Same sample. M.F.P. 4439–2; coord. 363/1136 (CPC 13040).

Fig. 8. *Alisporites* sp. 140
Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 282/1135 (CPC 13041). *a*. showing relatively small sacci and wide distal sulcus, *b*. showing granulate-microrugulate proximal cap.

Fig. 9. *Microcachryidites antarcticus* Cookson 140
Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 433/1090 (CPC 13042).

Figs. 10, 11. *Trisaccites microsaccatus* (Couper) 141
10. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 290/1120 (CPC 13043).
11. Same sample. M.F.P. 4449–2; coord. 290/1154 (CPC 13044).

Fig. 12. *Alisporites* sp. 140
Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 367/1150 (CPC 13045).

Fig. 13. *Podocarpidites ellipticus* Cookson
Not described. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 322/1124 (CPC 13046). *a*. focus on granulate proximal cap; distal ridge and reticulum of sacci visible, *b*. focus on wide, smooth sulcus.

Fig. 14. *Rugubivesiculites* sp. 139
Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 246/1100 (CPC 13047). Smooth sulcus area and microrugulate proximal cap distinct.

Fig. 15. Bisaccate form.
Not described. Bathurst Island No. 2; 1023′ 0–6″, 311.9 m. M.F.P. 4429–1; coord. 305/1087 (CPC 13048). No affinity with *Phyllocladidites*, as scutula not developed.

Figs. 16–18. *Hoegisporis uniforma* Cookson 141
16. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 393/1044 (CPC 13049).
17. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 420/1035 (CPC 13050). Most of exine on distal face disappeared.
18. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 420/1139 (CPC 13051). Oblique view, exine on distal face disappeared; showing exine in proximal and equatorial regions of equal thickness.

Figs. 19–20. *Hoegisporis* cf. *H. uniforma* Cookson. Possibly immature specimens of the species. 141
19. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 326/1138 (CPC 13052).
20. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 250/1155 (CPC 13053).

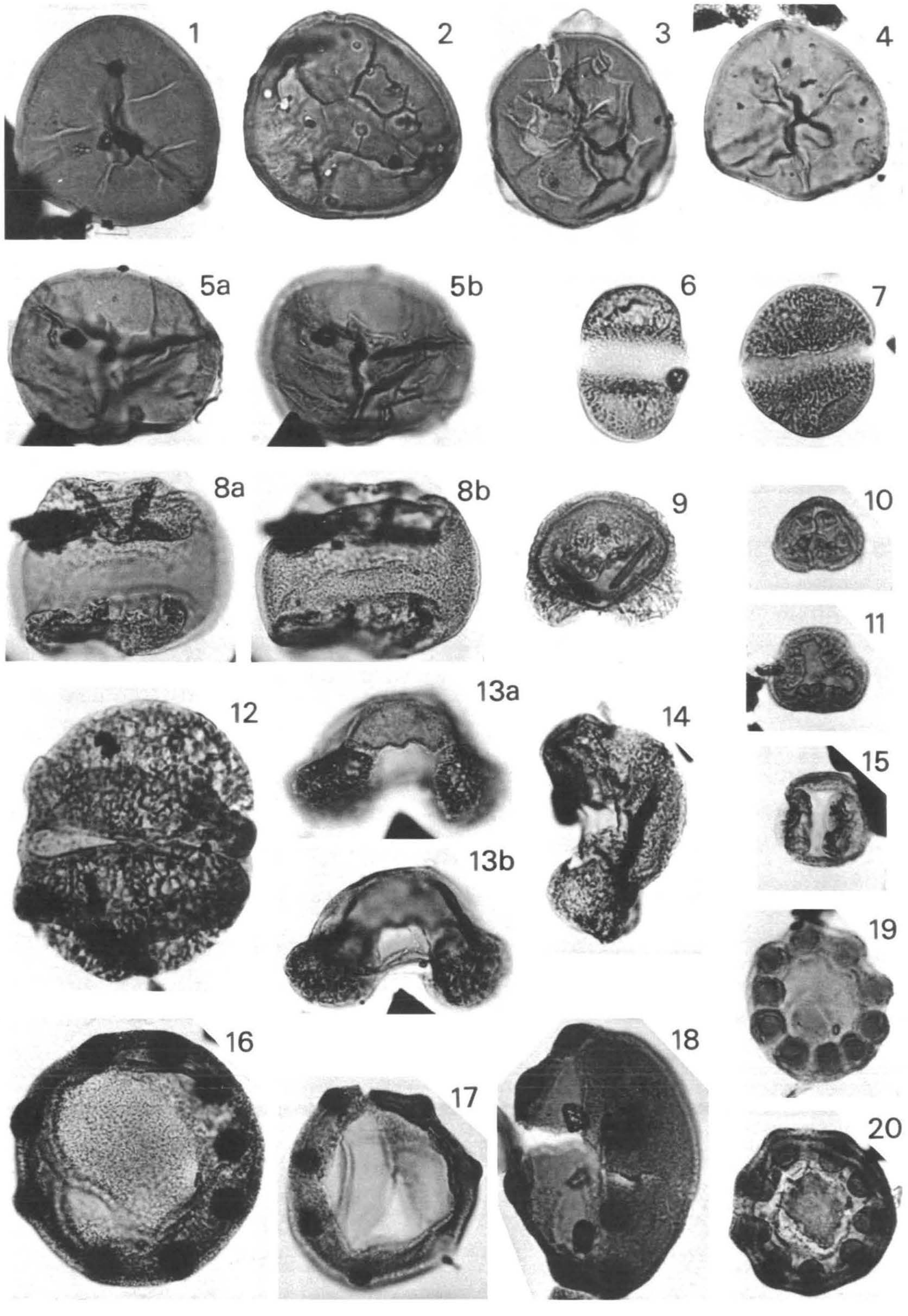
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PLATE 29

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Figs. 1–4. *Inaperturopollenites limbatus* Balme 142

1. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 336/1064 (CPC 13054); × 750. *a.* showing crowded granules on proximal face, *b.* distal exine almost entirely disappeared.
2. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 379/1127 (CPC 13055); × 750. Showing thin, wrinkled exine at proximal side of grain.
3. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–2; coord. 290/1044 (CPC 13056); × 750. Distal exine partially absent.
4. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 333/1157 (CPC 13057); × 750.

Figs. 5–8. *Ephedripites* spp. 144

5. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 328/1057 (CPC 13058); about × 1000.
6. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 398/1184 (CPC 13059); × 750.
7. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 289/1122 (CPC 13060); × 750.
8. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 318/1085 (CPC 13061); × 750.

Figs. 9–13. *Liliacidites peroreticulatus* (Brenner) 146

9. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 240/1164 (CPC 13062); × 1000. *a.* focus on central body, sulcus slightly gaping, *b.* focus on surface reticulum; muri crossing location of sulcus without interruption.
10. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 283/1164 (CPC 13063); × 1000. Showing partially detached sexine and regular reticulum.
11. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 284/1037 (CPC 13064); × 1000. *a.* focus on central body and (closed) sulcus, *b.* showing surface network and minutely granulate muri.
12. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–2; coord. 280/1177 (CPC 13065); × 1000.
13. Same sample. M.F.P. 4447–2; coord. 269/1134 (CPC 13066). *a.* focus on distal surface reticulum; muri continuing without interruption across sulcus; × 1000, *b.* enlargement of same specimen, about × 1900.

Figs. 14–16. *Clavatipollenites hughesii* Couper 145

14. Bathurst Island No. 2; 599′ 6–11″, 182.8 m. M.F.P. 4433–1; coord. 329/1185 (CPC 13067); × 1000.
15. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 389/1170 (CPC 13068); × 1000.
16. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–2; coord. 438/1153 (CPC 13069); × 1000.

Figs. 17, 18. cf. *Liliacidites* sp. Not described

17. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 272/1184 (CPC 13070); × 750.
18. Bathurst Island No. 2; 599′ 6–11″, 182.8 m. M.F.P. 4433–2; coord. 423/1101 (CPC 13071); × 1000.

Fig. 19. Striate monosulcate specimen. Not described.
Bathurst Island No. 1, 200′, 60.9 m. M.F.P. 4449–1; coord. 252/1135 (CPC 13072); × 1000. Striation approximately normal to equator.

Fig. 20. *Clavatipollenites* sp. A 146
Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 288/1201 (CPC 13073); × 1000.

Fig. 21. *Liliacidites* sp. Not described.
Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 250/1036 (CPC 13074); × 750.

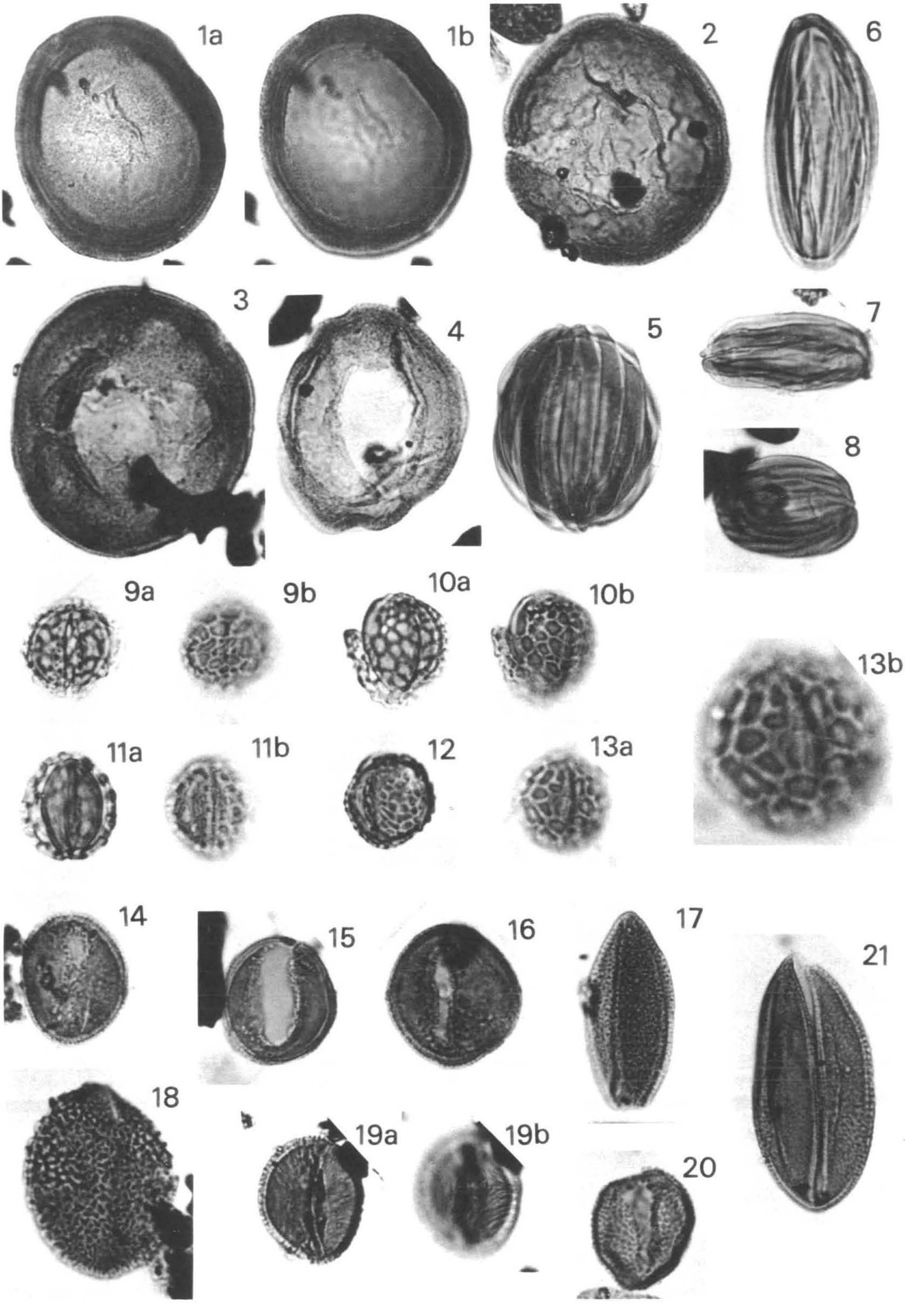
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PLATE 30

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Page

Figs. 1, 2. *Classopollis simplex* (Danzé-Corsin & Laveine) 142

1. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 359/1042 (CPC 13075); × 750. *a*. showing coarse structural elements of distal exine, *b*. focus on rimula.
2. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 280/1092 (CPC 13076); × 750. Equatorial striae visible.

Figs. 3–9. *Classopollis* sp. 142

3. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 430/1077 (CPC 13077); × 750. Distal pore and radial exine folding distinct.
4. Bathurst Island No. 2; 900′ 0–6″, 274.4 m. M.F.P. 4430–2; coord. 337/1015 (CPC 13078). *a*. × 750. *b*. same specimen; equatorial striation faint, no trace of rimula, × 1000.
5. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 373/1185 (CPC 13079); × 750.
6. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 351/1042 (CPC 13093); × 750.
7. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 359/1050 (CPC 13080). Radial folding of exine distinct, sexine detached from nexine. No rimula visible. *a*. × 750, *b*. about × 1250.
8. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 368/1183 (CPC 13081); × 750.
9. Same species? Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 273/1150 (CPC 13082). *a*. sexine detached from nexine, equatorial striation faint, rimula not visible; × 750, *b*. same specimen, about × 1870.

Figs. 10–15. *Asteropollis asteroides* Hedlund & Norris 144

10. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 435/1087 (CPC 13083) × 1000. Tetrachotomosulcate specimen, branches of aperture closed.
11. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 386/1022 (CPC 13084); × 1000.
12. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 362/1150 (CPC 13085); × 1000. Trichotomosulcate specimen.

13 & 14. Tetrachotomosulcate specimens, aperture opened, exine structure distinct.

13. Bathurst Island No. 1; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 350/1142 (CPC 13086); × 1000.
14. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 252/1072 (CPC 13087); × 1000.
15. Bathurst Island No. 1; 800′, 243.8 m. M.F.P. 4445–2; coord. 428/1204 (CPC 13088). Tetrachotomosulcate specimen. *a*. × 1000, *b*. same specimen, about × 1750.

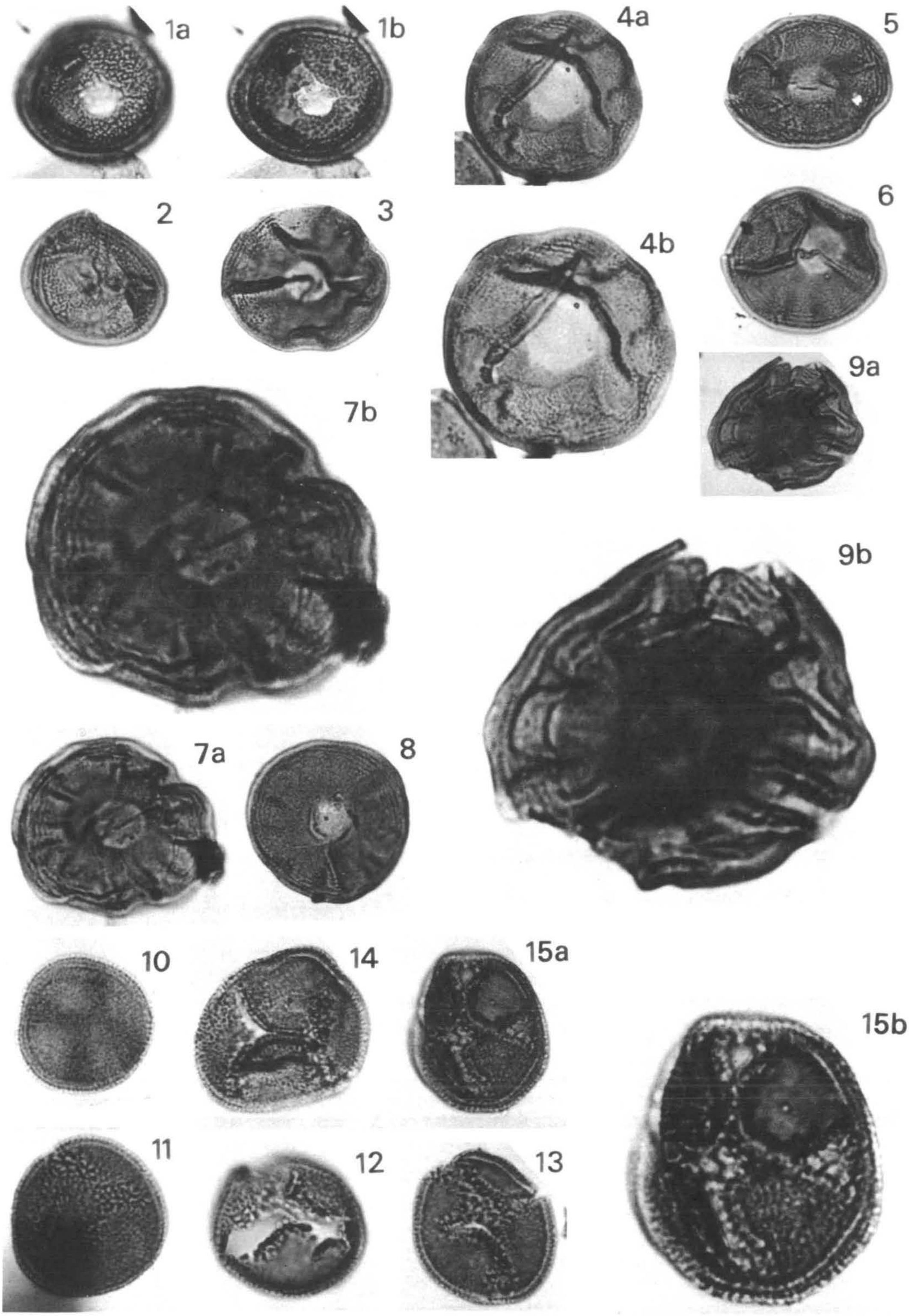
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PLATE 31

Magnification indicated for individual figures

Page

Figs. 1–3. *Asteropollis asteroides* Hedlund & Norris 144

1. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–2: coord. 400/1130 (CPC 13089); × 1000. Tetrachotomosulcate specimen.
2. Same sample. M.F.P. 4447–2; coord. 310/1115 (CPC 13090); × 1000. Trichotomosulcate specimen, aperture branches opened.
3. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 298/1036 (CPC 13091). Probable tetrachotomosulcate specimen, showing regular exine structure and coarser structure elements adjacent to aperture branches. *a.* × 1000, *b.* same specimen, about × 1630.

Figs. 4–9. *Liliacidites* cf. *L. kaitangataensis* Couper 147

4. Bathurst Island No. 2; 50′ 0–6″, 15.3 m. M.F.P. 4440–1; coord. 371/1103 (CPC 13092). Polar view, showing sulcus, exine stratification and outer surface reticulum; × 1000, *c.* same specimen, detail of reticulum, lumina closed, irregularly shaped; about × 2000.
5. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 354/1091 (CPC 13094); × 1000. Polar view, focus on sulcus and rupture.
6. Same sample. M.F.P. 4439–1; coord. 442/1095 (CPC 13095). *a, b.* equatorial view; × 1000, *c.* detail of imperfect surface reticulum, lumina not closed, several bacula remaining isolated; about × 2500.
7. Bathurst Island No. 1, 200′, 60.9 m. M.F.P. 4449–2; coord. 316/1183 (CPC 13096). *a, b.* polar view, showing exine structure and sulcus; × 1000, *c.* same specimen, detail of exine structure; about × 2500.

8 & 9. Oblique view, grains slightly distorted, sulcus and rupture distinct.

8. Bathurst Island No. 1, 300′, 91.4 m. M.F.P. 4455–2; coord. 225/998 (CPC 13097); × 1000.
9. Bathurst Island No. 2, 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 423/1088 (CPC 13098); × 1000.

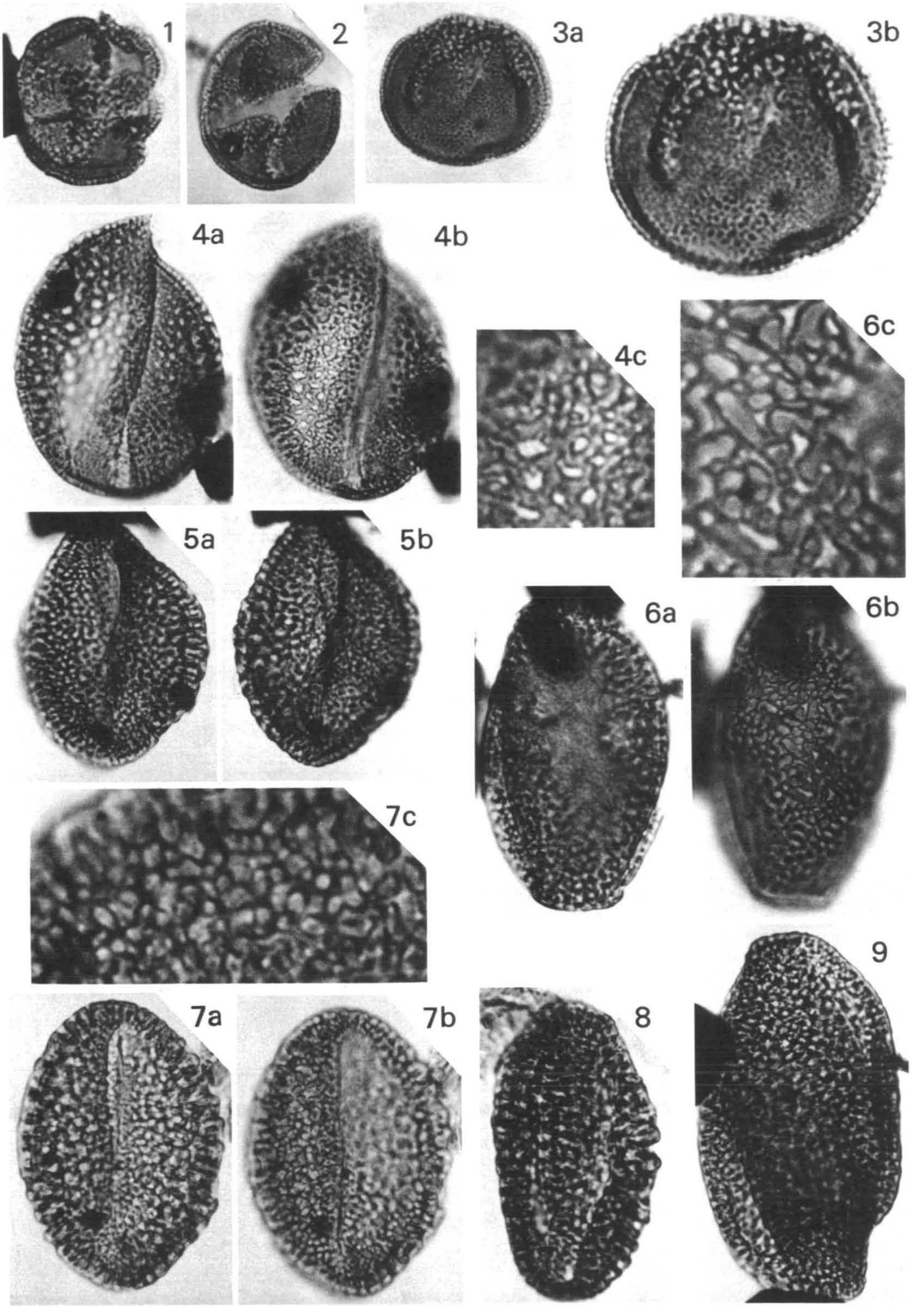
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PLATE 32

All figures × 1000, except fig. 5b.

		Page
Figs. 1, 2.	*Liliacidites* cf. *L. kaitangataensis* Couper 1. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–2; coord. 367/1046 (CPC 13099). Polar view; *a, b*, different focal planes. 2. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 283/1153 (CPC 13100).	147
Figs. 3–5, 7.	*Senectotetradites fistulosus* Dettmann Grains united in tetrahedral tetrads. Relatively thin exine and regular exine structure distinct. 3. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 396/1045 (CPC 13101). 4. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 323/1150 (CPC 13102). 5. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 298/1140 (CPC 13102). *b*. exine structure; about × 2700. 7. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 389/1059 (CPC 13104). Grains united in tetrad; successive planes of focus, showing part of colpus (*a*. grain at lower left, *c*. grain at left), regular exine structure, and stratification.	151
Fig. 6.	*Dicolpopollis* sp. Not described. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 383/1066 (CPC 13108). Equatorial view, different planes of focus; two sulculi and regular exine structure distinct.	
Figs. 8–9.	*Dicolpopollis* sp. A Equatorial view, exine structure visibly diminished to absent near sulculi and apices. 8. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 396/1007 (CPC 13105). 9. Bathurst Island No. 2; 1023′ 0–6″, 311.9 m. M.F.P. 4429–2; coord. 349/1147 (CPC 13106).	147
Fig. 10.	*Dicolpopollis*? sp. Not described. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 350/1028 (CPC 13107).	

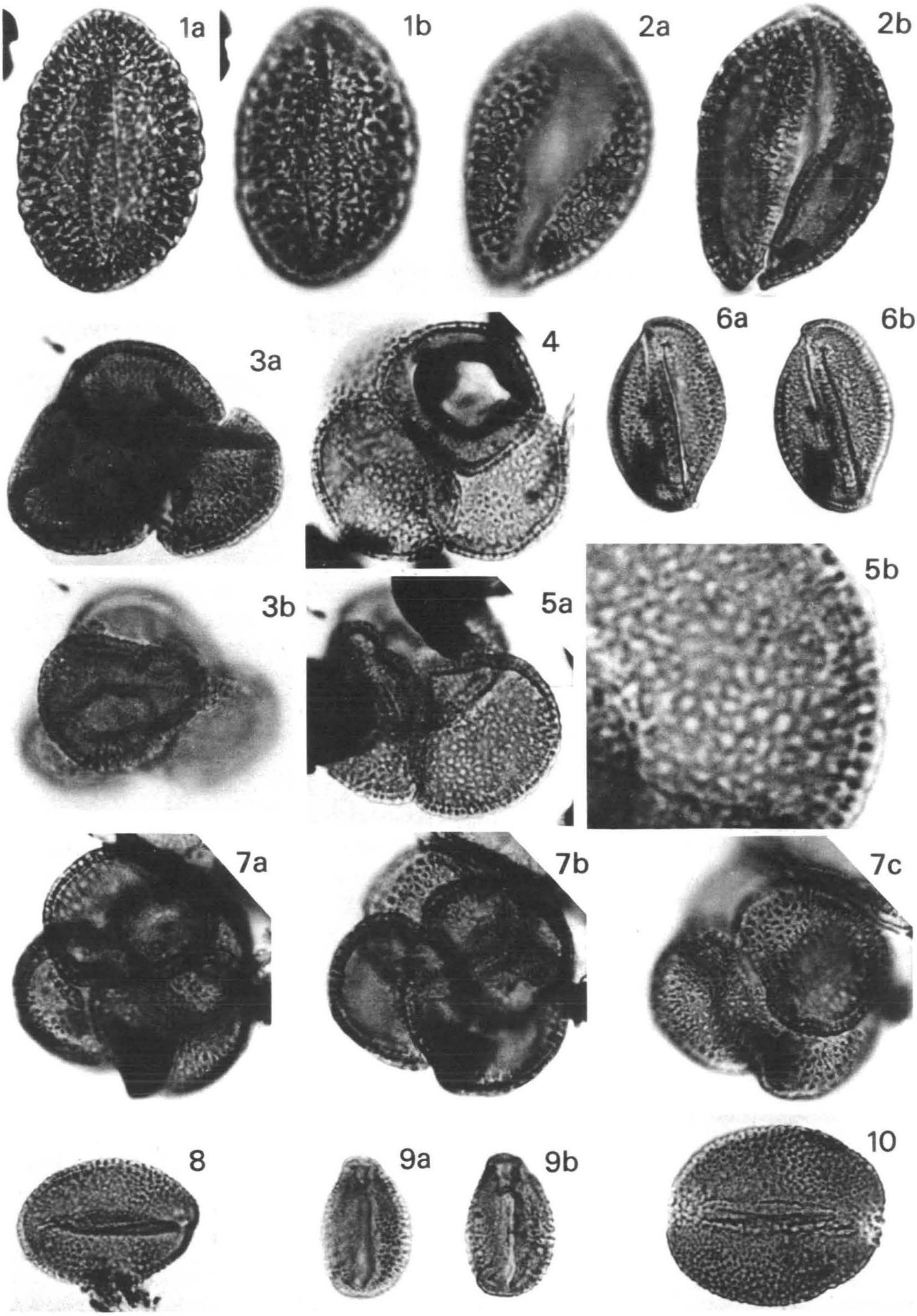
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PLATE 33

All figures × 1000

Page

Figs. 1–4. *Cupuliferoidaepollenites* cf. *C. parvulus* (Groot & Penny) 148

1. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 443/1093 (CPC 13109). Polar view.
2. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 279/1009 (CPC 13110). Equatorial view.
3. Same sample. M.F.P. 4447–2; coord. 370/1169 (CPC 13111).
4. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 314/1049 (CPC 13112), showing structureless exine and absence of pores.

Figs. 5–10. *Fraxinoipollenites variformis* sp. nov. 149

5. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 291/1081 (CPC 13113). Polar view, sculptural elements relatively large and ill-defined. Specimen corroded.
6. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 352/1067 (CPC 13114). Prolate specimen, poorly preserved, granulate sculpture.
7. Same sample. M.F.P. 4449–1; coord. 283/1153 (CPC 13115).
8. Same sample. M.F.P. 4449–1; coord. 365/1168 (CPC 13116). Showing double-layered exine and minutely undulate exine surface.
9. Same sample. M.F.P. 4449–1; coord. 278/1134 (CPC 13117). Prolate grain, with small, elongated exine elevations.
10. **Holotype.** Grain spherical, colpi shown in different focal planes; exine regularly granulate.

Figs. 11, 12. ?*Phimopollenites* sp. 150

11. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 316/1183 (CPC 13119). Exine structure not visible on micrograph.
12. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 420/1037 (CPC 13120). Exine microstructure just visible.

Figs. 13–15. *Tricolpites variabilis* Burger

13. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–2; coord. 302/1033 (CPC 13121).
14. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 332/1100 (CPC 13122).
15. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 265/1020 (CPC 13123).

Fig. 16. *Tricolpites georgensis* (Brenner)

Not described. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 418/1203 (CPC 13124). Presence possibly due to recycling of older sediments.

Figs. 17, 18. *Phimopollenites augathellaensis* (Burger) 149

17. Bathurst Island No. 2; 816′ 0–6″, 248.8 m. M.F.P. 4431–2; coord. 253/1032 (CPC 13125).
18. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 409/1101 (CPC 13126).

Fig. 19. *Senectotetradites varireticulatus* Dettmann 151

Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 405/1083 (CPC 13127). Grains united in tetrad, damaged. Stratified exine and irregular exine structure distinct.

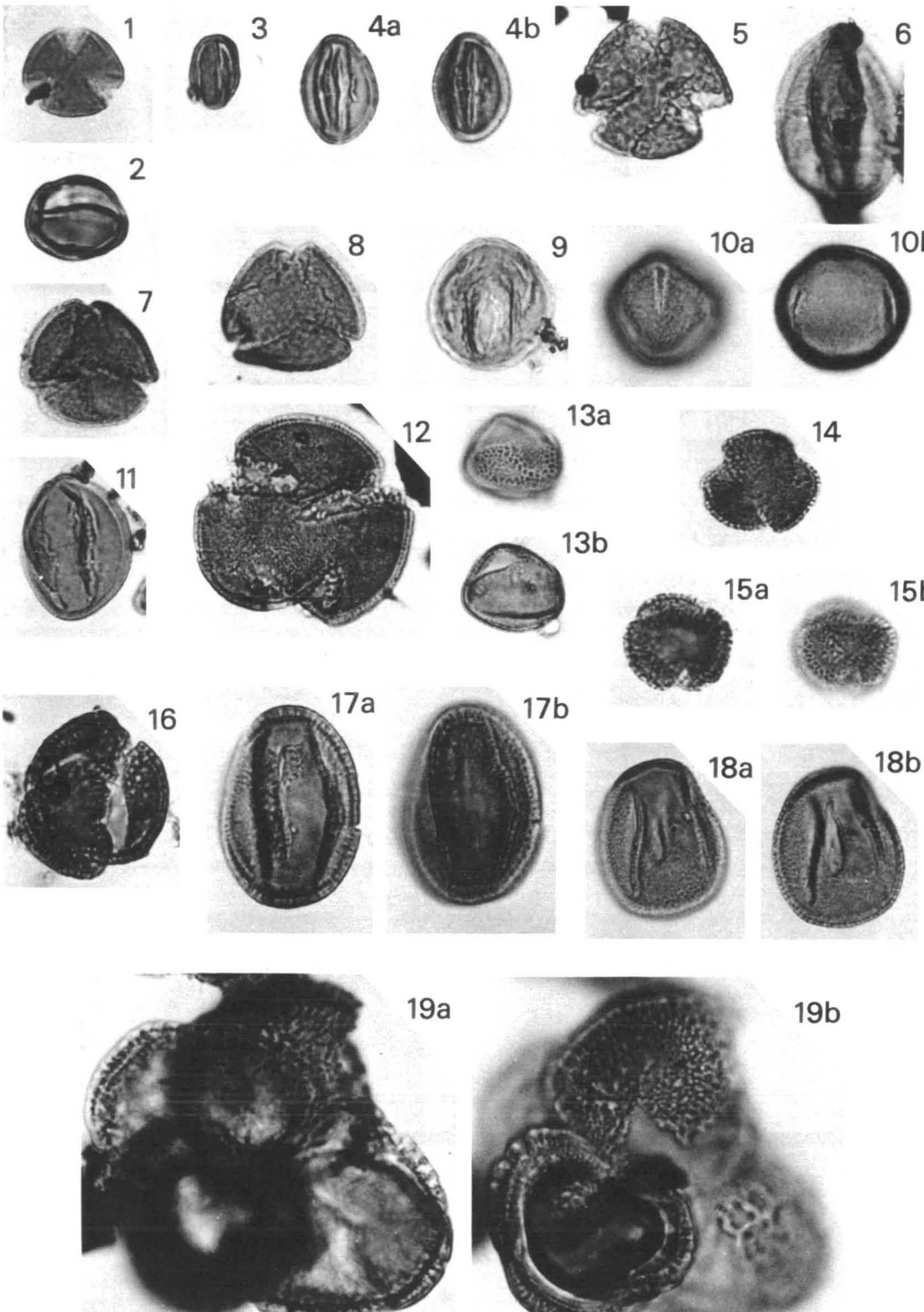
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PLATE 34

All figures × 1000, except figs. 6b, 9c, 11b.

Page

Figs. 1–3. *Senectotetradites varireticulatus* Dettmann — 151

1. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 302/1182 (CPC 13128). Grains in tetrahedral tetrad. Exine stratification distinct.
2. Bathurst Island No. 2; 418′ 0–6″, 126.5 m. M.F.P. 4435–2; coord. 264/1161 (CPC 13129). Showing relatively coarse exine structure and orientation of colpi.
3. Bathurst Island No. 1; 800′, 243.8 m. M.F.P. 4445–1; coord. 378/1042 (CPC 13130).

Figs. 4–9. *Striatopollis paraneus* (Norris) — 152

4. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 241/1020 (CPC 13131). Striation approximately parallel to polar axis.
5. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–2; coord. 413/1134 (CPC 13132). Striae partly in transverse orientation.

6, 7. Striation in equatorial region more or less transversely oriented.

6. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–2; coord. 250/1175 (CPC 13133). *b*. about × 2450. Nexine partially detached.
7. Bathurst Island No. 1;, 300′, 91.4 m. M.F.P. 4455–2; coord. 309/1100 (CPC 13134).
8. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–1; coord. 286/1141 (CPC 13135). Striae in thumbprint pattern.
9. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 378/1162 (CPC 13136). Structure of exine shown (see also text—fig. 8), *c*. about × 2500.

Figs. 10–14. *Tricolporites distinctus* (Groot & Penny) — 153

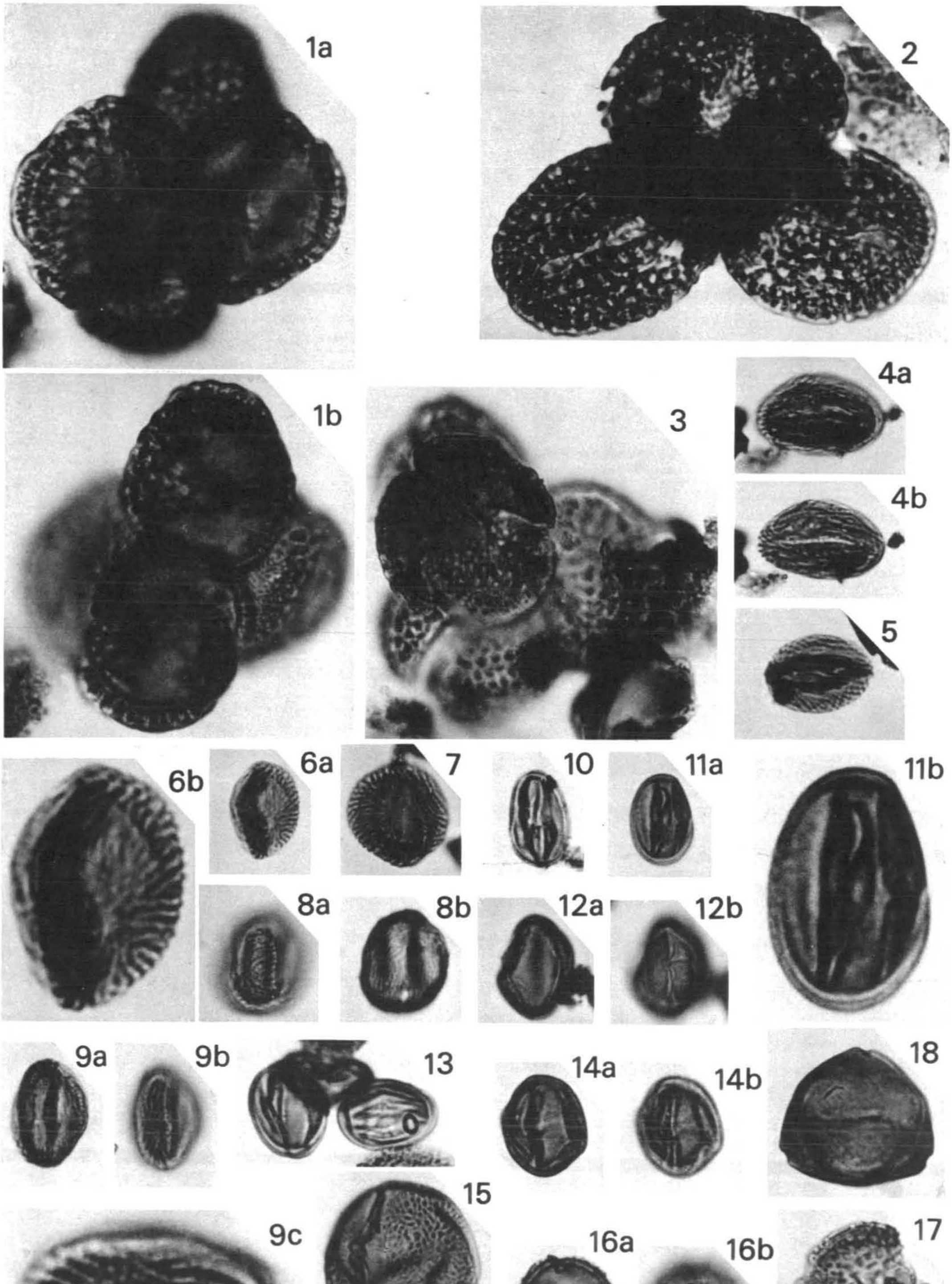
10. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 302/1145 (CPC 13137).
11. Bathurst Island No. 1; 200′, 60.9 m. M.F.P. 4449–1; coord. 396/1055 (CPC 13138). *b*. about × 2650.
12. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–1; coord. 394/1172 (CPC 13139).
13. Same sample. M.F.P. 4438–2; coord. 383/1052 (CPC 13140). Cluster of specimens, probably remainder of tetrad. Specimen at right shows indistinct pores.
14. Bathurst Island No. 1; 300′, 91.4 m. M.F.P. 4455–1; coord. 297/1117 (CPC 13141). *b*. showing slightly elongated pores.

Figs. 15–17. *Caprifoliipites* sp. — 154

15. Bathurst Island No. 1; 100′, 30.5 m. M.F.P. 4450–1; coord. 385/1135 (CPC 13142). Showing pore and characteristic reticulate pattern.
16. Bathurst Island No. 2; 150′ 0–6″, 45.8 m. M.F.P. 4439–1; coord. 365/1169 (CPC 13143). Polar view, showing typical reticulate pattern and intectate exine.
17. Bathurst Island No. 1; 600′, 182.9 m. M.F.P. 4447–2; coord. 426/1143 (CPC 13144). Decayed specimen. Polar view, showing intectate structure of exine.

Fig. 18. *Triatriopollenites* sp.

Not described. Bathurst Island No. 2; 200′ 0–6″, 61.0 m. M.F.P. 4438–2; coord. 451/1200 (CPC 13145). Presumably a Tertiary form, introduced by contamination (from circulating drilling mud?).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