ABSTRACT

Relatively rich marine palynomorph assemblages, consisting of dinocysts and acritarchs, occur in the majority of the 35 Cretaceous cores investigated from Site 361. The Early Cretaceous, Cores 48 to 27, is considered to be of Aptian age with the early-late Aptian boundary lying between Samples 33-3, 117-118 cm and 32-2, 117-119 cm. The Aptian dinocyst assemblage is comparable to that found in Australia and Europe. The Late Cretaceous, Cores 24 to 13, is more difficult to date because of the poor similarity of the assemblages with those from Europe; they are more comparable to the Australian assemblages where, unfortunately, the precise stratigraphic ranges of species are mainly unknown. Cenomanian was not identified and the succession begins in the Turonian. The top of the Turonian is tentatively drawn above Core 21 and the remainder of the Cretaceous sequence is assigned a Senonian-early Maestrichtian age. Normal marine conditions prevailed in the photic zone during the deposition of the above sediments; however, during most of the Aptian and Turonian, bottom conditions appear to have been anaerobic. During the Aptian, in particular, run-off from the surrounding landmasses was great and considerable amounts of terrestrially derived organic matter were transported to the site of deposition resulting in the accumulation of organically rich sediments; sapropel is abundant and, in this case, is probably land derived. Systematics are kept to a minimum and only four new taxa are proposed—_Australisphaera_ gen. nov.; _A. verrucosa_ sp. nov., _Aiora perforare_ sp. nov., and _Cyclonephelium distinctum_ subsp. _longispinatum_ subsp. nov.
cm, and 44-2, 111-113 cm—were subsequently acquired from SOEKOR and incorporated into the study.

All slides of type material with the prefix MPK and slides labeled CSA are housed in the Palynological Collection, Institute of Geological Sciences, Leeds, England. The slides borrowed from SOEKOR are now in their palynology laboratories, Johannesburg, South Africa. The co-ordinates of all specimens are from the Zeiss rotating and centering mechanical stage 50/75.

R. J. DAVEY

On the basis of this investigation the Cretaceous sequence can be divided into two parts, one of Early Cretaceous and one of Late Cretaceous age. The palynological residue from the Early Cretaceous is dominated by sapropelic organic matter, coarse terrestrial derived plant debris and sporomorphs; marine palynomorphs represent less than 5% of the palynomorph assemblage and are sometimes apparently absent. However, marine species, although low in abundance, are often quite high in diversity and more than 30 species may be present in an assemblage. The marine palynomorph assemblage is unusual in that acritarchs are typically abundant and, in some instances, outnumber the dinocysts. Microforaminifers occur in most samples.

The Late Cretaceous palynologic residues contain markedly less sapropelic organic matter—none at all in the younger samples—still with a considerable amount of terrestrially derived plant debris but fewer sporomorphs; marine palynomorphs, particularly dinocysts, are now generally common and compose up to 30% of the palynomorph assemblage. The number of marine species per sample, however, remains broadly similar to that found in the Early Cretaceous. Microforaminifers continue to be present but the acritarchs are considerably less abundant and disappear entirely higher in the sequence.

Stratigraphic Discussion

The majority of the marine palynomorphs recovered have been previously reported from sediments of similar age in other parts of the world, notably Australia and Northwest Europe and, to a lesser extent, North America. Literature on Cretaceous assemblages from southern Africa, South America, India, and Antarctica, however, is virtually nonexistent and so comparison with these and neighboring regions is impossible. This emphasizes the necessity for a detailed stratigraphic description of the present assemblages and is the reason for the morphologic and taxonomic comments made in part 2 of the systematics section.

The Cretaceous assemblages most closely resemble those described in many Australian publications and particularly those from Western Australia. Their stratigraphic ranges there, however, are not accurately known because most of the assemblages come from poorly dated boreholes. Thus only tentative dates can be obtained by comparison even though assemblage evolution appears to be almost identical in the two regions.

The European Cretaceous assemblages are the better known even though much still remains unpublished. The Early Cretaceous dinocyst assemblage of Site 361 is remarkably similar to that known to occur in France where the most detailed work has taken place. The Late Cretaceous assemblages are less similar because of the presence of several distinctive Australian forms which are not found in Europe. The stratigraphic ranges of species are particularly well known in France and England and dating of the Site 361 assemblages is effected mainly by data from these two countries.

There appears to be a relatively large difference between the Site 361 assemblages and those of comparable ages from North America, principally Canada, and detailed comparison leads to very few meaningful stratigraphic conclusions.

### TABLE 1

<table>
<thead>
<tr>
<th>Sample No. (CSA)</th>
<th>SOEKOR Palynology Sample No.</th>
<th>(Interval in cm)</th>
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<tr>
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<td>4978</td>
<td>13-1, 123-125</td>
</tr>
<tr>
<td>1726</td>
<td>4983</td>
<td>17-2, 51-53</td>
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<td>4984</td>
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<td>1729</td>
<td>4986</td>
<td>19-4, 91-92</td>
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<td>4987</td>
<td>20-2, 144-146</td>
</tr>
<tr>
<td>1731</td>
<td>4988</td>
<td>21-2, 131-133</td>
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<td>4989</td>
<td>22-2, 92-94</td>
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<td>4990</td>
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<td>4991</td>
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<td>4993</td>
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<td>1759</td>
<td>5024</td>
<td>48-2, 134-136</td>
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</table>
Cores 48 to 27: Aptian

The marine palynomorph assemblage in these cores consists of dinocysts and acritarchs, the vast majority of which also occur in Europe and Australia (see Figures 2, 3). Only two of the dinocyst species, *Dingodinium cerviculum* Cookson and Eisenack (1958) and "Canningia" ringnesii Manum and Cookson (1964) have not, as yet, been reported from Europe. Acritarchs typically outnumber the dinocysts and consist mainly of long-ranging species which are indicative of a special and characteristic marine environment rather than a certain stratigraphic level (see Paleontological Considerations).

The dinocyst assemblage as a whole is typical of the European Aptian (Davey and Verdier, 1974) although several of the characteristic and stratigraphically restricted European species are absent. Davey and Verdier (1974) indicate that the basal Aptian is characterized by the incoming of *Aptea polymorpha* Eisenack, 1958, *Cyclonephelium tabulatum* Davey and Verdier, 1974, and *Metourgonayaulax psoros* Davey and Verdier, 1974, and the appearance of *Protoeolithopodinum spinocrisatum* Davey and Verdier, 1971, during the early Aptian. None of these species were found during the present study, and of these four species only *P. spinocrisatum* has been reported from Australia (Morgan, 1975). In addition the marker species for the European Barremian (Milliond, 1969; Davey, 1974), *Pseudoceratium turneri* Gocht, 1957, and *Muderongia staurota* Sarjeant, 1966c, are also absent. Hence it is on rather negative evidence that the base of Site 361 is dated as Aptian; the possible presence of pre-Aptian strata cannot be completely dismissed.

Higher in the Early Cretaceous sequence several species are stratigraphically important and include, in alphabetical order, those listed below. It should be noted that much of the subsequent stratigraphic discussion is based on Davey and Verdier's 1974 study of the type Aptian (France).

1) *Achomosphaera neptuni* (Eisenack, 1958) and *A. cf. neptuni* of Davey and Verdier (1974). These occur spasmodically in the French Aptian but not in the Albian. The latter form last occurs in Core 27.

2) *Cauca parva* (Alberti, 1961) has a first stratigraphic occurrence within the late Aptian of France, and in Core 32.

3) *Chlamydophorella huguoni* (Valensi, 1955a) comb. nov. has a first stratigraphic occurrence at the base of the late Aptian in France, and in Core 32.

4) *Dingodinium albertii* Sarjeant, 1966c, and *D. cerviculum*. The taxonomic controversy surrounding these two species is discussed in the Systematics Section. In France the genus ranges to the top of the Aptian, but has never been observed in the Albian (Davey and Verdier, 1971; Verdier, 1975); it ranges to the top of the Early Cretaceous (Core 27) at Site 361. The distribution of *D. cerviculum* in Australia was discussed by Haskell (1969) who concluded that its top stratigraphic occurrence coincided with the top of Dettmann's (1963) *Speciosus Assemblage Zone* and with the top of the Aptian. Burger (in preparation) erects the *D. cerviculum* zone and regards it as Aptian (to ?Barremian) age. Burger's succeeding zone in the succession is that of *Pseudoceratium turneri* Cookson and Eisenack, 1958, a species which does not occur at Site 361, and this is considered to be of early to middle Albian age. *D. cerviculum* does occur rarely in this younger zone but, discussing these occurrences, Burger says "many of the specimens found are suspected to be of secondary (recycled) origin." Finally, relatively rare specimens of *D. cerviculum* have been reported from the Albian of Canada by Singh (1971) and Brideaux (1971). These Canadian occurrences are reminiscent of the younger Australian occurrences and suggest that in certain regions *Dingodinium* did linger on into the Albian.

5) *Kleithriasphaeridium simplicispinum* (Davey and Williams, 1966b). In the type Aptian this species has a top stratigraphic occurrence within the late Aptian; it last occurs in Core 32.

6) *Muderongia cf. staurota* Sarjeant, 1966c, of Davey and Verdier, 1974. This form extends into the Early-type Aptian and is the only *Muderongia* species to range into post-Barremian strata in Europe; it occurs rarely in many of the Early Cretaceous cores. *Muderongia cf. M. crucis* Neale and Sarjeant, 1962, of Burger (in preparation) is probably equivalent to *M. cf. staurota* and, as with *D. cerviculum*, Burger reports that it occurs rarely up into the early to middle Albian of Australia.

7) *Muderongia tetracantha* (Gocht, 1957) occurs only in Core 32; in Europe it has been reported from the Hauterivian of Germany (Gocht, 1957) and the early Barremian of England (Sarjeant, 1966c; Davey, 1974). Haskell (1969) considers that the top stratigraphic occurrence of *M. tetracantha* coincides with the top occurrence of *D. cerviculum* and the top of the Aptian. Burger (in preparation) however finds it associated with *M. cf. staurota* (as *M. cf. M. crucis*) and *D. cerviculum* in the early to middle Albian.

8) *Palaeoperidinium cretaceum* Pocock, 1962, first appears strongly at the top of the early Aptian in France and only occurs in Core 27 at Site 361.

9) *Subtilisphaera ventriosa* (Alberti, 1959) has only previously been reported from the so-called early Aptian of Germany by Alberti (1959) in borehole Werle 3 (Westmecklenberg). However, because of contamination, reworking and/or caving, no definite age can be assigned to the reported dinocyst assemblage.

From the above stratigraphic discussions, it may be concluded that, at the present time, the most reliable stratigraphic indices within the Aptian at Site 361 appear to be *Chlamydophorella huguoni* and *Kleithriasphaeridium simplicispinum*. These suggest that the base of the upper Aptian is between Samples 33-3, 117-118 cm and 32-2, 117-119 cm. The occurrence of *Dingodinium* and *Achomosphaera cf. neptuni* in Core 27, and the distribution of certain other species discussed above in the sequence, strongly suggests that it is Aptian in age.

Cores 26 and 25: Age Indeterminate

These cores consist mainly of reddish shales and interbedded siltstones; these are invariably palynologically barren. McLachlan and Pieterse (this volume)
Figure 2. Distribution chart of marine palynomorphs of Cretaceous age from Site 361.
Figure 2. (Continued).
Figure 3. Range chart of marine palynomorphs of Cretaceous age from Site 361.
Figure 3. (Continued)

- Cymbiosphaera, sp A of Singh
- Palaeophragmium cretaceum
- Polysphaeridium laminatespinaformis
- Palaeostracophora affinis
- Odontochitina costata
- Cyclonephelium distinctum longispinatum
- Florentinia deanei
- Palaeophragmium pyrophorum
- Trichodinium castanea
- Christophesphaeriaceae polytypes
- Florentinia reseei
- Aptedinidium granulatum
- Cyclonephelium compactum
- Dinopterigia cladofoi
d- Gymnacosphaera exigilacristata
- Kleithaphytridium lofrensis
- Maduradinulum sp A
- Membranarachnae polycladidata
- Subtilisphaera pirenaica
- Alteria ingrami
- Diconoidium arcticum
- Canningia cl scabrosa
- Chiarydophorale discrete
- Hystrichosphaeridium sp A
- Xenascus ceratoles
- Exochosphaeridium stromatolatum truncatum
- Astore perforare
- Microdinium ornatum
- Microdinium veligerum
- Palaeostomocystis fragilis
- Spindlinulum lantern
- Welodiophorum fusa
- Xiphosporidium alettum
- Conosphaeridium strictoconus
- Trithyridinulum sp A
- Diaphosphaera macrophylla
- Odontochitina criopoda
- Cyclonephelium distinctum distinctum
- Cannosphaeropsis fenestralia
- Chatanega cl victoriensis
- Gardinidium cl deflandrei
- Gottinia hymenophora
- Isabella cl amphista
- Odontochitina purpurea
- Amphidioidea denticulata
- Chatanega tripartita
- Dinogymnium westralium
- Exochosphaeridium bifidum
- Florentinia laciniata
- Isabella cretica
- Oligosphaeridium cl complex
- Silicosphaera buspina
- Silicosphaera ferox
- Spindinulum arenoplatum
- Australisphaera verrucosa
- Canosphaeropsis densiretilata
- Nelsoniella aceras
- Nelsoniella tuberculata
- Spindinulum echinus
- Trichodinium sp A
confirm this when they indicate that Sections 25-3, 26-3, -4, -5, and -6 are barren. Dinocyst assemblages of Albo-Cenomanian age are well known from Europe and Australia and many distinctive species, such as Lithospheridium siphoniphorum (Cookson and Eisenack, 1958), Hystrochospheridium arundum Eisenack and Cookson, 1960, and genera, such Ovoidinium Davey, 1970, and Carpodinium Cookson and Eisenack, 1962b, are typically present. However, none of these forms were found at Site 361 which suggests that the Albo-Cenomanian is either absent or represented in the paleontologically barren Cores 26 and 25.

Cores 24 to 21: Turonian,
Cores 20 to 13: Senonian to Maestrichtian

Many of the dinocyst species present in these cores are known to occur both in Europe and Australia but a few species have been previously only recorded from Australia. As in the Early Cretaceous, dating was effected principally by comparisons with European assemblages. A detailed stratigraphic study, by the author and Dr. J.-P. Verdier, of the late Albian to ?Santonian in the Lofre borehole, northern France, is in press, and several of the datings originate from this work. Even so, dating of the Site 361 Late Cretaceous is extremely tentative.

The following stratigraphically useful forms were recorded; Florentinia resex Davey and Verdier (1976) occurs in Cores 24 and 23, and in the Lofre borehole is restricted to the early Turonian. Subtitisphaera pirnaensis (Alberti, 1959), in Cores 23 and 22, is known to have principally an early to middle Turonian range in Europe, and Chlamydopharella huguonioti (Cores 23 and 22) ranges to the top of the Turonian. Core 21 does not contain any age-diagnostic European species although Conosphaeridium striatoconus (Deflandre and Cookson, 1955), previously found only in Australia, is considered to have a stratigraphic base in the Turonian. Core 20 does contain Hystrochospheridium sp. A., which has a basal occurrence in the Cenomanian of Lofre, and Disphaeria macropyla Cookson and Eisenack, 1960a, an Australian form, reported to be principally of Coniacian age. A form similar to D. macropyla occurs in the late Cenomanian -? Santonian of Lofre. Hence, on the evidence available, the Turonian-Coniacian boundary is tentatively placed between Samples 21-2, 131-133 cm and 20-2, 144-146 cm.

The comparison of assemblages from Cores 20 to 13 with European assemblages is not very meaningful and only a Senonian to early Maestrichtian age can be given. Many of the species present are restricted to and characteristic of the Australian Late Cretaceous and comparisons can easily be made with some of the described sequences. The most comparable sequence of assemblages was described by Cookson and Eisenack (1960a) from the Turonian to ?Campanian of Wapet's Rough Range South No. 1 bore, Carnarvon Basin, Western Australia. This publication, and all the many others these authors have published on Australian dinocysts, is basically a taxonomic study and it is impossible to construct a comprehensive distribution or range chart for the species present. Data from Australia, particularly Western Australia, indicate that Cores 20 to 13 are of Coniacian to Campanian age.

The genus Odontochitina Deflandre, 1935, represented by O. operculata (O. Wetzel, 1933a) ranges into the early Maestrichtian of Europe (Wilson, 1971) and suggests that Core 13, although containing a different species of this genus (O. portiera Cookson, 1956), could be as young as early Maestrichtian. It is interesting to note that the characteristic deflandroid species of Senonian-Maestrichtian age described from Senegal by Jain and Millipied (1973), from Gabon by Malloy (1972) and from Ghana by Davey (in press) were not found at Site 361.

Paleoeocological Considerations

McLachlan and Pieterse (this volume) discuss the various organic components making up the Cretaceous palynologic residues. Of particular interest from a paleoecological standpoint is their fig. 2 which indicates the proportions of the various constituents. The following discussion reappraises the palynologic data available pertaining to the conditions of deposition and type of water mass present during Cretaceous times from a slightly different point of view.

Aptian (Cores 48 to 27)

The Aptian samples typically yield dinocyst assemblages which are relatively rich in species but poor in numerical abundance. The majority of these species also occur in France and Australia. Hence it must be concluded that at least the photic zone above the site of deposition, inhabited by the motile dinoflagellates, was of near normal salinity and, in addition, that there was free oceanic connection between northwest Europe, Site 361, and Australia. Water temperatures were also probably rather similar in these regions.

The organic residues of the Aptian are unusual and are characterized by an abundance of sapropelic or amorphous organic matter (AOM of Davey and Rogers, 1975) or MOC of McLachlan and Pieterse (this volume) and also by an unusual abundance of non-spinose acritarchs belonging to the genera Pterospermella Eisenack, 1972, Cymatosphaera O. Wetzel, 1933b, and Eyrea Cookson and Eisenack, 1971. The AOM appears to be of marine origin in many of the regions where it has been recorded, e.g. the Late Jurassic of England, and in the Recent sediments offshore from South West Africa (Davey and Rogers, 1975) where it is associated with high marine phytoplankton productivity resulting from upwelling. However, in some AOM rich sediments, sporomorphs predominate over dinocysts. In this situation it is quite plausible to suggest that the AOM is associated with the sporomorphs and is of terrestrial origin.

The above acritarchs are a facies controlled element and have only previously been recorded together from Core 20 of the Eyre No. 1 bore, Eucla Basin, Western Australia (Cookson and Eisenack, 1971). The sediment here was described as a dark gray mudstone. In other parts of the world these non-spinose acritarchs, particularly Pterospermella and Cymatosphaera,
appear to be consistently associated with organic-rich sediments in the Mesozoic, e.g., in the mid-Cretaceous of central Canada (Davey, 1970; Singh, 1971), the Kimmeridgian of southern England, and the Kimmeridgian-Portlandian of the northern North Sea Basin. These forms do not occur in the APTian of northwest Europe. The reason for this association is not known, but a correlation with large run-off from the landmass and basins with a somewhat restricted bottom circulation appeared to be indicated.

Sporomorphs are abundant in the APTian and greatly outnumber the marine palynomorphs (see McLachlan and Pieterse, this volume). This palynomorph distribution is unusual in marine sediments and, together with the abundance of terrestrially derived plant material, indicates that there was a copious run-off from the neighboring landmass which reached the site of deposition; it also suggests that the AOM is terrestrially derived. As the dinocyst assemblage is relatively rich, it is perhaps easiest to envisage bottom currents bringing this terrestrial debris to the site of deposition.

A final detail is that the chitinous linings of foraminifers (termed microforaminifers) are relatively common in most of the APTian samples. At one time these would have been considered to be the remains of benthic foraminifers, but now, and particularly in the present situation, it appears more likely that they are derived from planktonic foraminifers which could represent early planktonic stages of benthic foraminifers. Anaerobic conditions undoubtedly prevailed beneath the water-sediment interface.

Turonian to Early Maestrichtian (Cores 28 to 13)

The amount of AOM in the sediment gradually decreases from Core 25 to disappear entirely by Core 21. Core 22 contains the youngest stratigraphic appearance of Pterospermella, and Eyrea last occurs in Core 21; these distributions again suggest a strong link between these acritarchs and the AOM content of the sediment. The proportion of dinocysts to sporomorphs is considerably greater now than in the APTian (see McLachlan and Pieterse, this volume), although marked fluctuations do occur, and indicate that normal marine conditions prevailed; the neighboring landmasses had less influence at the site of deposition. In the Turonian many of the observed dinocysts are found also in France, England and Australia; however, in the Senonian considerably fewer of the species are common both to northwest Europe and to Site 361, whereas many distinctive species, only previously described from Australia, are now common. It would appear that either changes in oceanic currents or in climatic belts cut off the water mass off southwestern Africa during the Senonian from direct contact with Europe but did retain the direct link with Australia.

SYSTEMATIC DESCRIPTIONS

This section is divided into two parts. The first part lists, in alphabetical order, the marine palynomorph species encountered during this study which require no special remarks; illustrated specimens are indicated. The second part deals with additional species which require certain amplifying remarks because of their morphology or classification.

Marine Palynomorph Species

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<th>Authors</th>
<th>Reference</th>
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<td>Achomosphaera cf. neptuni</td>
<td>Eisenack, 1958</td>
<td>Davey and Williams, 1966a, in Davey and Verdier, 1974 (Plate 1, Figure 1).</td>
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<td>(Deflandre and Courtville, 1939) Davey and Williams, 1966b.</td>
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<td>Chataignia tripartita</td>
<td>Cookson and Eisenack, 1960a (Plate 7, Figures 3-6).</td>
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<tr>
<td>Chamaephyriophora albertii</td>
<td>(Neale and Sarjeant, 1962) Davey comb. nov. (Plate 2, Figure 8).</td>
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<tr>
<td>C. discreta</td>
<td>Clarke and Verdier, 1967 (Plate 1, Figure 16).</td>
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<tr>
<td>C. haguiotii</td>
<td>(Valensi, 1955a) comb. nov. (Plate 2, Figure 12).</td>
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<td>Cleistosphaeridium flexuosum</td>
<td>Davey et al., 1966 (Plate 2, Figure 13).</td>
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<td>C. polytes</td>
<td>(Cookson and Eisenack, 1962b) Davey 1969a (Plate 2, Figure 11).</td>
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<td>Ctenophora oceanica</td>
<td>Cookson and Eisenack, 1958.</td>
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<td>Cribropodactinum edwardisi</td>
<td>(Cookson and Eisenack, 1958) Davey 1969a (Plate 2, Figures 14, 15; Plate 4, Figures 8, 9).</td>
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<tr>
<td>Cyclonephelium hastulatum Cookson and Eisenack, 1962b (Plate 3, Figures 1, 2).</td>
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<td>C. compactum</td>
<td>Deflandre and Cookson, 1955 (Plate 3, Figures 5, 6).</td>
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<td>Cymatiosphaera delicata</td>
<td>Cookson and Eisenack, 1971 (Plate 9, Figure 9).</td>
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<td>Diacypricyla pericyma</td>
<td>Manum and Cookson, 1964.</td>
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<td>Sarjeant, 1969 (Plate 5, Figures 11, 12).</td>
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<td>D. currelum</td>
<td>(Cookson and Manum, 1964) Lentin and Williams, 1975b (Plate 7, Figures 1, 8).</td>
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<td>Cookson and Eisenack, 1958 (Plate 4, Figure 1).</td>
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<td>Dinogynium westralium</td>
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Aiora perfurare nom. nov.

(Plate 1, Figures 2, 3)

1960 Aiora fenestrata (Deflandre and Cookson, 1955) Cookson and Eisenack, p. 9, pl. 2, fig. 17. 18. NON Cannosphaeropsis fenestrata Deflandre and Cookson, 1955, p. 283, pl. 3, fig. 2.

Derivation of name: Latin, perfurare, perforate—with reference to the taxial nature of the processes.


Dimensions: From Cookson and Eisenack, 1960b: holotype (measured from illustration pl. 2, fig. 17), shell diameter 50 × 65 µm, overall diameter 115-150 µm; range, shell diameter 50-80 µm, overall diameter 120-160 µm. Figured specimen, Plate 1, Figures 2, 3, shell diameter 51 × 59 µ, overall diameter 120 × 130 µm.

Description: The exact nature of the processes is difficult to determine but they appear to be single layered, flattened, or membranous structures. Five of these processes are present in the illustrated specimen. Here two appear to arise on opposite sides of the shell from high up on the precingular plates; one is circular arising from the left margin, one is postcingular arising from the right margin and one is antapical. An alternative way of describing this cyst would be to consider its basic morphology to be comparable to that of a Pterospermella species possessing a fenestrate periphragm wing. Approximately five large proximal perforations should then be envisaged with an increase in number, but decrease in size of the fenestration as the outer limit of the wing is approached. No direct relationship between Aiora and Pterospermella, however, is in any way implied here.

Genus AUSTRALISPRAEA gen. nov.

Type species: Australisphaera verrucosa sp. nov., Campanian-Maastrichtian, offshore South Africa, DSDP Leg 40, Site 361.

Derivation of name: Latin, australis, southern— with reference to its southerly occurrence in the South Atlantic.

Diagnosis: The cyst is dorso-ventrally flattened and has a subpolygonal outline; the hypotract is slightly asymmetric. A single antapical and two lateral features, developed as a relatively high ornament or low to high horns, are present. The ornament is low and high spines or processes are absent. The archeopyle is apical with a slightly to moderately zig-zag margin; the sulcal notch is offset to the left of the mid-line.

Remarks: The combination of slight asymmetry and lack of spinose ornament distinguishes Australisphaera from previously described genera; the horns, when developed, are quite unique. Australisphaera appears to possess the basic ceratioid features, as outlined by Wall and Evitt (1975), but does not appear to be closely related to any of the Cretaceous ceratioid genera. Unfortunately, as yet no complete specimens or detached operculae of A. verrucosa have been identified, so the form of the apical region remains unknown.

Cookson and Eisenack erected the genus Aiora in 1960 and made Cannosphaeropsis fenestrata Deflandre and Cookson, 1955, the type species. However, it is considered that Cookson and Eisenack, incorrectly attributed specimens that they found during their 1960 study to the previously described species C. fenestrata. The illustration of the holotype of the latter species (Deflandre and Cookson, 1955, pl. 3, fig. 2) distinctly shows that numerous processes radiate from the entire shell surface and are not restricted to one plane as in Aiora. Cookson and Eisenack's specimens are distinctive and warrant a separate genus; this they described as Aiora, basing it on the rough Range specimens which are below transferred from Cannosphaeropsis fenestrata to A. perforare nom. nov. which thus becomes the type species of the genus.
**Australisphaera verrucosa sp. nov.**

(Plate 2, Figures 1-5)

Diagnosis: A specimen of *Australisphaera* possessing a wall of moderate thickness which has a closely spaced surface ornament of low verrucae. The verrucae are larger in the lateral and antapical regions when they may be the only indication of these features. The horns, when present, grade from low bulges of the cyst wall to relatively long horns; the antapical horn arises from the ventral surface. The operculum is typically detached.

Holotype: MPK 1031, DSDP Leg 40, Site 361, Sample 13-1, 123-125 cm. Campanian-Maestrichtian, offshore South Africa.

Paratype: MPK 1032, DSDP Leg 40, Site 361, Sample 13-1, 123-125 cm. Campanian-Maestrichtian, offshore South Africa.

Dimensions:

<table>
<thead>
<tr>
<th>Type</th>
<th>Range</th>
</tr>
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<tr>
<td>Overall width</td>
<td>89 µm detached</td>
</tr>
<tr>
<td>Overall (operculum)</td>
<td>94 µm</td>
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Description: Tubercles, which completely cover the surface, are usually less than 0.3 mm in diameter. The large tubercles, mentioned in the diagnosis, and restricted to the lateral and antapical regions measure up to 3 mm in height and are particularly noticeable at the ends of the horns. The lateral horns tend to be of unequal length and may be notched. The sulcal notch is not an obvious feature of the archeopyle margin and definite splitting of the cyst wall along the precingular plane is minimal. Only rarely can any signs of a pre- and postcingular tabulation be discerned.

Genus CANNOSPHAEROPSIS O. Wetzel, 1933b, emend. Williams and Downie, 1966c

Cannosphaeropsis fenestrata Deflandre and Cookson, 1955

(Plate 1, Figure 11)

1955 Cannosphaeropsis fenestrata Deflandre and Cookson, p. 283, pl. 3, fig. 2.

Remarks: The retention of the type of this species in the genus *Cannosphaeropsis* has been discussed under the genus *Aitora*.

Genus CHLAMYDOPHORELLA Cookson and Eisenack, 1958

1961 Gardodinium Alberti, p. 18

Remarks: There appears to be no justification for keeping the morphologically identical genera *Chlamydophorella* and *Gardodinium* separate and hence their synonymization is here proposed. The reason that this has not been done before is because of the uncertainty of the archeopyle type of *Gardodinium*. G. deflandrei Clarke and Verdiere (1967) has an obvious precingular archeopyle and it was erroneously assumed that other species, including the type species, of this genus had a similar type of archeopyle. However, the type species of *Gardodinium*, G. trabeculosum Gocht, 1959, was shown by Davey (1974) to have an apical archeopyle and to be morphologically very similar to *Chlamydophorella* nyel Cookson and Eisenack, 1958, the type species of its genus.

Chlamydophorella is characterized by a subsphearaical to subpolygonal inner body which bears numerous short processes. The latter distally support a fine membrane which more or less completely surrounds the thicker walled inner body. However, the outer membrane being fine often suffers breakage and this appears to occur in some species more than others; the processes then are isolated and distally membranous. It is possible that sometimes these isolated processes were never linked distally by a membrane. Signs of a tabulation may be present and apical horns may be developed both on the inner body and by the outer membrane. The archeopyle is apical. Perhaps the most characteristic feature of the genus, however, is considered to be the short, distally bifurcating processes. When fine, the processes appear to be solid but when stouter they are obviously hollow with the lumen partially restricted by septa (see *Chlamydophorella hujonioti* as *Chlaemophorellum cancriferum* in Cookson and Eisenack, 1968, p. 120, and in Davey, 1969a, p. 155).

The stratigraphic range of *Chlamydophorella*, including *Gardodinium*, is Late Jurassic to Late Cretaceous with a peak abundance in the Early and Middle Cretaceous. The Jurassic genus *Stephanelytron* Sarjeant, 1961, is probably an early member of this lineage.

Chlamydophorella hujonioti (Valensi, 1955a) comb. nov.

(Plate 2, Figures 9, 10)

1955a Hystrixchosaeridium hujonioti Valensi, p. 38, fig. 2A.

1960b H. ancoriferum Cookson and Eisenack, p. 8, pl. 2, fig. 11.

1969a Cleistosphaeridium hujonioti (Valensi) Davey, p. 155, pl. 7, fig. 10.

Remarks: The present well-preserved specimens are identical to those described from Australia and Europe in several publications. The processes are of the stouter type typical of the genus *Chlamydophorella* and primarily for this reason this species has been transferred to the latter genus. There has been considerable discussion as to whether or not a surrounding membrane exists or that isolated processes terminating with a thin, transparent membrane are only present. Both extremes appear to exist and can be justifiably accommodated within a single species. There is no doubt that the present specimens do possess a completely surrounding outer membrane in the majority of cases. Occasionally this can be seen to be broken and discontinuous, and then the processes become isolated and the membrane is membranous. Occasionally the presence or absence of an outer membrane is probably related to specimen preservation and, in addition, may be difficult to positively identify even when it is present.

OTHER SPECIES

The following species, formerly placed in *Gardodinium*, are here transferred to *Chlamydophorella*. The taxonomic position of *Gardodinium deflandrei* Clarke and Verdiere will be discussed in a forthcoming paper by Dr. J.-P. Verdier and the author.


Chlamydophorella trabeculosus (Gocht) Davey, comb. nov. = *Scrinidinium trabeculosum* Gocht, 1959, p. 62, pl. 4, fig. 5. Hauterivian, Germany.

Genus CONOSPHAERIDIUM Cookson and Eisenack, 1969

Conosphaeridium striatocornus (Deflandre and Cookson, 1955)

Cookson and Eisenack, 1969

(Plate 2, Figures 6, 7)

Remarks: Although this is a relatively common species in the younger Cretaceous samples from Site 361, the specimens are often distorted. The shape of the archeopyle is polygonal, as noted by Cookson and Eisenack (1969), and only rarely approaches the classical precingular plate shape; detached operculae (Plate 2, Figure 7) are of similar form and bear a single process. Although not conclusive, evidence does strongly suggest that the archeopyle is formed by the loss of a single precingular plate.

Genus CRIBROPERIDINIUM Neale and Sarjeant, 1962, emend. Davey, 1969a

Criboperidinium sp. A.

(Plate 4, Figure 2)

Description: A large species of *Criboperidinium* having a rather thin, pitted wall and a weak tabulation defined mainly by low ridges. The latter sometimes develop low spines, especially along the apical horn, that are linked distally by trabeculae. The apical horn is strong and is of a subconical shape.

893
Genus CYCLONEPHELIUM Deflandre and Cookson, 1955, emend. Williams and Downie, 1966c

Remarks: During this investigation some difficulty was encountered in allocating the rather variable group of dinocysts characterized by a spinose ornament and an angular apical archeopyle to described species. Variation is mainly in the shape of the antapex and the length, density, and distribution of the spines. As so many specimens over a considerable stratigraphic interval were available for study, a re-evaluation of this group is attempted below.

Cyclonephelium distinctum subsp. distinctum
Deflandre and Cookson, 1955
(Plate 3, Figures 9, 12)

Remarks: The holotype of this species was re-illustrated by Cookson and Eisenack in 1962b (pl. 5, fig. 5), and this illustration clearly shows that practically all the dorsal and ventral surfaces are devoid of processes. Identical specimens occur at Site 361 and these are associated with the same dinocyst assemblage as occurs with the type material (in the Mollecap Greensand, near Gignin, Western Australia) and arelikewise of Senonian age. Cookson and Eisenack also attribute other specimens to C. distinctum (pl. 5, fig. 6-11) which are more densely spined, have smaller bald areas, and reportedly come from the Albo-Cenomanian of Western Australia. This second morphological variety can easily be distinguished from the type material of C. distinctum distinctum and also occurs in the older strata at Site 361; below these are attributed to a new subspecies of C. distinctum.

Cyclonephelium distinctum subsp. brevispinatum Millioud, 1969
(Plate 3, Figures 13-15)

Remarks: To this subspecies were attributed specimens possessing very short spines and a rounded to only slightly indented antapex. Similar specimens possessing a markedly indented antapex are placed in Canningia colliett Cookson and Eisenack, 1960b.

Cyclonephelium hirtellum (Alberti) comb. nov.
1961 Circulodinium hirtellum Alberti, p. 28, pl. 4, fig. 20.

Remarks: The original diagnosis of this species clearly indicates that the spines (3-4 µm in length) are restricted to the lateral margins of the shell. This characteristic indicates that the affinities of C. hirtellum lie more with Cyclonephelium than Canningia where the ornament, when present, is extremely low and should cover all surfaces equally. C. hirtellum is also characterized by two rounded antapical horns.

Cyclonephelium hystric (Eisenack) comb. nov.
(Plate 3, Figures 10, 11)
1958 Tenua hystric Eisenack, p. 410, pl. 23, fig. 1-4.

Remarks: Eisenack's type material of this species possesses the characteristics which typify the genus Cyclonephelium—processes more or less restricted to a circumferential zone and an angular apical archeopyle—and it is therefore transferred to this genus. C. hystric is characterized by numerous short, generally less than 10 µm, distally bent processes and a rounded antapex.

The above transference effectively removes the type species from Tenua Eisenack, 1958. However, Tenua was originally defined as having an overall covering of short processes, and has an obvious apical archeopyle. Hence the type species, T. hystric, possessing bald areas, never precisely complied with the generic diagnosis. Since its erection, Tenua has been widely used and has come to be regarded as being characteristic of the later Jurassic and all the species subsequently erected have been of this age. Only the type species is of Cretaceous age and this has fallen into disuse mainly because it does not comply with the generic diagnosis. It is hence here proposed to conserve the name Tenua, retaining Eisenack's original definition, and to erect T. riudrii Sarjeant as the new type species.

Genus TENUA Davey nom. cons. (non Tenua Eisenack, 1958)
Type species: Tenua riudrii Sarjeant, 1968; p. 231, pl. 1, fig. 12; pl. 2, fig. 1, 2, 4. Late Callovian, France.

Genus DINGODINIUM Cookson and Eisenack, 1958
Remarks: Although D. albertii Sarjeant, 1966c and D. cerviculum Cookson and Eisenack, 1958, were synonymized by Haskell in 1969, workers in various parts of the world continued to use either one or the other specific name; the two species are also still listed separately by Lentin and Williams (1973) suggesting that this synonymization was not accepted. The Europeans have tended to use D. albertii for their specimens and the Australians and Canadians use D. cerviculum. The difference between the two species is one of size rather than morphology: D. albertii, overall length of type material 50-66 µm; D. cerviculum, overall length of type material 81-109 µm. This separation on size appears to be valid because during the present study the specimens of Dingodinium could be immediately assigned either to a group of small specimens (D. albertii) having an overall length of 56 (60) 63 µm or to a group of larger specimens with an overall length of 75 (88) 100 µm.

Genus DISPHAERIA Cookson and Eisenack, 1960a
Disphaeria macrovula Cookson and Eisenack, 1960a
(Plate 4, Figures 10, 11)

Remarks: This species is composed of a small sack enclosed within a larger one, the two being in contact only on the supposed dorsal surface. On the single well-preserved specimen encountered there does appear to be a small precingular (3") plate archeopyle as implied by Norvick (1973). The apex of the inner sack bears several tubercles and additional tubercles are present on the dorsal periphragm. A large circular opening is present on the ventral surface. Very similar forms occur in the French Late Cretaceous and here the archeopyle is definitely precingular 3". At the moment I do not consider that Thalassicaphora Eisenack and Gocht, 1960, should be made a junior synonym of Disphaeria because of marked difference in wall structure. An interesting parallelism with regard to the ventral opening is its presence in Spiniferites sp. of Wilson, 1971, from the Maastrichtian, and in Spiniferites sp. A. of de Coninck, 1975, of Danian-middle Paleocene age.

Genus EXOCHOSPHAERIDIUM Davey et al., 1966
Remarks: Because of overall morphology and, in particular, the wall structure and precingular (3") archeopyle, the following species is here transferred to Exochosphaeridium.
Exochosphaeridium truncatum (Deflandre) Davey, comb. nov. = Hystrichosphaeridium truncatum Deflandre, 1937b, p. 71, pl. 13, fig. 6. Late Cretaceous, France. (Illustrated herein on Plate 4, Figures 12, 13.)

Genus HYSTRICHOSPHERIDIDIUM Deflandre, 1937b, emend. Davey and Williams, 1966b
Hystrichosphaeridium sp. A.
(Plate 5, Figure 4)

Remarks: A dinocyst species which possesses very fibrous, parallel-sided processes which widen distally to terminate with a recurved margin. The shell surface is fibrous and usually strongly reticulate. The precise position of the archeopyle has not been determined with certainty.

Genus MADURADINIUM Cookson and Eisenack, 1970a

Remarks: ?Maduradinium sp. A.
(Plate 5, Figures 5, 6)

Remarks: ?Maduradinium sp. A. is identical to specimens encountered in the Turonian-Coniacian of France. These specimens have, in common with M. pentagonum Cookson and Eisenack (1970a)
from Australia, a thin wall, the characteristic patches of granulation and irregular tubercles, and are of polygonal shape. However, apical and antapical horns and an intercalary archepyle are lacking in the European and South African specimens. Here the granulation is concentrated at the antapex, the cingulum and, to a lesser extent, along the weak tabulation. Arceopyle breakage is in the apical region and pronounced sutural splitting occurs between the precingular plates. It is possible that the apical plates are lost but this has yet to be confirmed.

Genus SPINIFERITES Mantell, 1850, emend. Sarjeant, 1970

Spiniferites ramosus (Ehrenberg, 1838) subsp. A. (Plate 6, Figures 8, 9)

Remarks: This form is similar to S. ramosus multibrévis Davey and Williams, 1966a, but possesses a thick, intraperforate wall with more numerous and finer sutural processes.

Genus SYSTEMATOPHORA Klement, 1960

Systemataphora sp. A. (Plate 9, Figures 1, 10)

Description: The processes of this species vary considerably from specimen to specimen and upon an individual. The cingular processes are of the bipartite type, typical of the genus, and each branch bifurcates distally. The post-, precingular, and antapical processes are more complex and arise from a circular or arcuate proximal ridge. They tend to be either flat and membranous and branch irregularly distally, or are composed of several branching processes which arise directly from the proximal ridge. The former type of process often gives the impression of being an aberrant tubular process that has lost part of its wall.


cf. Trichochinum sp. A. (Plate 9, Figure 3)

Description: This is a subsphaerical species composed of a thick, intraperforate wall. The numerous spines tend to be concentrated in the peritabular regions, leaving the sutural regions and the centers of the plates relatively free of processes. The spines are linked distally.

Genus TRITHYRODINUM Drugg, 1967, emend. Lentin and Williams, 1975b

Trithyrodinium sp. A. (Plate 9, Figures 14, 15)

Description: Several Senonian samples contained isolated endocysts with 3-plate intercalary endoarcheopyles. The walls of these endocysts are lightly to heavily granular. Such endocysts, having the intercalary plates cleanly detached rather than remaining partly joined to the endocysts, are typical of Trithyrodinium. However, since the peripty was never observed, specific determination was not possible.

REFERENCES

(All references to dinocysts mentioned in the text but not listed below are to be found in Lentin and Williams, 1973, 1975a.)


McIntyre, D.J., 1975. Morphologic changes in Deftandrea from a Campanian section, District of Mackenzie, N.W.T., Canada: Geosci. and Man, v. 11, p. 61-76.


PLATE 1

Figure 1  *Achomosphaera cf. neptuni* (Eisenack). Slide CSA 1751/1, MPK 1040. Shell 42 × 42 µm, processes 8-13 µm.

Figures 2, 3  *Aiora perforare* nom. nov. Slide SOEKOR 4988(b).1, co-ordinates 8.8/74.2. Overall diameter 124 × 129 µm, inner sac diameter 51 × 60 µm.
2. Ventral surface.
3. Dorsal surface.

Figure 4  *Batioladinium micropoda* (Eisenack and Cookson). Slide SOEKOR 4998(b).1, co-ordinates 1.7/91.5. 56 × 29 µm.

Figures 5, 6  *Apteodinium maculatum* Eisenack and Cookson. Slide CSA 1736/1, MPK 1042. Overall diameter 95 × 82 µm.
5. Ventral surface.

Figures 7, 8  "*Canningia*" cf. *scabrosa* Cookson and Eisenack.
7. Slide CSA 1726/1, MPK 1045. Overall diameter 60 × 70 µm.
8. Slide CSA 1732/1, MPK 1050. Overall diameter 69 × 79 µm.

Figure 9  "*Canningia*" *ringnesii* Manum and Cookson. Slide CSA 1736/1, MPK 1043. Overall diameter 41 × 44 µm.

Figure 10  *Canningia colliveri* Cookson and Eisenack. Slide CSA 1758/3, MPK 1059. Shell diameter 89 × 74 µm, spines up to 1.5 µm.

Figure 11  *Cannosphaeropsis fenestrata* Deflandre and Cookson. Slide SOEKOR 4985(b).1, co-ordinates 17.5/97.2. Overall diameter 80 × 63 µm.

Figure 12  *Cannosphaeropsis densiradiata* Cookson and Eisenack. Slide CSA 1725/2, MPK 1033. Overall diameter 68 × 65 µm.

Figures 13, 14  "*Canningia*" cf. *ringnesii* Manum and Cookson.
14. Slide CSA 1755/1, MPK 1061. Overall diameter 65 × 64 µm.

Figure 15  *Cassiculosphaeridia reticulata* Davey. Slide CSA 1735/1, MPK 1062. Shell diameter 49 × 50 µm, crests up to 1.5 µm.

Figure 16  *Chlamydophorella discreta* Clarke and Verdier. Slide CSA 1726/1, MPK 1046. Overall diameter 36 × 37 µm.
Figures 1-5  *Australisphaera verrucosa* sp. nov.
1. Holotype. Note that the antapical horn arises from the ventral surface rather than at the antapex.
2. Paratype.
3. Slide SOEKOR 4978(b).l, co-ordinates 5.7/84.5. Overall diameter 86 × 112 µm. (Interference contrast.)
4. Slide CSA 1725/2, MPK 1034. Overall diameter 70 × 96 µm.
5. Slide CSA 1725/2, MPK 1035. Overall diameter 89 × 101 µm.

Figures 6, 7  *Conosphaeridium striatoconus* (Deflandre and Cookson).
6. Slide SOEKOR 4986(b).l, co-ordinates 5.1/95.7. Shell diameter 72 × 64 µm, processes up to 15 µm. Note archoepyle to the north-west, and distal truncation of the processes.
7. Slide SOEKOR 4985(b), co-ordinates 8.0/116.1. Diameter 28 × 34 µm.

Figure 8  *Chlamydophorella albertii* (Neale and Sarjeant). Slide CSA 1758/1, MPK 1067. Overall diameter 67 × 44 µm.

Figures 9, 10  *Chlamydophorella huguoni* (Valensi). Slide CSA 1733/1, MPK 1068. Shell diameter 38 × 39 µm, processes 6-10 µm. Note enveloping membrane.
9. Interference contrast.

Figure 11  *Cleistosphaeridium polypes* (Cookson and Eisenack). Slide CSA 1733/1, MPK 1069. Shell diameter 41 × 34 µm, processes 10-18 µm.

Figure 12  *Cleistosphaeridium cf. huguoni* (Valensi). Slide CSA 1754/1, MPK 1080. Shell diameter 54 × 58 µm, processes 3-6 µm. Note relatively short processes not supporting a membrane.

Figure 13  *Cleistosphaeridium flexuosum* Davey et al. Slide CSA 1735/1, MPK 1063. Shell diameter 44 × 42 µm, processes up to 12 µm. (Phase contrast.)

Figures 14, 15  *Cribroperidinium edwardsi* (Cookson and Eisenack).
15. Slide CSA 1733/1, MPK 1070. Detached operculum (3′′).
Figures 1, 2 *Cyclonephelium lattadalicum* Cookson and Eisenack. Slide CSA 1726/2, MPK 1083. Overall diameter 67 × 56 µm.
1. Dorsal surface.
2. Ventral surface.

Figure 3 "*Canningia" cf. scabrosa* Cookson and Eisenack. Slide CSA 1732/1, MPK 1051. Overall diameter 62 × 73 µm.

Figures 4, 7, 8 *Cyclonephelium distinctum* subsp. *longispinatum* nov.
4. Slide CSA 1733/1, MPK 1071. Shell diameter 53 × 60 µm, processes up to 12 µm. Some of the processes are membranous, and such forms could well grade into *C. compactum*.
7. Type.
8. Slide CSA 1732/1, MPK 1052. Shell diameter 48 × 54 µm, processes up to 16 µm.

Figure 5 *Cyclonephelium compactum* Deflandre and Cookson. Slide SOEKOR 4991(b).l, co-ordinates 15.7/84.2. Shell diameter 63 × 70 µm, crests up to 15 µm.

Figure 6 *Cyclonephelium* cf. *compactum* Deflandre and Cookson. Slide SOEKOR 4986(b).l, co-ordinates 9.2/85.7. Shell diameter 70 × 85 µm, crests up to 5 µm. A single specimen with low crests.

Figures 9, 12 *Cyclonephelium distinctum* subsp. *distinctum* Deflandre and Cookson.
9. Slide SOEKOR 4985(b), co-ordinates 9.4/97.1. Shell diameter 81 × 74 µm, processes up to 11 µm.
12. Slide SOEKOR 4985(b).l, co-ordinates 22.1/78.0. Shell diameter 79 × 83 µm, processes up to 13 µm.

Figures 10, 11 *Cyclonephelium hystrix* (Eisenack). Slide CSA 1739/1, MPK 1086. Shell diameter 67 × 75 µm, processes up to 7 µm.
10. Ventral surface.
11. Dorsal surface.

13. Slide SOEKOR 5002(b).l, co-ordinates 8.6/82.0. Shell diameter 68 × 93 µm, processes up to 3 µm.
14. Slide SOEKOR 5014(b).l, co-ordinates 4.0/76.0. Shell diameter 66 × 74 µm, processes up to 5 µm.
15. Slide CSA 1733/1, MPK 1072. Shell diameter 104 × 99 µm, processes up to 5 µm.
PLATE 4

Figure 1  Dingodinium cerviculum Cookson and Eisenack. Slide SOEKOR 5018(b).1, co-ordinates 13.8/93.1. Overall diameter 92 × 59 µm.

Figure 2  Cribroperidinium sp. A. Slide SOEKOR 5012(b).1, co-ordinates 13.8/100.8. Overall diameter 155 × 103 µm.

Figure 3  Gonyaulacysta microceras (Eisenack). Slide SOEKOR 5023(b).1, co-ordinates 17.6/109.2. Overall diameter 81 × 71 µm.

Figures 4, 7  Gonyaulacysta exilicristata Davey.
4. Slide CSA 1734/1, MPK 1089. Overall diameter 90 × 80 µm.
7. Slide CSA 1732/1, MPK 1053. Overall diameter 82 × 69 µm.

Figures 5, 6  Gonyaulacysta tenuiceras (Eisenack).
5. Slide CSA 1735/1, MPK 1064. Overall diameter 92 × 78 µm. Dorsal surface with 2-plate precingular archeopyle.

Figures 8, 9  Cribroperidinium edwardsi (Cookson and Eisenack). Slide CSA 1733/1, MPK 1073. Overall diameter 157 × 121 µm.
8. Ventral surface.

Figures 10, 11  Disphaeria macropyla Cookson and Eisenack. Slide CSA 1730/1, MPK 1090. Overall diameter 83 × 70 µm, inner sack diameter 45 × 34 µm.
10. Ventral surface.
11. Dorsal surface.

Figures 12, 13  Exochosphaeridium truncigerum (Deflandre) comb. nov. Slide SOEKOR 4986(b).1, co-ordinates 1.8/93.1. Shell diameter 57 × 59 µm, processes up to 16 µm.
13. Ventral surface.
Figure 1  *Hystrichodinium pulchrum* Deflandre.
Slide CSA 1732/1, MPK 1054.
Shell diameter $54 \times 46 \mu m$, processes up to $22 \mu m$.

Figure 2  *Exochosphaeridium phragmites* Davey et al.
Slide CSA 1733/1, MPK 1074.
Shell diameter $70 \times 69 \mu m$, processes up to $17 \mu m$.

Figure 3  *Kleithriasphaeridium simplicispinum* (Davey and Williams).
Slide CSA 1754/1, MPK 1081.
Shell diameter $55 \times 47 \mu m$, processes $15-22 \mu m$.

Figure 4  *Hystrichosphaeridium* sp. A.
Slide CSA 1726/1, MPK 1047.
Shell diameter $46 \times 51 \mu m$, processes up to $16 \mu m$.

Figures 5, 6  *Maduradinium* sp. A.
5. Slide CSA 1733/1, MPK 1075.
Shell diameter $54 \times 59 \mu m$.
6. Slide CSA 1732/1, MPK 1055.
Shell diameter $62 \times 63 \mu m$.

Figure 7  *Paredonia ceratophora* Deflandre.
Slide CSA 1739/1, MPK 1087.
Overall diameter $95 \times 56 \mu m$.

Figures 8, 9  *Membranilarnacia polycladiata* Cookson and Eisenack.
Slide SOEKOR 4989(b).1.
8. Co-ordinates 17.8/85.5. Overall diameter $56 \times 60 \mu m$.
Lateral view.
9. Co-ordinates 20.2/106.7. Overall diameter $53 \times 59 \mu m$.
Apical-ventral view showing sulcal notch of archeopyle.

Figure 10  *Oligosphaeridium* cf. *complex* (White).
Slide CSA 1726/1, MPK 1048.
Shell diameter $40 \times 42 \mu m$, processes up to $16 \mu m$.
Note wide distal expansions of the processes.

Figures 11, 12  *Meiourogonyaulax* cf. *bulloidea* (Cookson and Eisenack).
Slide SOEKOR 5023(b).1, co-ordinates 2.1/103.0.
Shell diameter $107 \times 103 \mu m$, crests up to $7 \mu m$.
11. Ventral surface.

Figure 13  *Oligosphaeridium complex* (White).
Slide CSA 1732/1, MPK 1056.
Shell diameter $42 \times 43 \mu m$, processes $20-30 \mu m$. 
Figures 1, 7  *Odontochitina porifera* Cookson.
   Overall length 108 µm, horn length 85 µm.
7. Slide CSA 1725/2, MPK 1036.
   Shell diameter 50 × 63 µm, horn lengths 68 and 75 µm.

Figure 2  *Odontochitina cribropoda* Deflandre and Cookson.
Slide CSA 1729/1, MPK 1091.
Overall length 108 µm, horn length (broken) 69 µm.

Figure 3  *Muderongia tetracantha* (Gocht).
Slide SOEKOR 4998(b).1, co-ordinates 16.3/118.2.
Shell diameter 59 × 55 µm, antapical horn 45 µm, lateral horns 60 and 35 µm.

Figure 4  *Odontochitina costata* Alberti.
Slide CSA 1733/1, MPK 1076.
Shell diameter 67 × 65 µm, horn lengths 112 and 130 µm.

Figure 5  *Xenascus ceratioides* (Deflandre).
Slide CSA 1732/1, MPK 1057.
Shell diameter 71 × 62 µm, horn lengths 50 and 35 µm.

Figure 6  *Muderongia cf. staurota* Sarjeant.
Slide CSA 1751/1, MPK 1041.
Shell diameter 78 × 60 µm, antapical horn 52 µm, lateral horns 11 and 40 µm.

Figures 8, 9  *Spiniferites ramosus* subsp. A.
8. Slide SOEKOR 5018(b).1, co-ordinates 3.2/84.2. Shell diameter 61 × 48 µm, processes up to 10 µm. Specimen with numerous short sutural processes.
PLATE 7

Figures 1, 7 *Alterbia ingrami* (Cookson and Eisenack).
Slide CSA 1733/1.
1. MPK 1077. Overall diameter $89 \times 57 \mu m$. (Phase contrast.)
7. MPK 1078. Overall diameter $73 \times 52 \mu m$.

Figure 2 *Isabelia cf. lamphiata* (McIntyre).
Slide CSA 1727/1, MPK 1092.
Overall diameter $83 \times 37 \mu m$.

Figures 3-6 *Chatangiella tripartita* (Cookson and Eisenack).
   Overall diameter $94 \times 52 \mu m$. Ventral surface.
6. Same as Figure 3.
   Dorsal surface.
4. Slide CSA 1726/1, MPK 1049.
   Overall diameter $95 \times 64 \mu m$. Dorsal surface.
5. Ventral surface.

Figures 8, 9 *Chatangiella cf. victoriensis* (Cookson and Manum).
8. Slide SOEKOR 4985(b), co-ordinates 14.6/93.8. Overall diameter $87 \times 60 \mu m$.
9. Slide SOEKOR 4985(b).1, co-ordinates 15.6/102.3. Overall diameter $92 \times 66 \mu m$. 


PLATE 8

Figures 1-4

*Subtilisphaera ventriosa* (Alberti).
1, 2. Slide SOEKOR 4998(b), co-ordinates 8.1/116.5
Overall diameter 72 × 54 µm.
1. Interference contrast.
3. Slide CSA 1741/1, MPK 1093.
Overall diameter 61 × 52 µm.
4. Slide CSA 1741/1, MPK 1094.
Overall diameter 65 × 52 µm.

Figure 5

*Palaeoperidinium pyrophorum* (Ehrenberg).
Slide CSA 1733/1, MPK 1079.
Overall diameter 84 × 73 µm. (Phase contrast.)

Figure 6

*Palaeoperidinium cretaceum* Pocock.
Slide CSA 1735/1, MPK 1066.
Overall diameter 77 × 65 µm.
Note lack of second antapical horn. (Phase contrast.)

Figure 7

*Subtilisphaera pirnaensis* (Alberti).
Slide CSA 1732/1, MPK 1058.
Overall diameter 87 × 60 µm.

Figures 8, 9

*Subtilisphaera ventriosa* (Alberti).
Slide CSA 1736/1, MPK 1044.
Overall diameter 62 × 52 µm.
8. Phase contrast.
9. Interference contrast.

Figure 10

*Nelsoniella aceras* Cookson and Eisenack.
Slide CSA 1725/2, MPK 1037.
Overall diameter 67 × 69 µm.

Figure 11

*Spinidinium echinoideum* (Cookson and Eisenack).
Slide CSA 1725/1, MPK 1095.
Overall diameter 54 × 46 µm. (Phase contrast.)

Figure 12

*Pareodinia ceratophora* Deflandre.
Slide CSA 1739/1, MPK 1088.
Shell diameter 88 × 44 µm.

Figure 13

*Spinidinium lanterna* Cookson and Eisenack.
Slide CSA 1732/1, MPK 1096.
Overall diameter 71 × 51 µm. (Phase contrast.)
PLATE 9

Figures 1, 10 *Systematophora* sp. A.
1. Slide CSA 1759/3, MPK 1097.
   Processes 17-21 µm. Detached operculum with 4 processes.
10. Slide CSA 1758/3, MPK 1060.
   Shell diameter 49 × 43 µm, processes up to 20 µm.

Figure 2 *Trichodinium castanea* (Deflandre).
Slide CSA 1732/1, MPK 1097.
Shell diameter 50 × 47 µm, processes up to 5 µm.

Figure 3 cf. *Trichodinium* sp. A.
Slide CSA 1725/2, MPK 1038.
Overall diameter 66 × 57 µm.

Figures 4, 8 *Organism* sp. A.
Slide SOEKOR 4989(b).1, co-ordinates 18.6/95.3.
Shell diameter 35 × 21 µm, processes up to 20 µm.
Only one specimen of this unusual form was recorded.

Figures 5-7 *Pterospermella centrata* (Cookson and Eisenack).
5. Slide SOEKOR 4998(b).1, co-ordinates 11.5/75.2.
   Overall diameter 78 × 64 µm.
6. Slide SOEKOR 5011(b).1, co-ordinates 3.8/86.2.
   Overall diameter 65 × 63 µm.
7. Slide SOEKOR 5012(b).1, co-ordinates 2.3/106.7.
   Overall diameter 60 × 61 µm.

Figure 9 *Cymatiosphaera delicata* Cookson and Eisenack.
Slide SOEKOR 4993(b).1, co-ordinates 13.5/107.6.
Shell diameter 59 × 58 µm, crests up to 3 µm.

Figure 11 *Eyrea nebulosa* Cookson and Eisenack.
Slide SOEKOR 5018(b).1, co-ordinates 4.0/114.0.
Central palynomorph diameter 65 × 62 µm.

Figures 12, 13 *Spinidinium sverdrupianum* (Manum).
Slide CSA 1726/2, MPK 1085.
Overall diameter 82 × 61 µm.
13. Ventral surface.

Figures 14, 15 *Trithyrodinium* sp. A.
14. Slide SOEKOR 4985(b), co-ordinates 20.2/80.3.
   Overall diameter 41 × 57 µm.
15. Slide CSA 1730/2, MPK 1098.
   Overall diameter 51 × 49 µm.