

25. MARINE CRETACEOUS PALYNOLOGY OF SITE 361, DSDP LEG 40, OFF SOUTHWESTERN AFRICA

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ABSTRACT

Relatively rich marine playnomorph 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.

INTRODUCTION

Site 361 (35°03.97'S, 15°26.91'E) is located near the base of the southwest African continental rise (water depth 4549 m) at approximately 180 miles west-southwest of Cape Town, South Africa. (Figure 1) A practically complete Eocene to Aptian section was penetrated to a depth of 1314 meters and 49 cores were taken. Of these 12 to 49 inclusive are of Cretaceous age.

Palynologic slides prepared from 35 samples (see below), representing 29 cores, were examined during this study for their marine palynomorph (dinocyst and acritarch) content. The slides were, in part, made available for examination by Mr. I.R. McLachlan who also provided wet residues from which additional slides were made. He and Elizabeth Pieterse, in a paper entitled "Preliminary palynological results: Site 361, Leg 40, Deep Sea Drilling Project" in the present volume report on all the components of the organic residues, principally to elucidate paleoecological conditions within the depositional basin. The present study involves a more detailed account and description of the dinocysts and acritarchs and supercedes the

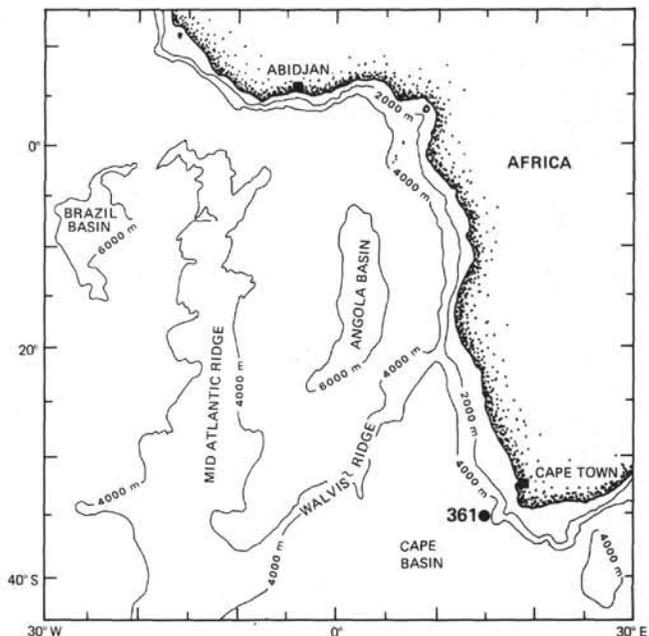


Figure 1. Location of DSDP Leg 40 Site 361.

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provisional identifications of McLachlan and Pieterse. Three additional samples—29-3, 48-50 cm, 38-2, 38-40

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, number 4896 472, IGS, Leeds.

SAMPLES EXAMINED

Table 1 lists the samples examined during the present study. The SOEKOR numbers refer to samples also analyzed by McLachlan and Pieterse (this volume).

PALYNOLOGICAL RESULTS

General Discussion

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

terrestrially 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
Samples Examined

I.G.S. Sample No. (CSA)	SOEKOR Palynology Sample No.	Sample (Interval in cm)
1725	4978	13-1, 123-125
1726	4983	17-2, 51-53
1727	4984	18-2, 140-141
1728	4985	19-2, 143-145
1729	4986	19-4, 91-92
1730	4987	20-2, 144-146
1731	4988	21-2, 131-133
1732	4989	22-2, 92-94
1733	4990	23-2, 61-64
1734	4991	24-2, 96-98
1735	4993	27-2, 119-121
1736	4995	28-6, 115-117
1737		29-3, 48-50
1738	4997	31-4, 129-131
1739	4998	32-2, 117-119
1740	5000	33-3, 117-118
1741	5001	34-2, 60-62
1742	5002	35-2, 130-132
1743	5003	35-3, 50-52
1744	5004	36-1, 103-105
1745	5005	36-2, 136-138
1746	5006	36-3, 77-79
1747	5007	37-2, 129-131
1748		38-2, 38-40
1749	5010	40-2, 87-89
1750	5011	40-3, 99-101
1751	5012	41-1, 90-92
1752	5014	41-3, 53-55
1753	5017	43-2, 116-118
1754	5018	43-3, 12-13
1755		44-2, 111-113
1756	5019	45-1, 134-136
1757	5022	46-2, 124-125
1758	5023	47-1, 128-130
1759	5024	48-2, 134-136

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 Paleocological 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 *Meiourogonaulax psoros* Davey and Verdier, 1974, and the appearance of *Protoellipsoidinium spinocristatum* 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. spinocristatum* has been reported from Australia (Morgan, 1975). In addition the marker species for the European Barremian (Milliond, 1969; Davey, 1974), *Pseudoceratium pelliiferum* 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 huguonioti* (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) *Kleithrisphaeridium 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 huguonioti* and *Kleithrisphaeridium 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)

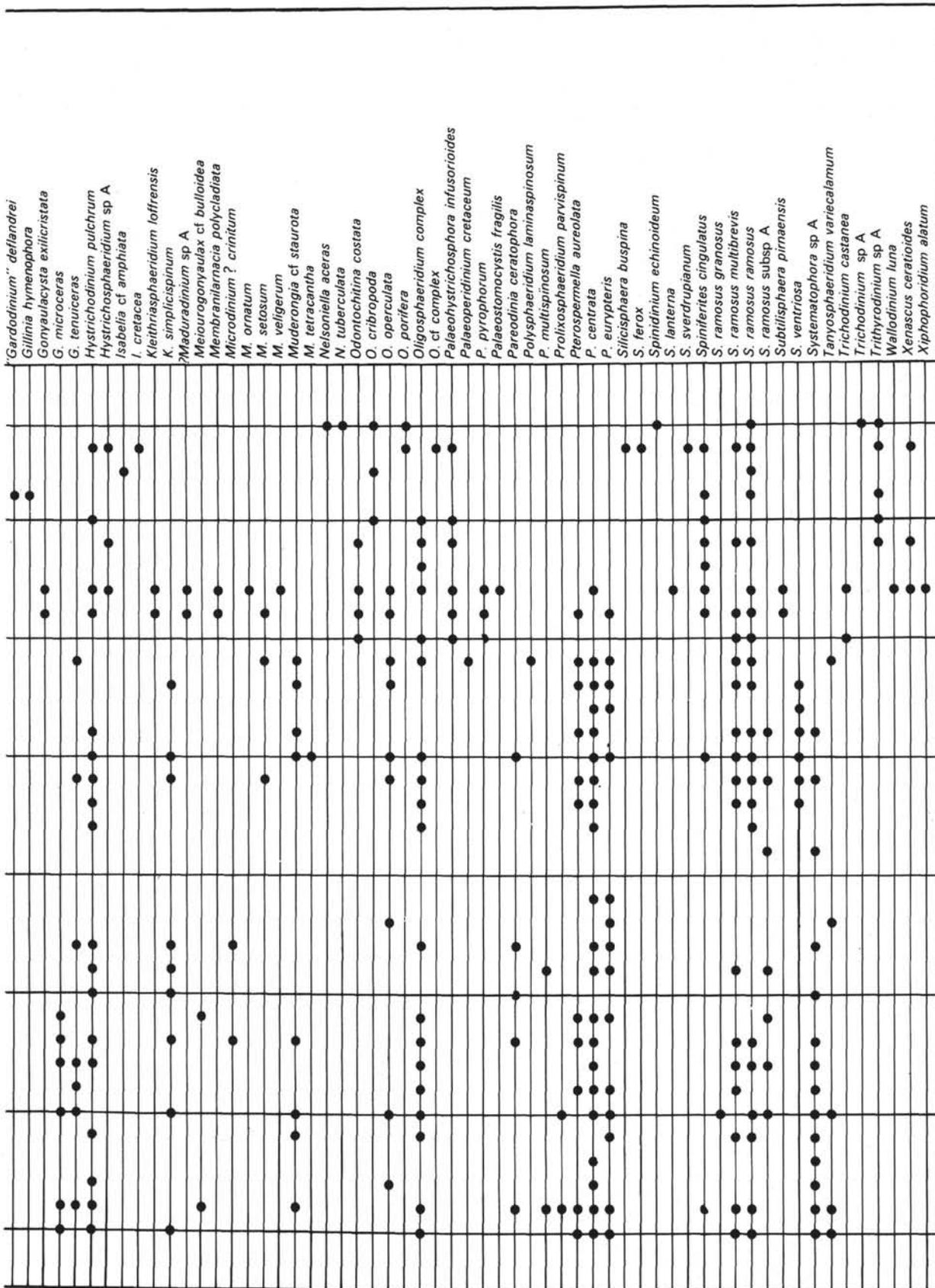


Figure 2. (Continued).

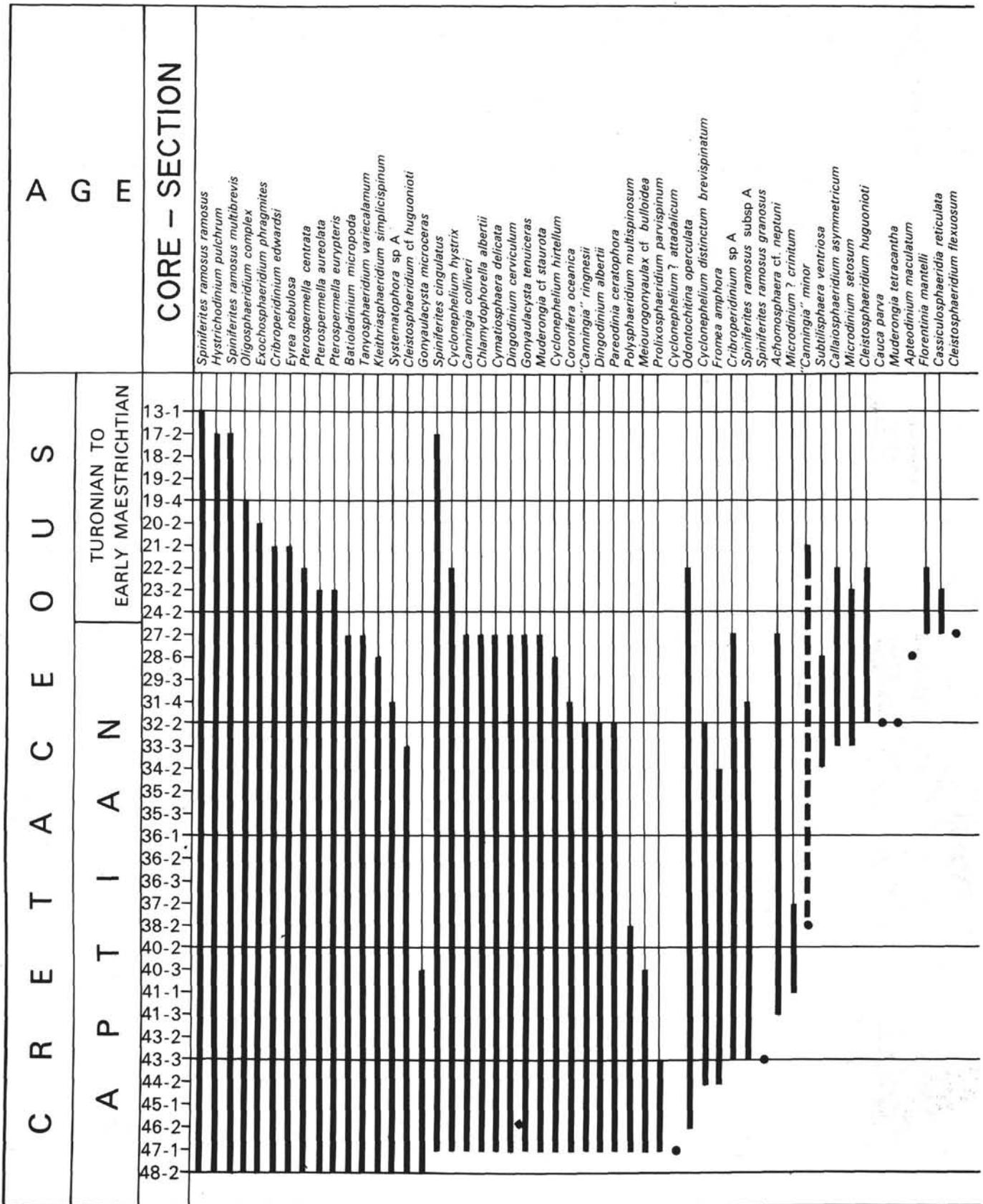


Figure 3. Range chart of marine palynomorphs of Cretaceous age from Site 361.

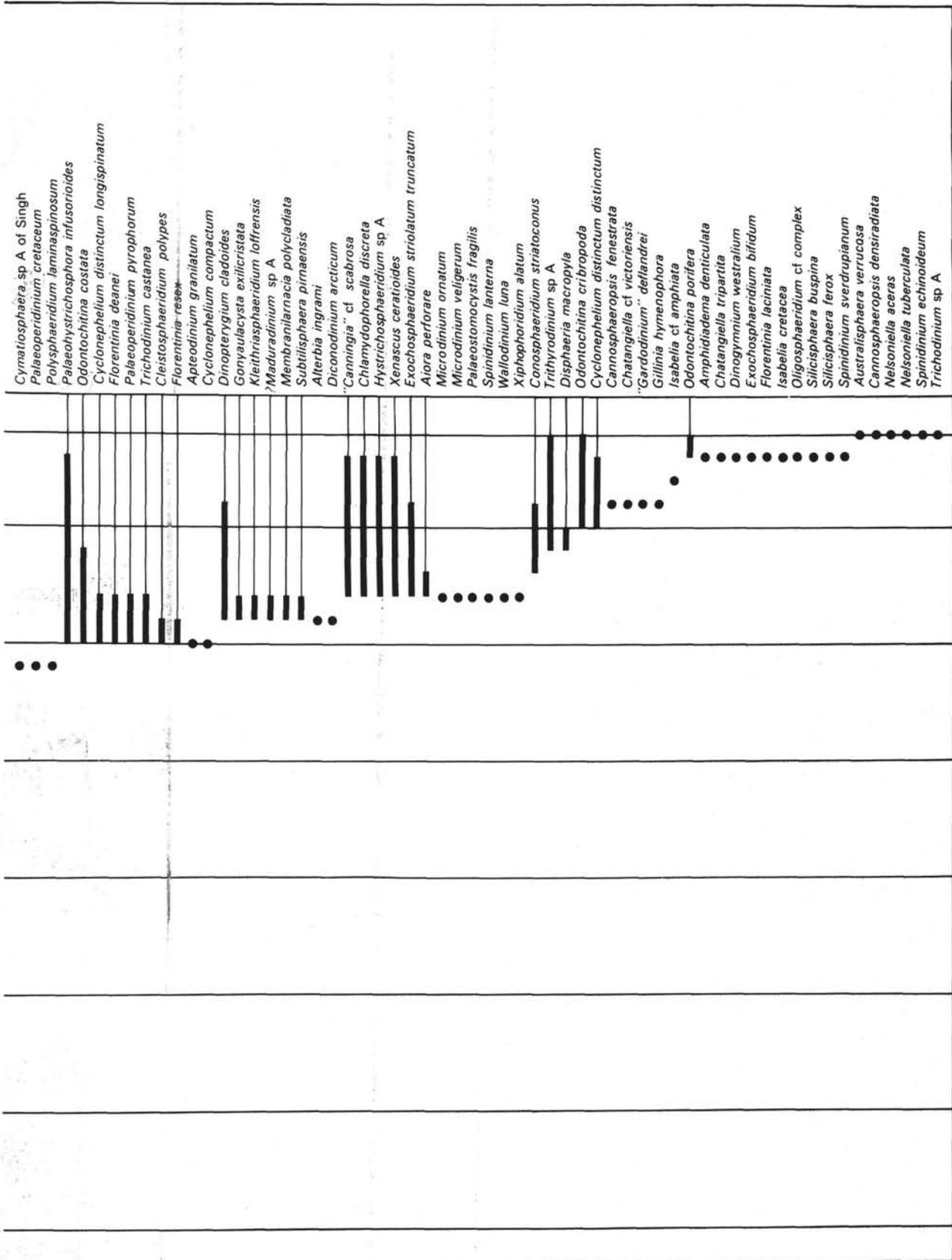


Figure 3. (Continued).

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 *Litosphaeridium siphoniphorum* (Cookson and Eisenack, 1958), *Hystrichosphaeridium arundum* Eisenack and Cookson, 1960, and genera, such as *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 Loffre 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 Loffre borehole is restricted to the early Turonian. *Subtilisphaera pirnaensis* (Alberti, 1959), in Cores 23 and 22, is known to have principally an early to middle Turonian range in Europe, and *Chlamydothorella 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 *Hystrichosphaeridium* sp. A., which has a basal occurrence in the Coniacian of Loffre, 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 Coniacian -? Santonian of Loffre. 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. porifera* 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.

Paleoecological 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, *Cymatiosphaera* 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 *Cymatiosphaera*,

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 landmasses 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 now 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

- Achomosphaera* cf. *neptuni* (Eisenack, 1958) Davey and Williams, 1966a, in Davey and Verdier, 1974 (Plate 1, Figure 1).
Alterbia ingrarni (Cookson and Eisenack, 1970) Lentin and Williams, 1975b (Plate 7, Figures 1, 7).
Amphidiadema denticulata Cookson and Eisenack, 1960a.
Apteodinium granulatum Eisenack, 1958.
A. maculatum Eisenack and Cookson, 1960 (Plate 1, Figures 5, 6).
Batioladinium micropoda (Eisenack and Cookson, 1960) Bricheux, 1975 (Plate 1, Figure 4).
Calliosphaeridium asymmetricum (Deflandre and Courteville, 1939) Davey and Williams, 1966b.
Canningia colliveri Cookson and Eisenack, 1960b (Plate 1, Figure 10).
 "C." *minor* Cookson and Hughes, 1964.
 "C." *ringesii* Manum and Cookson, 1964 (Plate 1, Figures 9, 13, 14).
 "C." cf. *scabrosa* Cookson and Eisenack, 1970a (Plate 1, Figures 7, 8; Plate 3, Figure 3).
Cannosphaeropsis densiradiata Cookson and Eisenack, 1962b (Plate 1, Figure 12).
Cassiculosphaeridia reticulata Davey 1969a (Plate 1, Figure 15).
Cauca parva (Alberti, 1961) Davey and Verdier, 1971.
Chatangiella tripartita (Cookson and Eisenack, 1960a) Lentin and Williams, 1975b (Plate 7, Figures 3-6).
C. cf. *victoriensis* (Cookson and Manum, 1964) Lentin and Williams, 1975b (Plate 7, Figures 8, 9).
Chlamydophorella albertii (Neale and Sarjeant, 1962) Davey comb. nov. (Plate 2, Figure 8).
C. discreta Clarke and Verdier, 1967 (Plate 1, Figure 16).
C. cf. *huguonioti* (Valensi, 1955a) comb. nov. (Plate 2, Figure 12).
Cleistosphaeridium flexuosum Davey et al., 1966 (Plate 2, Figure 13).
C. polypes (Cookson and Eisenack, 1962b) Davey, 1969a (Plate 2, Figure 11).
Coronifera oceanica Cookson and Eisenack, 1958.
Cribroperidinium edwardsi (Cookson and Eisenack, 1958) Davey 1969a (Plate 2, Figures 14, 15; Plate 4, Figures 8, 9).
Cyclonephelium ?attadalicum Cookson and Eisenack, 1962b (Plate 3, Figures 1, 2).
C. compactum Deflandre and Cookson, 1955 (Plate 3, Figures 5, 6).
Cymatiosphaera delicata Cookson and Eisenack, 1971 (Plate 9, Figure 9).
Cymatiosphaera sp. A of Singh, 1971.
Diconodinium arcticum Manum and Cookson, 1964.
Dingodinium albertii Sarjeant, 1966c.
D. cerviculum Cookson and Eisenack, 1958 (Plate 4, Figure 1).
Dinogymnium westralium (Cookson and Eisenack, 1958) Evitt et al., 1967.
Dinopterygium cladiodes Deflandre, 1935.
Eyrea nebulosa Cookson and Eisenack, 1971 (Plate 9, Figure 11).
Exochosphaeridium bifidum (Clarke and Verdier, 1967) Clarke et al., 1968.
E. phragmites Davey et al., 1966 (Plate 5, Figure 2).
E. striolatum (Deflandre, 1937b) subsp. *truncatum* Davey, 1969a.
Florentinia deanei (Davey and Williams, 1966b) Davey and Verdier, 1973.
F. laciniata Davey and Verdier, 1973.
F. mantelli (Davey and Williams, 1966b) Davey and Verdier, 1973.
F. resex Davey and Verdier (1976).
Fromea amphora Cookson and Eisenack, 1958.
 "Gardodinium" *deflandrei* Clarke and Verdier, 1967.
Gillinia hymenophora Cookson and Eisenack, 1960a.
Gonyaulacysta exilicristata Davey, 1969a (Plate 4, Figures 4, 7).
G. microceras (Eisenack, 1958) Clarke and Verdier, 1967 (Plate 4, Figure 3).
G. tenuiceras (Eisenack, 1958) Sarjeant, 1969 (Plate 4, Figures 5, 6).
Hystrichodinium pulchrum Deflandre, 1935 (Plate 5, Figure 1).
Isabella cf. *amphiata* (McIntyre, 1975) Lentin and Williams, 1975b (Plate 7, Figure 2).
I. cretacea (Cookson, 1956) Lentin and Williams, 1975b.
Kleithrisphaeridium loffrensis Davey and Verdier (1976).
K. simplicispinum (Davey and Williams, 1966b) Davey, 1974 (Plate 5, Figure 3).
Meiurogonyaulax cf. *bulloidea* (Cookson and Eisenack, 1960b) Sarjeant, 1969 (Plate 5, Figures 11, 12).
Membranilarnacia polycladiata Cookson and Eisenack in Eisenack, 1963a (Plate 5, Figures 8, 9).
Microdinium ?crinitum Davey, 1969a.

- M. ornatum* Cookson and Eisenack, 1960a.
M. setosum Sarjeant, 1966b.
M. veligerum (Deflandre, 1937b) Davey, 1969a.
Muderongia cf. *staurota* Sarjeant, 1966c (Plate 6, Figure 6).
M. tetracantha (Gocht, 1957) Alberti, 1961 (Plate 6, Figure 3).
Nelsoniella aceras Cookson and Eisenack, 1960a (Plate 8, Plate 10).
N. tuberculata Cookson and Eisenack, 1960a.
Odontochitina costata Alberti, 1961 (Plate 6, Figure 4).
O. cribropoda Deflandre and Cookson, 1955 (Plate 6, Figure 2).
O. operculata (O. Wetzel, 1933a) Deflandre and Cookson, 1955.
O. porifera Cookson, 1956 (Plate 6, Figures 1, 7).
Oligosphaeridium complex (White, 1842) Davey and Williams, 1966b (Plate 5, Figure 13).
O. cf. complex (White, 1842) Davey and Williams, 1966b (Plate 5, Figure 10).
Palaeohystrichophora infusorioides Deflandre, 1935.
Palaeoperidinium cretaceum Pocock, 1962, ex Davey, 1970 (Plate 8, Figure 6).
P. pyrophorum (Ehrenberg, 1838) Deflandre, 1935 (Plate 8, Figure 5).
Palaeostomocystis fragilis Cookson and Eisenack, 1962b.
Pareodinia ceratophora Deflandre, 1947c (Plate 5, Figure 7; Plate 8, Figure 12).
Polysphaeridium laminaspinosum Davey and Williams, 1966b.
P. multispinosum Davey, 1974.
Prolixosphaeridium parvispinum (Deflandre, 1937b) Davey et al., 1969.
Pterospermella aureolata (Cookson and Eisenack, 1958) Eisenack, 1972.
P. centrata (Cookson and Eisenack, 1971) Eisenack and Cramer, 1973 (Plate 9, Figures 5-7).
P. eurypteris (Cookson and Eisenack, 1958) Eisenack and Cramer, 1973.
Silicisphaera buspina Davey and Verdier (1976).
S. ferox (Deflandre, 1937b) Davey and Verdier (1976).
Spinidinium echinoideum (Cookson and Eisenack, 1960a).
S. lanterna Cookson and Eisenack, 1970a (Plate 8, Figure 13).
S. sverdrupianum (Manum, 1963) Lentin and Williams, 1975b (Plate 9, Figures 12, 13).
Spiniferites cingulatus (O. Wetzel, 1933b) Sarjeant, 1970.
S. ramosus (Ehrenberg, 1838) subsp. *granosus* Davey and Williams, 1966a.
S. ramosus subsp. *ramosus* (Ehrenberg, 1838) Sarjeant, 1970.
Subtilisphaera pirnaensis (Alberti, 1959b) Jain and Millepied, 1973 (Plate 8, Figure 7).
S. ventricosa (Alberti, 1959b) Jain and Millepied, 1973 (Plate 8, Figures 1-4, 8, 9).
Tanyosphaeridium variecalamum Davey and Williams, 1966b.
Trichodinium castanea (Deflandre, 1935) Clarke and Verdier, 1967 (Plate 9, Figure 2).
Waliodinium luna (Cookson and Eisenack, 1960a) Lentin and Williams, 1973.
Xenascus ceratioides (Deflandre, 1937b) Lentin and Williams, 1973 (Plate 6, Figure 5).
Xiphophoridium alatum Sarjeant, 1966b.

Class DINOPHYCEAE Fritsch, 1929

Order PERIDINIALES Haeckel, 1894

Genus AIORA Cookson and Eisenack, 1960a, emend.

Type species: *Aiora perforare* nom. nov., ?Turonian-Senonian, Australia.

Emended diagnosis: The cyst consists of a dorso-ventrally flattened shell, subcircular in outline, from which radiate a low number of processes in the plane of flattening at or near the lateral margins. These processes either branch complexly and link distally with the two adjacent processes or broaden into a surrounding fenestrate membrane, all in the plane of flattening; the outline of this outer structure is subcircular. The archeopyle is dorsal precingular formed by the loss of a single plate (type P).

Remarks: The diagnosis of this genus is emended to draw attention to the positioning of the processes and to the presence of a dorsal precingular archeopyle.

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.

Aiora perforare 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, *perforare*, perforate—with reference to the distal nature of the processes.

Diagnosis: A species of *Aiora* possessing a smooth, thin-walled shell of subcircular outline from which arise approximately five flat, equally spaced processes or process groups. These may subdivide proximally and/or medially to give rise to two or more branches diverging in the plane of flattening, and distally in a complex manner to form a fenestrate membrane. The fenestrations are subcircular to rounded-polygonal in outline and tend to become smaller distally. The membrane links adjacent processes and forms a continuously circular network around the shell. The outer extremity of the membrane is smooth and tends to be slightly recurved.

Holotype: Nat. Mus. Vic. No. P17808. Illustrated as the hypotype of *Aiora fenestrata*, Cookson and Eisenack, 1960a, pl. 2, fig. 17.

Dimensions: From Cookson and Eisenack, 1960: holotype (measured from illustration pl. 2, fig. 17), shell diameter $50 \times 65 \mu\text{m}$, overall diameter $115 \times 150 \mu\text{m}$; range, shell diameter 50-80 μm , overall diameter 120-160 μm . Figured specimen, Plate 1, Figures 2, 3, shell diameter $51 \times 59 \mu\text{m}$, overall diameter $120 \times 130 \mu\text{m}$.

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 postcircular 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 AUSTRALISPHAERA gen. nov.

Type species: *Australisphaera verrucosa* sp. nov., Campanian-Maestrichtian, 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 Evtit (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.

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:

	Holotype	Paratype	Range
Overall width	110 μm	137 μm	98 (113) 137 μm
Overall width (operculum detached)	89 μm	94 μm	70 (85) 98 μm

Paratype: Approximate length of lateral horns 30 and 45 μm ; length of antapical horn 30 μm .

Description: The wall is of 1 to 1.5 μm thick and the low tubercles, which completely cover the surface, are usually less than 0.5 μm high. The large tubercles, mentioned in the diagnosis, and restricted to the lateral and antapical regions measure up to 3 μm 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 plate boundaries 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 *Aiora*.

Genus CHLAMYDOPHORELLA Cookson and Eisenack, 1958

1961 *Gardodinium* Alberti, p. 18.

Remarks: There appears to be no justification for keeping the morphologically identical genera *Chlamydothorella* 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 Verdier (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 *Chlamydothorella nyei* Cookson and Eisenack, 1958, the type species of its genus.

Chlamydothorella is characterized by a subspherical 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 are 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 partly restricted by septa (see *Chlamydothorella huguonioti* as *Cleistosphaeridium ancoriferum* in Cookson and Eisenack, 1968, p. 120, and in Davey, 1969a, p. 155).

The stratigraphic range of *Chlamydothorella*, 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.

Chlamydothorella huguonioti (Valensi, 1955a) comb. nov.
(Plate 2, Figures 9, 10)

1955a *Hystrichosphaeridium huguonioti* Valensi, p. 38, fig. 2A.

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

1969a *Cleistosphaeridium huguonioti* (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 *Chlamydothorella* 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 have membranous distal extremities. Hence 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 *Chlamydothorella*. The taxonomic position of *Gardodinium deflandrei* Clarke and Verdier will be discussed in a forthcoming paper by Dr. J.-P. Verdier and the author.

Chlamydothorella albertii (Neale and Sarjeant) Davey, comb. nov. = *Gardodinium albertii* Neale and Sarjeant, 1962, p. 445, pl. 19, fig. 6. Hauterivian, England.

Chlamydothorella elongata (Singh) Davey, comb. nov. = *Gardodinium elongatum* Singh, 1971, p. 381, pl. 68, fig. 3, 4. Albian, Canada.

Chlamydothorella ordinale (Davey) Davey, comb. nov. = *Gardodinium ordinale* Davey, 1974, p. 51, pl. 3, fig. 5, 6. Barremian, England.

Chlamydothorella pyriformis (Vozzhennikova) Davey, comb. nov. = *Gardodinium pyriformis* Vozzhennikova, 1967, p. 179, pl. 100, fig. 1, 4. Barremian, U.S.S.R.

Chlamydothorella trabeculosa (Gocht) Davey, comb. nov. = *Scrinioidinium trabeculosum* Gocht, 1959, p. 62, pl. 4, fig. 5. Hauterivian, Germany.

Genus CONOSPHAERIDIUM Cookson and Eisenack, 1969

Conosphaeridium striatoconus (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

Cribroperidinium sp. A.
(Plate 4, Figure 2)

Description: A large species of *Cribroperidinium* 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.

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

Remarks: During this investigation some difficulty was experienced 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 Molecap Greensand, near Gingin, Western Australia) and are likewise 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 group 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. longispinatum subsp. nov.
(Plate 3, Figures 4, 7, 8)

Diagnosis: A subspecies of *C. distinctum* having a denser covering of long spines which extend well on to the dorsal and ventral surfaces leaving only small areas devoid of processes.

Type: MPK 1039, DSDP Leg 40, Site 361, Sample 24-2, 9698 cm. Turonian, offshore South Africa.

Dimensions: Type: length of shell (including operculum) 65 μ m, width 60 μ m, length of processes 8-14 μ m. Range: length of shell (operculum detached) 48-53 μ m, width 54-60 μ m, length of processes up to 15 μ m.

Cyclonephelium distinctum subsp. brevispinatum Milliod, 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 colliveri* Cookson and Eisenack, 1960b.

Cyclonephelium hirtellum (Alberti) comb. nov.

1961 *Circulodinium hirtellum* Alberti, p. 28, pl. 4, fig. 20.
1969 *Canningia hirtella* (Alberti) Milliod, p. 425.

Remarks: The original diagnosis of this species clearly indicates that the spines (3-4 μ m 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 hystrix (Eisenack) comb. nov.
(Plate 3, Figures 10, 11)

1958 *Tenua hystrix* 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. hystrix* is characterized by numerous short, generally less than 10 μ m, distally bifid 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. hystrix*, 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. rioulti* Sarjeant as the new type species.

Genus TENUA Davey nom. cons. (non *Tenua* Eisenack, 1958)

Type species: *Tenua rioulti* Sarjeant, 1968; p. 231, pl. 1, fig. 12, 22; 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 Lentini 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 μ m; *D. cerviculum*, overall length of type material 81-109 μ m. 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 μ m or to a group of larger specimens with an overall length of 75 (88) 100 μ m.

Genus DISPHAERIA Cookson and Eisenack, 1960a

Disphaeria macropylla 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 *Thalassiphora* 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 Maestrichtian, 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 truncigerum (Deflandre) Davey, comb. nov. = *Hystrichosphaeridium truncigerum* Deflandre, 1937b, p. 71, pl. 13, fig. 6, 7. Late Cretaceous, France. (Illustrated herein on Plate 4, Figures 12, 13).

Genus HYSTRICHOSPHAERIDIUM 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

?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 archeopyle 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. Archeopyle 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 multibrevis* Davey and Williams, 1966a, but possesses a thick, intraperforate wall with more numerous and finer sutural processes.

Genus SYSTEMATOPHORA Klement, 1960

Systematophora 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.

Genus TRICHODINIUM Eisenack and Cookson, 1960,
emend. Clarke and Verdier, 1967

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

Description: This is a subspherical 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 TRITHYRODINIUM 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 pericyst was never observed, specific determination was not possible.

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

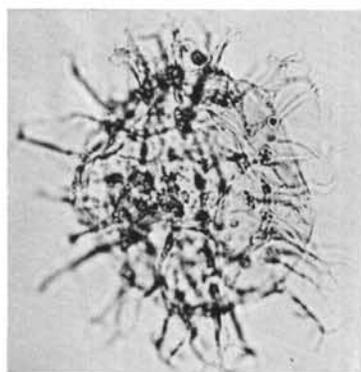
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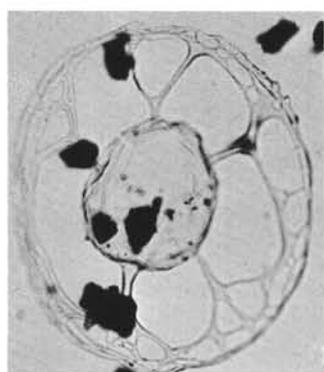
PLATE 1

- Figure 1 *Achomosphaera* cf. *neptuni* (Eisenack). Slide CSA 1751/1, MPK 1040. Shell $42 \times 42 \mu\text{m}$, processes 8-13 μm .
- Figures 2, 3 *Aiora perforare* nom. nov. Slide SOEKOR 4988(b).1, co-ordinates 8.8/74.2. Overall diameter $124 \times 129 \mu\text{m}$, inner sac diameter $51 \times 60 \mu\text{m}$.
2. Ventral surface.
3. Dorsal surface.
- Figure 4 *Batioladinium micropoda* (Eisenack and Cookson). Slide SOEKOR 4998(b).1, co-ordinates 1.7/91.5. $56 \times 29 \mu\text{m}$.
- Figures 5, 6 *Apteodinium maculatum* Eisenack and Cookson. Slide CSA 1736/1, MPK 1042. Overall diameter $95 \times 82 \mu\text{m}$.
5. Ventral surface.
6. Dorsal surface.
- Figures 7, 8 "*Canningia*" cf. *scabrosa* Cookson and Eisenack.
7. Slide CSA 1726/1, MPK 1045. Overall diameter $60 \times 70 \mu\text{m}$.
8. Slide CSA 1732/1, MPK 1050. Overall diameter $69 \times 79 \mu\text{m}$.
- Figure 9 "*Canningia*" *ringnesii* Manum and Cookson. Slide CSA 1736/1, MPK 1043. Overall diameter $41 \times 44 \mu\text{m}$.
- Figure 10 *Canningia colliveri* Cookson and Eisenack. Slide CSA 1758/3, MPK 1059. Shell diameter $89 \times 74 \mu\text{m}$, spines up to $1.5 \mu\text{m}$.
- Figure 11 *Cannosphaeropsis fenestrata* Deflandre and Cookson. Slide SOEKOR 4985(b).1, co-ordinates 17.5/97.2. Overall diameter $80 \times 63 \mu\text{m}$.
- Figure 12 *Cannosphaeropsis densiradiata* Cookson and Eisenack. Slide CSA 1725/2, MPK 1033. Overall diameter $68 \times 65 \mu\text{m}$.
- Figures 13, 14 "*Canningia*" cf. *ringnesii* Manum and Cookson.
13. Slide SOEKOR 4993(b).1, co-ordinates 6.3/83.8. Overall diameter $78 \times 65 \mu\text{m}$.
14. Slide CSA 1755/1, MPK 1061. Overall diameter $65 \times 64 \mu\text{m}$.
- Figure 15 *Cassiculosphaeridia reticulata* Davey. Slide CSA 1735/1, MPK 1062. Shell diameter $49 \times 50 \mu\text{m}$, crests up to $1.5 \mu\text{m}$.
- Figure 16 *Chlamydophorella discreta* Clarke and Verdier. Slide CSA 1726/1, MPK 1046. Overall diameter $36 \times 37 \mu\text{m}$.

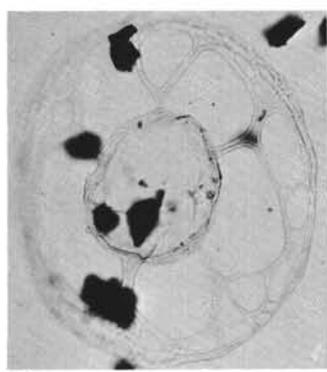
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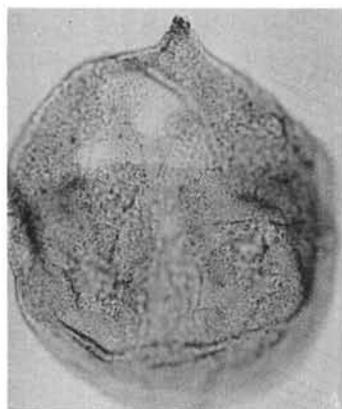
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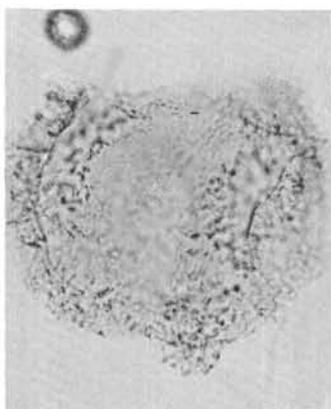
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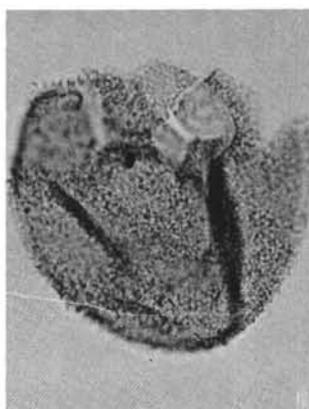
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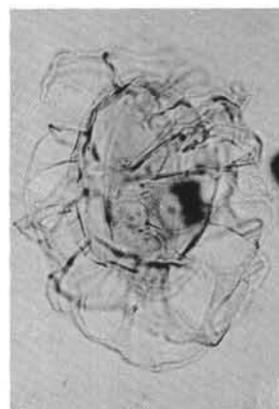
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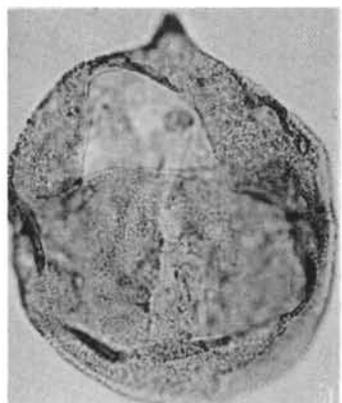
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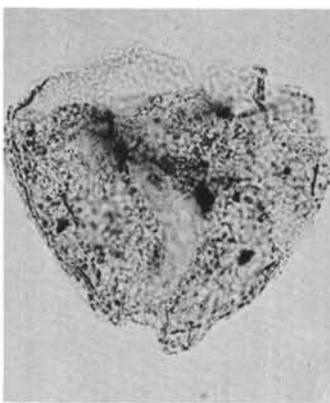
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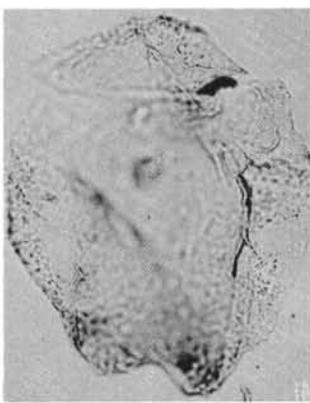
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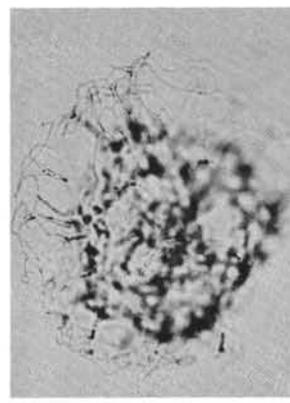
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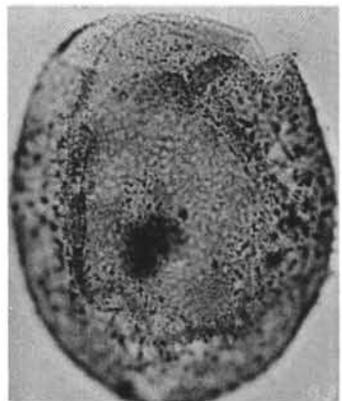
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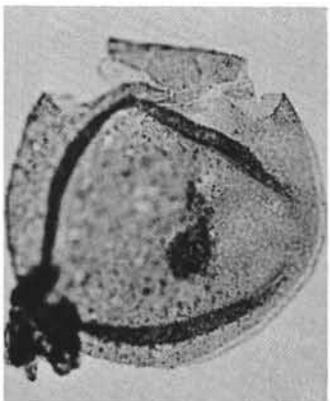
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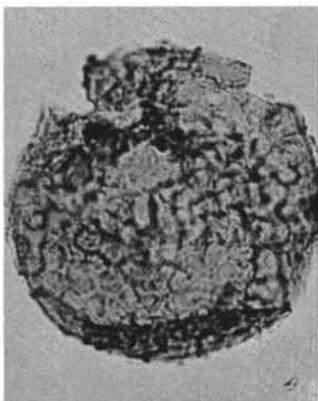
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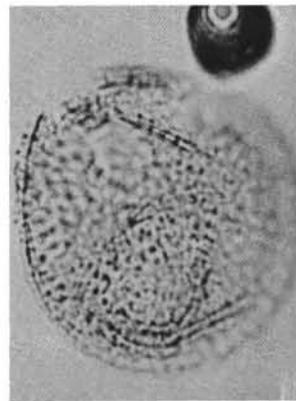
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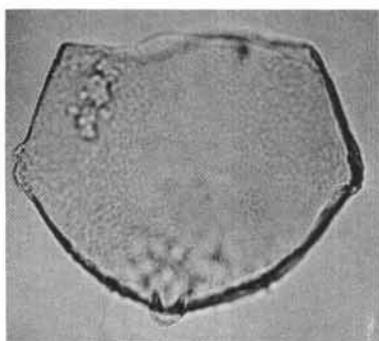


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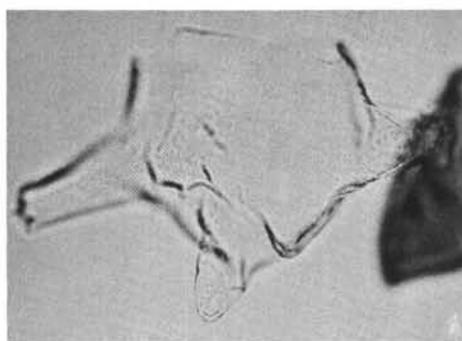
PLATE 2

- 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).1, co-ordinates 5.7/84.5. Overall diameter $86 \times 112 \mu\text{m}$. (Interference contrast.)
 4. Slide CSA 1725/2, MPK 1034. Overall diameter $70 \times 96 \mu\text{m}$.
 5. Slide CSA 1725/2, MPK 1035. Overall diameter $89 \times 101 \mu\text{m}$.
- Figures 6, 7 *Conosphaeridium striatoconus* (Deflandre and Cookson).
6. Slide SOEKOR 4986(b).1, co-ordinates 5.1/95.7. Shell diameter $72 \times 64 \mu\text{m}$, processes up to $15 \mu\text{m}$. Note archeopyle to the north-west, and distal truncation of the processes.
 7. Slide SOEKOR 4985(b), co-ordinates 8.0/116.1. Diameter $28 \times 34 \mu\text{m}$.
- Figure 8 *Chlamydophorella albertii* (Neale and Sarjeant). Slide CSA 1758/1, MPK 1067. Overall diameter $67 \times 44 \mu\text{m}$.
- Figures 9, 10 *Chlamydophorella huguonioti* (Valensi). Slide CSA 1733/1, MPK 1068. Shell diameter $38 \times 39 \mu\text{m}$, processes $6\text{-}10 \mu\text{m}$. Note enveloping membrane.
9. Interference contrast.
- Figure 11 *Cleistosphaeridium polypes* (Cookson and Eisenack). Slide CSA 1733/1, MPK 1069. Shell diameter $41 \times 34 \mu\text{m}$, processes $10\text{-}18 \mu\text{m}$.
- Figure 12 *Cleistosphaeridium* cf. *huguonioti* (Valensi). Slide CSA 1754/1, MPK 1080. Shell diameter $54 \times 58 \mu\text{m}$, processes $3\text{-}6 \mu\text{m}$. Note relatively short processes not supporting a membrane.
- Figure 13 *Cleistosphaeridium flexuosum* Davey et al. Slide CSA 1735/1, MPK 1063. Shell diameter $44 \times 42 \mu\text{m}$, processes up to $12 \mu\text{m}$. (Phase contrast.)
- Figures 14, 15 *Cribroperidinium edwardsi* (Cookson and Eisenack).
14. Slide CSA 1733/2, MPK 1082. Apical view.
 15. Slide CSA 1733/1, MPK 1070. Detached operculum (3'').

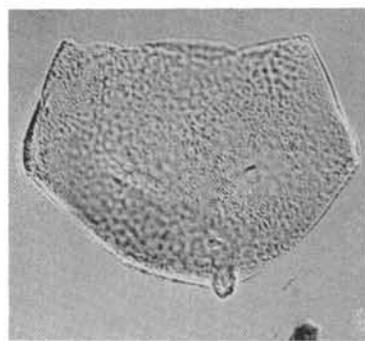
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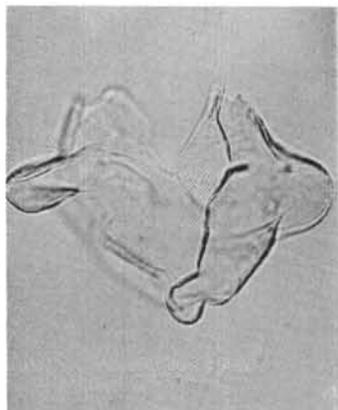
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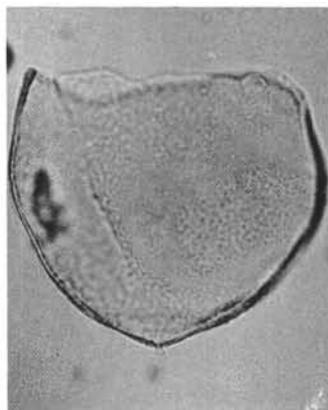
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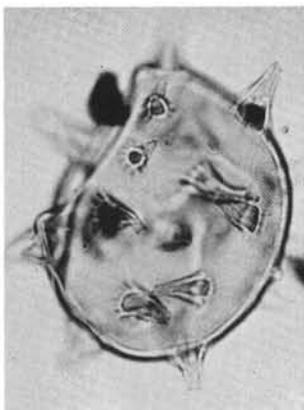
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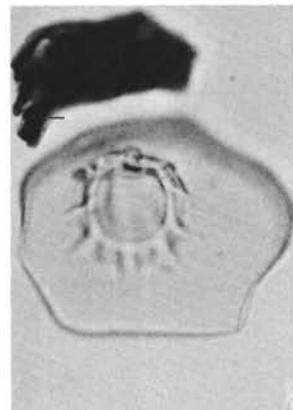
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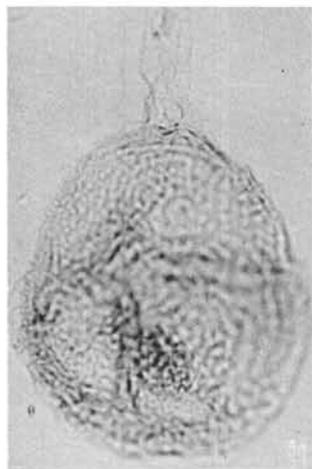
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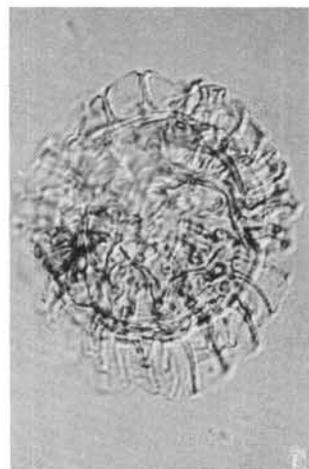
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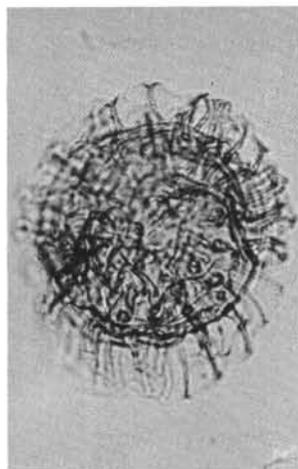
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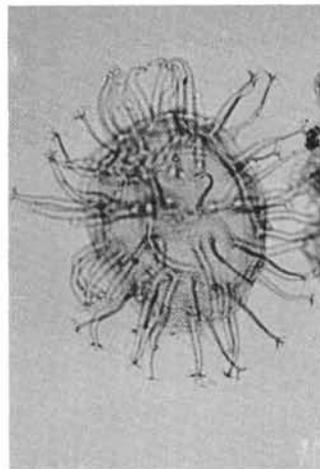
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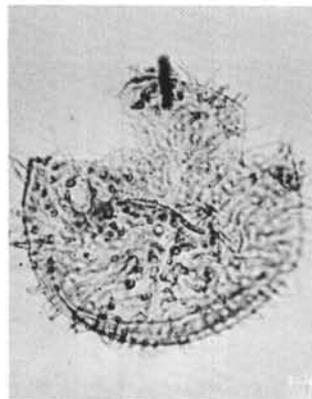
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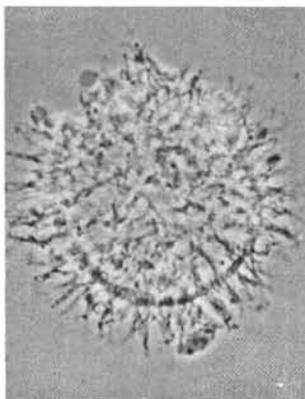
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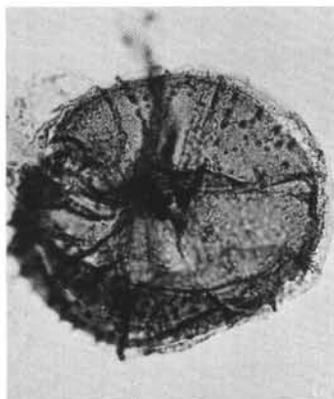
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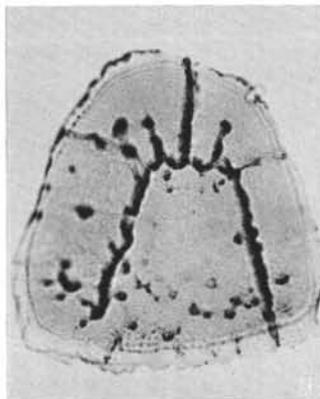
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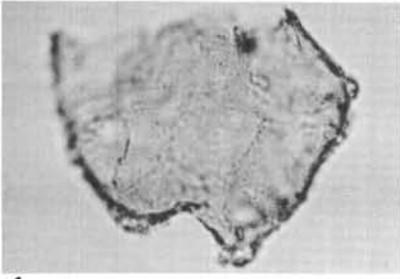


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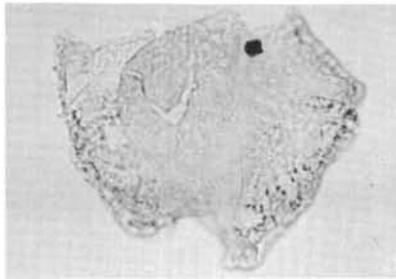
PLATE 3

- Figures 1, 2 *Cyclonephelium ?attadalicum* Cookson and Eisenack. Slide CSA 1726/2, MPK 1083. Overall diameter $67 \times 56 \mu\text{m}$.
 1. Dorsal surface.
 2. Ventral surface.
- Figure 3 "*Canningia*" cf. *scabrosa* Cookson and Eisenack. Slide CSA 1732/1, MPK 1051. Overall diameter $62 \times 73 \mu\text{m}$.
- Figures 4, 7, 8 *Cyclonephelium distinctum* subsp. *longispinatum* nov.
 4. Slide CSA 1733/1, MPK 1071. Shell diameter $53 \times 60 \mu\text{m}$, processes up to $12 \mu\text{m}$. 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 $48 \times 54 \mu\text{m}$, processes up to $16 \mu\text{m}$.
- Figure 5 *Cyclonephelium compactum* Deflandre and Cookson. Slide SOEKOR 4991(b).1, co-ordinates 15.7/84.2. Shell diameter $63 \times 70 \mu\text{m}$, crests up to $15 \mu\text{m}$.
- Figure 6 *Cyclonephelium* cf. *compactum* Deflandre and Cookson. Slide SOEKOR 4986(b).1, co-ordinates 9.2/85.7. Shell diameter $70 \times 85 \mu\text{m}$, crests up to $5 \mu\text{m}$. 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 $81 \times 74 \mu\text{m}$, processes up to $11 \mu\text{m}$.
 12. Slide SOEKOR 4985(b).1, co-ordinates 22.1/78.0. Shell diameter $79 \times 83 \mu\text{m}$, processes up to $13 \mu\text{m}$.
- Figures 10, 11 *Cyclonephelium hystrix* (Eisenack). Slide CSA 1739/1, MPK 1086. Shell diameter $67 \times 75 \mu\text{m}$, processes up to $7 \mu\text{m}$.
 10. Ventral surface.
 11. Dorsal surface.
- Figures 13-15 *Cyclonephelium distinctum* subsp. *brevispinatum* Millioud.
 13. Slide SOEKOR 5002(b).1, co-ordinates 8.6/82.0. Shell diameter $68 \times 93 \mu\text{m}$, processes up to $3 \mu\text{m}$.
 14. Slide SOEKOR 5014(b).1, co-ordinates 4.0/76.0. Shell diameter $66 \times 74 \mu\text{m}$, processes up to $5 \mu\text{m}$.
 15. Slide CSA 1733/1, MPK 1072. Shell diameter $104 \times 99 \mu\text{m}$, processes up to $5 \mu\text{m}$.

PLATE 3



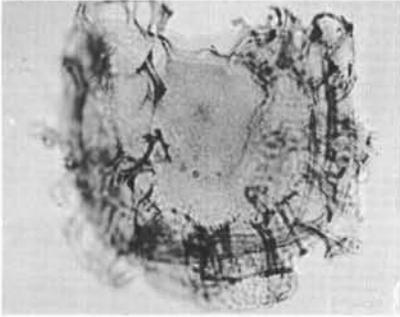
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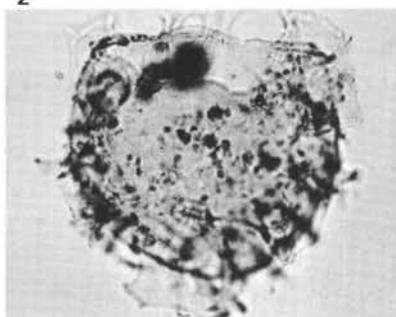
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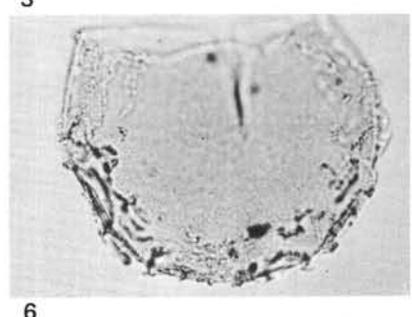
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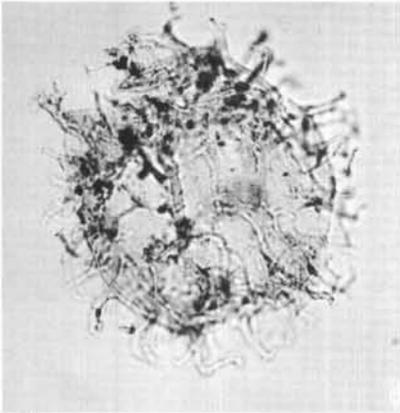
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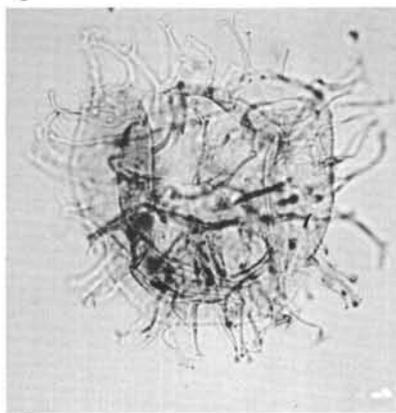
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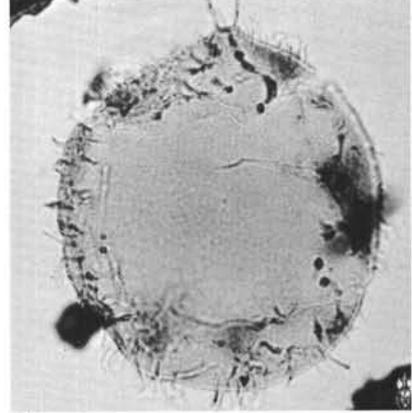
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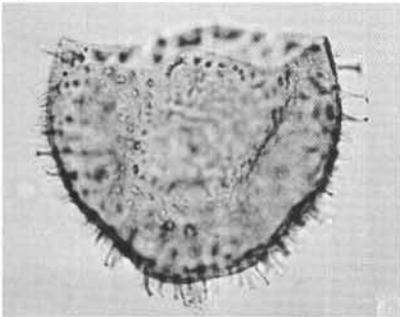
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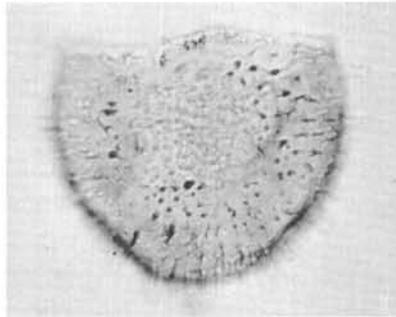
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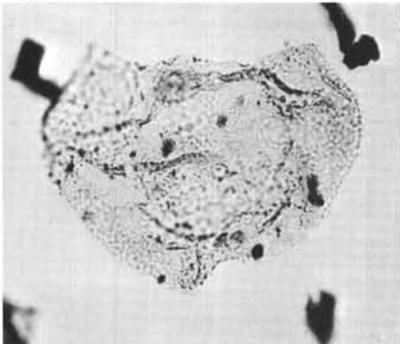
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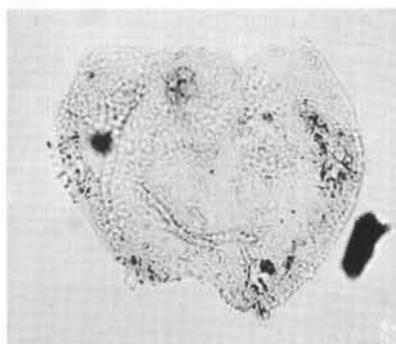
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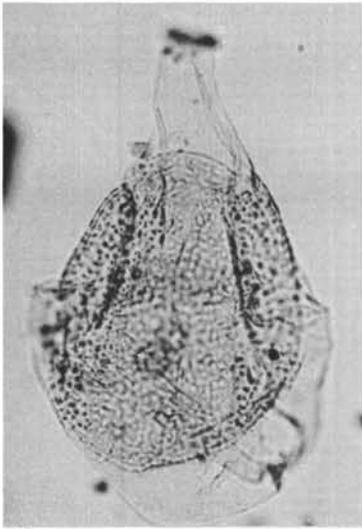


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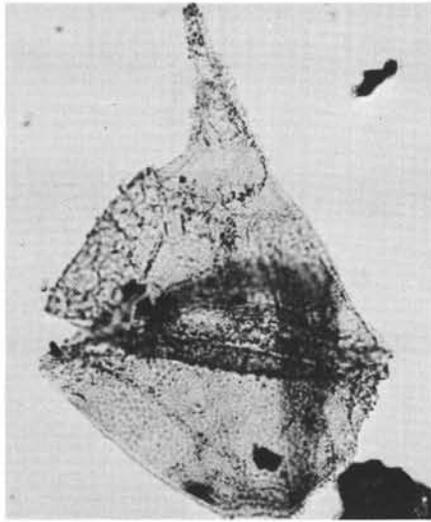
PLATE 4

- Figure 1 *Dingodinium cerviculum* Cookson and Eisenack. Slide SOEKOR 5018(b).1, co-ordinates 13.8/93.1. Overall diameter $92 \times 59 \mu\text{m}$.
- Figure 2 *Cribroperidinium* sp. A. Slide SOEKOR 5012(b).1, co-ordinates 13.8/100.8. Overall diameter $155 \times 103 \mu\text{m}$.
- Figure 3 *Gonyaulacysta microceras* (Eisenack). Slide SOEKOR 5023(b).1, co-ordinates 17.6/109.2. Overall diameter $81 \times 71 \mu\text{m}$.
- Figures 4, 7 *Gonyaulacysta exilicristata* Davey.
4. Slide CSA 1734/1, MPK 1089. Overall diameter $90 \times 80 \mu\text{m}$.
7. Slide CSA 1732/1, MPK 1053. Overall diameter $82 \times 69 \mu\text{m}$.
- Figures 5, 6 *Gonyaulacysta tenuiceras* (Eisenack).
5. Slide CSA 1735/1, MPK 1064. Overall diameter $92 \times 78 \mu\text{m}$. Dorsal surface with 2-plate precingular archeopyle.
6. Slide CSA 1735/1, MPK 1065. Overall diameter $79 \times 75 \mu\text{m}$. Ventral surface.
- Figures 8, 9 *Cribroperidinium edwardsi* (Cookson and Eisenack). Slide CSA 1733/1, MPK 1073. Overall diameter $157 \times 121 \mu\text{m}$.
8. Ventral surface.
9. Dorsal surface, with precingular archeopyle.
- Figures 10, 11 *Disphaeria macropyla* Cookson and Eisenack. Slide CSA 1730/1, MPK 1090. Overall diameter $83 \times 70 \mu\text{m}$, inner sack diameter $45 \times 34 \mu\text{m}$.
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 $57 \times 59 \mu\text{m}$, processes up to $16 \mu\text{m}$.
12. Dorsal surface.
13. Ventral surface.

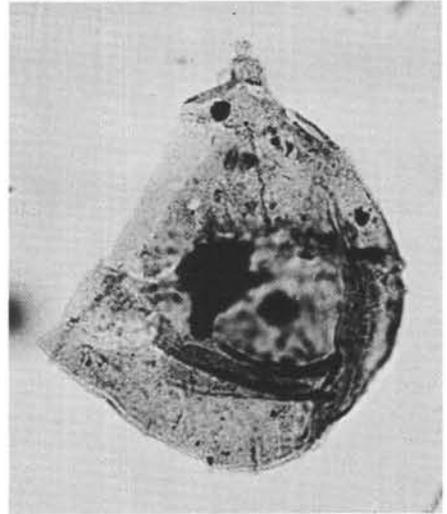
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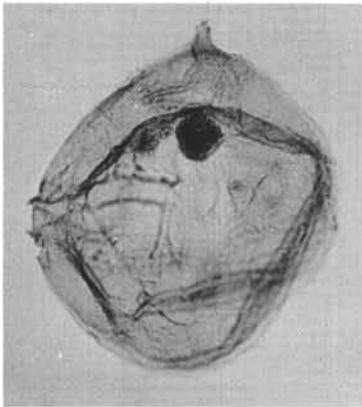
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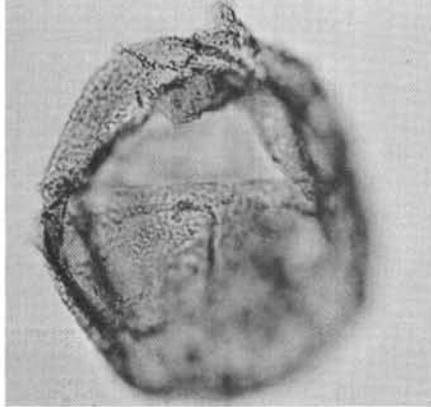
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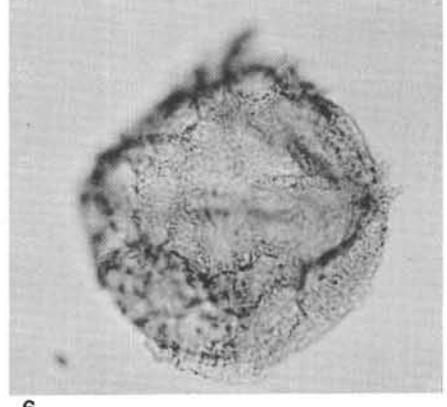
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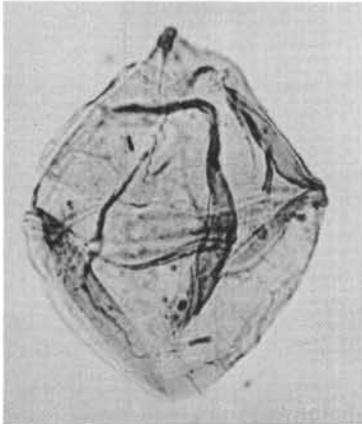
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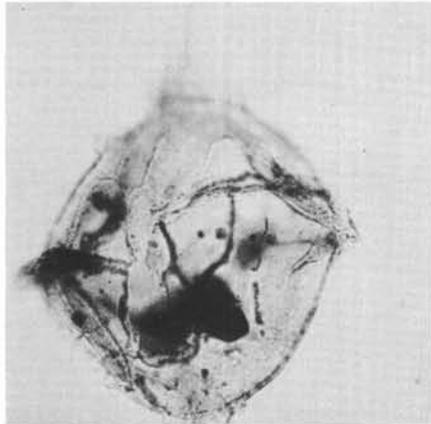
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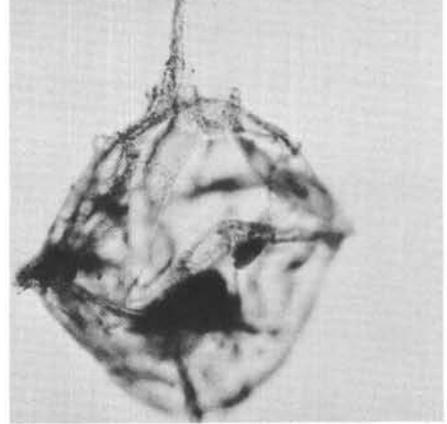
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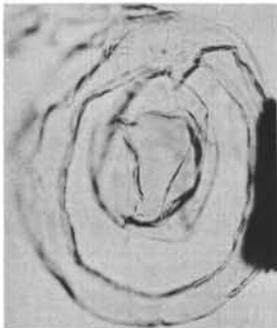
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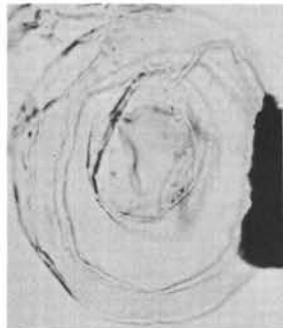
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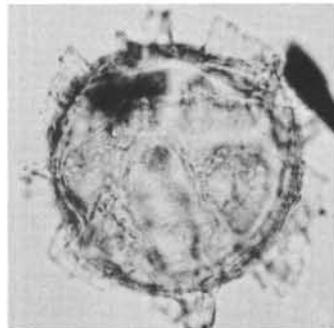
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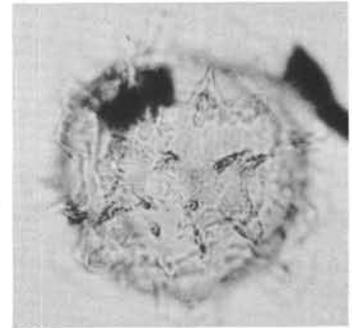
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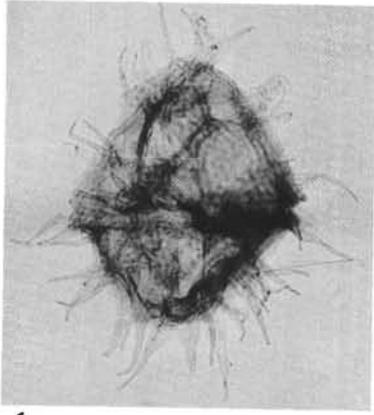


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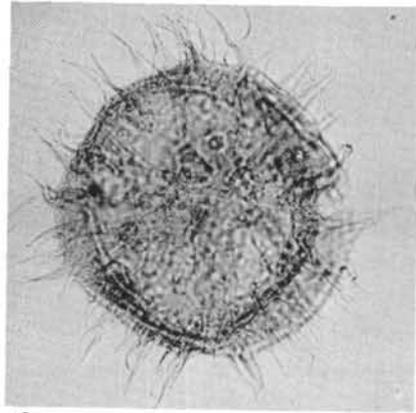
PLATE 5

- Figure 1 *Hystrichodinium pulchrum* Deflandre.
Slide CSA 1732/1, MPK 1054.
Shell diameter $54 \times 46 \mu\text{m}$, processes up to $22 \mu\text{m}$.
- Figure 2 *Exochosphaeridium phragmites* Davey et al.
Slide CSA 1733/1, MPK 1074.
Shell diameter $70 \times 69 \mu\text{m}$, processes up to $17 \mu\text{m}$.
- Figure 3 *Kleithriasphaeridium simplicispinum* (Davey and Williams).
Slide CSA 1754/1, MPK 1081.
Shell diameter $55 \times 47 \mu\text{m}$, processes $15\text{-}22 \mu\text{m}$.
- Figure 4 *Hystrichosphaeridium* sp. A.
Slide CSA 1726/1, MPK 1047.
Shell diameter $46 \times 51 \mu\text{m}$, processes up to $16 \mu\text{m}$.
- Figures 5, 6 ?*Maduradinium* sp. A.
5. Slide CSA 1733/1, MPK 1075.
Shell diameter $54 \times 59 \mu\text{m}$.
6. Slide CSA 1732/1, MPK 1055.
Shell diameter $62 \times 63 \mu\text{m}$.
- Figure 7 *Paredonia ceratophora* Deflandre.
Slide CSA 1739/1, MPK 1087.
Overall diameter $95 \times 56 \mu\text{m}$.
- Figures 8, 9 *Membranilarnacia polycladiata* Cookson and Eisenack.
Slide SOEKOR 4989(b).1.
8. Co-ordinates $17.8/85.5$. Overall diameter $56 \times 60 \mu\text{m}$.
Lateral view.
9. Co-ordinates $20.2/106.7$. Overall diameter $53 \times 59 \mu\text{m}$.
Apical-ventral view showing sulcal notch of archeopyle.
- Figure 10 *Oligosphaeridium* cf. *complex* (White).
Slide CSA 1726/1, MPK 1048.
Shell diameter $40 \times 42 \mu\text{m}$, processes up to $16 \mu\text{m}$.
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 $107 \times 103 \mu\text{m}$, crests up to $7 \mu\text{m}$.
11. Ventral surface.
12. Dorsal surface.
- Figure 13 *Oligosphaeridium complex* (White).
Slide CSA 1732/1, MPK 1056.
Shell diameter $42 \times 43 \mu\text{m}$, processes $20\text{-}30 \mu\text{m}$.

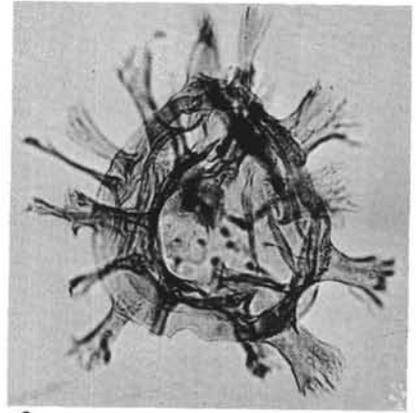
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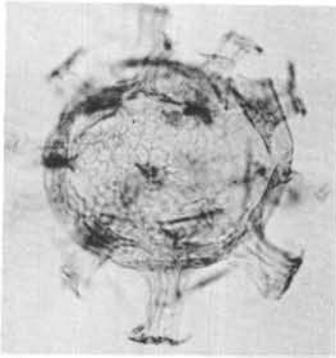
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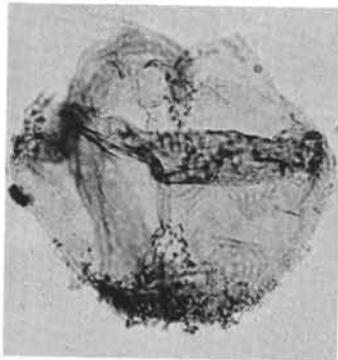
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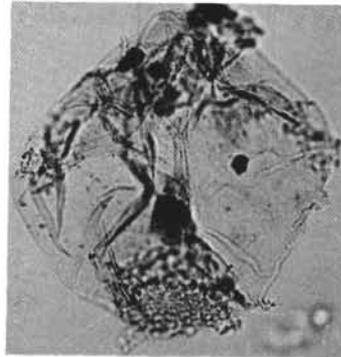
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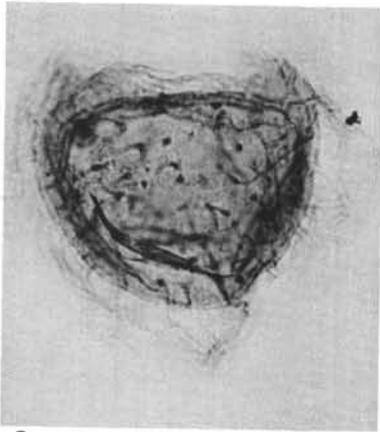
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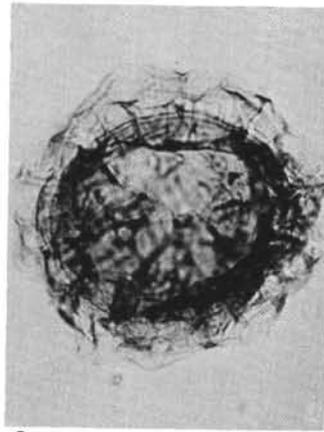
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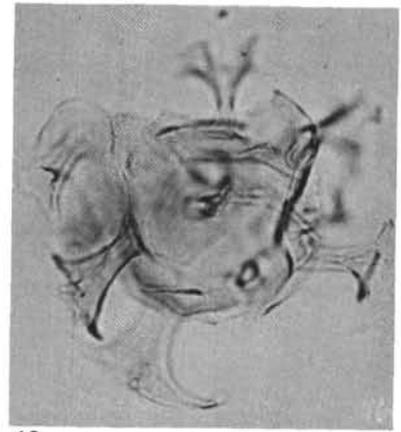
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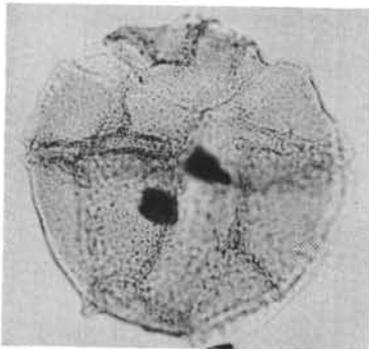
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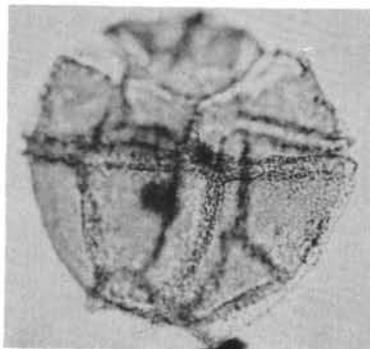
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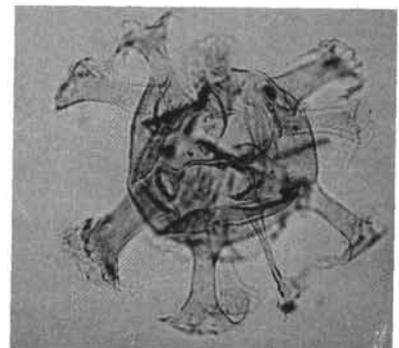
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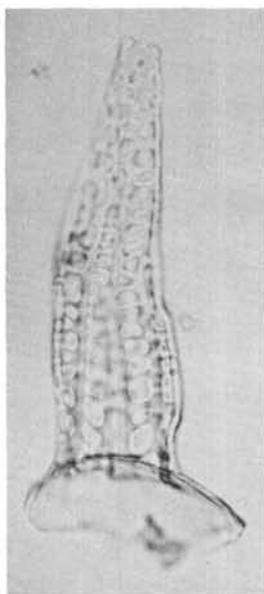


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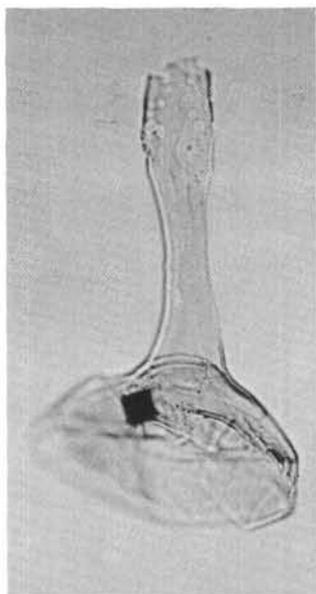
PLATE 6

- Figures 1, 7 *Odontochitina porifera* Cookson.
 1. Slide SOEKOR 4983(b).1, co-ordinates 14.3/91.6.
 Overall length 108 μm , horn length 85 μm .
 7. Slide CSA 1725/2, MPK 1036.
 Shell diameter 50 \times 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 \times 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 \times 65 μm , horn lengths 112 and 130 μm .
- Figure 5 *Xenascus ceratioides* (Deflandre).
 Slide CSA 1732/1, MPK 1057.
 Shell diameter 71 \times 62 μm , horn lengths 50 and 35 μm .
- Figure 6 *Muderongia* cf. *staurota* Sarjeant.
 Slide CSA 1751/1, MPK 1041.
 Shell diameter 78 \times 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 \times 48 μm , processes up to 10 μm . Specimen with numerous short sutural processes.
 9. Slide SOEKOR 4991(b).1, co-ordinates 19.2/101.5. Shell diameter 48 \times 39 μm , processes up to 10 μm .

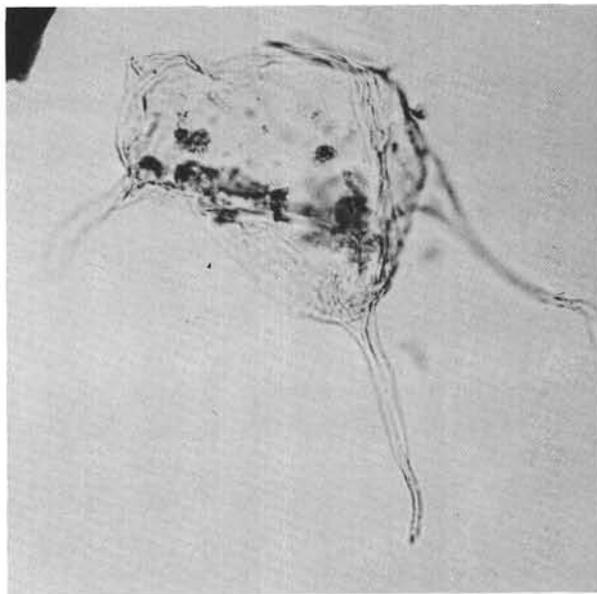
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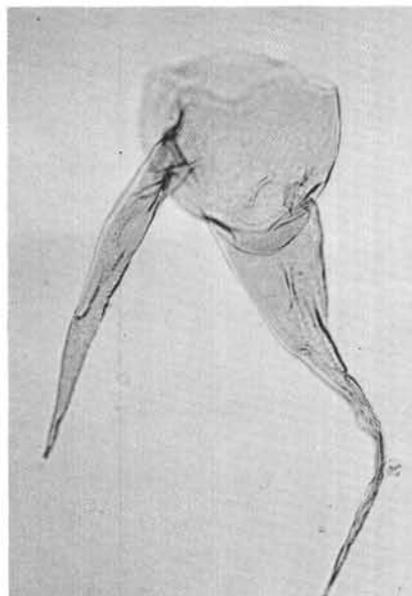
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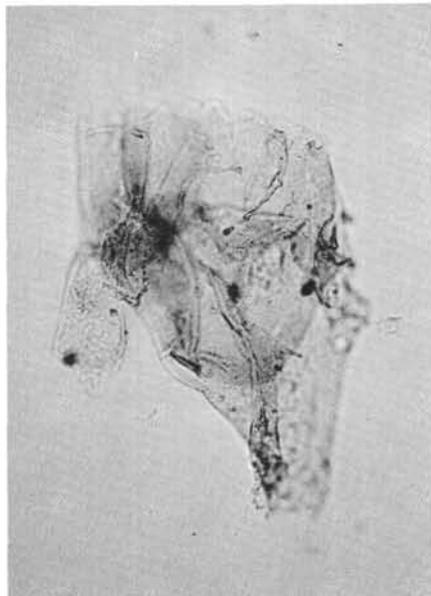
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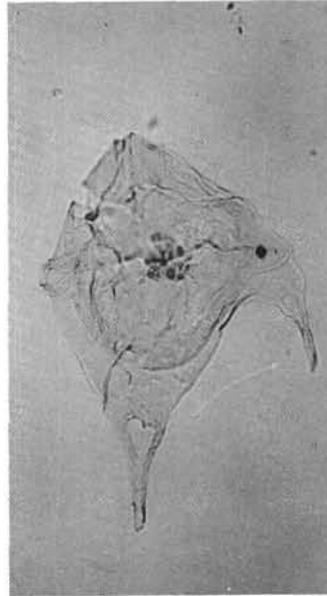
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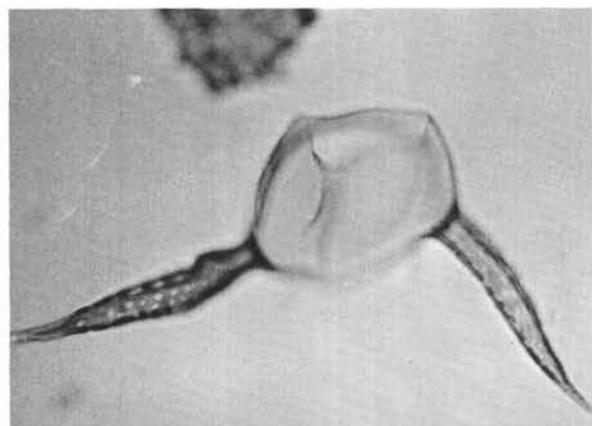
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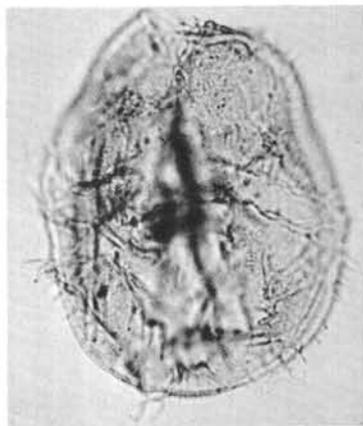
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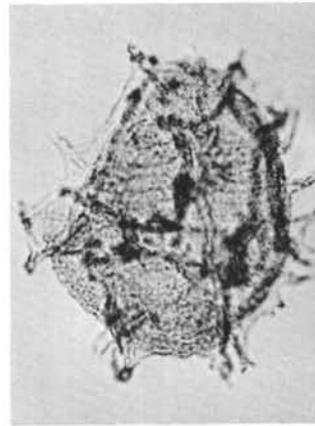
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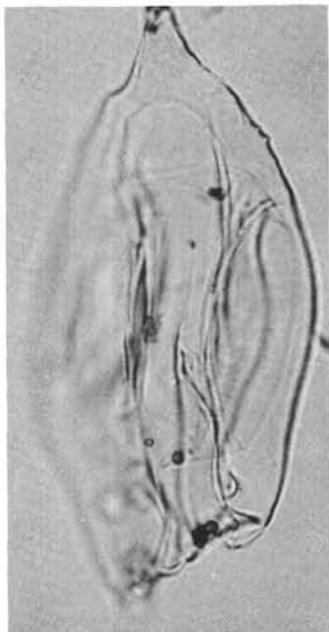
PLATE 7

- Figures 1, 7 *Alterbia ingrami* (Cookson and Eisenack).
Slide CSA 1733/1.
1. MPK 1077. Overall diameter $89 \times 57 \mu\text{m}$.
(Phase contrast.)
7. MPK 1078. Overall diameter $73 \times 52 \mu\text{m}$.
- Figure 2 *Isabelia* cf. *?amphiata* (McIntyre).
Slide CSA 1727/1, MPK 1092.
Overall diameter $83 \times 37 \mu\text{m}$.
- Figures 3-6 *Chatangiella tripartita* (Cookson and Eisenack).
3. Slide CSA 1726/2, MPK 1084.
Overall diameter $94 \times 52 \mu\text{m}$. Ventral surface.
6. Same as Figure 3.
Dorsal surface.
4. Slide CSA 1726/1, MPK 1049.
Overall diameter $95 \times 64 \mu\text{m}$. 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 $87 \times 60 \mu\text{m}$.
9. Slide SOEKOR 4985(b).1, co-ordinates
15.6/102.3. Overall diameter $92 \times 66 \mu\text{m}$.

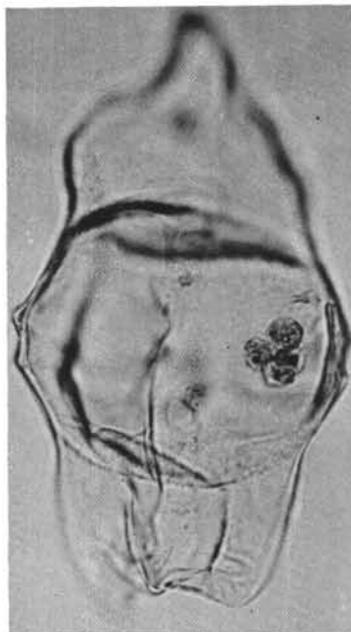
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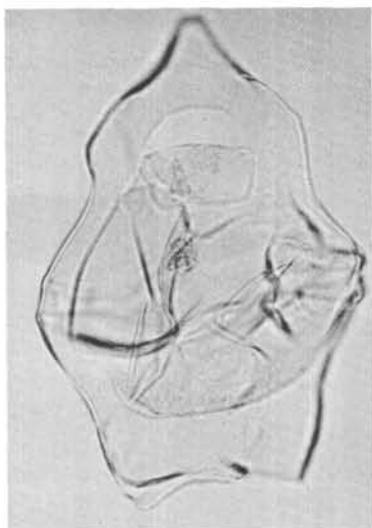
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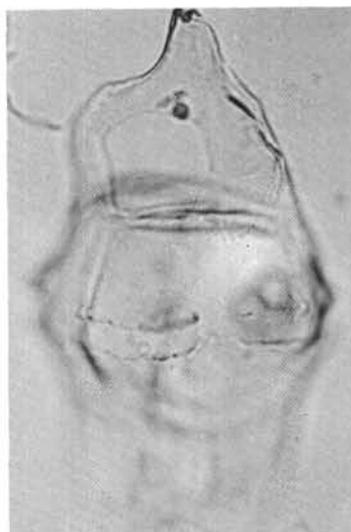
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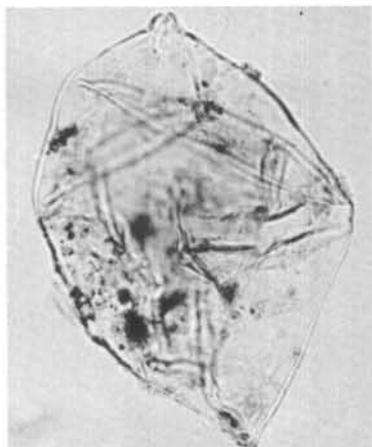
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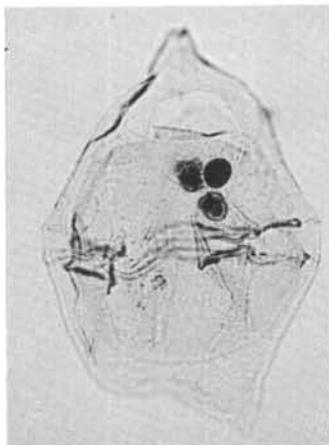
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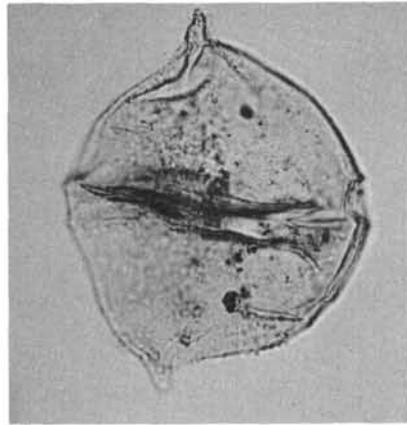
PLATE 8

- Figures 1-4 *Subtilisphaera ventriosa* (Alberti).
 1, 2. Slide SOEKOR 4998(b).1, co-ordinates
 8.1/116.5
 Overall diameter $72 \times 54 \mu\text{m}$.
 1. Interference contrast.
 3. Slide CSA 1741/1, MPK 1093.
 Overall diameter $61 \times 52 \mu\text{m}$.
 4. Slide CSA 1741/1, MPK 1094.
 Overall diameter $65 \times 52 \mu\text{m}$.
- Figure 5 *Palaeoperidinium pyrophorum* (Ehrenberg).
 Slide CSA 1733/1, MPK 1079.
 Overall diameter $84 \times 73 \mu\text{m}$. (Phase contrast.)
- Figure 6 *Palaeoperidinium cretaceum* Pocock.
 Slide CSA 1735/1, MPK 1066.
 Overall diameter $77 \times 65 \mu\text{m}$.
 Note lack of second antapical horn. (Phase
 contrast.)
- Figure 7 *Subtilisphaera pirnaensis* (Alberti).
 Slide CSA 1732/1, MPK 1058.
 Overall diameter $87 \times 60 \mu\text{m}$.
- Figures 8, 9 *Subtilisphaera ?ventriosa* (Alberti).
 Slide CSA 1736/1, MPK 1044.
 Overall diameter $62 \times 52 \mu\text{m}$.
 8. Phase contrast.
 9. Interference contrast.
- Figure 10 *Nelsoniella aceras* Cookson and Eisenack.
 Slide CSA 1725/2, MPK 1037.
 Overall diameter $67 \times 69 \mu\text{m}$.
- Figure 11 *Spinidinium echinoideum* (Cookson and Eisenack).
 Slide CSA 1725/1, MPK 1095.
 Overall diameter $54 \times 46 \mu\text{m}$. (Phase contrast.)
- Figure 12 *Pareodinia ceratophora* Deflandre.
 Slide CSA 1739/1, MPK 1088.
 Shell diameter $88 \times 44 \mu\text{m}$.
- Figure 13 *Spinidinium lanterna* Cookson and Eisenack.
 Slide CSA 1732/1, MPK 1096.
 Overall diameter $71 \times 51 \mu\text{m}$. (Phase contrast.)

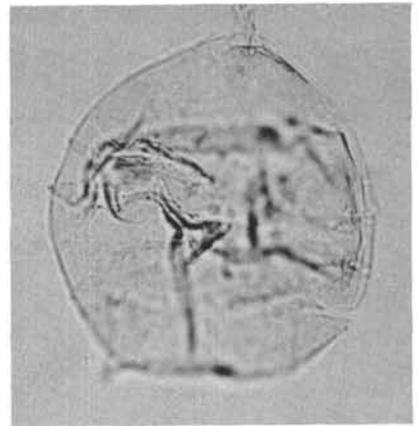
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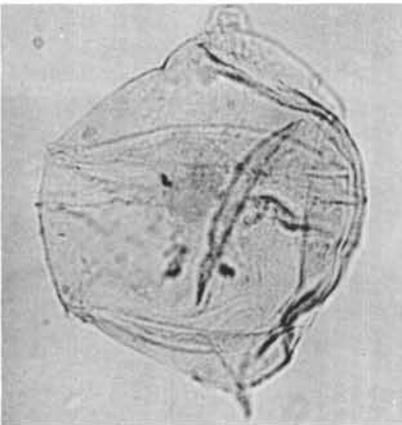
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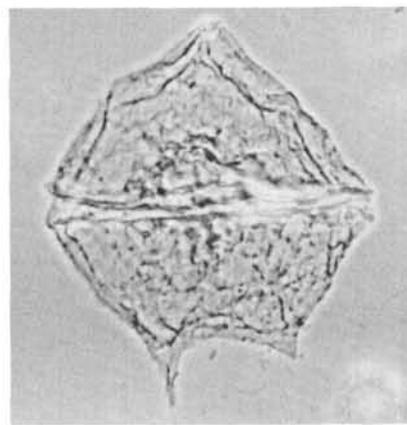
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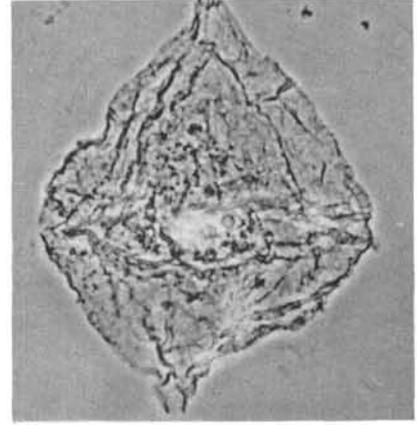
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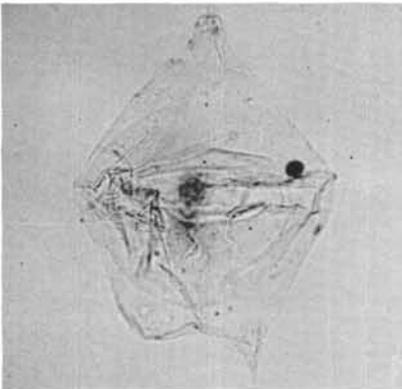
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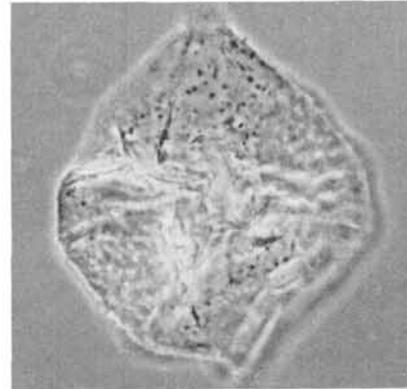
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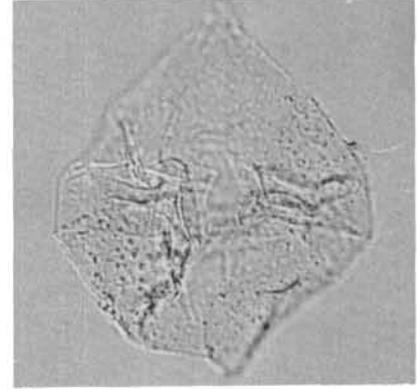
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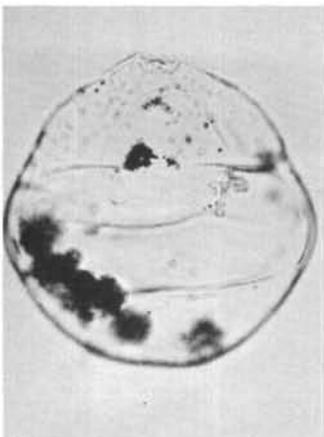
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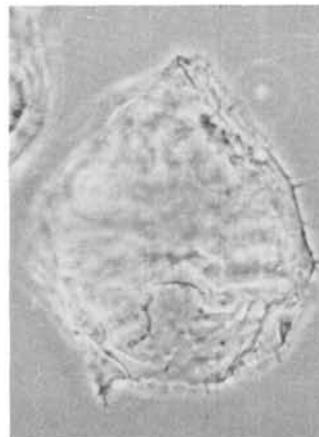
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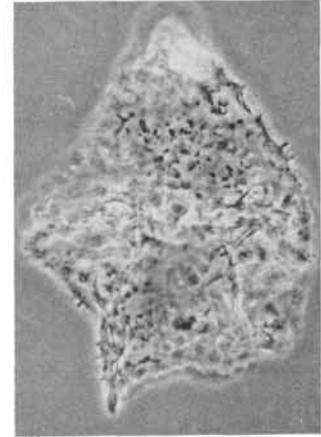
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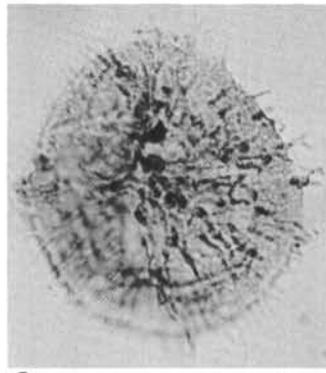
PLATE 9

- 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 $49 \times 43 \mu\text{m}$, processes up to 20 μm .
- Figure 2 *Trichodinium castanea* (Deflandre).
 Slide CSA 1732/1, MPK 1097.
 Shell diameter $50 \times 47 \mu\text{m}$, processes up to 5 μm .
- Figure 3 cf. *Trichodinium* sp. A.
 Slide CSA 1725/2, MPK 1038.
 Overall diameter $66 \times 57 \mu\text{m}$.
- Figures 4, 8 *Organism* sp. A.
 Slide SOEKOR 4989(b).1, co-ordinates 18.6/95.3.
 Shell diameter $35 \times 21 \mu\text{m}$, 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 $78 \times 64 \mu\text{m}$.
 6. Slide SOEKOR 5011(b).1, co-ordinates 3.8/86.2.
 Overall diameter $65 \times 63 \mu\text{m}$.
 7. Slide SOEKOR 5012(b).1, co-ordinates 2.3/106.7.
 Overall diameter $60 \times 61 \mu\text{m}$.
- Figure 9 *Cymatiosphaera delicata* Cookson and Eisenack.
 Slide SOEKOR 4993(b).1, co-ordinates 13.5/107.6.
 Shell diameter $59 \times 58 \mu\text{m}$, 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 $65 \times 62 \mu\text{m}$.
- Figures 12, 13 *Spinidinium sverdrupianum* (Manum).
 Slide CSA 1726/2, MPK 1085.
 Overall diameter $82 \times 61 \mu\text{m}$.
 12. Dorsal surface.
 13. Ventral surface.
- Figures 14, 15 *Trithyrodinium* sp. A.
 14. Slide SOEKOR 4985(b), co-ordinates 20.2/80.3.
 Overall diameter $41 \times 57 \mu\text{m}$.
 15. Slide CSA 1730/2, MPK 1098.
 Overall diameter $51 \times 49 \mu\text{m}$.

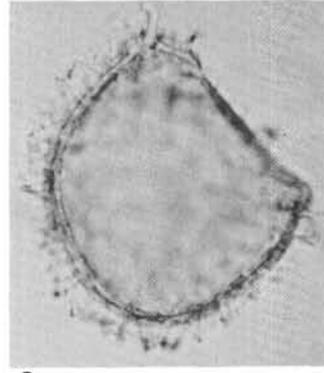
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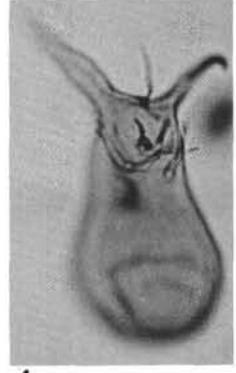
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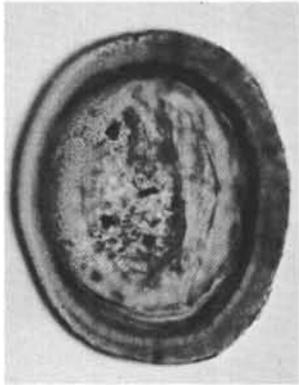
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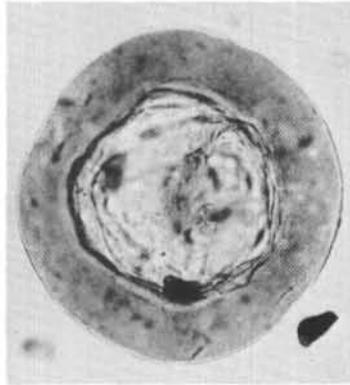
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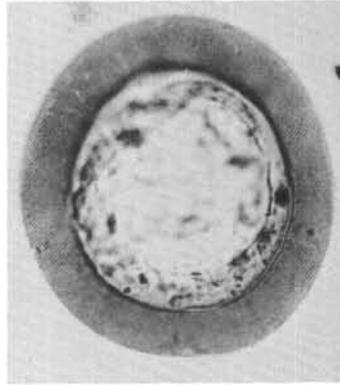
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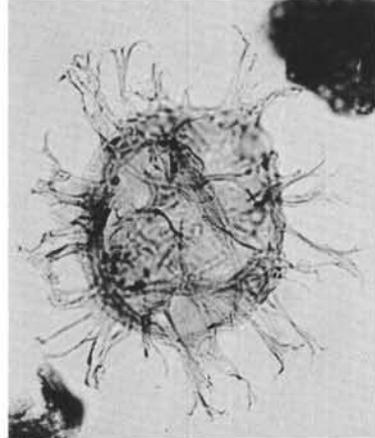
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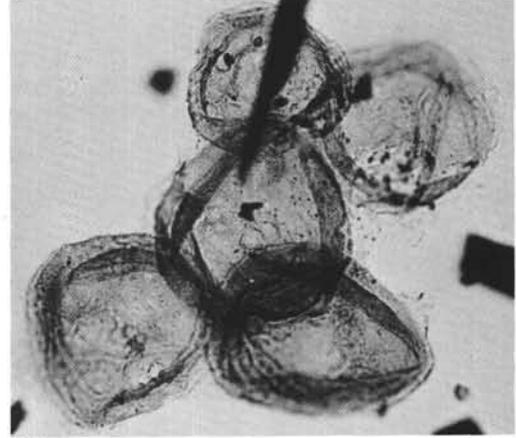
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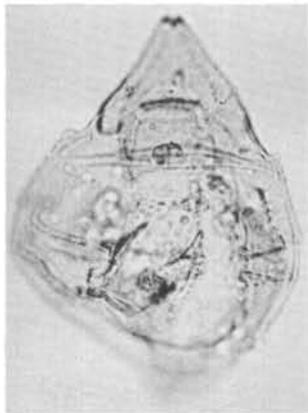
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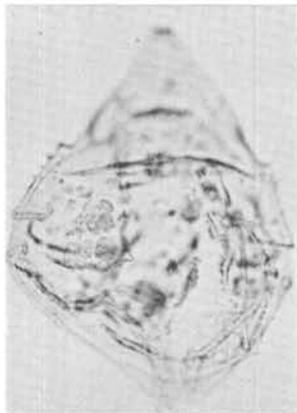
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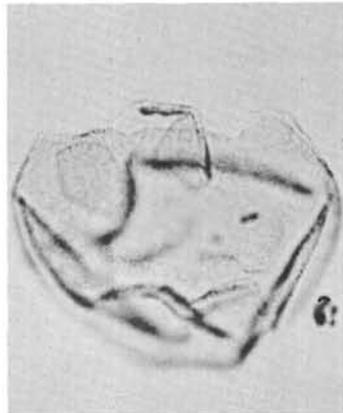
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