ABSTRACT
Relatively rich marine palynomorph assemblages consisting mainly of dinocysts, but also of microforaminifers and acritarchs, occur throughout the Apto-Albian sequences in Holes 400A and 402A. Of the sporomorphs, bisaccate pollen grains are always abundant and spores are relatively frequent only in Hole 402A. Dating was effected by the comparison of dinocyst distributions here with those in southern England and France. The early-late Aptian boundary is situated between Sections 72-3 and 70-0 in Hole 400A, and near Section 33-6 in Hole 402A. The Apto-Albian boundary is placed immediately above Section 67-0 in Hole 400A and between Sections 26-1 and 25-5 in Hole 402A. Lower Albian was not positively identified and, in Hole 400A, Sections 66-3, 65-2, and probably 64-3 are considered to be of middle Albian age. Only upper Albian was identified above the latter section. The Albian in Hole 402A could not be subdivided. Palynomorph distribution indicates that the Apto-Albian in Hole 400A was deposited at a reasonable distance from the landmass and probably not on the continental shelf. In contrast, contemporaneous deposition at Site 402A is considered to be nearshore. The characteristics of oceanic and epicontinental assemblages are discussed. The richness of the dinocyst assemblages has necessitated a section on their systematics; three new genera, Bacchidinium, Hapsocysta, and Nexosispinum, and twelve new species, B. sarmentum, Codoniellapsygma, Gonyaulacystapolythris, H. dictyota, N. hesperum, Nematosphaerospsis singularis, Oligosphaeridium verrucosum, Ovoidinium diversum, O. implantum, Spiniferites confossus, Surculosphaeridium trunculum, and Systematophora cretacea are proposed.

INTRODUCTION

Hole 400A
Hole 400A (47°22.90'N, 09°11.90'W) is located at the foot of the Meriadzek Escarpment near the ocean-continent boundary on the northern continental margin of the Bay of Biscay. It is situated about 300 kilometers west of Brest (Brittany) in a water depth of 4399 meters. The top of the Albian was penetrated at 654 meters and the hole terminated at 777.5 meters within the lower Aptian. The Albian is overlain by a thin Campanian-Maestrichtian interval. Cores 62 to 74 were taken in the Apto-Albian sequence, which consists principally of interbedded marly nanno-chalk and sapropelic mudstone; samples from all of these cores, except Core 73, have been analyzed palynologically.

Hole 402A
Hole 402A (47°52.48'N, 08°50.44'W) is located on a spur of the northern continental margin of the Bay of Biscay north of the Meriadzek Escarpment in a water depth of 2339.5 meters. It is situated about 320 kilometers west of Brest (Brittany). The top of the Albian was penetrated at 175 meters and the hole terminated at 469.5 meters within the lower Aptian. The Albian is overlain by a middle to upper Eocene interval. Cores 5 to 35 were taken in the Apto-Albian sequence, but, due to poor core recovery, only Cores 11 to 35 have been analyzed palynologically. These cores consist mainly of carbonaceous marly limestones assignable to the "black shale facies."
complicated by reworking (Figure 2). Hence the Apto-Albian of Hole 402A could only be dated indirectly by comparison with Hole 400A (Figure 3). Although the majority of dinocyst species recovered at these sites has also been found in England and France, several have been previously recorded in the Apto-Albian of Western Australia. Others are new and are described in the section on systematics. Dating by comparison with results from other parts of the world, for example from Australia (Burger, in press), Canada (Singh, 1964, 1971; Brideaux, 1971a, b; Brideaux and McIntyre, 1975) and offshore South Africa (Davey, in press b), is not possible but does yield important data concerning the geographic distribution of dinocyst species.

**Aptian**

Most species in the Aptian at these two sites are either not restricted to this stratigraphic stage, or show somewhat reduced ranges compared with those from the type Aptian (Davey and Verdier, 1974), southern France and southern England (unpublished data).

*Chlamydophorella hugonioti* (Valensi) occurs but rarely in Hole 400A; its earliest occurrence is in Sample 72-3, 40-42 cm. In southern England it commonly occurs as low as the base of the upper Aptian and in southern France it has a possible record in the upper lower Aptian (Davey and Verdier, 1974). Two stratigraphically important species occur higher in the sequence in Section 70-0, Hole 400A, *Melourogyonaulax stoveri* Millioud and *Cauca parva* Davey and Verdier. In southern England and southern France the former first appears near the base of the upper Aptian whereas the latter first appears in the mid-upper Aptian. Distribution of the three species in Hole 400A indicates that the lower-upper Aptian boundary should be placed tentatively between Section 70-0 and Sample 72-3, 40-42 cm. They do not occur at this stratigraphic level in Hole 402A, and the Aptian here can only be dated indirectly by comparing distributions of other species with those in Hole 400A (see Figure 3). The correlations are based on the following species: (1) *Membranosphaera* sp. A, which occurs abundantly in Sample 71-1, 111-113 cm (Hole 400A) and is present in Sample 33-6, 35-38 cm in Hole 402A; (2) *Ovoidinium diversum* sp. nov., which is abundant in Hole 402A, first appearing in Sample 32-7, 0-4 cm, whereas it is rare in Hole 400A and first occurs in Sample 71-1, 111-113 cm; and (3) the earliest occurrence of *Codoniella psygma* sp. nov. and the peak abundance of *Oligosphaeridium verrucosum* sp. nov. are in Sample 32-7, 0-4 cm in Hole 402A and in Section 70-0 in Hole 400A. The distribution of these species indicates that Sample 33-6, 35-38 cm, Hole 402A must be near the early/late Aptian boundary and that Sample 32-7, 0-4 cm, is probably early late Aptian.

**Apto-Albian Boundary**

On the evidence discussed below, the Apto-Albian boundary in Hole 400A has been placed above Section 67-0. Sample 400A-68-2, 24-26 cm, contains the youngest strati-
Figure 1. (Continued).

graphic occurrence of two species most commonly restricted to pre-Albian strata. *Polystephanephorus anthophorum* (Cookson and Eisenack) has an uppermost occurrence in the upper Aptian (upper Gargasian) of southern France (Davey and Verdier, 1974), in the uppermost Aptian (*H. jacobi* Zone) of southern England, and in the upper middle Albian (D. mammillatum Zone) of northern France (Verdier, 1975), and in the upper middle Albian of Germany (Dörhöfer, personal communication). In Canada, although it was recorded only from the Aptian by Brideaux and McIntyre (1975), in other localities it ranges into the middle and upper Albian (Davey, 1969a; Brideaux, 1971; Singh, 1971). This extended range into the Albian of Canada, Germany, and northern France indicates that the temporal range of *P. anthophorum* was either climatically controlled or that, in those sections, it has been reworked. The former explanation is favored by Dörhöfer (personal communication) who regards the species as a cold water form characteristic of the subarctic water mass. In Hole 402A it occurs to the top of the Albian (Sample 11-4, 105-108 cm) and, in this case, is regarded as being reworked because of association with other reworked species in this section. Thus, on the evidence from southern England and southern France and its absence from the Albian of the Paris Basin, (Davey and Verdier, 1971), at this latitude the youngest occurrence of *P. anthophorum* is regarded as topmost Aptian. The second species, *Subtilisphaera perlucida* (Alberti), has a youngest recorded occurrence in the upper Aptian (mid-Gargasian) of southern France (Davey and Verdier, 1974) and in the upper Aptian (*H. jacobi* Zone) of southern England.

In Section 67-0, Hole 400A, is the last occurrence of three species restricted to pre-Albian strata. The uppermost limit for *Muderongia cf. staurota* Sarjeant of Davey and Verdier (1974) is in the upper lower Aptian (upper Bedoulian) of southern France, in the uppermost Aptian (*H. jacobi* Zone) of southern England, and in the upper Aptian at Site 361, DSDP Leg 40 (Davey, in press b). For *Cyclonephelium tabulatum* Davey and Verdier it is the uppermost Aptian of southern France (Davey and Verdier, 1974), northern France (Verdier, 1975), and in the *H. jacobi* Zone of southern England, and for *Surculosphaeridium trunculum* sp. nov. it is in the *H. jacobi* Zone of southern England.

The Apto-Albian boundary in Hole 400A is based thus on the last occurrence of the above forms. Although these species occur in Hole 402A, they cannot there be used for dating because of extensive reworking. In their stead, first stratigraphic occurrence of *Hapsocysta peridictya* (Eisenack and Cookson) comb. nov. in Sample 26-1, 9-14 cm, Hole 402A is the defined marker species. It occurs also in Section 67-0, Hole 400A. On this basis the Apto-Albian boundary in Hole 402A is tentatively placed above Section 26-1, which position is substantiated by the first stratigraphic occurrence of *Lecaniella foveata* Singh in Sample 30-6, 60-63 cm, Hole 402A, and in Sample 68-2, 24-26 cm, Hole 400A; in southern England it first appears in the uppermost Aptian (*H. jacobi* Zone).
**Figure 2.** Range-distribution chart of marine palynomorphs in the Apto-Albian at Hole 402A.

**Albian**

Most of the species in the lower Albian in Hole 400A are not stratigraphically restricted to this stage and the two species *Litosphaeridium arundinum* (Eisenack and Cookson) comb. nov. and *Microdinium setosum* Sarjeant that elsewhere first appear in the lower Albian do not occur until higher in the 400A sequence. *Systematophora cretacea* sp. nov. occurs in Samples 66-3, 55-60 cm; 65-2, 19-22 cm; and 64-3, 52-55 cm. Previously it has been recorded from the lower middle Albian (*H. dentatus* Zone) of France (Davey and Verdier, 1971) and southern England, and from the upper middle Albian (*E. lautus* Zone), and upper Albian (*D. cristatum* and *M. inflatum* zones) of northern France (Verdier, 1975). The latter isolated occurrence in the *M. inflatum* Zone is not considered significant; *S. cretacea* is probably
mainly a middle Albian species which may range up into the
D. cristatum Zone. Sections 66-3 and 65-2 are hence of
middle Albian age and Section 64-3 is probably situated near
the middle-late Albian boundary.

Higher in the sequence in Hole 400A, Sample 63-2, 80-83
contains the first stratigraphic appearance of several
forms: 1) Apteodinium grande Cookson and Hughes which first
occurs near the top of the M. inflatum Zone in southern
England and within this zone in France (Davey and Verdier,
1971, 1973; Verdier, 1975); 2) Hexagonifera chlamydata
Cookson and Eisenack which first appears within the M. inflatum
Zone in southern England and France (Davey and Verdier,
1971, 1973; Verdier, 1975); 3) Litosphaeridium conispinum
Davey and Verdier which is restricted to the M. inflatum Zone in southern

1 Tanyosphaeridium cf. regulare
2 Cannigia ringnesii
3 Chlamyphorella albertii
4 Achomosphaera cf. neptuni
5 Hystrichosphaeridium recurvatum
6 Palaeoperidinium cretaceum
7 Cribroperidinium sepiamentum
8 Pterospermella aureolata
9 Aptea securigera
10 Gonyaulacysta tenuiceras
11 Pareodinia ceratophora
12 Membranosphaera sp. A
13 Gonyaulacysta cassidata
14 Gonyaulacysta sp. (of D & V, 1974)
15 Nematosphaeropsis singularis
16 Ovoidinium diversum
17 Spinifentes ramosus reticulatus
18 Gonyaulacysta helicoidea
19 Cyclonephelium distinctum brevispinatum
20 Codoniella psychoidea
21 Oligosphaeridium verrucosum
22 Polystephanaeophorus anthophorum
23 Apteodinium maculatum
24 Cyclonephelium cf. tabulatum
25 Eyrea nebulae
26 Polysphaeridium multispinosum
27 Tanyosphaeridium boletum
28 Achomosphaera ramulifera
29 Cannigia sp. A
30 Chlamyphorella hagannoti
31 Aptea cf. polymorpha
32 Cannigia sp. A
33 Microdinium crinitum
34 Cannigia cf. scabra (of Davey, in press)
35 Cannigia minor
36 Kleithrasphaeridium loffrensis
37 ? Maduradinium sp. A (of Davey, in press)
38 Florentinia radiculata
39 Schizosphaeridium laevigata
40 Cyclonephelium eisenacki

Figure 2. (Continued).
M. inflatum Zone in England and France (Davey and Verdier, 1975).

Palaeohystrichophora cf. infusoroides Deflandre of Davey and Verdier, 1973; and

Thalassiphora munda Davey and Verdier, first occurs in the M. inflatum Zone of France (Davey and Verdier, 1973; Verdier, 1975). Thus Sample 63-2, 80-83 cm is undoubtedly assignable to the M. inflatum Zone.

Sample 62-4, 111-113 cm, also belongs to the M. inflatum Zone because it contains the highest stratigraphic occurrence of Litosphaeridium arundum (Eisenack and Cookson) comb. nov., which in England and in France (Davey and Verdier, 1971) does not range higher than this zone.

The topmost sample (62-2, 41-43 cm) examined from Site 400A is assignable to the upper part of the M. inflatum Zone because it contains both Litosphaeridium siphoniphorum (Cookson and Eisenack) and L. consipinum (see Davey and Verdier, 1973).

Unfortunately none of the above stratigraphically restricted Albian species occur in Hole 402A. The only noteworthy occurrence is that of Maduradinium sp. A of Davey (in press b) in Sample 14-3, 87-89 cm. It also occurs in Sample 65-2, 19-22 cm, Hole 400A, in the middle Albian of England, in the Upper Cretaceous of Australia (as ?Meiozourogonyaulax sp. A of Norvick and Burger, 1976), at Site 361 (DSDP Leg 40) (Davey, in press b) and in France (unpublished data). The suggested site correlation must be regarded as most tenuous.

Dinocyst Distribution

The dinocyst assemblages from the Apto-Albian of Holes 400A and 402A compare most closely with those of similar age from southern England and the Paris Basin. This is not surprising considering the distance (600-1000 km) separating the sites from those onshore. In addition, deposition in each case must have been at a similar paleolatitude, approximately 30°N (Smith et al., 1973). Species differences in Hole 400A can be attributed to the bathyal water depth at that site and distance from shore, but at Site 402 deposition took place in a shallow water, nearshore environment comparable to that in southern England and the Paris Basin. Other factors must have been responsible for the differences in species occurrence and abundance.

Several of the species that occur consistently, and often abundantly, in the Apto-Albian of southern England and the Paris Basin either do not occur in Holes 400A and 402A or are very rare. These include Apteodinium granulatum Eisenack, 1958, Causa parva (Albetti), Dingodinium albertii Sarjeant, Floreartina lacintata Davey and Verdier, F. radiculata (Davey and Williams), Gonyaulacysta tenuicruris (Eisenack), Litosphaeridium arundum (Eisenack and Cookson), Microdinium crinitum Davey, Ovoidinium verrucosum (Cookson and Hughes) Davey, 1970, Protoellipsodinium spinocrisatum Davey and Verdier and Scritinodinium campanula Gocht. Conversely certain species only occur in the Biscay holes, namely Bacchidinium sarmentum sp. nov., Codoniella kompanionata (Cookson and Eisenack), C. psygma sp. nov., Gonyaulacysta polythris sp. nov., Haplocysta dictyota sp. nov., H. peridictya, Nematosphaeropsis singularis sp. nov. Hexosiphon hesperum sp. nov., Ovoidinium implanum sp. nov., and Spindiferites confossus sp. nov. C. camppanionata and H. peridictya have been previously recorded only from Western Australia; a third Western Australian species, Cannosphaeropsis tutulosa Cookson and Eisenack has been only observed once in southern England. Probable examples of C. psygma, reported as Hystrichosphaeropsis ovum by Habib (1972) occur in the Apto-Albian of the western North Atlantic (Leg 11, DSDP).

Morophologically, the genera Cannosphaeropsis O. Wetzel, 1933b, Codoniella Cookson and Eisenack, 1961a, and Hapsocysta gen. nov. have in common extensive periphragm structures which aid flotation and are considered to be oceanic adaptations. A comparable example of this adaptation is seen in Nematosphaeropsis labrinthea (Ostenfeld) Reid, 1974, which is characteristic of the North Atlantic. The virtual absence of these genera from the Apto-Albian epicontinental seas of southern England, the Paris Basin, southern France, Canada, and Queensland, Australia (Burger, in press) substantiates this conclusion.

Thus, during the Apto-Albian, Sites 400 and 402 had an oceanic geographic setting whereas, in southern England and the Paris Basin, sediments accumulated in epicontinental seas covering extensive shelf areas. However, significant differences exist between the dinocyst assemblages at the two

Figure 3. Dating of the Apto-Albian sequence at Hole 400A and its correlation to Hole 402A. (Dashed lines indicate tentative correlations.)

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sites, mainly because of their different distances from land and perhaps different water depths. Although species content and number of species per sample of the two sites is similar (except in the middle and upper Albian which, in part at least, is not present at Hole 402A), the relative abundance of species and groups of species differ albeit that reworking cannot be assessed in the upper part of Hole 402A. In general, chorate cyst genera such as Bacchidinium gen. nov., Cyclonephelium Deflandre and Cookson, 1955, Oligosphaeridium Davey and Williams, 1966b, Spiniferites Mantell, 1850, and Sarcosphaeridium Davey et al., 1966, comprise more than 50 per cent of all assemblages. In Hole 402A the peridinacean cysts Subtilisphaera Jain and Millepied, 1973, and Ovoidinium diversum sp. nov. are also consistently abundant whereas in Hole 400A they are uncommon. In contrast, in Hole 400A, moderate sized proximate cysts of the Pterodinium-Leptodinium group and Spiniferites cingulatus (O. Wetzel) are often abundant particularly in Cores 68 to 74. Increased abundance of peridinacean cysts is a well-established nearshore phenomenon reported by, amongst others, Davey (1970) in the Cenomanian, Harland (1971) in the Campanian, and in Recent sediments by Harada (1974, unpublished) and Harland (in press). At the present day, however, Leptodinium Klement, 1960, is rare or absent in shelf sediments (Reid and Harland, in press), and becomes abundant only in offshore, deeper water (oceanic) deposits (Wall and Dale, 1967; Davey and Rogers, 1975). An alternative explanation of the differences may be that Site 402 had been affected by a relatively cold current (Dörhöfer, personal communication).

Ovoidinium diversum is another form that appears to be almost restricted to an oceanic, rather than an epicontinental, nearshore environment. It has not been recorded from the Paris Basin and has been recorded only once in southern England. O. indistinctum (Cookson and Eisenack) (Lentin and Williams, 1975) which is rather similar to O. diversum also has been recorded only from the oceanic Apto-Albian sediments of Western Australia.

Two other genera may be indexes of depositional environment. Lecaniella Cookson and Eisenack (1962) occurs rarely in Sections 17-2, 19-4, 20-4, 21-7, 22-6, 23-6, 26-1, and 30-6 in Hole 402A and in 67-0 and 68-2 at Hole 400A. The Hole 400A occurrences are in sapropelic mudstones and are probably the result of down-slope contamination rather than in place occurrences. Schizocystis Cookson and Eisenack (1962a) was found only in Section 12-1, Hole 402A. In southern England, Lecaniella is well represented in the uppermost Aptian (H. jacobi Zone) and Schizocystis has a single occurrence in the lower upper Aptian (C. marinioides Zone). However, these two genera have been found, sometimes abundantly, in some southwest England (Institute of Geological Sciences) offshore boreholes (SLS 64, Lizard; SLS 28 and 72, Haig Fras; SLS 74, Scilly). The palynologic assemblages containing these genera are dominated by terrestrial plant debris and sporomorphs and in these respects closely resemble the Hole 402A assemblages. The only other localities where Lecaniella and Schizocystis are known to occur abundantly are in the Albian of northwest Alberta, Canada (Singh, 1971) and the Apto-Albian of Australia (Cookson and Eisenack, 1962a). Lecaniella has been also recorded from the District of Mackenzie, Canada, by Breedaux and McIntyre (1975). Neither genus has been reported from the Paris Basin (Davey and Verdier, 1974), the Grand Banks (Williams and Breedaux, 1975), or Queensland, Australia (Burger, in press). The known distribution of Lecaniella and Schizocystis suggest that they prefer a near-shore, oceanic environment in northwest Europe.

SYSTEMATIC DESCRIPTIONS

The following section is divided into two parts. The first lists, in alphabetical order, all marine palynomorph species encountered during this study and indicates, where appropriate, the plates on which they are figured. Figures in the square brackets refer to the position of that species on Figures 1 and 2, i.e. [25][47] indicates that this species is number 25 on Figure 1 and number 47 on Figure 2. New species or those that require certain amplifying remarks are indicated by an asterisk (*) and are dealt with in the second part. All type material and figured specimens have been assigned MKP numbers and are housed in the palynologic slide collection at the Institute of Geological Sciences, Leeds.

Palynomorph Species


A. ramulifera (Deflandre, 1957b) Evitt, 1963. [88].

A. ramulifera (Deflandre, 1957b) Evitt, 1963. (Plate 1, Figure 1). [59] [78].

Achomosphaera sp. A. (Plate 1, Figures 4-6). [100].

Apteodinium grande Cookson and Hughes, 1964. [98].

A. securigera Davey and Verdier, 1974. [84].

A. spiniferites Davey and Verdier, 1974. [38][52].

*Bacchidinium polysyles polyles (Cookson and Eisenack, 1962b) comb. nov. (Plate 1, Figure 7). [15][31].

B. cf. polysyles polyles (Cookson and Eisenack, 1962b) comb. nov. [34].

B. polysyles (Cookson and Eisenack, 1962b) comb. nov. subsp. clavatum Davey, 1969a. [99].

*B. sarmentum sp. nov. (Plate 1, Figures 8-12). [49].

Baltisphaeridium whitei Deflandre and Courteville, 1939. [73][24].

B. crameri Singh, 1971. (Plate 1, Figure 13). [108][20].

Callisiaphoridium asymetricum (Deflandre and Courteville, 1939) Davey and Williams, 1966b. (Plate 2, Figure 1). [46][1].

Canningia collivieri Cookson and Eisenack, 1960b. [65].

C. minor Cookson and Hughes, 1964. [13][85].

C. ringnesii Manum and Cookson, 1964. (Plate 2, Figure 4). [1][45].

C. cf. ringnesii Manum and Cookson, 1964. - [37].

C. scabrosa Cookson and Eisenack, 1970a, of Davey, in press b. [84].

*Canningia sp. A. (Plate 3, Figure 4). [85][82].

*Canningia sp. B. (Plate 1, Figures 14, 15). - [79].


Carpodinium granulatum Cookson and Eisenack, 1962b. [63].

Cassitisphaeridium recticulata Davey, 1969a. (Plate 2, Figure 3). [42][30].


Chlamydophorella albertii (Neale and Sarjeant, 1962) Davey, in press b. [22][46].

*C. hugonoius (Valensi, 1955a) Davey, in press b. (Plate 4, Figure 18). [30][80].

Cleistosphaeridium armatum (Deflandre, 1937b) Davey, 1969a. [68][42].

*Codoniella campanulata (Cookson and Eisenack, 1960a) Downie and Sarjeant, 1964. (Plate 2, Figure 8). [102].

*C. pygmae sp. nov. (Plate 2, Figures 9-14). [47][63].


*C. oceanica Cookson and Eisenack, 1958. [31][15].


C. intricatum Davey, 1969a. [109].

C. segmentum Neale and Sarjeant, 1962. [56][50].


MARINE APTO-ALBIAN PALYNOMORPHS
C. distinguished Deflandre and Cookson, 1955, subsp. longispinatum Davey, in press b. [105].

C. eisenacki Davey, 1969a. - [90].

C. hystric (Eisenack, 1958) Davey, in press b [32] [4].

C. tabulatum Davey and Verdier, 1974. [17] [23].

C. cf. tabulatum Davey and Verdier, 1974. - [74].

Dingodinium albertii Sarjeant, 1966c. [26] [39].

Dinosponyrella cladothoe Deflandre, 1925. [89].


Ellipsodinium rugulosum Clarke and Verdier, 1967. [110].

Exochosphaeridium phragmites (Cookson and Eisenack, 1962b) Sarjeant, 1966b. [92].

Eyrea nebulosa Cookson and Eisenack, 1971. (Plate 5, Figure 13). [39] [65].

Eyrea ovoidalis (Davey and Williams, 1966b) Davey and Verdier, 1973. [94].

Fromea amphora (Cookson and Eisenack, 1962) Deflandre, 1936a. [95] [72].

Fromeo amplicosta Cassidula (Eisenack and Cookson, 1960) Sarjeant, 1966b. [40].

G. deflandrei Davey, 1969a. [103].

G. eisenacki Sarjeant, 1966b. [112].

G. helicoides (Eisenack and Cookson, 1960) Sarjeant, 1966b. [53] [61].


G. cf. perforans (Cookson and Eisenack, 1960) Sarjeant, 1969. - [40].

G. pollenulatum (Davey and Williams, 1966b) Davey and Verdier, 1973. [37] [6].


H. deflandrei Davey, 1974. [17] [23].

H. cf. recurvatum (White, 1842) Davey and Williams, 1966b. [48].

Hydrichosphaeridium cf. longifloris Deflandre and Verdier, 1976. [81] [86].

K. simplicispinum (Davey and Williams, 1966b) Davey, 1974. [37] [6].

Lecantella foveata Singh, 1971. (Plate 4, Figure 6). [64] [69].

Liothrixosphaeridium arundinale (Eisenack and Cookson, 1960) comb nov. (Plate 4, Figures 13, 14). [84].

L. conspersum Davey and Verdier, 1973. (Plate 4, Figure 15). [93].

L. sp. nov. (Cookson and Eisenack, 1960) Davey and Williams, 1966b. [113].


T. cf. regularis Davey and Williams, 1966b. [62] [44].


Trichodinium castanea (Deflandre, 1935) Clarke and Verdier, 1967. [10] [14].

Trichodinium sp. Davey and Verdier, 1974. (Plate 8, Figure 5). [53] [19].

Wallodinium lunum (Cookson and Eisenack, 1960a) Deflandre and Verdier, 1973. [21] [38].

Xiphosphoria latifolia (Cookson and Eisenack, 1962b) Sarjeant, 1966b. [97].

TAXONOMY

Class DINOPHYCEAE Fritsch, 1929

Order PERIDINIALES Haeckel, 1894

Genus ACHOMOSPHAERA Evitt, 1963

Achomosphaera cf. ramulifera (Deflandre) Evitt, 1963

(Plate 1, Figure 1)

Remarks: Specimens attributed to A. cf. ramulifera differ from A. ramulifera s.s. by having mainly membranous processes. These are particularly well developed and noticeable in the circular and dorsal postcircular regions. In contrast A. ramulifera has thin, usually hollow processes that are circular in cross-section.
crests. Although these ridges are probably sutural, a precise tabulation is not determinable. However, the processes do appear to be gonatid in position and are of the Spiniferites ramosus-type. Distally, each process divides giving rise to two to several, sometimes irregular, spines. A small archeopyle is usually present and in both position and shape appears to be formed by the loss of a single precingular paraplate.

**Dimensions:**

<table>
<thead>
<tr>
<th>Central body diameter</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td>24 (30) 36 µm</td>
<td></td>
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**Remarks:** A. neptuni, from the Aptonian of Germany, has fewer and considerately stouter processes than A. Achomosphaera sp. A.

Genus **BACCHIDINIUM** gen. nov.

**Type species:** Bacchidinium polypes (Cookson and Eisenack, 1962b) comb. nov. Albian-Cenomanian, Australia.

**Derivation of name:** This genus is named after the Roman god Bacchus.

**Diagnosis:** The cysts are subspherical and bear many solid, mainly intratabular processes. One or more processes may be present per paraplate. Paratabulation is absent and the only polar structure that may be present is a small apical boss. Process alignment parallel to the paracingular may be present. The archeopyle is dorsal precingular formed by the loss of one or two paraplates.

**Remarks:** Bacchidinium gen. nov. is a relatively simple genus and is characterized by its subspherical shape, solid, predominantly intratabular processes and its precingular archeopyle. The superficially most similar genus is Operculocodium Wall, 1967, which has a type P archeopyle and solid intratabular processes. Stereoscan studies of O. centrocarpum (Flanagne and Cookson, 1955) Wall, 1967, by Harland (1973) and Jux (1976) show that the wall of this species is extremely fibrous and quite similar to that of Cordosphaeridium Eisenack, 1962b. Although the precise wall structure of B. polypes is unknown, this species is not considered to belong to the Exochosphaeridium-Cordosphaeridium lineage. Protosellospodium Davey and Verdier, 1971, is distinguished from Bacchidinium by being distinctly elongate in shape.

**Bacchidinium polypes** (Cookson and Eisenack, 1962b) comb. nov. (Plate 1, Figure 7)

**Description:** The wall of the cyst is smooth to slightly punctate and, being thin, is often deformed. The processes may be almost parallel-sided but often, as in the present material, they widen proximally. Distally the processes typically give rise to several small flexuous spines although in some specimens this type of termination is largely replaced by one that is recurved and non-spinose. Because both types of termination may occur on an individual specimen, specific differentiation is considered unnecessary. The distinctive type 2P archeopyle was observed in several specimens but in the majority of cases either the shape and position of the archeopyle could not be determined or no opening at all was apparent.

**Bacchidinium sarmentum** sp. nov. (Plate 1, Figures 8-12)

**Derivation of name:** Latin, sarmentum, twig— with reference to the distal branching of the processes.

**Diagnosis:** This is a thin-walled, subspherical species of Bacchidinium possessing one process per paraplate. The processes vary only slightly in size with the smallest ones occupying the sulcal region. The processes are relatively rigid and almost parallel-sided, although they do widen a little proximally where they may be striate. Distally they give rise to two to several stout spines orientated approximately parallel to the cyst wall. An archeopyle is typically present formed by the loss of a single precingular plate (3’).

**Holotype:** MPK 1698, DSDP Leg 48, Hole 400A, Sample 69-1, 84-86 cm. Aptonian, northern Bay of Biscay.

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3At the present it does not appear necessary to distinguish genetically forms having one process per paraplate from those having several processes per paraplate; nor to place much significance on whether one or two precingular paraplates are lost in archeopyle formation.

**Dimensions:**

<table>
<thead>
<tr>
<th>Central body diameter</th>
<th>Holotype Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 × 34 µm 25 (30) 34</td>
<td>10-16 µm 15 (16) 16 µm (maxima)</td>
</tr>
</tbody>
</table>

**Description:** The processes average approximately 1.5 µm in width and, because they are solid, are rarely deformed. The majority of the processes are of rather similar size with the slightly larger ones occupying the paracingular, antapical, and distal regions. These processes typically bear six to eight distal spines and these occasionally bifurcate medially; their overall span distally may be up to 15 µm.

**Remarks:** B. sarmentum sp. nov. differs from B. polypes by having fewer and stouter processes. Closostephaedrum tribuliferum (Sarjeant, 1962a) Davey et al. 1969 differs by possessing many more processes which only give rise to two to four spines distally.

Genus **CANNINGIA** Cookson and Eisenack, 1960b

**Remarks:** This genus is reserved for forms having in common an apical archeopyle (type A), low ornamentation, and lack a clear paratabulation.

**Canningia sp. A** (Plate 3, Figure 4)

**Description:** This is a large, thin-walled species possessing a low density covering of granules and tubercles.

**Canningia sp. B** (Plate 1, Figures 14, 15)

**Description:** This form has a rounded, subconical hypotroch and is covered by a dense network of granules and low, variously shaped spines of up to 1.5 µm in length.

**Cannosphaeropsis tutulosa** Cookson and Eisenack, 1960a

**Remarks:** This species is subspherical in shape and has a small apical boss. Beneath this is the precingular archeopyle (3’). The paratabular processes do not appear to be arranged regularly along the paraplate boundaries and a Spiniferites-type of organization is not obvious. This is due to the complexity of the processes and to the dorso-ventrally flattened nature of the cysts which means that the processes and trabeculae are splayed out laterally.

Only a single example of C. nttulosa has been recovered from onshore sediments and that occurred near the base of the Gault Clay (middle Albian, H. dentatus Zone) in the Isle of Wight, southern England.

**Cannosphaeropsis tutulosa** Cookson and Eisenack, 1960a

**Remarks:** This species is subspherical and has a small apical boss. Beneath this is the precingular archeopyle (3’). The paratabular processes do not appear to be arranged regularly along the paraplate boundaries and a Spiniferites-type of organization is not obvious. This is due to the complexity of the processes and to the dorso-ventrally flattened nature of the cysts which means that the processes and trabeculae are splayed out laterally.

**Type species:** Codoniella companulata (Cookson and Eisenack, 1960a, as Codonia, p. 11, pl. 3, fig. 1-3. Cenomian?/Santonian, Australia.

**Emended diagnosis:** The cyst is subspherical and has either an incomplete or a complete paratabulation of the type 3-4*, 6*, 5*, 0-0p, 1*.

The tabulation is marked by parasutural thickenings and sometimes crests in the paracingular, pre-, and postcingular regions, although it may be almost lacking here and confined to the apical and antapical regions. Along the parasutural boundaries between the apical and precingular and the antapical and postcingular paraplates there are developed regular and extremely high crests. The parasutural thickenings extend along these crests and distally continue, just inside the outer limit of the crests. Thus high membranous apical and antapical structures are formed which are open distally and supported by parasutural thickenings. Processes and a periplan apical horn are absent. Pre- and postcingular crests may be present. The archeopyle is precingular (3’).

**Remarks:** Codoniella is here emended to particularly draw attention to the orientation of the cyst. The membranous extensions are now considered to be apical and antapical rather than equatorial and in this respect somewhat resemble those of Hystrixosphaeropsis (Deflandre, 1935) Sarjeant, 1966b, and Roonessa Cookson and Eisenack, 1961b. Both of these genera, however, have an apical pericoel, with apical horn, and parasutural spines. The parasutural thickenings which occur distally just within the outer margins of the crests are distinctive and, as yet, have only been recorded in one other genus, the genus Hesihernia Sarjeant, 1966b.
The crests in this genus are evenly distributed and an epitractal archopyle is present thus easily differentiating it from *Codoniella*.

**Codoniella campanulata** (Cookson and Eisenack) Downie and Sarjeant, 1965, emend.

(Plate 2, Figure 8)

1960a *Codoniella campanulata* Cookson and Eisenack, p. 11, pl. 3, fig. 1-3.


**Emended diagnosis:** A thin-walled species of *Codoniella* which lacks paracingular tabulation and parasutural thickenings between the pre- and post-cingular paraplates. The crests surrounding the apical and antapical regions are very high and each forms a funnel-like structure which widens distally; these are strengthened by longitudinal thickenings and distal thickenings which occur just within the crest margin. Occasionally, crests extend from these structures along the pre- and postcingular paraplate boundaries to the paracingular but these do not possess distal thickenings. The crests are almost smooth distally. An archeopyle is typically developed.

**Holotype:** *Codoniella campanulata* (Cookson and Eisenack, 1960a, as *Codonia*), p. 11, pl. 3, fig. 1, Turonian, Western Australia.

**Dimensions:**

- Overall length: 128 µm
- Endocyst diameter: 46 µm

**Remarks:** *C. campanulata* is characterized by its high funnel-shaped, membranous structures extending apically and antapically from a thin walled, basically non-tabulate endocyst. Cookson and Eisenack (1960a) recorded it from the Cenomanian to ?Santonian of Western Australia; during the present study it was found only in Sections 62-2 and 62-4 in Hole 400A of late Albian age.

*Codoniella psygma* sp. nov.

(Plate 2, Figures 9-14)

**Derivation of name:** Greek, *psygma*, fan — with reference to the shape of the polar structures.

**Diagnosis:** This is a species of *Codoniella* possessing a paracingulum which is clearly defined by parasutural thickenings. The boundaries between the pre- and postcingular paraplates are either defined by low parasutural thickenings or by crests, and in the latter case the thickening extends along the crest just within its outer border. An archopyle is typically present.

**Holotype:** MPK 1680, DSDP Leg 48, Hole 400A, Sample 64-3, 52-55 cm, Albian, northerm Bay of Biscay.

**Dimensions:**

- Overall length: 89 µm
- Endocyst diameter: 36 x 40 µm

**Description:** The polar, funnel-like structures, typical of *Codoniella*, are well developed and the crests between the pre- and postcingular paraplates abut against them. The antapical funnel is simply comprised of crests bordering the pre- and postcingular paraplates. However the apical funnel appears more complex in that, although the main funnel-shaped structure resembles that at the antapex, additional crests may be developed along apical paraplate boundaries. Distally the crests are smooth to slightly serrate.

**Remarks:** *C. psygma* sp. nov. may be distinguished from *C. campanulata* by its clearly defined paracingular tabulation. This species appears to have been illustrated by Habib (1972, pl. 15, fig. 3) as *Hystrichosphaeropsis ovum* from Leg 11, DSDP Hole 101A, Sample 6-1, 70-73 cm, western North Atlantic; it is here probably of Apto-Albian age.

Genus **HAPSOCYSTA** gen. nov.

**Type species:** *Hapscysta peridictya* (Eisenack and Cookson, 1960) comb. nov. Aptian to Cenomanian, Australia.

**Derivation of name:** Greek, *hapso*, mesh or network — with reference to the net-like structure surrounding the inner body.

**Diagnosis:** The cyst consists of a subterminal endocyst which is almost completely enveloped by a net-like periphragm structure; the areas between the strands may be filled by a subsidiary network. The net is joined to the endocyst only around the circumference of the archopyle which is dorsal precingular (3°) and this is the only part of the cyst not enclosed by the net. The mesh of the net is composed of a single strand or two closely adhering strands which are parasutural in position and define a tabulation. This consists of large, basically pentagonal, pre-, postcingular, and antapical areas, elongate paracingular areas and small, subcirrular parasulcal areas; apical areas do not appear to be defined.

**Remarks:** The presence of a net-like structure almost completely surrounding the endocyst differentiates *Hapscysta* gen. nov. from all previously described species. The overall appearance of this species, however, indicates that it belongs to the *G. helicoideum* lineage.

**Hapscysta peridictya** (Eisenack and Cookson, 1960) comb. nov. and emend.

(Plate 4, Figures 1-5)

1958 *Cannosphaeropsis fenestrata* Deflandre and Cookson, p. 46, pl. 7, fig. 1-3.

1960 *C. peridictya* Eisenack and Cookson, p. 8, pl. 3, fig. 5, 6.

**Emended diagnosis:** A species of *Hapscysta* having a relatively small, thin-walled endocyst which is almost completely surrounded by a large subangular, wide-meshed, net-like structure. The bipartite strands of the net are smooth to lightly granular and generally closely adhere to each other. Where branching, the two strands tend to diverge and a very fine membrane is seen to connect them. An archopyle is probably normally developed but it is difficult to observe.

**Holotype:** *Cannosphaeropsis peridictya* Eisenack and Cookson, 1960, p. 8, pl. 3, fig. 6.

**Description:** The bipartite strands of the net are partly hollow in some specimens but this feature is usually difficult to discern. Rarely, fine ridges...
occur on the endocyst and these probably partly define a tabulation. The thin-walled endocyst is typically distorted which makes orientation by archoepyle position extremely difficult. However, the small meshes of the parasutural region (Pl. 4, Fig. 2, 5) are usually obvious and may be related to the elongate paracircular meshes (Pl. 4, Fig. 4) thus aiding in orientation.

**Hapsocysta dickyota sp. nov.**

(Plate 3, Figures 5-10, 13, 14)

**Derivation of name:** Greek, dickyotai, an — with reference to the appearance of the outer membrane.

**Diagnosis:** A species of Hapsocysta possessing a thin, subglobular endocyst partly surrounded by an extensive net-like peripharamembranous. Parasulcal ribs strengthen the latter structure and the thin peripharamembranous of the intratabular regions is perforated by subpolygonal to circular perforations where gonial prominences are present around the antapical prolongation and that it almost completely surrounds the endocyst. Parasutural ribs are sometimes obvious and may be related to the elongate paracingular meshes (Pl. 4, Fig. 4) thus aiding in orientation.

**Membranosphaera sp. A.**

(Plate 4, Figures 8-12)

**Description:** This is a relatively thick walled (about 1 µm) cyst of subcircular outline. The cyst surface bears numerous short (about 2 µm) spines which vary in width, up to about 1 µm, and broaden distally where they sometimes bifurcate and link with adjoining ones. This linkage is most pronounced towards the lateral margins of the cyst where crest-like structures may develop; they are usually aligned longitudinally. These crests often give the impression that an outer membrane is present, but this is considered unlikely. Towards the centers of the dorsal and ventral surfaces the processes become reduced to tubercles. The apical archoepyle has a strongly zigzag margin and a deep parasutural notch; the operculum is usually detached.

**Genus LITOSPHAERIDIA Davey and Williams, 1966b, emend. Davey and Verdier, 1973**

*Genus NEXOSISPINUM gen. nov.*

1960 *Hystrichosphaeridion arundum* Eisenack and Cookson, 1960 comb. nov. (Plate 4, Figures 16, 17)

**Remarks:** Litosphaeridium arundum comb. nov. closely resembles *L. consipitum* Davey and Verdier, 1973, in most respects including the number of processes, except that the paracingular and parasutural processes of the former are tubular. In both species the paracingular and parasutural processes are narrower than the other processes. The operculum usually remains attached in *L. arundum* and on one specimen was observed to bear three processes as does the operculum of *L. siphonicorphorum* (Cookson and Eisenack, 1958).


**Membranosphaera** sp. A.

(Plate 4, Figures 8-12)

**Description:** This is a relatively thick walled (about 1 µm) cyst of subcircular outline. The cyst surface bears numerous short (about 2 µm) spines which vary in width, up to about 1 µm, and broaden distally where they sometimes bifurcate and link with adjoining ones. This linkage is most pronounced towards the lateral margins of the cyst where crest-like structures may develop; they are usually aligned longitudinally. These crests often give the impression that an outer membrane is present, but this is considered unlikely. Towards the centers of the dorsal and ventral surfaces the processes become reduced to tubercles. The apical archoepyle has a strongly zigzag margin and a deep parasutural notch; the operculum is usually detached.

**Dimensions:**

<table>
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<th>MPK 1703</th>
<th>MPK 1705</th>
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</thead>
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<tr>
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<td>Range</td>
</tr>
<tr>
<td></td>
<td>(operculum detached)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>36 µm</td>
<td>41 µm</td>
</tr>
<tr>
<td>Cyst width</td>
<td></td>
</tr>
<tr>
<td>32 (36) 44 µm</td>
<td></td>
</tr>
</tbody>
</table>

(Holotype: MPK 1739, DDSF Leg 48, Hole 402A, Sample 25-5, 5-8 cm. Aiptian, northern Bay of Biscay.

**Dimensions:**

<table>
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<th>MPK 1712</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyst length</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>42 µm</td>
</tr>
<tr>
<td>Cyst width</td>
</tr>
<tr>
<td>32 µm</td>
</tr>
</tbody>
</table>

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

**Nematosphaeropsis singularis sp. nov.**

(Plate 5, Figures 6, 10, 14)

**Derivation of name:** Latin, singularis, different — with reference to the unusual processes.

**Diagnosis:** The cyst is subglobular and is composed of a thin, lightly granular wall which bears variably shaped processes arising from low parasutural ridges. Both gonial and parasutural processes are present and vary from being broadly membranous to being quite delicate; branching may occur. All are of about equal height on an individual. Distally, each process expands before bifurcating or trifurcating to give rise to weak, generally smooth trabeculae which link adjacent processes along parasutural ridges. Although the latter are usually present, it is not possible to define the complete tabulation. An archoepyle is normally developed and appears to be precingular (3°).

**Holotype:** MPK 1739, DDSF Leg 48, Hole 402A, Sample 25-5, 5-8 cm. Aiptian, northern Bay of Biscay.

**Dimensions:**

<table>
<thead>
<tr>
<th>Central body diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of processes</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>42 x 50 µm</td>
</tr>
<tr>
<td>6-12 µm</td>
</tr>
</tbody>
</table>

**Genus NEXOSISPINUM gen. nov.**

**Type species:** *Nexosispinum kepernum* sp. nov., Aiptian-Albian, northern Bay of Biscay.

**Derivation of name:** Latin, nexosus, much intertwined or complicated — with reference to the anastomosing nature of the processes.
**Nexosispinum vetusculum** (Davey) Davey, comb. nov. =

is smooth beneath the processes. The apical archeopyle is usually de-
intercalary (lp) processes which are noticeably smaller. The endophragm
cesses vary only slightly in size except the parasulcal and the posterior
of a relatively thick periphragm which is discretely granular on the endo-
Nexosispinum.

Davey, 1974, is here transferred to
distally terminate with a rather irregular secate-aculeate margin. The pro-
cyst, but is smooth when it forms the processes. The latter are tubiform and
appearance of the cyst wall.

shorter, and less complexly linked.
about 0.5 µm. The exact shape of the archeopyle is normally very difficult
ing to discern because of cyst distortion; occasionally the operculum remains in
position.

Remarks: N. hesperum sp. nov. differs from N. vetusculum comb. nov.
by having a punctate wall and by the processes which are fewer in number,
shorter, and less complexly linked. N. vetusculum has not been recorded
above the early Barremian of England (Davey, 1974; Duxbury, 1977).

**Genus OLIGOSPHAERIDIUM** Davey and Williams, 1966b

The following species, tentatively placed in *Adnathosphaeridium* by
Davey, 1974, is here transferred to *Nexosispinum*.

*Nexosispinum vetusculum* (Davey) Davey, comb. nov. = *Adnathosphaeridium vetusculum* Davey, 1974, p. 45, pl. 1, fig. 1, 2. Early
Barremian, England.

**Genus OLOIDINIDIUM** Davey, 1970, emend. Lentin and Williams, 1976

**Oloidinium diversum** sp. nov. (Plate 6, Figures 6-16)

Derivation of name: Latin, *diversum*, different or diverse — with refer-
cence to the variable extension of the outer membranes.

Diagnosis: The cyst is subspherical in shape and composed of a very thick,
intraperforate endophragm and a variably developed, thin peri-
phragm. The latter may closely adhere to the endophragm or it may be
quite distinct and sometimes forms irregularly shaped protuberances; in the
latter case the pericoel is also irregularly developed. The combina-
tion archeopyle, of type 4A2I, is always developed and the operculum often
remains attached; endophragm and periphragm always remain attached in
the operculum.

Holotype: MPK 1740, DSDP Leg 48, Hole 402A, Sample 25-5, 5-8
cm. Apto-Albian, northern Bay of Biscay.

Paratype 1: MPK 1720, DSDP Leg 48, Hole 402A, Sample 13-2,
93-96 cm. Apto-Albian, northern Bay of Biscay.

Paratype 2: MPK 1697, DSDP Leg 48, Hole 402A, Sample 68-2,
24-26 cm. Apto-Albian, northern Bay of Biscay.

**Dimensions:**

<table>
<thead>
<tr>
<th></th>
<th>Hostotype</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of endophragm</td>
<td>68 µm</td>
<td>50 (38) 68 µm</td>
</tr>
<tr>
<td>Height of periphragm</td>
<td>0-15 µm</td>
<td>0-14 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process length</td>
<td>6-7 µm</td>
<td>6-9 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocyst length</td>
<td>57 µm</td>
<td>50 (53) 57 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocyst width</td>
<td>40 x 41 µm</td>
<td>38 (47) 69 µm</td>
</tr>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

**Diagnosis:** The cyst wall varies from lightly to densely granular and,
when the latter, the granules tend to be aligned on either side of the pre-
and postcircular paraplate boundaries. Wall thickness varies up to 2 µm.
The processes are strongly developed and sometimes appear to be fibrous.
A smooth circular portion of endophragm is exposed beneath each process.

**Remarks:** This large, robust species of *Oloidinium* occurs abun-
dantly in Section 7-0 (Hole 400A), fairly commonly in Section 32-7, and
rarely in Section 31-6, both of Hole 402A.

**Oloidinium implanus** sp. nov. (Plate 5, Figures 7-9, 11, 12)

Derivation of name: Latin, implanus, uneven — with reference to the
rough wall of the cyst.

<table>
<thead>
<tr>
<th></th>
<th>Hostotype</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of endophragm</td>
<td>68 µm</td>
<td>50 (38) 68 µm</td>
</tr>
<tr>
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<td>0-14 µm</td>
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</tr>
<tr>
<td>Endocyst length</td>
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<td>50 (53) 57 µm</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Endocyst width</td>
<td>40 x 41 µm</td>
<td>38 (47) 69 µm</td>
</tr>
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</tbody>
</table>

**Remarks:** The thickness of the endophragm and particularly the
irregular development of the periphragm distinguishes *O. diversum* sp.
from all previously described species. In most other species of
*Oloidinium* the periphragm is relatively consistent in its development and
regular apical and antapical paraplates are present. Hence the original
concept of *Oloidinium* has been modified and more emphasis is now
placed on the presence of the unique 4A31 archeopyle type. The most
similar species to *O. diversum* is *O. indistinctum* (Cookson and Eisenack)
Lentin and Williams, 1975, from the Apto-Albian of Western Australia,
which, however, apparently does not have a thick, intraperforate endophragm.
The Australian species is also considerably larger — overall length 86 to 104 µm,
overall width 66 to 96 µm. All other members of this genus are also of mid-Cretaceous age.

*O. diversum* sp. nov. is rare in Hole 400A (Cores 71 to 64) but abundant in
Hole 402A (Cores 32 to 11). This species has only been found in one
onshore sample in the *H. jacobi* Zone (Upper Aptian) of the basal
Sandrock-top Ferruginous Sands at Atherfield Bay, Isle of Wight.

**Oloidinium implanus** sp. nov. (Plate 5, Figures 7-9, 11, 12)

Derivation of name: Latin, implanus, uneven — with reference to the
rough wall of the cyst.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Length of endophragm</td>
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<tr>
<td>Endocyst width</td>
<td>40 x 41 µm</td>
<td>38 (47) 69 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Diagnosis: A subspherical to ovoid species of *Oovidiunum* composed of endophragm and periphragm both of moderate thickness; the apical region is broadly subconical. The periphragm is closely adpressed to the endophragm except at the antapex where a small pericoel is usually present and at the apex where occasionally an apical pericoel exists. The periphragm is strongly ornamented and all gradations exist from coarse irregularly shaped pits (fossulate-foveolate ornamentation) to a dense, fine intraperforation. A pericingulum and antapically widening perisulcus are usually noticeable. The combination archeopyle (type 4A31) is always developed and the operculum often remains attached.

Holotype: MPK 1668, DSDP Leg 48, Hole 400A, Sample 62-4, 111-113 cm. Albian, northern Bay of Biscay.

Dimensions:
- Endocyst length: 39 µm (39-42 µm)
- Endocyst width: 37 µm (37-44 µm)
- Endocyst length (complete specimen): 42-50 µm

Description: The wall layers are each of about 0.5 µm in thickness. The endophragm appears to be smooth whereas the periphragm has a characteristically strong ornamentation and, although some positive elements may occasionally be detected around the lateral part of the cyst, it appears most probably that a negative ornamentation is typical. The antapical periphagm extension when present, may either be almost symmetrical (see holotype) or may be more strongly developed on the left side.

Remarks: The reduced pericoels and the structure of the periphragm distinguishes *O. implanum* sp. nov. from all previously described species.

This distinctive species only occurred in Section 62-4 where it was

*O. implanum* distinguishes sp. nov. from all previously described species.

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Genus *SPINIFERITES* Mantell, 1850, emend. Sarjeant, 1970

Remarks: There is some difficulty in distinguishing *Spiniferites* possessing a thin, smooth to lightly punctuate wall and a clear tabulation defined by high perforate crests. The taxa used to be highest in the gonal areas and generally more strongly developed towards the antapex. The outer limit of the crests is always entire, usually smooth, and sometimes noticeably thickened. The perforations are smooth in outline, vary considerably in size and, when large, the crest may be represented only by a distal trabecula. A precingular archeopyle is typically developed.

Holotype: MPK 1722, DSDP Leg 48, Hole 400A, Sample 69-1, 84-86 cm. Aptian, northern Bay of Biscay.

Dimensions:
- Endocyst length: 42 µm (36 (39) 42 µm)
- Endocyst width: 29 µm (29 (32) 34 µm)
- Height of crests: 5-12 µm (9 (11) 14 µm (max.))

Description: Gonal thickening appears to be well developed and support the crests perpendicular to the cyst surface. Although the crests are generally smooth distally, sometimes a slight notching is weakly developed.

Remarks: This distinctive species is distinguished from other similar forms by the presence of high perforate sutural crests. It is considered most comparable to *Spiniferites* cingulatus (O. Wetzel) although its high crests are reminiscent of *Pterodinium aliferum* Eismeck which, however, possesses denticulate crests. *S. confossus* could possibly have been assigned to *Nematopsphaeropsis* but the latter genus should probably be restricted to species having definite gonal processes.

Genus *SURCULOSPHAERIDIIUM* Davey et al., 1966

*Surculosphaeridium trunculum* sp. nov. (Plate 8, Figures 6-9)

Derivation of name: Latin, *trunculus*, trunk—with reference to the thickened regions of the proximal part of the processes.

Diagnosis: A smooth walled, subspherical species of *Surculosphaeridium* possessing one, or more rarely two, solid processes per paraplate. The wider processes, which occupy the pre-, postcingular, and antapical regions, typically have a proximal bifurcation giving the processes a basal subconical perforation. Often, particularly in the paracircular region, the processes may be deeply forcate or a single paracircular process may be represented by two finer processes; sometimes these latter processes are joined by a medial bar. Distally the processes fork irregularly. An archeopyle is usually developed.

Holotype: MPK 1742, DSDP Leg 48, Hole 400A, Sample 25-5, 5-8 cm. Apto-Albian, northern Bay of Biscay.

Dimensions:
- Endocyst length: 42 µm (36 (39) 42 µm)
- Endocyst width: 29 µm (29 (32) 34 µm)
- Height of crests: 5-12 µm (9 (11) 14 µm (max.))

Description: Gonal thickening appear to be well developed and support the crests perpendicular to the cyst surface. Although the crests are generally smooth distally, sometimes a slight notching is weakly developed.

Remarks: This distinctive species is distinguished from other similar forms by the presence of high perforate sutural crests. It is considered most comparable to *Spiniferites* cingulatus (O. Wetzel) although its high crests are reminiscent of *Pterodinium aliferum* Eismeck which, however, possesses denticulate crests. *S. confossus* could possibly have been assigned to *Nematopsphaeropsis* but the latter genus should probably be restricted to species having definite gonal processes.

Genus *POLYSPHAERIDIIUM* Davey and Williams, 1966b

*Polyphagoidium pumilum* Davey and Williams, 1966b

(Plate 7, Figures 2, 3)

Remarks: Specimens definitely attributable to *P. pumilum* occur in Core 62 (Hole 400A) but in lower samples, particularly in Core 64, specimens tend to increase in size and have fewer processes. Whereas the Cenomanian type-material was described as having a maximum endocyst diameter of 25 µm, the Core 64 specimens range up to 36 µm; process length in the Cenomanian forms is 7 to 10 µm and in Core 64 it is 10 to 15 µm; process number in the Cenomanian is 38 to 44 and in Core 64 it is often under 30. Finally the Core 64 specimens tend to have the thickish intraperforate wall which is similar to that found in *Litosphaeridium*. Numbers of specimens are insufficient at present to assess the significance of the above variation.

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Genus *POLYSPHAERIDIIUM* Davey et al., 1966

*Surculosphaeridium trunculum* sp. nov. (Plate 8, Figures 6-9)

Derivation of name: Latin, *trunculus*, trunk—with reference to the trunk-like appearance of the proximal part of the processes.

Diagnosis: A smooth walled, subspherical species of *Surculosphaeridium* possessing one, or more rarely two, solid processes per paraplate. The wider processes, which occupy the pre-, postcingular, and antapical regions, typically have a proximal bifurcation giving the processes a basal subconical perforation. Often, particularly in the paracircular region, the processes may be deeply forcate or a single paracircular process may be represented by two finer processes; sometimes these latter processes are joined by a medial bar. Distally the processes fork irregularly. An archeopyle is usually developed.

Holotype: MPK 1742, DSDP Leg 48, Hole 400A, Sample 25-5, 5-8 cm. Apto-Albian, northern Bay of Biscay.

Dimensions:
- Endocyst length: 42 µm (36 (39) 42 µm)
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Genus *POLYSPHAERIDIIUM* Davey et al., 1966

*Surculosphaeridium trunculum* sp. nov. (Plate 8, Figures 6-9)
Genus SYSTEMATOPHORA Klement, 1960

Systematophora cretacea sp. nov.

(Plate 8, Figures 10, 13-15)

1971 Systematophora fasciculigera Klement, in Davey and Verdi, p. 35, pl. 6, fig. 10, 11.

Derivation of name: Named after the Cretaceous System.

Diagnosis: A subspherical species of Systematophora composed of a thick, densely granular wall which bears processes arranged in annular complexes. The paracingular processes give rise to a number of processes which may subdivide distally. Proximally the annular complexes arise from a subconical basal thickening. The paracingular plate then bears two simple processes. An apical complex always appears to be divided. An apical archeopyle always appears to be present.

Holotype: MPK 1683, DSDP Leg 48, Hole 400A, Sample 64-3, 52-55 cm, Albian, northern Bay of Biscay.

Dimensions:

- Holotype length: 72 µm
- (operculum attached) 60-64 µm
- Endocyst length: 66 µm
- Endocyst width: 62-20 µm
- Length of processes: 16 (20) 24 µm

Description: The largest annular complexes occupy the pre-, postcingular, and antapical regions; the apical and parasulcal complexes are smaller and the paracingular is marked by a small, elongate complex which bears two simple processes. The parasulcal region may have simple processes. An apical archeopyle always appears to be present. An apical archeopyle always appears to be present.

Remarks: S. cretacea sp. nov. strongly resembles S. fasciculigera Klement, 1960, which differs by having longer and more complex processes and by not having a thick granular wall. S. valensii (Sarjeant, 1960) Downie and Sarjeant, 1964, is also similar and may, in fact, be synonymous with S. fasciculigera.

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REFERENCES

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


Davey, R. J., in press a. The stratigraphic distribution of dinocysts in the Portlandian (latest Jurassic) to Barremian (Early Cretaceous) of northwest Europe, American Association of Stratigraphic Palynologists, Contribution Series.


Fritsch, F. E., 1929. Evolutionary sequence and affinities among Protophyta, Biological Review, v. 4, p. 103-151.


Harland, R., 1977. Recent and late Quaternary (Flandrian and Devensian) dinoflagellate cysts from marine continental shelf sediments around the British Isles, Palaeontographica, v. 164, p. 87-126.


Reid, P. C. and Harland, R., in press. Studies of Quaternary dinoflagellate cysts from the North Atlantic, American Association of Stratigraphic Palynologists, Contribution Series.


PLATE 1
(Magnification ×500)

Figure 1  Achomosphaera cf. ramulifera (Deflandre). MPK 1660. Sample 402A-62-2, 41-43 cm. Dorsal view.

Figures 2, 3  Achomosphaera cf. neptuni (Eisenack).
2. MPK 1711. Sample 400A-72-3, 40-42 cm.
3. MPK 1756. Sample 402A-34-3, 94-98 cm.
Dorsal surface with precingular (3") archeopyle (arrow) and aligned paracingular processes (interference contrast).

Figures 4-6  Achomosphaera sp. A. Sample 400A-63-2, 80-83 cm.
4. MPK 1673. 4, dorsal surface with precingular (3") archeopyle (arrow). 5, ventral surface. (Interference contrast).
5. MPK 1674 (phase contrast).

Figure 7  Bacchidinium polypes subsp. polypes (Cookson and Eisenack) MPK 1738. Sample 402A-25-5, 5-8 cm.
Dorsal surface with precingular (2P) archeopyle; arrow points to re-entrant angle of archeopyle (interference contrast).

Figures 8-12  Bacchidinium sarmentum sp. nov. 8, 9, 12, Sample 400A-69-1, 84-86 cm. 10, 11, Sample 400A-65-2, 19-22 cm.
8. Holotype. Arrow indicates precingular archeopyle (interference contrast).
10. MPK 1687. Arrow indicates precingular archeopyle (interference contrast).
11. MPK 1687. Arrow indicates precingular archeopyle.

Figure 13  Baltisphaeridium crameri Singh. MPK 1734. Sample 402A-23-6, 35-38 cm.

Figures 14, 15  Canningia sp. B.
15. MPK 1735. Sample 402A-23-6, 87-91 cm. (Phase contrast).
Figure 1  *Callaisphaeridium asymmetricum* Deflandre and Courteville. MPK 1747. Sample 402A-30-6, 60-63 cm. Antapical view; arrow indicates parasulcal processes.

Figure 2  *Canningia colliveri* Cookson and Eisenack. MPK 1694. Sample 400A-68-2, 24-26 cm.

Figure 3  *Cassiculosphaeridia reticulata* Davey. MPK 1702. Sample 400A-71-1, 111-113 cm. Ventral view illustrating parasulcal notch.

Figure 4  *Canningia ringnesii* Manum and Cookson. MPK 1965. Sample 400A-68-2, 24-26 cm. Operculum partly attached.

Figures 5-7  *Cannosphaeropsis tutulosa* Cookson and Eisenack. MPK 1665. Sample 400A-62-4, 111-113 cm.
5. Ventral view (interference contrast).
6. Ventral view (phase contrast).
7. Dorsal surface; arrow indicating precingular archeopyle (phase contrast).

Figure 8  *Codoniella campanulata* (Cookson and Eisenack). MPK 1666. Sample 400A-62-4, 111-113 cm. Ventral surface; arrow indicates parasutural crest thickenings.

Figures 9-14  *Codoniella psygma* sp. nov.
9, 10. Holotype. 9, dorsal surface; arrow indicating precingular archeopyle immediately above the well defines paracingulum. 10, ventral view.
11, 12. MPK 1748. Sample 402A-30-6 60-63 cm.
11, lateral view; arrow indicates precingular archeopyle. 12, lateral view.
13. MPK 1755. Sample 402A-32-7, 0-4 cm.
14. MPK 1696. Sample 400A-68-2, 24-26 cm. Parasutural thickenings very noticeable (interference contrast).
PLATE 3
(Magnification ×500 unless otherwise stated.)

Figures 1-3  *Gonyaulacysta polythris* sp. nov. Holotype. 3, note perforations in precingular crest. ×1250 (phase contrast).

Figure 4  *Canningia* sp. A. MPK 1681. Sample 402A-64-3, 52-55 cm (phase contrast).

Figures 5-10,  *Hapsocysta dictyota* sp. nov.
5, 6. Holotype. 5, ventral surface. 6, dorsal surface; arrow indicates precingular archeopyle (interference contrast).
8. MPK 1676. Sample 400A-63-2, 80-83 cm. Dorsal surface; arrow indicates precingular archeopyle. Note that most of the dorsal surface is not enclosed by the outer net.
10. MPK 1678. Sample 400A-63-2, 80-83 cm. Antapical view. Note perforations are smaller and more circular than in the holotype (phase contrast).
13, 14. MPK 1679. Sample 400A-63-2, 80-83 cm. Lateral views. 13, arrow indicates position of archeopyle. Note small circular perforations in this extreme specimen. 14, note bifurcating parasutural ribs (phase contrast).

11. Dorsal surface with developed archeopyle.
12. Ventral surface.

15. Ventral surface of epicyst.
Figures 1-5 *Hapsocysta peridictya* (Eisenack and Cookson).
1. MPK 1692. Sample 400A-67-0. Lateral view; arrow indicates the parasutural strand of a postcingular paraplate (interference contrast).
2. MPK 1729. Sample 402A-18-4, 75-78 cm. Ventral view; arrow indicates the small parasulcal meshes (phase contrast).
4. MPK 1693. Sample 400A-67-0. 4, Dorso-lateral view; arrow indicates an elongate paracingular mesh situated above a large postcingular mesh. 5, Ventro-lateral view; arrow indicates the small parasulcal meshes.

Figure 6 *Lecaniella foveata* Singh. MPK 1726. Sample 402A-17-2, 119-122 cm.

Figure 7 *Hystrichodinium dasys* Davey. MPK 1758. Sample 402A-35-1, 108-111 cm. Lateral view illustrating paracingular, pre- and postcingular paraplates.

Figures 8-12 *Membranosphaera* sp. A. Sample 400A-71-1, 111-113 cm.
8. MPK 1703. Dorsal view.
10. MPK 1705. Medial view; operculum attached.
12. MPK 1707. Ventral view.

Figures 13, 14 *Histioctyla* sp. A. MPK 1712. Sample 400A-72-3, 40-42 cm.

Figure 15 *Litospheeridium conspinum* Davey and Verdier. MPK 1663. Sample 400A-62-2, 41-43 cm. Medial view illustrating subconical paracingular processes.


Figure 18 *Chlamydophorella huguoni* (Valensi). MPK 1667. Sample 400A-62-4, 111-113 cm.
Figures 1-3  *Oligosphaeridium verrucosum* sp. nov.
1. 2. Holotype. 1. Ventral view; arrow indicates bald precingular paraplate boundary. 2. Dorsal view.
3. MPK 1701. Sample 400A-70-0. Detached operculum; note the elongate first apical paraplate (1').

Figures 4, 5  *Muderongia* cf. *staurota* Sarjeant.
4. MPK 1753. Sample 402A-31-6, 15-19 cm.
5. MPK 1749. Sample 402A-30-6, 60-63 cm.

Figures 6, 10, 14  *Nematosphaeropsis singularis* sp. nov.
6. MPK 1730. Sample 402A-19-4, 81-84 cm (phase contrast).
10. MPK 1743. Sample 402A-26-1, 9-14 cm.
14. Holotype (interference contrast).

Figures 7-9, 11, 12  *Ovoidinium implanum* sp. nov. Sample 400A-62-4, 111-113 cm.
7. 11. Holotype. 7. Ventral view. 11. Ventral hypocyst illustrating reduced pericoel. ×1250 (phase contrast).
8. MPK 1669. Dorsal view; operculum partially attached (phase contrast).
9. MPK 1670 (phase contrast).
12. MPK 1671 (complete specimen).

Figure 13  *Eyrea nebulosa* Cookson and Eisenack. MPK 1713.
Sample 400A-72-3, 40-42 cm.
Figures 1-5  
**Nexosispinum hesperum** sp. nov.  
3. MPK 1718. Sample 400A-74-1, 4-6 cm. 3, Antapical surface. 4, Apical-archeopyle surface.  
5. Holotype. Dorsal surface with precingular (2P) archeopyle; arrow points to re-entrant angle of archeopyle.

Figures 6-16  
**Ovoidinium diversum** sp. nov.  
6-8. Detached opercula. 6, MPK 1754. Sample 402A-31-6, 15-19 cm. Arrows indicate separation of delicate periphagm from the endophagm. 7, MPK 1689. Sample 402A-19-4, 81-84 cm. Boundaries between the individual apical and intercalary paraplates are shown. 8, MPK 1690. Sample 402A-26-1, 9-14 cm. The periphagm is here loosely adhering to the individual opercular paraplates.  
10. Paratype 1. Dorsal surface. Note large extensions of the periphagm above apical, antapical, pre- and postcingular paraplates. Arrow indicates the boundary between paraplates 2a and 4".  
11. Paratype 2. Dorsal view. Periphagm closely adhering to the endophagm. Archeopyle developed; arrow pointing the 2a - 4" paraplate boundary.  
12. MPK 1741. Sample 402A-25-5, 5-8 cm. Apical view with operculum in place; arrow points to the 2a - 4" paraplate boundary. Note apparent paraplate thickenings which sometimes occur.  
15. MPK 1722. Sample 402A-13-2, 93-96 cm. Medial view illustrating the nature of the periphagm.  
16. MPK 1750. Sample 402A-30.6, 60-63 cm. Dorsal view; archeopyle developed. Arrow indicates the boundary between paraplates 2a and 4".

Figures 17-20  
**Ovoidinium** sp. A. Sample 400A-72-3, 40-42 cm.  
17. MPK 1714. Ventral view.  
18. MPK 1715. Ventral view.  
PLATE 7
(Magnification ×500 unless otherwise stated.)

Figures 1, 4, 9 *Polystephanophorus anthophorum* (Cookson and Eisenack).
1, 4. MPK 1719. Sample 402A-11-4, 105-108 cm.
1. Apical view; archeopyle developed. The finer parasulcal processes are at the bottom. 4. Antapical view.

Figures 2, 3 *Polysphaeridium pumilum* Davey and Williams.
MPK 1682. Sample 400A-64-3, 52-55 cm.

Figures 5-7 *Prolixosphaeridium parvispinum* (Deflandre).
5. MPK 1708. Sample 400A-71-1, 111-113 cm.
6. MPK 1717. Sample 400A-72-3, 40-42 cm (interference contrast).

Figures 8, 11 *Spiniferites ramosus* (Ehr.) subsp. reticulatus (Davey and Williams). MPK 1709. Sample 400A-71-1, 111-113 cm. 8, Lateral view. 11, Surface detail. ×1250 (phase contrast).

Figure 10 *Polysphaeridium laminaspinosum* Davey and Williams. MPK 1672. Sample 400A-62-4, 111-113 cm (phase contrast).

Figure 12 *Pterodinium* cf. *aliferum* Eisenack. MPK 1686. Sample 400A-65-2, 19-22 cm. Lateral view.

Figures 13, 14 *Pterodinium aliferum* Eisenack.
PLATE 8
(Magnification ×500)

Figures 1-4  
*Spiniferites confossus* sp. nov.
1-3. Holotype. 1, Dorsal view; precingular archeopyle developed. 2, Medial view. 3, Ventral view.
4. MPK 1746. Sample 400A-69-1, 84-86 cm.

Figure 5  
*Trichodinium* sp. MPK 1733. Sample 402A-20-4, 7-10 cm. Detached precingular operculum.

Figures 6-9  
*Surculosphaeridium trunculum* sp. nov.
6. MPK 1751. Sample 402A-30-6, 60-63 cm. Lateral view; arrow indicates two fine paracingular processes developed on one cingular paraplate.
7. Holotype. Lateral view; arrows indicate basal furcations in precingular processes (interference contrast).
8. MPK 1752. Sample 402A-30-6, 60-63 cm. Lateral view; arrow indicates two fine paracingular processes linked by a bar.

Figures 10, 13-15  
*Systematophora cretacea* sp. nov.
14. MPK 1684. Sample 400A-64-3, 52-55 cm. Detached operculum. Arrow indicates paraplate 2' which does not bear a process.
15. MPK 1691. Sample 400A-66-3, 55-60 cm. Detached operculum.

Figure 11  
*Subtilisphaera terrula* (Davey). MPK 1731. Sample 402A-19-4, 81-84 cm. Lateral view; arrow indicates archeopyle breakage high on the epicyst (phase contrast).

Figure 12  

Figures 16, 17  
*Scolecodonts*.
17. MPK 1685. Sample 400A-64-3, 52-55 cm.