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HOLMES, JOHN C. and GALTIER, JEAN:

MORPHOLOGY AND EVOLUTION OF *BOTRYOPTERIS*, A CARBONIFEROUS AGE FERN. PART III. *BOTRYOPTERIS DICHOTOMA*, A NEW WESTPHALIAN SPECIES FROM BELGIUM WITH OBSERVATIONS ON OTHER SPECIES. (PAGE 1—17. WITH 8 PLATES AND 6 FIGURES IN THE TEXT.)

DUXBURY, S.:

A STUDY OF DINOFLAGELLATE CYSTS AND ACRITARCHS FROM THE LOWER GREENSAND (APTIAN TO LOWER ALBIAN) OF THE ISLE OF WIGHT, SOUTHERN ENGLAND. (PAGE 18—80. WITH 10 PLATES AND 35 FIGURES IN THE TEXT AND ON 2 FOLDOUTS.)

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A STUDY OF DINOFLAGELLATE CYSTS AND ACRITARCHS FROM THE LOWER GREENSAND (APTIAN TO LOWER ALBIAN) OF THE ISLE OF WIGHT, SOUTHERN ENGLAND

BY

S. DUXBURY *)

With 10 plates and 35 figures in the text and on 2 foldouts

Abstract

Dinoflagellate cysts and acritarchs from the Aptian and Lower Albian of the Isle of Wight, England, have been studied. Three localities, Atherfield, Compton Bay and Redcliff have been sampled and the observed occurrences of 102 taxa are summarised in Text-Figs. 2, 3 and 4. One hundred taxa are photographically illustrated in the plates. Two genera, *Cepadinium* and *Desmocysta* are described as new, as are 20 species, *Aldorfia vectensis, Aptea plera, Australisphaera dolabella, A. vitrea, Cepadinium variabilis, Cribroperidinium conopium, Cyclonephelium inconspicuum, C. intonsum, Cyclopsiella mura, Desmocysta plekta, Florentinia abjuncta, Gonyaulacysta ?kleithria, Kiokansium prolatum, Muderongia ?digitata, M. pariata, Occisucysta ?echinata, Ovoidinium incomptum, O. incorporeum, Stephanelytron cretaceum* and *Stephodinium spinulosum*. Two new subspecies, *Oligosphaeridium perforatum* subsp. *colum* and *O. perforatum* subsp. *perforatum* are also described, 4 genera and 3 species are emended and 4 new combinations are effected.

Key words: Phytoplankton – Aptian, Lower Albian – Southern England.

Contents

I. Introduction

This work is the result of an investigation of dinoflagellate cysts and acritarchs recovered from 68 samples from three Lower Greensand sections on the Isle of Wight (Atherfield, Compton Bay and Redcliff). Although 68 samples are insufficient for a comprehensive study, the present work may be considered a pilot

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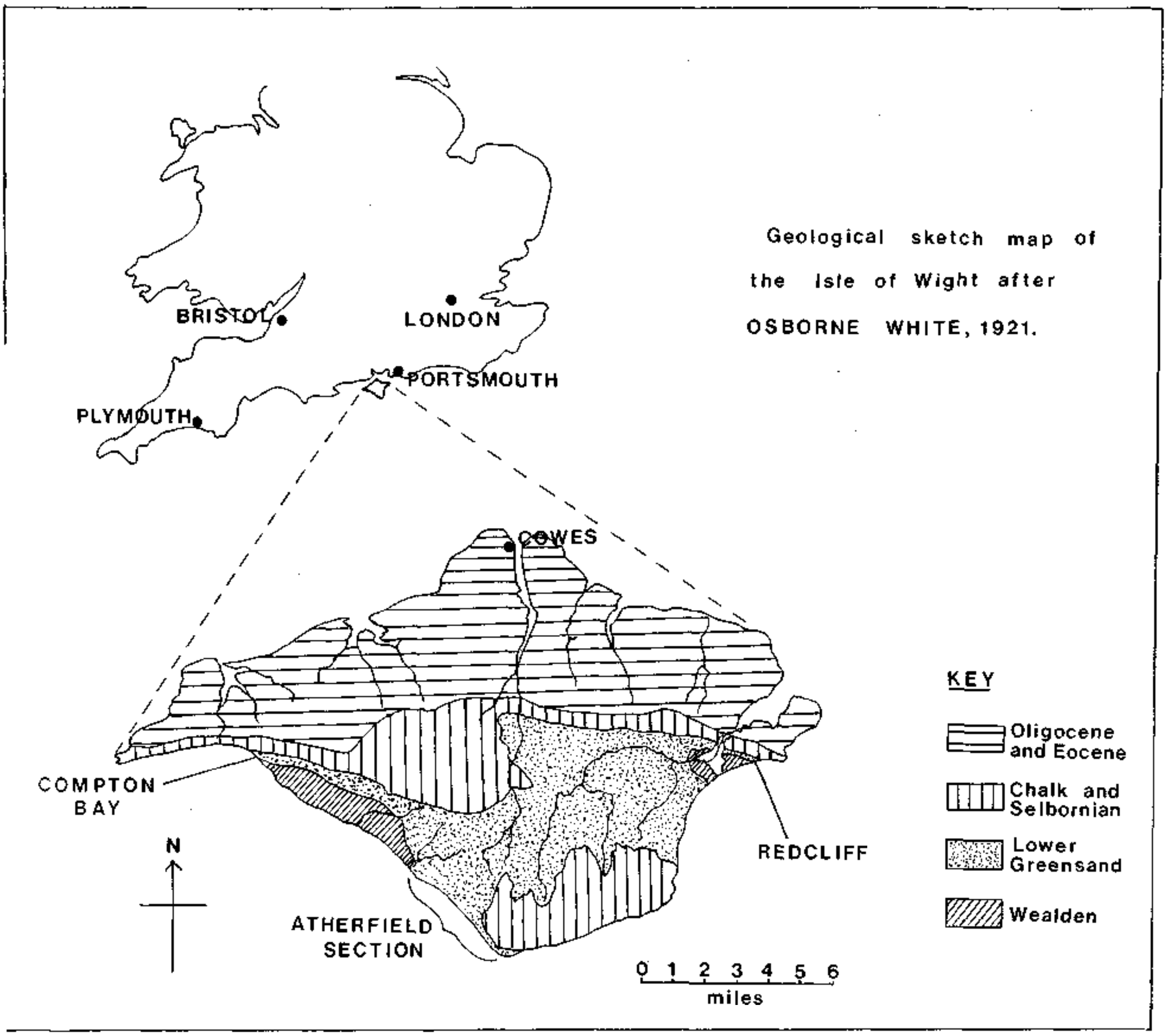
investigation to illustrate the richness and diversity of marine palynomorphs which may be recovered from the Lower Greensand. Also, several taxa are considered particularly useful in a palynostratigraphical sense and their ranges are illustrated in Text-Fig. 34.

The Lower Greensand of the Isle of Wight is a series of arenaceous deposits occuring between the Wealden Shales and the Gault. It is the most complete section of Aptian and Lower Albian strata in Britain and reaches a maximum thickness of approximately 800 feet in the Atherfield (Chale Bay) section (see Text-Fig. 2). The Lower Greensand/Wealden Shales contact is sharply defined and, as pointed out by Osborne White (1921) in his introduction to chapter 3 (Lower Greensand), "Evidence of erosion at the contact are to be seen here in the puckering and brecciation of the top of the Wealden Shales, and in the presence of rolled fossils, derived from Wealden and older strata, in a seam of grit at the base of the Lower Greensand." As pointed out by Casey (1961, p. 505), the obviously derived material is not confined to the basal Lower Greensand, but may be observed several feet higher. The Lower Greensand/Wealden Shales contact does not appear to represent any lengthy break of sedimentation or period of erosion. Casey (1961, p. 490) argues that ammonites recovered from a few inches



Text-Fig. 1. The location of the studied sections.

above the base of the Lower Greensand indicate a level just above the base of the Aptian and that the little evidence available from the topmost beds of the Wealden Shales indicates an Upper Barremian level. This supports ALLEN's (1955, p. 272) view that the top of the Wealden Beds is not much older than the Lower Greensand.

In her major paper describing Aptian and Albian miospores from Southern England, KEMP (1970) studied samples taken largely from the three sections studied here and the lithological columns included in Text-Figs. 2, 3 and 4 here are reproduced as closely as possible to Text-Figs. 2, 3 and 4 in KEMP, 1970 (pp. 76–78). This is done to aid comparisons of the spore and pollen ranges of KEMP and those of the dinoflagellate cysts and acritarchs of the present work. In her introduction, KEMP (1970, p. 74) stated, "The marine nature of the sediments has two consequences. Firstly, the presence of rich faunas of marine invertebrates provides a zonal framework to which the spore and pollen assemblages can be referred. Secondly, it results in the mixing of spore and pollen species from widely separated source areas." There is, however, a third consequence, which is that dinoflagellate cysts and acritarchs are present throughout the Lower Greensand, often very abundantly and usually very well-preserved. Of the 68 samples examined here, only 1 was completely devoid of marine palynomorphs and the others yielded over 100 such taxa. The observed ranges of 102 of these are illustrated in Text-Figs. 2, 3 and 4.

The three sections studied here, those of Atherfield (Chale Bay), Compton Bay and Redcliff, are separately discussed below.

The Atherfield (Chale Bay) Section

The Lower Greensand in Chale Bay is exposed between Atherfield Point and Rocken End, a total distance of about 3½ miles. By convention, the Chale Bay section is referred to simply as the Atherfield section and this designation is employed here (see Text-Fig. 1). The thickness of the Lower Greensand in the Atherfield section has been variously estimated with the estimates ranging from the 752 feet 11 inches of SIMMS, 1845 to the 833 feet of IBBETSON & FORBES, 1845. Whatever the true thickness is, it is certain that the Atherfield section represents the thickest recorded section of Lower Greensand deposits.

The Atherfield section was examined in great detail by FITTON between the years 1824 and 1847 and was described in a number of papers, of which the most important is FITTON, 1847. He divided the section into 6 major and 16 minor groups (A to F and I to XVI respectively, both in ascending order). These sub-divisions have been figured in several publications, notably OSBORNE WHITE, 1921 and CASEY, 1961. Unfortunately, FITTON's sub-divisions were largely inapplicable to the Isle of Wight sections and BRISTOW (1889) chose a 4-fold division into Atherfield Clay, Ferruginous Sands, Sandrock and Carstone as an easier scheme to use for the purpose of mapping by the Geological Survey. Both the 16-fold division of FITTON and the 4-fold division of BRISTOW are included in Text-Fig. 2 here. CASEY (1961, p. 504) proposed the inclusion of the whole of FITTON's group III in the Atherfield Clay Series, thus altering the scheme of BRISTOW so that the Atherfield Clay/Ferruginous Sands boundary is somewhat higher. This proposal is accepted here and Text-Fig. 2 is drawn accordingly.

The Atherfield section is important, not only in being the thickest Lower Greensand section recorded, but also in being the most productive of megafossils. As a consequence, CASEY (1961) was able to define the boundaries of ammonite Zones within the section and his designations are included in Text-Fig. 2. The boundary between the Zones of *Hypacanthoplites jacobi* and *Leymeriella tardefurcata* (the Aptian/Albian boundary) was not precisely indicated by CASEY and that author (1961, p. 512), in his comments on the Sandrock, simply stated, "This part of the succession must fall within the *jacobi* and *tardefurcata* Zones." As remarked in the Palynostratigraphical Comments section (below), the top of the Aptian here is taken at the highest occurrence of *Dingodinium albertii* SARJEANT, 1966b and, therefore, a tentative boundary between the *jacobi* and *tardefurcata* Zones is included in Text-Fig. 2.

Thirty-six samples were palynologically examined from the Atherfield section and each yielded rich dinoflagellate cyst and acritarch assemblages. It has been possible, largely due to the work of CASEY (1961) to plot the observed occurrences of these microfossils against an ammonite zonation (see Text-Fig. 2). The conclusions in the Palynostratigraphical Comments section (below) are based largely on this juxtaposition. Further, by comparing the occurrences of dinoflagellate cyst species in the Atherfield section with the occurrences of the same taxa in other sections, where megafossil evidence may be poor, some idea of the ammonite Zone equivalence may be gained. An example of this last possibility is summarised in the Palynostratigraphical Comments section (below) where the Compton Bay section is compared with those at Atherfield and Redcliff. In Compton Bay, ammonite evidence may not be directly used and CASEY (1961, p. 513) wrote that in Compton Bay, "Fossils are very scarce above the Perna Beds and the only ammonites that have been obtained from the main mass of the strata are insufficient to prove more than the presence of the *bowerbanki* and *martinioides* Zones".

The Compton Bay Section

The Lower Greensand at Compton Bay is much thinner than at Atherfield (approximately 400 feet as opposed to approximately 800 feet). Due to the change in character of the deposits and the scarcity of megafossils above the Perna Beds, the Compton Bay section has not been correlated with the Atherfield section with any degree of accuracy. As remarked above, a comparison of the Compton Bay and Atherfield sections is made in the Palynostratigraphical Comments section (below). The examination of only 36 samples from Atherfield and 22 from Compton Bay is obviously inadequate for any detailed correlations to be made. However, the potential of dinoflagellate cysts in particular as correlation tools in the two sections is indisputable.

The Redcliff Section

The whole Lower Greensand succession (approximately 600 feet thick) is exposed in the northern part of Sandown Bay, at Redcliff. The cliffs are, however, deeply weathered and above the Atherfield Clay, it is impossible to correlate the sequence with the detailed sub-divisions established at Atherfield. As remarked by OSBORNE WHITE (1921). "Remains of their indigenous fauna seem to have been entirely destroyed by the deep weathering to which the Ferruginous sands of Redcliff owe their ruddy tint". CASEY (1961, p. 513) argues that representatives of the Crackers and Lobster Beds may be present but this is suggested by museum material since such beds cannot be observed in the Redcliff section. Further, body chambers of *Dufrenoyia* as observed in the Lower Crioceras Bed at Atherfield have been observed among beach pebbles but again their source in the section is unknown.

Only 10 samples were examined from the Redcliff section here since, for this pilot study, it was felt unwise to sample the particularly arenaceous deposits which constitute by far the greater part of the section. Some comments on the dinoflagellate cyst and acritarch assemblages recovered are made, however, in the Palynostratigraphical Comments section (below).

Samples are designated here as AB1, AB2, etc., from the Atherfield section, CB17, CB18, etc., from the Compton Bay section and R1, R4, etc., from the Redcliff section. Such designation is in accordance with their reference numbers within the British Petroleum Company p.l.c., Stratigraphy Branch, Sunbury-on-Thames.

II. Acknowledgements

The author is indebted to J. E. WILLIAMS for his comments on the text and for his constructive criticisms. He is also indebted to the British Petroleum Company p.l.c. for permission to publish.

III. Systematic Descriptions

Dimensions referred to below in the form x(y)z refer to x, the greatest, z, the smallest and y, the average of all observed values for any single dimension.

For simplicity of terminology, species discussed here are subdivided simply into ceratiacean cysts, gonyaulacacean cysts, peridiniacean cysts and acritarchs.

Ceratiacean Cysts

Aptea EISENACK, 1958 emend. DAVEY & VERDIER, 1974

1958 *Aptea* EISENACK, p. 394.
1966b *Doidyx* SARJEANT, p. 205.
1974 *Aptea* EISENACK in DAVEY & VERDIER pp. 640, 641.

Remarks: One species of this genus, *Aptea plera* n. sp., has its surface ornament so arranged as to demonstrate clearly a paratabulation pattern of the formula 4', 6", 6c, 6"', 1p, 1"", la.s., 2s. This is a gonyaulacacean formula and its distribution is clearly equivalent to the ceratiacean pattern described in WALL & EVITT, 1975.

In their emended diagnosis of *Aptea*, DAVEY & VERDIER state (1974, pp. 640, 641), " . . . and a flat or indented (two horns) antapical region are never present". On page 642, in Text-Fig. 5 (VI), however, these authors illustrate a specimen referred to *A. polymorpha* (the type species) in which the antapical region is very clearly indented. In the present author's opinion, specimens referable to *A. polymorpha* may exhibit antapical regions ranging from convex to distinctly concave. Such variability is also demonstrated by *A. plera* n. sp. (see Text-Fig. 6).

A second emendation of *Aptea* was undertaken in DÖRHÖFER & DAVIES, 1980 in order to "circumscribe more closely the archeopyle". The archeopyle type quoted by DÖRHÖFER & DAVIES is (4A 2I) and this implies the presence of two intercalary paraplates, which would be inconsistent with a typically ceratiacean paratabulation scheme. Such a scheme was observed in *Aptea plera* n. sp. and this, combined with the unconvincing illustrations of *A. polymorpha* in DÖRHÖFER & DAVIES (1980, figs. 16, 37 A, 38 A–F, 39 A–F) leads the present author to doubt the presence of intercalary paraplates in *Aptea* and to reject this last emendation.

Aptea plera DUXBURY n. sp.

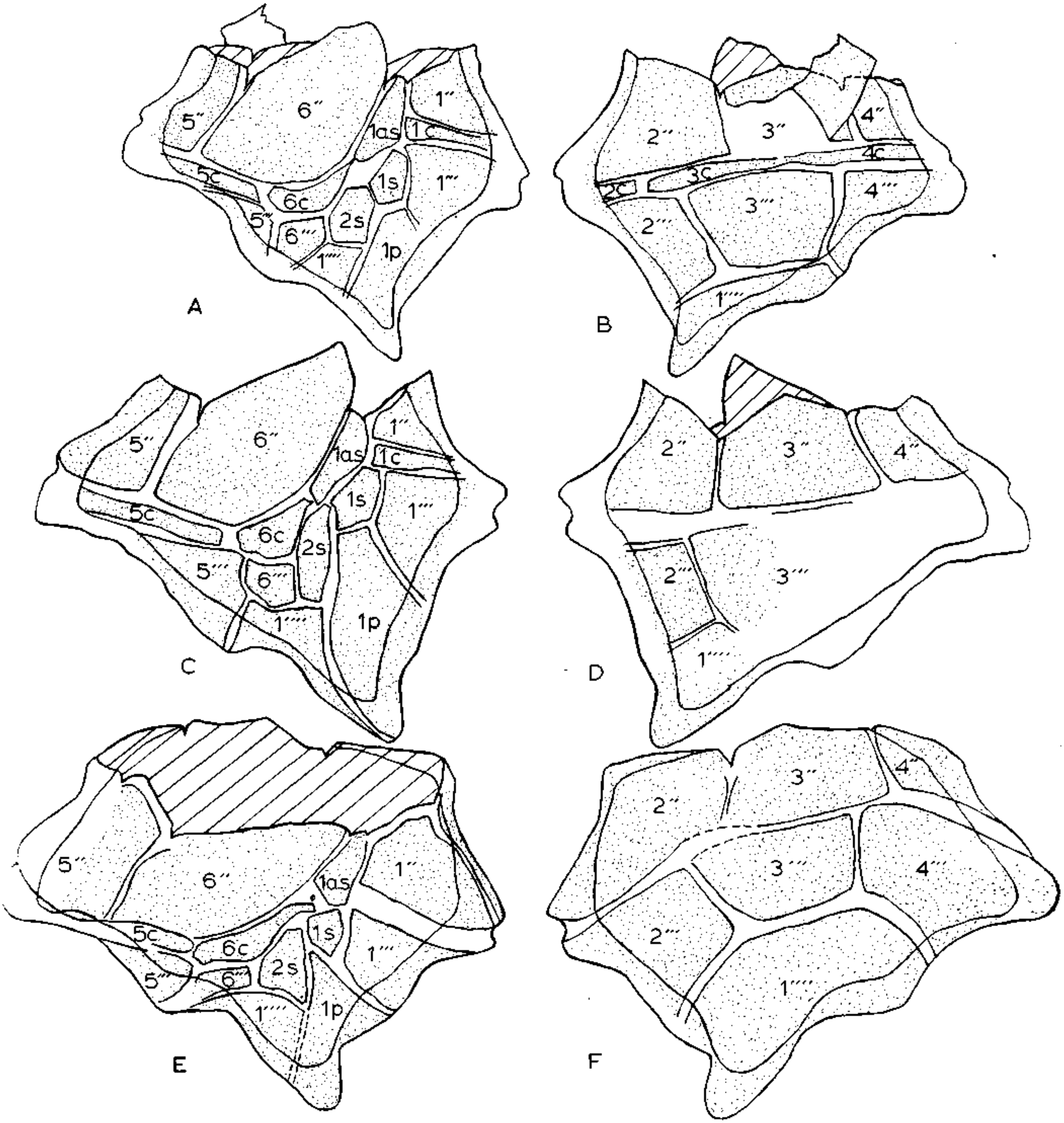
Pl. 1, figs. 7, 8, 11, pl. 10, fig. 3; Text-Figs. 5, 6

Derivation of Name: From the latin *plerus*, very many - in reference to the numerical abundance of this species.
Holotype: Pl. 1, fig. 7.
Type Locality: Sample AB29, Upper Lobster Beds, Atherfield Clay Series, Atherfield section, Isle of Wight.

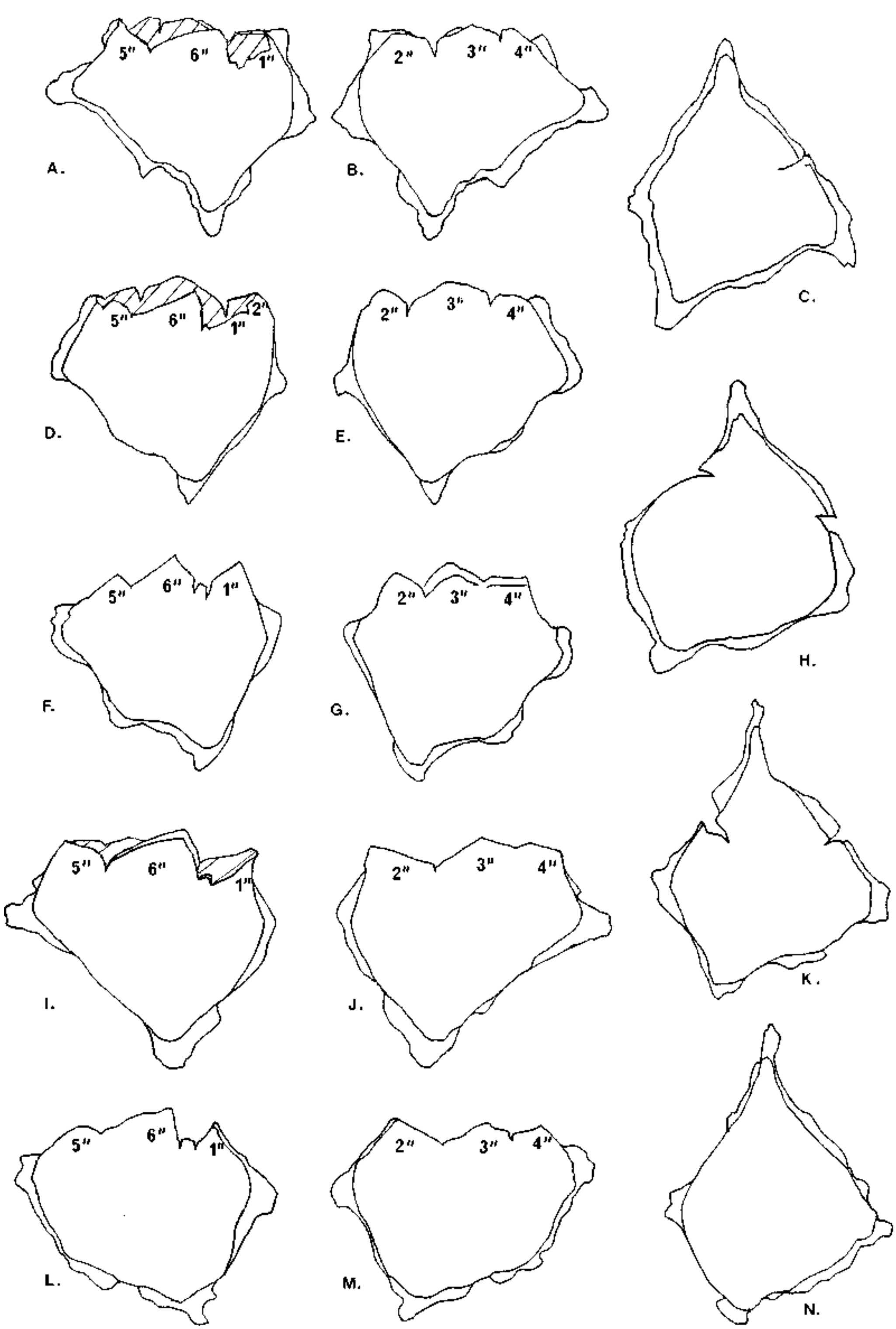
Diagnosis: A large, dorso-ventrally flattened cyst with well-developed right lateral and left antapical horns. Poorly developed left lateral and right antapical horns may be present and the antapex may vary from convex to concave. Short, solid, distally and proximally flaring rods cover paraplate areas and these are distally united by a fine reticulum. Parasutural areas are free of such ornament and a paratabulation pattern of the formula 4', 6", 6c, 6"', 1p, 1"", la.s., 2s may be inferred. The "parasulcal" notch is offset to the left and the archeopyle is apical, formed by detachment of the whole apical series.

Observed Dimensions: Holotype – 82 x 102 μm
Complete specimens – 131 (125) 113 x 116 (99) 90 μm
Specimens measured – 6
Operculum detached – 102 (84) 70 x 116 (96) 75 μm
Specimens measured – 30

Remarks: The presence of well-defined areas of ornament which express paratabulation in *A. plera* allows comparisons to be made between this species and other, similar genera and species, particularly with the ceratiacean types described in WALL & EVITT, 1975. In their excellent drawings of *Ceratium*, WALL & EVITT have illustrated a tabulation of the formula 4', 6", 5–6c, 6"', 1p, 1"", plus two or more sulcal platelets. The paratabulation pattern of *A. plera* is almost identical to this and its distribution is remarkably similar to that demonstrated for *Ceratium carolinianum* in WALL & EVITT, 1975. Their Text-Fig. 5 A and B is reproduced here (Text-Fig. 10) with the apical series deleted so that direct comparisons may be made between the morphology of *C. carolinianum* and that of *A. plera*. It is interesting to note that the sulcus in *C. carolinianum* occupies the comparative position of the two



Text-Fig. 5. Camera lucida drawings of three paratypes of *Aptea plera* **Duxbury** n. sp. A, C and E ventral surfaces, B, D and F dorsal surfaces. Ornament purely diagrammatic. All X890.



Text-Fig. 6. Form and variation in *Aptea plera* DUXBURY n. sp. Left-hand column ventral surfaces, central column dorsal surfaces of the same specimens. Right-hand column dorsal surfaces of complete specimens. All X450.

paraplates designated 1s and 2s in *A. plera*. Paraplate 1s is equivalent to that small paraplate frequently designated $1'''$ in gonyaulacacean paratabulation diagrams but its clear homology with part of the sulcus in *Ceratium* must dictate its being classed as a parasulcal paraplate. Similarly, 2s is probably equivalent to that paraplate frequently termed 1 p.v.

Davey & Verdier (1974, p. 641) have stressed the "typical and characteristic asymmetry" of *Aptea* which they consider distinguishes that genus from the similar genera *Cyclonephelium, Canningia* and *Tenua*. Such asymmetry has prompted the present author to include *Aptea plera* in that genus. However, that species termed *Canningia* cf. *reticulata* in Duxbury, 1977 has been re-examined by the author and, as well as possessing similar body ornament, distal reticular areas and ornament-free pandasutural regions to *A. plera*, it also has remarkably similar paratabulation and paraplate distribution. In fact, the only relevant difference between *A. plera* and *C.* cf. *reticulata* is the absence in the latter of the "typical and characteristic asymmetry" of *Aptea*, largely because of its lack of horns or possession of generally shorter horns (see remarks under *Cerbia* below). The presence or absence of the *Aptea* asymmetry may prove a difficult criterion to maintain at generic level.

Australisphaera Davey, 1978 emend. herein.

1978 *Australisphaera* Davey, p. 892.

Emended Diagnosis: Proximate, ceratiacean dinoflagellate cysts which are single-walled, dorso-ventrally flattened and have lateral and antapical features developed as unusually high ornament or low to high, hollow, distally closed horns. Overall, the ornament may be low, but spines may occur, usually concentrated at horn terminations, sometimes extending the horns considerably. Vague paratabulation may be indicated by ornament alignment. The archeopyle is apical with a zig-zag margin and the parasulcus is offset to the left of the mid-line.

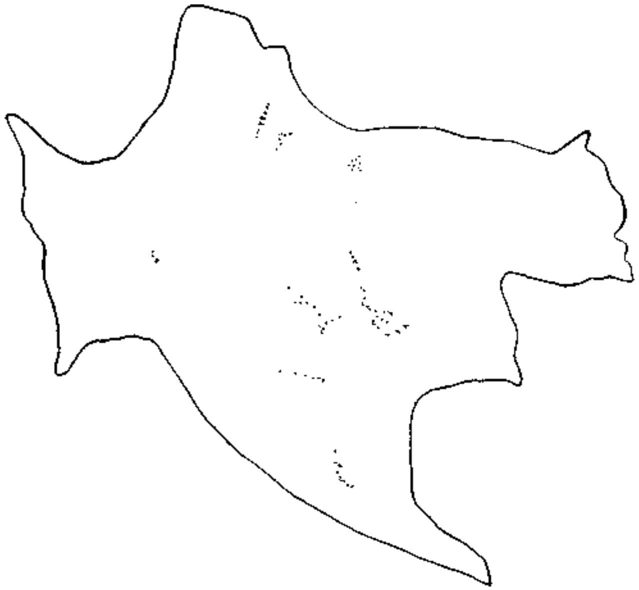
Remarks: The diagnosis of *Australisphaera* Davey, 1978 is here emended to include forms with spinose ornament (Davey's original diagnosis stated "the ornament is low and high spines or processes are absent") and to emphasise the single-layered nature of this genus. In their original diagnosis of *Muderongia*, Cookson & Eisenack (1958, p. 40) state that it is "composed of a thin outer membrane and an internal body or capsule" and this is considered most important in defining that genus. Typical *Muderongia* species exhibit a dorso-ventrally flattened cyst which is obviously two-layered. The inner body is ellipsoidal to ovoidal and may possess small apical, antapical and lateral bulges. The outer body is of a typically ceratiacean shape and is produced into a single apical, two lateral and one or two antapical horns. Both body layers are smooth and the outer may be perforate, particularly at the horn extremes. *Australisphaera*, on the other hand, includes single-layered, ceratiacean dinoflagellate cysts which demonstrate positive body ornament, particularly well-developed at the horn extremes and which have two lateral horns. The presence of positive body ornament on a single-walled ceratiacean cyst may imply that *Australisphaera* may be a *Muderongia*-shaped cyst of the *Aptea/Pseudoceratium* group.

Australisphaera dolabella Duxbury n. sp.

Pl. 3, fig. 11; Text-Fig. 7

Derviation of Name: From the Latin *dolabella*, a small axe or hatchet – in reference to the lateral horn morphology.
Holotype: Pl. 3, fig. 11; Text-Fig. 7.
Type locality: Sample CB17, Sandrock Series, Redcliff section, Isle of Wight.

Diagnosis: A very thin-walled species of *Australisphaera* having two lateral and two antapical horns. The lateral horns are short, broad and distally bear two short, digitate projections which are of approximately equal length. The distal termination of each lateral horn is characteristically hatchet-shaped. The antapical horns comprise one which is long and curved and one which is short and digitate. The body surface has isolated, usually linear, granular areas and the archeopyle is apical.



Text-Fig. 7. Camera lucida drawing of *Australisphaera dolabella* DUXBURY n. sp., holotype. X1250.

Observed Dimensions: Holotype – 70 x 70 µm.

Complete specimens	– 84 (78) 75 x 73 (64) 58 µm
Specimens measured	– 8
Operculum detached	– 67 (61) 52 x 81 (73) 61 µm
Specimens measured	– 9

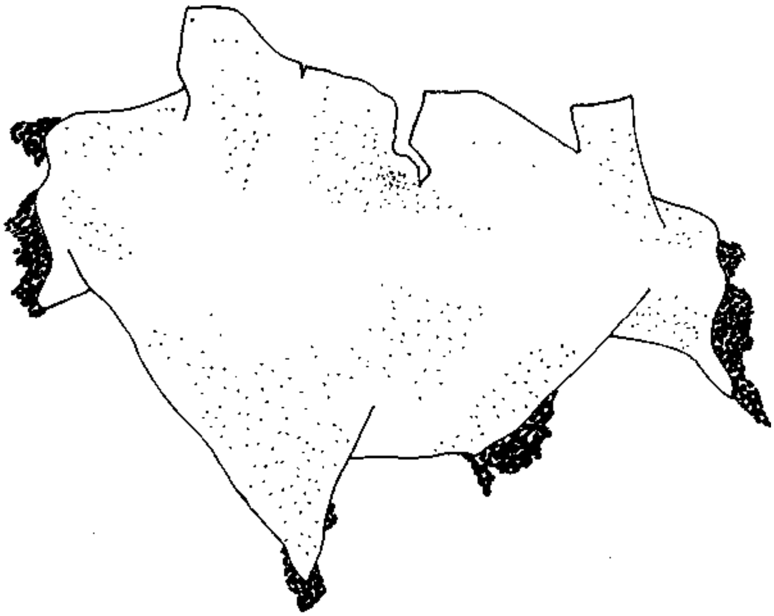
Remarks: This is a most distinctive species, particularly in the nature of the lateral horns and in having a very thin cyst wall. The most comparable species is *Muderongia? digitata* DUXBURY n. sp., particularly in the presence of digitate extensions to the lateral horns. Both *A. dolabella* and *M? digitata* are, however, very thin-walled and the possible second body layer remarked in the latter (see below) may be due to folding of a single layer. However, until better specimens of *M? digitata* are observed to establish the number of body layers present, that species must tentatively remain in *Muderongia*.

Australisphaera vitrea DUXBURY n. sp.

Pl. 2, fig. 11, pl. 3, fig. 5; Text-Fig. 8

Derivation of Name: From the Latin *vitreus*, glassy – in reference to the cyst wall texture.
Holotype: Pl. 2, fig. 11; Text-Fig. 8.
Type Locality: Sample AB30, Lower Gryphaea Group, Ferruginous Sands Series, Atherfield section, Isle of Wight.

Diagnosis: A fairly thick-walled dinoflagellate cyst species bearing two lateral horns and one or two antapical horns. The lateral horns are short and broad and display a paracingular notch at their distal extremes. Short, posteriorly-directed, digitate projections extend from below the lateral post-paracingular margins and these are hollow and taper to sharp points. One large, conical, left antapical horn is always present and a right antapical horn is sometimes indicated by a very low protuberance. The single body layer is glassy in appearance and is covered by granular ornament which is particularly concentrated at the extremes of the horns. In the case of the antapical horns, coarse ornament is present in the position of the right antapical, whether the wall protrudes at that point or not. The archeopyle is apical.



Text-Fig. 8. Camera lucida drawing of *Australisphaera vitrea* DUXBURY n. sp., holotype. X1250.

Observed Dimensions: Holotype - 67 x 90 µm

Operculum detached - 75 (64) 55 x 90 (70) 58 µm
Specimens measured - 16

Remarks: The fairly thick, vitreous nature of the wall and the distinctive granular ornament renders *A. vitrea* an easily recogniseable species. Although *Australisphaera verrucosa*, the type species, bears low, positive ornament which may include large tubercules restricted to the lateral and antapical regions, the granular body ornament of *A. vitrea* is more irregularly distributed and attains considerable height at the distal extremes of the horns. Also, the lateral horns of *A. verrucosa*, when formed, are distally blunt and lack the characteristic hollow, sharply tapering, posteriorly-directed projections so characteristic of *A. vitrea.*

Other Species

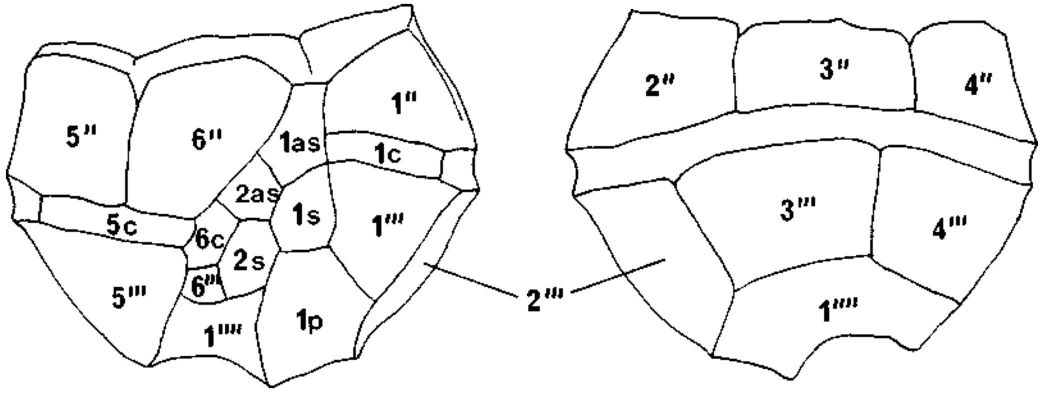
Australisphaera pannosa (DUXBURY, 1980) n. comb. = *Muderongia pannosa* DUXBURY, 1980, p. 129, pl. 10, figs. 3, 6; Text-Fig. 12.

Cerbia BELOW, 1981

1981 *Cerbia* BELOW, p. 8.

Remarks: The most comparable species to *Cerbia tabulata* (DAVEY & VERDIER, 1974) BELOW, 1981, the type species, are *Cyclonephelium distinctum* DEFLANDRE & COOKSON, 1955 and *Canninginopsis denticulata* COOKSON & EISENACK, 1962. The former possesses similar spines but these tend to be concentrated around the periphery of the cyst, which is aparatabulate other than around the archeopyle margin. *C. denticulata,* however, is paratabulate and may be closely compared with *C. tabulata.* It is the close similarity of *C. denticulata* to *C. tabulata* which suggests a ceratiacean nature for the latter and the reasons for this are discussed below.

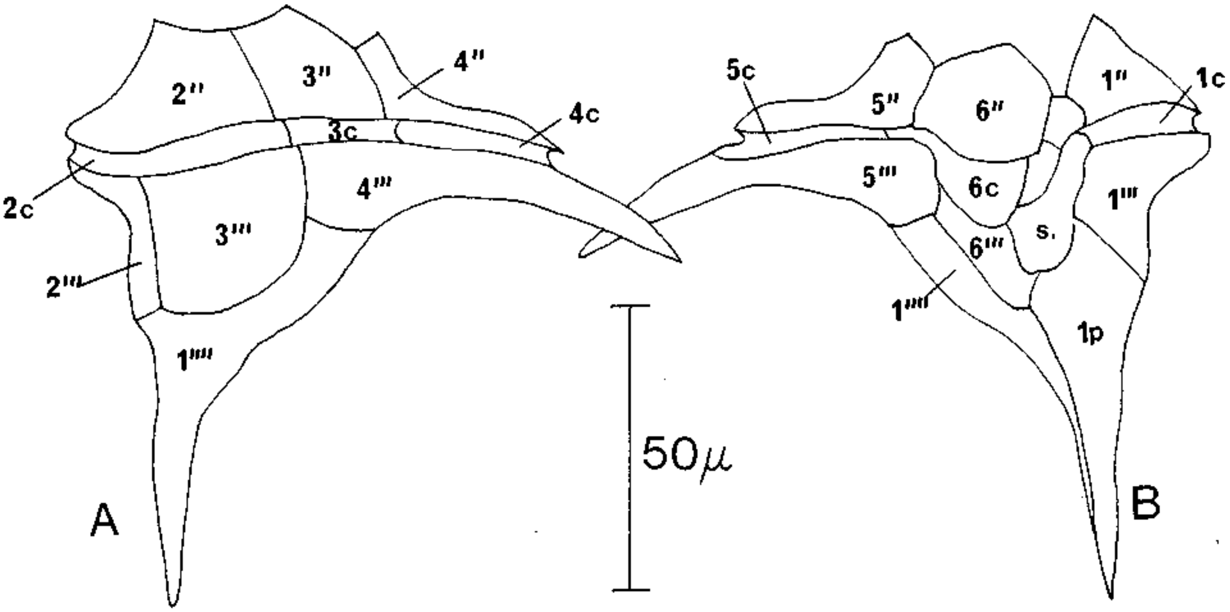
WALL & EVITT (1975, pp. 35, 36) discussed the paratabulation of *Canninginopsis denticulata* COOKSON & EISENACK, 1962, the type species of that genus. They concluded that although the epicystal paraplate arrangement is almost identical to the epitractal arrangement in *Ceratium*, there are "several critical differences between the



Text-Fig. 9. A re-interpretation of the paratabulation in *Canninginopsis denticulata* Cookson & Eisenack, 1962 (after Cookson & Eisenack, 1962, Text-Figure 2).

organisation of the hypotract in *Canninginopsis denticulata* and the hypotheca of *Ceratium*." In fact, two main differences were noted.

The first "critical difference" cited by Wall & Evitt is that, "the right horn in *C. denticulata* is formed by plate areas 6‴ and 1⁗ with some participation by the posterior sulcal-platelet area, and this contrasts with the situation in *Ceratium*, where the right horn is strictly postcingular and comprises plates 4‴ and 5‴ ". Examination of the paratabulation pattern and reconstruction of the theca of *C. denticulata*, both illustrated in Wall & Evitt (1975, Text-Fig. 11), clearly indicate some misinterpretation on the part of those authors. That horn in *C. denticulata* which Wall & Evitt compare with the right lateral horn of *Ceratium* is clearly antapical. A similar horn, similary constructed, may be seen in *Aptea plera* Duxbury n. sp. (Text-Figs. 5 and 6). In *A. plera*, a true right lateral horn is also present so that the antapical nature of the other right horn is readily apparent.



Text-Fig. 10. *Ceratium carolinianum*, after Wall & Evitt, 1975 (Text-Figure 5). The apical plates have been deleted.

The second "critical difference" between *Canninginopsis denticulata* and *Ceratium* according to Wall & Evitt involves the paraplate distribution. They state (p. 36), "the dorsal surface of *C. denticulata* shows plates 3''', 4''' and 5'''; *Ceratium* shows plates 2''', 3''' and 4'''. The ventral surface of *C. denticulata* shows plates 1''', 2''', 1p and 6'''; the equivalent surface in *Ceratium* has plates 1''', 1p, 5''' and 6'''." This statement implies that each plate or paraplate described for a species is directly homologous to the similarly numbered plate or paraplate with which it is being compared (i.e. plate 1''' of *Ceratium* in Wall & Evitt, 1975 is directly equivalent to paraplate 1''' of *Canninginopsis denticulata* in Cookson & Eisenack, 1962). Unfortunately, this is not always the case and, in the author's opinion, the equivalent in *Ceratium* of paraplate 1''' in *C. denticulata* as illustrated in Cookson & Eisenack, 1962 is involved in the sulcus (see Wall & Evitt, 1975, Text-Fig. 5). The consequence of this is that plate 1''' in *Ceratium* is equivalent to paraplate 2''' in Cookson & Eisenack's interpretation of *C. denticulata* (see remarks under *Aptea plera* Duxbury n. sp.) and that each postcingular paraplate in *C. denticulata* must be re-designated before meaningful comparisons may be made with *Ceratium*. A re-appraisal of the paratabulation scheme in Cookson & Eisenack's original diagram of *C. denticulata* is included here (Text-Fig. 9) in the light of Wall & Evitt's scheme for *Ceratium*. It may be observed that the organisation of *Ceratium* and of *C. denticulata* is virtually identical.

It is therefore apparent that there are no "critical differences" between *Ceratium* and *Canninginopsis denticulata* and, by implication, between *Ceratium* and the *Areoligera – Cyclonephelium* complex (see Wall & Evitt, 1975, pp. 34, 35). The only notable difference is the presence in *Ceratium* (and the absence in the *Areoligera – Cyclonephelium* complex) of distinct apical, lateral (or post-cingular) and antapical horns. In the remarks under *Aptea plera* Duxbury n. sp., some discussion is given to the importance or otherwise of "typical and characteristic asymmetry" in *Aptea* Eisenack, 1958 emend. Davey & Verdier, 1974. The same remarks may apply to the importance or otherwise of distinct horns in ceratiacean genera. Alternatively, it may be the case that the obviously single-layered cysts of some of the *Areoligera-Cyclonephelium* complex (particularly the very simple forms *Cyclonephelium distinctum, Cerbia tabulata,* etc.) are equivalent to the inner bodies of such genera as *Endoceratium, Muderongia, Phoberocysta,* etc., and as such would not necessarily have pronounced horns.

The remarks concerning *C. denticulata* (above) may equally well be applied to *C. tabulata* and would confirm the ceratiacian nature of the latter.

Cerbia tabulata (Davey & Verdier, 1974) Below, 1981

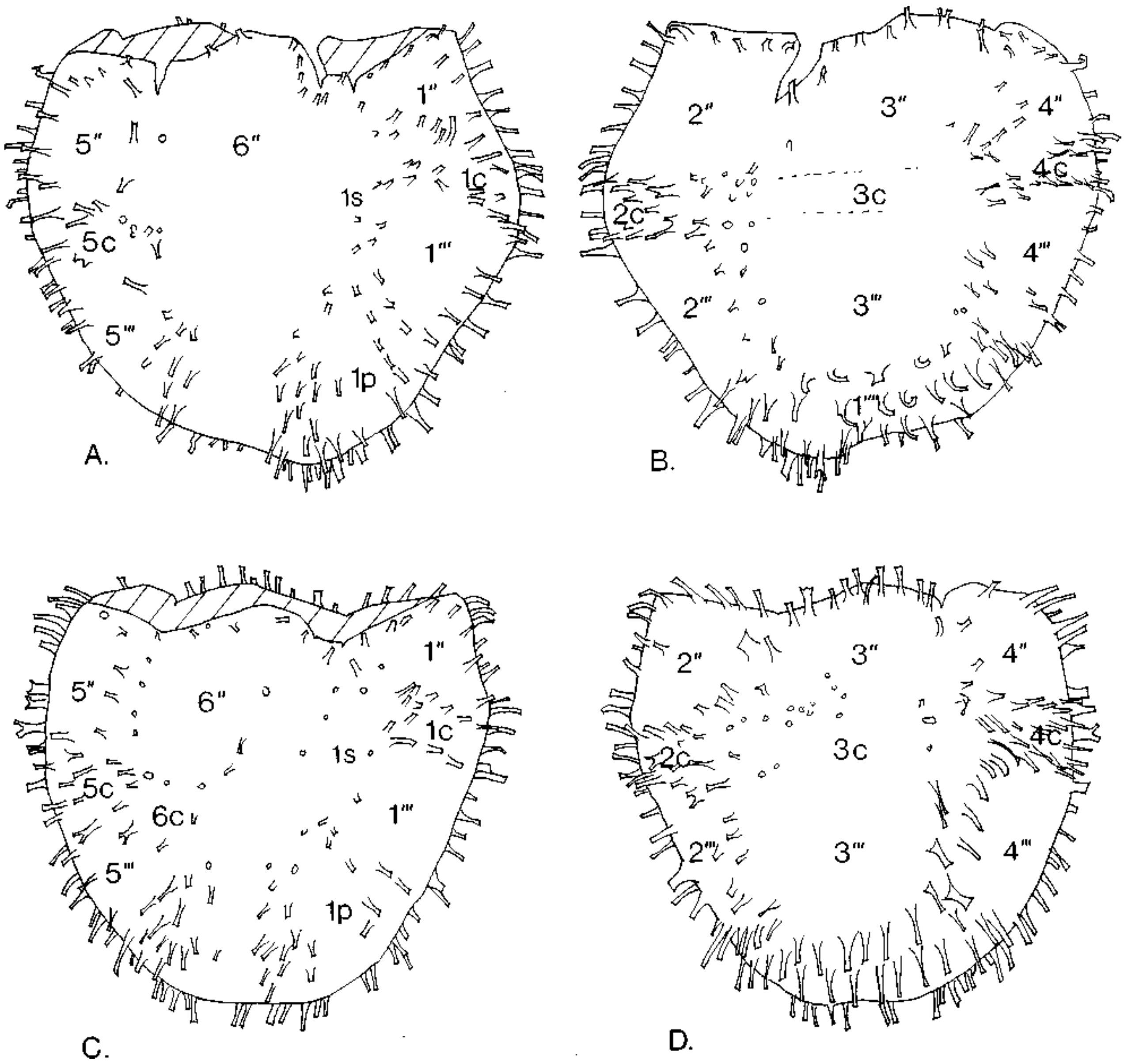
Pl. 1, figs. 6, 9, 12; Text-Figs. 11, 12

1974 *Cyclonephelium tabulatum* Davey & Verdier, p. 630, pl. 92, figs. 1–4, pl. 93, fig. 6.
1977 *Canninginopsis ?tabulata* (Davey & Verdier) Duxbury, p. 27, pl. 8, figs. 3, 4, Text-Fig. 5.
1981 *Cerbia tabulata* (Davey & Verdier) Below, p. 9, pl. 4, figs. 1, 2, pl. 11, fig. 20, pl. 12, figs. 17–19, Text-Figs. 5, 6.

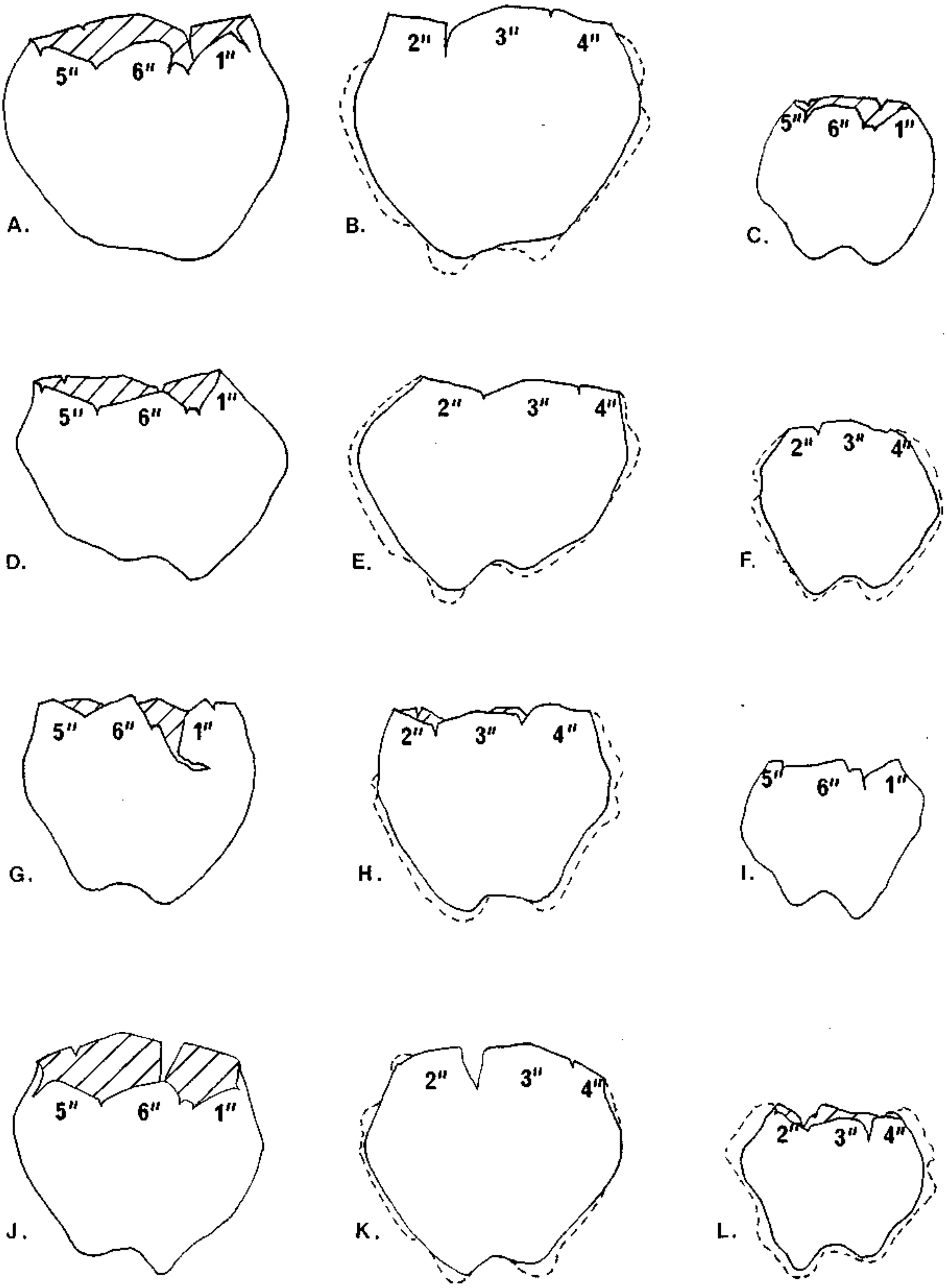
Remarks: Numerous specimens of this species were observed during the present work and these show some morphological variation. In general, the smaller the specimen, the more pronounced is the antapical concavity and the parasulcal depression (see Text-Fig. 12). Conversely, the larger the specimen, the more rounded the ambitus and the more pronounced is the dorso-ventral flattening.

G. L. Williams (pers. comm.) has pointed out the similarity between *Cerbia tabulata* and *Canningia attadalica* (Cookson & Eisenack, 1962) Stover & Evitt, 1978. *C. attadalica* (as *Cyclonephelium ?attadalicum*) was originally described as having "two rows of appendages that appear to delimit a girdle-like zone". Also, "on the opposite surface a slight deepening runs from the limits of the girdle zone to the antapex." Clearly, then, *C. attadalicum* goes some way towards having a system of reflected tabulation, as is demonstrated by *C. tabulata*. However, in the present author's opinion, the presence of a clear paratabulation pattern in *C. tabulata* (see Duxbury, 1977, Text-Fig. 5, Text-Fig. 11 herein and Below, 1981, Text-Fig. 5) must set in apart from the largely aparatabular *C. attadalicum*.

The tentative transfer of *tabulata* into *Canninginopsis* in Duxbury, 1977, was prompted by the presence of clearly defined paratabulation with a distribution very similar to that in *Canninginopsis denticulata*, the type species. This paratabulation is defined by double rows of spines in *C. tabulata* and in *C. denticulata*, by implication in the original description (COOKSON & EISENACK, 1962, p. 488), it is defined by single rows of "small tooth-like projections". This apparent discrepancy between double rows in *C. tabulata* and single rows in *C. denticulata* caused the present author to only tentatively transfer *tabulata* into *Canninginopsis* in 1977 (denoted by the question mark). If it were to be shown, however, that *C. denticulata* has paratabulation marked by double rows of spines then it would be possible to positively assign *tabulata* to *Canninginopsis*. Examination of COOKSON & EISENACK's photographic illustrations (1962, pl. 1, figs. 16–18) provides some evidence that this may, indeed, be the case. The holotype (pl. 1, fig. 16) appears to display at least one double row on the operculum and, in fact, both zig-zag margins bear single rows of spines upon opercular detachment. Further, some poorly preserved specimens examined by the present author from Papua, New Guinea sometimes show splits between precingular



Text-Fig. 11. Camera lucida drawings of two specimens of *Cerbia tabulata* (DAVEY & VERDIER, 1974) BELOW, 1981. A and C ventral surfaces, B and D dorsal surfaces. All X1000.



Text-Fig. 12. Form and variation in *Cerbia tabulata* (Davey & Verdier, 1974) Below, 1981. Left-hand column, C and I ventral surfaces, central column, F and L dorsal surfaces. Dotted lines define lateral extent of spine cover. All X520.

Observed Dimensions: Holotype – 58 x 64 μm

Complete specimens – 75 (70) 64 x 73 (67) 64 μm
Specimens measured – 3
Operculum detached – 61 (58) 49 x 73 (67) 58 μm
Specimens measured – 7

Remarks: The species most comparable with *C. inconspicuum* are *C. vannophorum* Davey, 1969 and *C. intonsum* Duxbury n. sp. *C. inconspicuum* differs from *C. vannophorum* in possessing a punctate/microreticulate layer which is separated from the cyst by very short rods, as opposed to the very irregular, spinose ornament of *C. vannophorum* which is variously connected along its length.

The body ornament of *C. intonsum* is very low but is nevertheless distally free. Whatever microreticulation may be observed is produced by lateral fusion of individual elements rather than distal fusion. Further, the ornament of *C. intonsum* is almost exclusively confined to the ventral surface whereas that of *C. inconspicuum* is on both surfaces, particularly the dorsal.

Cyclonephelium intonsum Duxbury n. sp.

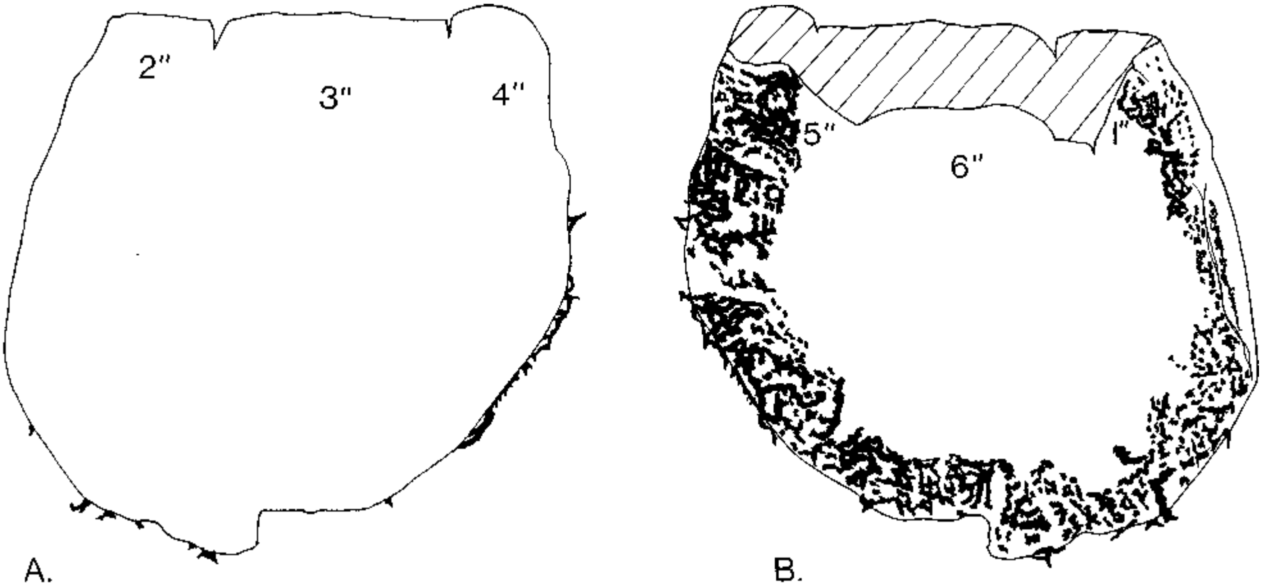
Pl. 2, fig. 7, pl. 10, fig. 12; Text-Figs. 13, 14

Derivation of Name: From the Latin *intonsus*, unshaved, bearded – in reference to the low, irregular ornament around the ventral periphery.

Holotype: Pl. 2, fig. 7, Text-Figs. 13, 14A.

Type Locality: Sample AB8, Sandrock Series, Atherfield section, Isle of Wight.

Diagnosis: A species of *Cyclonephelium* whose outline is roughly circular. It has a low, distally rounded and closed apical horn and a left antapical prominence may be present. A dense, low ornament covers the ventral periphery and takes the form of irregular granules or short coni which may coalesce laterally to produce a crude



Text-Fig. 13. Camera lucida drawings of *Cyclonephelium intonsum* Duxbury n. sp., holotype. X1000.

microreticulum. Some interruption of ornament may be observed laterally in a position corresponding to the paracingulum. The archeopyle is apical with the operculum usually completely detached. Paratabulation is lacking, but parasutural splits around the archeopyle margin indicate the presence of six precingular paraplates. The parasulcus is offset to the left.

Observed Dimensions: Holotype – 75 x 81 μm

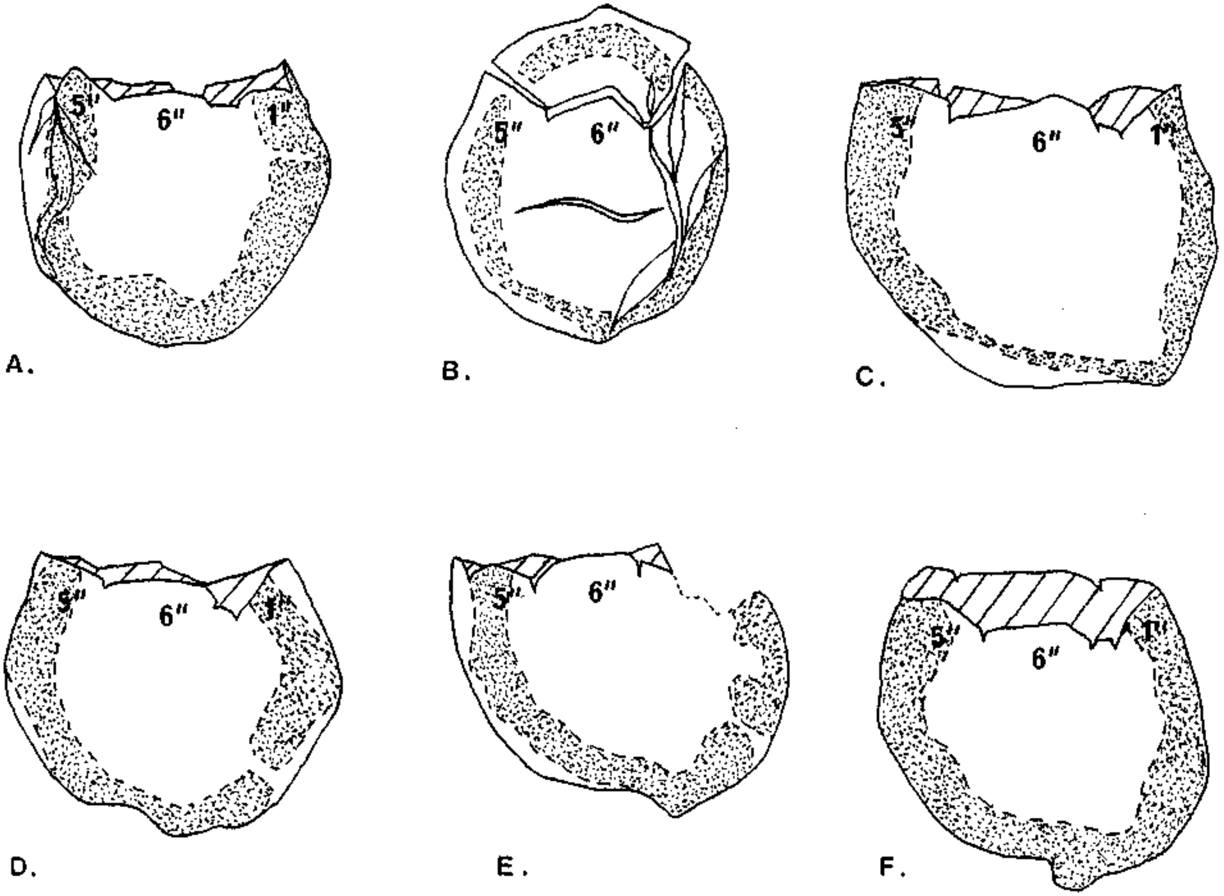
Complete specimens – 84 (81) 78 x 75 (73) 70 μm
Specimens measured – 2
Operculum detached – 87 (70) 58 x 87 (75) 61 μm
Specimens measured – 29

Remarks: This species differs from all others of the genus in the nature and distribution of the peripheral ornament.

Cyclonephelium vannophorum Davey, 1969

Pl. 3, fig. 16

1969 *Cyclonephelium vannophorum* Davey, p. 168, pl. 9, fig. 3, pl. 11, figs. 11, 12, Text-Fig. 16E.



Text-Fig. 14. Form and variation in *Cyclonephelium intonsum* Duxbury n. sp. Ventral surfaces. Ornament purely diagrammatic. All X750.

Remarks: Davey (1969, pp. 168 and 170) suggests that *C. vannophorum* may have been reworked into his sample CB 3 (Lower Cenomanian). His reasons are that he observed this species only in CB 3 (an unusual distribution) and that, in his opinion, the similarity of *C. vannophorum* to a Lower Cretaceous form, *?C. attadalicum* Cookson & Eisenack, 1962 may be significant. In the present work, *C. vannophorum* was observed only in the lower part of the studied section, being probably restricted to the Atherfield Clay (no younger than *Deshayesites forbesi* Zone). This would appear to support Davey's suggestion of it having been reworked into the Lower Cenomanian. It is, however, possible that it's presence in Davey's CB 3 is indigenous since it is not rare (it comprises 2% of the microplankton content of that sample) and since it has been recorded in Late Cretaceous material by several authors (e.g. Cenomanian and ?Early Turonian in Norvick & Burger, 1976, and as young as Coniacian in Williams, 1975).

Muderongia Cookson & Eisenack, 1958

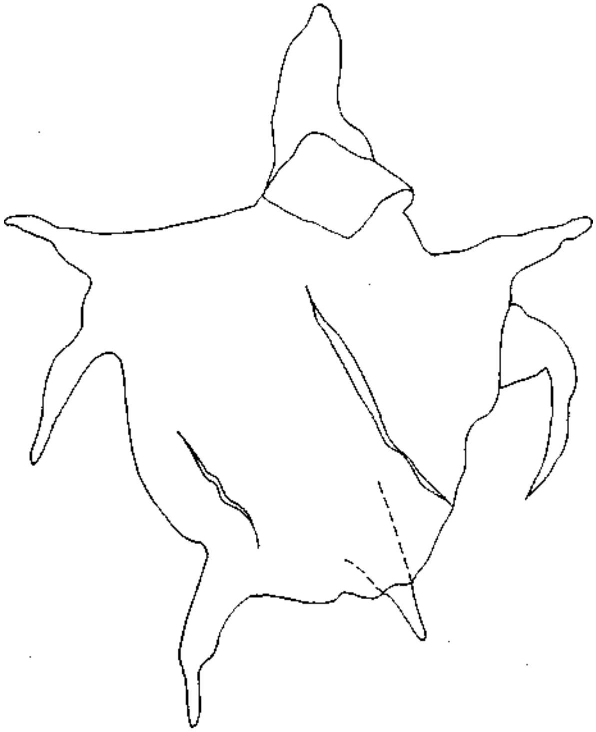
1958 *Muderongia* Cookson & Eisenack, p. 40

Remarks: In his remarks under *Muderongia imparilis*, Duxbury (1980, pp. 128, 129) stated that *Muderongia simplex* is the type species. This is of course erroneous since the type species is *Muderongia mcwhaei* Cookson & Eisenack, 1958.

Muderongia ? digitata Duxbury n. sp.

Pl. 3, fig. 15; Text-Fig. 15

Derivation of Name: From the Latin *digitatus*, having fingers – in reference to the distinctive lateral horns.
Holotype: Pl. 3, fig. 15; Text-Fig. 15
Type Locality: Sample AB 11, Ferruginous Sands Series, Atherfield section, Isle of Wight.



Text-Fig. 15. Camera lucida drawing of *Muderongia ?digitata* Duxbury n. sp., holotype. X1200.

Diagnosis: A very thin-walled, proximate dinoflagellate cyst species which is roughly pentagonal in outline and which bears a total of seven digitate projections representing five horns. There is a single apical horn, which is the broadest of all, two antapical horns, which are narrow and of approximately equal length and two lateral horns composed of two pairs of long, narrow, digitate projections with the paracingulum running between each pair. The lateral horns are similar in length to those at the antapex and the posterior element of each pair is usually slightly the longer. The archeopyle is apical with the operculum usually remaining attached.

Observed Dimensions: Holotype – 87 x 67 µm

Complete specimens – 102 (93) 87 x 90 (81) 67 µm
Specimens measured – 7

Remarks: This species is only tentatively assigned to *Muderongia*. The presence of digitate lateral horns, one digitation being present on either side of the parcingulum, is a feature atypical of *Muderongia*. Further, the very thin-walled nature of this species makes it difficult to discern whether one or two walls are present and, therefore, to positively assign it to either *Muderongia* or *Australisphaera* DAVEY, 1978. Occasionally, some indication of an inner body is observed, but this may be due simply to folding of the very thin cyst.

Muderongia pariata DUXBURY n. sp.

Pl. 2, figs. 5, 8; Text-Fig. 16

1974 *Muderongia* cf. *staurota* SARJEANT, 1966 in DAVEY & VERDIER, p. 644, pl. 91, figs. 4, 8.
1981 *Muderongia perforata* ALBERTI, 1961 in BELOW, p. 16, pl. 2, fig. 7, Text-Fig. 11.

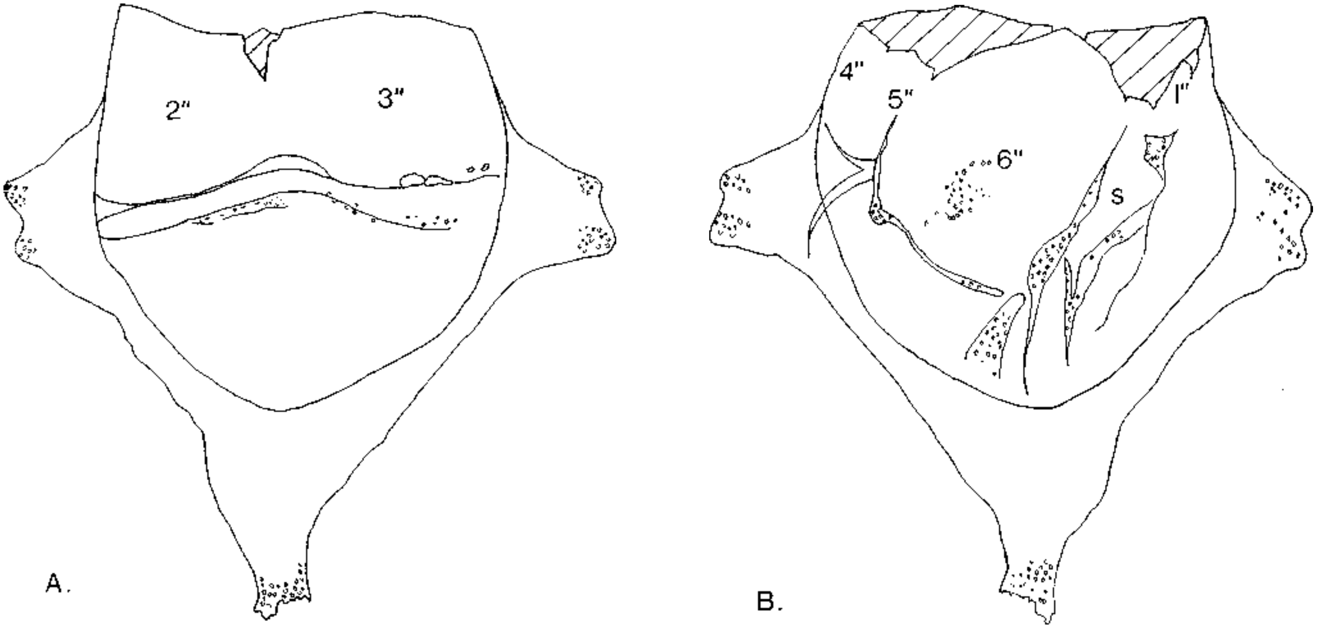
Derivation of Name: From the Latin *pariatus*, made equal, balanced - in reference to the symmetrical outline of this species.
Holotype: Pl. 2, figs. 5, 8; Text-Fig. 16.
Type Locality: Sample AB 33, Scaphites Beds, Ferruginous Sands Series, Atherfield section, Isle of Wight.

Diagnosis: A thin-walled, obviously cavate *Muderongia* with a smooth endophragm and a generally smooth to finely perforate periphragm. The periphragm forms one apical, two lateral and one centrally positioned antapical horn. The apical and antapical horns are distally open and are of similar length, as are the laterals, which are short, distally blunt and notched. The cyst is dorso-ventrally flattened and the body layers are in contact over much of the dorsal and ventral surfaces, but are noticeably separate around much of the periphery. Distinctly perforate areas may be observed at the horn tips and in the mid-dorsal and mid-ventral areas. The archeopyle is apical, formed by detachment of the entire apical series. Paratabulation is absent except where expressed by the archeopyle margin, by linear, finely perforate areas on the ventral surface and by the paracingulum.

Observed Dimensions: Holotype – 81 x 81 µm

Complete specimens – 136 x 73 µm
Specimens measured – 1
Operculum detached – 107 (90) 73 x 110 (84) 64 µm
Specimens measured – 17

Remarks: BELOW (1981) described this species as *Muderongia perforata* ALBERTI, 1961, but he noted that it differs from that species as described in ALBERTI, 1961 in having only a single antapical horn. The distinctly cavate hypocyst terminating in a single, broad-based, antapical horn distinguishes this species from all but two others, *Muderongia staurota* SARJEANT, 1966b and *M. imparilis* DUXBURY, 1980. *M. pariata* most resembles *M. staurota* in its overall shape and in the relative disposition of the body layers, but it differs in the character of the lateral horns. In *M. staurota*, the lateral horns are usually of unequal length with the right lateral usually distinctly longer than the left. Also, the distal portions of these horns are backwardly-tapering at approximately one-third



Text-Fig. 16. Camera lucida drawings of *Muderongia pariata* DUXBURY n. sp., holotype. A dorsal and B ventral surfaces. X1050.

their length and no notching is observed. The lateral horns of *M. pariata* are short, distally blunt and notched. In his diagnosis of *M. staurota*, SARJEANT (1966b, p. 203) stated, "shell showing neither trace of tabulation nor of cingulum or sulcus". *M. pariata*, however, often displays some indication of the paracingulum, particularly on the dorsal surface, and may exhibit hints of paratabulation on the ventral surface, marked by linear, finely perforate areas. *M. pariata* also differs from *M. staurota* in having a distally open antapical horn as opposed to the sharply tapering, distally closed horn of the latter.

Muderongia imparilis, as was discussed in DUXBURY, 1980 (p. 128), appears to be morphologically intermediate between *Muderongia* and *Odontochitina* DEFLANDRE, 1935 emend. DAVEY, 1970. As such, its length to breadth ratio is considerably greater than that of *M. pariata*. Also, the lateral horns are very unequal with the left being blunt and unnotched whilst the right is considerably longer and tapers to a point.

Pseudoceratium GOCHT, 1957 emend. DÖRHÖFER & DAVIES, 1980

1957 *Pseudoceratium* GOCHT, p. 166.
1980 *Pseudoceratium* GOCHT in DÖRHÖFER & DAVIES, p. 39.

Remarks: The emended diagnosis for *Pseudoceratium* proposed by DÖRHÖFER & DAVIES (1980, p. 39) is accepted here with certain reservations. They state, "tabulation traces occasionally apparent", and they propose the paratabulation formula 4', 2a, 6", 5–6c, 6"', 1"", ?3–6s. This seems over precise considering the statement quoted above.

The presence of two anterior intercalary paraplates in *Pseudoceratium* is felt by the present author to be most unlikely. As may be remarked from Text-Fig. 17 herein, the certiacean nature of *Pseudoceratium pelliferum*, the type species, is indisputable since its paratabulation scheme closely matches the scheme proposed for *Ceratium* in WALL & EVITT, 1975. *Ceratium* possesses no anterior intercalary plates and it would seem probable that *Pseudoceratium*, similarly, should possess no anterior intercalary paraplates. However, no specimens of *P. pelliferum* were observed here which displayed the epicystal paratabulation adequately for detailed analysis to be undertaken and the precise nature of the epicystal arrangement in *P. pelliferum* must, therefore, remain open to speculation.

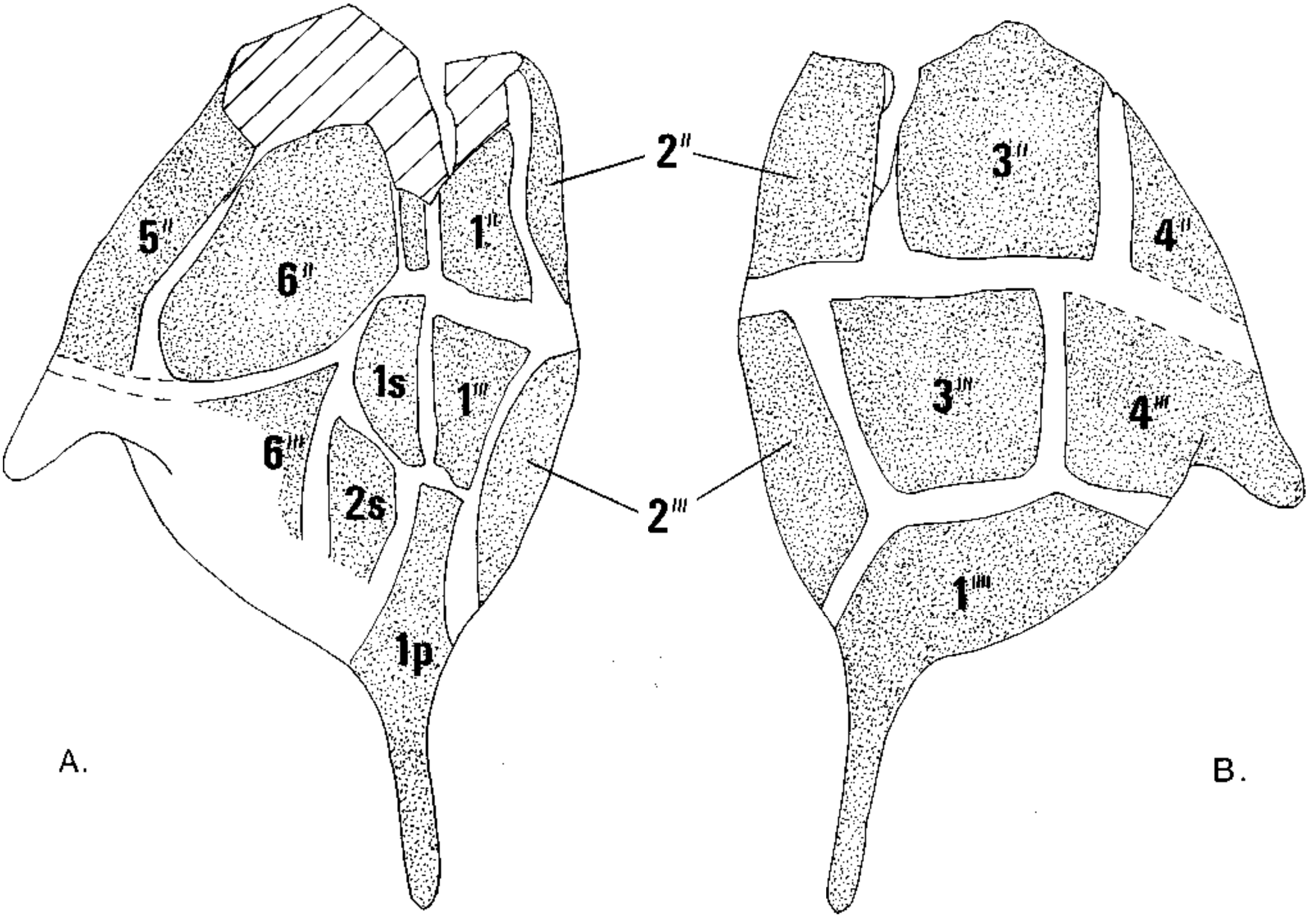
Pseudoceratium pelliferum GOCHT, 1957

Pl. 3, figs. 1, 2; Text-Fig. 17

1957 *Pseudoceratium pelliferum* GOCHT, p. 166, pl. 18, figs. 1, 2, Text-Figs. 1–3.
1962 *Pseudoceratium (Eopseudoceratium) gochti* NEALE & SARJEANT, pp. 446–448, pl. 20, figs. 3, 4; Text-Fig. 5.

Remarks: Specimens of *P. pelliferum* were observed here which are ornamented in such a way that pandasutural areas are free or largely free of ornament. Unfortunately, the opercula are usually detached so that opercular paratabulation distribution could not be discerned. Nevertheless, a formula of ?4’, 6”, 6”’, 1p., 1” ”, 1a.s, 2s may be proposed. The paraplate distribution is typically ceratiacean and is illustrated in Text-Fig. 17.

As suggested by MILLIOUD (1969, p. 433) there seems to be a range of degree of ornamentation in *P. pelliferum* in which some specimens show no trace of paratabulation except around the archeopyle margin, whereas others show faint traces or even a virtually complete paratabulation scheme. This implies that *Pseudoceratium (Eopseudoceratium) gochti*, as described by NEALE & SARJEANT (1962) has a particularly well-defined paratabulation but may nevertheless be included in *P. pelliferum*. The emended diagnosis of *Pseudoceratium* proposed by DÖRHÖFER & DAVIES includes the possibility of paratabulate forms (before this, paratabulate forms were specifically excluded from *Pseudoceratium*, so that the 1978 transfer of *gochti* into *Pseudoceratium* in STOVER & EVITT was questionable). It is felt that *P. (E.) gochti* may be formally synonymised with *P. pelliferum* here.



Text-Fig. 17. Camera lucida drawings of *Pseudoceratium pelliferum* GOCHT, 1957. A ventral and B dorsal surfaces. X1250.

Gonyaulacacean Cysts

Aldorfia STOVER & EVITT, 1978

1978 *Aldorfia* STOVER & EVITT, p. 140

Remarks: The present author accepts the concept of *Aldorfia* STOVER & EVITT, 1978 only with reservations. Whilst he agrees that the original assignation of the type species of *Aldorfia, A. aldorfensis,* to *Gonyaulacysta* (in GOCHT, 1970, p. 136) is untenable, it is not altogether clear where it should be classified. In an unpublished palynological study of south-west German Jurassic samples, the present author and D. I. WHARTON have examined material containing that species termed *Gonyaulacysta aldorfense* in GOCHT, 1970 as well as younger and older material (GOCHT's study involved a single, Early Bathonian horizon). We concluded that the true (evolutionary) significance of *"G." aldorfense* is as an end member of that very diverse group of cysts included in *Endoscrinium galeritum* (DEFLANDRE, 1938) VOZZHENNIKOVA, 1967, which is particularly well illustrated in KLEMENT, 1960. That is, it appears that the slight separation of body layers in *"G." aldorfense,* which was excellently described and illustrated in GOCHT, 1970, may have become more pronounced in younger material with a simultaneous loss of connective material (see GOCHT, 1970, pl. 30, figs. 1–3 and Text-Fig. 9). Again, the bounds of a purely morphological classification system may not be totally adequate to contain separate members of what is probably an evolutionary lineage, However, as remarked under *Spiniferites* (below), since a morpholgical classification is the only system which may be meaningfully employed in sub-dividing the very large majority of dinoflagellate cysts and since any attempt to introduce evolutionary concepts would lead to the recognition of numerous "borderline cases", then *Aldorfia,* as conceived by STOVER & EVITT (1978), must be recognised.

Aldorfia vectensis DUXBURY n. sp.

Pl. 4, figs. 3, 7, 10

Derivation of Name: From the Latin *Vectis,* the Isle of Wight – in reference to the type locality.
Holotype: Pl. 4, figs. 3, 7, 10.
Type Locality: Sample CB38, Ferruginous Sands Series, Compton Bay section, Isle of Wight.

Diagnosis: A holocavate, gonyaulacacean dinoflagellate cyst species. The autocyst is spheroidal to ovoidal with a distinct, distally closed, apical projection. The ectophragm, which is finely punctate, is clearly separate from the autophragm and the resultant ectocoel is particularly pronounced at the apex, the antapex and in the paracingular area. A distinct, distally closed apical horn is always present which mirrors the apical projection of the autocyst. Narrow muri constituting a crude reticulum are present between the auto- and ectocyst. The paracingulum is laevorotatory, is indicated by two parallel, low ridges with a depression between and is almost totally devoid of reticulation. The parasulcus is clearly defined by a distinct ventral depression. Paratabulation is faintly marked on the ectophragm surface by low ridges and the archeopyle is formed by detachment of paraplate 3".

Observed Dimensions: Holotype – 82 x 73 µm
Overall – 84 (78) 67 x 73 (67) 61 µm
Specimens measured – 8

Remarks: *A. vectensis* is similar in many respects to *A. aldorfensis,* the type species. It differs, however, in possessing a better developed, more sharply-tapering apical horn on the pericyst and in possessing a distinct apical protrusion on the endocyst which mirrors this. *A. aldorfensis* bears a short, blunt apical projection on the pericyst (typical of the *Endocrinium galeritum* group – see above) and the epicyst is broadly-rounded apically. Nevertheless, the similarity between *A. vectensis* and *A. aldorfensis* clearly demonstrates the morphological convergence which is possible in cysts of very different ages.

Callaiosphaeridium Davey & Williams, 1966 emend. Duxbury, 1980

1966b *Callaiosphaeridium* Davey & Williams, p. 103.
1967 *Hexasphaera* Clarke & Verdier, p. 42.
1980 *Callaiosphaeridium* Davey & Williams in Duxbury, p. 113.

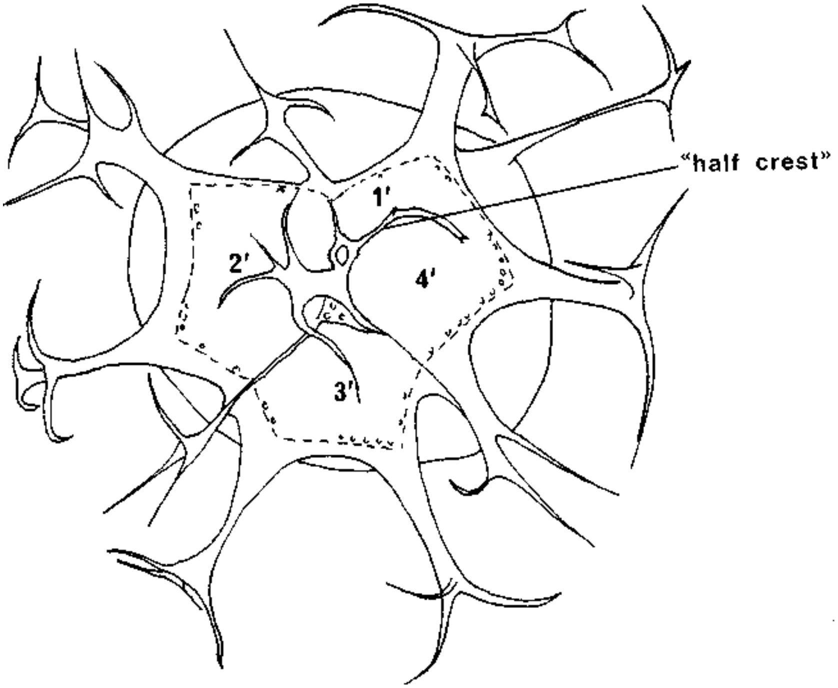
Remarks: The placing in synonymy of *Avellodinium* Duxbury, 1977 with *Callaiosphaeridium* in Below (1981, p. 27) is rejected here. In both the original diagnosis of *Callaiosphaeridium* and the emended diagnosis in Duxbury, 1980 emphasis was placed on the presence of two distinct process types and these were summarised by Davey & Williams (1966b, p. 103) as, "(i) cingular processes large and tubular, open distally, and (ii) apical, precingular, postcingular and sulcal processes solid". *Avellodinium* possesses only the type (ii) processes noted above and therefore cannot possibly be included in *Callaiosphaeridium*.

Callaiosphaeridium trycherium Duxbury, 1977

Pl. 5, figs. 13, 20, pl. 10, fig. 8.

1980 *Callaiosphaeridium trycherium* Duxbury, p. 114.

Remarks: In Text-Fig. 20a of Below, 1981, that author illustrates the epicystal paratabulation pattern of *Callaiosphaeridium trycherium* Duxbury, 1980. It is interesting to note that the crest figured between paraplates 4' and 1' is incomplete and that a process arises from that end of the crest nearest the parasulcus. Precisely the same structure has been observed in *Callaiosphaeridium asymmetricum* (Deflandre & Courteville, 1939) Davey & Williams, 1966b here and this is illustrated in Text-Fig. 18.



Text-Fig. 18. Camera lucida drawing of a detached epicyst of *Callaiosphaeridium asymmetricum* (Deflandre & Courteville, 1939) Davey & Williams, 1966b. X1600.

Chlamydophorella Cookson & Eisenack, 1958 emend. herein

1958 *Chlamydophorella* Cookson & Eisenack, p. 56.
1961 *Gardodinium* Alberti, p. 18.

Emended Diagnosis: Holocavate dinoflagellate cysts whose autophragms may be spheroidal, ovoidal or flattened ovoidal and may display an apical protuberance. The autophragm bears numerous, solid or hollow processes of generally uniform length supporting a smooth to perforate ectophragm; the ectophragm may mirror the autophragm shape or may be apically produced into a distally closed or open, hollow horn. Parasutures may be faintly discernible on the ectophragm surface in the form of very low ridges. Archeopyle formed by displacement of the entire apical series.

Type Species: *Chlamydophorella nyei* Cookson & Eisenack, 1958.

Remarks: The diagnosis of *Chlamydophorella* is here emended in order to emphasis the large morphological range of the genus and to formally include the designation of the archeopyle as apical. This last feature has been observed in several papers, notably Davey, 1970 (p. 357), Brideaux, 1971 (p. 98) and Stover & Evitt, 1977 (p. 28) and was, in fact, suggested by the original authors Cookson & Eisenack (1958, p. 57).

The present author agrees with the synonymising of *Gardodinium* with *Chlamydophorella* in Davey, 1978 (p. 893). It was Brideaux (1971, p. 98) who pointed out that because of the great morphological similarities which were apparent between *Gardodinium* and *Chlamydophorella*, "should both genera prove to have apical archeopyles, it would be difficult to maintain two different names for the same concept". It was already known in 1971 that *Chlamydophorella* possesses an apical archeopyle but the description of *Gardodinium deflandrei* (now *Aldorfia deflandrei* – see Stover & Evitt, 1978, p. 140), a species with an obviously precingular archeopyle, in Clarke & Verdier, 1967, led some palynologists to assume that other species of *Gardodinium* had a similar archeopyle. This was the situation until Davey (1974) showed the type species of *Gardodinium, G. trabeculosum* Gocht, 1959, to have an apical archeopyle.

Chlamydophorella nyei Cookson & Eisenack, 1958

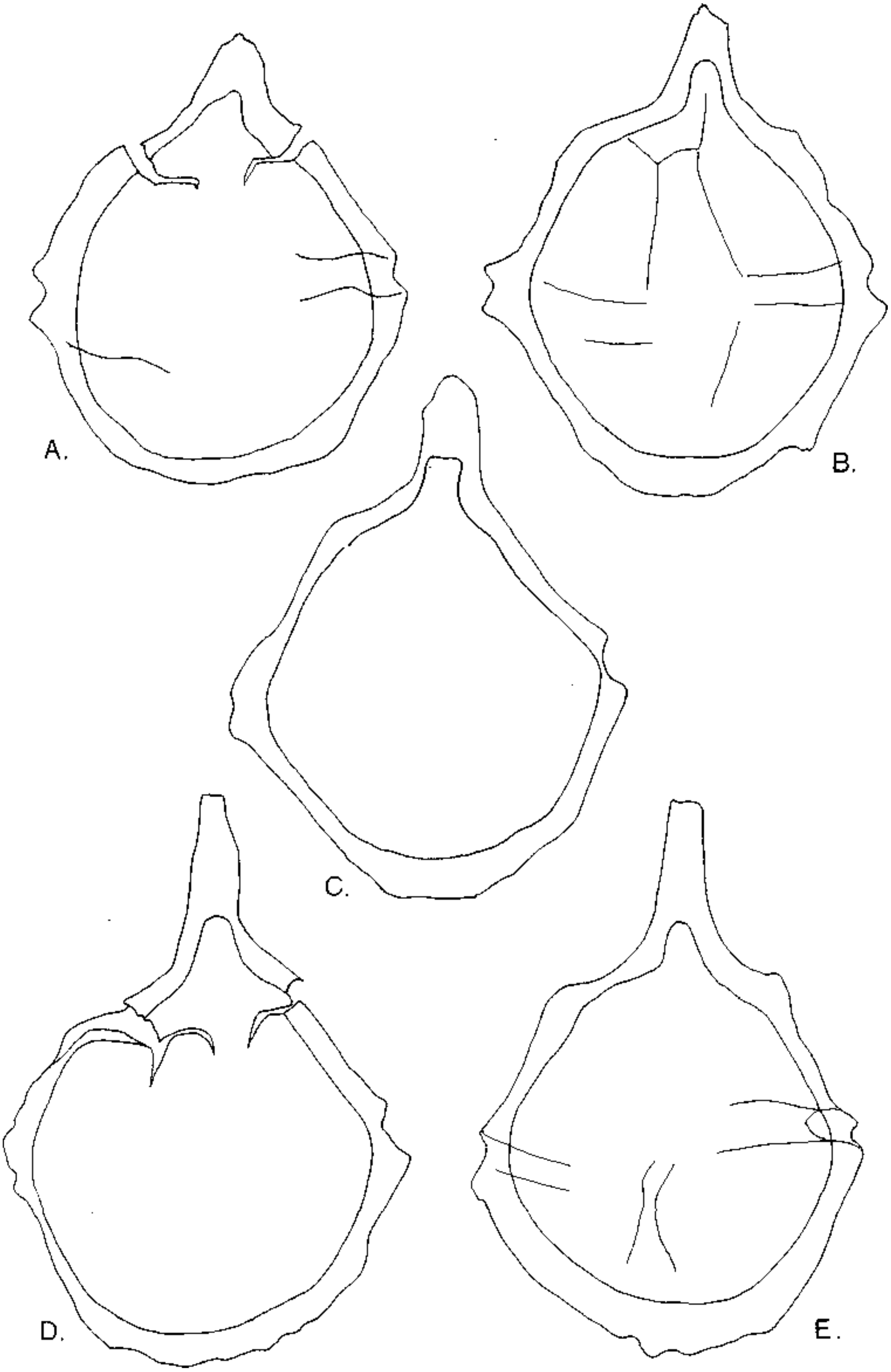
Pl. 3, figs. 4, 8, 10; Text-Fig. 19

1958 *Chlamydophorella nyei* Cookson & Eisenack, pp. 56, 57, pl. 11, figs. 1–3.

Remarks: The present author has observed many specimens of *C. nyei* during the present work and this species has proved to exhibit a wide morphological range. Towards the latter part of its stratigraphical range, *C. nyei* varies from approximately spheroidal forms with short apical horns (very similar to Cookson & Eisenack's holotype) to larger, more rhomboidal forms, each possessing a long, open-ended apical horn which may be a quarter of the total body length. Vague paratabulation may be apparent and paracingular and parasulcal areas may be indicated by low, very fine ridges. Those variants on *C. nyei* with long horns tend to demonstrate some dorso-ventral flattening of the cyst. A graphical representation of the morphological range observed is given in Text-Fig. 19 and pl. 3, figs. 4, 8 and 10.

Since there appears to be a continous series of morphologies between spheroidal types with small apical horns to rhomboidal, flatter forms with long apical horns, the present author has chosen not to attempt any formal subdivison. However, the longer-horned variety appears to be of some stratigraphical significance and is entered on the range charts (Text-Figs. 2, 3, 4 and 34) as "*Chlamydophorella nyei* Cookson & Eisenack, 1958 (long horned)".

Stover & Evitt (1978, p. 28) consider *Gardodinium* and *Chlamydophorella* to be separable and state, "Our inclination is to regard *Gardodinium* as differing from *Chlamydophorella* in always having a prominent apical horn, in having more slender, delicate, less densely distributed processes, and in showing faint indications of paratabulation other than the archeopyle." However, the morphological range shown by specimens observed here,



Text-Fig. 19. Form and variation in *Chlamydophorella nyei* COOKSON & EISENACK, 1958. Considerable variation may be seen, particularly in the degree of development of the apical horn. All X1200.

which include forms very similar to COOKSON & EISENACK's holotype, encompasses specimens with prominent apical horns and faint indications of paratabulation. The genus *Chlamydophorella* as a whole may encompass a considerable variety of process breadth and density of distribution (see remarks under *Chlamydophorella* in DAVEY, 1978, p. 893).

Cribroperidinium NEALE & SARJEANT, 1962 emend. DAVEY, 1969

1962 *Cribroperidinium* NEALE & SARJEANT, p. 443.
1969 *Cribroperidinium* NEALE & SARJEANT in DAVEY, p. 125.

Cribroperidinium conopium DUXBURY n. sp.

Pl. 4, fig. 11

Derivation of Name: From the Latin *conopium*, a mosquito net – in reference to the coarse surface reticulum.
Holotype: Pl. 4, fig. 11.
Type Locality: Sample AB 9, Sandrock Series, Atherfield section, Isle of Wight.

Diagnosis: A large, ovoidal, proximate dinoflagellate cyst species which possesses a long, distally tapering, blunt-ended apical horn. The entire surface, with the exception of the parasulcal depression, is covered by a coarse reticulum. Typically gonyaulacacean paratabulation is superimposed on the reticulum in the form of very low crests which may be distally denticulate. Accessory crests are present within paraplate areas. The archeopyle is formed by detachment of paraplate 3".

Observed Dimensions: Holotype – 133 x 90 µm
Overall – 136 (128) 116 x 116 (96) 78 µm
Specimens measured – 6

Remarks: The surface reticulum demonstrated by this species sets it apart from all other species of the genus.

Desmocysta DUXBURY n. gen.

Derivation of Name: From the Greek *desmos*, a cable and *kystis*, a sac or cell – in reference to the characteristic antapical filaments on otherwise largely featureless cysts.

Diagnosis: Spheroidal to ovoidal dinoflagellate cysts. Paratabulation is absent except where indicated by a two-paraplate, precingular archeopyle, whose precise paraplate equivalence may not be discerned. Long, fine filaments extend from the antapex.

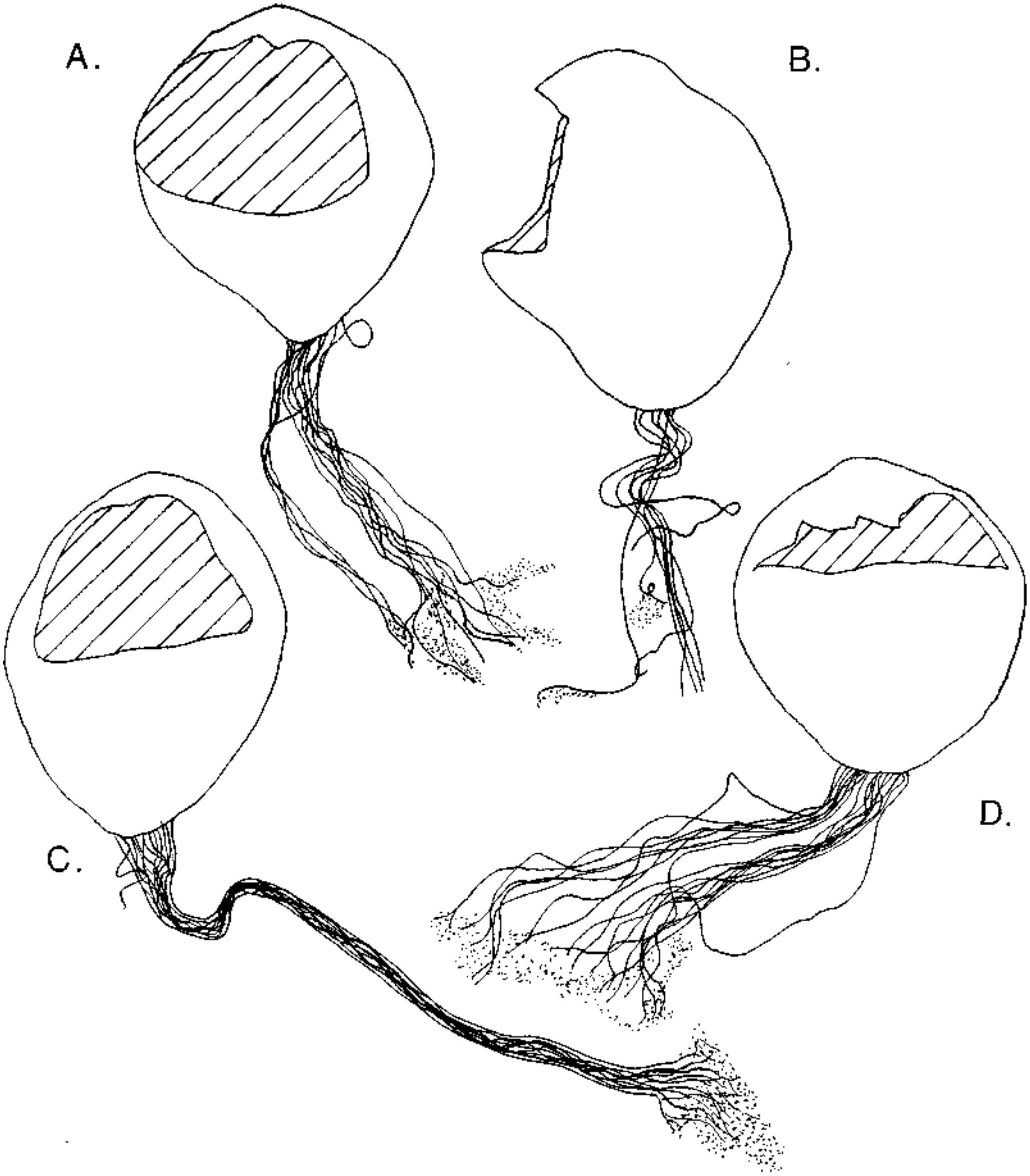
Type Species: *Desmocysta plekta* DUXBURY n. gen. et sp.

Remarks: This genus bears some resemblance to *Ophiobolus* WETZEL, 1933 (or *Scuticabolus* LOEBLICH, 1967) and *Dimastigobolus* DEFLANDRE, 1936.

In his thorough discussion of *Ophiobolus lapidiaris* WETZEL, 1933, EVITT (1968) expressed his opinion that that species represents the egg case of a planktonic organism and that the filaments originating from one pole were either attachments or buoyancy aids designed to support the eggs in the planktonic realm. *O. lapidiaris* was, in EVITT's opinion, classifiable under the Zoological Code so that LOEBLICH's (1967) argument that a genus of ascomycete fungi (described by RIESS, 1854) has priority for the generic name *Ophiobolus* need not apply. The present author is not entirely convinced as to the faunal origin of *Ophiobolus* WETZEL, 1933. Photographic illustrations in EVITT, 1968, pl. 1 could equally well be interpreted as representing dinoflagellate cysts and figs. 5, 11 and 12 particularly appear to show parasutural splits between precingular paraplates. In this case, the genus must be termed *Scuticabolus* LOEBLICH, 1967 and this would seem to differ from *Desmocysta* DUXBURY n. gen. in having some type of apical (or at least pre-precingular) archeopyle, as opposed to the 2P type typical of this last genus.

Dimastigobolus was separated from *Ophiobolus* WETZEL, 1933, in DEFLANDRE (1936, p. 161) on the grounds of its being (translation), "covered with a very distinctive vermiculate ornamentation, noticeably oriented in the direction of the long axis". EVITT (1969, p. 7) suggests that such strongly ornamented specimens as those included in *Dimastigobolus* by DEFLANDRE may represent extreme variants of *Ophiobolus lapidiaris*. In this case, the comments distinguishing *Ophiobolus* WETZEL, 1933 from *Desmocysta* also apply to *Dimastigobolus*.

Although only a single species of *Desmocysta* was recorded here, others are known to exist, notably that termed *Ophiobolus* sp.A. in DAVEY, 1979b and that termed *Klementia barbata* (unpublished) in WARREN, 1967.



Text-Fig. 20. Camera lucida drawings of *Desmocysta plekta* DUXBURY n. gen et sp. A, C and D dorsal surfaces, B right lateral aspect. D, holotype, A, B, C, paratypes. All X1050.

Desmocysta plekta Duxbury n. sp.

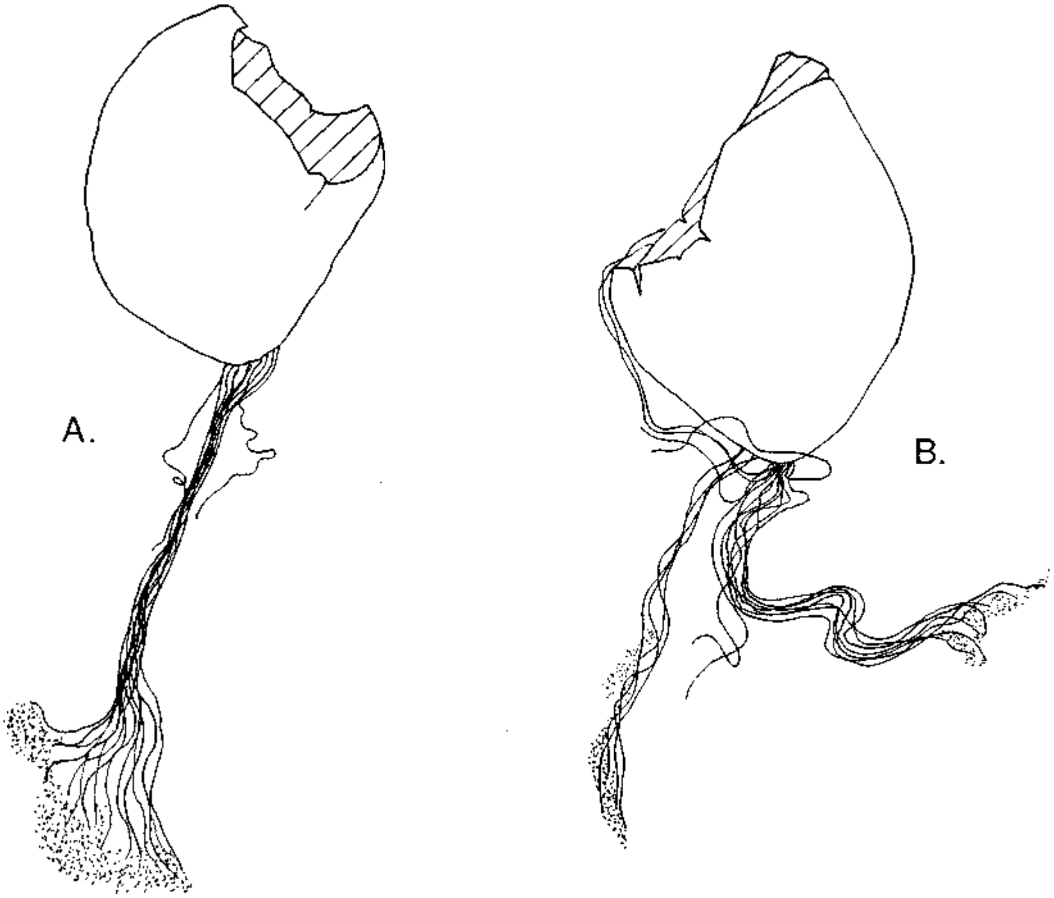
Pl. 8, fig. 11; Text-Figs. 20, 21

Derivation of Name: From the Greek *plektos*, plaited, twisted – in reference to the rope-like antapical projection.
Holotype: Pl. 8, fig. 11; Text-Fig. 20 D.
Type Locality: Sample AB 12, Upper Crioceras Beds, Ferruginous Sands Series, Atherfield section, Isle of Wight.

Diagnosis: A spheroidal to ovoidal dinoflagellate cyst species which always displays a distinct antapical protrusion and which may display a similar protrusion at the apex. A large, two paraplate, precingular archeopyle is invariably present and this is the only expression of paratabulation in an otherwise featureless cyst. Long, fine filaments (usually 10 or more) extend from a small area at the antapex and these may be more than twice the length of the capsule. These are usually tangled to some extent and may form a continuous "rope". The filaments terminate in a granular, amorphous mass.

Observed Dimensions: Holotype – Cyst 38 x 38 μm
Antapical filaments 58 μm
Overall – Cyst 52 (46) 35 x 44 (35) 32 μm
Antapical filaments 81 (46) 26 μm
Specimens measured – 27

Remarks: *Ophiobolus* sp. A. of Davey, 1979b is similar to *Desmocysta plekta* in the cyst shape and wall texture. It has not been included in *D. plekta* here simply because it possesses only very few antapical filaments.



Text-Fig. 21. Camera lucida drawings of *Desmocysta plekta* Duxbury n. gen. et sp., paratypes. A left lateral and B right lateral aspects. Both X1050.

Exiguisphaera Duxbury, 1979

1979 *Exiguisphaera* Duxbury, p. 198.

Exiguisphaera plectilis Duxbury, 1980

Pl. 8, fig. 7

?1977 *Adnatosphaeridium* sp. A Brideaux, pp. 21, 22, pl. 8, figs. 10, 11.
1980 *Exiguisphaera plectilis* Duxbury, pp. 118, 119, pl. 3, figs. 5, 8, 11.

Remarks: Those specimens referred to in Brideaux, 1977 as *Adnatosphaeridium* sp. A appear to bear very close morphological resemblance to *Exiguisphaera plectilis* Duxbury, 1980. Brideaux (1977, p. 22) states that the archeopyle of *Adnatosphaeridium* sp. A is, "formed by the loss of the four apical paraplates", and this, of course, contrasts with the two paraplate precingular (3" + 4") archeopyle of *Exiguisphaera*. Brideaux, however, also states, "compression of specimens renders observation of paratabulation difficult", and this may have affected his archeopyle-type designation. One specimen of *Adnatosphaeridium* sp. A was photographically illustrated by Brideaux (1977, pl. 8, figs. 10, 11) and this is very reminiscent in the parasutural distribution to the apical view of an *Exiguisphaera* illustrated in Duxbury, 1979, Text-Fig. 2.

Florentinia Davey & Verdier, 1973 emend. Duxbury, 1980

1973 *Florentinia* Davey & Verdier, pp. 185, 186.
1976 *Silicisphaera* Davey & Verdier, pp. 320, 321.
1976 *Achilleodinium* Eaton, p. 234.
1980 *Florentinia* Davey & Verdier in Duxbury, p. 119.

Florentinia abjuncta Duxbury n. sp.

Pl. 6, figs. 9, 10

Derivation of Name: From the Latin *abjunctus*, disunited, separated – in reference to the characteristically separate process elements.
Holotype: Pl. 6, figs. 9, 10.
Type Locality: Sample CB 62, Ferruginous Sands Series, Compton Bay section, Isle of Wight.

Diagnosis: A species of *Florentinia* possessing a spheroidal to ovoidal central body with a distinct, distally closed and rounded apical projection. The periphragm is produced into numerous slender, proximally broad-based and distally capitate process elements which may occasionally be proximally united. A large, broad-based and distally tapering antapical process is present and this is open with a ragged margin at its distal extremity. The process elements and antapical process are smooth, but the main body is densely, though finely granular. The archeopyle is formed by detachment of a single, mid-dorsal paraplate (3").

Observed Dimensions: Holotype – 70 x 67 μm
Overall – 81 (73) 67 x 81 (67) 58 μm
Specimens measured – 14

Remarks: This species is distinguished by its numerous process elements (representing relatively few actual processes), by its granular body surface, by its apical projection and by its distally open antapical process. The most closely comparable species are *Florentinia resex* Davey & Verdier, 1976 and *F. interrupta* Duxbury, 1980. *F. abjuncta* differs from the former in possessing a distally open antapical horn and an apical projection. It differs from the latter in lacking striae on the processes, in being granular rather than having a microreticulate body surface, in having processes typically broken down into individual elements and in having an apical projection. *Florentinia radiculata* (Davey & Williams, 1966b) Davey & Verdier, 1973 is similar to *F. abjuncta* in possessing slender, capitate process elements but differs in having notably fewer such elements and in having an antapical process which is narrow and sometimes difficult to distinguish in certain orientations. Also, *F. radiculata* is very distinctive in possessing processes which display a single, deep, primary bifurcation (see pl. 4, figs. 4 and 6 in DAVEY & VERDIER, 1971 and compare figs. 9 and 10 with fig. 13 in pl. 6, herein).

Gonyaulacysta DEFLANDRE ex NORRIS & SARJEANT, 1965 emend. SARJEANT, 1969

1964 *Gonyaulacysta* DEFLANDRE, p. 5 (type species not validly proposed)
1965 *Gonyaulacysta* DEFLANDRE ex NORRIS & SARJEANT, p. 65
1969 *Gonyaulacysta* DEFLANDRE ex NORRIS & SARJEANT in SARJEANT, p. 7

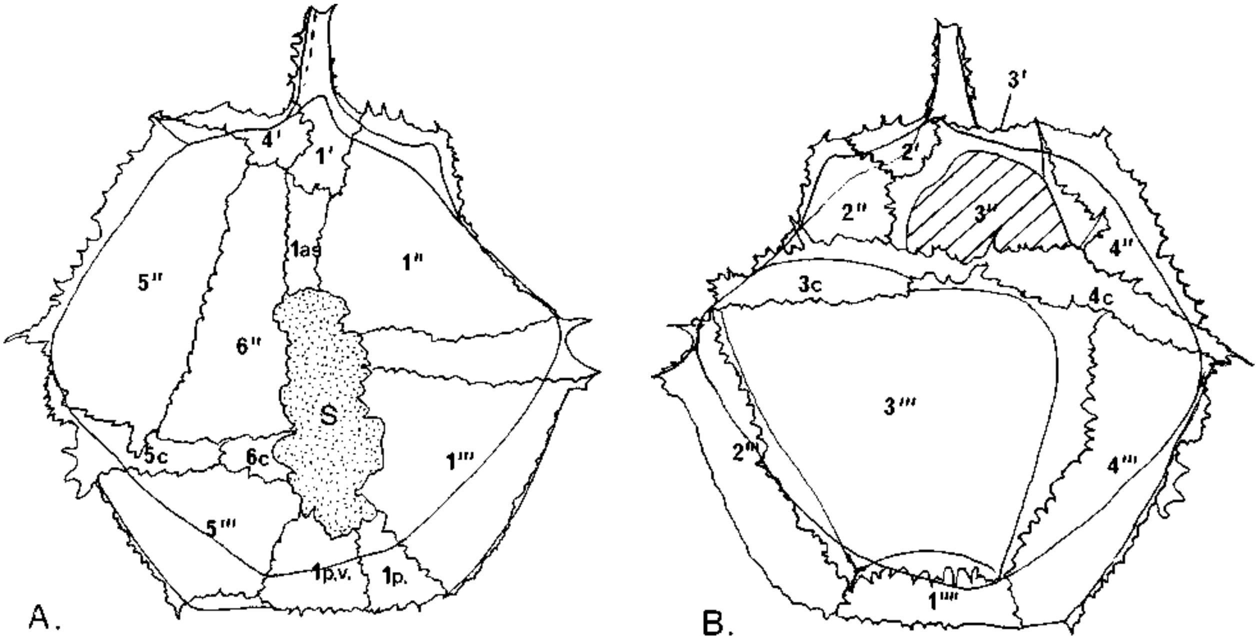
Gonyaulacysta? kleithria DUXBURY n. sp.

Pl. 5, figs. 1, 2; Text-Fig. 22

Derivation of Name: From the Greek *kleithria,* a keyhole – in reference to the parasulcal hole.
Holotype: Text-Fig. 22.
Type Locality: Sample AB30, Lower Gryphaea Group, Ferruginous Sands Series, Atherfield section, Isle of Wight.

Diagnosis: A fairly large, partially cavate, gonyaulacacean dinoflagellate cyst species. The smooth endocyst is approximately square in outline and has a distinct, distally rounded and closed apical projection. The pericyst, which is also smooth, is in contact with the endocyst only on the dorsal surface and is produced into a well-developed, staight or concave-sided, open apical horn. Paratabulation of the formula 4', 1a.s., 6", ?c, 5"', 1p., 1p.v., 1"" is marked on the periocoel surface by low crests which are distally irregularly denticulate. An irregular hole is observed in the ventral pericoel, presumably marking the parasulcus. An archeopyle is formed by detachment of paraplate 3".

Observed Dimensions: Holotype – 67 x 67 μm
Overall – 78 (67) 55 x 73 (58) 46 μm
Specimens measured – 26



Text-Fig. 22. Camera lucida drawings of *Gonyaulacysta ?kleithria* DUXBURY n. sp., holotype. A ventral surface demonstrating the parasulcal hole, B dorsal surface. X1050.

Remarks: The placement of this species in *Gonyaulacysta* is only tentative since there is a characteristic cavation which is invariably observed over the whole surface other than the dorsal area. In all respects other than the cavation, the morphology of this species is typical of the genus *Gonyaulacysta.*

The irregular hole which is always present in the ventral pericoel presumably represents the parasulcus. It is noteworthy that the area where paraplate 1''' (in conventional gonyaulacacean schemes) would normally be found is incorporated within the hole. This homology of paraplate 1''' (in the conventional sense) with part of the parasulcus was also noted in *Aptea plera* Duxbury n. sp. and was discussed in the remarks under that species (above). The obvious conclusion from this observation is that the paraplate which has up to now been termed 1''' is truly parasulcal and the paratabulation of *G? kleithria* has been interpreted accordingly here (see Text-Fig. 22).

Hystrichosphaerina Alberti, 1961

1961 *Hystrichosphaerina* Alberti, p. 38
1961b *Polystephanephorus* Sarjeant, p. 1096.

Remarks: Specimens here referred to *Hystrichosphaerina schindewolfii* Alberti, 1961 ranged from those possessing slender, poorly developed paracingular processes (see Duxbury, 1980, Text-Fig. 10) to those possessing no such paracingular features (see pl. 8, fig. 3 herein). *H. schindewolfii* is the type species and the possession of paracingular processes was included in the generic diagnosis by Alberti (1961, p. 38), thus inferring that all species referable to *Hystrichosphaerina* must possess such processes. The present author considers the main characteristic feature of *Hystrichosphaerina* to be the presence of ring trabeculae linking the distal extremes of process elements. The lack of paracingular processes in species similar to *H. schindewolfii,* notably *H. sarjeantii* (Gitmez, 1970) Duxbury, 1980, and of a gradation between specimens here referred to *H. schindewolfii* from those with paracingular processes to those without may suggest that not only is this feature unreliable at a generic level, but that it may be equally unreliable specifically. In view of the importance placed on the presence or absence of paracingular processes in defining other genera, particularly *Hystrichosphaeridium* and *Oligosphaeridium*, the present author chooses not to emend Alberti's diagnosis of *Hystrichosphaerina* in order to dismiss the importance of paracingular processes in that genus. He rather chooses to suggest that *H. schindewolfii*, on the evidence of specimens observed during the present work, may or may not possess paracingular processes.

Kiokansium Stover & Evitt, 1978 emend. herein

1978 *Kiokansium* Stover & Evitt, p. 167.
1979a *Bacchidinium* Davey, p. 555.

Emended Diagnosis: Spheroidal to elongate ellipsoidal dinoflagellate cysts bearing solid, distally acuminate or branched processes. Processes number from 19 to over 40. Archeopyle two-paraplate precingular with paratabulation indicated only by archeopyle margin.

Type Species: *Kiokansium polypes* (Cookson & Eisenack, 1962) Below, 1982 emend. herein.

Remarks: Below's contention (1982, pp. 13–15) that *Bacchidinium* Davey, 1979a is a junior synonym of *Kiokansium* Stover & Evitt, 1978 is wholly supported here. In addition, however, the respective type species of *Kiokansium* and *Bacchidinium, K. unituberculatum* (Tasch in Tasch, McClure & Oftedahl, 1964) and *B. polypes* (Cookson & Eisenack, 1962), are here considered synonymous. Stover & Evitt (1978, p. 268) wrote, *"Cleistosphaeridium polypes* (Cookson & Eisenack, 1962b) Davey 1969a, which has the same general appearance and strikingly similar processes (and, apparently, process variability), is similar to *K. unituberculatum.* However, the main body of *C. polypes* is spherical, and the archeopyle, although not noted by the original authors, is considered by Davey as probably being apical". In fact, the original description of *polypes* in Cookson & Eisenack (1962, p. 492) states, "Shell circular to subcircular in outline", and Davey (1969, p. 154) describes it as, "spherical to subspherical". Also, the present author's observations of this species comply with those of Davey (1979a, p. 555), when he states, "the distinctive type 2P archeopyle was observed in several specimens".

It is apparent, therefore, that *Bacchidinium* DAVEY, 1979a is a junior synonym of *Kiokansium* STOVER & EVITT, 1978 and that the species *polypes* (COOKSON & EISENACK, 1962) is senior to *unituberculatum* (TASCH in TASCH, McCLURE and OFTEDAHL, 1964). Consequently, it has been necessary to re-define and validate the genus *Kiokansium* here and to install *Kiokansium polypes* (COOKSON & EISENACK, 1962) BELOW, 1982 emend. herein as the type species.

The concept of including species with one and two paraplate precingular archeopyles within a single genus, as proposed by DAVEY (1979a, p. 555) is here rejected.

Kiokansium is distinguished from *Taleisphaera* DUXBURY, 1979 in that it lacks the penitabular crests linking individual processes which are so characteristic of the latter genus. Also, *Taleisphaera* often displays a distinctly pentagonal ambitus whereas that of *Kiokansium* is circular to elongate elliptical. The placing in synonymy of *Taleisphaera* with *Kiokansium* in BELOW 1982 (p. 13) is therefore rejected.

Kiokansium polypes (COOKSON & EISENACK, 1962) BELOW, 1982 emend.

Pl. 7, fig. 7

1962 *Hystrichosphaeridium recurvatum* var. *polypes* COOKSON & EISENACK, p. 491, pl. 4, fig. 11.
1964 *Hystrichosphaeridium magnarmatum* TASCH, p. 192, pl. 1, fig. 22.
1964 *Hystrichosphaeridium valgum* TASCH, pp. 192, 193, pl. 2, fig. 10.
1964 *Hystrichosphaeridium kiowanum* TASCH, p. 193, pl. 2, fig. 1.
1964 *Hystrichosphaeridium replexum* TASCH, p. 193, pl. 3, fig. 14.
1964 *Hystrichosphaeridium marsupium* TASCH, p. 193, pl. 3, fig. 16.
1964 *Hystrichosphaeridium entomium* TASCH, p. 193, pl. 3, fig. 15.
1964 *Hystrichosphaeridium aruncium* TASCH, p. 193, pl. 3, fig. 12.
1964 *Hystrichosphaeridium perovatum* TASCH, p. 194, pl. 3, fig. 13.
1964 *Hystrichosphaeridium unituberculatum* TASCH, p. 194, pl. 3, fig. 8.
1964 *Hystrichosphaeridium protellipticum* TASCH, p. 194, pl. 2, fig. 2.
1964 *Hystrichosphaeridium triradicosum* TASCH, p. 194, pl. 2, figs. 4, 14.
1964 *Hystrichosphaeridium eccentrum* TASCH, p. 194, pl. 1, fig. 6, pl. 2, fig. 9.
1964 *Hystrichosphaeridium fabium* TASCH, p. 195, pl. 2, fig. 5.
1964 *Hystrichosphaeridium tribrachiosum* TASCH, p. 195, pl. 1, fig. 3.
1964 *Hystrichosphaeridium follium* TASCH, p. 195, pl. 1, fig. 8.
1964 Dinoflagellate genus and species undetermined, no. 1 TASCH, p. 198, pl. 1, fig. 14.
1964 Dinoflagellate cyst, forma A TASCH, p. 199, pl. 3, fig. 11.
1964 Dinoflagellate cyst, forma B TASCH, p. 199, pl. 3, fig. 9.
1964 Dinoflagellate cyst, forma C TASCH, p. 199, pl. 3, fig. 6.
1969 *Cleistosphaeridium polypes* (COOKSON & EISENACK) DAVEY, p. 154, pl. 6, figs. 7, 8.
1979 *Bacchidinium polypes* (COOKSON & EISENACK) DAVEY, p. 555, pl. 1, fig. 7.
1982 *Kiokansium polypes* (COOKSON & EISENACK) BELOW, p. 16, pl. 6, fig. 9, pl. 9, fig. 8.

Emended Diagnosis: Spheroidal dinoflagellate cysts bearing numerous solid processes which flare proximally and are distally flared and furcate, often into several very fine, flexuous spines. Paratabulation is absent except where indicated by the archeopyle margin. Archeopyle two-paraplate precingular.

Remarks: The diagnosis of *Kiokansium polypes* is here emended to emphasise the two-paraplate precingular archeopyle. Although DAVEY (1979a, p. 555) and BELOW (1982, p. 16) have referred to this feature, it has not been previously incorporated in a formal diagnosis.

Taleisphaera hydra DUXBURY, 1977 is very similar to *K. polypes* but the penitabular crests joining mainly gonal and some crestal processes in the former constitute a very distinctive feature.

Kiokansium prolatum DUXBURY n. sp.

Pl. 6, figs. 4, 8

1971 *Oligosphaeridium prolixispinosum* DAVEY & WILLIAMS, 1966 in SINGH, pl. 56, fig. 4 only.

Derivation of Name: From the Latin *prolatus*, extended, elongated - in reference to the cyst elongation.
Holotype: Pl. 6, fig. 8.
Type Locality: Sample CB20, Sandrock Series, Compton Bay section, Isle of Wight.

Diagnosis: An elongate ellipsoidal, thin-walled, chorate dinoflagellate cyst. It has 19 slender, solid processes which are proximally flared and distally produced into several flat, tapering, recurved spines. Each process is paraplate centred and a gonyaulacacean paratabulation pattern of the formula 4', 6", ?c, 6"', 1p., 1p.v., 1"" may be inferred. The paracingulum is devoid of processes. The pre- and postcingular processes are longer than elsewhere, so that the length to breadth ratio of the entire cyst is considerably smaller than that of the main body. The archeopyle is two-paraplate precingular.

Observed Dimensions: Holotype - 78 x 55 μm
Overall - 89 (69) 61 x 78 (53) 41 μm
Main Body - 61 (45) 38 x 38 (27) 20 μm
Specimens measured - 20

Remarks: The elongate shape of this species, particularly of the main body, renders it most distinctive. The most closely comparable taxon is *Hystrichosphaeridium? phoenix* Duxbury, 1980, a species which bears very similar processes to *K. prolatum*, both numerically and morphologically. *H. ?phoenix*, however, has a spheroidal main body with processes of equal length, whereas *K. prolatum* is elongate with pre- and postcingular processes longer than processes elsewhere.

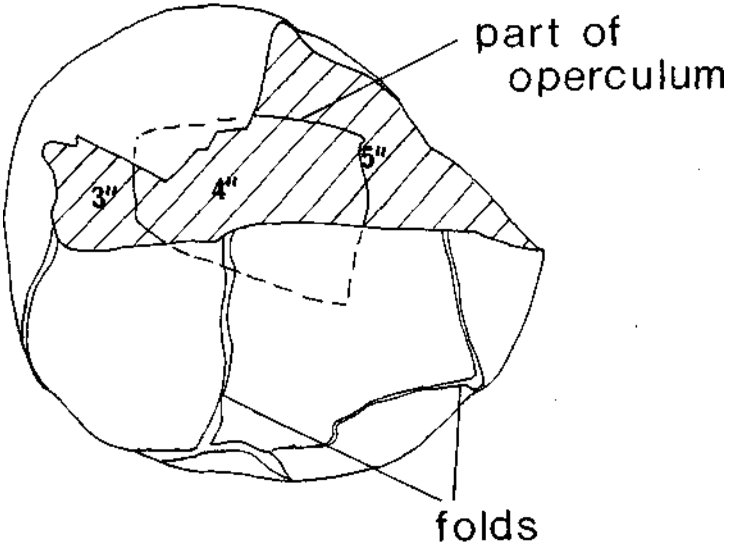
The specimen figured by Singh (1971, pl. 56, fig. 4) and referred to *Oligosphaeridium prolixispinosum* Davey & Williams, 1966b is here considered an example of *Kiokansium prolatum.* Singh's illustration shows well the elongate ellipsoidal shape, variability in process length and, more particularly, the distinctive process terminations of *K. prolatum.*

Nexosispinum Davey, 1979a

1979a *Nexosispinum* Davey, pp. 557, 558

?Nexosispinum hesperum Davey, 1979a

Pl. 7, fig. 8; Text-Fig. 23



Text-Fig. 23. Camera lucida drawing of *?Nexosispinum hesperum* Davey, 1979a, spines omitted. X1300.

Remarks: Specimens referred to *?Nexosispinum hesperum* here conform in every respect with Davey's diagnosis for that species (1979a, p. 558) except in the archeopyle type. Although Davey does not categorically state in the specific diagnosis that *N. hesperum* has a two paraplate, precingular archeopyle, this is stated in the generic diagnosis and must therefore, apply to *N. hesperum*, the type species. Those specimens examined here exhibit a 3P archeopyle and although no parasutural ornament allows "first hand" designation of the paraplates involved, comparisons with a similar cyst genus, *Exiguisphaera* Duxbury, 1979, allow the archeopyle type to be expressed as $3P_{3'-5'}$ (see Text-Fig. 23).

Occisucysta Gitmez, 1970

1970 *Occisucysta* Gitmez, p. 267.

Remarks: The present author has examined the holotype of *Occisucysta* balios Gitmez, 1970, the type species, and this proves to be cornucavate and to possess an apical horn similar to but much smaller than that of *O. tentoria* Duxbury, 1977. A previously undescribed species, *O. ?echinata* (see below) is similarly cornucavate and in this respect, *O. balios, O. tentoria* and *O. ?echinata* differ from other species which have been included in this genus.

Occisucysta ?echinata Duxbury n. sp.

Pl. 4, figs. 12, 13.

Derivation of Name: From the Latin *echinatus*, spiny – in reference to the very spiny nature of this species.
Holotype: Pl. 4, figs. 12, 13.
Type Locality: Sample R9, Ferruginous Sands Series, Redcliff section, Isle of Wight.

Diagnosis: A proximate to proximo-cavate dinoflagellate cyst species which is spheroidal to ovoidal in shape and which is surmounted by a prominent, notably cavate apical horn. A crude reticulum, in the form of low, punctate muri, extends over the whole body surface. Numerous spines arise from the reticulum and these may be proximally vacuolate to such a degree that localised or extensive cavation may result. An ectophragm covers the reticulum but leaves the distal ends of the spines free. The ectophragm bears low paracingular and parasutural crests which are perforate, finely denticulate distally and which mark out a typically gonyaulacacean paratabulation pattern. Some small grana and/or coni may be present on the ectophragm surface. The archeopyle is formed by detachment of paraplates 2" and 3".

Observed Dimensions:		
	Holotype	– 81 x 90 µm
	Overall	– 81 (75) 70 x 90 (73) 61 µm
	Specimens measured	– 7

Remarks: This species is most distinctive, particularly in being an extremely spinose *Occisucysta*-type cyst with a clearly marked reticulum between the body layers. The variation in the degree of development of the vacuoles at the proximal ends of the spines results in some specimens being largely proximate whilst others are almost entirely cavate. No other species of *Occisucysta* demonstrates this last feature and for this reason the assignment of *echinata* to *Occisucysta* may be only tentative.

Oligosphaeridium Davey & Williams, 1966

1966 *Oligosphaeridium* Davey & Williams, pp. 70, 71.

Oligosphaeridium perforatum (Gocht, 1959) Davey & Williams, 1969

1959 *Hystrichosphaeridium perforatum* Gocht, p. 68, pl. 3, fig. 7, pl. 7, figs. 13–16.
1969 *Oligosphaeridium perforatum* (Gocht) Davey & Williams, p. 5.

Remarks: During the present study, specimens of *O. perforatum* have been observed to fall into two distinct types. Some are of the type originally described in Gocht, 1959 and possess polygonal process terminations with, typically, no gonal spines (although very short, broad-based ones may be present) and some distal perforations which never approach widespread fenestration. The second type comprise specimens similar in the overall morphology of their process terminations to those described above but differ in that the distal process terminations are distinctly fenestrate. It is felt that the erection of two sub-species of *O. perforatum* is necessary and this is effected below.

Oligosphaeridium perforatum (Gocht, 1959) Davey & Williams, 1969 subsp. *perforatum* Duxbury n. subsp.

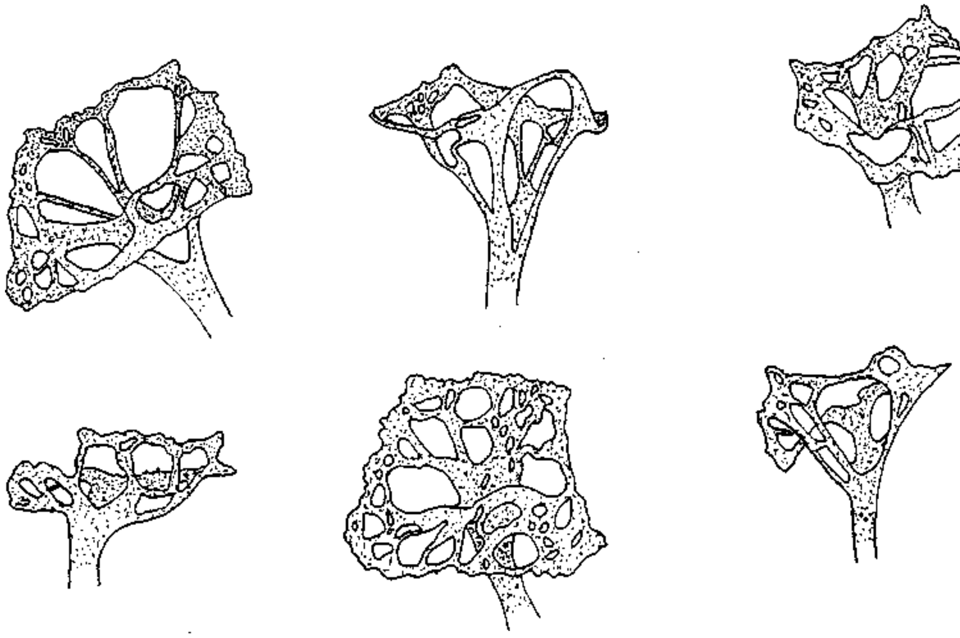
Pl. 8, fig. 6

1959 *Hystrichosphaeridium perforatum* Gocht, p. 68, pl. 3, fig. 7, pl. 7, figs. 13–16.
1969 *Oligosphaeridium perforatum* (Gocht) Davey & Williams, p. 5.

Holotype: Tübingen, Geol. Paläont. Inst., Pr. 1106, Präp. N. 40 – figured in Gocht, 1959, pl. 3, fig. 7.
Type Locality: Raum Hannover (Niedersachsen); (Upper?) Barremian.

Diagnosis: A sub-species of *Oligosphaeridium perforatum* (Gocht, 1959) Davey & Williams, 1969 in which the distal process extremities are perforate but in which the perforations are never so developed as to produce an overall fenestration.

Observed Dimensions: Holotype – main body 61 x 56 μm; processes 29–40 μm; overall width 125 μm. Largest dimension of other specimens from 80–100 μm.



Text-Fig. 24. Camera lucida drawings demonstrating the distal process morphology in *Oligosphaeridium perforatum* (Gocht, 1959) Davey & Williams, 1969 subsp. *colum* Duxbury n. subsp. All X1500.

Oligosphaeridium perforatum (GOCHT, 1959) DAVEY & WILLIAMS, 1969 subsp. *colum* DUXBURY n. subsp.

Pl. 8, fig. 9; Text-Fig. 24

1975 *Oligosphaeridium anthophorum* (COOKSON & EISENACK) DAVEY in BRIDEAUX & MCINTYRE, pl. 8, figs. 12, 13.

Derivation of Name: From the Latin *colum*, a sieve, strainer – in reference to the distal process fenestration.
Holotype: Pl. 8, fig. 9.
Type Locality: Sample AB8, Sandrock Series, Atherfield section, Isle of Wight.

Diagnosis: A sub-species of *Oligosphaeridium perforatum* (GOCHT, 1959) DAVEY & WILLIAMS, 1969 in which the distal process extremities are highly fenestrate.

Observed Dimensions: Holotype – 84 x 110 μm
Range: Main Body – 64 (55) 44 x 64 (55) 44 μm
Processes – 20–52 μm
Specimens measured – 15.

Remarks: The degree of distal process fenestration sets this sub-species apart from *O. perforatum* (GOCHT, 1959) DAVEY & WILLIAMS, 1969 subsp. *perforatum* DUXBURY n. subsp., which has distal process terminations similar in overall morphology to those of *O. perforatum* subsp. *colum*, but possesses fewer perforations which may not be considered to form an overall fenestration (see GOCHT, 1959, pl. 3, fig. 7, pl. 7, figs. 13–16). *Oligosphaeridium dictyophorum* (COOKSON & EISENACK, 1958) DAVEY & WILLIAMS, 1979 is similar to *O. perforatum* subsp. *colum* in possessing processes which are distally fenestrate. It differs, however, in having solid processes (atypical of the genus *Oligosphaeridium*) and in lacking the distinct angularity to the distal process extremes which is a major characteristic of *O. perforatum* (see Text-Fig. 24, herein).

Protoellipsodinium DAVEY & VERDIER, 1971

1971 *Protoellipsodinium* DAVEY & VERDIER, p. 26.

Protoellipsodinium clavulum DAVEY & VERDIER, 1974 emend. herein

Pl. 5, figs. 16, 19

1974 *Protoellipsodinium clavulum* DAVEY & VERDIER, p. 637, pl. 93, fig. 7.
1977 *Operculodinium? spinigerum* BRIDEAUX, p. 30, pl. 12, figs. 8, 9, pl. 13, figs. 1–11.

Emended Diagnosis: An elongate ovoidal to ellipsoidal, smooth-walled cyst bearing fairly numerous slender processes which may be absent around the equator. The processes are less than half the cyst width in length and may be solid or hollow with a restricted lumen. Distally the processes may be capitate, bifurcate, trifurcate or multifurcate. The archeopyle is single paraplate precingular.

Remarks: *Operculodinium? spinigerum* BRIDEAUX, 1977 is here considered a junior synonym of *Protoellipsodinium clavulum* DAVEY & VERDIER, 1974. Specimens observed during the present study range from examples whose process tips are capitate to larger forms with multifurcate distal extremes. There is a gradation between such forms and, therefore, there appears to be no justification for separating specimens with bi- or trifurcate processes from those with multifurcate ones. The present author's observations compare very well with those of BRIDEAUX (1977, p. 30) who states, "distal margins of processes highly variable, bifid, trifurcate with distal bifid tips, or quadrifurcate to multifurcate". In their original diagnosis of *Protoellipsodinium clavulum*, DAVEY & VERDIER (1974, p. 637) include the possibility of bi- or trifurcate distal process extremities and in their description, they state, "the processes expand at their distal extremities and are basically capitate; this expansion is usually slight (approximately 1 μm in width) but occasionally is wide and gives rise to two or three recurved spines". It would appear that those specimens observed by DAVEY & VERDIER from the Aptian type sections represent the less elaborate end of the morphological range observed by BRIDEAUX (1977) and in the present work. In order to include the more extreme forms encountered in these last two works, the diagnosis is emended above to include the specimens with more than three distal spines to the processes. The diagnosis is also altered to include the possibility of solid processes being present, a feature observed when processes are particularly slender.

Spiniferites MANTELL, 1850 emend. SARJEANT, 1970

1850 *Spiniferites* MANTELL, p. 191.
1937 *Hystrichosphaera* WETZEL, 1933 ex DEFLANDRE, p. 61.
1953 *Hystrichokibotium* KLUMPP, p. 387.
1963 *Achomosphaera* EVITT, p. 163.
1970 *Spiniferites* MANTELL, 1850 in SARJEANT, p. 75.

Remarks: The separability of *Achomosphaera* EVITT, 1963 from *Spiniferites* MANTELL, 1850 emend. SARJEANT, 1970 has been a subject of discussion for several years. The main argument appears to centre on whether or not these genera may be effectively distinguished simply on the presence or absence of ridges or septa connecting process bases. Authors opposed to such separation include REID (1974) who stated (p. 609), "the sole criterion of the reduction of sulcal crests to faint lines, or their complete absence is not considered sufficient variation for the distinction of the Genus *Achomosphaera* from *Spiniferites*". Other authors tend to admit difficulties but elect to retain the two genera. Such authors include STOVER & EVITT (1978), who stated (p. 138), "transitional forms with parasutural features intermediate between those on typical species of each genus make consistent identification difficult". This problem with transitional forms extends even to the type material. In DAVEY & WILLIAMS (1966a, p. 46), in the remarks under *Achomosphaera*, it is stated that DAVEY's examination of the type material of *Achomosphaera ramulifera* revealed a paratype (DEFLANDRE, 1937, pl. 14, fig. 6) to have, "very faint lines on the surface of the central body delimiting the plate boundaries". DAVEY & WILLIAMS also observed that, "such lines were not observed on the holotype but this was probably due to the obscuring nature of particles within the flint".

In a purely morphological classification system, one must decide on criteria for generic separation and adhere to them. Rare, "borderline" cases may cause problems, but these may usually be resolved by strict application of the criteria defined as important. In the case of *Achomosphaera* and *Spiniferites*, therefore, starting with the premise that all such forms without parasutural features are referable to *Achomosphaera*, one may, for instance, separate *Achomosphaera alcicornu* (EISENACK, 1954) DAVEY & WILLIAMS, 1966a from *Spiniferites pseudofurcatus* (KLUMPP, 1953) SARJEANT, 1970. In anything other than a purely morphological system, these last two species would have been inseparable.

The basis of a workable morphological classification system is clear definition of the type species and type specimens. It is unfortunate that, in the case of *Achomosphaera*, there is some doubt as to the lack of paratabulation in the holotype of the type species, as discussed in DAVEY & WILLIAMS (1966a, p. 46). Whether or not the presence of "very faint lines" marking parasutures in *A. ramulifera* is important in invalidating the genus *Achomosphaera* is itself debateable. In EVITT's original description of that genus, he stated that *Hystrichosphaera* (sic) differs from *Achomosphaera* in having "well-developed sutural ridges or septa". EVITT did not suggest where specimens demonstrating "very faint lines" should be placed. Presumably, any positive parasutural connections, however faint, exclude specimens from *Achomosphaera*, as originally defined.

The present author feels that a morphological classification system is the only scheme which may be used to effectively sub-divide dinoflagellate cysts. Any attempt to introduce evolutionary concepts or to apply knowledge gained from studying recent cyst/theca cycles, etc. would lead to the recognition of so many "borderline cases" as to make the classification unworkable. MAY's (1980, p. 64) statement, "thus, specimens with *Spiniferites* – like processes which lack sutural ridges are likely *Spiniferites* variants and should be assigned to the genus *Spiniferites*", therefore has no relevance in a purely morphological sense. However, it is considered here that the presence of parasutural lines on the paratype figured in DEFLANDRE, 1937, pl. 14, fig. 6 (see DAVEY & WILLIAMS, 1966a, p. 46) and the suggestion in DAVEY & WILLIAMS, 1966a, p. 46 that the reason that paratabulation was not observed in the holotype was that debris obscured the specimen, clearly bring into doubt the validity of *Achomosphaera* from the outset. This, coupled with the difficulty in separating forms with parastural lines from those without, when such lines are often narrow and indistinct, leads the present author to follow REID, 1974 and May, 1980 in synonymising *Achomosphaera* with *Spiniferites.*

Spiniferites neptunii (EISENACK, 1958) n. comb. emend. herein

Pl. 7, figs. 13, 14

1958 *Baltisphaeridium neptuni* EISENACK, p. 399, pl. 26, figs. 7, 8; Text-Fig. 8.
1966a *Achomosphaera neptuni* (EISENACK) in DAVEY & WILLIAMS, p. 51, pl. 3, fig. 7, pl. 9, fig. 11.

Emended Diagnosis: A chorate dinoflagellate cyst species possessing a fairly thick-walled, fibro-reticulate central body. Trifurcate gonal and bifurcate parasutural processes are present and these may be proximally connected by low crests. Rarely, the processes may have a secondary bifurcation. The processes are fibrous and, particularly proximally, the fibres may be aligned parallel to the long axis. The archeopyle is single paraplate precingular (3").

Remarks: The diagnosis is here emended in order to emphasise the single-paraplate, precingular archeopyle in this species and to include the possibility of parasutural crests being present. Both of these features were noted by DAVEY & WILLIAMS (1966a, p. 51).

All specimens of *S. neptunii* examined here possess parasutural crests whilst in all other respects they are similar to specimens observed by the present author from the Speeton Clay. Some Speeton Clay specimens do, apparently, demonstrate very low parasutural features, as suggested by DAVEY & WILLIAMS (1966a, p. 51), who describe, "the fibres sometimes radiating from the bases of the processes and these may be slightly thickened along the reflected plate boundaries joining the processes". The holotype, described by EISENACK (1958), apparently does not have parasutural crests since examination of that specimen by EVITT prompted STOVER & EVITT (1978, p. 139) to state that it has, "terminally closed, hollow, single intratabular processes".

Specimens referred to here as *Spiniferites* cf. *neptunii* are equivalent to those termed *Achomosphaera* cf. *neptunii* in DAVEY & VERDIER (1974, pp. 628, 629, pl. 92, fig. 2) and in DUXBURY (1980, p. 112, pl. 6, figs. 1, 2), and are undoubtedly referable to *Achomosphaera verdieri* BELOW, 1982.

Spiniferites ramuliferus (DEFLANDRE, 1937) REID, 1974

Pl. 5, figs. 4, 9

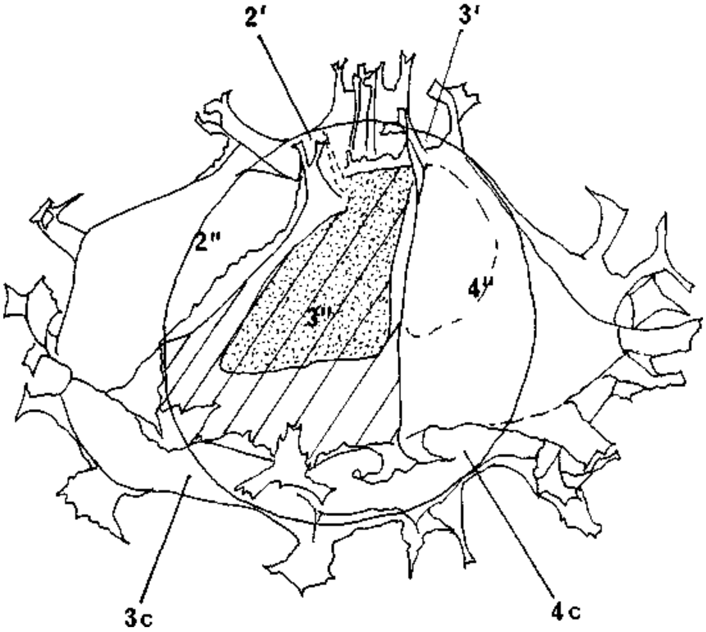
1935 *Hystrichosphaera* cf. *ramosa* (EHRENBERG) in DEFLANDRE, pl. 5, fig. 11.
1937 *Hystrichosphaeridium ramuliferum* DEFLANDRE, p. 74, pl. 14, figs. 5, 6, pl. 17, fig. 10.
1963 *Baltisphaeridium ramuliferum* (DEFLANDRE) in DOWNIE & SARJEANT, p. 92.
1974 *Spiniferites ramuliferus* (DEFLANDRE) in REID, p. 608, pl. 4, figs. 39, 40.

Remarks: Specimens of *S. ramuliferus* observed in the present work are similar to those in MAY (1980, p. 63) in that some possess parasutural crests, whereas the majority are devoid of such features.

Stephanelytron SARJEANT, 1961 emend. STOVER, SARJEANT & DRUGG, 1977

1961 *Stephanelytron* SARJEANT, p. 109
1977 *Stephanelytron* STOVER, SARJEANT & DRUGG, p. 331

Remarks: It is remarkable, considering the morphological similarities between the genera, that *Stephanelytron* and *Chlamydophorella* COOKSON & EISENACK, 1958 emend. herein have not been compared to date. Both genera comprise holocavate species possessing thin ectophragms supported by short, proximally and distally flaring tubules; these are usually hollow but may be solid when particularly slender. The only noteworthy differences are the presence in *Chlamydophorella* of an apical horn of varying lengths and in *Stephanelytron* of coronas at or near



Text-Fig. 25. Camera lucida drawing of *Stephodinium spinulosum* DUXBURY n. sp., paratype. Oblique dorsal view. X1300.

the antapex. There are species of *Chalamydophorella* which are closely comparable with species of *Stephanelytron;* a particularly good example is the similarity of *C. huguonioti* (VALENSI, 1955) DAVEY, 1978 to *S. cretaceum* DUXBURY n. sp. and *S. scarburghense* SARJEANT, 1961.

Stephanelytron cretaceum DUXBURY n. sp.

Pl. 7, figs. 5, 6

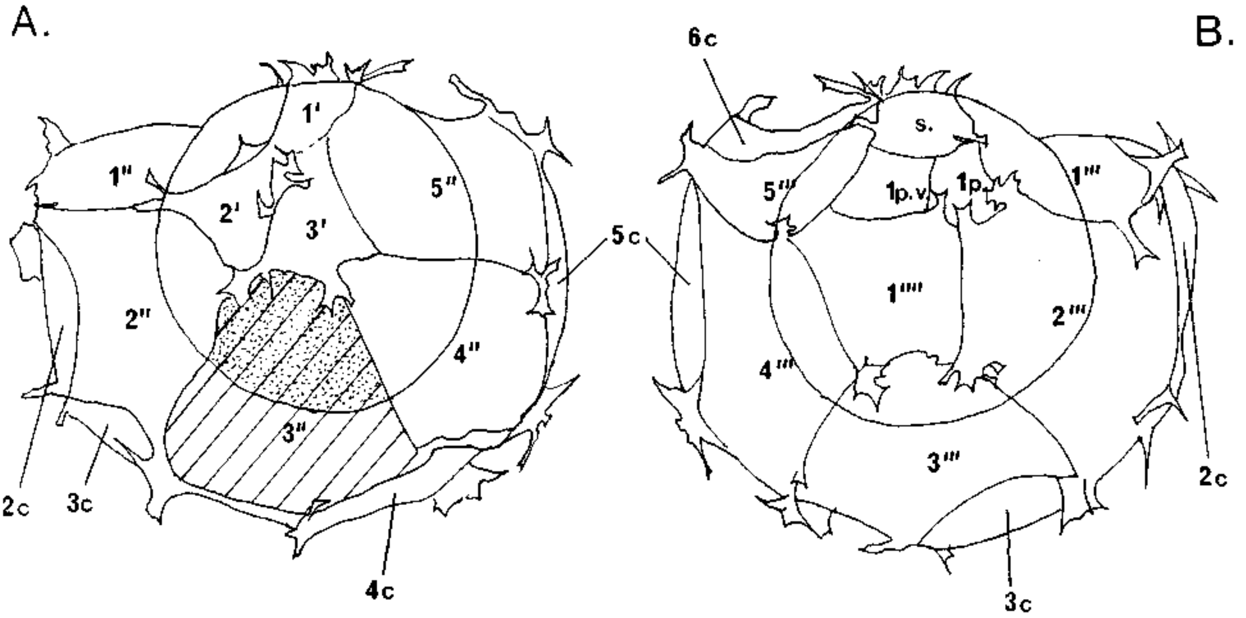
1979b *Chlamydophorella* sp. A. DAVEY, p. 56, pl. 3, figs. 10–13.

Derivation of Name: From Cretaceous – in reference to the recorded age of this species to date.
Holotype: Pl. 7, figs. 5, 6.
Type Locality: Sample AB 14, Walpen Clay and Sand, Ferruginous Sands Series, Atherfield section, Isle of Wight.

Diagnosis: A spheroidal, holocavate dinoflagellate cyst possessing a low apical protuberance. The autophragm is smooth and bears numerous short, slender, hollow tubules which flare proximally and distally. The tubules may be distally united by a continuous or fragmentary, very delicate ectophragm. A small corona is present near the antapical pole and the cyst surface within the corona is densely granular. The archeopyle is apical and no paratabulation is apparent except around the archeopyle margin.

Observed Dimensions: Holotype – 52 x 49 µm
Overall – 58 (52) 46 x 58 (49) 44µm
Specimens measured – 18

Remarks: The species to which *S. cretaceum* bears resemblance are *Stephanelytron scarburghense* SARJEANT, 1961 and *Chlamydophorella huguonioti* (VALENSI, 1955) DAVEY, 1978. *S. scarburghense* differs, however, in possessing a very distinct and larger corona than *S. cretaceum* and, in some cases, it has two coronas. *C. huguonioti* differs in lacking any corona.



Text-Fig. 26. Camera lucida drawings of *Stephodinium spinulosum* DUXBURY n. sp., paratype. A apical and B antapical aspects. X1300.

Stephodinium DEFLANDRE, 1936 emend. DAVEY, 1970

1936 *Stephodinium* DEFLANDRE, p. 58.
1970 *Stephodinium* DEFLANDRE in DAVEY, p. 347.

Remarks: In their "comparisons" under *Stephodinium*, STOVER & EVITT (1978, p. 192) remark that one of the differences between *Hystrichostrogylon* AGELOPOULOS, 1964 and *Stephodinium* is that the former, "has processes, which *Stephodinium* lacks". However, there is nothing in the diagnosis of *Stephodinium* which debars that genus from possessing processes. The main characteristic feature of *Stephodinium* is the separation of the two body layers in an area roughly coincident with the paracingulum and this was recognised by DEFLANDRE (1936, p. 58). Paratabulation is marked on the periphragm by low ridges.

A species referred to *Stephodinium* here, *S. spinulosum* DUXBURY n. sp., displays short gonal and (rarely) parasutural processes, most reminiscent of the gonal and parasutural processes of the genus *Spiniferites* MANTELL 1850 emend. SARJEANT, 1970. The two body layers in *Stephodinium spinulosum* are, however, appressed only over part of the anterior, posterior and ventral areas and a large cavation is present, mainly coincident with the paracingulum (see Text-Figs. 25 and 26). It may be that *S. spinulosum* is a transitional form between the genus *Spiniferites* and *Stephodinium coronatum* DEFLANDRE, 1936, the type species.

Stephodinium spinulosum DUXBURY n. sp.

Pl. 5, figs. 6, 10, 14; Text-Figs. 25, 26

Derivation of Name: From the Latin *spinulosus*, having small thorns – in reference to the processes.
Holotype: Pl. 5, fig. 6.
Type Locality: Sample R7, Ferruginous Sands Series, Redcliff section, Isle of Wight.

Diagnosis: A fairly thick-walled, distinctly bi-layered, proximo-cavate dinoflagellate cyst species with smooth endo- and periphragm. The body layers are appressed except in an area including the paracingulum and those portions of the pre- and postcingular series adjacent to it. Paratabulation of the formula 3’, ?6”, ?6c, 5”’, 1p. v., 1”” is outlined by low parasutural crests. Gonal areas bear short, trifurcate processes and, rarely, bifurcate parasutural ones may be present. The archeopyle is single-paraplate precingular (3”).

Observed Dimensions: Holotype – 52 x 70 μm
Overall – 67 (61) 49 x 84 (75) 61 μm
Specimens measured – 16

Remarks: The presence of short, *Spiniferites*-type processes distinguishes this species from *Stephodinium coronatum* DEFLANDRE, 1936, the most closely comparable taxon.

Peridiniacean Cysts

Cepadinium DUXBURY n. gen.

Derivation of Name: From the Latin *cepa*, onion – in reference to the variable number of body layers.

Diagnosis: Proximo-cavate, peridiniacean dinoflagellate cysts which are dorso-ventrally flattened with a slight ventral concavity. Three horns are usually present, consisting of one apical, one well-developed left-antapical and one reduced right-antapical. Three or four body layers are usually present, in which case an ornament of granules and/or coni may be present on the second layer in. As few as two layers may be seen and in this case, the granules and/or coni are present on the external surface. A laevo-rotatory paracingulum is present, and, laterally, a paracingular notch may be observed which becomes increasingly pronounced with an increasing number of body layers. The archeoplyle is of a $3A_{2'-4'}3I$ type and the operculum usually remains attached ventrally.

Type Species: *Cepadinium variabilis* DUXBURY n. gen. et. sp.

Remarks: This genus differs from all others of the peridiniacean lineage in its archeopyle type and in the variability in the number of body layers observed. The archeopyle involves displacement of three apical paraplates and three intercalaries (2’–4’ + 3I) which remain mutually attached to form a coherent unit, the operculum, which is usually attached ventrally.

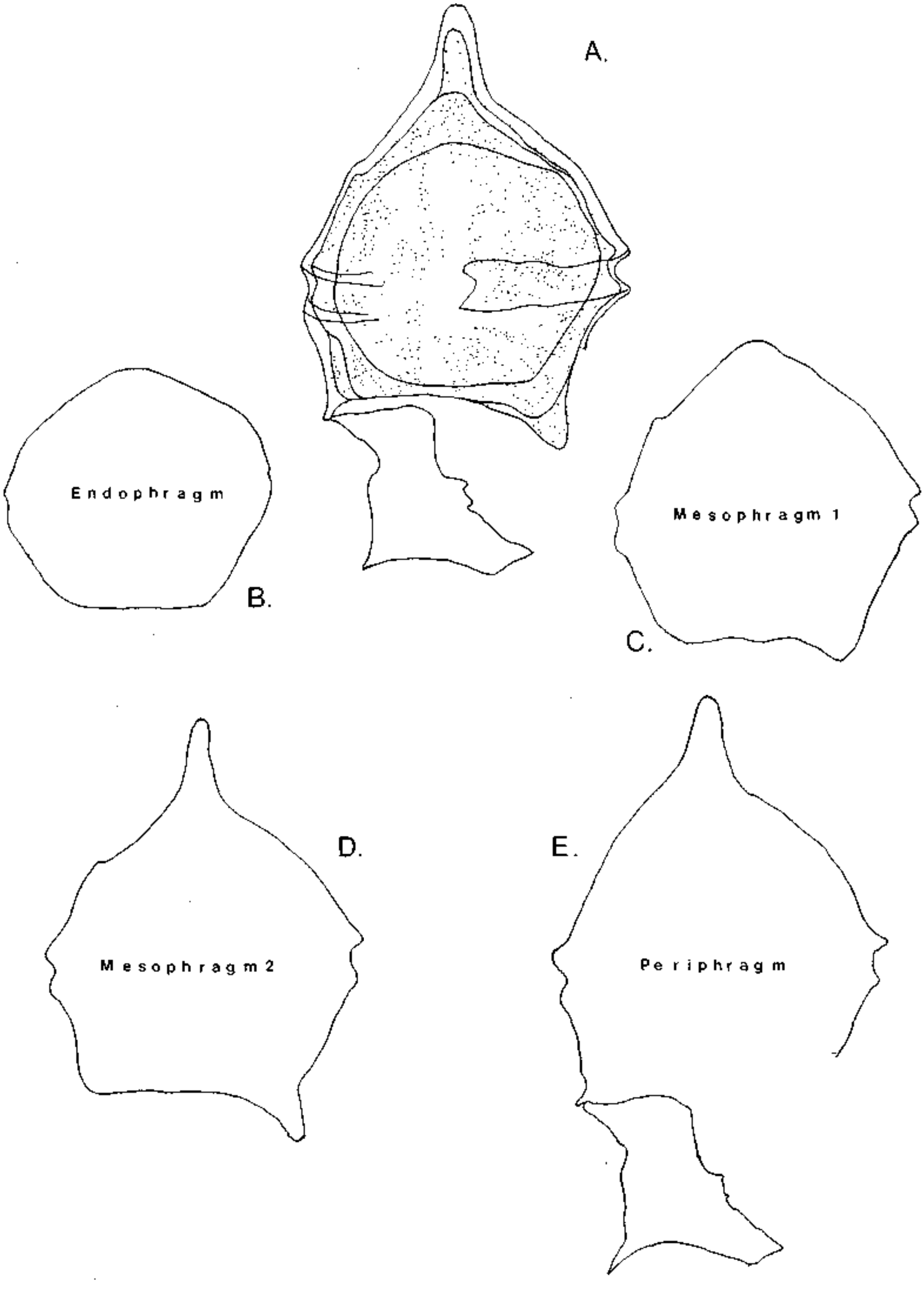
The development of more than two body layers was mentioned as a possibility for the genus *Deflandrea* in EVITT (1969, p. 459, fig. 18–9h, i and j). No details were given, however.

Cepadinium variabilis DUXBURY n. sp.

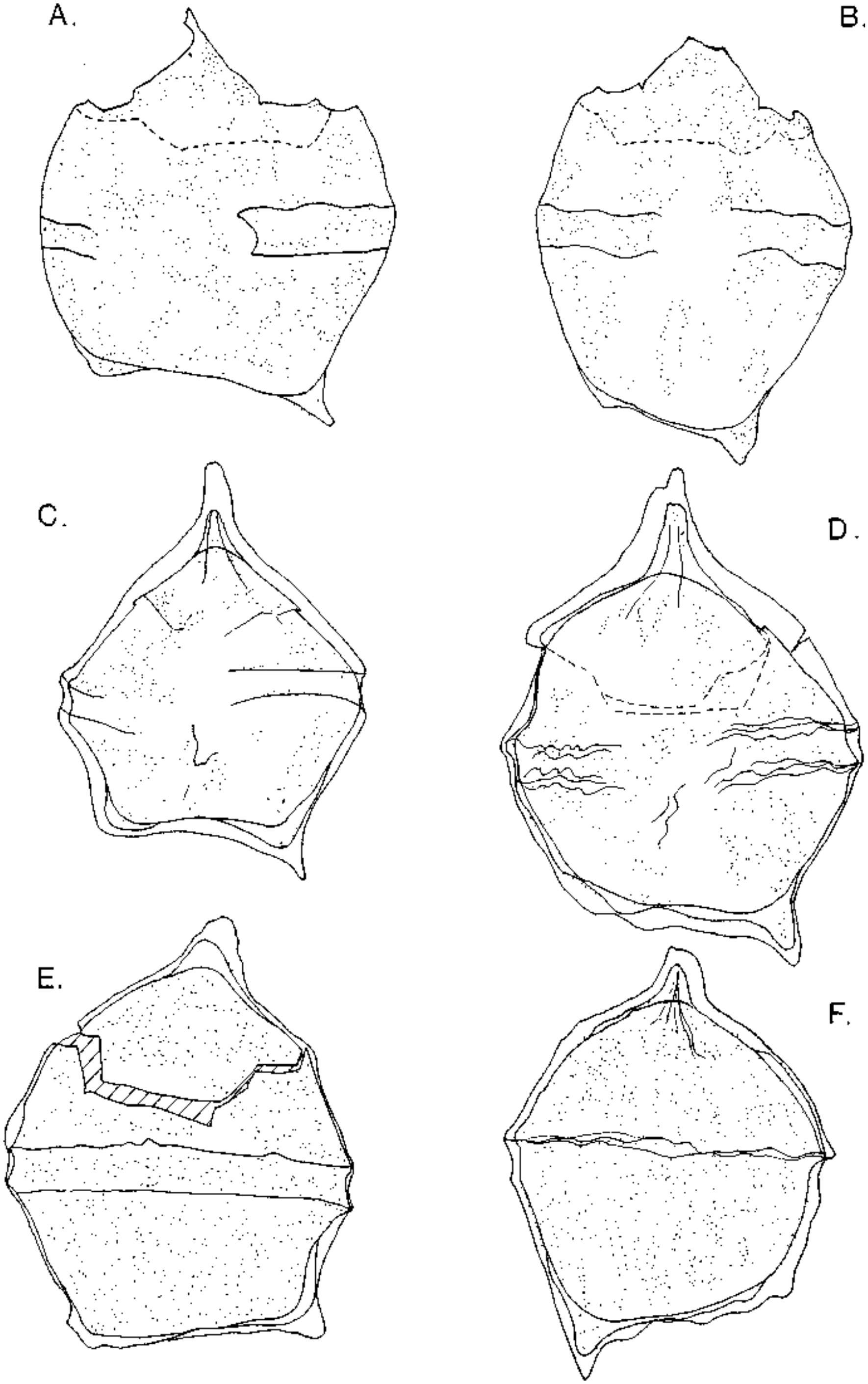
Pl. 9, figs. 1, 4, 8; Text-Figs. 27, 28

Derivation of Name: From the Latin *variabilis*, changeable – in reference to the variable number of body layers.
Holotype: Pl. 9, fig. 8; Text-Fig. 27.
Type Locality: Sample AB 30, Lower Gryphaea Grit, Ferruginous Sands Series, Atherfield section, Isle of Wight.

Diagnosis: A proximo-cavate dinoflagellate cyst possessing well-developed apical and left-antapical horns and a right-antapical horn which is reduced to varying degrees. Four body layers are present in the most completely preserved specimens but more commonly only three are observed. In each of these cases, a granular and/or conical body ornament is present on the second layer in. Two body layers may be observed in extreme cases, in which event the ornament is observed on the outer layer. A laevorotatory paracingulum is always present, as is a ventral depression which may contain a poorly-defined rostrum. The archeopyle is of a $3A_{2'-4'}3I$ type and the operculum usually remains attached ventrally. No paratabulation other that that reflected by the paracingulum and archeopyle margin has been observed.



Text-Fig. 27. Camera lucida drawing of *Cepadinium variabilis* DUXBURY n. gen. et sp., holotype (A), separated graphically into its four constituent layers. All X850.



Text-Fig. 28. Camera lucida drawings of *Cepadinium variabilis* DUXBURY n. gen. et sp. A and B two-layered, C–F three-layered. A–F paratypes. All X850.

Observed Dimensions: Holotype (four-layered) – 73 x 58 µm
Overall – 87 (67) 46 x 64 (49) 42 µm
Specimens measured – 24

Remarks: This species is most distinctive and easily recognisable. The variation in the number of body layers is remarkable and, as noted above, results in specimens possessing anything from two to four body layers (see Text-Figs. 27 and 28). As is shown in Text-Fig. 27, the outline of the four body layers becomes more pronouncedly peridiniacean towards the exterior of the cyst. Specimens possessing four body layers are rare but those with three are fairly abundant and it is noteworthy that in both the four-layered and the three-layered forms, the granular/conical body ornament is observed on the second layer in (designated Mesophragm 2 in Text-Fig. 27). The two layered specimens possess ornament on the outer layer. On the evidence afforded by the very ornamented layer in *C. variabilis*, it may be inferred that the three-layered specimens differ from the four-layered ones in lacking the endophragm (as defined in Text-Fig. 27) whilst the two-layered forms also lack the periphragm (again as defined in Text-Fig. 27).

"Canningia" turrita Brideaux, 1977 is most reminiscent of the two-layered forms of *C. variabilis*, particularly in the archeopyle type. Brideaux states (1977, p. 13), "Archeopyle interpreted as being formed by the loss of at least three apical paraplates (probably 2'–4') and one or three intercalary paraplates (1a or 1a–3a)", and this is very similar to that inferred for *C. variabilis* (3A$_{2'-4'}$3I). From his further remarks on *"C." turrita*, Brideaux may be seen to consider his species as possibly related to the peridinoid lineage and again this suggests some comparability with *C. variabilis*. Brideaux has, however, stated (pers. comm.) that he has not observed *"C." turrita* other than in the type area (Richardson Mountains, District of Mackenzie, Canada) and that *"C." turrita* never exhibited any wall layers other than those discussed in Brideaux, 1977 (thin, smooth endophragm and thin periphragm with scattered grana or coni). *C. variabilis* is here considered a new species but the similarity between it and *"C." turrita* must be recognised, particularly in the mode of archeopyle formation.

Luxadinium Brideaux & McIntyre, 1975

1975 *Luxadinium* Brideaux & McIntyre, p. 36.

Luxadinium primulum Brideaux & McIntyre, 1975

Pl. 10, figs. 6, 7, 10; Text-Fig. 29.

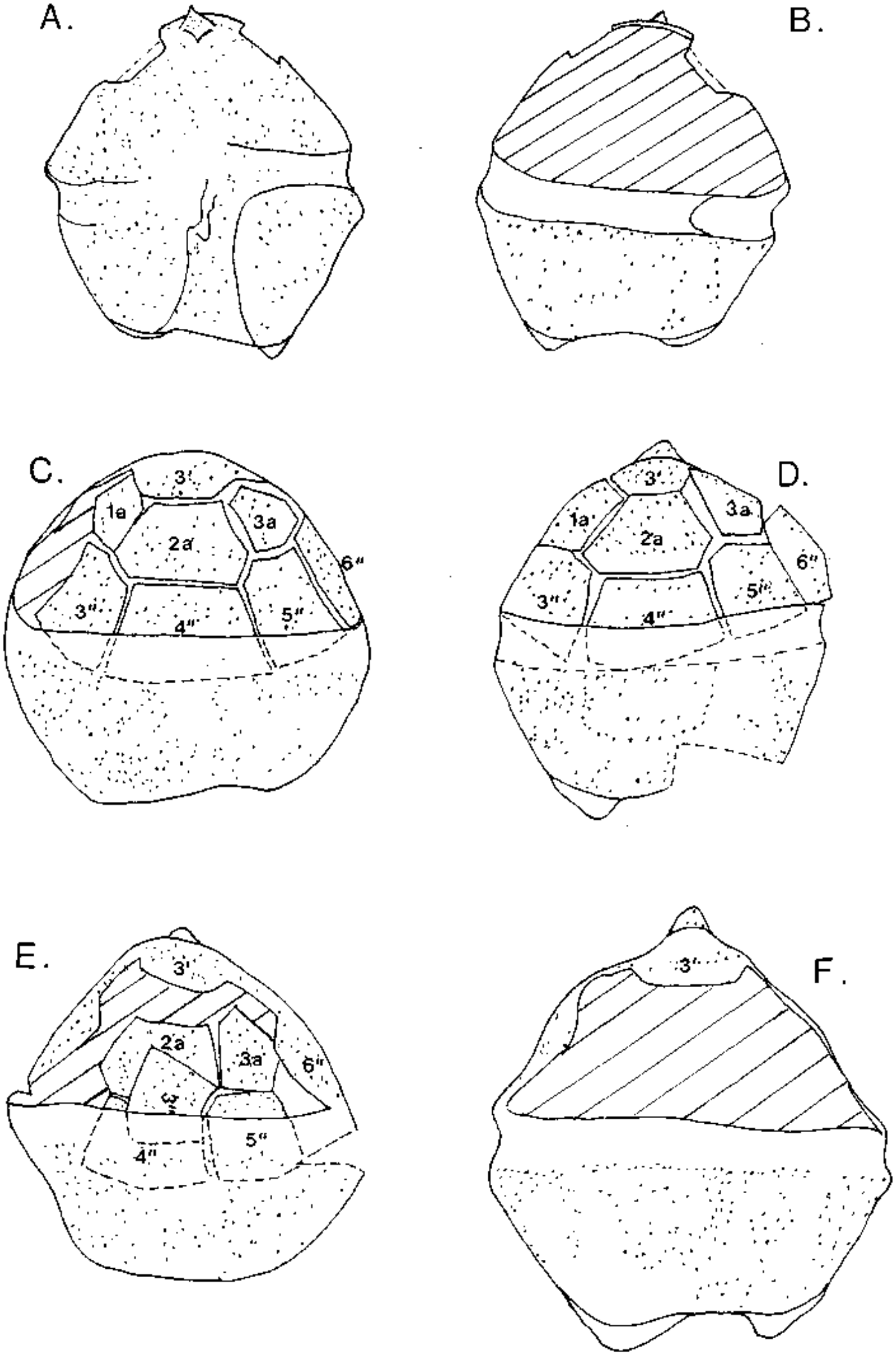
1975 *Luxadinium primulum* Brideaux & McIntyre, p. 37, pl. 12, figs. 9–12, pl. 13, figs. 1–8.

Remarks: Specimens assigned to *L. primulum* here agree very closely in their morphology with the type material of Brideaux & McIntyre. As remarked by those authors, "Reflected tabulation is defined on the endophragm by intratabular clusters of apiculate sculpture separated by smooth intertabular regions". The paratabulation scheme quoted for *L. primulum* by Brideaux & McIntyre is 4', 7", Oc, 5" (sic), 2"" and this is more detailed than could be discerned during the present work. However, occasionally ridges were observed to transect the paracingulum (see Text-Fig. 29B) and this suggests that, although no alignment of "intratabular clusters of apiculate sculpture" were observed to allow detailed subdivision of the paracingulum, Brideaux & McIntyre's designation "Oc" is incorrect.

Ovoidinium Davey, 1970 emend. herein

1970 *Ovoidinium* Davey, p. 351.
1973 *Pocockia* Lentin & Williams, p. 114.

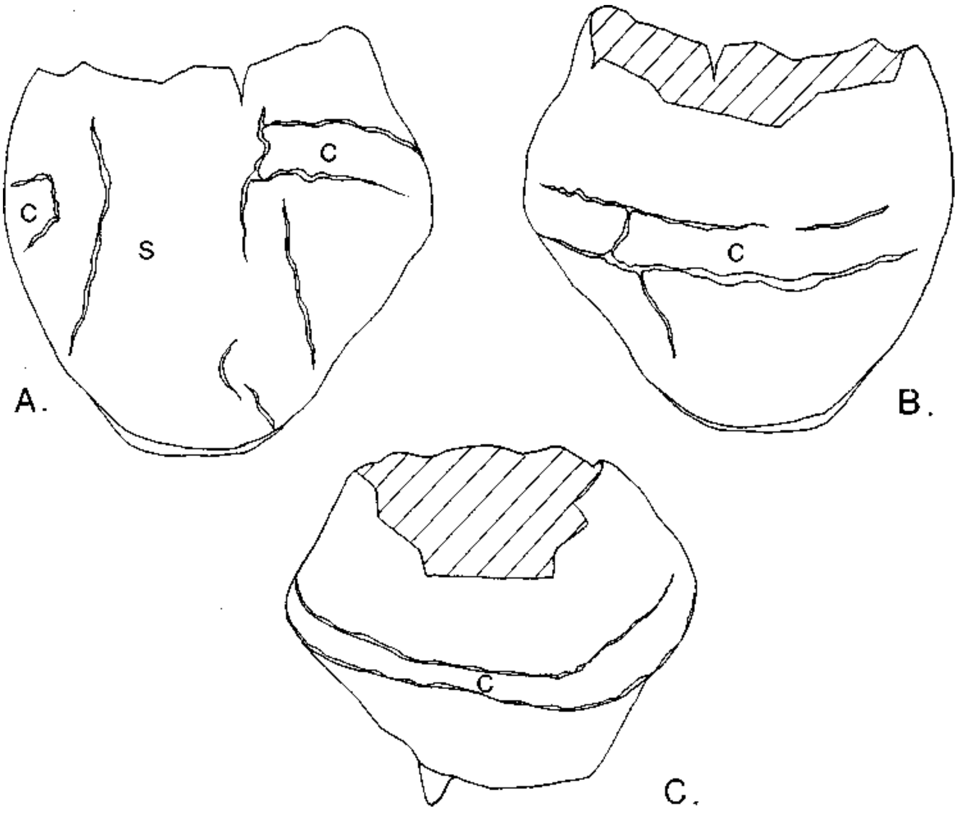
Emended Diagnosis: Peridiniacean dinoflagellate cysts which are distinctly bi-layered and which are most variable in the degree of body layer separation. The endophragm is smooth to very finely granular and forms an ovoidal to spheroidal endocyst which may be dorso-ventrally flattened. The periphragm may be smooth or may be



Text-Fig. 29. Camera lucida drawings of *Luxadinium primulum* Brideaux & McIntyre, 1975. A ventral surface, B–F dorsal surfaces with varying degrees of opercular fragmentation. All X1050.

variously ornamented and the pericyst may be closely appressed to the endocyst with separations being confined to a small apical and a small left antapical horn. However, separation of the body layers into apical and antapical pericoels is usually oberved and the degree of cavation is most variable. In the extreme, cysts adopt a deflandreoid shape with the apical and antapical pericoels forming a well-developed apical and two well-developed antapical horns, respectively. Often, only the left antapical is formed. Some indication of the paracingulum and parasulcus is usually observed, indicated by folding or by surface ornament alignment. The archeopyle is of the $\overline{\mathrm{tA\ tI}}$ type and the operculum may remain attached or may be lost.

Remarks: It has become apparent, through recent observations, that the genus *Ovoidinium* Davey, 1970 emend. herein may not be confined to species possessing well-developed apical and antapical pericoels. Davey (1979a, pp. 558, 559) described two species of *Ovoidinium*, *O. diversum* and *O. implanum*. The former was described as possessing a periphragm which, "may closely adhere to the endophragm or it may be quite distinct", and in the latter, "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". In the present work, one species, *Ovoidinium incomptum*, has been recorded which possesses an apical and a left antapical horn (small-scale cornucavation) or a very small antapical pericoel may be observed. It has been felt necessary here to emend the diagnosis of *Ovoidinium* in order to allow the presence of only very reduced pericoels (down to the degree of cornucavation) and to emphasise the great variation in morphology possible within this genus.



Text-Fig. 30. Camera lucida drawings of *Ovoidinium incomptum* Duxbury n. sp. A and B paratype displaying slight body layer separation antapically. C holotype, dorsal aspect. All X925.

Ovoidinium incomptum Duxbury n. sp.

Pl. 10, figs. 4, 5, 9; Text-Fig. 30

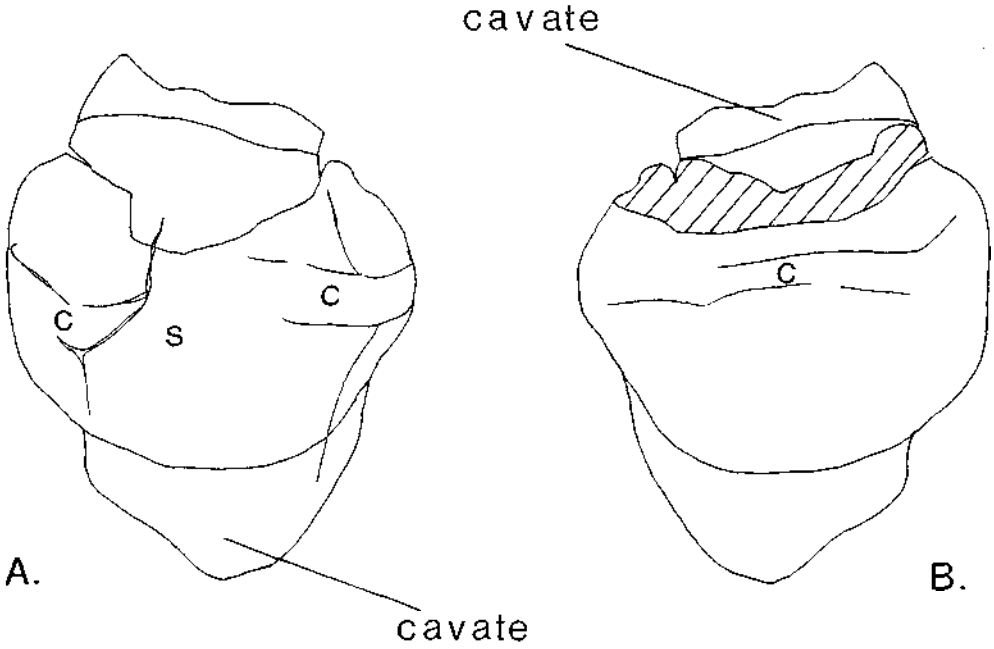
Derivation of Name: From the Latin *incomptus*, unadorned – in reference to the "simple" morphology of this species.
Holotype: Pl. 10, figs. 5, 9; Text-Fig. 30C.
Type Locality: Sample R9, Ferruginous Sands Series, Redcliff section, Isle of Wight.

Diagnosis: A small, thin-walled peridiniacean cyst species which is ovoidal and dorso-ventrally flattened. A low, distally rounded and closed apical projection is present and a small apical horn, composed entirely of periphragm may be superimposed on this. A similar, small left antapical horn is invariably present and this small scale posterior cornucavation may be extended so that slight separation of the whole posterior portion of the cyst into two layers may occur. A $\overline{\text{tAtI}}$ archeopyle is observed and the operculum only rarely remains attached. The paracingulum is usually indicated by surface folding, as are some parasutures.

Observed Dimensions: Holotype – 52 x 58 µm
Overall – 61 (49) 38 x 61 (49) 41 µm
Specimens measured – 16

Remarks: This species is similar to *Ovoidinium incorporeum* Duxbury n. sp. but differs in lacking any overt cavation.

O. incomptum differs from *O. diversum* Davey, 1979a in having a thin endophragm. The latter was described by Davey (1979a, p. 558) as possessing "a very thick, intraperforate endophragm". Also, the maximum development of pericoels in *O. incomptum* is confined to slight antapical separation of the body layers. There is no indication of the usual situation in *O. diversum* where the periphragm is "quite distinct and sometimes forms irregularly shaped protuberances."



Text-Fig. 31. Camera lucida drawings of *Ovoidinium incorporeum* Duxbury n. sp., holotype. A ventral and B dorsal aspects. X1100.

Ovoidinium incorporeum Duxbury n. sp

Pl. 10, fig. 14; Text-Fig. 31

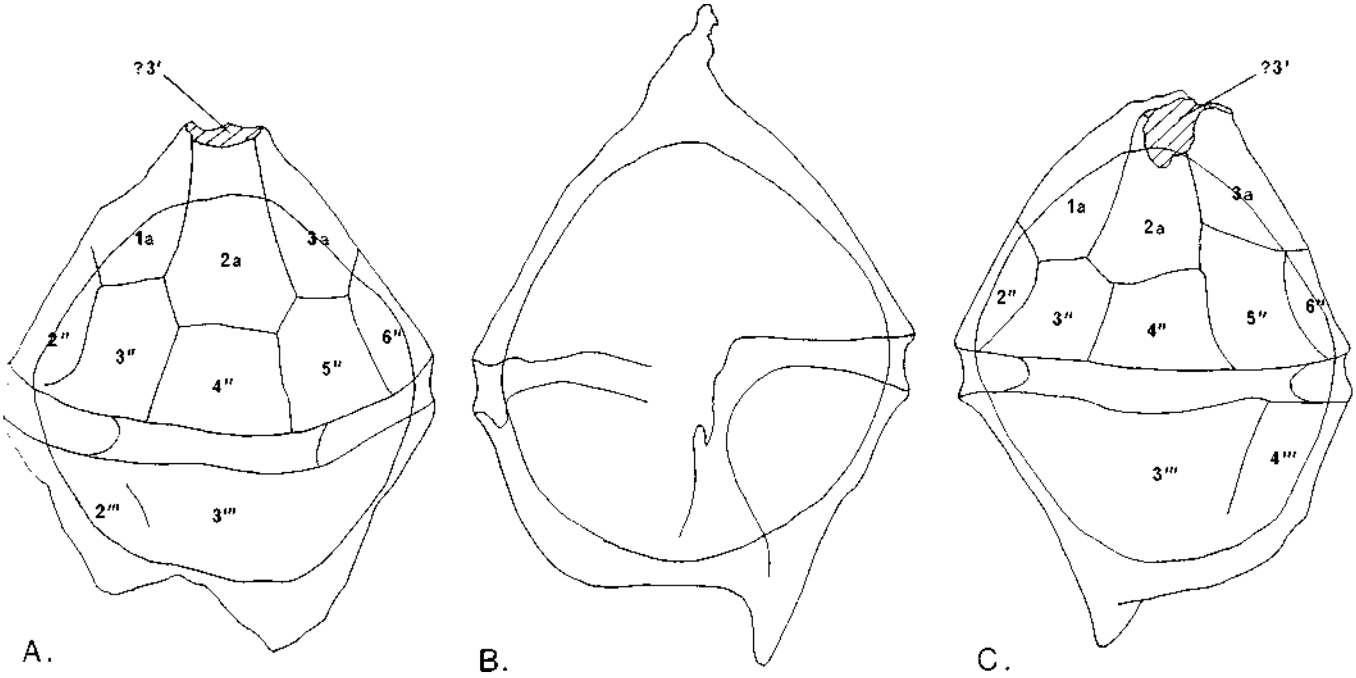
Derivation of Name: From the Latin *incorporeus*, immaterial, intangible – in reference to the very thin-walled nature of this species.
Holotype: Pl. 10, fig. 14; Text-Fig. 31.
Type Locality: Sample R12, Ferruginous Sands Series, Redcliff section, Isle of Wight.

Diagnosis: A thin-walled, dorso-ventrally flattened species of *Ovoidinium.* Both endo- and periphragm may be extensively folded and the endophragm surface may be smooth or finely granular. Anterior and posterior cavation is developed with the latter considerably better developed than the former. A $\overline{\text{tAtI}}$ archeopyle is developed with the operculum only rarely remaining attached. Low ridges or periphragm folds may indicate the paracingulum and some parasutures.

Observed Dimensions: Holotype – 67 x 52 µm
Complete specimens – 67 (64) 55 x 52 (46) 41 µm
Specimens measured – 6
Operculum detached – 52 (49) 44 x 58 (49) 38 µm
Specimens measured – 15

Remarks: The posterior cavation in *O. incorporeum* is approximately rounded triangular in outline with the apex of the triangle towards the antapex of the cyst. It does, however, possess a right lateral bulge and it may be suggested, therefore, that a left antapical and reduced right-antapical horns are being reflected in the posterior cavation of this species.

O. incorporeum is most comparable with *Ovoidinium incomptum* Duxbury n. sp. and *Ovoidinium scabrosum* (Cookson & Hughes, 1964). It differs from the former by being bicavate with well-developed anterior and posterior cavations (the latter is always better developed than the former). *O. scabrosum* is a thicker-walled, more robust species than *O. incorporeum* and its posterior cavation appears to reflect two equally well-developed antapical horns (see Cookson & Hughes, 1964, pl. 5, figs. 1–3) as opposed to the considerably better developed left-antapical of *O. incorporeum.*



Text-Fig. 32. Camera lucida drawings of *Subtilisphaera perlucida* (Alberti, 1959) Jain & Millepied, 1973. A and C dorsal aspects, B ventral aspect. X1075.

Subtilisphaera Jain & Millepied, 1973 emend. Lentin & Williams, 1975

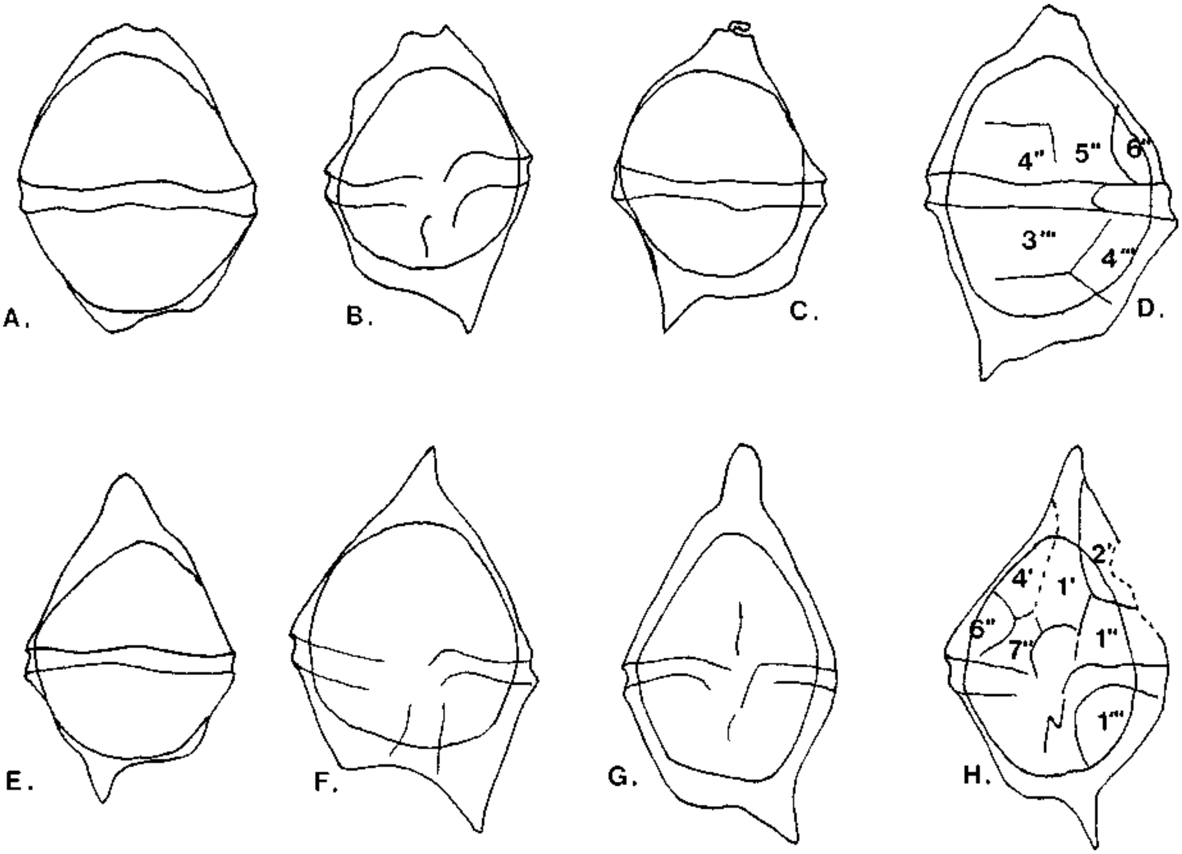
1973 *Subtilisphaera* Jain & Millepied, pp. 26, 27.
1975 *Subtilisphaera* Jain and Millepied in Lentin & Williams, pp. 117, 118.

Subtilisphaera perlucida (Alberti, 1959) Jain & Millepied, 1973

Pl. 9, figs. 5, 9, 14; Text-Figs. 32, 33

1959 *Deflandrea perlucida* Alberti, p. 102, pl. 9, figs. 16, 17.
1973 *Subtilisphaera perlucida* (Alberti) Jain & Millepied, p. 27.
1980 *Subtilisphaera pirnaensis* (Alberti) Jain & Millepied in Duxbury, pl. 11, fig. 7.

Remarks: Numerous specimens of *S. perlucida* have been examined during the present work and these fall within a morphological plexus. There appears to be a continuous gradation between forms with a broadly-rounded apex and a single, short antapical horn (see Alberti, 1959, pl. 9, figs. 16, 17) to forms with long apical and single antapical horns (see Text-Fig. 33). Duxbury (1980, pl. 11, fig. 7) has figured an example of this last type, which he termed *Subtilisphaera pirnaensis* (Alberti, 1959) Jain & Millepied, 1973. The type occurrence of *S. pirnaensis* is quoted in Alberti, 1959, p. 100 (as *Deflandrea pirnaensis*) as middle Turonian and Lentin & Williams (1975, p. 118) state, "only two of the species which were included in *Subtilisphaera* have intercalary archeopyles. These are *Subtilisphaera pirnaensis* (Alberti, 1959b) and . . .". The archeopyle type in those specimens referred to *S. perlucida* here is uncertain, but it is certainly not intercalary (see below) and the stratigraphical range of this plexus in Barremian and Aptian. It is most unlikely, therefore, that any true specimens of *S. pirnaensis* have been recorded by the present author to date.



Text-Fig. 33. Form and variation in *Subtilisphaera perlucida* (Alberti, 1959) Jain & Millepied, 1973. All X650.

Although many specimens of *S. perlucida* were observed here, none displayed a clearly defined archeopyle of any "typically" peridiniacean type. Some specimens displayed a faint paratabulation marked by very low ridges (particularly notable on the dorsal epicyst – see Text-Figs. 32 and 33H) and a paratabulation scheme of 4', 3a, 7'', ?c, ?5''', ?'''' may be inferred. Some specimens displayed a parasulcal rostrum (see Text-Fig. 32B) and this is again a typically peridiniacean feature. It is tempting to assume, in the light of evidence from other peridinacean cysts, that the archeopyle type in *S. perlucida* must involve the intercalary paraplates, whether alone or in combination with apical and dorsal precingular series. Indeed, LENTIN & WILLIAMS (1975, p. 118) state, "Specimens assigned to *Subtilisphaera perlucida* by the present authors have an A3I3P archeopyle with the operculum remaining attached". No obvious archeopyle was observed by the present author, however, nor by the original author (ALBERTI, 1959, p. 102), who stated (translation), "an archeopyle has not, to date, been detected". In the present work, however, a small, fairly irregular hole was observed at the apex (see Text-Fig. 32A and C) and some specimens displayed a ragged, tapering, apical extension very similar to that observed in two-layered specimens of *Cepadinium variabilis* DUXBURY n. gen. et sp. (compare Text-Figs. 32B and 28A). In a typically peridiniacean epicystal paratabulation scheme, the position of the apical hole observed in *S. perlucida* would be occupied by paraplate 3'. It may be suggested, therefore, that the mode of excystment of *S. perlucida* may involve loss or displacement of paraplate 3' only and that the "ragged, tapering extension" mentioned above may represent part of paraplate 1' or may be paraplate 3', still attached.

Acritarchs

Cyclopsiella DRUGG & LOEBLICH, 1967

1967 *Cyclopsiella* DRUGG & LOEBLICH, p. 188.

Remarks: This genus has been included in the acritarchs here since it demonstrates none of the primary features (paratabulation, angular archeopyle margin, well-defined parasulcus, etc.) which would justify its inclusion in the dinoflagellate cysts.

Cyclopsiella mura DUXBURY n. sp.

Pl. 9, fig. 15

Derivation of Name: From the Latin *murus*, a wall – in reference to the characteristic encircling flange.
Holotype: Pl. 9, fig. 15.
Type Locality: Sample R9, Ferruginous Sands Series, Redcliff section, Isle of Wight.

Diagnosis: A species of *Cyclopsiella* which is oval in outline and which may be flattened at one pole. A distinct flange encircles the body and a fairly large, circular hole surrounded by a thickened rim is invariably present just below one pole. The body surface is finely granular to crudely reticulate.

Observed Dimensions: Holotype – 64 x 52 µm
Overall – 73 (58) 44 x 67 (49) 38 µm
Specimens measured – 19

Remarks: This species is distinguished from others of the genus in having an encircling flange.

Wallodinium LOEBLICH & LOEBLICH, 1968

1968 *Wallodinium* LOEBLICH & LOEBLICH, p. 212

Wallodinium cylindricum (Habib, 1970) Duxbury n. comb.

Pl. 9, fig. 16

1970 *Prismatocystis cylindrica* Habib, p. 374, pl. 10, fig. 2.
1971 *Fromea elongata* Beju, p. 289, pl. 3, figs. 7–10, Text-Fig. 6.
1972 *Hexagonifera cylindrica* (Habib) in Habib, p. 378, pl. 10, fig. 5.

Remarks: Drugg has pointed out (pers. comm.) that the species termed *Wallodinium elongatum* (Beju, 1971) in Duxbury, 1980 may be considered a junior synonym of that described as *Prismatocystis cylindrica* in Habib, 1970. Despite the consistently convex lateral outline of Habib's specimens, the present author agrees with Drugg and the appropriate taxonomic emendations are made above.

IV. Palynostratigraphical Comments

Samples examined in the present work yielded generally rich and well-preserved dinoflagellate cyst and acritarch assemblages. Over 100 such taxa were recorded and a total of 102 are listed, together with their observed occurrences and some indication of their abundance, in Text-Figs. 2, 3 and 4. Of these taxa, 37 are considered to be of particular palynostratigraphical significance and these are listed in Text-Fig. 34 and briefly discussed below. Reworked palynomorphs were observed in many samples and these were often abundant. A tabulation of reworked taxa is presented in Text-Fig. 35 and some discussion of this phenomenon is included under a separate heading at the end of this section.

Of the 12 taxa illustrated as becoming extinct within the Early Aptian in Text-Fig. 34, *Heslertonia heslertonensis* (Neale & Sarjeant, 1962) Sarjeant, 1966a, *Ctenidodinium elegantulum* Millioud, 1969 and *Pseudoceratium pelliferum* Gocht, 1957 have previously been considered typically Barremian and older taxa. Lack of adequate, firmly dated outcrop sections across the Barremian/Aptian boundary has led to some speculation as to the precise "tops" of some dinoflagellate cyst species, and widely varying records of observed ranges has led to confusion. For example, the range of *P. pelliferum* was illustrated by Millioud (1969, tables 2 and 3) as extending no higher than Upper Barremian, whereas Alberti (1961, table opposite p. 44) records it up to the Albian. Davey & Verdier (1974, p. 650) suggested that since *P. pelliferum* had been previously recorded only from, "pre-Aptian Early Cretaceous strata", then Alberti's *P. pelliferum*-bearing strata are, in reality, Barremian or older. This may be largely based on the fact that Millioud (1969) recorded *P. pelliferum* no higher than Upper Barremian at Angles, the type locality. It is noteworthy that Alberti (1961, table opposite p. 44) recorded *Phoberocysta neocomica* (Gocht, 1957) Millioud, 1969 (as *Wetzeliella neocomica*) continuously up to the Upper Barremian, but not above, whereas Millioud (1969, tables 2 and 3) recorded it also within the Lower Aptian. If Davey & Verdier (1974, p. 650) were correct in suggesting that those samples in which Alberti (1961) recorded *P. pelliferum* must be Barremian or older, then it is most unusual that some of those same samples should lack *P. neocomica*. It may be seen from Text-Fig. 34 here that *P. pelliferum* does range higher than *P. neocomica* in the Isle of Wight, but only within the Lower Aptian. It seems equally likely, therefore, that those samples yielding *P. pelliferum* above *P. neocomica* in Alberti (1961) may be Early Aptian in age and that the reason for Millioud's not recording *P. pelliferum* above *P. neocomica* is one of palaeoenvironmental cause (this is further discussed in considering the relative inceptions of *Occisucysta tenuiceras* (Eisenack, 1958) Below, 1981 and *Protoellipsodinium spinocristatum* Davey & Verdier, 1971 below).

Other species which appear to become extinct within the Early Aptian include *Diphasiosphaera stolidota* Duxbury, 1980, *Pterodinium premnos* Duxbury, 1980 and *Callaiosphaeridium trycherium* Duxbury, 1980. Each of these species was considered to range no younger than Middle Barremian in Duxbury, 1980, (p. 137) and their presence in the Early Aptian of the Isle of Wight appears to indicate some palaeoenvironmental control. Unfortunately, totally marine Barremian sediments do not occur on the Isle of Wight and the Aptian part of the Speeton succession is unavailable because of land-slip. No conclusions may be drawn, therefore, concerning the variations in the total ranges of these three species geographically.

Two previously undescribed species, *Gonyaulacysta ?kleithria* and *Cepadinium variabilis*, appear to be restricted to the Early Aptian but since no Barremian/Aptian boundary study was possible here and since only the lower part of the Late Barremian was studied in DUXBURY, 1980, then these species may well range down into the Late Barremian also.

The highest occurrence of *Chlamydophorella trabeculosa* (GOCHT, 1959) DAVEY, 1978 appears to be very variable, depending on the geographical location of samples examined. Some of this variation is undoubtedly due to mis-dating of samples, but this can not account for all of it. A short discussion of this variation is given below.

In the present study, *C. trabeculosa* was observed to range only as high as the *forbesi* Zone of the Early Aptian and, as such, the observed range is considerably shorter than those reported by previous authors. ALBERTI (1961) reported this species (as *Gardodinium eisenacki*) from deposits as young as Late Aptian and this record concurs with that in DAVEY & VERDIER, 1974. These last authors reported *C. trabeculosa* (as *Gardodinium trabeculosum*) as high as the lower part of the Gargasian on p. 648 (Text-Fig. 7), although they report it throughout the Gargasian on p. 649 (Text-Fig. 8). It may be concluded, therefore, that the highest occurrences of *C. trabeculosa* in ALBERTI, 1961 and DAVEY & VERDIER, 1974 agree in being within the Late Aptian. In the present work, the range of *C. trabeculosa* would appear to be somewhat foreshortened, although, as mentioned in the Systematic Descriptions section (above), specimens of *Chlamydophorella nyei* COOKSON & EISENACK, 1958 have been observed whose apical horns are unusually long and whose bodies are somewhat flatter than usual. Such forms may have been included in *C. trabeculosa* by DAVEY & VERDIER, 1974 and ALBERTI, 1961, although this may not be suggested with any degree of certainty since DAVEY & VERDIER did not illustrate *"Gardodinium trabeculosum"* at all and of the six specimens illustrated by ALBERTI (pl. 3, figs. 8–13), five were from the Upper Barremian with the sixth from Aptian deposits of unspecified level.

Records of *C. trabeculosa* in Canada suggest that this species may range at least as high as Late Albian. SINGH (1971, p. 381) remarked the presence of *C. trabeculosa* (as *Gardodinium eisenacki*) in the Loon River Formation, Harmon Member and lower Shaftesbury Formation of the Peace River Area of Alberta and this last formation is considered Late Albian in age. DAVEY & VERDIER (1974, p. 650) suggested that the occurrence of what they considered typically Aptian material in association with the Late Albian – indicative species *Deflandrea limpida* and *Ovoidinium verrucosum* suggested that there was reworked Aptian in the upper part of SINGH's section. As was also remarked by DAVEY & VERDIER, none of SINGH's material was pre-Aptian in age. That specimen figured in SINGH (1971, pl. 68, fig. 1) as *Gardodinium eisenacki* is undoubtedly referable to *Chlamydophorella ordinale* (DAVEY, 1974) DAVEY, 1978, a species recorded no younger than Barremian to date and which was totally absent from samples studied here. Again, therefore, reworking of pre-Albian material must be invoked.

BRIDEAUX & MCINTYRE (1975, p. 33), again working in Canada, recorded *C. trabeculosa* (as *Gardodinium eisenackii*) from sediments as young as Middle Albian (Langton Bay and Horton River Formations along Horton River). They included elongate forms regarded as a separate species, *Gardodinium elongatum*, in SINGH, 1971 and no such forms were recorded here. In BRIDEAUX & MCINTYRE, 1975, fig. 6 the range of *C. trabeculosa* (as *G. eisenackii*) is observed to extend to the top of the Middle Albian and, in so doing, it extends higher than the total range of *Luxadinium primulum* BRIDEAUX & MCINTYRE, 1975. This is important since the range of this last species is considered here to be confined to the Early Albian (Text-Fig. 34 shows the lower part of the range and unpublished research would suggest that it ranges only marginally higher than this). This being so, then the range of *C. trabeculosa* given by BRIDEAUX & MCINTYRE would suggest that an Albian top is indeed correct. The Middle Albian top may be questionable, however, since BRIDEAUX & MCINTYRE, 1975 would have *Luxadinium primulum* confined to the Middle Albian, whereas its range on the Isle of Wight is totally Early Albian. Nevertheless, *C. trabeculosa* would appear to range at least into the Early Albian. Unfortunately, it is not clear whether those forms observed in BRIDEAUX & MCINTYRE's Albian material are all of the elongate type (which was not observed here) or if some were of the more "normal" type described by GOCHT (1959).

The stratigraphical range of *C. trabeculosa* is, therefore, open to some speculation. DAVEY & VERDIER (1974) obviously consider it to range no younger than Aptian whilst SINGH (1971) would consider it to range as high as Upper Albian. In the North West Territories of Canada, it is the Middle Albian extinction proposed by BRIDEAUX & MCINTYRE (1975) which is favoured and in a major paper concerning Cretaceous and Tertiary palynological zones, DOERENKAMP, JARDINE & MOREAU (1976) have erected a *Gardodinium eisenacki* zone which is reported to extend as high as Middle Albian. DOERENKAMP et al. point out, however, that the attribution of an age as young as

Middle Albian is based purely on Canadian data and that European evidence would suggest something older (see Doerenkamp et al., 1976, pp. 380–382).

As evidenced in the present work, *Cyclonephelium vannophorum* Davey, 1969 appears to be restricted to the *forbesi* Zone of the Early Aptian in the Isle of Wight. Davey (1969, pp. 168 and 170) suggested that *C. vannophorum* may have been reworked into his sample CB3 (Lower Cenomanian), the type horizon and the only sample in which Davey (1969) recorded this species. As remarked in the Systematic Descriptions section (above), although the present work would appear to support Davey's suggestion, several authors have reported this species from younger material than was examined here (as young as Coniacian in Williams, 1975). Considerable variety may be exhibited by the genus *Cyclonephelium* and it may be that forms closely similar to Davey's type specimens of *C. vannophorum* may have occurred at different stratigraphical levels in different geographical areas. The usefulness of *C. vannophorum* as a stratigraphical tool must, therefore, be questionable.

Three previously undescribed species, *Aptea plera, Australisphaera vitrea* and *Florentinia abjuncta* were observed only in the Early Aptian. The first appears to span the *forbesi* and *deshayesi* Zones, the second, in addition, ranges through much of the *bowerbanki* Zone and the third is restricted to the *deshayesi* and *bowerbanki* Zones. Being previously undescribed, these species are of untried palynostratigraphical value.

The earliest occurrences of two species, *Occisucysta tenuiceras* (Eisenack, 1958) Below, 1981 and *Protoellipsodinium spinocristatum* Davey & Verdier, 1971 were observed within the *deshayesi* Zone, with the former towards the base of that zone and the latter towards the top. This situation is most reminiscent of that described by Davey & Verdier (1974, Text-Fig. 8) in which *O. tenuiceras* (as *Gonyaulacysta tenuiceras*) is described as first occurring near the base of the Bedoulian and *P. spinocristatum* first occurs near the top. In their Text-Fig. 2, Davey & Verdier (1974, p. 625) figure the Bedoulian (and, therefore, the whole of the Early Aptian) as belonging to the zone of *Deshayesites deshayesi*. This being the case, the first occurrences within the *deshayesi* Zone of the Isle of Wight of *O. tenuiceras* and *P. spinocristatum* fully confirm those recorded in Davey & Verdier 1974. What is obvious from the above statement is that the type section of the Bedoulian (and, therefore, of the Early Aptian) would appear to be considerably reduced with respect to the section considered as Early Aptian on the Isle of Wight. Davey & Verdier (1974, p. 650) remarked that Millioud recorded *Phoberocysta neocomica* in samples of Early Aptian age from Angles. They suggest that the absence of that species in their Bedoulian material, "could be explained by the fact that the two oldest Aptian samples at La Bédoule (limestone facies) were practically barren and/or that [this] species disappeared during earliest Aptian time". A third possibility, of course, is that *P. neocomica* became extinct in pre-Bedoulian times and this last possibility is supported by the presence of *P. neocomica* only in pre-*deshayesi* Zone sediments here.

As remarked above, Millioud (1969, tables 2 and 3) recorded *Phoberocysta neocomica* higher than *Pseudoceratium pelliferum*, a situation the reverse of that observed in Alberti, 1961 and the present work. Also, *P. pelliferum* was not observed at all in Davey & Verdier, 1974 and those authors considered this to be due to *P. pelliferum* being confined to Barremian and older sediments. It is considered here that the lack of *P. pelliferum* in Millioud's Aptian material and in Davey & Verdier's samples is due to palaeoenvironmental factors. In the present work, the first occurrences of *O. tenuiceras* and *P. spinocristatum* occur before the highest occurrence of *P. pelliferum* (marginally in the case of *P. spinocristatum*). Since both of these first occurrences were observed in Davey & Verdier, 1974, then one would expect *P. pelliferum* to occur throughout much of the Bedoulian in that work, unless palaeoenvironmental conditions were hostile to its presence.

Two previously undescribed species, *Kiokansium prolatum* and *Ovoidinium incorporeum* first occur, together with the extreme forms of *Cyclonephelium compactum* Deflandre & Cookson, 1955 discussed in the Systematic Descriptions section (above), within the *martiniodes* Zone. In addition, although *K. prolatum* was observed to the top of the studied section here, unpublished research suggests that this species is absent above the *mammilatum* Zone (i.e. that it is confined to the Late Aptian and Early Albian).

No sediments of *nutfieldensis* Zone age were examined here. This is due to the section at Atherfield being obscured at this level and to the presence of what appears to be a break in sequence in the Compton Bay and Redcliff sections based on dinoflagellate cyst evidence (see below). Consequently, nothing may be remarked as to the inceptions or extinctions of dinoflagellate cyst taxa within this Zone other than that since *Cyclonephelium compactum* Deflandre & Cookson, 1955 is absent from all *martinioides* Zone samples examined and present in all *jacobi* Zone samples, then its first occurrence may be within the *nutfieldensis* zone. This is signified in Text-Fig. 34 by the lower part of the range of *C. compactum* being dotted.

The previously undescribed taxa *Cyclonephelium intonsum, Stephodinium spinulosum* and *Oligosphaeridium perforatum* (Gocht, 1959) Davey & Williams, 1969 subsp. *colum* first occur in the *jacobi* Zone. The first and last of these were observed to become extinct within the *tardefurcata* Zone and the second has been observed in unpublished research to range only slightly higher into the Early Albian.

The highest occurrence of *Dingodinium albertii* Sarjeant, 1966b is tentatively taken to mark the top of the Aptian in the sections studied here. Casey (1961, p. 512) was unable to fix the Aptian/Albian boundary, based on ammonites and in commenting on the Sandrock Series, he simply stated, "this part of the succession must fall within the *jacobi* and *tardefurcata* Zones". *D. albertii* was described by Millioud (1969, p. 428) from the Barremian stratotype at Angles. Millioud stated (p. 428), "This form is abundant in the upper Hauterivian, lower Barremian, and at the base of the upper Barremian; scarce in the Late Barremian; not observed in the lower Aptian". The presence of this species throughout the Bedoulian and Gargasian and into the Clansayesian was confirmed in Davey & Verdier, 1974. *D. albertii* is a ubiquitous form in the North Sea and its extinction (against the background of other dinoflagellate cyst occurrences) appears to coincide very closely with that observed here. The present author therefore suggests that the Aptian/Albian boundary may be placed at the highest observed occurrence of this species in the present work.

A second species, *Subtilisphaera perlucida* (Alberti, 1959) Jain & Millepied, 1973 appears to become extinct near the top of the Aptian in the Isle of Wight. Unlike *D. albertii*, however, this species appears to be somewhat unreliable as a palynostratigraphical marker in a wider geographical context. Alberti (1961) recorded it only rarely; one record in the Upper Barremian (as *Deflandrea perlucida*). Millioud, on the other hand recorded this species (as *Deflandrea pirnaensis*) as being common as high as the lower Aptian, whereas Davey & Verdier (1974) recorded it (as *Deflandrea perlucida*) only as high as the lower part of the Gargasian. This discrepancy must indicate that *S. perlucida* may be used palynostratigraphically with confidence only in a restricted regional sense.

Five species, *Cribroperidinium conopium* Duxbury n. sp., *Florentinia radiculata* (Davey & Williams, 1966b) Davey & Verdier, 1973, *Surculosphaeridium longifurcatum* (Firtion, 1952) Davey, Downie, Sarjeant & Williams, 1966, *Luxadinium primulum* Brideaux & McIntyre, 1975 and *Chichaouadinium arabicum* Below, 1981 were first observed in the *tardefurcata* Zone and are therefore absent from pre-Albian sediments. The first of these appears to be confined to the *tardefurcata* Zone.

As was noted above, the range of *Luxadinium primulum* was considered to be confined to the Middle Albian in Brideaux & McIntyre, 1975. In fig. 6 of this last publication, *L. primulum* has a very restricted stratigraphical range and, indeed, a short range was observed in the present work. Unpublished research indicates that the total range of *L. primulum* in the Isle of Wight is confined to the *tardefurcata* and *mammilatum* Zones and this may suggest that material considered by Brideaux & McIntyre (1975) to be of Middle Albian age is, in fact, Early Albian.

Stratigraphical Comparisons

By comparing the observed stratigraphical ranges of dinoflagellate cyst taxa in the three sections studied here, particularly those figured in Text-Fig. 34, some conclusions may be reached concerning the stratigraphical relationships of those sections. As this may be considered only a pilot study involving large sample gaps, it is considered inadvisable here to attempt any detailed comparisons between the sections. With further refining of observed ranges, such comparisons may undoubtedly be attempted, however.

Despite the reticence of the present author to attempt a detailed palynostratigraphical comparison of the studied sections, one previously unrecognised feature may be proposed – the presence of a gap in the succession at Compton Bay and, possibly, at Redcliff, compared with that at Atherfield. It may be noted from Text-Fig. 3 that in the Compton Bay section, 9 microplankton taxa were observed in sample CB 44 which were absent below. Of these, several are known to range into earlier Aptian and pre-Aptian sediments and their first occurrence in CB 44 here must be due to palaeoenvironmental control. Other species, however, have been recorded only from Late Aptian and younger sediments, and these include *Kiokansium prolatum* Duxbury n. sp., *Cyclonephelium compactum* Deflandre & Cookson, 1955 and *Stephodinium spinulosum* Duxbury n. sp. In addition, species were observed to occur in sample CB 50 which were absent above, including *Australisphaera vitrea* DUXBURY n. sp. and *Aptea polymorpha* EISENACK, 1958. By reference to the Atherfield section (Text-Fig. 2), it may be observed that the earliest occurrences of those species listed above as first occurring in sample CB 44 are widely separated. *K. prolatum* is observed as low as AB 12 *(martinioides* Zone), *C. compactum* is observed as low as AB 11 *(jacobi* Zone), although the true first occurrence of this species is questionable because of the Atherfield section sample gap, and *S. spinulosum* is observed as low as AB 8 (late *jacobi* Zone). The highest occurrences of *A. vitrea* and *A. polymorpha* in the Atherfield section are observed in the early *bowerbanki* and *martinioides* Zones respectively.

On palynological evidence, therefore, sample CB 44 of the Compton Bay section appears to be no older than *jacobi* Zone age. In addition, sample CB 50 appears to be at least as old as early *bowerbanki* Zone age so that a gap of approximately three ammonite Zones may be proposed between these samples. This view is supported by palynological evidence from samples other than the two discussed above and comparisons may be made between Text-Figs. 2 and 3 herein, but, as remarked above, in this pilot study it may be unwise to attempt any detailed comparisons.

The Redcliff section was particularly poorly sampled here from a palynostratigraphical comparisons point of view. However, sample R 9 yielded several important species which were absent below, particularly *Cyclonephelium compactum* and *Stephodinium spinulosum* and, as remarked above, this last species indicates an age no older than late *jacobi* Zone. *Kiokansium prolatum* was not observed in R 9, but was present in the sample above. Its absence from the lower sample is probably significant only in that palaeoenvironmental conditions precluded its presence or that the total number of microplankton specimens observed in the R 9 sample were inadequate for low numbers of *K. prolatum* to be observed. The absence of *C. compactum, S. spinulosum* and *K. prolatum* from samples below R 9 may indicate a gap in the succession, as at Compton Bay but the sample gaps are too great for any firm conclusions to be reached.

Reworking

Reworked palynomorphs were recovered from the large majority of samples studied here and a chart (Text-Fig. 35) is included which lists these obviously reworked taxa. As may be observed from this chart, the taxa included may be roughly sub-divided into six categories, lettered A–F with A containing Middle and Late Jurassic forms, B containing Carboniferous forms, C containing latest Triassic and Early Jurassic forms, D containing Early Cretaceous forms, E containing Permo-Triassic forms and F containing Late Jurassic and Early Cretaceous forms. The groups are thus ordered to give some idea of abundance. It is immediately obvious that category A by far exceeds all other categories in taxa included and this must reflect the source of sedimentation to a large extent. It is beyond the scope of the present work to atempt any palaeo-source interpretation, but it must nevertheless be recognised that palynology might provide such information provided that reworked taxa are recognised as such. WINDLE, 1979 has expressed his opinion that some spores described as *in situ* Lower and Middle Jurassic taxa are, in reality, of Carboniferous origin. He also stated (p. 182), "reworking should, in the future, be a valuable tool in the recognition of the age and nature of rocks which formed the palaeolandmasses; and thus enhance paleogeographic reconstructions". The present author is doubtful as to the feasibility of recognising the "nature" of source rocks but is in general in agreement with WINDLE's conclusions.

V. Conclusions

The large majority of the samples examined here yielded rich and diverse palynomorph assemblages. Although usually less abundant than the land-derived elements, the dinoflagellate cysts and acritarchs are generally abundant and constitute both rich and varied assemblages. Preservation is usually good and may be excellent and fine details of palynomorph structure and ornament may be readily observed.

As mentioned in the introductory remarks, a description of palynomorph occurrences in 68 samples from 3 sections is by no means comprehensive, particularly when, as in this case, the total thickness of sediment involved is approximately 1800 feet. Nevertheless, it is felt that as a pilot study, the present work serves its purpose and that the great potential of marine palynomorphs as dating and correlating tools in Aptian and Lower Albian sequences has been clearly demonstrated. Further, in conjunction with Kemp's (1970) work on the spores and pollen grains from the same sections, the present work provides some idea of the total palynomorph content of the Lower Greensand, something which is rarely available for published sections.

It is readily apparent that the marine conditions which prevailed throughout the Lower Greensand deposition on the Isle of Wight were somewhat restricted. The general preponderence of land-derived palynomorphs in a dominantly arenaceous sequence points to deposition in a very nearshore environment. The abundance of reworking, particularly in the Atherfield section (see Text-Fig. 35) may reflect the energy of the environment or may simply suggest nearness to the sediment source. In view of the restricted nature of marine conditions in the Lower Greensand, therefore, the value of the observed inceptions and extinctions of the indigenous marine microplankton may be limited. Certainly, several taxa which are known to range older than Aptian elsewhere were absent from the lower part of the Lower Greensand. Such taxa include *Carpodinium granulatum* Cookson & Eisenack, 1962, *Impagidinium alectrolophum* (Sarjeant, 1966a) Stover & Evitt, 1978, *Rhombodella vesca* Duxbury, 1980, etc., and it must be concluded that further work is necessary over a wider geographical area than was covered here in order to assess the palynostratigraphical potential of taxa observed. In the Isle of Wight, correlations based on marine microplankton appear to be sound and a probable gap in the Compton Bay section may be recognised, compared with the Atherfield section (see Palynostratigraphical Comments section, above).

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Plate 1

Figs. 1–3.	*Aptea securigera* Davey & Verdier, 1974. 1 focussed on the ventral surface, 2 demonstrating the cyst outline and 3 focussed on the dorsal surface. A11 X650.
Figs. 4, 5.	*Aptea polymorpha* Eisenack, 1958. 4 focussed on the ventral surface and 5 demonstrating the general cyst outline. Both X650.
Figs. 6, 9, 12.	*Cerbia tabulata* (Davey & Verdier, 1974) Below, 1981. 6 ventral focus, 9 focussed to show the general outline and 12 dorsal focus. All X650.
Figs. 7, 8, 11.	*Aptea plera* Duxbury n. sp. 7 holotype showing the typically asymmetrical outline, 8 and 11 paratype with 8 focussed on the dorsal surface and 11 focussed on the ventral surface. 8 shows the ornament on paraplate 3" partially detached. All X650.
Fig. 10.	*Cyclonephelium distinctum* Deflandre & Cookson, 1955. X650.


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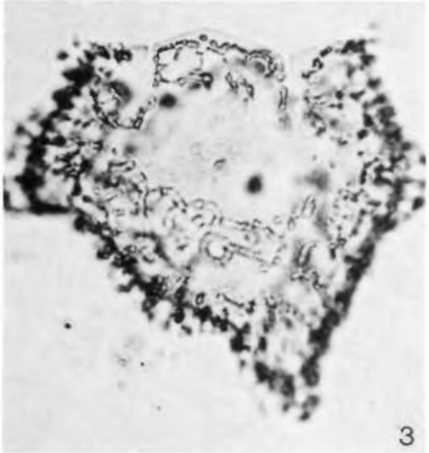
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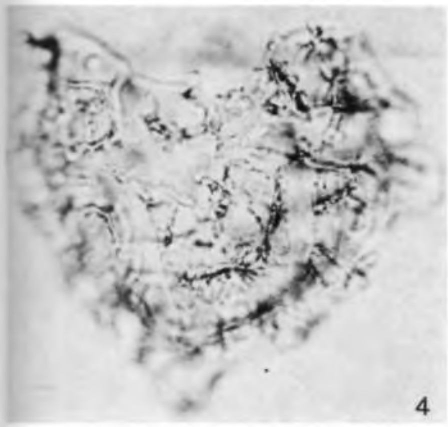
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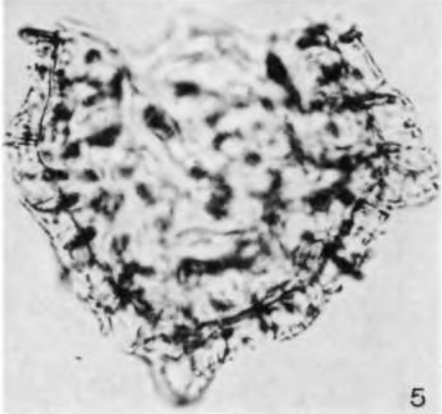
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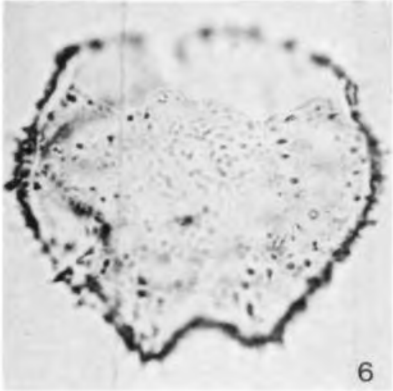
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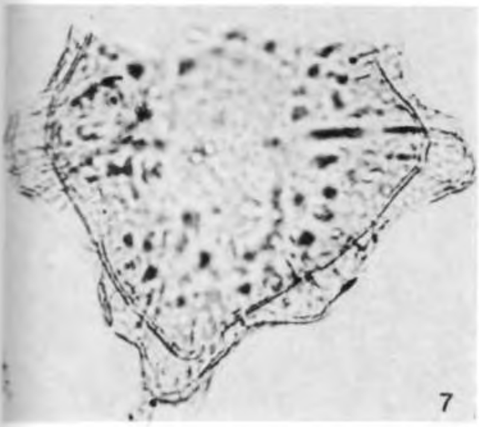
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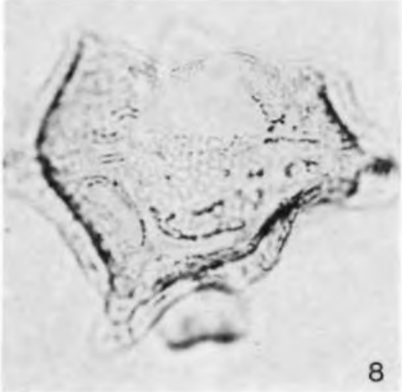
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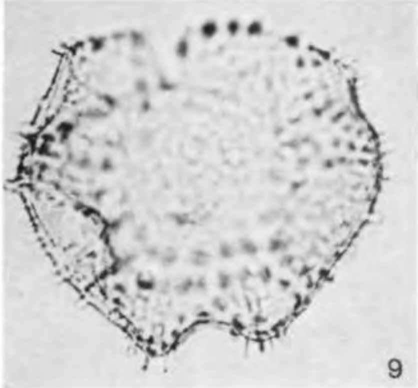
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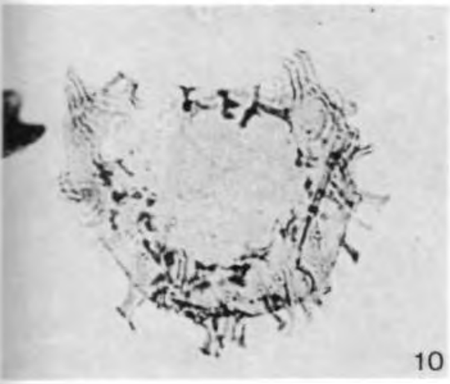
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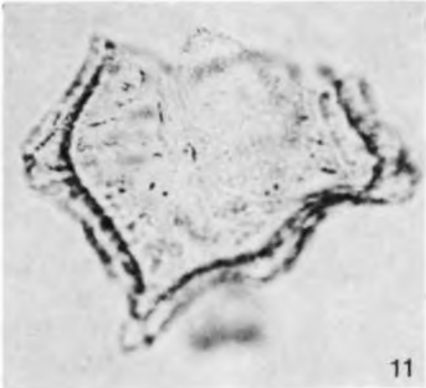
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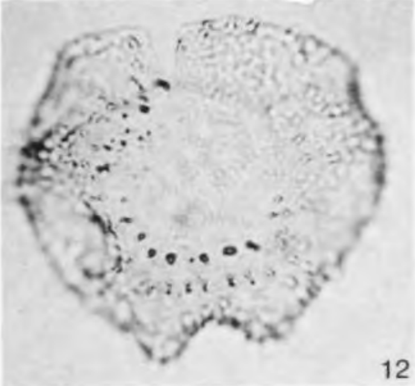
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S. Duxbury: A study of dinoflagellate cysts and acritarchs from the Lower Greensand.

Plate 2

Figs. 1, 2. *Odontochitina operculata* (Wetzel, 1933) Deflandre & Cookson, 1955. 1 focussed to show the nature of the horns and 2 focussed on the ventral area. Both X475.

Figs. 3, 4. *Muderongia asymmetrica* Brideaux, 1977. Different foci to show both lateral horns. Both X650.

Figs. 5, 8. *Muderongia pariata* Duxbury n. sp. Holotype. 5 shows the general cyst outline, 8 shows the ventral surface with paraplate $6'''$ particularly well demonstrated. Both X650.

Fig. 6. *Senoniasphaera microreticulata* Brideaux & McIntyre, 1975. A specimen folded to some extent but showing the characteristic punctation of the periphragm. X650.

Fig. 7. *Cyclonephelium intonsum* Duxbury n. sp. Holotype. Focussed to show the ventral surface, particularly the characteristic peripheral ornament. X650.

Fig. 9. *Batioladinium jaegeri* (Alberti, 1961) Brideaux, 1975. The operculum is slightly detached from the rest of the cyst. X650.

Fig. 10. *Batioladinium micropodum* (Eisenack & Cookson, 1960) Brideaux, 1975. A specimen demonstrating some splitting around the archeopyle margin. X650.

Fig. 11. *Australisphaera vitrea* Duxbury n. sp. Holotype. The very characteristic body ornament is clearly demonstrated. X650.

Figs. 12–14. *Cyclonephelium compactum* Deflandre & Cookson, 1955. The very wide range of body ornament height is clearly apparent. 14 represents cysts included on the range charts as "*Cyclonephelium compactum* Deflandre & Cookson, 1955 (extreme)". All X650.


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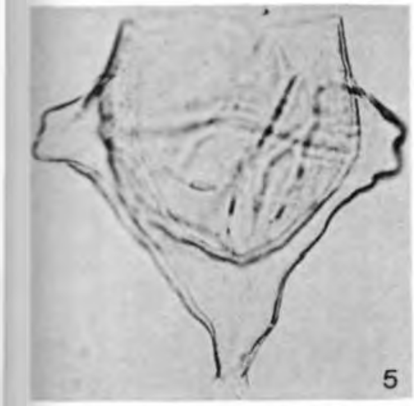
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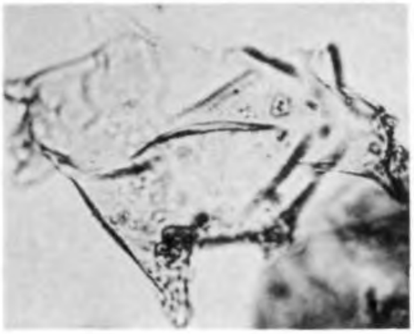


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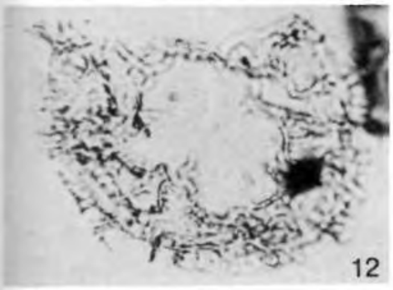
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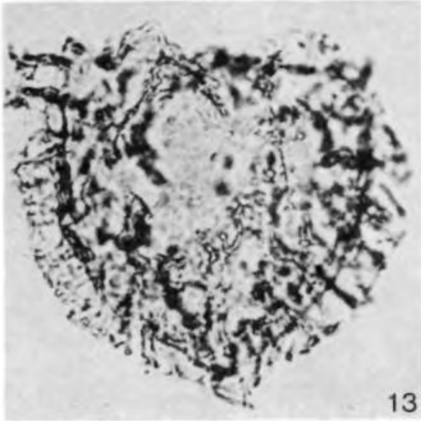
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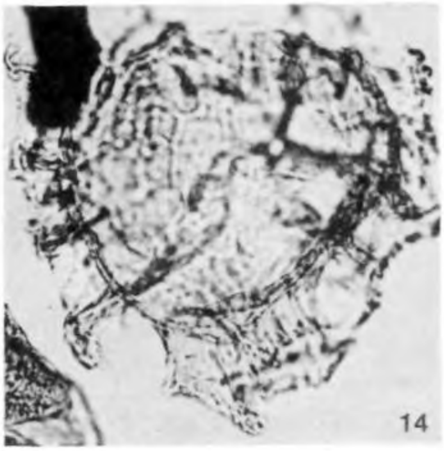
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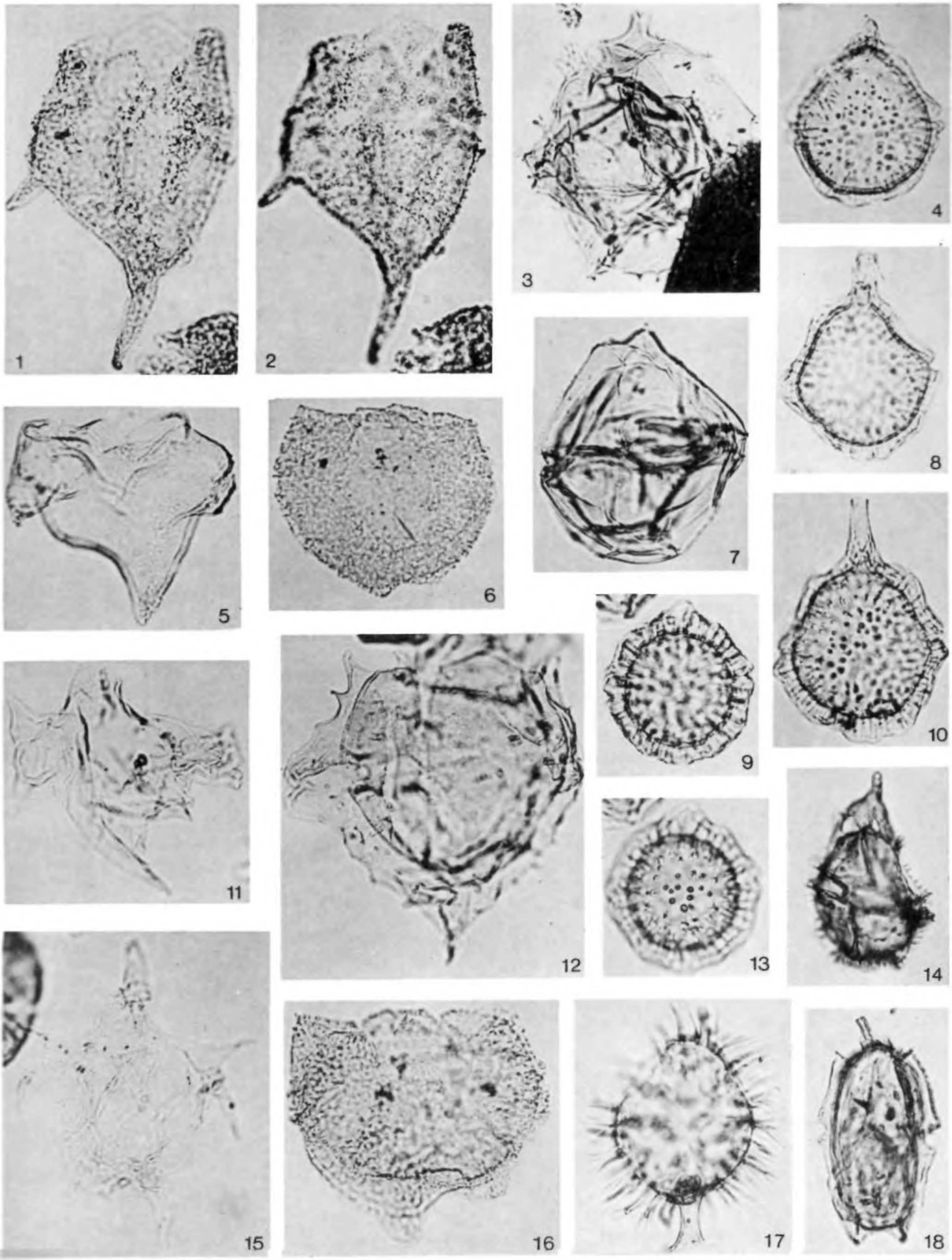
S. Duxbury: A study of dinoflagellate cysts and acritarchs from the Lower Greensand.

Plate 3

Figs. 1, 2.	*Pseudoceratium pelliferum* Gocht, 1957. A specimen demonstrating some concentration of body ornament within the paraplate areas. 1 focussed ventrally and 2 focussed dorsally. Both X650.
Fig. 3.	*Diphasiosphaera stolidota* Duxbury, 1980. A lateral aspect illustrating well the characteristic cavation and the *Spiniferites*-type processes. X650.
Figs. 4, 8, 10.	*Chlamydophorella nyei* Cookson & Eisenack, 1958. The wide range of morphologies encountered is encompassed by these 3 specimens. 10 is an example of those specimens illustrated on the range charts as "*Chlamydophorella nyei* Cookson & Eisenack, 1958 (long horned)". All X650.
Fig. 5.	*Australisphaera vitrea* Duxbury n. sp. Paratype.
Fig. 6.	*Cyclonephelium inconspicuum* Duxbury n. sp. Holotype. The characteristic raised reticulum around the periphery, particularly on the dorsal surface, is well-demonstrated. X650.
Fig. 7.	*Athigmatocysta glabra* Duxbury, 1977. The denticulate parasutural crests may be observed. X650.
Figs. 9, 13.	*Chlamydophorella huguonioti* (Valensi, 1955) Davey, 1978. 9 focussed to show the general cyst outline and 13 showing the hollow nature of individual tubules. Both X650.
Fig. 11.	*Australisphaera dolabella* Duxbury n. sp. Holotype. The "hatchet-shaped" lateral horns are clearly demonstrated. X650.
Fig. 12.	*Phoberocysta neocomica* (Gocht, 1957) Millioud, 1969. X650.
Fig. 14.	*Gonyaulacysta cassidata* (Eisenack & Cookson, 1960) Sarjeant, 1966a. A specimen clearly demonstrating the epicavate nature of this species. X650.
Fig. 15.	*Muderongia ?digitata* Duxbury n. sp. Holotype. The digitate nature of the lateral horns may be observed, as may the "7-horned" aspect of the cyst as a whole. X650.
Fig. 16.	*Cyclonephelium vannophorum* Davey, 1969.
Fig. 17.	*Coronifera oceanica* Cookson & Eisenack, 1958. The "apical" projection and antapical horn may be observed, as may the archeopyle (in lateral aspect to the upper left of the photograph). X650.
Fig. 18.	*Carpodinium granulatum* Cookson & Eisenack, 1962. The general outline of the cyst and the apical horn are clearly demonstrated. X650.



S. Duxbury. A study of dinoflagellate cysts and acritarchs from the Lower Greensand.

Plate 4

Figs. 1, 2. *Meiourogonyaulax stoveri* Millioud, 1969. 1 focussed to show the general cyst outline, 2 focussed on the parasulcal depression. Both X590.

Figs. 3, 7, 10. *Aldorfia vectensis* Duxbury n. sp. Holotype. 3 focussed to demonstrate the single-paraplate precingular archeopyle (3”), 7 focussed to show the body-layer separation and 10 focussed on the parasulcal depression to illustrate the characteristic body reticulum. All X650.

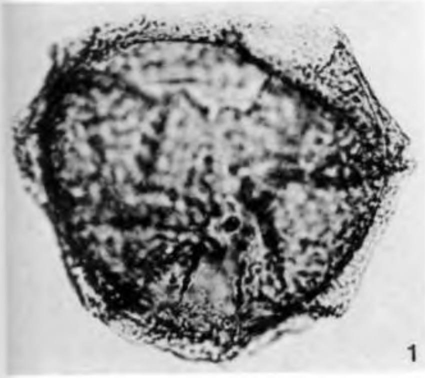
Figs. 4, 8. *Occisucysta tenuiceras* (Eisenack, 1958) Below, 1981. 4 shows the apical horn and general cyst outline and 8 shows the ventral paratabulation. Both X650.

Figs. 5, 6. *Gonyaulacysta helicoidea* (Eisenack & Cookson, 1960) Sarjeant, 1966a. 5 showing the general outline and cornucavate nature of this species and 6 focussed on the single-paraplate precingular archeopyle (3”). Both X650.

Fig. 9. *Cribroperidinium edwardsii* (Cookson & Eisenack, 1958) Davey, 1969. A specimen whose operculum is present but detached from the rest of the cyst. X520.

Fig. 11. *Cribroperidinium conopium* Duxbury n. sp. Holotype. The surface reticulum and some of the ventral paratabulation are apparent. X520.

Figs. 12, 13. *Occisucysta ?echinata* Duxbury n. sp. Holotype. 12 focussed on the general cyst outline, 13 demonstrating the two-paraplate precingular archeopyle (2”+3”). Both X650.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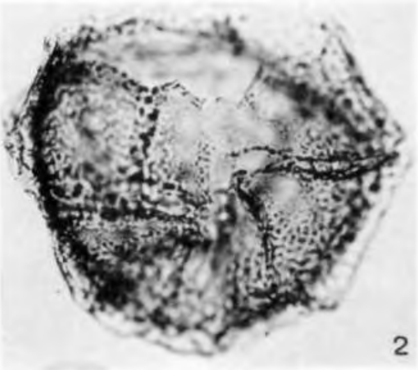
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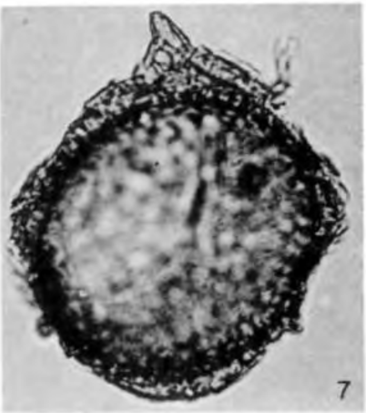
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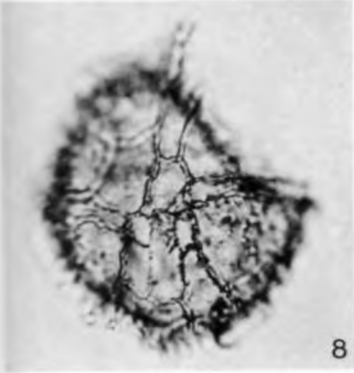
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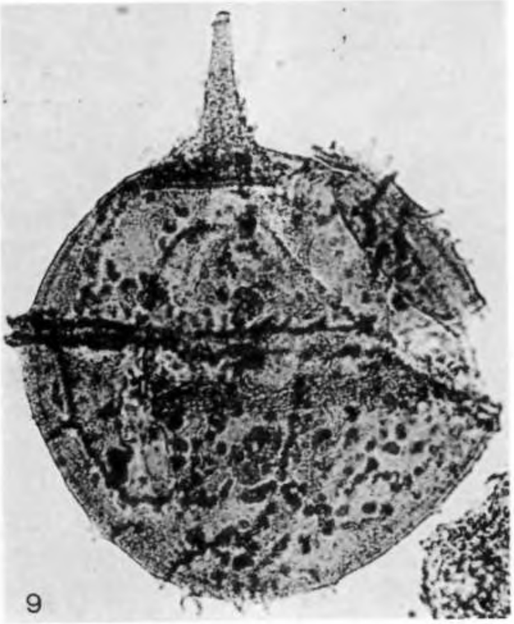
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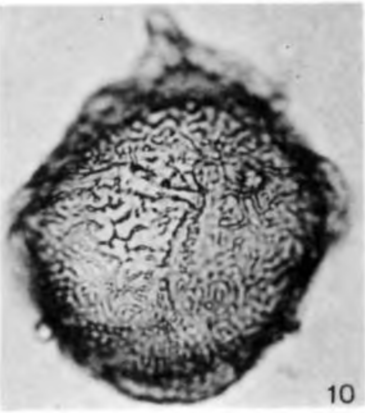
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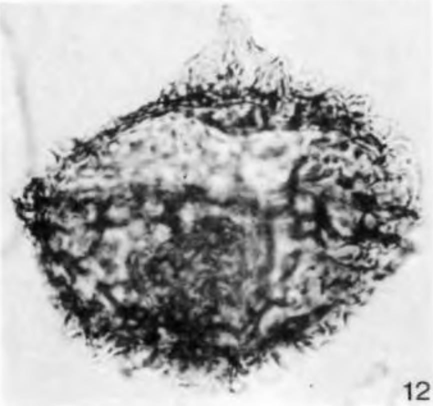
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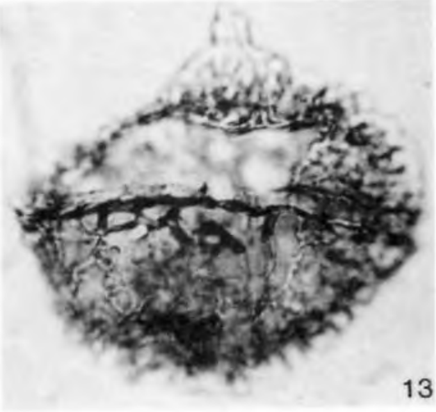
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S. Duxbury: A study of dinoflagellate cysts and acritarchs from the Lower Greensand.

Plate 5

Figs. 1, 2.	*Gonyaulacysta ?kleithria* Duxbury n. sp. Paratype. 1 showing the general outline and 2 demonstrating the parasulcal hole in the periphragm. Both X650.
Fig. 3.	*Impagidinium alectrolophum* (Sarjeant, 1966a) Stover & Evitt, 1978. The operculum (3") is clearly visible within the cyst.
Figs. 4, 9.	*Spiniferites ramuliferus* (Deflandre, 1937) Reid, 1974. A laterally oriented specimen with 4 focussed to demonstrate the general cyst outline (including a ventral cavation) and 9 focussed to illustrate the process terminations. Both X650.
Figs. 5, 8.	*Lithodinia sagena* Duxbury, 1980. 5 showing the general outline and 8 demonstrating denticulate parasultural crests superimposing the characteristic reticulum. Both X650.
Figs. 6, 10, 14.	*Stephodinium spinulosum* Duxbury n. sp. 6 holotype in dorso-ventral orientation. 10, 14 paratype in polar orientation with 10 focussed on the apical paraplates and 14 showing the general outline and the *Spiniferites*-type spines. All X650.
Fig. 7.	*Pterodinium premnos* Duxbury, 1980. A specimen focussed to show two of the characteristic paraplate-centred projections. X650.
Figs. 11, 12.	*Callaiosphaeridium asymmetricum* (Deflandre & Courteville, 1939) Davey & Williams, 1966b. 11 a specimen with the operculum detached, focussed to show the paracinglar process type. 12 a detached operculum demonstrating the "half crest" between paraplates 1' and 4'. Both X650.
Figs. 13, 20.	*Callaiosphaeridium trycherium* Duxbury, 1980. 13 focussed to show the characteristic parasutural crest type and the epicystal archeopyle and 20 focussed on the tubular processes. Both X650.
Fig. 15.	*Wallodinium lunum* (Cookson & Eisenack, 1960a) Lentin & Williams, 1973. X650.
Figs. 16, 19.	*Protoellipsodinium clavulum* Davey & Verdier, 1974. 16 a specimen with fairly simple processes. 19 a specimen with relatively numerous processes whose distal terminations are complex. Both X650.
Fig. 17.	*Stephodinium coronatum* Deflandre, 1936. A polar aspect. X650.
Fig. 18.	*Discorsia nanna* (Davey 1974) Duxbury, 1977. A specimen clearly showing the process variability and longitudinal striations. X650.

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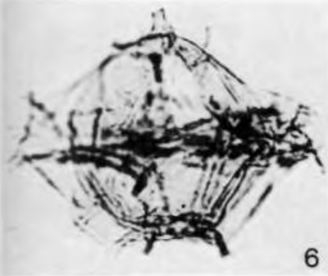

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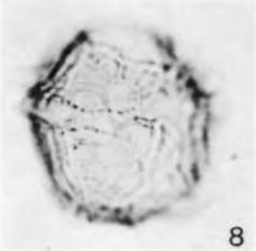

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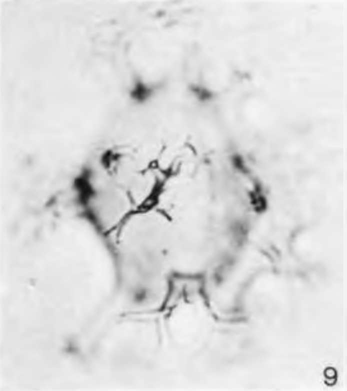

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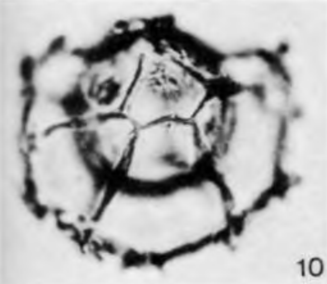

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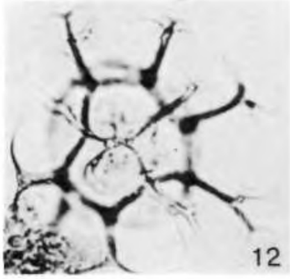

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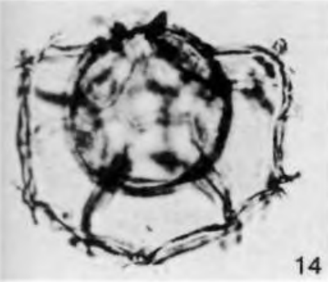

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Plate 6

Figs. 1, 2. *Kleithriasphaeridium loffrensis* Davey & Verdier, 1976. 1 focussed to demonstrate the cyst outline, particularly the ovoidal central body surmounted by a distinct prominence. 2 focussed on the ventral processes. Both X650.

Fig. 3. *Systematophora cretacea* Davey, 1979a. X650.

Figs. 4, 8. *Kiokansium prolatum* Duxbury n. sp. 4 paratype, a lateral aspect demonstrating well the process type. 8 holotype, showing the two-paraplate precingular archeopyle. Both X650.

Fig. 5. *Florentinia cooksoniae* (Singh, 1971) Duxbury, 1980. A specimen clearly showing the process variability on individual specimens. X650.

Fig. 6. *Prolixosphaeridium deirense* Davey, Downie, Sarjeant & Williams, 1966. A specimen with the operculum displaced. X650.

Fig. 7. *Prolixosphaeridium parvispinium* (Cookson & Eisenack, 1958) Davey, Downie, Sarjeant & Williams, 1969. X650.

Figs. 9, 10. *Florentinia abjuncta* Duxbury n. sp. Holotype. 9 focussed to show the distinctive antapical process and the general cyst outline and 10 focussed on several slender process elements. Both X650.

Fig. 11. *Florentinia mantellii* (Davey & Williams, 1966b) Davey & Verdier, 1973. A specimen focussed to show the general cyst outline and the characteristic distal furcation of the processes. X650.

Fig. 12. *Florentinia interrupta* Duxbury, 1980. X650.

Fig. 13. *Florentinia radiculata* (Davey & Williams, 1966b) Davey & Verdier, 1973. The characteristically deeply furcate processes are readily apparent. X650.

Fig. 14. *Tanyosphaeridium prolixispinosum* (Davey & Williams, 1966b) Duxbury, 1980. X650.

Fig. 15. *Hystrichosphaeridium? phoenix* Duxbury, 1980. A specimen showing clearly the characteristic process type. X650.


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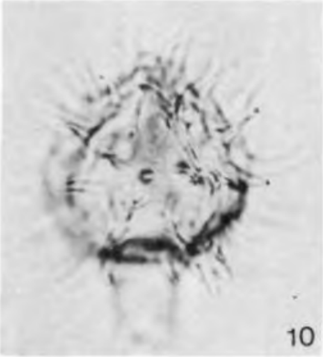
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S. Duxbury: A study of dinoflagellate cysts and acritarchs from the Lower Greensand.

Plate 7

Fig. 1. *Systematophora complicata* Neale & Sarjeant, 1962. Some cross-connection of process elements is apparent towards the antapex. X650.

Fig. 2. *Surculosphaeridium longifurcatum* *(Firtion, 1952) Davey, Downie, Sarjeant & Williams, 1966*. Focussed on the archeopyle margin and on a characteristically deeply-furcate paracingular process. X650.

Fig. 3. *Surculosphaeridium trunculum* Davey, 1979a. X650.

Fig. 4. *Spiniferites* cf. *neptunii* (Eisenack, 1958) Duxbury n. comb. A specimen with characteristically slender processes demonstrating the single-paraplate precingular archeopyle. X650.

Figs. 5, 6. *Stephanelytron cretaceum* Duxbury n. sp. Holotype. 5 shows the characteristic corona and the general cyst outline and 6 shows the hollow nature of individual tubules. Both X650.

Fig. 7. *Kiokansium polypes* (Cookson & Eisenack, 1962) Below, 1982. X650.

Fig. 8. *?Nexosispinum hesperum* Davey, 1979a. The archeopyle is clearly visible. X650.

Fig. 9. *Dingodinium albertii* Sarjeant, 1966b. A lateral aspect focussed to give an equitorial view, demonstrating the cavate nature of this species. X650.

Fig. 10. *Taleisphaera hydra* Duxbury, 1979. A specimen focussed to show the proximal, penitabular connections between individual processes. X650.

Fig. 11. *Heslertonia heslertonensis* (Neale & Sarjeant, 1962) Sarjeant, 1966a. A specimen showing the epicystal breakage developed in archeopyle formation. X650.

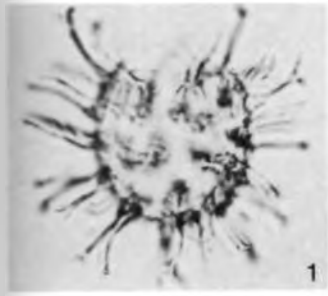
Fig. 12. *Chalmydophorella trabeculosa* (Gocht, 1959) Davey, 1978. X650.

Figs. 13, 14. *Spiniferites neptunii* (Eisenack, 1958) Duxbury n. comb. 13 focussed to show the general outline and wall thickness. 14 focussed to show the parasutural crests connecting processes. Both X650.

Figs. 15, 18. *Sirmiodinium grossii* Alberti, 1961. Both X650.

Figs. 16, 17. *Occisucysta tentoria* Duxbury, 1977. 16 showing the characteristic apical horn and body layer separation. 17 demonstrating the two-paraplate precingular archeopyle (2"+3"). Both X650.

Fig. 19. *Protoellipsodinium spinocristatum* Davey & Verdier, 1971. A specimen focussed to show the longitudinal striations connecting spine bases. X650.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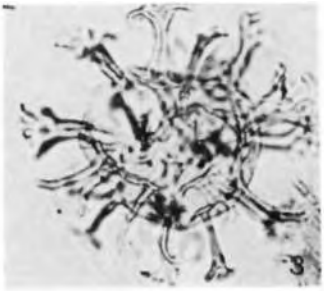
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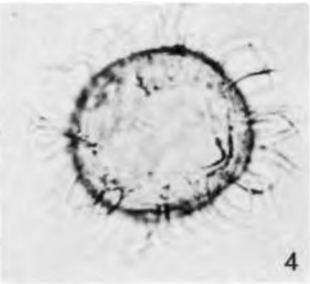
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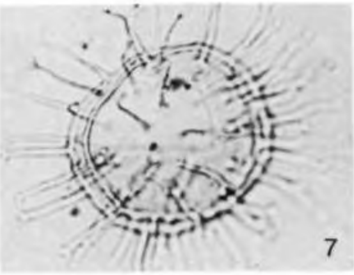
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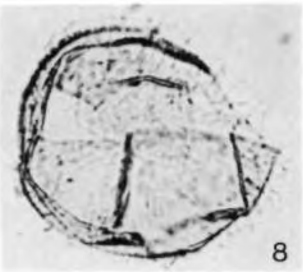
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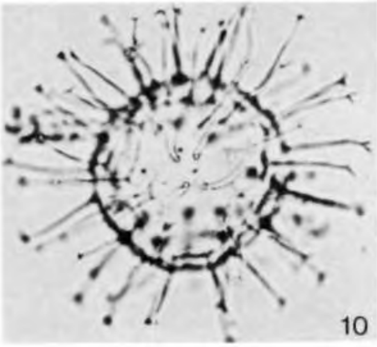
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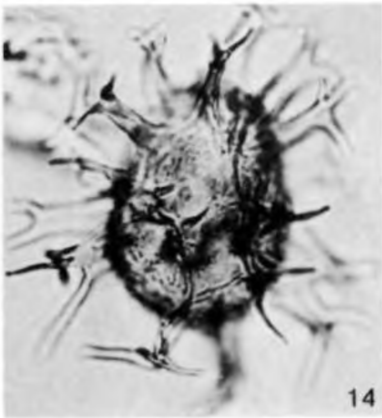
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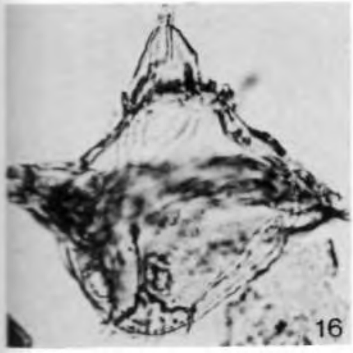
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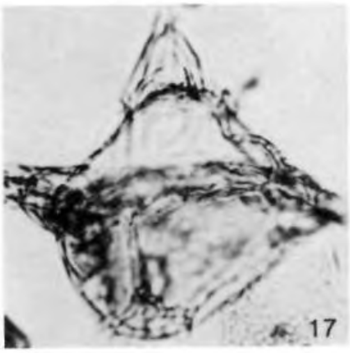
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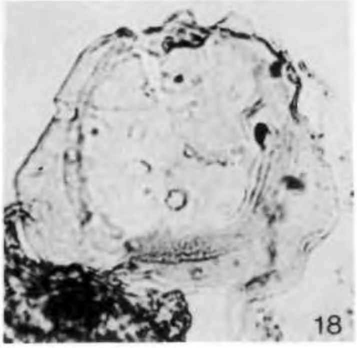
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Plate 8

Fig. 1. *Oligosphaeridium pulcherrimum* (Deflandre & Cookson, 1955) Davey & Williams, 1966b. A specimen showing the typically fenestrate process terminations. X650.

Fig. 2. *Oligosphaeridium complex* (White, 1842) Davey & Williams, 1966b. X650.

Fig. 3. *Hystrichosphaerina schindewolfii* Alberti, 1961. A specimen focussed to demonstrate the totally fenestrate processes terminating in ring tabeculae. X650.

Fig. 4. *Protoellipsodinium spinosum* Davey & Verdier, 1971. The single-paraplate precingular archeopyle may be clearly seen to the upper right of the photograph. X650.

Fig. 5. *Hystrichosphaeridium recurvatum* (White, 1842) Davey & Williams, 1966b. X650.

Fig. 6. *Oligosphaeridium perforatum* (Gocht, 1959) Davey & Williams, 1969 subsp. *perforatum* Duxbury n. subsp. A specimen focussed to demonstrate the small-scale fenestration/perforation of the process terminations which is characteristic of this subspecies. X650.

Fig. 7. *Exiguisphaera plectilis* Duxbury, 1980. A specimen clearly demonstrating the two-paraplate precingular archeopyle (3"+4") to the upper right of the photograph. X650.

Fig. 8. *Microdinium? crinitum* Davey, 1969. The apical archeopyle of this species is demonstrated by a zig-zag split between apical and precingular paraplates. X1100.

Fig. 9. *Oligosphaeridium perforatum* (Gocht, 1959) Davey & Williams, 1969 subsp. *colum* Duxbury n. subsp. Holotype. The highly fenestrate nature of the distal process terminations is obvious. X650.

Fig. 10. *Endoscrinium campanulum* (Gocht, 1959) Vozzhennikova, 1967. A specimen focussed to demonstrate the single-paraplate precingular archeopyle (3"). X650.

Fig. 11. *Desmocysta plekta* Duxbury n. gen. et sp. Holotype. Focussed to show the general outline of the cyst and the two-paraplate precingular archeopyle. X650.


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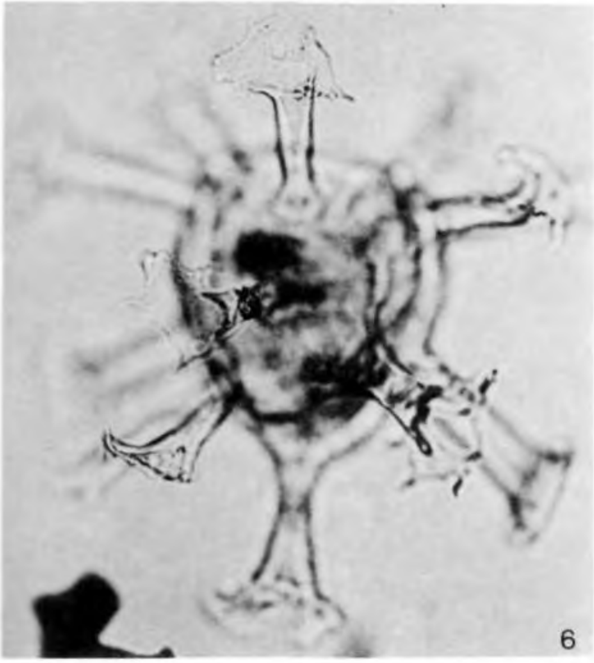
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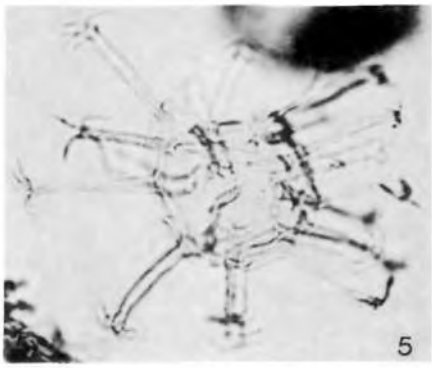
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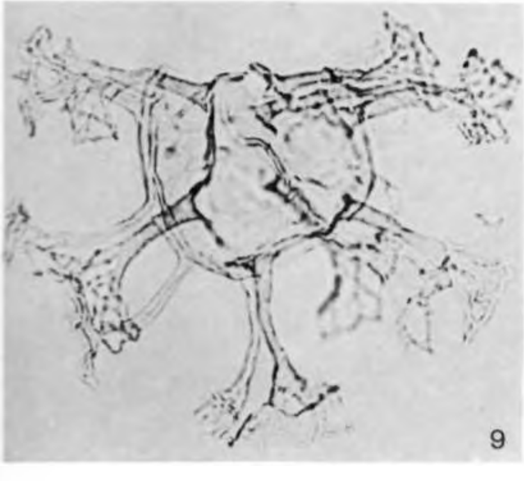
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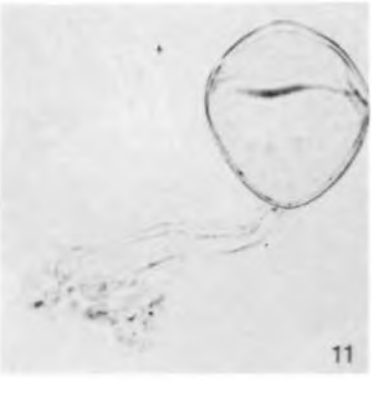
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S. Duxbury: A study of dinoflagellate cysts and acritarchs from the Lower Greensand.

Plate 9

Figs. 1, 4, 8.	*Cepadinium variabilis* Duxbury n. gen. et sp. 1, a paratype, is two-layered and demonstrates well the characteristic archeopyle type. 4, a paratype, is three-layered and 8, the holotype, is four-layered and both 4 and 8 have ornament on the second layer in. All X650.
Fig. 2.	*Cauca parva* (Alberti, 1961) Davey & Verdier, 1971. A specimen demonstrating the epicystal archeopyle and the small apical protuberance which appears to be typical. X650.
Fig. 3.	*Hystrichodinium pulchrum* Deflandre, 1935.
Figs. 5, 9, 14.	*Subtilisphaera perlucida* (Alberti, 1959) Jain & Millepied, 1973. Specimens demonstrating the variation in horn length observed in this species. All X650.
Figs. 6, 11.	*Ctenidodinium elegantulum* Millioud, 1969. Two hypocysts bearing typically slender, distally bifurcate parasutural spines. Both X650.
Fig. 7.	*Kleithriasphaeridium simplicispinum* (Davey & Verdier, 1966b) Davey, 1974. A specimen focussed to illustrate the characteristic granular areas within individual process bases. X650.
Fig. 10.	*Fromea amphora* Cookson & Eisenack, 1958. X650.
Figs. 12, 13.	*Chichaouadinium arabicum* Below, 1981. 12 demonstrates the breakage typical for this species and 13 illustrates its two-layered nature. Both X650.
Fig. 15.	*Cyclopsiella mura* Duxbury n. sp. Holotype. The characteristic hole and the distinctive encircling flange are clearly illustrated. X650.
Fig. 16.	*Wallodinium cylindricum* (Habib, 1970) Duxbury n. comb. This specimen provides a clear illustration of the two-layered body and the characteristic body-layer separation. X650.
Fig. 17.	*Rhombodella vesca* Duxbury, 1980. X1100.

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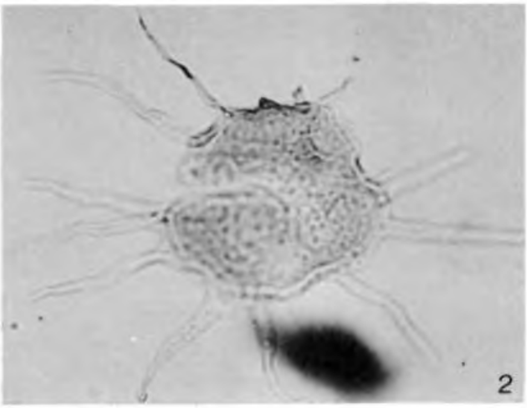

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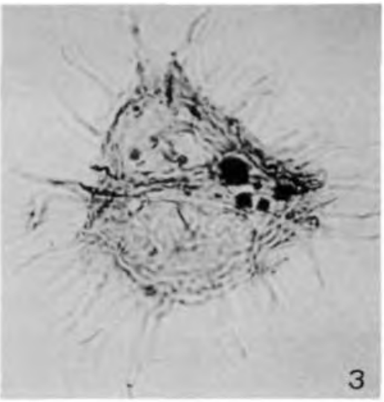

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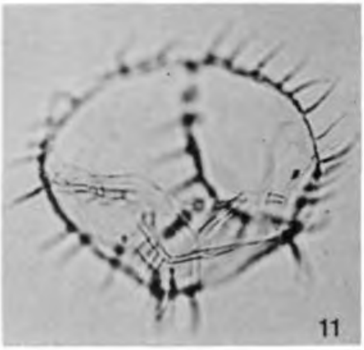

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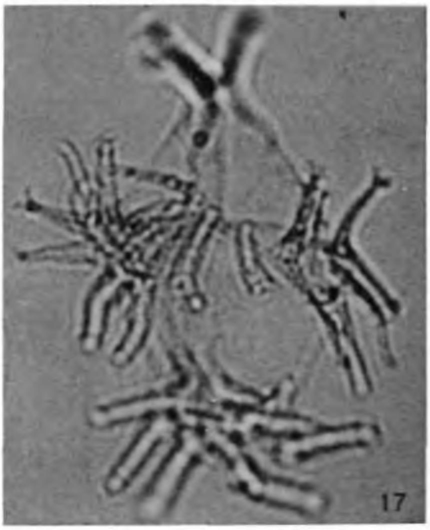

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Plate 10

Fig. 1. *Kalyptea disceras* Cookson & Eisenack, 1960b, X650.

Figs. 2, 13. *Palaeoperidinium cretaceum* Pocock, 1962 ex Davey, 1970. 2 is a specimen with the operculum completely detached. Both X650.

Fig. 3. *Aptea plera* Duxbury n. sp. Paratype. A complete specimen with the operculum partially detached. X650.

Figs. 4, 5, 9. *Ovoidinium incomptum* Duxbury n. sp. 4 paratype, demonstrating very slight separation of the two layers at the antapex and the characteristic archeopyle. 5 and 9 holotype with 5 showing a single antapical horn and 9 demonstrating the archeopyle. All X650.

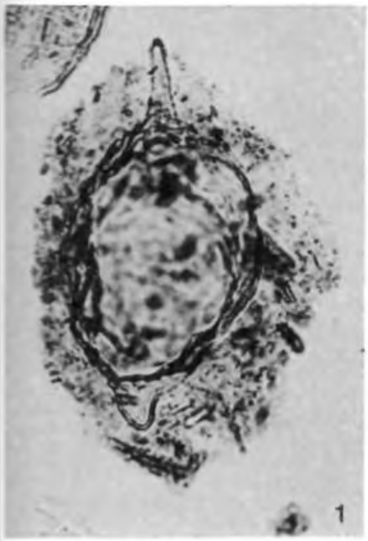
Figs. 6, 7, 10. *Luxadinium primulum* Brideaux & McIntyre, 1975. 6 and 10 a specimen with the operculum completely detached. 7 demonstrates the general cyst outline and 10 is focussed to illustrate the regularly arranged body ornament, particularly bordering the paracingulum. 7 is a more rounded specimen whose partially fragmented operculum has been slightly displaced. All X650.

Fig. 8. *Callaiosphaeridium trycherium* Duxbury, 1980. A specimen clearly showing the characteristic parasutural crest type. X650.

Fig. 11. *Tanyosphaeridium* cf. *variecalamum* Davey & Williams, 1966b. X650.

Fig. 12. *Cyclonephelium intonsum* Duxbury n. sp. Paratype. X650.

Fig. 14. *Ovoidinium incorporeum* Duxbury n. sp. Holotype. Focussed to demonstrate the partially detached operculum and the degree of hypocystal cavation. X650.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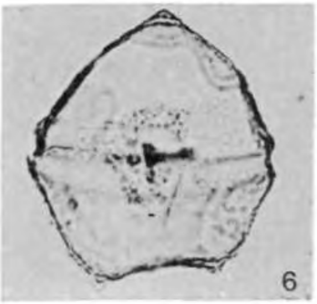
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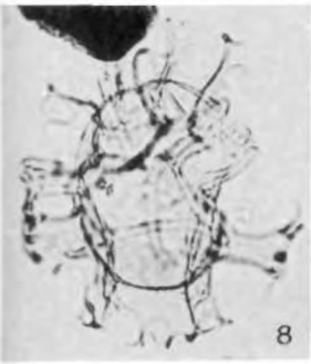
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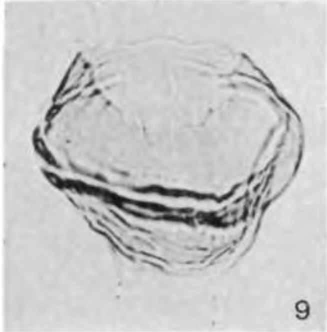
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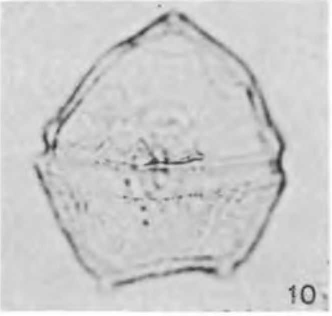
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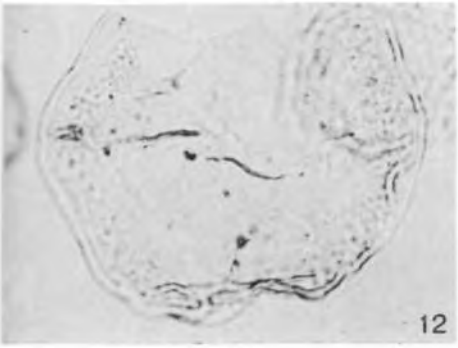
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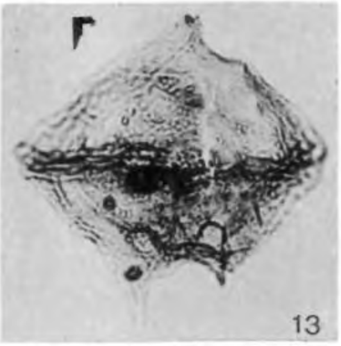
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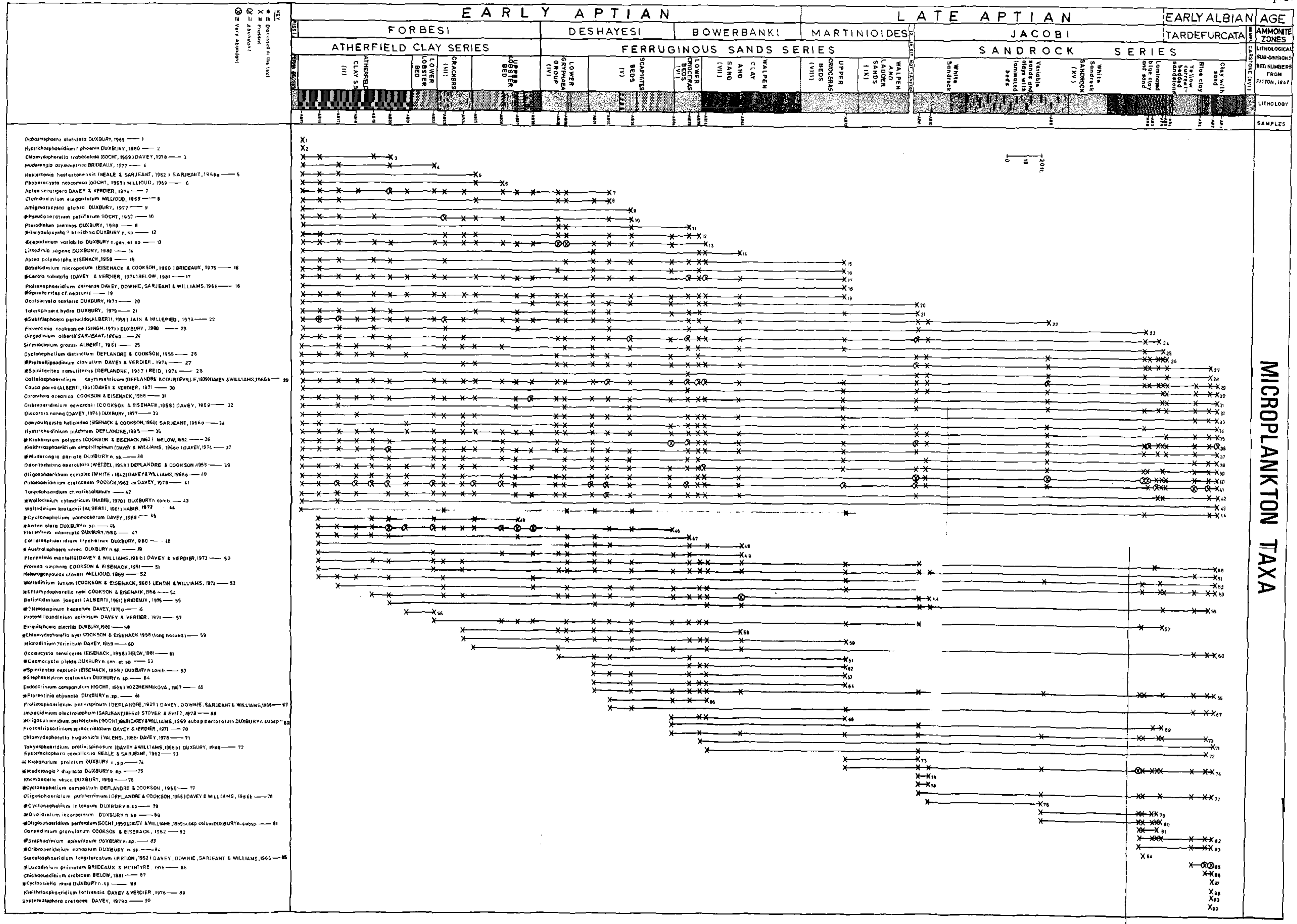
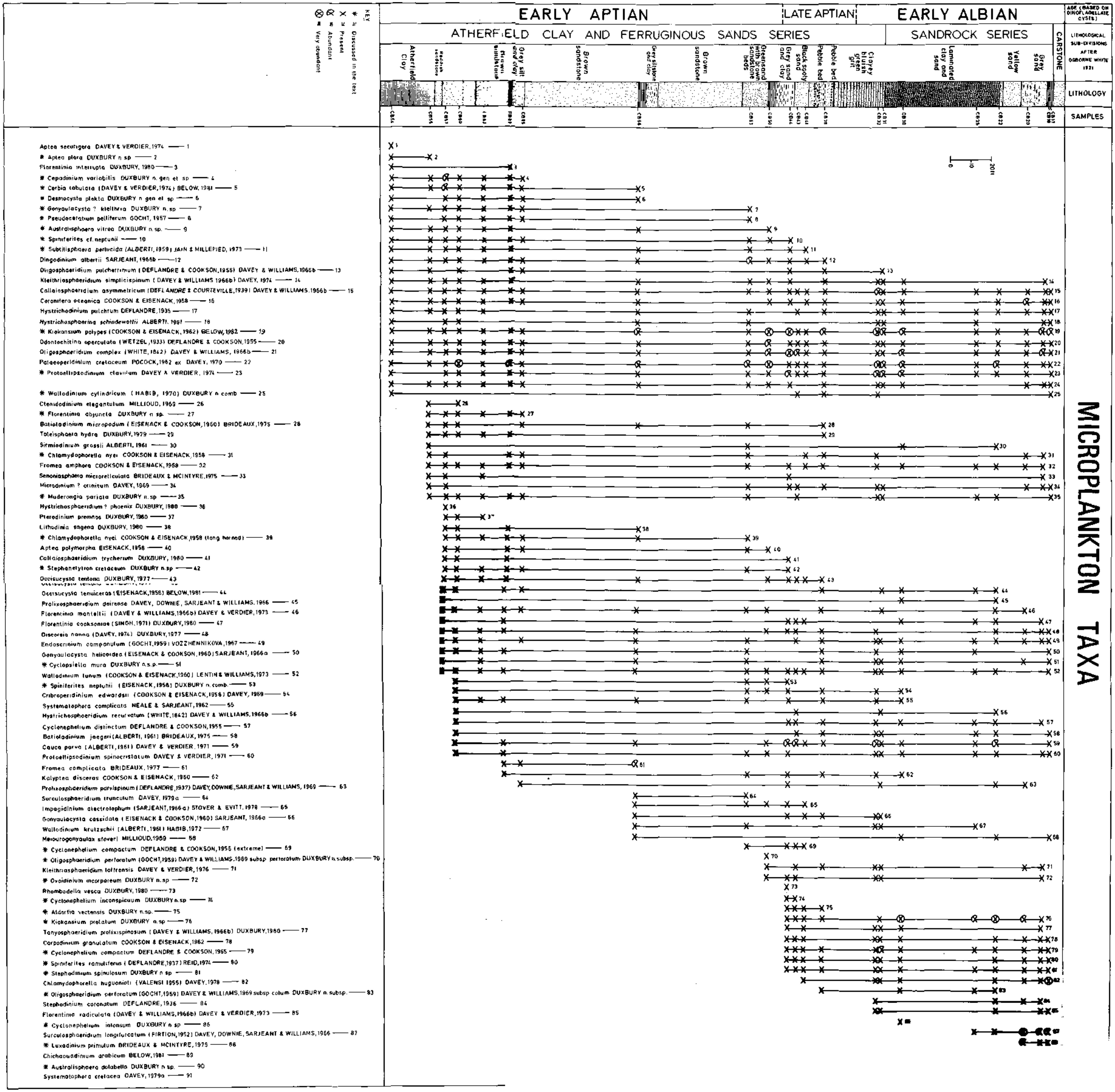
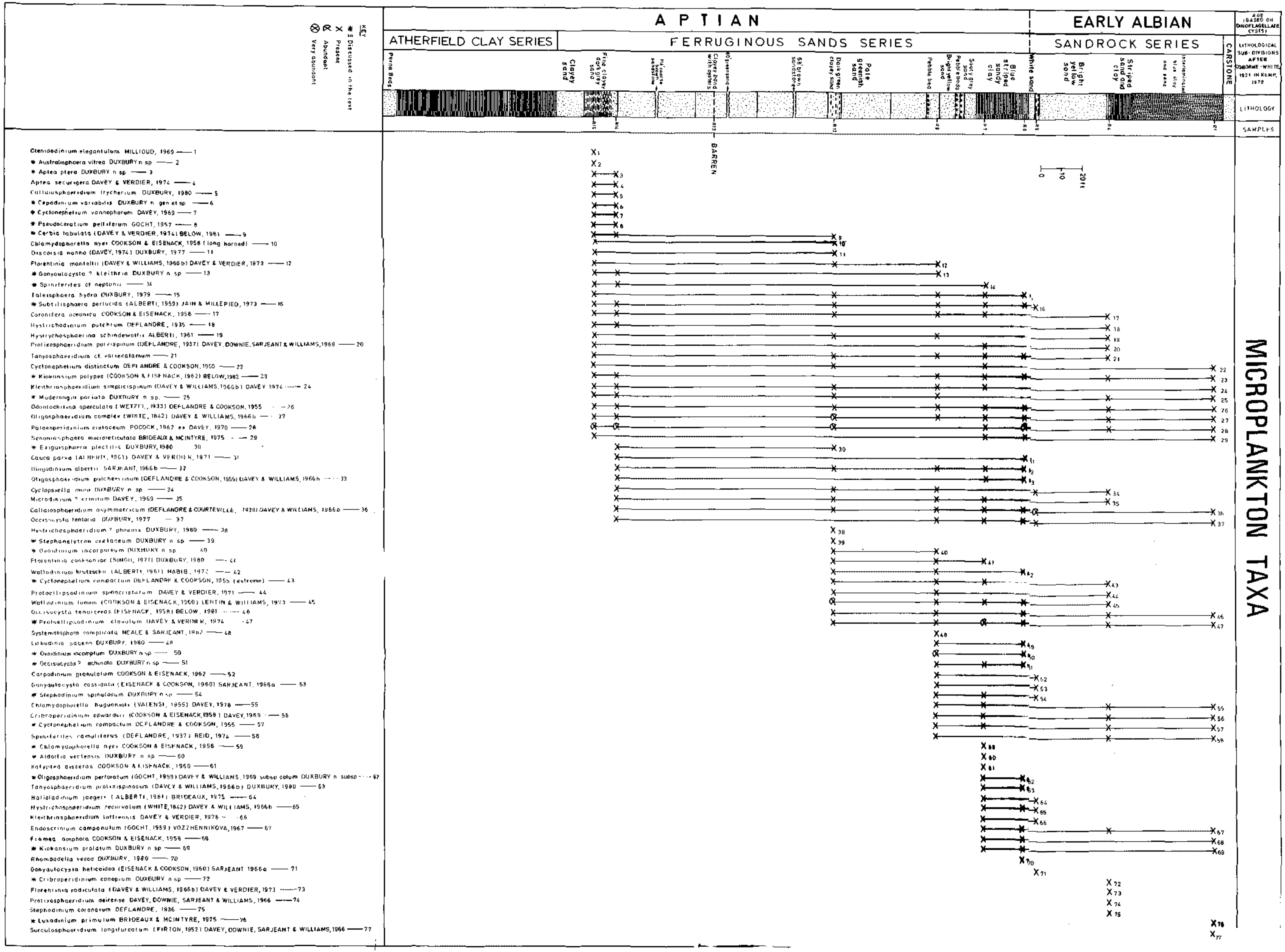


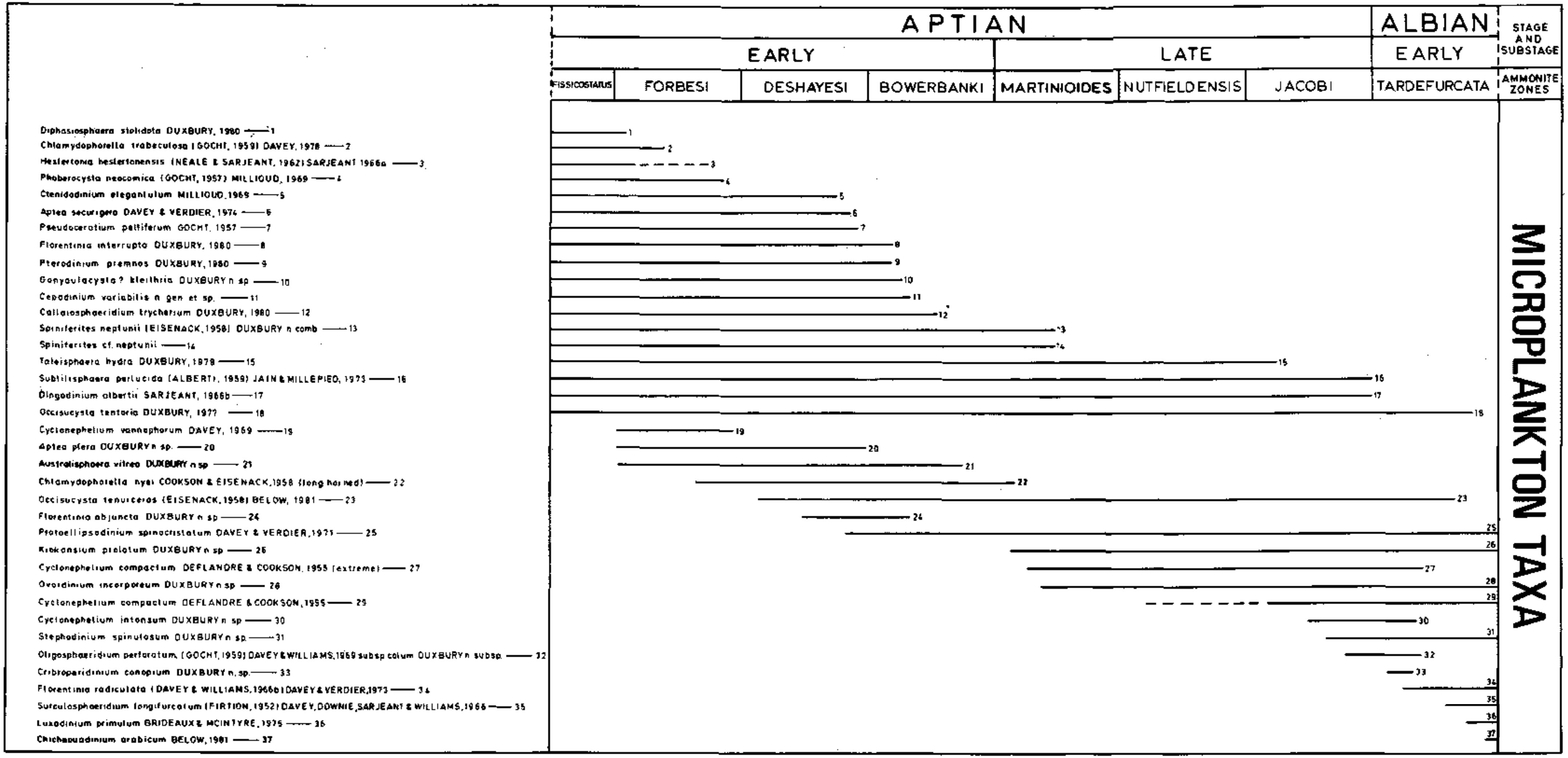
Text-Fig. 2. The distribution of microplankton taxa in the Atherfield section.



Text-Fig. 3. The distribution of microplankton taxa in the Compton Bay sectionn.



Text-Fig. 4. The distribution of microplankton taxa in the Redcliff section.



Text-Fig. 34. An illustration of the observed stratigraphical ranges of selected dinoflagellate cyst taxa through the studied sections.

REWORKED PALYNOMORPHS	ATHERFIELD SECTION																																				COMPTON BAY SECTION																						REDCLIFF SECTION									
	AB15	AB16	AB17	AB18	AB19	AB20	AB21	AB22	AB23	AB24	AB25	AB26	AB27	AB29	AB28	AB30	AB31	AB32	AB33	AB34	AB35	AB36	AB14	AB13	AB12	AB11	AB10	AB9	AB8	AB7	AB6	AB5	AB4	AB3	AB2	AB1	CB64	CB55	CB57	CB60	CB62	CB63	CB65	CB66	CB53	CB50	CB44	CB43	CB41	CB38	CB32	CB31	CB30	CB25	CB22	CB20	CB18	CB17	R15	R14	R13	R12	R9	R7	R6	R5	R4	R1
GROUP A																																																																				
Ctenidodinium combazi DUPIN, 1968	1		1	1																	1		1													1																																
Ctenidodinium continuum GOCHT, 1970																												1																										1														
Ctenidodinium ornatum (EISENACK, 1935) DEFLANDRE, 1938										1											1							1																									2			1				2								
Ctenidodinium pachydermum (DEFLANDRE, 1938) GOCHT, 1970																												1																																								
Ctenidodinium panneum (NORRIS, 1965) LENTIN & WILLIAMS, 1973																					2	4																				1			1																	1						
Ctenidodinium tenellum DEFLANDRE, 1938																										1					1																																					
Egmontodinium polyplacophorum GITMEZ & SARJEANT, 1972																1																																																				
Endoscrinium galeritum (DEFLANDRE, 1938) VOZZHENNIKOVA, 1967		1																			1		1						1		2									1														1														
Endoscrinium luridum (DEFLANDRE, 1938) GOCHT, 1970		1							1							1		1					2								1																1										1					1			1			
Glossodinium dimorphum IOANNIDES, STAVRINOS & DOWNIE, 1977	2	6				1		1	2	1					2	1	5	4	4	3	5	3	4		2	6	5				2	2			1		1		1	1		1		1	3	4	5							1			1		1	1		4		1	1			
Gonyaulacysta jurassica (DEFLANDRE, 1938) NORRIS & SARJEANT, 1965	2	8	4	2	1	4		2	2		2			2	4	4	6	4	2		9	4	3		4	4	1	3	3	2		2	3	1	7	6	1	1	2	2	4	1		1	1		2						7	6	5		3	5	1	1		2	1				2	3
Gonyaulacysta longicornis (DOWNIE, 1957) SARJEANT, 1969		1																					1				3													1																			1									
Gonyaulacysta cf. perforans (COOKSON & EISENACK, 1958) SARJEANT, 1969 cf. IOANNIDES, STAVRINOS & DOWNIE, 1977									1														1														1						1	1		1									1							1		1				
Gonyaulacysta scarburghensis SARJEANT, 1964		1	1						1																	2					1	1				1			1								1						2	2														
Kleithriasphaeridium sp. A of DAVEY, 1979 b																					1																																															
Leptodinium arcuatum KLEMENT, 1960												1				1	2																1		1											1				1						1		1		1								
Lithodinia jurassica EISENACK, 1935		1	1							1																																																										
Nannoceratopsis pellucida DEFLANDRE, 1938								2	1			3			2		1			1	2		1		1	1			2		1								1		1					2		1			1		2	1	1	2		2					1					
Nannoceratopsis spiculata STOVER, 1966													1																																																	1						
Occisucysta balios GITMEZ, 1970																																																																	1				
Oligosphaeridium pulcherrimum (DEFLANDRE & COOKSON, 1955) DAVEY & WILLIAMS, 1966b of GITMEZ, 1970																					1	1																																														
Pluriarvalium osmingtonense SARJEANT, 1962			1																		1																																										1					
Prolixosphaeridium granulosum (DEFLANDRE, 1937) DAVEY, DOWNIE, SARJEANT & WILLIAMS, 1966				2											1						2					1																			1												1											
Prolixosphaeridium mixtispinosum (KLEMENT, 1960) DAVEY, DOWNIE, SARJEANT & WILLIAMS, 1969	1																				2																																															
Rhynchodiniopsis cladophora (DEFLANDRE, 1938) BELOW, 1981		3				1			2		1				1		1			1		1										1			1	2			1	1	1			1		2								3			1	1										
Scriniodinium crystallinum (DEFLANDRE, 1938) KLEMENT, 1960	1	2	1			1				1						1					2	3	1																	1													1	1	1			1					1		1			
Scriniodinium dictyotum COOKSON & EISENACK, 1960			1																							1		1																									1															
Senoniasphaera jurassica (GITMEZ & SARJEANT, 1972) LENTIN & WILLIAMS, 1976									1	1					1	1		1	1	1	4	4	1		2	5	2	1	1	1								1				1		2		2	4			1																		1
Sentusidinium pilosum (EHRENBERG, 1843) SARJEANT & STOVER, 1978					1					1							1									2										3						1	1							1				1	1	2		1										
Stephanelytron redcliffense SARJEANT, 1961									1																																																											
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Wanaea acollaris DODEKOVA, 1975														1																																								1														
Wanaea digitata COOKSON & EISENACK, 1958																												1																										2														
GROUP B																																																																				
Crassispora kosankei (POTONIE & KREMP, 1955) BHARADWAJ, 1957			2	2		2		1																																																								1				
Endosporites globiformis (IBRAHIM, 1932) SCHOPF, WILSON & BENTALL, 1944				1		1		1																																																												
Endosporites sp.																																			1																																	
Lycospora pucilla (IBRAHIM, 1932) SCHOPF, WILSON & BENTALL, 1944																									1																																											
Murospora sp.						1																													1																																	
Raistrickia saetosa (LOOSE, 1932) SCHOPF, WILSON & BENTALL, 1944				1																																																																
Vestispora tortuosa (BALME, 1952) SPODE (in press) in SMITH & BUTTERWORTH, 1967						1																																																														
GROUP C																																																																				
Kraeuselisporites reissingeri (HARRIS, 1957) MORBEY, 1975	1			2	1						2																																																									
Liasidium variable DRUGG, 1978																																																																					1
Nannoceratopsis gracilis ALBERTI, 1961			1					1																									1																																			
Nannoceratopsis senex VAN HELDEN, 1977						1		1			1		1			1									3						1						1	1		1	1				1								2	2	3			1		1		1						
Ovalipollis ovalis (KRUTZSCH, 1955) SCHEURING, 1970																																1																																				
Rhaetogonyaulax rhaetica (SARJEANT, 1963) LOEBLICH & LOEBLICH, 1968																																				2																						2										
GROUP D																																																																				
Avellodinium falsificum DUXBURY, 1977																																																															1					
Ctenidodinium elegantulum MILLIOUD, 1969																																	1																																			
Isthmocystis distincta DUXBURY, 1979																1																																																				
Muderongia crucis NEALE & SARJEANT, 1962																											1																																									
GROUP E																																																																				
Lueckisporites virkkiae POTONIE & KLAUS, 1954						1	1				1																																																									
Striatoabieites sp								1													1																																															
Taeniaesporites spp.			1			1					1																																																									
GROUP F																																																																				
Adnatosphaeridium apiculatum (COOKSON & EISENACK, 1960) LENTIN & WILLIAMS, 1973 of DUXBURY, 1977							1		1										1								2												1																					1								1
Dichadogonyaulax culmula (NORRIS, 1965) LOEBLICH & LOEBLICH, 1968																1																														1																						
Parvocavatus spinosus DUXBURY, 1977						1		1																																																														

KEY
GROUP A = MIDDLE & LATE JURASSIC TAXA
GROUP B = CARBONIFEROUS TAXA
GROUP C = LATEST TRIASSIC AND EARLY JURASSIC TAXA
GROUP D = EARLY CRETACEOUS TAXA
GROUP E = PERMO - TRIASSIC TAXA
GROUP F = LATE JURASSIC AND EARLY CRETACEOUS TAXA

Text-Fig. 35. A numerical representation of reworked palynomorphs in the studied sections.