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BARREMIAN PHYTOPLANKTON FROM SPEETON, EAST YORKSHIRE

BY

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With 13 Plates and 17 Figures in the text

Abstract

This is a study of phytoplankton recovered from 8 samples taken from the Barremian of the Speeton Clay of Speeton, East Yorkshire. Well over 100 dinoflagellate cyst and acritarch taxa were observed, of which 96 are listed, together with their occurrences in the present work, in text-fig. 3. Of these 96, 19 species and 2 genera are described as new and discussed in the "Systematic Descriptions" section. Also, 5 genera and 3 species are emended and 14 recombinations effected. Graphical illustrations consist of 17 figures in the text and all 96 species are photographically illustrated on 13 plates. The present study is compared and contrasted with previous Barremian palynological studies in a "Palynostratigraphical Comments" section.

Key words: Phytoplankton — Barremian — England.

Contents

I. Introduction

The Speeton Clay is a sequence of light to very dark mudstones, clays and cementstones which outcrop between the Chalk (to the South) and the Kimmeridge Clay (to the North) in Filey Bay, East Yorkshire (see text-fig. 1). It was sub-divided into 5 units by LAMPLUGH (1889) and these were designated A to E in descending order. It is not within the scope of the present work to discuss the stratigraphy of the whole Speeton Clay sequence. For greater detail, therefore, the reader should consult LAMPLUGH (1889 and 1924), NEALE (1960, 1962 and 1968), KAYE (1964) and FLETCHER (1969 and 1973).

The B Beds were divided into three parts by LAMPLUGH (1889); Lower B, The Cement Beds (Middle B) and Upper B. Due to his not seeing sufficiently good exposures, LAMPLUGH was unable to describe the sequence of B Beds completely and it was KAYE (1964) who first fully divided the Lower B and Cement Beds and described the complete sequence. KAYE divided the Lower B Beds into six units, LB 1—6 in descending order, and further divided LB 2, LB 4 and LB 5 into four, four and five sub-divisions respectively, denoted by initials (i.e. LB2A, LB2B, etc.). The total thickness of the Lower B Beds, according to KAYE, is 68 ft., whereas LAMPLUGH (1889) considered Lower B to be 90 ft. thick with a gap betweeen it and the Cement Beds. KAYE (1964, p. 345) suggests that LAMPLUGH inadvertently measured part of the Cement Beds within his Lower B and that he had been confused by lack of knowledge of the many small slip faults which affect the Speeton section. Prof. J. W. NEALE of Hull University, in an open letter to the Geological Society Sub-Committee on the Barremian (dated 17th May 1971), argues that the Barremian/Hauterivian boundary in

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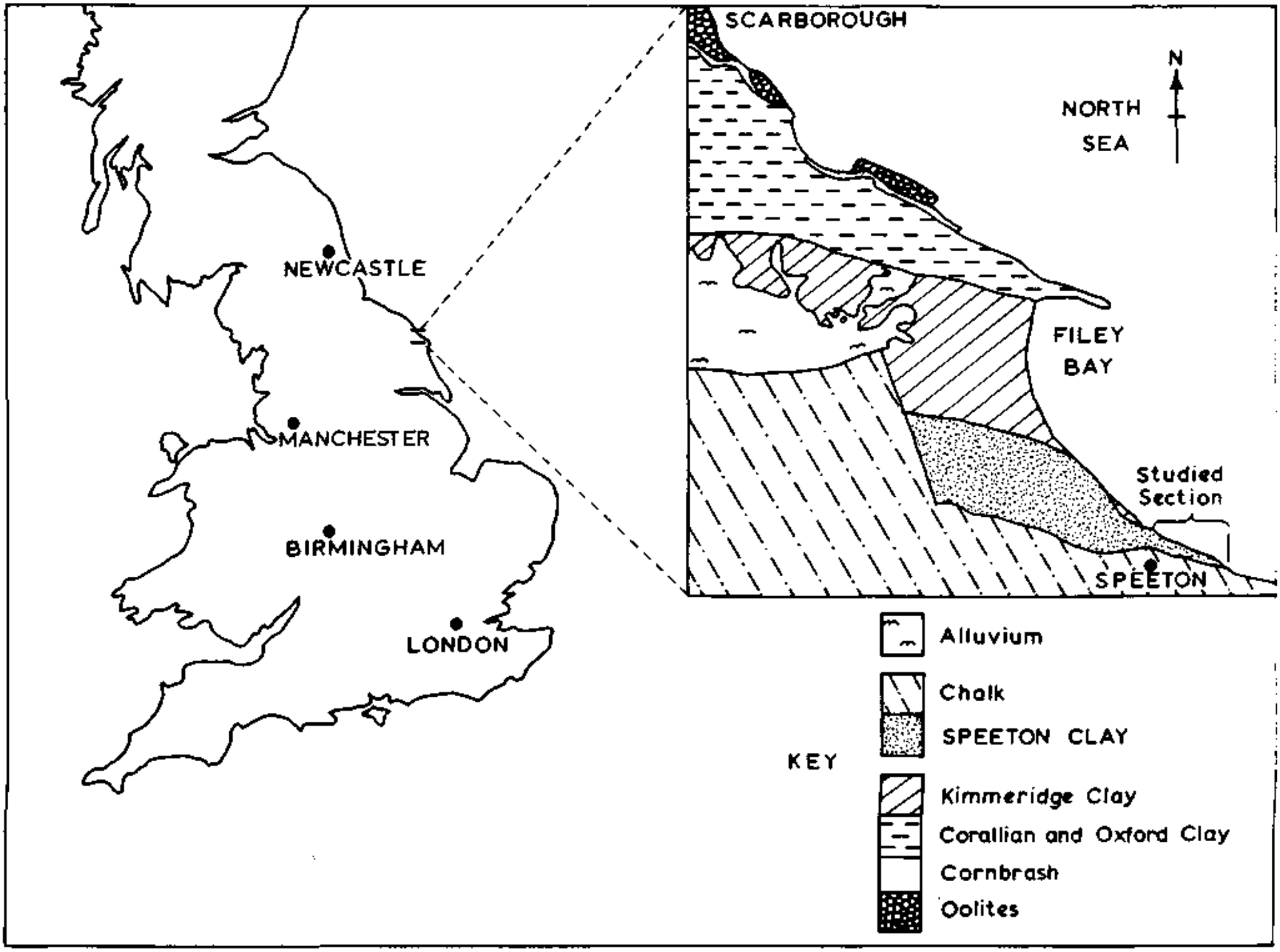
the Speeton Clay lies between LB5E and LB6, so that all but the lowest division of Lower B may be considered Early Barremian in age. Fletcher (1973, pp. 166, 167) argues that the foraminiferal distribution in the Lower B Beds is very similar to that in north-west Germany and that the Barremian/Hauterivian boundary might be as high as LB4C. Rawson (1971a, 1971b) suggests a provisional Barremian/Hauterivian boundary at the base of LB5D (which is very close to that suggested by Neale). It appears, therefore, that the precise position of the Barremian/Hauterivian boundary in the Speeton Clay is open to some discussion. Nevertheless, its position within the lower Lower B Beds may be assumed.



Text-fig. 1. The location of the studied section (scale of blow-up — 1 cm ≡ 1 km).

The Middle B Beds are distinguished by the presence of 7 distinct layers of calcareous nodules termed α, β, γ, δ, ε, ζ and η in descending sequence. Each nodule band is separated from its neighbours by approximately 6 ft. of clay and these clay bands tend to be grey closest to the nodules, mottled a little distance away from them and dark blue/grey furthest from them. Undoubtedly, the Middle B Beds represent a period of cyclic deposition. Each nodule band may represent shallowing of the overlying water so that the sediment is brought within the wave base. Mottled sediments have been shown by Moore & Scruton (1957) to be usually caused by organic reworking in fairly shallow marine conditions where little clastic material is being deposited. Megafossils are common in the Middle B Beds but, apart from the belemnites, they are usually fragile and difficult to extract. Ammonites are very rare and of little use in subdivision, although large but usually poorly preserved specimens of *Hoplocrioceras* and *Paracrioceras* are commonly associated with nodule band ζ. Mining for cement making in the early part of last century has produced many good examples of fossils from the Cement Beds. These are now in museums and private collections and it is unfortunate that the precise stratigraphical origins of such fossils are not known, especially in view of the difficulty in correlating the Cement Beds with their European equivalents.

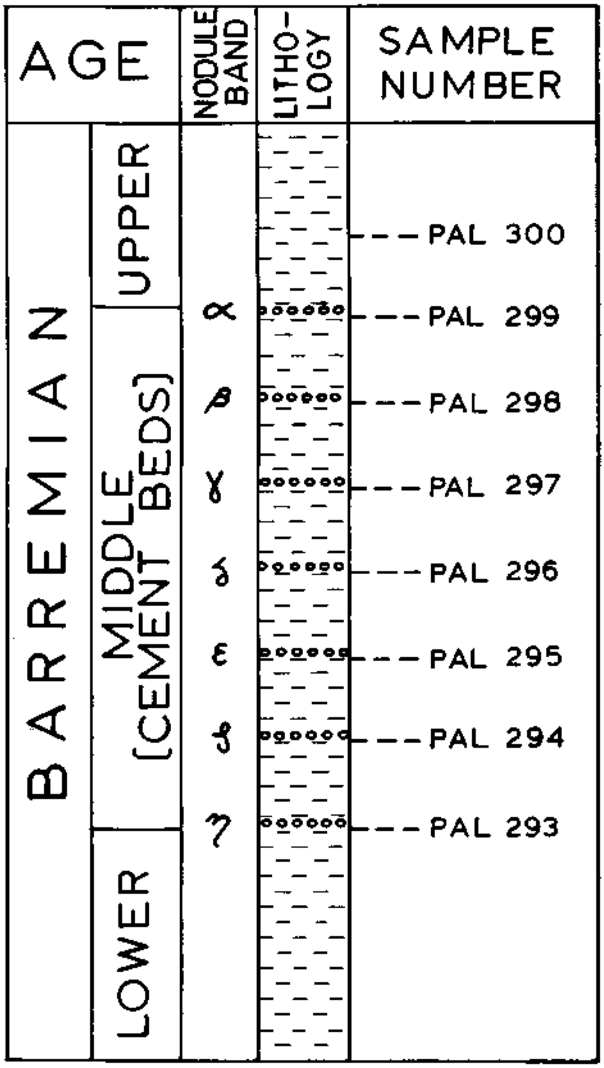
The upper B Beds are approximately 30 ft. thick and the Aptian/Barremian boundary lies near their top. As stated by Kaye (1964, p. 352), "The uppermost few feet of the Upper B which yielded poorly preserved specimens of the genus *Deshayesites* of a *bodei* zone age, belong to the basal Lower Aptian".

The present work embodies a study of mikroplankton recovered from 8 samples taken from the Speeton Clay Barremian. The samples are designated PAL 293 to PAL 300 inclusive, these being their reference numbers within The British Petroleum Company Limited, Palaeontology Branch, Sunbury-on-Thames. PAL 293 was taken immediately below nodule band η in Middle B and is therefore from the top of LB1 (= top Lower Barremian). Samples PAL 294 to PAL 299 inclusive were taken from immediately below nodule bands ζ to α in Middle B and are Middle Barremian in age. PAL 300 was taken 6 ft. above nodule band α in Middle B and is Late Barremian in age. The statigraphical positions of the studied samples are indicated in text-fig. 2.

Samples studied here were remarkable in the richness and diversity of their palynomorph content. Well over 100 species of dinoflagellate cysts and acritarchs were observed, together with numerous spores and pollen grains. Land-derived palynomorphs were often as numerous as marine representatives. Preservation in all samples was excellent.

Ninety-six dinoflagellate cyst and acritarch taxa are listed in text-fig. 3, together with their observed occurrences within the studied section. Of these, 2 genera and 19 species are previously undescribed, 5 generic and 3 specific diagnoses are emended and 14 new combinations are effected.

All figured specimens are housed in the Department of Palaeontology, British Museum (Natural History) and B.M. (N.H.) "V" reference numbers are included where appropriate.



Text-fig. 2. The stratigraphical position of the studied samples. Vertical scale — 1 cm ≡ 2 m.

II. Acknowledgements

The author is most grateful to Prof. J. W. Neale of the University, Kingston-upon-Hull for lending his stratigraphical expertise in the collection of samples. He is also indebted to Dr. J. E. Williams of B.P., Sunbury-on-Thames, Dr. G. L. Eaton and Mr. J. R. Weston of B.P. Dyce, each of whom has constructively criticised the text. Thanks are due to Mr. A. H. Tutton for his considerable trouble with the photography, to Miss J. M. Eaton for her typing skills and to Miss M. F. Sullivan for her help with the more difficult drawings. Permission to publish was granted by The British Petroleum Company Limited.

III. Systematic Descriptions

Because of his recent receipt of the major work by Stover & Evitt (1978), the present author has not yet had adequate opportunity to consider or discuss the many taxonomic considerations relating to the present

Text-fig. 3. An alphabetical list of ninety-six taxa observed in the present work, together with their stratigraphical occurrences (those discussed in the "Systematic Descriptions" section are marked with an asterisk).

BARREMIAN								
L B	MIDDLE B (CEMENT BEDS)						UB	
PAL 293	PAL 294	PAL 295	PAL 296	PAL 297	PAL 298	PAL 299	PAL 300	
	×	×	×	×	×	×		* *Achomosphaera neptuni* (EISENACK, 1958) DAVEY & WILLIAMS, 1966a. Pl. 6, fig 8.
×	×	×	×	×	×	×	×	* *Achomosphaera* cf. *neptuni* Pl. 6, figs 1, 2.
						×	×	*Achomosphaera ramulifera* (DEFLANDRE, 1937) EVITT, 1963. Pl. 10, fig 8
×	×	×	×	×	×	×	×	* *Aprobolocysta neistosa* n.sp. Pl 2, figs 8, 9, Text-fig 4
×								*Aptea anaphrissa* (SARJEANT, 1966b) SARJEANT & STOVER, 1978. Pl 9, figs 6, 7
	×	×	×	×	×	×	×	*Avellodinium falsificum* DUXBURY, 1977. Pl 6, fig 7
	×	×	×	×	×	×	×	*Batioladinium jaegeri* (ALBERTI, 1961) BRIDEAUX, 1975 Pl 6, fig 4, pl 12, fig 9.
×	×	×	×	×	×	×	×	*Batioladinium longicornutum* (ALBERTI, 1961) BRIDEAUX, 1975. Pl. 7, fig. 11.
			×	×			×	*Batioladinium micropodum* (EISENACK & COOKSON, 1960) BRIDEAUX, 1975. Pl. 13, fig. 7.
×	×	×	×	×	×		×	*Callaiosphaeridium asymmetricum* (DEFLANDRE & COURTEVILLE, 1939) DAVEY & WILLIAMS, 1966b. Pl. 8, figs. 3, 6, 11.
×		×	×					* *Callaiosphaeridium trycherium* n.sp. Pl 11, figs 6, 9.
	×	×	×	×	×	×	×	*Canninginopsis ? tabulata* (DAVEY & VERDIER, 1974) DUXBURY, 1977. Pl 10, figs 5, 7.
						×	×	*Carpodinium granulatum* COOKSON & EISENACK, 1962 emend LEFFINGWELL & MORGAN, 1977. Pl. 3, fig. 7
×	×	×			×	×	×	*Cassiculosphaeridia magna* DAVEY, 1974. Pl. 13, figs 1, 4
	×	×	×	×	×	×	×	*Cauca parva* (ALBERTI, 1961) DAVEY & VERDIER, 1971. Pl 12, fig 1
×	×	×	×	×	×	×	×	*"Cleistosphaeridium" polypes* (COOKSON & EISENACK, 1962) DAVEY, 1969. Pl. 13, fig. 10.
×	×	×	×	×	×	×	×	* *Coronifera oceanica* COOKSON & EISENACK, 1958. Pl 10, fig. 2
		×				×	×	*Cribroperidinium cornutum* DAVEY, 1974. Pl. 10, fig. 1
×	×	×	×	×	×	×	×	*Cribroperidinium edwardsii* (COOKSON & EISENACK, 1958) DAVEY, 1969. Pl. 1, figs 6, 10.
		×	×	×	×	×	×	*Ctenidodinium elegantulum* MILLIOUD, 1969 Pl. 8 fig 9
×	×	×	×	×	×	×	×	*Cyclonephelium distinctum* DEFLANDRE & COOKSON, 1955 Pl 8. fig. 1.
×	×	×	×	×	×	×	×	*Dingodinium albertii* SARJEANT, 1966b. Pl. 3 fig 10.
	×	×	×					* *Diphasiosphaera stolidota* n. gen et sp Pl. 1, figs. 5, 9; Text-fig 5
	×	×	×	×	×	×	×	*Discorsia nanna* (DAVEY, 1974) DUXBURY, 1977. Pl. 4, figs 6, 7.
×	×		×	×		×		* *Druggidium jubatum* n.sp Pl 3, figs 3, 4
					×	×	×	* *Ellipsodinium reticulatum* n sp. Pl 4 figs 4, 8
		×	×	×	×	×	×	*Endoscrinium campanulum* (GOCHT, 1959) VOZZHENNIKOVA, 1967. Pl. 4, figs. 5, 9
	×	×			×	×		* *Exiguisphaera plectilis* n sp. Pl 3, figs 5, 8, 11.
	×	×	×	×	×			* *Florentinia cooksoniae* (SINGH, 1971) n. comb emend. Pl 7, figs. 6, 9; Text-fig 6
	×	×	×	×	×	×		* *Florentinia interrupta* n. sp. Pl. 12, fig 3, Text-fig. 7
×		×	×	×	×	×	×	*Florentinia mantellii* (DAVEY & WILLIAMS, 1966b) DAVEY & VERDIER, 1973. Pl. 12, figs 4, 7.
×		×	×		×	×	×	*Fromea amphora* COOKSON & EISENACK, 1958. Pl 13, fig 14.
	×	×	×	×	×	×	×	* *Fromea quadrugata* n sp. Pl 4, figs 12-15; Text-fig. 14
		×	×			×	×	*Gardodinium ordinale* DAVEY, 1974. Pl 13, fig 3.
		×	×		×	×	×	*Gardodinium trabeculosum* (GOCHT, 1959) ALBERTI, 1961 Pl. 11, fig. 5.
		×	×	×			×	*Gonyaulacysta boreas* DAVEY, 1974 Pl. 2, fig. 5.
		×						*Gonyaulacysta cassidata* (EISENACK & COOKSON, 1960) SARJEANT, 1966a. Pl. 13, fig. 13
		×	×		×	×	×	* *Gonyaulacysta compta* n. sp Pl 2, figs. 1, 2, 4.
	×			×				*Gonyaulacysta fastigiata* DUXBURY, 1977 Pl 1, figs 7, 8.
			×	×	×			* *Gonyaulacysta fimbriata* n. sp. Pl. 1, figs. 1-3
×	×		×	×	×	×	×	*Gonyaulacysta helicoidea* (EISENACK & COOKSON, 1960) SARJEANT, 1966a Pl. 1, fig. 4.
×	×	×	×	×	×	×	×	* *Heslertonia heslertonensis* (NEALE & SARJEANT, 1962) SARJEANT, 1966a emend. Pl. 12, fig. 6
×			×	×				*Hystrichodinium pulchrum* DEFLANDRE, 1935. Pl. 13, fig 12
	×	×		×	×	×	×	*Hystrichodinium ramoides* ALBERTI, 1961. Pl. 5, fig 6
×	×	×	×	×	×	×	×	*Hystrichodinium voigtii* (ALBERTI, 1961) DAVEY, 1974. Pl. 5, figs 1, 12
×		×	×	×		×	×	*Hystrichosphaeridium arborispinum* DAVEY & WILLIAMS, 1966b. Pl. 6, fig 3.
		×	×	×	×	×	×	* *Hystrichosphaeridium ? phoenix* n sp Pl 13, figs 5, 6; Text-fig. 8
×	×	×	×	×		×		*Hystrichosphaeridium recurvatum* (WHITE, 1842) DAVEY & WILLIAMS, 1966b. Pl. 10, fig. 4
×	×	×	×	×	×	×	×	* *Hystrichosphaerina schindewolfi* ALBERTI, 1961. Pl. 6, fig. 6; Text-fig. 9.
	×							*Kleithriasphaeridium corrugatum* DAVEY, 1974 Pl. 9, fig. 3.
×								*Kleithriasphaeridium fasciatum* (DAVEY & WILLIAMS, 1966b) DAVEY, 1974. Pl. 12 fig 2
×	×	×	×	×	×	×	×	*Kleithriasphaeridium simplicispinum* (DAVEY & WILLIAMS, 1966b) DAVEY, 1974. Pl 12, fig 5.
			×	×		×		*Leptodinium alectrolophum* SARJEANT, 1966a. Pl 6, fig 5.
			×	×	×	×	×	* *Lithodinia sagena* n.sp Pl 3, figs. 6, 9, 12, 13
×	×	×	×	×	×	×	×	*Lithodinia stoveri* (MILLIOUD, 1969) DUXBURY, 1977. Pl 5, fig. 3
×								* *Muderongia crucis* NEALE & SARJEANT, 1962. Pl. 8 fig. 10.
		×	×	×		×	×	* *Muderongia imparilis* n. sp. Pl 5, figs. 2, 4, 5; Text-fig. 10
			×	×				* *Muderongia pannosa* n.sp Pl 10, figs 3, 6; Text-fig 11.
×								*Muderongia simplex* ALBERTI, 1961. Pl 11, fig 3.
×	×	×	×	×	×	×	×	*Muderongia staurota* SARJEANT, 1966b. Pl 2, fig 7
×	×	×	×	×	×	×	×	* *Occisucysta tentoria* DUXBURY, 1977 Pl 2, figs 3, 6
		×	×	×	×	×	×	* *Odontochitina operculata* (WETZEL, 1933) DEFLANDRE & COOKSON, 1955. Pl. 5, fig 9.
×	×	×		×		×	×	*Oligosphaeridium complex* (WHITE, 1842) DAVEY & WILLIAMS, 1966b Pl. 7, fig 12.
		×						* *Oligosphaeridium fenestratum* n. sp Pl 9, figs. 8, 9.
×	×	×	×	×	×	×	×	*Oligosphaeridium perforatum* (GOCHT, 1959) DAVEY & WILLIAMS, 1969. Pl. 7, figs. 4, 7.
		×	×	×	×	×	×	*Oligosphaeridium pulcherrimum* (DEFLANDRE & COOKSON, 1955) DAVEY & WILLIAMS, 1966b. Pl. 7, fig. 13.
	×	×	×	×	×	×	×	*Palaeoperidinium cretaceum* POCOCK, 1962 ex DAVEY, 1970. Pl 9, fig. 4.
×	×	×	×	×	×	×	×	*Phoberocysta neocomica* (GOCHT, 1957) MILLIOUD, 1969. Pl 13, fig. 11
		×	×	×		×	×	*Polysphaeridium laminaspinosum* DAVEY & WILLIAMS, 1966b Pl 11, fig 12
×	×	×	×	×	×	×	×	*Polysphaeridium multispinosum* DAVEY, 1974. Pl 7, fig. 10.
		×	×	×	×	×	×	*Prolixosphaeridium deirense* DAVEY, DOWNIE, SARJEANT & WILLIAMS, 1966. Pl 5 fig. 11
		×	×		×			*Protoellipsodinium clavulum* DAVEY & VERDIER, 1974. Pl 7, fig 3
×	×	×	×	×	×	×	×	*Protoellipsodinium spinosum* DAVEY & VERDIER, 1971. Pl. 7, fig 2.
×	×	×	×	×	×	×	×	*Pseudoceratium pelliferum* GOCHT, 1957. Pl. 12, fig 10
		×	×	×	×	×	×	*Pseudoceratium pelliferum* GOCHT, 1957 subsp. *solocispinum* DAVEY, 1974. Pl 9, fig. 10
			×		×			* *Pterodinium premnos* n. sp Pl. 3, figs. 1, 2.
		×	×	×	×			* *Rhombodella vesca* n sp. Pl. 5, figs 7, 10; Text-fig. 15
×		×	×	×	×	×	×	*Sirmiodinium grossii* ALBERTI, 1961 emend. WARREN, 1973. Pl 4, figs. 10, 11.
×			×	×				*Spiniferites cingulatus* (WETZEL, 1933) SARJEANT, 1970. Pl 11, fig. 10.
	×		×	×	×	×	×	*Spiniferites ramosus* (EHRENBERG, 1838) MANTELL, 1854 subsp. *granosus* DAVEY & WILLIAMS, 1966a. Pl. 13, fig 8.
×	×	×	×	×	×	×	×	*Spiniferites ramosus* (EHRENBERG, 1838) MANTELL 1854 subsp. *ramosus* DAVEY & WILLIAMS, 1966a Pl. 7, fig 1.
×	×	×	×	×	×	×	×	* *Spiniferites speetonensis* n sp. Pl. 11, figs. 1, 2, 4.
	×	×	×	×	×	×	×	*Subtilisphaera perlucida* (ALBERTI, 1959) JAIN & MILLEPIED, 1973. Pl. 8, fig. 8.
	×					×	×	*Subtilisphaera pirnaensis* (ALBERTI, 1959) JAIN & MILLEPIED, 1973 Pl. 11, fig 7.
×	×	×		×				*Subtilisphaera ? terrula* (DAVEY, 1974) LENTIN & WILLIAMS, 1976. Pl. 8, figs. 2, 5.
×	×		×	×	×			*Systematophora complicata* NEALE & SARJEANT, 1962. Pl 5, fig. 8
×								*Systematophora vetuscula* (DAVEY, 1974) DUXBURY, 1977. Pl. 11 fig. 13.
		×	×	×	×	×		*Taleisphaera hydra* DUXBURY, (in press). Pl. 4, figs 1, 2
		×	×	×	×	×	×	* *Tanyosphaeridium prolixispinosum* (DAVEY & WILLIAMS, 1966b) n comb. Pl. 7, figs. 5, 8.
×	×	×	×	×	×	×	×	*Tanyosphaeridium* cf. *variecalamum* DAVEY & WILLIAMS, 1966b Pl 13, fig. 9
			×	×	×			* *Trabeculidium quinquetrum* n gen et sp Pl 9, figs 1, 2, 5.
×	×	×		×	×	×		*Trichodinium castaneum* (DEFLANDRE, 1935) CLARKE & VERDIER, 1967. Pl. 13, fig 2
		×	×	×	×	×	×	*Trichodinium speetonensis* DAVEY, 1974. Pl. 5, figs [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	* [illegible]

work. Consequently, although the present work contains some references to STOVER & EVITT (1978), by and large, taxonomic considerations are restricted to pre- STOVER & EVITT, 1978 publications.

Species described below are divided simply into dinoflagellate cysts and acritarchs. Taxa discussed here are only those which are previously undescribed, those which have been emended or transferred from one genus to another or those which the author feels he must include in order to make specific taxonomic or morphological points. Alphabetical order is maintained throughout.

In the "Observed Dimensions" sections below (included only for previously undescribed taxa), the measurements recorded as x(y)z refer to x, the greatest observed, z the smallest observed and y the average of all observed values for any single dimension.

Dinoflagellate Cysts

Genus *Achomosphaera* EVITT, 1963

1963 *Achomosphaera* EVITT, p. 163.

Achomosphaera neptuni (EISENACK, 1958) DAVEY & WILLIAMS, 1966a

Pl. 6, fig. 8; text-fig. 4

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

Text-fig. 4. Camera lucida drawings of *Achomosphaera neptuni* (EISENACK, 1958) DAVEY & WILLIAMS, 1966a. **A and B a specimen in** lateral orientation. C an oblique dorsal view. x 650. A, B: V. 60277(5), C: V. 60292(1).

Remarks: DAVEY (1974, p. 44) remarked that EVITT considered the archeopyle type displayed by this species to be apical. This was reiterated in STOVER & EVITT (1978, p. 139) in which it is stated that EVITT's examination of the holotype shows that *A. neptuni*, "has an apical archeopyle and multifurcate, terminally closed, hollow, single intratabular processes". GOCHT has also examined the holotype and has stated (pers. comm.) that although it is difficult to be certain what type of archeopyle is present, he favours the apical type. Specimens encountered during the present work have displayed the archeopyle to good advantage and have shown it to be single-paraplate precingular. It is the opinion of the present author that both holotype and paratype (EISENACK, 1958, pl. 26, figs. 7, 8) may be laterally oriented. Comparison may be made between those specimens and text-fig. 4A and B herein in which a similarly laterally-oriented specimen is figured. EATON (pers. comm.) shares the author's opinion that EISENACK's type specimens may be oriented laterally.

A. neptuni bears processes which are typically distally trifurcate or bifurcate and each distal furcation tapers to a sharp point. In the opinion of the present author, such tri- and bifurcate processes are typical of gonal and parasutural areas respectively in the *Achomosphaera/Spiniferites* group. The concept of such processes being intratabular (as stated by STOVER & EVITT) is untenable.

Specimens referred to in the present work as *Achomosphaera* cf. *neptuni* were similarly referred to in DAVEY & VERDIER (1974, pp. 628, 629, pl. 92, fig. 2). They are similar to *A. neptuni* in their body ornament and process type but are generally smaller with much more numerous processes. Although *A.* cf. *neptuni* may be easily distinguished, it is felt that its general similarity to *A. neptuni* precludes its erection as a separate species.

Genus *Aprobolocysta* DUXBURY, 1977 emend.

1977 *Aprobolocysta* DUXBURY, p. 52.

Emended Diagnosis: Distinctly elongate proximate to proximochorate dinoflagellate cysts with bi-layered cyst wall. Paratabulation absent or indistinctly indicated by periphragm folds, parasutural crests and/or irregular archeopyle margin. Apex and antapex bluntly rounded. Archeopyle apical.

Remarks: The diagnosis is emended to include reference to the indistinct paratabulation and proximochorate form shown by one species in the genus, *A. neistosa* n. sp.

The archeopyle type demonstrated by *Aprobolocysta* is similar to that seen in *Batioladinium* BRIDEAUX, 1975 in which a deep ventral notch is observed upon complete opercular detachment. This deep notch is undoubtedly a consequence of general epicystal elongation, causing paraplate 1′, which probably occupied the notch, to become distinctly elongate also.

Aprobolocysta neistosa n. sp.

Pl. 2, figs. 8, 9; text-fig. 5

Derivation of Name: From the Greek *neistos*, newest, youngest, last — in reference to the stratigraphical position of this species with respect to others of the genus.

Holotype: Pl. 2, figs. 8, 9; text-fig. 5.

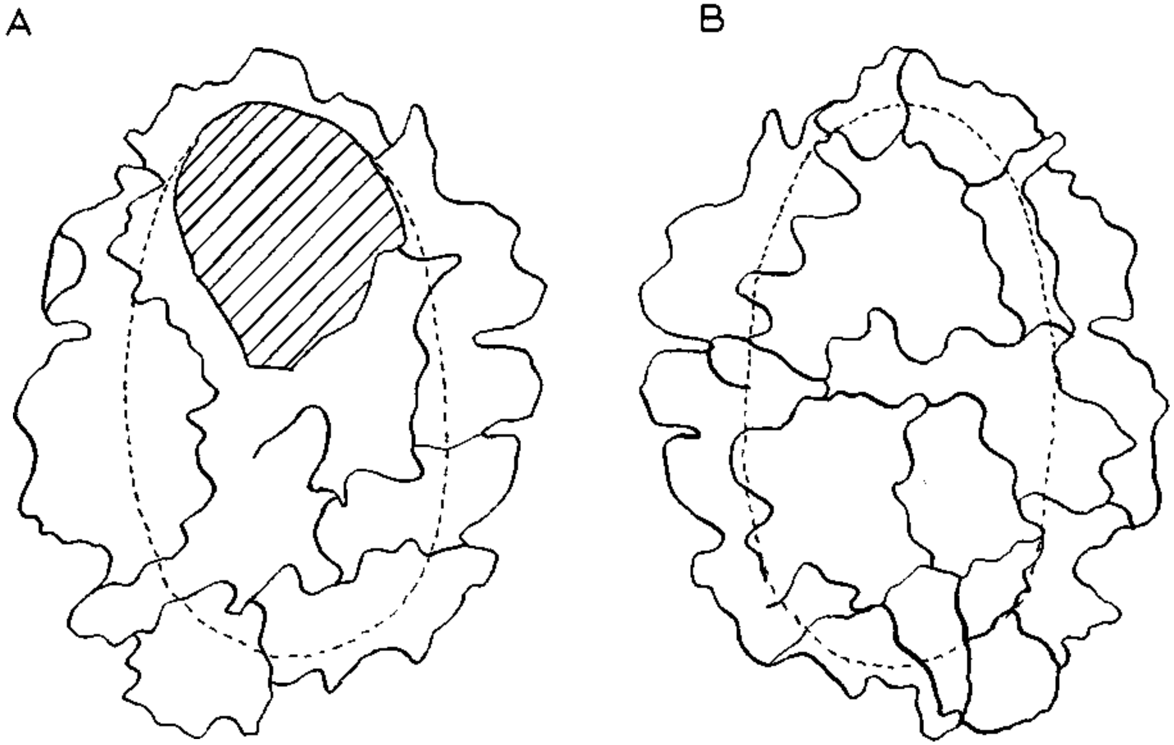
Type Locality: Division MB, immediately below cementstone nodule band β, Speeton Clay, Speeton, England.

Diagnosis: An elongate ovoidal, proximate to proximochorate dinoflagellate cyst. It has distinctive, delicate crests which may attain a height equal to half the main body width. The crests are clearly lobate and sometimes outline an indistinct paratabulation pattern. Usually, secondary crests are present and these break up the paraplate areas into a crude reticulum. The archeopyle is apical with the operculum sometimes remaining attached.

Observed Dimensions:

Holotype (operculum detached) — 67 x 49 μm
Complete Specimens — 75 (72) 67 x 64 (53) 46 μm
Specimens Measured — 3
Operculum Detached — 73 (63) 57 x 55 (47) 39 μm
Specimens Measured — 9

Remarks: This species differs from others of the genus in having very distinctive, delicate crests which sometimes reflect an indistinct paratabulation pattern or form a crude reticulum. *Aprobolocysta eilema* DUXBURY, 1977 has folds which run sinuously around the paracingulum and from the paracingulum to the antapex, but displays no parasutural and secondary crests, as in *A. neistosa* n. sp. *Aprobolocysta varigranosa* DUXBURY, 1977 has neither folds nor crests.



Text-fig. 5. Camera lucida drawings of *Aprobolocysta neistosa* n. sp. holotype. A ventral and B dorsal aspect. x 1300. V. 60301(1).

Genus *Callaiosphaeridium* DAVEY & WILLIAMS, 1966b emend.

1966b *Callaiosphaeridium* DAVEY & WILLIAMS, p. 103.
1967 *Hexasphaera* CLARKE & VERDIER, p. 42.

Emended Diagnosis: Spheroidal to ellipsoidal dinoflagellate cysts. The paracingulum has six tubular, distally open processes which are roughly equidistant from one another and which bear secondary, flexuous spines near their distal terminations. The epi- and hypocystal areas bear long gonal and parasutural processes connected by parasutural crests of varying height. Such parasutural crests may be merely low surface ridges or may attain a height equal to that of the gonal processes. In the latter case, individual gonal and parasutural spines may be indistinguishable and the epi- and hypocystal areas may be considered to bear only high parasutural crests. The paratabulation is typically gonyaulacacean and the archeoplye is epicystal.

Remarks: The genus *Callaiosphaeridium* DAVEY & WILLIAMS, 1966b is here emended in order to include some reference to the variability of epi- and hypocystal processes and/or crests. In the present author's opinion, the main characteristic feature of *Callaiosphaeridium* is the presence of six tubular, paracingular processes. In other respects, it may be compared with *Avellodinium* DUXBURY, 1977 and *Heslertonia* SARJEANT, 1966a emend. herein. *Avellodinium* bears only gonal processes and has only very low parasutural crests. *Heslertonia* has only high, regular parasutural crests without tubular or *Avellodinium*-type processes. In the epi- and hypocystal areas, therefore, *Callaiosphaeridium* may combine the gonal process type of *Avellodinium* with the high parasutural crests typical of *Heslertonia*.

Callaiosphaeridium trycherium n. sp.

Pl. 11, figs. 6, 9

Derivation of Name: From the Greek *trycheros*, ragged, tattered, worn — in reference to the parasutural crests.
Holotype: Pl. 11, fig. 6.
Type Locality: Division LB1, immediately below cementstone nodule band η in MB, Speeton Clay, Speeton, England.

Diagnosis: A spheroidal to ovoidal dinoflagellate cyst with a smooth to finely granular surface. It bears six tubular paracingular processes which have several secondary, flexuous spines near their distal terminations. The epi- and hypocystal areas bear distinctive, high parasutural crests which outline a typically gonyaulacacean paratabulation pattern. The parasutural crests are distally irregular and possess variously-grouped spines along their distal margins suggesting the terminal furcations of gonal and parasutural processes. Individual gonal and parasutural processes cannot, however, be distinguished. Parasutural crests occasionally connect tubular paracingular processes to trifurcate gonal areas, suggesting that the tubular processes are themselves gonal or parasutural in position. The archeopyle is epicystal.

Observed Dimensions:
Holotype — 73 x 77 μm
Overall — 87 (77) 70 x 87 (79) 67 μm
Specimens Measured — 18

Remarks: Near their proximal edge, the parasutural crests of this species have a vacuolar appearance. as have the parasutural crests in *Callaiosphaeridium asymmetricum* (DEFLANDRE & COURTEVILLE, 1939) DAVEY & WILLIAMS, 1966b.

The high parasutural crests and lack of individually distinguishable epi- and hypocystal processes distinguish this species from *Callaiosphaeridium asymmetricum.*

Genus *Cannosphaeropsis* WETZEL, 1933 emend.

1933 *Cannosphaeropsis* WETZEL, p. 6.

Emended Diagnosis: Chorate dinoflagellate cysts comprising a spheroidal to ellipsoidal central body which has a spheroidal enclosing network of solid trabeculae. An apical protuberance may be present. The trabecular network marks out a gonyaulacacean paratabulation pattern with each parasuture reflected by a single trabeculum. Gonal areas bear three short, solid, equal spines which may bifurcate distally, and trabeculae bear pairs of spines, similar to the gonal ones, set at right angles to the trabecular axis. Both gonal and trabecular spines may be raised above the general trabecular network on short "stalks". Usually rare, solid processes attach the central body to some gonal areas of the enclosing network. The central body usually displays a single paraplate archeopyle, presumably precingular in position.

Type Species: *Cannosphaeropsis utinensis* WETZEL, 1933 emend. herein.

Remarks: The diagnosis of *Cannosphaeropsis* WETZEL, 1933 is here emended in order to emphasise its very distinctive characteristics. The emended diagnosis proposed by WILLIAMS & DOWNIE (1966, p. 222), is here rejected since it fails to encompass the type species, *C. utinensis* WETZEL, 1933 emend. herein. Forms referable to the group described by WILLIAMS & DOWNIE (1966, p. 222) are described below as *Trabeculidium* n. gen.

Cannosphaeropsis consists essentially of spheroidal to ellipsoidal central bodies enclosed in a network of solid trabeculae with each trabeculum marking a parasutural line. This structure contrasts with that displayed by *Trabeculidium* since the latter has double trabeculae marking out the paratabulation. Gonal areas in *Cannosphaeropsis* bear three short, solid spines which are either attached directly to the gonal area (in which case a single, small hole is usually present at this point) or which are separated from the gonal area by short "stalks". Similar variation is exhibited by the pairs of trabecular spines. The possession of gonal trifurcations and trabecular bifurcations surmounting the general trabecular network contrasts strongly with the situation in *Trabeculidium.* In the latter genus, the trabeculae arise from the tips of each tri- and bifurcation.

The trabecular network in *Cannosphaeropsis* is attached to the central body by solid processes which meet the network at gonal areas. Unlike *Trabeculidium*, which has connecting processes at each gonal point and at some parasutural ones, *Cannosphaeropsis* usually has only rare, gonal, connecting processes and consequently the points of origin of gonal and parasutural spines are generally free.

Cannosphaeropsis utinensis WETZEL, 1933 emend.

1933 *Cannosphaeropsis utinensis* WETZEL, p. 6, pl. 3, figs. 9—17; text-fig. 12.

Emended Diagnosis: As for the emended generic diagnosis herein.

Remarks: *Cannosphaeropsis utinensis* is a species typically present in the Senonian and has not, therefore, been observed in the present work. The emendations here of the genus and species have therefore been based on specimens encountered in the present author's palynostratigraphical work, particularly on the North West European Continental Shelf. They are also based on the excellent illustrations of WETZEL's original material, in both WETZEL, 1933 and EISENACK & KJELLSTRÖM, 1971, Bd. II.

Genus *Coronifera* (COOKSON & EISENACK, 1958) DAVEY, 1974

1958 *Coronifera* COOKSON & EISENACK, p. 45.

Coronifera oceanica COOKSON & EISENACK, 1958

Pl. 10, fig. 2

1958 *Coronifera oceanica* COOKSON & EISENACK, p. 45, pl. 12, fig. 6.
non 1958 *Coronifera oceanica* COOKSON & EISENACK, pl. 12, fig. 5.

Remarks: During the present study, the author has observed many specimens of *C. oceanica* and has seen none in which a "clean" single paraplate precingular archeopyle could be discerned. Certainly, several were seen which lacked a single mid-dorsal paraplate, but the total archeopyle involved some splitting between apical and precingular paraplate series, as has previously been suggested by DAVEY (1974, p. 47). The overall structure of *Coronifera,* therefore, seems to be very similar to that of *Florentinia* DAVEY & VERDIER, 1973 emend. herein. The major difference between *Coronifera* and *Florentinia* appears to be the presence in the former of numerous stiff, solid spines which may furcate distally and which are proximally connected by a low, crude surface reticulum as opposed to the somewhat flaccid processes arranged in ring complexes or tubular processes displayed by *Florentinia.*

Genus *Diphasiosphaera* n. gen.

Derivation of Name: From the Greek *diphasios,* double and *sphaera,* ball — in reference to the cavate, bi-layered nature of this genus.

Diagnosis: Dinoflagellate cysts which are cavate and distinctly bi-layered. Both endoblast and periblast are spheroidal and the latter bears a prominent apical protuberance. The archeopyle is single-paraplate precingular (3'') and the body layers are in contact only around and posterior to the archeopyle margin. Vague paratabulation, which appears gonyaulacacean, is outlined on the periblast by largely degenerate gonal and parasutural processes, with or without proximal connecting ridges. The ventral periblast displays a large hole in a parasulcal position.

Type Species: *Diphasiosphaera stolidota* n. sp.

Remarks: This genus has characters in common with several other genera. In encompassing cavate cysts with single paraplate precingular archeopyles, it is similar to *Stephodinium* DEFLANDRE, 1936 emend. DAVEY, 1970, *Athigmatocysta* DUXBURY, 1977 and *Endoscrinium* (KLEMENT, 1960) VOZZHENNIKOVA, 1967. It differs from each of these in the mode of attachment of the two body layers since it is completely cavate except for the archeopyle margin and that portion of the paracingulum directly beneath it.

Stephodinium is proximate except in an area roughly coincident with the paracingulum, where very pronounced cavation may be observed. It is interesting to note that European specimens of *Stephodinium* recorded by DEFLANDRE (1936), COOKSON & HUGHES (1964), CLARKE & VERDIER (1967) and DAVEY (1970) have ventral appression of the body layers as well as that in the epi- and hypocystal areas. The present author, in working on Northwest European Continental Shelf material, has also encountered such ventral appression. The Australian members of this genus, *S. australicum*, reported in COOKSON & EISENACK (1962), are different from their European counterparts in having their body layers appressed dorsally as well as in the epi- and hypocystal regions. This "Australian appression" is clearly demonstrated in COOKSON & EISENACK (1962, pl. 2, figs. 5 and 10). The irregular sulcal hole is also discernible in these photographs. It would appear, therefore, that the Australian species, *S. australicum* may not be a junior synonym of *S. coronatum*, as suggested in CLARKE & VERDIER (1967, p. 67).

Endoscrinium is a genus which, at present, contains many various dinoflagellate cyst species. Some are ellipsoidal, some dorso-ventrally flattened, some bear apical horns and some do not, etc. In the present author's opinion, the type species, *E. galeritum* (DEFLANDRE, 1938) must set it apart generically from most, if not all, of the other species at present included in this genus.

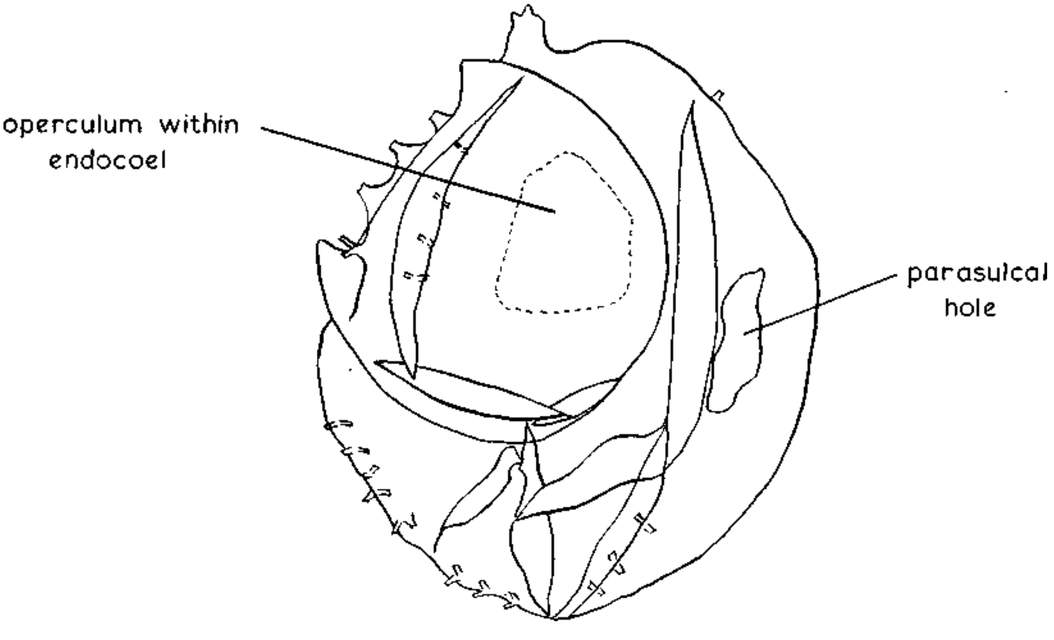
Diphasiosphaera stolidota n. sp.

Pl. 1, figs. 5, 9; text-fig. 6

Derivation of Name: From the Greek *stolidotos*, in folds, folded — in reference to the easily folded nature of the type species.

Holotype: Pl. 1, fig. 5; text-fig. 6.
Type Locality: Division MB, immediately below cementstone nodule band ε, Speeton Clay, Speeton, England.

Diagnosis: A cavate dinoflagellate cyst which is distinctly bi-layered and consists of a smooth, spheroidal endoblast and a smooth to finely perforate, spheroidal periblast. The periplast bears a distinct apical projection and has a large sulcal hole. Both body layers are characteristically extensively folded. Apparently typically gonyaulacacean paratabulation is outlined on the periblast by parasutural processes of varying height. The archeopyle is single-paraplate precingular (3″). Around the archeopyle margin, where the two body layers are appressed, the full development of fairly closely-spaced parasutural processes is seen and in this area, parasutural crests may proximally connect the processes. Away from the archeopyle margin and that part of the paracingulum directly posterior to it, the parasutural processes are reduced to a varying extent. As a rule, the greater the distance between the body layers, the shorter the parasutural processes, so that in the ventral area they may be reduced to nothing.



Text-fig. 6. Camera lucida drawing of *Diphasiosphaera stolidota* n. gen. et sp. holotype. x 990. V. 60268(1).

Observed Dimensions: Holotype — 86 x 70 μm
Overall — 95 (76) 65 x 92 (69) 59 μm
Specimens Measured — 15

Remarks: This is a very distinctive species, particularly in the extent of its cavation and in the mode of attachment of the body layers. The parasutural processes, at their fullest development, are similar to those of some species of *Spiniferites* MANTELL, 1850 emend. SARJEANT, 1970. Reduction of processes in the more cavate regions involves firstly the loss of process "stalks" so that one may see double rows of spines marking out paraplate boundaries with these spines representing the distal bifurcation of parasutural processes. Eventually, when the cavation reaches a sufficient extent, the double rows are reduced to nothing.

Genus *Druggidium* HABIB, 1973

1973 *Druggidium* HABIB, pp. 49, 51.

Druggidium jubatum n. sp.

Pl. 3, figs. 3, 4

1974 *Druggidium* sp. DAVEY, p. 50, pl. 2, figs. 7—9, pl. 3, fig. 3.

Derivation of Name: From the Latin *jubatus*, maned, crested — in reference to the hypocystal parasutural crests.

Holotype: Pl. 3, fig. 3.
Type Locality: Division MB, immediately below cementstone nodule band γ, Speeton Clay, Speeton, England.

Diagnosis: A small dinoflagellate cyst with a prominent paracingulum which divides the body unequally so that the epicyst is $^1/_4$ to $^1/_3$ of the overall length. Paratabulation is outlined by parasutural crests and these are low on the epicyst and high on the hypocyst. Paraplate areas and crests are thick and microperforate and possess a spongy texture. The epicystal paratabulation is indiscernible but that of the hypocyst is clear and of the formula 6''', 1p.v., 1''''. The archeopyle is precingular, mid-dorsal in position.

Observed Dimensions: Holotype — 35 x 32 μm
Overall — 36 (34) 29 x 35 (31) 29 μm
Specimens Measured — 12

Remarks: The spongy body texture and crestal height variation (epicystal crests markedly higher than hypocystal ones) in *D. jubatum* distinguish it from all previously described species.

D. apicopaucicum HABIB, 1973 has a scabrate to microgranulate surface with some small variation in crestal height (see HABIB, 1973, text-fig. 3). *D. deflandrei* (MILLIOUD, 1969) HABIB, 1973 and *D. rhabdoreticulatum* HABIB, 1973 both display what appears to be a reticular pattern, with that of the former tending to be concentrated near parasutural lines. According to HABIB (1973, p. 54), "the membrane of *D. rhabdoreticulatum* is raised above the central tract and is supported by short baculae, imparting an angularity to the outline of the cysts". Such angularity is displayed by *D. jubatum*, but is due to the crestal height variation rather than to any obvious body layer separation.

Genus *Ellipsodinium* CLARKE & VERDIER, 1967

1967 *Ellipsodinium* CLARKE & VERDIER, pp. 68, 69.

Ellipsodinium reticulatum n. sp.

Pl. 4, figs. 4, 8

Derivation of Name: From the Latin *reticulatus*, netlike, netted — in reference to the surface reticulum.

Holotype: Pl. 4, figs. 4, 8.
Type Locality: Division MB, immediately below cementstone nodule band β, Speeton Clay, Speeton, England.

Diagnosis: A small ellipsoidal to ovoidal dinoflagellate cyst. The surface is ornamented with a crude, fairly fine reticulum which is of equal height over the whole body except in the paracingulum, where it is absent. This reticulum may be largely degenerate and in places may be broken down into small coni. The archeopyle is single paraplate precingular, mid-dorsal in position.

Observed Dimensions: Holotype — 46 x 38 μm
Overall — 46 (41) 35 x 44 (35) 27 μm
Specimens Measured — 15

Remarks: *Ellipsodinium rugulosum* CLARKE & VERDIER, 1967, the type species of the genus, is characterised by having low crests outlining a reticulum which is elongated parallel to the long axis of the body. The crests of *E. rugulosum* become lower toward the poles. *E. reticulatum* n. sp., on the other band, bears a fairly fine, crude reticulum with no preferred elongation and no variation in the crest height. Further, the reticulum of *E. reticulatum* may be degenerate and so consist of isolated sections of crest punctuated by gaps or of such sections associated with small coni.

Genus *Exiguisphaera* DUXBURY (1979)

Remarks: Mr. D. G. BELL of the I.K.U. in Trondheim has pointed out (pers. comm.) the apparent similarity between *Exiguisphaera* DUXBURY (1979) and *Diacanthum* HABIB, 1972, particularly the similarity between text-fig. 1 of DUXBURY (1979) and text-fig. 2 of HABIB (1972). The present author has not examined specimens of *Diacanthum hollisteri* HABIB, 1972, the type species, but from HABIB's illustrations (1972, pl. 9, figs. 1, 3, pl. 10, fig. 1; text-fig. 2), several conclusions may be drawn and these are discussed below.

Firstly, the wall structure of *D. hollisteri* is completely different to that seen in *Exiguisphaera*. The entire surface of the former appears finely microreticulate with the microreticulum punctuated by numerous, broadly tapering spines. It is difficult to see clearly on HABIB's illustrations, but the broadly tapering spines appear to have radial thickenings extending from their bases for a short distance over the body surface. *Exiguisphaera*, on the other hand, has a smooth, distinctly microperforate wall with any intratabular spines which may be present having no proximal radial thickenings.

The crests of *D. hollisteri* are described by HABIB as perforate "for the most part". From HABIB's photographs, the parasutural crests appear variable in height on individual specimens, appear to be perforate in a much more complex fashion than suggested in HABIB's text-fig. 2 and appear to have a broad line of insertion on the main body surface. Further, there may be "false" paraplate boundaries marked by crests similar to the parasutural ones. The crests of *Exiguisphaera* are inserted on the body along single, narrow lines. They are fenestrate, usually on a large scale, with those of *E. phragma* DUXBURY (1979), the type species, consisting of single strands supporting a single trabeculum, and they never form "false" paraplate boundaries.

The paratabulation proposed for *D. hollisteri* (HABIB, 1972, text-fig. 2) is complicated by HABIB's difficulty in extracting a coherent scheme from his available material and it therefore differs considerably from that proposed for *E. phragma* (DUXBURY, 1979, text-figs. 1, 2). Nevertheless, it is probable that paraplate 2″ in *D. hollisteri* is equivalent to paraplate 1″ in *E. phragma*. It is possible, therefore, that the archeopyle type of *D. hollisteri* involves detachment of paraplates 2″ and 3″, compared with the scheme for *E. phragma*. This last species loses paraplates 3″ and 4″ in the same scheme. Loss of paraplates 2″ and 3″ in archeopyle formation would align *D. hollisteri* closely with *Occisucysta* GITMEZ, 1970.

The overall size of *Diacanthum* is constantly much greater than that of *Exiguisphaera*.

The present author recognises the similarities between the two genera discussed above, but is satisfied that they may be retained as separate entities.

Exiguisphaera plectilis n. sp.

Pl. 3, figs. 5, 8, 11

Derivation of Name: From the Latin *plectilis*, complicated, intricate — in reference to the parasutural crestal structure.

Holotype: Pl. 3, figs. 5, 8.
Type Locality: Division MB, immediately below cementstone nodule band α, Speeton Clay, Speeton, England.

Diagnosis: A thick-walled, spheroidal dinoflagellate cyst whose surface is distinctly microperforate. Paratabulation typical for the genus is outlined by fairly high parasutural crests. These crests are distally entire, widely fenestrate and composed of single, solid strands which furcate and fuse between the proximal and distal crestal margins in a complicated manner. Slender, intratabular spines are usually present and are equal in height to the parasutural crests. The archeopyle is dorsal in position and formed by detachment of two precingular paraplates.

Observed Dimensions:	Holotype — 64 x 67 μm
	Overall — 81 (69) 61 x 81 (70) 61 μm
	Specimens Measured — 16

Remarks: This is a very distinctive species which differs from *Exiguisphaera phragma* DUXBURY (1979) in several respects. The body wall of *E. plectilis* is much thicker and less prone to folding than that of *E. phragma.* Also, *E. plectilis* bears the higher and more complex parasutural crests and is generally larger than *E. phragma.*

Due to the spheroidal shape of *E. plectilis* and the consequent random orientation of observed specimens, it is rare to see the two-paraplate precingular archeopyle as well displayed as it is in the holotype. Nevertheless, the other characteristics of this species render it easily recognisable.

Genus *Florentinia* DAVEY & VERDIER, 1973 emend.

1973 *Florentinia* DAVEY & VERDIER, pp. 185, 186.
1976 *Silicisphaera* DAVEY & VERDIER, pp. 320, 321.
1976 *Achilleodinium* EATON, p. 234.

Emended Diagnosis: Spheroidal to ellipsoidal dinoflagellate cysts bearing large epi- and hypocystal processes which reflect a paratabulation of the formula 4′, 6″, 5‴, 1⁗. There are a variable number of paracingular and parasulcal processes. The epi- and hypocystal process form is very variable and ranges from single tubes which are open, partially closed or closed distally to process complexes composed of distally tapering, free-standing spines or tubules which impart a complex appearance to the cyst but which nevertheless represent only a few processes. Some variation in process size is usually apparent with the order of increasing size being paracingular and parasulcal, apical, precingular and postcingular. The antapical process is most variable and may be insignificant, may be of equal length to the postcingular processes or may be longer than all others. Usually, the antapical process is noticeably narrower than the postcingular ones. Both epi- and hypocystal processes usually bear secondary tubules towards, but not at, their distal extremities. The archeopyle is single-paraplate precingular with or without splitting between apical and precingular paraplate series.

Remarks: *Silicisphaera* DAVEY & VERDIER, 1976 and *Achilleodinium* EATON, 1976 are here considered to be junior synonyms of *Florentinia* DAVEY & VERDIER, 1973.

In comparing the original generic descriptions of *Florentinia* and *Silicisphaera,* only one difference emerges as being important, that of the typical possession by *Florentinia* of "a distinctively large, tubular antapical process". In *Silicisphaera,* on the other hand, "the antapical process is not distinctive or particularly large". Having written this, however, DAVEY & VERDIER (1976, pp. 326, 327) illustrate a taxon termed *Silicisphaera* aff. *ferox* which certainly possesses a distinctive antapical process and, by their own definition, must be placed in *Florentinia.* On their range chart, DAVEY & VERDIER (1976, p. 331) illustrate the range of the genus *Silicisphaera* as Turonian to Maastrichtian. Taxa observed in the present work, based on the presence or absence of a particularly large or distinctive antapical process, could have been placed either in *Florentinia* or *Silicisphaera.* The present author chooses to consider the variability of the antapical process to be an intrageneric feature.

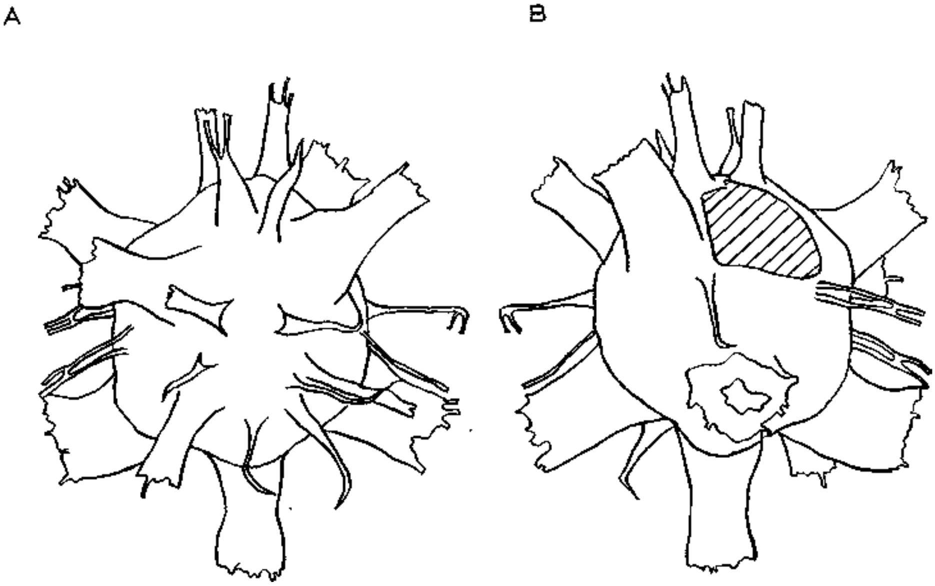
Achilleodinium was erected by Eaton to include taxa basically similar to *Hystrichokolpoma* KLUMPP, 1953 emend. WILLIAMS & DOWNIE, 1966 but with a single-paraplate precingular archeopyle as opposed to the tetratabular apical one of the latter genus. EATON compares *Achilleodinium* with *Florentinia* and states, "In *Florentinia* the archeopyle is formed by displacement of precingular plate 3″ with breakage or displacement of the apical plates". The original diagnosis of *Florentinia* includes the possibility of a single paraplate precingular (3″) archeopyle and therefore EATON's distinction of *Achilleodinium* from *Florentinia* is unfounded. EATON (pers. comm.) has expressed reservations to *Achilleodinium* being synonymised with *Florentinia* on the grounds that there is a distinct stratigraphical gap between the highest records of *Florentinia* and the lowest occurrence of *Achilleodinium*. By implication, therefore, *Achilleodinium* may be unrelated to *Florentinia* and may exhibit homeomorphy. The present author views unfavourably the introduction of such a concept into what can only be a purely morphological classification system and *Achilleodinium* is therefore regarded here as a junior synonym of *Florentinia*.

Florentinia cooksoniae (SINGH, 1971) n. comb. emend.

Pl. 7, figs. 6, 9; text-fig. 7

1971 *Hystrichosphaeridium cooksoni*, SINGH, pp. 329, 330, pl. 51, figs. 7, 8, pl. 52, figs. 1—4.

Emended Diagnosis: A species of *Florentinia* having tubular processes, one per paraplate area, which are parallel sided or slightly constricted at about ²/₃ their length. The tubular processes are variable in their length and width on individual specimens with the apical ones the smallest, the precingular ones larger and the postcingular ones largest of all. Secondary tubules are often present towards, but not at, the distal process margins. Within each paraplate series, there is some variation in process breadth, presumably due to variation in size of the paraplates, so that ventral processes are generally more slender than dorsal ones. The antapical process is variable and may be very similar in length and breadth to the postcingular ones, may be equal in length to the postcingulars but narrower or may be narrower than the postcingulars and longer. The tubular processes reflect a paratabulation of the formula 4′, 6″, 5‴, 1⁗. Slender paracingular and parasulcal processes are present in varying numbers and these usually taper to a capitate extremity but may furcate at any point along their length. Both the central body and the processes may be slightly fibrous, smooth to finely granular or finely perforate. The archeopyle is single-paraplate precingular (3″) with sometimes some dislocation of the apical paraplate series.



Text-fig. 7. Camera lucida drawings of *Florentinia cooksoniae* (SINGH, 1971) n. comb. emend. herein. A ventral and B dorsal aspect. x 750. V. 60258(1).

Remarks: SINGH's original diagnosis is here emended to include reference to the single-paraplate precingular archeopyle as opposed to the apical archeopyle assumed by that author. The variable nature of the antapical process is also described since SINGH (1971, p. 329) states, "antapical process distinctly larger and wider than other processes". In his illustration of the holotype (pl. 51, fig. 7), however, the antapical process is seen to be no longer and distinctly narrower than some postcingular ones.

Singh does not describe slender paracingular and parasulcal processes such as those described above. Specimens observed in the present work showed some variability in the number of such processes present so that their apparent absence in Singh's material is treated here as intraspecific variability.

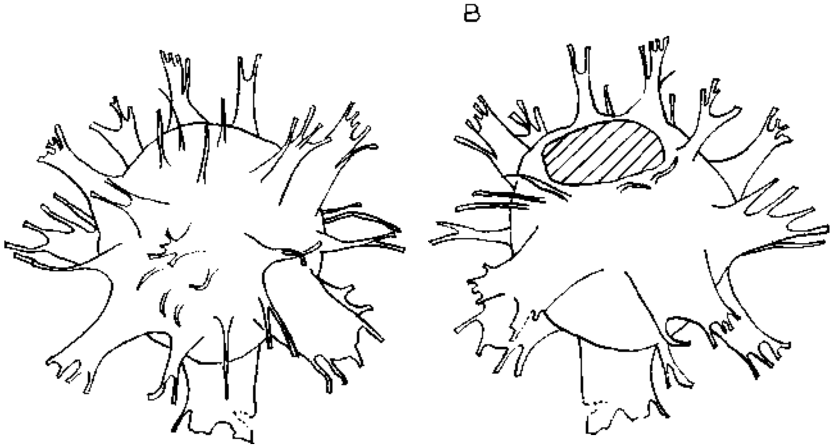
Florentinia interrupta n. sp.

Pl. 12, fig. 3; text-fig. 8

Derivation of Name: From the Latin *interruptus,* broken apart — in reference to the splitting of processes into secondary spines or tubules.

Holotype: Pl. 12, fig. 3.
Type Locality: Division MB, immediately below cementstone nodule band γ, Speeton Clay, Speeton, England.

Diagnosis: A species of *Florentinia* with a spheroidal central body and fibrous processes which reflect a paratabulation of the formula 4′, 6″, 5‴, 1⁗. There are a variable number of parasulcal and paracingular processes. The apical, precingular and postcingular processes typically taper towards their distal extremities and furcate into several capitate tubules. This furcation may occur at any point along the process length. The antapical process is usually somewhat longer than the others, does not furcate in the complex manner described above and always bears tubules near, but not at, the distal extremity. Paracingular and parasulcal processes are slender and taper distally to capitate tips. Again, these may furcate at any point along their length. The fibres of the processes coalesce on the central body to produce a crude microreticulum. The archeopyle is precingular, formed by detachment of paraplate 3″.



Text-fig. 8. Camera lucida drawings of *Florentinia interrupta* n. sp. paratype. A ventral and B dorsal aspect. x 750. V. 60271(3).

Observed Dimensions:
Holotype — 70 x 73 μm
Overall — 86 (75) 68 x 81 (74) 65 μm
Specimens Measured — 16

Remarks: This species differs from all others of the genus in having distinctly fibrous processes whose striations coalesce on the central body to produce a crude microreticulum.

Other Species:

Florentinia biformoides (Eisenack, 1954) n. comb. = *Hystrichosphaeridium biformoides* Eisenack, 1954, p. 68, pl. 11, figs. 16—20.

Florentinia buspina (Davey & Verdier, 1976) n, comb. = *Silicisphaera buspina* Davey & Verdier, 1976, pp. 321, 322, pl. 2, figs. 1—6; text-fig. 3.

Florentinia ferox (Deflandre, 1937) n. comb. = *Hystrichosphaeridium ferox* Deflandre, 1937, p. 72, pl. 14, figs. 3, 4.

Florentinia tenera (Davey & Verdier, 1976) n. comb. = *Silicisphaera tenera* Davey & Verdier, 1976, pp. 326, 327, pl. 3, figs. 8—12; text-fig. 6.

Florentinia tridactylites (Valensi, 1955) n. comb. = *Hystrichosphaeridium tridactylites* Valensi, 1955, pp. 37, 38, fig. 1D.

Genus *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.

Remarks: The author is aware of the erection of *Millioudodinium* by Stover & Evitt (1978, p. 173) to include species previously largely included in *Gonyaulacysta. Millioudodinium* comprises of taxa which the present author has described (Duxbury, 1977, p. 33) as, "generally larger, thicker-walled and altogether more robust", than the *Gonyaulacysta jurassica* lineage.

Whilst agreeing with the separation of this "robust" group from *Gonyaulacysta,* the present author is inclined to consider *Cribroperidinium* Neale & Sarjeant, 1962 a more acceptable repository than *Millioudodinium* for such taxa. The "false" paraplate boundaries, or growth bands (see Gocht, 1979), which have to date been considered the main generically-important feature of *Cribroperidinium,* are here considered simply an intrageneric feature displayed to a greater or lesser extent (sometimes not at all) by the "robust" group. Such intrageneric significance was suggested by Singh (1971, p. 301) who wrote, "There seems to be no essential difference between the two genera", *(Cribroperidinium* and *Gonyaulacysta).*

The type species of *Millioudodinium, M. fetchamense* (Sarjeant, 1966a) Stover & Evitt, 1978 was originally described by Sarjeant, based on three specimens, two of which were "severely damaged". Sarjeant wrote (1966a, p. 130), "In the holotype, a broken line of "tubercles", like an embryonic crest, crosses plate $5''$". Stover & Evitt (1978, p. 173), in their synopsis of *Millioudodinium,* wrote, "paraplates without accessory ridges, septa or other rectilinear markings". The holotype of the type species of *Millioudodinium* is, therefore, seen to possess a feature specifically excluding it from that genus and, incidentally, including it in *Cribroperidinium.*

Due to the present discussion regarding the *Gonyaulacysta/Cribroperidinium* question, the present author chooses to include the "robust" group in *Gonyaulacysta,* at least for the present.

Gonyaulacysta compta n. sp.

Pl. 2, figs. 1, 2, 4

Derivation of Name: From the Latin *comptus,* ornamented — in reference to the surface ornament.

Holotype: Pl. 2, figs. 1, 2, 4.
Type Locality: Division MB, immediately below cementstone nodule band β, Speeton Clay, Speeton, England.

Diagnosis: A fairly thick-walled dinoflagellate cyst with a spheroidal to ellipsoidal body surmounted by a distinct apical horn. Paratabulation typical for the genus is outlined by generally low, distally entire parasutural crests which are sometimes perforate. The paraplates are completely covered by short, conical spines, each of which have ridges radiating from their bases onto the body surface. The paraplate areas are, therefore, covered by a complex system of fine ridges. The archeopyle is precingular, formed by displacement of paraplate $3''$.

Observed Dimensions: Holotype — 80 x 64 μm
Overall — 97 (83) 76 x 76 (65) 54 μm
Specimens Measured — 14

Remarks: In its overall morphology. *G. compta* n. sp. resembles *Trichodinium castaneum* (Deflandre, 1935) Clarke & Verdier, 1967, especially in the ornament of conical spines and surface ridges. *G. compta* differs, however, in having a distinct apical horn (*T. castaneum* displays only an apical "tuft") and in displaying a complete paratabulation pattern (the genus *Trichodinium* lacks paratabulation except that the paracingulum and parasulcus may often be seen).

The *Trichodinium*-type body ornament combined with complete paratabulation renders *G. compta* different from all other species of the genus.

Gonyaulacysta fimbriata n. sp.

Pl. 1, figs. 1—3

Derivation of Name: From the Latin *fimbriatus*, fringed — in reference to the high, very distinctive anterior paracingular crest.

Holotype: Pl. 1, figs. 1, 2.

Type Locality: Division MB, immediately below cementstone nodule band β, Speeton Clay, Speeton, England.

Diagnosis: A large dinoflagellate cyst with both epi- and hypocyst triangular in dorso-ventral view. A pronounced apical horn is always present and the body surface is finely reticulate. Paratabulation of the formula 4′, 2a, 6″, ?c, 6‴, lp, lp.v., 1⁗, is outlined by generally low parasutural crests. In the epi- and hypocystal regions, these crests are low, distally entire or sparsely denticulate and proximally perforate. The epicystal crests are lower than those of the hypocyst except for those on the apical horn which impart a feathered effect to this structure and which coalesce and extend for some distance beyond the horn tip, terminating in a coronate structure. The paracingular crests are most distinctive in so far as they differ from each other and from all the other crests. The posterior paracingular crest is fairly low and bears a closely-spaced. regular row of flat-ended denticles. The anterior paracingular crest, on the other hand, is high, distally entire and highly fenestrate. The antapical paraplate is typically formed into a distinct, broadly-rounded protuberance. The archeopyle is single-paraplate precingular (3″).

Observed Dimensions:
Holotype — 151 x 136 μm
Overall — 151 (123) 111 x 136 (114) 95 μm
Specimens Measured — 20

Remarks: This is a most distinctive species, remarkable mainly in the structure of the paracingular crests. The fenestrate, anterior paracingular crest is very high and is commonly so high as to make the overall width of the cyst greater than the overall length. Consequently, *G. fimbriata* is often observed in polar orientation and in this orientation the anterior paracingular crest is reminiscent of the paracingular crest of *Wanaea fimbriata* SARJEANT, 1961a.

In genera such as *Ctenidodinium* DEFLANDRE, 1938 and *Wanaea* COOKSON & EISENACK, 1958, where there is total or near total reduction of one paracingular crest, it is the anterior paracingular crest which is reduced. In *G. fimbriata*, however, it is notable that it is the posterior paracingular crest which is the lower.

In its overall form, *G. fimbriata* is most comparable to that species termed *Gonyaulacysta cladophora* (DEFLANDRE, 1938) DODEKOVA, 1967 in DUXBURY 1977.

G. fimbriata possesses two small, accessory paraplates in a position where paraplates 2′, 3′, 3″ and 4″ would otherwise meet. Such paraplates are considered by the present author to be a feature of the Gonyaulacacean Group and have been observed by him in several genera, including *Endoscrinium* (KLEMENT, 1960) VOZZHENNIKOVA, 1967, *Lithodinia* EISENACK, 1935 emend. GOCHT, 1975 and *Ctenidodinium* DEFLANDRE, 1938 as well as *Gonyaulacysta*. They have been observed by the present author in *Gonyaulacysta jurassica* (DEFLANDRE, 1938) NORRIS & SARJEANT, 1965, the type species of this genus and have been clearly illustrated in this species by EVITT (1961, pl. 2, fig. 5) and by STOVER & EVITT (1978, fig. 2B and C). GOCHT (1970, pl. 29, fig. 5) has illustrated them in *Ctenidodinium pachydermum* (DEFLANDRE, 1938) GOCHT, 1970. It is possibly the small size of these dorsal accessory paraplates which has precluded their description in many other gonyaulacacean genera and species.

Genus *Heslertonia* SARJEANT, 1966a emend.

1966a *Heslertonia* SARJEANT, p. 133.

Emended Diagnosis: Spheroidal to ovoidal dinoflagellate cysts bearing high, regular parasutural crests outlining a typically gonyaulacacean paratabulation pattern. The crests are higher than $^{1}/_{4}$ the main body diameter and may vary in height on individual specimens. The main body surface is smooth to finely granular and the archeopyle is epicystal.

Remarks: The type species of this genus, *Heslertonia heslertonensis* (NEALE & SARJEANT, 1962) SARJEANT, 1966a emend. herein has been encountered in large numbers during the present author's studies of Speeton Clay dinoflagellate cyst assemblages. It has proved to exhibit an epicystal archeopyle rather than the precingular (3″) type reported by NEALE & SARJEANT. This epicystal breakage has been previously recognised by DAVEY (1979b). The generic diagnosis of *Heslertonia* is therefore emended accordingly here.

Heslertonia heslertonensis (NEALE & SARJEANT, 1962) SARJEANT, 1966a emend.

Pl. 12, fig. 6

1962 *Gonyaulax heslertonense* NEALE & SARJEANT, pp. 440, 441, pl. 19, fig. 5, pl. 20, fig. 5.
1966a *Heslertonia heslertonensis* (NEALE & SARJEANT) SARJEANT, p. 133, pl. 22, fig. 2.

Emended Diagnosis: A species of *Heslertonia* having a spheroidal to ovoidal main body bearing high parasutural crests which outline a typically gonyaulacacean paratabulation pattern. Those portions of the parasutural crests very close to the main body frequently exhibit vacuolar structures and the distal crestal margins have very narrow, linear thickenings. Typically, epicystal crests are lower than hypocystal ones. The archeopyle is epicystal with the epicyst usually remaining attached in the parasulcal area.

Remarks: In exhibiting an epicystal archeopyle, in frequently having vacuolar structures along proximal crestal margins and in its overall size, *H. heslertonensis* is very similar both to *Avellodinium falsificum* DUXBURY, 1977 and *Callaiosphaeridium asymmetricum* (DEFLANDRE & COURTEVILLE, 1939) DAVEY & WILLIAMS, 1966b, especially to the latter. Further, the presence of high parasutural crests (albeit irregular) in *Callaiosphaeridium trycherium* n. sp. emphasises the closeness of *Callaiosphaeridium* and *Heslertonia.*

Genus *Hystrichosphaeridium* (DEFLANDRE, 1937) DAVEY & WILLIAMS, 1966b

1937 *Hystrichosphaeridium* DEFLANDRE, p. 68.
1966b *Hystrichosphaeridium* (DEFLANDRE) DAVEY & WILLIAMS, pp. 55, 56.

Hystrichosphaeridium ? *phoenix* n. sp.

Pl. 13, figs. 5, 6; text-fig. 9

Derivation of Name: From the Latin *phoenix,* a date palm — in reference to the morphology of each process.

Holotype: Pl. 13, figs. 5, 6; text-fig. 9.
Type Locality: Division UB, Speeton Clay, Speeton, England.

Diagnosis: A chorate cyst with a small, smooth central body which is spheroidal, though usually extensively folded and which bears long (up to 3/4 main body diameter), solid processes. The processes are smooth and may number up to 20 per individual. Each process flares proximally, and distally divides into a number (usually 6—8) of slender, flat spines. The overall diameter of the process terminations may exceed the main body radius.

Observed Dimensions:	Holotype — 76 x 73 μm Overall — 84 (71) 57 x 76 (65) 52 μm Specimens Measured — 14

Remarks: *Hystrichosphaeridium* ? *phoenix* is a most distinctive species but may be compared with other taxa, particularly *Melitasphaeridium choanophorum* (DEFLANDRE & COOKSON, 1955) HARLAND & HILL, 1979, *Hystrichosphaeridium recurvatum* (WHITE, 1842), DAVEY & WILLIAMS, 1966b, *Bacchidinium polypes* (COOKSON & EISENACK, 1962) DAVEY, 1979a and *Taleisphaera hydra* DUXBURY (1979).

H. recurvatum and *M. choanophorum* both have hollow processes with distal spines (or fringes with spines) around the distal tubular margins. This contrasts with the solid processes of *H.* ? *phoenix. B. polypes* and *T. hydra* possess solid processes but the number of such processes is markedly greater than in *H.* ? *phoenix.* Also, the first two taxa have a constantly greater main body/overall diameter ratio than the latter. *T. hydra* has angularity to the main body and penitabular crests and neither of these features is demonstrated by *H.* ? *phoenix.*

The archeopyle type in *H.* ? *phoenix* is debatable. It is possibly tetratabular apical, as in such taxa as *H. recurvatum,* single-paraplate precingular, as in *M. choanophorum,* or two paraplate precingular as in *T. hydra* and (probably) *B. polypes.* The presence of solid processes tends to suggest that *H.* ? *phoenix* may be closer to the *B. polypes/T. hydra* group of cysts than to others. Rather than describe a new genus based on *H.* ? *phoenix,* whose archeopyle is uncertain, the author chooses to place this species tentatively in *Hystrichosphaeridium.*

Text-fig. 9. Camera lucida drawing of *Hystrichosphaeridium* ? *phoenix* n. sp. holotype. x 1500. V. 60260(3).

Genus *Hystrichosphaerina* ALBERTI, 1961

1961 *Hystrichosphaerina* ALBERTI, p. 38.
1961b ***Polystephanephorus*** **SARJEANT, p. 1096.**

Remarks: The genus *Polystephanephorus* SARJEANT, 1961b (published September 1961) is here considered a junior synonym of *Hystrichosphaerina* ALBERTI, 1961 (published June 1961). *Hystrichosphaerina* was erected to include spheroidal cysts with vase or beaker-like processes, the walls of which are fenestrate with the meshes often elongate and commonly extending from the base to the distal edge of each process. ALBERTI (1961, p. 38) states (translation), "Walls of beakers often so loosely fenestrate that they consist of single 'rods' which stand in the direction of the longitudinal axis of the processes and which are arranged in an almost circular manner (usually ± deviating from this) on the shell and are flared and connected together at the bases as well as at their distal ends". In its entirety, ALBERTI's diagnosis of *Hystrichosphaerina* amply covers the forms included in *Polystephanephorus* by SARJEANT (1961b) and by GITMEZ (1970). SARJEANT (1961b), in his remarks on *Polystephanephorus* states, "The special character of the hystrichospheres of this genus is the possession of clusters of processes linked at their tips by ring trabeculae".

SARJEANT (1961b) transferred into *Polystephanephorus* the three species of *Polystephanosphaera* SARJEANT, 1960 which he considered to fall outside the genus *Systematophora* KLEMENT, 1960. Re-allocation of these was necessary because, as SARJEANT stated, "The type species of *Polystephanosphaera, P. valensii,* falls clearly within KLEMENT's genus". Two of these three species are transferred into *Hystrichosphaerina* below.

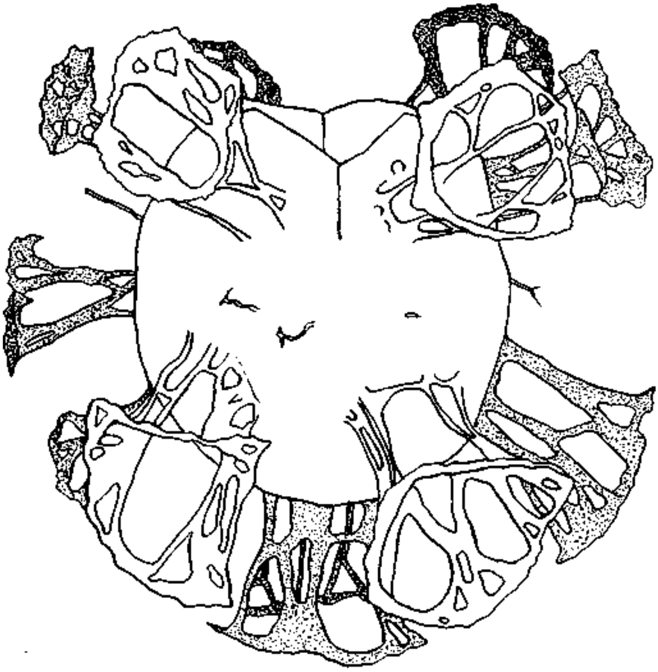
The transfer in DOWNIE & SARJEANT (1964(5)) of *Hystrichosphaerina schindewolfi* into *Systematophora* is here rejected since the presence of ring trabeculae linking the distal extremes of process elements is here considered generically important.

Hystrichosphaerina schindewolfi ALBERTI, 1961

Pl. 6, fig. 6; text-fig. 10

1961 *Hystrichosphaerina schindewolfi* ALBERTI, pp. 38, 39, pl. 10, figs. 1—3, 6, 7.
1964(5) *Systematophora schindewolfi* (ALBERTI) DOWNIE & SARJEANT, p. 146.
1969 *Perisseiasphaeridium eisenacki* DAVEY & WILLIAMS, p. 6.

Remarks: The suggested synonymy in DAVEY (1979a) of *Hystrichosphaeridium anthophorum* COOKSON & EISENACK, 1958 and *Hystrichosphaerina schindewolfi* ALBERTI, 1961 is here rejected. Nevertheless, the overall characteristics of *H. anthophorum* demand its inclusion in *Hystrichosphaerina* (see below).



Text-fig. 10. Camera lucida drawing of *Hystrichosphaerina schindewolfi* ALBERTI, 1961. x 860. V. 60302(1).

Other Species:

Hystrichosphaerina anthophora (COOKSON & EISENACK, 1958) n. comb. = *Hystrichosphaeridium anthophorum* COOKSON & EISENACK, 1958, pp. 43, 44, pl. 11, figs. 12, 13; text-figs. 16—18.

Hystrichosphaerina calatha (SARJEANT, 1961a) n. comb. = *Polystephanephorus calathus* SARJEANT, 1961a, p. 104, pl. 14, fig. 7; text-fig. 7.

Hystrichosphaerina paracalatha (SARJEANT, 1960) n. comb. = *Polystephanosphaera paracalathus* SARJEANT, 1960, p. 143, pl. 6, fig. 4; text-fig. 3b.

Hystrichosphaerina sarjeantii (GITMEZ, 1970) n. comb. = *Polystephanephorus sarjeantii* GITMEZ, 1970, pp. 291, 292, pl. 11, fig. 4; text-fig. 25.

Genus *Lithodinia* EISENACK, 1935 emend. GOCHT, 1975

1935 *Lithodinia* EISENACK, p. 175.

Lithodinia sagena n. sp.

Pl. 3, figs. 6, 9, 12, 13

Derivation of Name: From the Latin *sagena,* a fish-net — in reference to the surface reticulum.

Holotype: Pl. 3, figs. 6, 9, 12.
Type Locality: Division MB, immediately below cementstone nodule band γ, Speeton Clay, Speeton, England.

Diagnosis: A thin-walled species of *Lithodinia* which has a spheroidal endocyst bearing a low surface reticulum. The reticulum may be fine or coarse, entire or degenerate. A delicate pericyst completely envelopes the thicker endocyst and the body layers are attached along the distal margin of the reticulum. The pericyst has regularly denticulate crests which mark out a typically gonyaulacacean paratabulation pattern. The archeopyle is apical, tetratabular and the operculum is sometimes attached in the parasulcal region.

Observed Dimensions:
Holotype — 44 x 52 μm
Overall — 55 (48) 44 x 61 (49) 44 μm
Specimens Measured — 16

Remarks: This species most closely resembles *Cassiculosphaeridia reticulata* DAVEY, 1969 in size, shape and in possessing a low reticulum. The presence of denticulate parasutural crests marking out a gonyaulacacean paratabulation, however, dictates its inclusion in *Lithodinia.*

Both the endocyst reticulum and the parasutural crests are quite variable. The reticulum may be fine, regular and entire but equally may be coarse, irregular and degenerate. The parasutural crests may vary in height and the denticles may be slender, long and closely spaced or may be broad-based, short and widely separated.

The parasutural crestal pattern appears to bear no relationship to the underlying endocyst reticulum. Consequently, long, straight parasutural crests, particularly on the dorsal surface and bordering the paracingulum, are often seen to cut directly across the reticular ramifications beneath.

Genus *Muderongia* COOKSON & EISENACK, 1958

1958 *Muderongia* COOKSON & EISENACK, pp. 40, 41.

Muderongia crucis NEALE & SARJEANT, 1962

Pl. 8, fig. 10

1962 *Muderongia crucis* NEALE & SARJEANT, pp. 449, 450, pl. 20, figs. 2, 6.

Remarks: *Muderongia crucis* ranges in morphology from forms which have no notching of the lateral horns to those which exhibit slight notching. This intraspecific variation suggests that *M. crucis* is morphologically very similar to *M. tetracantha* (GOCHT, 1957). However, specimens of *M. crucis* which the author has examined from the Speeton Clay (DUXBURY, 1977 and present work) are similar to those of NEALE & SARJEANT, 1962 in being consistently larger than those specimens of *M. tetracantha* described in GOCHT (1957). This discrepancy in size between the two species was also noted by SARJEANT (1966b, p. 204).

The recurved portions of the lateral horns of *M. tetracantha* in GOCHT, 1957 appear to be somewhat more slender than those in *M. crucis.* This may not generally be the case, however, since GOCHT (1957, p. 169) stated that he observed (translation), "one half specimen with relatively short, broad-based horns".

The major difference between *M. crucis* and *M. tetracantha,* therefore, appears to be one of size with the former consistently larger than the latter.

Muderongia imparilis n. sp.

Pl. 5, figs. 2, 4, 5; text-fig. 11

1961 *Odontochitina* sp. A. ALBERTI, p. 31, pl. 6, fig. 4 only.

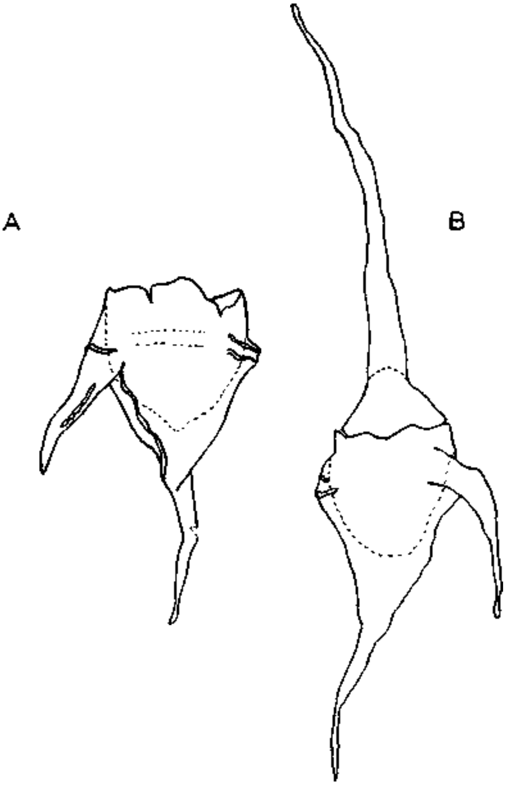
Derivation of Name: From the Latin *imparilis*, unequal, odd, different — in reference to the size difference in the lateral horns.

Holotype: Pl. 5, figs. 4, 5; text-fig. 11B.

Type Locality: Division UB, Speeton Clay, Speeton, England.

Diagnosis: A species of *Muderongia* with a finely perforate periblast produced into three well-developed horns (apical, antapical and lateral) and one which is greatly reduced (lateral). The lateral horns are, therefore, distinctly disproportionate with the larger one extending at right angles from the body for a short distance and then recurving towards the antapex and tapering gradually to a point. The slender lateral horn is little more than a short, distally rounded lateral projection. The endoblast is spheroidal and may exhibit projections into any of the horns. The endoblast and periblast are separate except in the epicystal region. The paracingulum is reflected by a distinct double line of folding along the lateral horns (only up to the point of recurving on the longer). The archeopyle is apical.

Observed Dimensions:
Holotype (complete) — 278 x 70 μm
Complete Specimens — 278 (251) 223 x 70 (70) 70 μm
Specimens Measured — 2
Operculum Detached — 159 (149) 105 x 111 (106) 73 μm
Specimens Measured — 15



Text-fig. 11. Camera lucida drawings of *Muderongia imparilis* n. sp. A paratype with operculum completely detached. B holotype. x 400. A: V. 60280(1), B: V. 60259(2).

Remarks: This species is reminiscent in several respects of *Muderongia staurota* SARJEANT, 1966b but differs in being generally more elongate and in the character of the lateral horns. *M. staurota* may, however, have lateral horns of different lengths. *M. imparilis* is also reminiscent of species of *Odontochitina* DEFLANDRE, 1935 emend. DAVEY, 1970, especially O. *operculata* (WETZEL, 1933) DEFLANDRE & COOKSON, 1955. It differs, however, in possessing a second lateral horn, greatly reduced through this is. It is possible, therefore, that *M. imparilis* may represent an intermediate stage in the evolution of the genus *Odontochitina* from *Muderongia*.

WALL & EVITT (1975, p. 32) have expressed their concept of *Muderongia* as a ceratioid dinoflagellate cyst having two lateral attenuations, each having a distal, postcingular horn. They state, "The two lateral horns in *Muderongia* vary considerably in length from species to species (e.g. long in *M. tetracantha* (GOCHT) ALBERTI, 1961; short in *M. simplex* ALBERTI, 1961)". In the present author's view, the distinguishing feature of *Muderongia* is the presence of the two lateral attenuations, whether or not two distal, postcingular horns may be present. DAVEY (1979b, pl. 2, figs. 4, 5) illustrates *Muderongia* sp. A from the Upper Kimmeridge Clay. His species certainly belongs in the genus *Muderongia,* since it is obviously an end member of the *Muderongia simplex* (the type species) group. Neither of DAVEY's illustrated specimens displays any trace of distal. postcingular horns. Similarly, one lateral projection of *M. imparilis* bears no distal, postcingular horn but, in the present author's concept of the genus, must be included in *Muderongia.*

Muderongia pannosa n. sp.

Pl. 10, figs. 3, 6; text-fig. 12

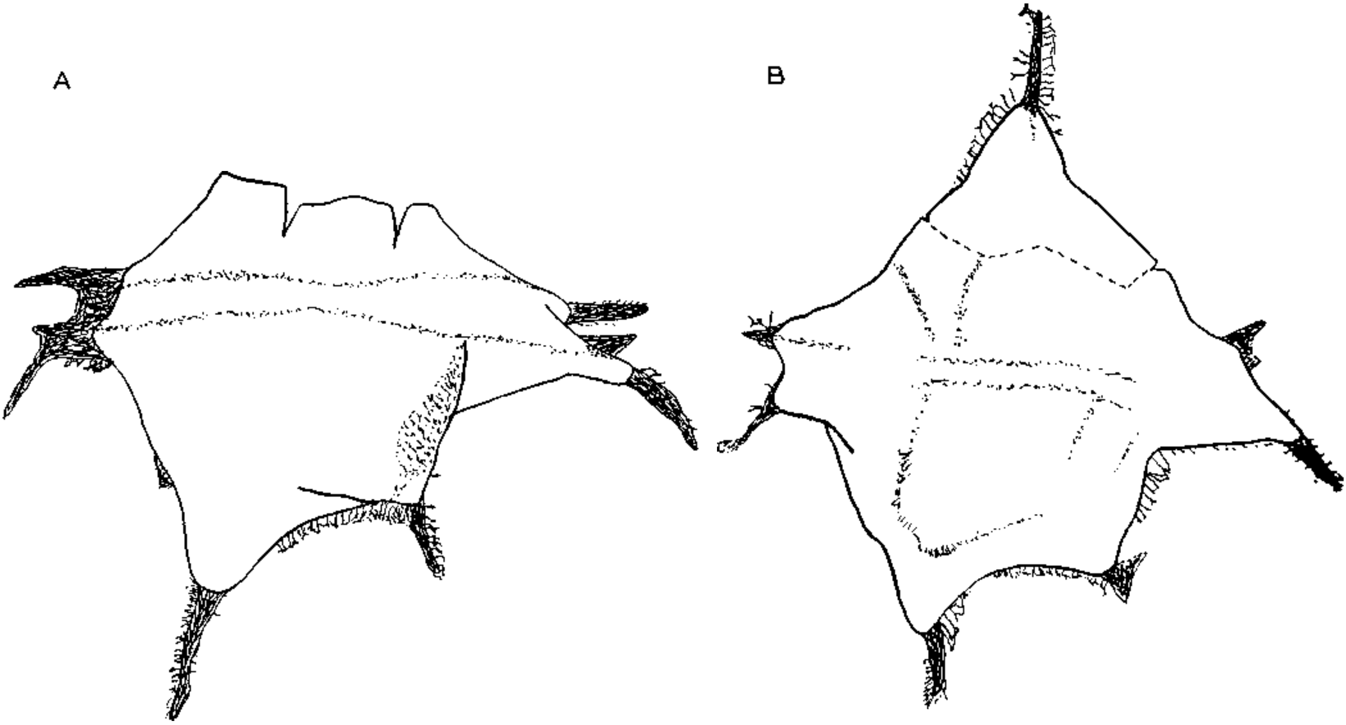
Derivation of Name: From the Latin *pannosus,* ragged, tattered — in reference to the surface ornament.

Holotype: Pl. 10, fig. 3; text-fig. 12B.

Type Locality: Division MB, immediately below cementstone nodule band δ, Speeton Clay, Speeton, England.

Diagnosis: A species of *Muderongia* which has a spheroidal to oviodal, apparently single-layered body produced into five horns. There is a single apical horn, which is the longest of all, two broad, usually equal, short lateral horns, which are usually blunt-ended and distinctly notched distally, and two unequal antapical horns. The region between the antapical horns is distinctly concave. The body surface has granular to spinose ornament which is locally dense along parasutural boundaries, marking out an apparently gonyaulacacean paratabulation scheme.

The paracingular and central paraplate areas are typically devoid of ornament. The maximum height of body ornament is observed on the horn tips, where solid projections are present. Each solid projection displays fine, free or anastomising spines along its length. The lateral horns each display two solid projections at their extremes, one on each side of the paracingular notch, with the hypocystal projection the longer of the two. The archeopyle is apical.



Text-fig. 12. Camera lucida drawings of *Muderongia pannosa* n. sp. A paratype with operculum completely detached **B holotype.** x 950. A: V. 60297(1), B: V. 60291(2).

Observed Dimensions: Holotype (complete) — 102 x 90 μm
Operculum Detached — 75 (71) 64 x 104 (76) 64 μm
Specimens Measured — 6

Remarks: The body ornament and general morphology of this species distinguish it from all others. *Muderongia asymmetrica* BRIDEAUX, 1977 appears comparable, but the general inequality of the lateral horns and the smooth to granular body surface contrast with the usually equal lateral horns and the granular to spinose or anastamosing/spinose ornament (all types seen on individual specimens) of *M. pannosa.* Also, those specimens of *M. asymmetrica* depicted by BRIDEAUX (1977, pl. 15, figs. 9, 10) do not display the pronounced notching of the lateral horns seen in *M. pannosa,* nor do they possess solid projections at the horn tips.

Genus *Occisucysta* GITMEZ, 1970

1970 *Occisucysta* GITMEZ, p. 267

Occisucysta tentoria DUXBURY, 1977

Pl. 2, figs. 3, 6

1958 Gen. et. sp. indet. (ex aff. *Wanaea*?) EISENACK, p. 389, pl. 25, fig. 2.
1974 *Gonyaulacysta* sp. DAVEY & VERDIER, pp. 632, 633, pl. 93, fig. 5.
1977 *Occisucysta tentoria* DUXBURY, pp. 44, 45, pl. 3, figs. 8, 9; text-fig. 16.

Remarks: Those specimens referred to as "Gen. et. sp. indet. (ex aff. *Wanaea* ?)" in EISENACK, 1958 and "*Gonyaulacysta* sp." in DAVEY & VERDIER (1974) are probably referable to *Occisucysta tentoria* DUXBURY, 1977. The reference to *Wanaea* in EISENACK, 1958, is probably due to the common polar orientation of this species in the latter part of its range. This is due to the width of the paracingular crests making the overall width greater than the overall length. In polar orientation, the perforate, distally denticulate paracingular crests certainly are comparable with such crests in some species of *Wanaea.*

Genus *Odontochitina* (DEFLANDRE, 1935) DAVEY, 1970

1935 *Odontochitina* DEFLANDRE, p. 234.

Odontochitina operculata (WETZEL, 1933) DEFLANDRE & COOKSON, 1955

Pl. 5, fig. 9

1933 *Ceratium (Euceratium) operculatum* WETZEL, p. 170, pl. 2, figs. 21, 22.
1935 *Odontochitina silicorum* DEFLANDRE, p. 234, pl. 9, figs. 8—10.
1946 *Odontochitina operculata* (WETZEL) DEFLANDRE, cards 1016—19.
1955 *Odontochitina operculata* (WETZEL) DEFLANDRE in DEFLANDRE & COOKSON, pp. 291, 292, pl. 3, figs. 5, 6.
non 1959 *Odontochitina operculata* (WETZEL) DEFLANDRE in GOCHT, p. 64, pl. 6, fig. 12.

Remarks: That specimen termed *Odontochitina operculata* (WETZEL) DEFLANDRE in GOCHT, 1959 and illustrated in GOCHT's pl. 6, fig. 12, is clearly referable to *Batioladinium longicornutum* (ALBERTI, 1961) BRIDEAUX, 1975.

Genus *Oligosphaeridium* DAVEY & WILLIAMS, 1966b

1966b *Oligosphaeridium* DAVEY & WILLIAMS, pp. 70, 71.

Oligosphaeridium fenestratum n. sp.

Pl. 9, figs. 8, 9

Derivation of Name: From the Latin *fenestratus,* windowed — in reference to the process structure.

Holotype: Pl. 9, figs. 8, 9.
Type Locality: Division MB, immediately below cementstone nodule band ε, Speeton Clay, Speeton, England.

Diagnosis: A large, thin-walled, chorate dinoflagellate cyst consisting of a smooth to finely granular, spheroidal central body bearing 19 long processes, intratabular, assumed to be one per paraplate. The processes flare slightly proximally and greatly distally so that the process ends may be equivalent in diameter to half the main body. Process terminations are polygonal in plan view and have short, flaccid spines at each angle. Processes are very highly fenestrate from about $^{1}/_{3}$ of their length to the distal terminations and each small fenestration is elongate in the direction of the process axis. A paratabulation of the formula 4', 6'', 6''', 1p., 1p.v., 1'''', is suggested by process grouping with the dorsal processes, especially those on the hypocyst, being the larger. The archeopyle is apical, tetratabular.

Observed Dimensions: Holotype — 116 x 105 μm
Overall — 140 (127) 103 x 130 (112) 100 μm
Specimens Measured — 6

Remarks: The process type demonstrated by this species renders it different from all others. The process terminations are reminiscent, in plan view, of those of *Oligosphaeridium perforatum* (GOCHT, 1959) DAVEY & WILLIAMS, 1969 but in lateral view, the very highly fenestrate, distally greatly flaring processes of *O. fenestratum* are most distinctive.

Genus *Pterodinium* EISENACK, 1958

1958 *Pterodinium* EISENACK, p. 395.

Pterodinium premnos n. sp.

Pl. 3, figs. 1, 2

Derivation of Name: From the Greek *premnos*, stump of a tree — in reference to the paraplate-centred projections.

Holotype: Pl. 3, figs. 1, 2.
Type Locality: Division MB, immediately below cementstone nodule band β, Speeton Clay, Speeton, England.

Diagnosis: An ovoidal to ellipsoidal dinoflagellate cyst bearing a short, parallel-sided, flat-ended apical horn. Typically gonyaulacacean paratabulation is outlined by high parasutural crests which are minutely perforate and distally bear numerous, very short denticles. Hollow, broad-based, paraplate-centred projections are present, one per paraplate area and these taper and are distally closed and convex. The archeopyle is precingular (3'').

Observed Dimensions: Holotype — 58 x 55 μm
Overall — 61 (59) 58 x 58 (57) 55 μm
Specimens Measured — 3

Remarks: The combination of high, minutely perforate parasutural crests and plate-centred projections renders *P. premnos* distinct from all other species.

Genus *Spiniferites* (MANTELL, 1850) SARJEANT, 1970

1850 *Spiniferites* MANTELL, p. 191.

Spiniferites speetonensis n. sp.

Pl. 11, figs. 1, 2, 4

Derivation of Name: From Speeton, England, the type locality.

Holotype: Pl. 11, figs. 1, 2, 4.
Type Locality: Division MB, immediately below cementstone nodule band ζ, Speeton Clay, Speeton, England.

Diagnosis: A species of *Spiniferites* with smooth endophragm and periphragm. The main body is ovoidal with the epicyst more tapering and less broadly rounded than the hypocyst. Short gonal (trifurcate) and parasutural (bifurcate) processes are proximally connected by low parasutural ridges. Distally, the processes are most distinctive since each bi- and trifurcation is fairly broad, flat-ended or slightly concave and perforate, sometimes to the extent of small-scale fenestration. Occasionally, a ventral pericoel is observed and this displays a large hole in the periphragm. The archeopyle is precingular (3'').

Observed Dimensions:
Holotype — 70 x 65 μm
Overall — 78 (70) 59 x 70 (60) 54 μm
Specimens Measured — 16

Remarks: This species is distinctive in having distally perforate to fenestrate gonal and parasutural processes. Similar process terminations have been observed in *Achomosphaera andalousiense* JAN DU CHÊNE, 1977, from the Miocene.

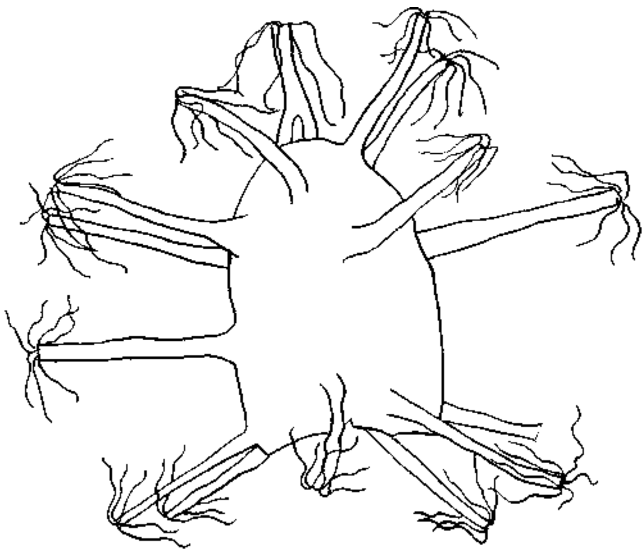
Genus *Tanyosphaeridium* DAVEY & WILLIAMS, 1966b

1966b *Tanyosphaeridium* DAVEY & WILLIAMS, p. 98.

Tanyosphaeridium prolixispinosum (DAVEY & WILLIAMS, 1966b) n. comb.

Pl. 7, figs. 5, 8; text-fig. 13

1966b *Oligosphaeridium prolixispinosum* DAVEY & WILLIAMS, pp. 76, 77, pl. 8, figs. 2, 3.



Text-fig. 13. Camera lucida drawing of *Tanyosphaeridium prolixispinosum* (DAVEY & WILLIAMS, 1966b) in comb. x 1000. V. 60259(4).

Remarks: This species must, in the opinion of the present author, be included in *Tanyosphaeridium*. The number of processes present is constantly greater than 19, which would be the maximum for the genus *Oligosphaeridium* DAVEY & WILLIAMS, 1966b. Certainly, only a single paracingular process might be observed, but commonly the number is higher than this. Indeed, the holotype (DAVEY & WILLIAMS, 1966b, pl. 8, fig. 3) appears to possess at least two such processes. The process type of *T. prolixispinosum* is again not typical of the genus *Oligosphaeridium*. The narrow, distally tapering, tubular processes bearing long, very slender, recurved terminal spines are most reminiscent of those of *Hystrichosphaeridium recurvatum* (WHITE, 1842) DAVEY & WILLIAMS, 1966b and it is largely the elongate central body of *T. prolixispinosum* which separates it from *H. recurvatum*. Occasionally, two tubular processes may coalesce at about half their length to form a single tubular process distally. This feature is illustrated in text-fig. 13.

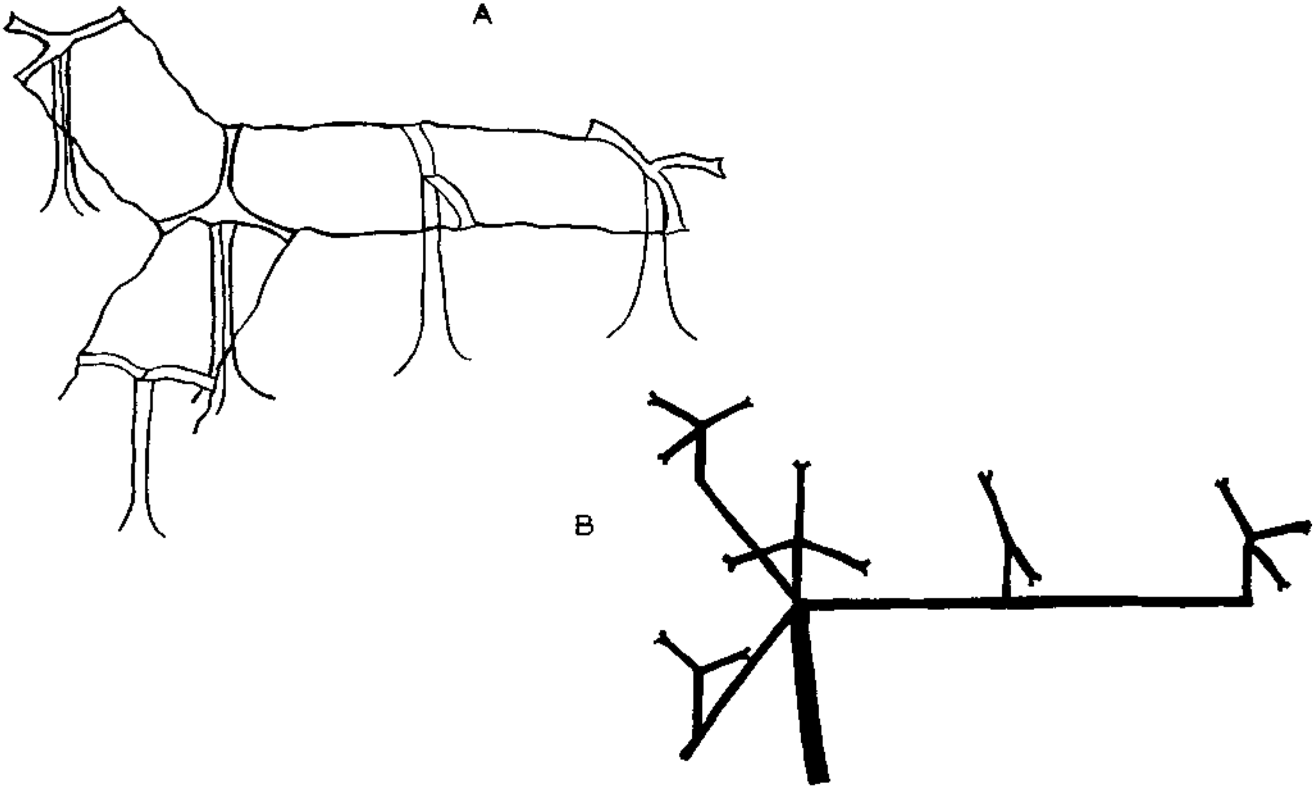
Genus *Trabeculidium* n. gen.

Derivation of Name: From the Latin *trabecula*, a small or slender beam — in reference to the characteristic distal trabeculae.

Diagnosis: Spheroidal, ovoidal or rhomboidal dinoflagellate cysts bearing gonal and parasutural processes. The gonal processes are distally trifurcate and the parasutural ones bifurcate. Parasutural crests or other proximal indicators of paratabulation are absent. The distal extremes of process furcations are connected by slender trabeculae so that paratabulation is reflected in a distal trabecular network; each parasuture is marked by a double trabeculum. The distal trabecular network marks a gonyaulacacean paratabulation pattern. The archeopyle is precingular (3″).

Type Species: *Trabeculidium quinquetrum* n. sp.

Remarks: Species referable to this genus are basically similar in morphology to *Achomosphaera* Evitt, 1963 except that whereas *Achomosphaera* has processes which are distally free, *Trabeculidium* has distal trabeculae joining adjacent process tips. The gonal processes are trifurcate with the double trabeculum marking each parasuture originating on adjacent trifurcations. This involves the trifurcations each being at about 60° to the parasutural direction. Parasutural processes are bifurcate and at right angles to the parasutural direction, giving a "telegraph pole" effect.



Text-fig. 14. An illustration of the trabecular structure demonstrated by A. *Trabeculidium* n. gen. and B. *Cannosphaeropsis* Wetzel, 1933 emend. herein.

The genus *Trabeculidium* encompasses taxa described by Williams & Downie (1966, p. 222) in their emended diagnosis of *Cannosphaeropsis* Wetzel, 1933 emend. herein. As mentioned under *Cannosphaeropsis* (above), the concept of that genus merely being a *Spiniferites*-type of cyst, without parasutural crests and with distal trabeculae, is completely untenable. The type species *Cannosphaeropsis utinensis* Wetzel, 1933 emend. herein is most distinctive and very far from the *Spiniferites*/*Achomosphaera*/*Trabeculidium* group, not least in possessing single trabeculae which originate below distally free bi- and trifurcations. Species formerly included in *Cannosphaeropsis* which the present author feels must be placed in *Trabeculidium* are included below. Text-fig. 14 illustrates the basic structural differences between the genera *Trabeculidium* and *Cannosphaeropsis*.

Trabeculidium quinquetrum n. sp.

Pl. 9, figs. 1, 2, 5

Derivation of Name: From the Latin *quini,* five and *-quetrus,* — sided — in reference to the pentagonal outline of this species.

Holotype: Pl. 9, fig. 2.
Type Locality: Division MB, immediately below cementstone nodule band γ, Speeton Clay, Speeton, England.

Diagnosis: A species of dinoflagellate cyst whose main body is pentagonal in lateral view due to its having a distinctly triangular epicyst and sharp-angled, trapeziform hypocyst. Trifurcate gonal and bifurcate parasutural processes are present and these vary in length so that despite the polyhedral shape of the main body, the cyst as a whole is spheroidal. Both gonal and parasutural processes are proximally unconnected and distally joined by solid, thin trabeculae. Each parasutural line is distally reflected by two trabeculae· The archeopyle is precingular, formed by detachment of paraplate 3″.

Observed Dimensions:
Holotype — 76 x 76 μm
Overall — 81 (74) 68 x 78 (70) 59 μm
Specimens Measured — 26

Other Species:
Trabeculidium elegantulum (Drugg, 1967) n. comb. = *Cannosphaeropsis elegantula* Drugg, 1967, p. 25, pl. 4, fig. 17.
Trabeculidium pusulosum (Morgenroth, 1966) n. comb. = *Cannosphaeropsis pusulosa* Morgenroth, 1966, p. 8, pl. 2, fig. 6.

Acritarchs

Genus *Fromea* Cookson & Eisenack, 1958

1958 *Fromea* Cookson & Eisenack, p. 55.

Remarks: Assignment of this genus to the dinoflagellates is here rejected. Certainly the type species, *Fromea amphora* Cookson & Eisenack, 1958 appears to possess some faint trace of an equatorial "girdle" and there is, as described by Cookson & Eisenack (1958, p. 55), "a wide aperture at one end". However, the aperture is sometimes fringed by a raised lip and the aperture margin demonstrates none of the regular arrangement of parasutural splits which characterise dinoflagellate cyst apical archeopyles. Further, species of *Fromea*, whether whole or broken, have never given any indication of paratabulation.

Fromea quadrugata n. sp.

Pl. 4, figs. 12—15; text-fig. 15

Derivation of Name: From the Latin *quadra*, a square and *ruga*, crease, wrinkle — in reference to the distinctive folds on one side of the test.

Holotype: Pl. 4, figs. 12, 13; text-fig. 15.
Type Locality: Division UB, Speeton Clay, Speeton, England.

Diagnosis: A species of *Fromea* which is flask-shaped. The lower portion is semi-circular in lateral view and the upper portion tapers to a flat apex. One side of the "flask" has folds in the form of a square with one corner of this square pointing towards the apex. Sometimes, a ragged-edged hole is apparent in the central area of the square. A circular pylome is present at the apex.

Observed Dimensions:
Holotype — 96 x 90 μm
Overall — 111 (91) 81 x 90 (80) 68 μm
Specimens Measured — 11

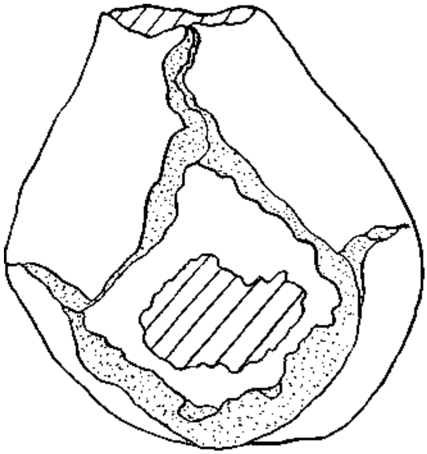
Remarks: The general outline of the body together with the square of folds on one side separate this species from all others of the genus.

Genus *Rhombodella* Cookson & Eisenack, 1962

1962 *Rhombodella* Cookson & Eisenack, p. 496.

Remarks: *Rhombodella* is here included in the acritarchs since, in the author's opinion, it displays none of the more important dinoflagellate cyst characteristics (i.e. paracingulum and/or parasulcus, paratabulation, zig-zag archeopyle margin). It appears, on the grounds of comparative morphology, to be very close to the genus *Wallodinium* LOEBLICH & LOEBLICH, 1968, differing only in having four groups of processes and, in some cases, in displaying two lateral "bulges".

The synonymising of *Rhombodella* with *Palaeotetradinium* in STOVER & EVITT (1978, p. 70) is rejected. The presence of four groups of processes at the "corners" of *Rhombodella* is here considered generically important. Further, as stated above, *Rhombodella*'s closest comparable genus is *Wallodinium.*



Text-fig. 15. Camera lucida drawing of *Fromea quadrugata* n. sp. holotype, showing the characteristic folding surrounding a prominent hole on one surface. x 650. V. 60259(1).

Rhombodella vesca n. sp.

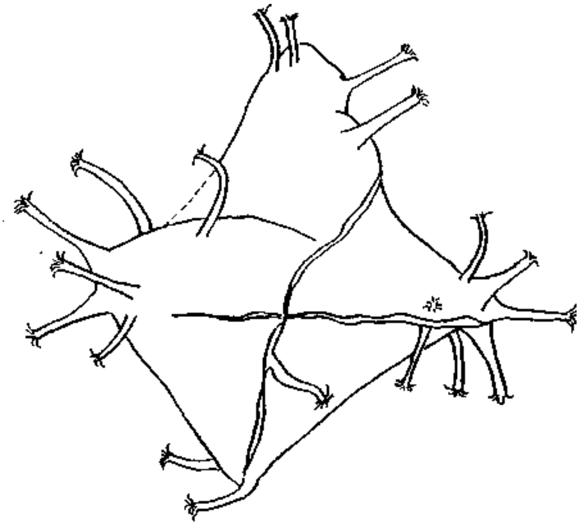
Pl. 5, figs. 7, 10; text-fig. 16

Derivation of Name: From the Latin *vescus,* weak, poor, little — in reference to the small, thin-walled nature of this species.

Holotype: Pl. 5, figs. 7, 10.

Type Locality: Division MB, immediately below cementstone nodule band ε, Speeton Clay, Speeton, England.

Diagnosis: A small, thin-walled species of *Rhombodella.* The body wall is smooth and the overall shape is more or less square in lateral view. The "corners" of the body are bluntly rounded and taper folds commonly connect opposite ones. Each "corner" bears long (approximately 1/4 main body diameter). slightly flexuous processes which number up to 10 per "corner" and which divide distally into numerous fine hairs which may be recurved towards the body.



Text-fig. 16. Camera lucida drawing of *Rhombodella vesca* n. sp. paratype. x 1500. V. 6030(4).

Observed Dimensions: Holotype — 49 x 41 μm
Overall — 59 (43) 35 x 41 (37) 35 μm
Specimens Measured — 5

Remarks: This is a most distinctive, though small species. *Rhombodella natans* Cookson & Eisenack, 1962 is generally larger, more robust and bears processes which are much shorter with respect to the main body size than those of *R. vesca*. *R. paucispina* (Alberti, 1961) n. comb. herein is generally larger than *R. vesca* with simple spines rather than distally furcate processes as in the latter species. Also, *R. paucispina* appears somewhat more elongate and less obviously "four-cornered" than either *R. natans* or *R. vesca*.

Other Species:

Rhombodella paucispina (Alberti, 1961) n. comb. = *Palaeohystrichophora paucispina* Alberti, 1961, pp. 19, 20, pl. 3, fig. 25.

Genus *Wallodinium* Loeblich & Loeblich, 1968

1968 *Wallodinium* Loeblich & Loeblich, p. 212.

Wallodinium elongatum (Beju, 1971) n. comb.

Pl. 11, fig. 11

1971 *Fromea elongata* Beju, pp. 289, 290, pl. 3, figs. 7—10; text-fig. 6A-E.

Remarks: The morphological characteristics of this species dictate its inclusion in *Wallodinium*.

Text-fig. 17. The stratigraphical distribution of the more age-significant taxa recorded here.

IV. Palynostratigraphical Comments

Well over 100 dinoflagellate cyst and acritarch taxa were observed during the present study, of which 96 form the basis of the present work. Of these, 34 are considered to be of particular palynostratigraphical significance and are listed in text-fig. 17 and briefly discussed below.

The species *Aptea anaphrissa, Kleithriasphaeridium fasciatum, Muderongia crucis* and *Systematophora vetuscula* were observed only in the upper Lower Barremian here (PAL 293 = top LB1) and this suggests that each becomes extinct at or very near to top of the Lower Barremian. Davey (1974) recorded *A. anaphrissa* (as *Doidyx anaphrissa*) from the lower Middle Barremian of Speeton (his sample NB6 = lower MB) as well as in lower samples. Since Davey's sample NB6 is equivalent to PAL 294 here (see text-fig. 2), then the true stratigraphical top of *A. anaphrissa* may be in the lower Middle Barremian. The present author has logged 10 slides of PAL 294 and observed no specimens of *A. anaphrissa.* It is certain, therefore, that if *A. anaphrissa* is present in the Middle Barremian of Speeton, it is in virtually insignificant numbers, and any common occurrence of this species probably indicates Lower Barremian deposits. Davey (1974) recorded *M. crucis* no higher than lower Lower Barremian or Upper Hauterivian (bed LB4D) and *S. vetuscula* (as *Adnatosphaeridium vetusculum)* no higher than middle Lower Barremian (bed LB2D). With Davey's suggested stratigraphical tops for these last two species, neither should have been encountered in the present work. Nevertheless, both were recorded in significant numbers in the upper Lower Barremian here (PAL 293 = top LB1) and may therefore be considered indigenous at this level.

Middle Barremian deposits form the bulk of the samples studied here and, within this interval, several easily recognisable palynostratigraphically useful taxa were observed. Duxbury (1977) dealt with Speeton Clay material as young as earliest Middle Barremian so that sample SPE 1b in Duxbury (1977) may be considered equivalent to cementstone nodule band η in MB. Samples PAL 294 to PAL 300 are therefore younger than any in Duxbury (1977).

Several species were observed in the lower Middle Barremian here (as low as PAL 294 = lowest Middle Barremian sample taken) which were not observed in Duxbury (1977). These include *Cauca parva, Diphasiosphaera stolidota, Exiguisphaera plectilis* and *Palaeoperidinium cretaceum.* The stratigraphical ranges of these four taxa may, therefore, be considered to begin at or very close to the Lower/Middle Barremian boundary. Stratigraphical tops for two of these four were recorded in the present work since *D. stolidota* and *E. plectilis* are apparently Middle Barremian-restricted with the latter ranging throughout that substage. Other species which appear to become extinct at or near the top of the Middle Barremian include *Druggidium jubatum, Leptodinium alectrolophum* and *Taleisphaera hydra. D. jubatum* (as *Druggidium* sp.) was recorded no higher than middle Lower Barremian (bed LB2D) in Davey (1974) so that observations in the present work have extended its known range through the Middle Barremian also. *L. alectrolophum* has previously been recorded from the Middle Barremian of the Speeton Clay in Sarjeant's (1966a) work on the Shell West Heslerton No. 1 borehole and has a recorded range of Middle Barremian to date. Similarly, *T. hydra* has thus far only been recorded from the Speeton Clay Middle Barremian.

Several species which are present in the oldest sample here (upper Lower Barremian = PAL 293) become extinct within the Middle Barremian. These include *Callaiosphaeridium trycherium, Kleithriasphaeridium corrugatum* and *Subtilisphaera ? terrula. K. corrugatum* was observed in the lower Middle Barremian (PAL 294) and this extends the known range of the species above the Lower Barremian records of Davey (1974). *C. trycherium* and *S. ? terrula* were absent above the middle Middle Barremian (PAL 296 and PAL 297 respectively). Davey (1974) also recorded *S. ? terrula* only as high as Middle Barremian but Verdier (1975) recorded it as high as Upper Albian.

Six new species are restricted to the Middle Barremian. These are *Diphasiosphaera stolidota* (PAL 294 to PAL 296), *Gonyaulacysta fimbriata* (PAL 296 to PAL 298), *Oligosphaeridium fenestratum* (PAL 295), *Pterodinium premnos* (PAL 296 to PAL 298), *Rhombodella vesca* (PAL 295 to PAL 298) and *Trabeculidium quinquetrum* (PAL 296 to PAL 298). The Middle/Upper Barremian boundary is difficult to define precisely, but the presence of six species which become extinct within the Middle Barremian make this latter unit most distinctive and easily recognisable in borehole material.

Several species first occur within the Middle Barremian and are then present up to the lower Upper Barremian (PAL 300). These include *Achomosphaera ramulifera, Carpodinium granulatum, Cribroperidinium cornutum, Ellipsodinium reticulatum, Gonyaulacysta compta, G. boreas, Hystrichosphaeridium ? phoenix, Lithodinia sagena, Muderongia imparilis, M. pannosa, Odontochitina operculata, Prolixosphaeridium deirense* and *Tanyosphaeridium prolixispinosum*. The first two of these were observed only in the upper Middle Barremian and lower Upper Barremian here (PAL 299 and PAL 300 respectively). None of the above list were observed in Duxbury (1977) so that on the present author's observations, the stratigraphical range of each must extend no lower than Middle Barremian. In the cause of economy, a detailed palynostratigraphical discussion of each species listed above is not attempted here. Rather, a selection of particularly relevant species (in the sense that their observed ranges here may be compared with other author's records) is taken and discussed below.

The presence of *Achomosphaera ramulifera* in the upper Middle and lower Upper Barremian here is perhaps surprising since this long-ranging species has previously been considered indigenous to Upper Aptian and younger deposits (see Davey & Verdier (1971) and Verdier (1975)). Nevertheless, specimens examined here conform entirely with the specific diagnosis and are therefore considered to represent the oldest record of *A. ramulifera* to date.

The occurrence of *Carpodinium granulatum* in the upper Middle and lower Upper Barremian here confirms the record of this species in the upper Middle Barremian of Davey (1974) and is in agreement with the range quoted in Verdier (1975).

Odontochitina operculata was absent from the upper Lower Barremian and lowest Middle Barremian samples here and from all samples studied in Duxbury (1977). On the evidence of the present author's work, therefore, the lowest stratigraphical occurrence of this species in the Speeton Clay is in the lower part of the Middle Barremian. However, several authors have recorded *O. operculata* from pre-Barremian sediments and the present author considers such records quite insubstantial.

The first pre-Barremian record of *O. operculata* was by Gocht (1959), who recorded a single operculum and a single specimen lacking the apex from the Late Hauterivian of Germany. As pointed out by Millioud (1969, p. 431), "Detached apical parts are not always easy to identify with certainty, since similar horns could belong to various species of *Muderongia*". The operculum recorded by Gocht is, therefore, inconclusive. The specimen lacking its apex is clearly seen from Gocht's illustration (pl. 6, fig. 12) to be referable to *Batioladinium longicornutum*. A second pre-Barremian record of *O. operculata* was reported in Alberti, 1961. Alberti indicated the questionable presence of *O. operculata* in the late Hauterivian but he neglected to state why it was questioned and he did not illustrate any specimens from this level. It is, therefore, difficult to be objective about this record. In 1962, Pocock recorded *O. operculata* (as *O. silicorum*) from the Late Jurassic. This record may be immediately dismissed since there has been no subsequent confirmation of the occurrence of *O. operculata* in pre-Cretaceous strata. Millioud (1969) recorded a single specimen of *O. operculata* from the Late Hauterivian of Angles, France. Again, the occurrence of a single specimen may not be taken as irrefutable proof of a species' indigenous presence.

Davey & Verdier (1971, pp. 25, 26) published a comprehensive list of reported occurrences of *O. operculata*. In that list, the only records which are noteworthy in the present context are those of Alberti, 1961, Millioud, 1969 (both of which are discussed briefly above) and Warren, 1967. Davey & Verdier suggested that Warren's range for *O. operculata* was uppermost Hauterivian to Albian. In fact, although Warren wrote (p. 275) that *O. operculata* is the "zonal index for the *Odontochitina operculata* zone, occurring throughout the zone" (this zone encompasses late Hauterivian to Albian sediments), on his range chart, this species is shown to occur no lower than the upper part of his Barremian interval.

In the opinion of the present author, pre-Barremian records of *O. operculata* may be disregarded. Further, the true stratigraphical inception of this species is probably within the Middle Barremian.

In the present work, *Prolixosphaeridium deirense* was observed to range through lower Middle Barremian and younger samples (PAL 295 to PAL 300). This agrees well with Davey (1974) in which *P. deirense* occurred in sample NB1 (equivalent to PAL 299 here) and not below (Davey's next sample below NB1 was NB6 which is equivalent to PAL 294 here). Davey, Downie, Sarjeant & Williams (1966) recorded *P. deirense* only in the 39.0 m sample from the Shell West Heslerton No. 1 borehole (Middle Barremian). Millioud, 1969 recorded specimens which he designated *P. deirense* in deposits as old as late Early Barremian at Angles, France and he wrote (p. 432), "They differ somewhat from the British middle Barremian specimens in being more elongated (length/breadth ratio often more than 2), and in having shorter processes (5—7 μ)". Examination of MILLIOUD's illustrations of this species (pl. 3, figs. 5—7) causes the present author some doubt as to whether or not they may be placed in *P. deirense* as illustrated by DAVEY, DOWNIE, SARJEANT & WILLIAMS. The true range of typical examples of *P. deirense* probably begins, as seen in the present work, within the early Middle Barremian.

No species were confined exclusively to PAL 300. This observation accords largely with the situation in DAVEY (1974) although one species, *Xiphophoridium alatum* was recorded from the Upper Barremian of this last work. *X. alatum* was not observed here and it is somewhat unusual that it should be recorded as old as Upper Barremian. Records other than DAVEY, 1974 suggest an age no older than Late Albian (see DAVEY & VERDIER (1971) and VERDIER (1975). Unfortunately, DAVEY (1974) did not illustrate *X. alatum* or comment about numbers observed. In the present author's opinion, it is unlikely that *X. alatum* would be observed in deposits older than Late Albian and certainly not in the Upper Barremian of the Speeton Clay.

V. Conclusions

Each of the eight samples studied here has yielded very rich and diverse microfloral assemblages. Dinoflagellate cysts, acritarchs, spores and pollen were all common and each group was generally excellently preserved.

The large numbers of microplankton species observed in each sample here may be significant in indicating variable conditions of deposition within the Speeton Clay Barremian. Professor J. DODGE of the Royal Holloway College, University of London has stated (pers. comm.) that in modern marine conditions, dinoflagellate populations are generally dominated by single species. Further, the number of species observed within a given area is usually low. This may imply that stable depositional conditions produce a low diversity of dinoflagellate cysts, dominated by a very small number of species and, conversely, that a large number of dinoflagellate cyst species with none particularly predominant may imply fluctuating palaeoenvironmental conditions. The assemblages observed in the present work, therefore, would suggest considerable palaeoenvironmental change, even within the time scale represented by single samples.

Which specific palaeoenvironmental factors were fluctuating in order to produce such assemblages as were observed here are beyond speculation. Lack of detailed knowledge of present day dinoflagellate régimes, of motile stage/cyst relationships and cyst function, of factors affecting the growth of dinoflagellates, etc. makes palaeoenvironmental interpretations based solely on dinoflagellate cysts impossible.

The large majority of dinoflagellate cysts observed in the present work become extinct within the Cretaceous. Using the maxim of WILLIAMS (1971a, p. 94) that, "unlike foraminifera, the forms found in the sediments cannot be correlated with those in the water without a detailed knowledge of the life-histories of the species", it is seen that working with long-extinct dinoflagellate cysts can produce no worthwhile palaeoenvironmental results. Indeed, HARLAND (1977, p. 91), in his work on Recent and Late Quaternary dinoflagellate cysts, found some difficulty in interpreting his Quaternary data. He wrote, "In any attempt to elucidate the palaeoecology of Quaternary dinoflagellates and, hence palaeoenvironments, the first consideration must be thecal data. Unfortunately very little work is available on the distribution and ecological requirements of the thecal stage in general or at specific level and more research is urgently required". HARLAND's emphasis on thecal data reiterates WILLIAMS' maxim quoted above. Work on present day motile and encysted dinoflagellates, such as that of GRAHAM & BRONIKOWSKY, 1944, WOOD, 1954, WILLIAMS, 1971a and 1971b, WALL 1965 and 1971, WALL & DALE, 1967, 1968, 1970, etc. are therefore important contributions towards the recognition of palaeoenvironments, at least in Quaternary and Recent sediments. Work on older sediments becomes palaeoenvironmentally less reliable the older the sediments are and the higher the proportion of extinct dinoflagellate cysts recorded. WALL & EVITT (1975) serves to illustrate the problems faced in attempting to use comparative morphology as a criterion for palaeoenvironmental indication. WALL & EVITT wrote (p. 37), "With *Ceratium* we find that Cretaceous species of *Pseudoceratium* and *Muderongia*, for example, resemble living fresh-water species, such as *C. hirundinella* and *C. carolinianum*, more than they do any marine species". In the fossil record, *Pseudoceratium* and *Muderongia* both became extinct within the Lower Cretaceous and both are considered marine in origin.

The presence of common spores, pollen grains and angular cuticular and other woody debris indicates that deposition of each of the samples examined here occurred close to a land mass. The types of fine-grained sediments which make up the whole of the Speeton Clay sequence suggest that the land mass was low-lying. As mentioned in the "Introduction" above, the calcareous nodule bands within MB indicate cyclicity of deposition with each cycle being completed within approximately 6 ft. of sediment. The palynomorph content of samples examined here supports the idea of fluctuating depositional conditions and, furthermore, proves a near shore depositional environment. In addition, the large number of dinoflagellate cyst and acritarch species present in each sample may show that conditions were changing on a much shorter time scale than may be observed simply from large-scale lithological indications.

In the present work, the author has confined his descriptions to those species which are previously undescribed or which demand re-definition or re-allocation. The description of other, well-documented species (which may occur in large numbers, excellently preserved in the Speeton Clay Barremian) was considered beyond the scope of the present work and these are simply listed and illustrated in the plates.

VI. References

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VII. Explanation of Plates

Plate 1

Figs. 1—3.	*Gonyaulacysta fimbriata* n. sp. 1, 2 holotype. 1 demonstrates the ventral paratabulation and antapical protuberance. 2 demonstrates the apical horn and precingular (3″) archeopyle. 3, paratype, in polar orientation showing the fenestrate, distally entire anterior paracingular crest. All x 430. 1, 2: V. 60276(1), 3: V.60277(1).
Fig. 4.	*Gonyaulacysta helicoidea* (EISENACK & COOKSON, 1960) SARJEANT, 1966a. A specimen focussed to show the parasulcal area and the apical horn. x 750. V. 60295(1).
Figs. 5, 9.	*Diphasiosphaera stolidota* n. gen. et sp. 5, holotype, focussed to show the general cyst outline, the relationship of the body layers and the operculum (3″) within the endoblast. 9, paratype, a broken specimen with the operculum displaced. Both x 750. 5: V. 60268(1), 9: V. 60268(2).
Figs. 6, 10.	*Cribroperidinium edwardsii* (COOKSON & EISENACK, 1958) DAVEY, 1969. 6 focussed to show the general cyst outline, the intratabular tubercles and the apical horn. 10 focussed on the slightly displaced operculum. Both x 430. V. 60273(1).
Figs. 7, 8.	*Gonyaulacysta fastigiata* DUXBURY, 1977. 7 hypocystal and 8 epicystal focus. Both x 750. V. 60256(1).

Plate 2

Fig. 1, 2, 4.	*Gonyaulacysta compta* n. sp. holotype. 1 focussed on the ventral paratabulation, 2 focussed to show the general body outline and the apical horn and 4 focussed to show the dorsal surface, especially the *Trichodinium*-type intratabular spines. All x 750. V. 60299(1).
Figs. 3, 6.	*Occisucysta tentoria* DUXBURY, 1977. 3 a lateral aspect showing the ventral epicystal paratabulation and the distinctive apical horn. 6 a polar view with the parasulcal depression to the right of photograph. 6 demonstrates the paracingular crestal structure and the two-paraplate precingular archeopyle. Both x 750.
Fig. 5.	*Gonyaulacysta boreas* DAVEY, 1974. A specimen demonstrating the precingular (3″) archeopyle and the distinctive body outline. x 750. V. 60267(1).
Fig. 7.	*Muderongia staurota* SARJEANT, 1966b. x 550. V. 60260(1).
Figs. 8, 9.	*Aprobolocysta neistosa* n. sp. holotype. 8 focussed on the ventral portion of the archeopyle margin. 9 focussed to show the irregular body outline. Both x 1000. V. 60301(1).

VII. Explanation of Plates

Plate 1

Figs. 1—3. *Gonyaulacysta fimbriata* n. sp. 1, 2 holotype. 1 demonstrates the ventral paratabulation and antapical protuberance. 2 demonstrates the apical horn and precingular (3″) archeopyle. 3, paratype, in polar orientation showing the fenestrate, distally entire anterior paracingular crest. All x 430. 1, 2: V. 60276(1), 3: V.60277(1).

Fig. 4. *Gonyaulacysta helicoidea* (Eisenack & Cookson, 1960) Sarjeant, 1966a. A specimen focussed to show the parasulcal area and the apical horn. x 750. V. 60295(1).

Figs. 5, 9. *Diphasiosphaera stolidota* n. gen. et sp. 5, holotype, focussed to show the general cyst outline, the relationship of the body layers and the operculum (3″) within the endoblast. 9, paratype, a broken specimen with the operculum displaced. Both x 750. 5: V. 60268(1), 9: V. 60268(2).

Figs. 6, 10. *Cribroperidinium edwardsii* (Cookson & Eisenack, 1958) Davey, 1969. 6 focussed to show the general cyst outline, the intratabular tubercles and the apical horn. 10 focussed on the slightly displaced operculum. Both x 430. V. 60273(1).

Figs. 7, 8. *Gonyaulacysta fastigiata* Duxbury, 1977. 7 hypocystal and 8 epicystal focus. Both x 750. V. 60256(1).


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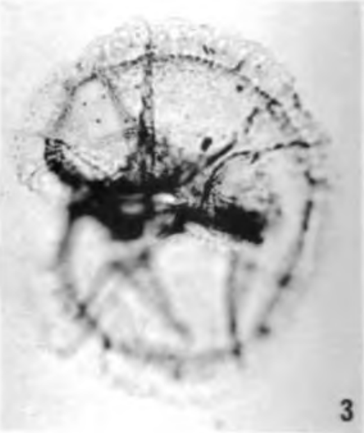
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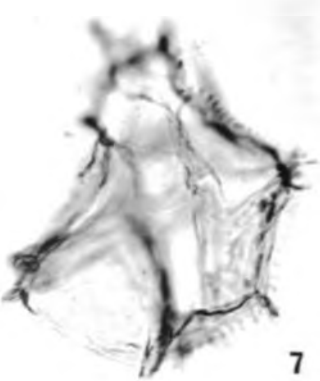
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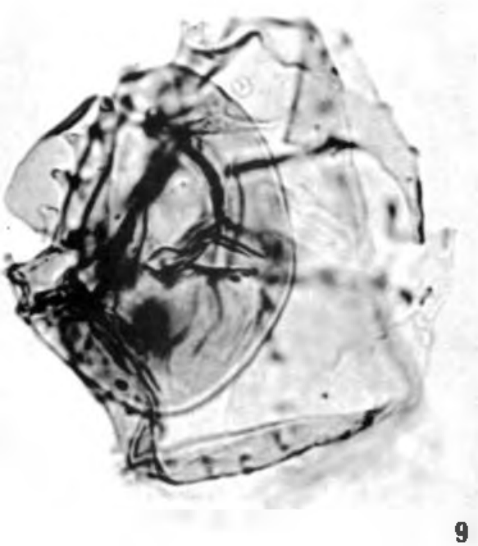
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Plate 2

Fig. 1, 2, 4. *Gonyaulacysta compta* n. sp. holotype. 1 focussed on the ventral paratabulation, 2 focussed to show the general body outline and the apical horn and 4 focussed to show the dorsal surface, especially the *Trichodinium*-type intratabular spines. All x 750. V. 60299(1).

Figs. 3, 6. *Occisucysta tentoria* Duxbury, 1977. 3 a lateral aspect showing the ventral epicystal paratabulation and the distinctive apical horn. 6 a polar view with the parasulcal depression to the right of photograph. 6 demonstrates the paracingular crestal structure and the two-paraplate precingular archeopyle. Both x 750.

Fig. 5. *Gonyaulacysta boreas* Davey, 1974. A specimen demonstrating the precingular (3″) archeopyle and the distinctive body outline. x 750. V. 60267(1).

Fig. 7. *Muderongia staurota* Sarjeant, 1966b. x 550. V. 60260(1).

Figs. 8, 9. *Aprobolocysta neistosa* n. sp. holotype. 8 focussed on the ventral portion of the archeopyle margin. 9 focussed to show the irregular body outline. Both x 1000. V. 60301(1).


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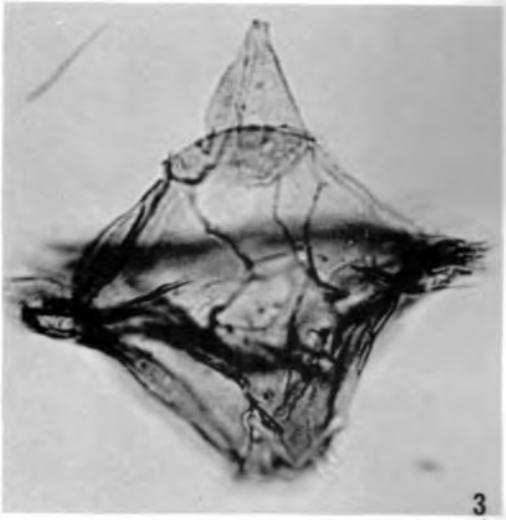
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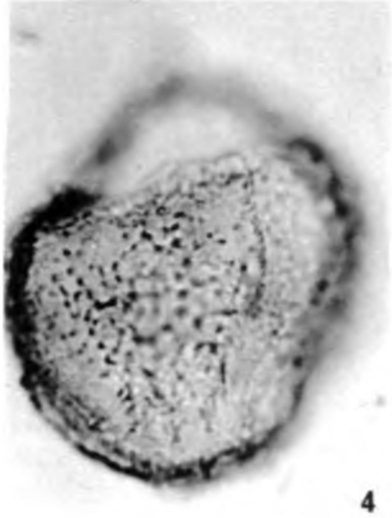
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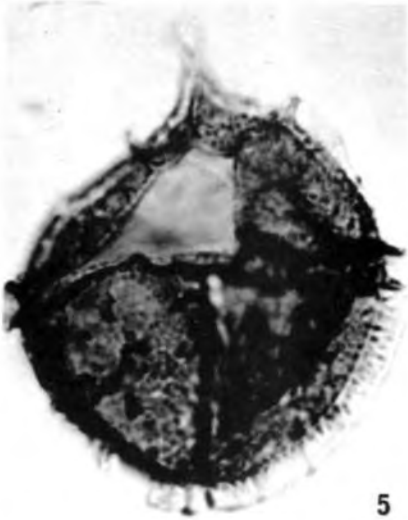
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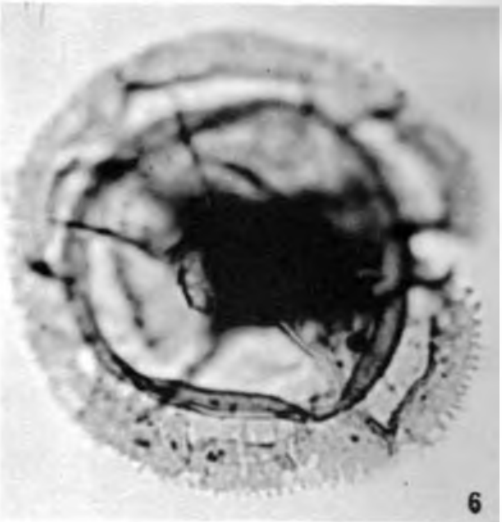
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Plate 3

Figs. 1, 2. *Pterodinium premnos* n. sp. holotype. 1 focussed to show the general body outline and apical projection. 2 focussed on the dorsal surface. Both x 750. V. 60298(1).

Figs. 3, 4. *Druggidium jubatum* n. sp. 3, holotype, demonstrating the ventral hypocyst. 4, paratype, showing the large precingular archeopyle. Both x 1000. 3: V. 60296(1), 4: V. 60296(2).

Figs. 5, 8, 11. *Exiguisphaera plectilis* n. sp. 5, 8 holotype. 5 focussed on the two-paraplate archeopyle. 8 demonstrates the body wall thickness and parasutural crestal height. 11, paratype, has both detached opercular paraplates within the cyst. All x 750. 5, 8: V. 60278(1).

Figs.6,9,12,13. *Lithodinia sagena* n. sp. 6, 9, 12 holotype. 6 focussed on the dorsal surface, 9 focussed to show the general cyst outline and parasutural crestal type and 12 focussed to show the parasulcal notch. 13, paratype, a complete specimen with the operculum slightly displaced. All x 1000. 6, 9, 12: V. 60295(2), 13: V. 60294(1).

Fig. 7. *Carpodinium granulatum* Cookson & Eisenack, 1962 emend. Leffingwell & Morgan, 1977. x 750. V. 60303(1).

Fig. 10. *Dingodinium albertii* Sarjeant, 1966b. A specimen showing the archeopyle split, the parasulcal hole and the anterior bare area on the endoblast. x 750. V. 60301(3).


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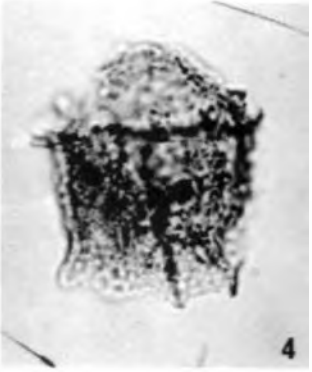
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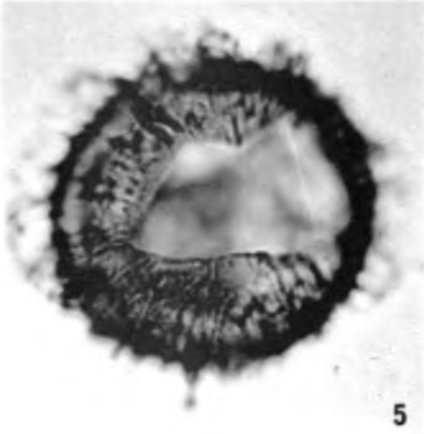
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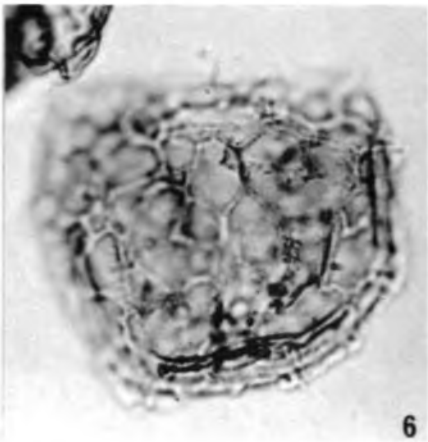
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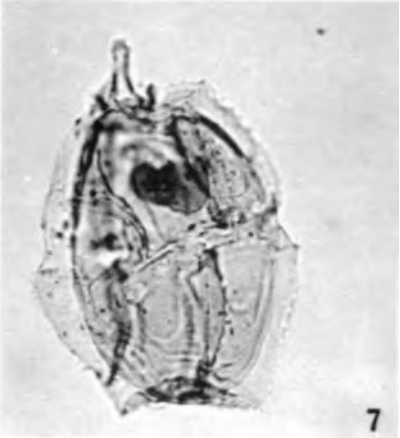
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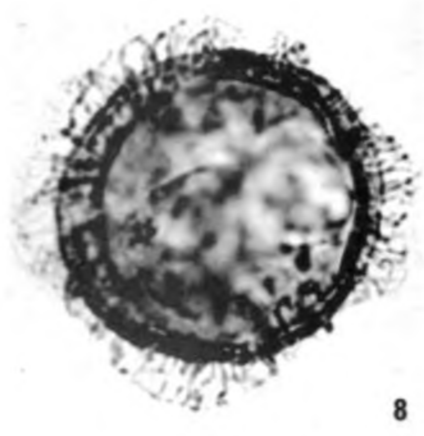
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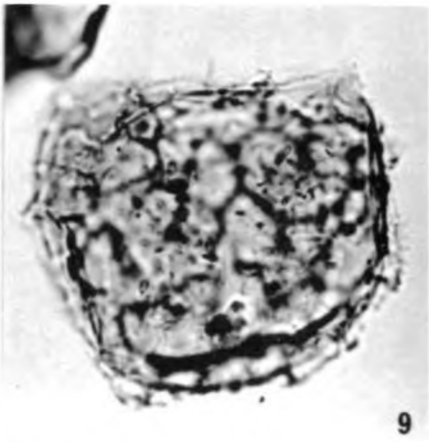
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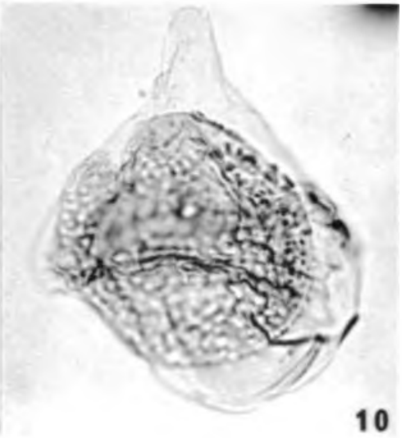
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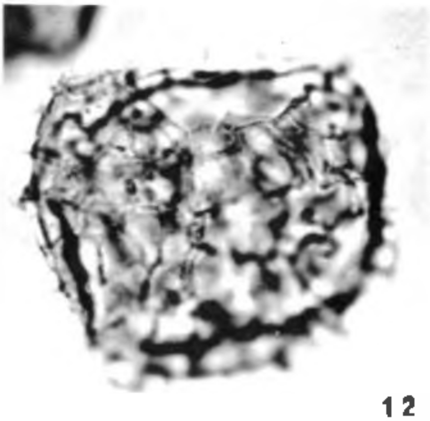
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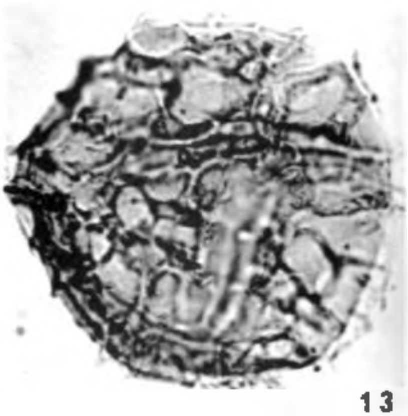
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Plate 4

Figs. 1, 2. *Taleisphaera hydra* Duxbury (in press). 1, holotype, focussed to show the penitabular crests and the archeopyle margin. 2, paratype, showing clearly the two-paraplate precingular archeopyle. Both x 1000. 1: V. 60058(1), 2: V. 60060(1).

Fig. 3. *Wallodinium krutzschii* (Alberti, 1961) Habib, 1972. A specimen demonstrating the differentiation into two body layers with the outer one lacking one pole and the inner one split in a corresponding position. x 750. V. 60286(1).

Figs. 4, 8. *Ellipsodinium reticulatum* n. sp. holotype. 4 focussed on the epicyst and 8 focussed on the hypocyst. Both x 1000. V. 60300(1).

Figs. 5, 9. *Endoscrinium campanulum* (Gocht, 1959) Vozzhennikova, 1967. 5 focussed to show the apical horn and endocystal projectioi 9 focussed on the hypocyst. Both x 430. V. 60273(2).

Figs. 6, 7. *Discorsia nanna* (Davey, 1974) Duxbury, 1977. 6 demonstrates striations extending from the processes onto the main body surface. 7 shows the split between the apex and the precingular paraplates. Both x 1000. V. 60286(2).

Figs. 10, 11. *Sirmiodinium grossii* Alberti, 1961 emend. Warren, 1973. 10 shows the mid-dorsal paraplate displaced and "hinged" posteriorly. 11 shows the split between apical and precingular paraplate series. Both x 430. V. 60268(3).

Fig. 12—15. *Fromea quadrugata* n. sp. 12, 13 holotype. 14, 15 paratype. 13, 15 display the characteristic folding around a large hole on one surface of the test. 12, 14 show the general cyst outline and pylome. All x 430. 12, 13: V. 60259(1), 14, 15: V. 60260(2).


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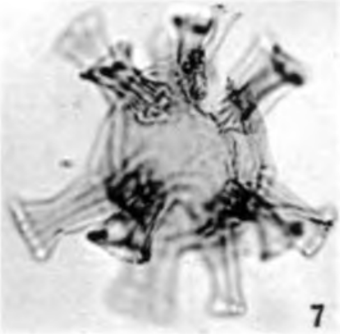
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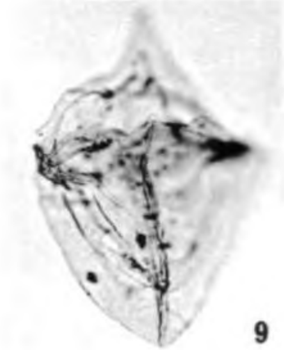
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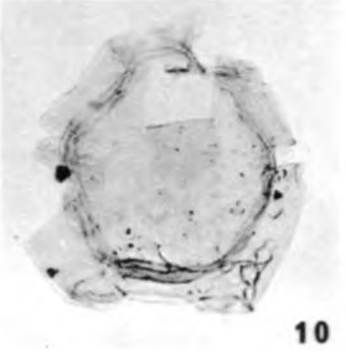
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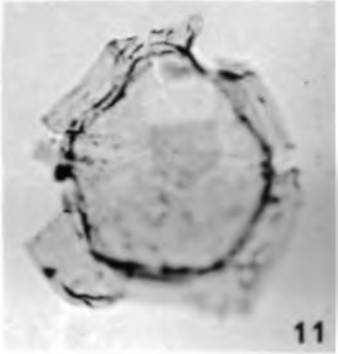
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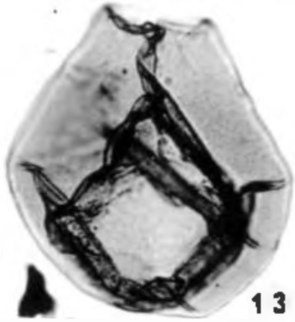
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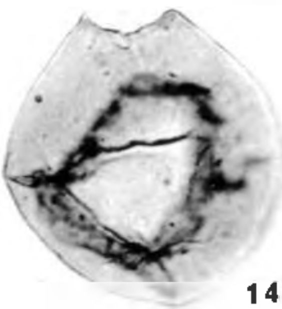
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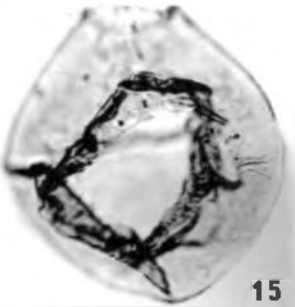
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Plate 5

Figs. 1, 12. *Hystrichodinium voigtii* (ALBERTI, 1961) DAVEY, 1974. 1 a specimen with long, mainly gonal processes focussed to show the mid-dorsal (3″) archeopyle. 12 a specimen with more numerous processes than 1 and these are mainly parasutural. 12 focussed on the ventral surface Both x 430. 1: V. 60267(2), 12: V. 60268(4).

Figs. 2, 4, 5. *Muderongia imparilis* n. sp. 4, 5 holotype with 4 focussed on the split between apical and precingular paraplates and the longest lateral horn and 5 focussed on the shortest lateral horn. 2, paratype, with the operculum completely detached and with a posterior endocystal protuberance. All x 430. 2: V. 60280(1), 4, 5: V. 60259(2).

Fig. 3. *Lithodinia stoveri* (MILLIOUD, 1969) DUXBURY, 1977. A complete specimen. x 430. V. 60272(1).

Fig. 6. *Hystrichodinium ramoides* ALBERTI, 1961. An oblique dorsal view illustrating the spheroidal central body and multifurcate process terminations. x 430. V. 60259(3).

Figs. 7, 10. *Rhombodella vesca* n. sp. holotype. Both x 1000. V. 60289(1).

Fig. 8. *Systematophora complicata* NEALE & SARJEANT, 1962. A specimen demonstrating the process complexes and the parasulcal notch. x 750. V. 60277(3).

Fig 9. *Odontochitina operculata* (WETZEL, 1933) DEFLANDRE & COOKSON, 1955. A complete specimen with the operculum attached only in the anterior parasulcal area. x 550. V. 60251(1).

Fig. 11. *Prolixosphaeridium deirense* DAVEY, DOWNIE, SARJEANT & WILLIAMS, 1966. A specimen with the apical paraplate series completely detached. x 750. V. 60286(3).


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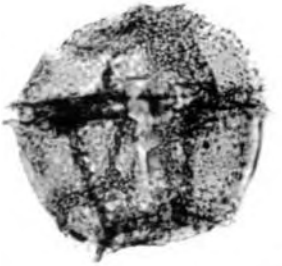
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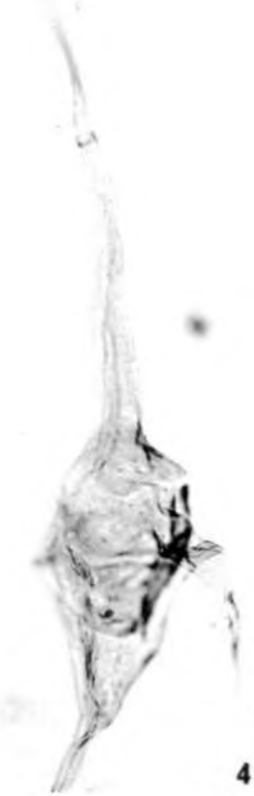
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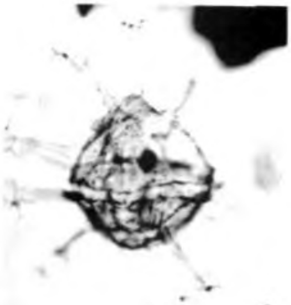
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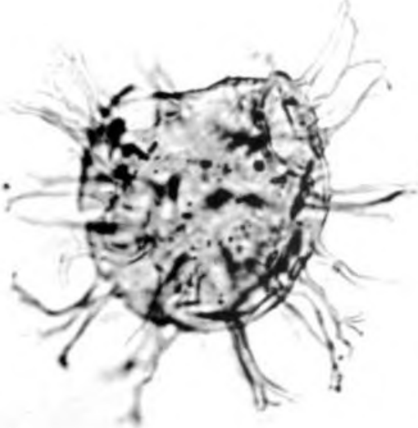
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Plate 6

Figs. 1, 2. *Achomosphaera* cf. *neptuni* (Eisenack, 1958) Davey & Williams, 1966a. 1 demonstrates the general cyst outline and 2 is focussed on the single-paraplate precingular archeopyle. Both x 750. V. 60271(1).

Fig. 3. *Hystrichosphaeridium arborispinum* Davey & Williams, 1966b. x 750. V. 60262(1).

Fig. 4. *Batioladinium jaegeri* (Alberti, 1961) Brideaux, 1975. A specimen with the operculum completely detached. The characteristic parasulcal notch and "fish-tail" antapex are clearly demonstrated. x 550. V. 60284(1).

Fig. 5. *Leptodinium alectrolophum* Sarjeant, 1966a. The contrast between the thick endocyst and the delicate parasutural crests is obvious. x 750. V. 60256(2).

Fig. 6. *Hystrichosphaerina schindewolfi* Alberti, 1961. A specimen demonstrating the process complexes and the narrow striations radiating from them onto the main body surface. x 750. V. 60302(1).

Fig. 7. *Avellodinium falsificum* Duxbury, 1977. The epicystal archeopyle is clearly demonstrated. x 750. V. 60270(1).

Fig. 8. *Achomosphaera neptuni* (Eisenack, 1958) Davey & Williams, 1966a. The characteristic process type and single-paraplate precingular archeopyle are obvious. x 750. V. 60292(1).


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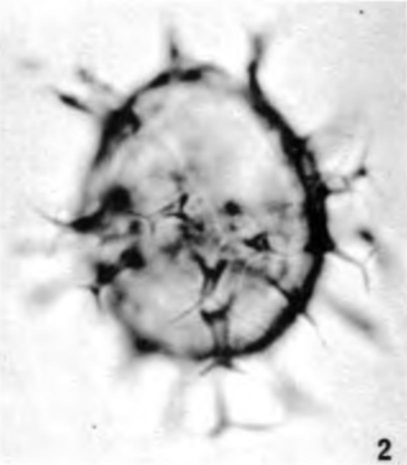
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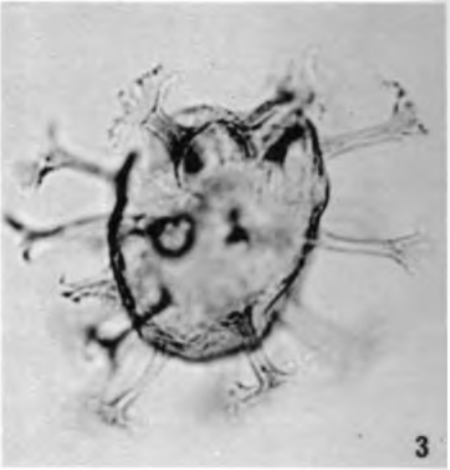
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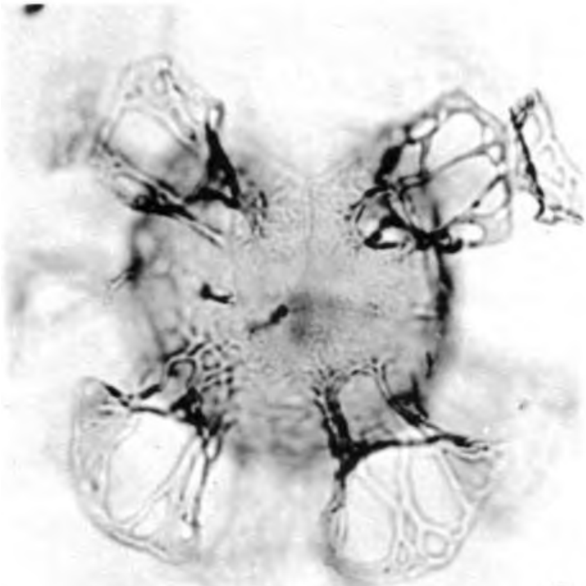
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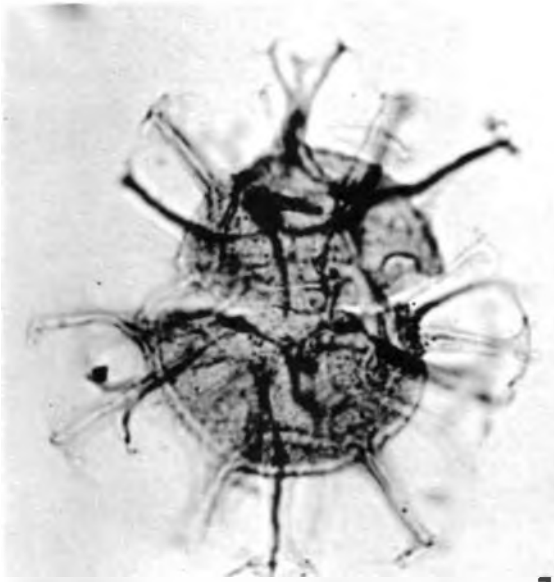
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Plate 7

Fig. 1. *Spiniferites ramosus* (Ehrenberg, 1838) Mantell, 1854 subsp. *ramosus* Davey & Williams, 1966a. x 550. V. 60272(2).

Fig. 2. *Protoellipsodinium spinosum* Davey & Verdier, 1971. Focussed to show the single-paraplate precingular archeopyle. x 550. V. 60304(1).

Fig. 3. *Protoellipsodinium clavulum* Davey & Verdier, 1974. The single-paraplate precingular archeopyle and long, slender, capitate or distally furcate processes are clearly demonstrated. x 750. V. 60284(2).

Figs. 4, 7. *Oligosphaeridium perforatum* (Gocht, 1959) Davey & Williams, 1969. 4 shows the general cyst outline and some processes in lateral view. 7 demonstrates the distal process structure. Both x 450. V. 60277(4).

Figs. 5, 8. *Tanyosphaeridium prolixispinosum* (Davey & Williams, 1966b) n. comb. 5 shows the general cyst outline, demonstrating the elongate nature of the central body. 8 shows the typically recurved distal process spines. Both. x 750. V. 60259(4).

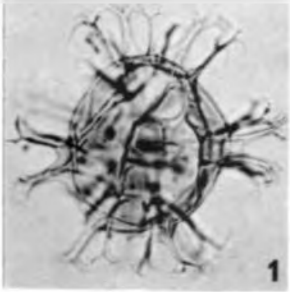
Figs. 6, 9. *Florentinia cooksoniae* (Singh, 1971) n. comb. emend. herein. 6 is an oblique dorsal aspect showing the mid-dorsal paraplate to be missing. 9 is a ventral focus showing the processes to be more slender than on the dorsal surface. Both x 450. V. 60257(1).

Fig. 10. *Polysphaeridium multispinosum* Davey, 1974. A specimen showing the thick, highly granular endophragm and demonstrating the zig-zag archeopyle margin. x 750. V. 60302(2).

Fig. 11. *Batioladinium longicornutum* (Alberti, 1961) Brideaux, 1975. A specimen with the operculum completely detached which shows well the parasulcal notch and solid antapical projections. x 450. V. 60300(2).

Fig. 12. *Oligosphaeridium complex* (White, 1842) Davey & Williams, 1966b. Focussed to show the process terminations. x 550. V. 60291(1).

Fig. 13. *Oligosphaeridium pulcherrimum* (Deflandre & Cookson, 1955) Davey & Williams, 1966b. Focussed to show the process terminations. x 450. V. 60267(3).



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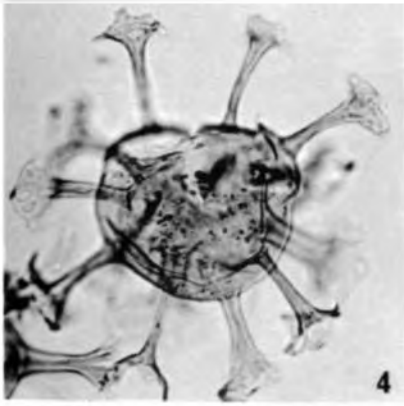

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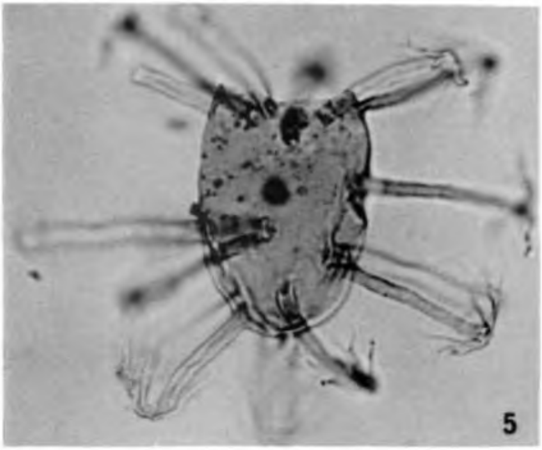

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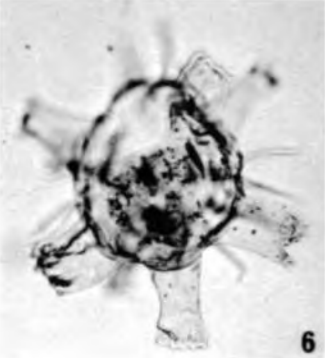

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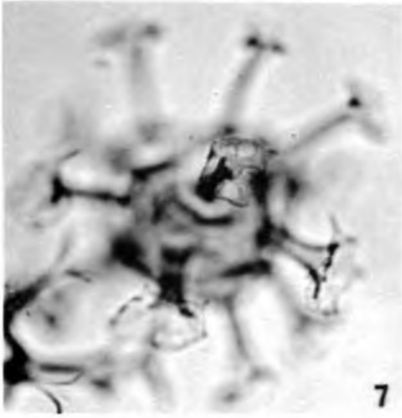

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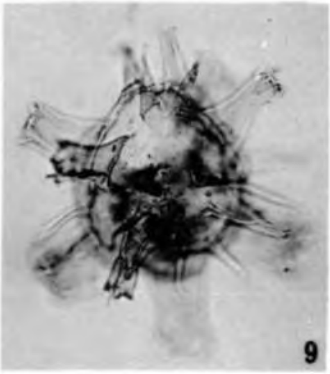

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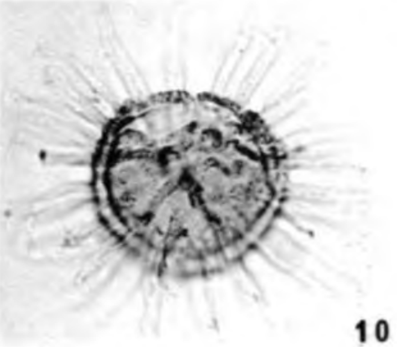

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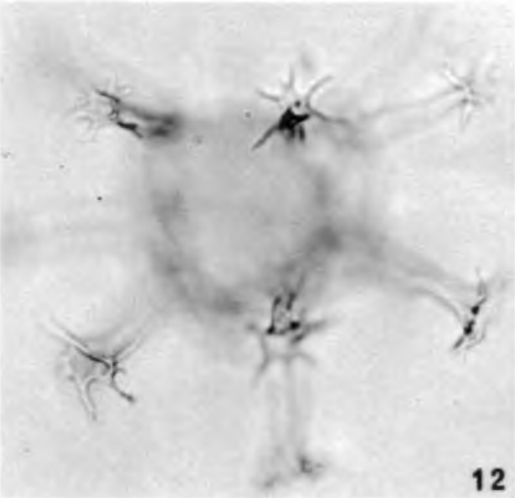

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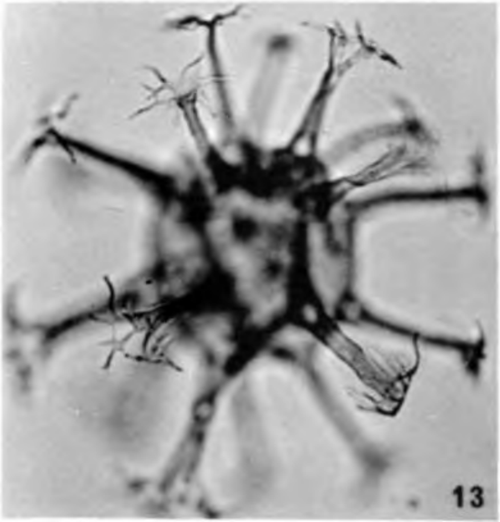

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Plate 8

Fig. 1. *Cyclonephelium distinctum* Deflandre & Cookson, 1955. The operculum is slightly displaced. x 750. V. 60275(2).

Figs. 2, 5. *Subtilisphaera ? terrula* (Davey, 1974) Lentin & Williams, 1976. 2 shows the general cyst outline and 5 demonstrates something of the dorsal paratabulation. Both x 750. V. 60281(1).

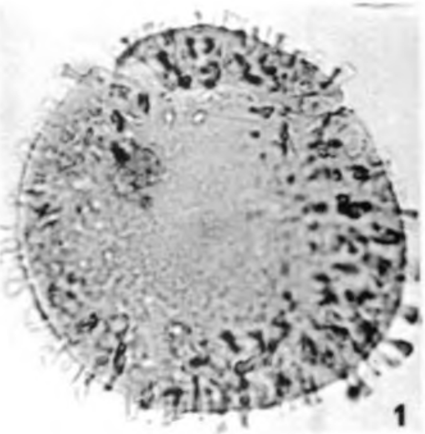
Figs. 3, 6, 11. *Callaiosphaeridium asymmetricum* (Deflandre & Courteville. 1939) Davey & Williams, 1966b. 3, 6 same specimen with 3 focussed on the tubular paracingular processes and 6 focussed on the processes bordering paraplate $1''''$ 11 focussed to show the vacuolar parasutural crests. All x 750. 3, 6: V. 60258(2), 11: V. 60269(1).

Figs. 4, 7. *Trichodinium speetonensis* Davey, 1974. 4 focussed on the parasulcal area. 7 focussed on the posterior archeopyle margin. Both demonstrate the areas devoid of spines which characterise the species. Both x 750. V. 60272(3).

Fig. 8. *Subtilisphaera perlucida* (Alberti, 1959) Jain & Millepied, 1973. Focussed to show the general body outline. x 750. V. 60288(1).

Fig. 9. *Ctenidodinium elegantulum* Millioud, 1969. A specimen with the epicyst completely detached focussed to show the parasutural crest type and crestal spines. x 450. V. 60259(5).

Fig. 10. *Muderongia crucis* Neale & Sarjeant, 1962. The operculum is completely detached, leaving a zig-zag archeopyle margin. x 450. V. 60261(1).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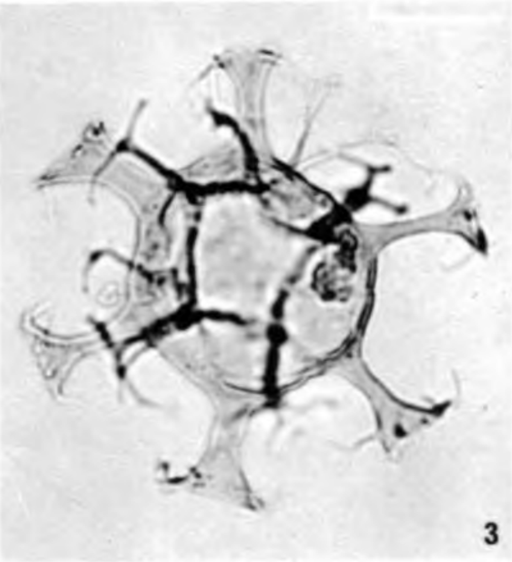
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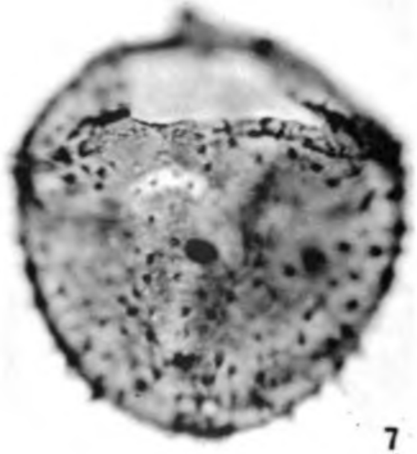
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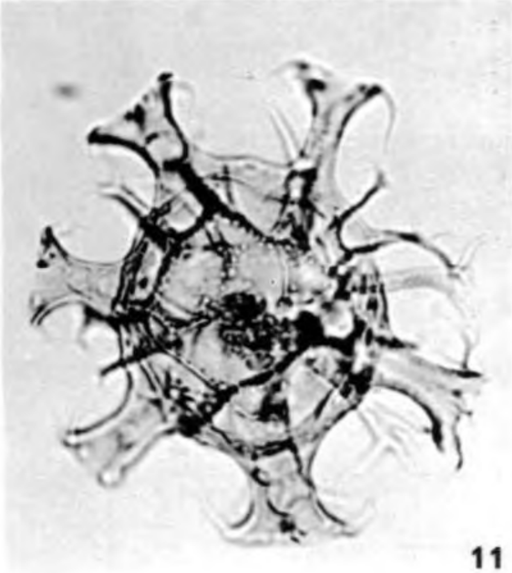
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Plate 9

Figs. 1, 2, 5. *Trabeculidium quinquetrum* n. gen. et sp. 1 and 5 paratype with 1 showing the central body outline and 5 focussed on the distal trabecular network. 2, holotype, focussed to show its pentagonal main body outline. All x 750. 1, 5: V. 60271(2), 2: V. 60277(5).

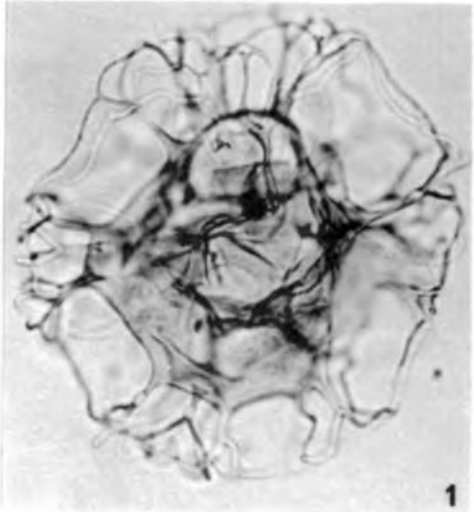
Fig. 3. *Kleithriasphaeridium corrugatum* Davey, 1974. x 450. V. 60266(1).

Fig. 4. *Palaeoperidinium cretaceum* Pocock, 1962 ex Davey, 1970. Focussed to show the general outline and dorsal paracingulum. x 750. V. 60299(2).

Figs. 6, 7. *Aptea anaphrissa* (Sarjeant, 1966b) Sarjeant & Stover, 1978. 6 a complete specimen with the operculum displaced but attached in the parasulcal area. 7 a specimen with the operculum completely detached along a zig-zag line. Both x 450. 6: V. 60263(1). 7: V. 60262(2).

Figs. 8, 9. *Oligosphaeridium fenestratum* n. sp. holotype. 8 shows the general outline (a polar orientation). 9 is an enlargement of part of 8 showing the highly fenestrate nature of the processes. 8 x 450, 9 x 2,000. V. 60267(4).

Fig. 10. *Pseudoceratium pelliferum* Gocht, 1957 subsp. *solocispinum* (Davey, 1974) Lentin & Williams, 1975. A specimen with the operculum completely detached. x 450. V. 60302(3).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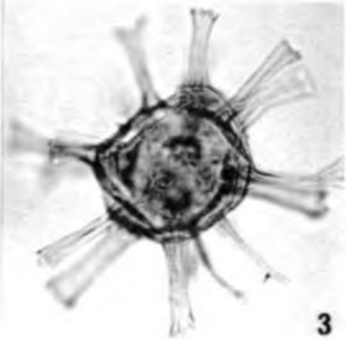
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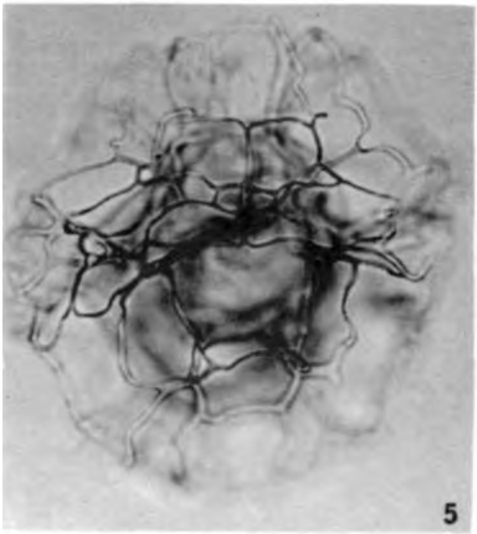
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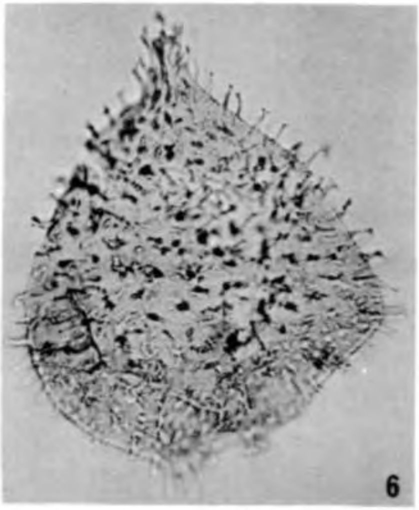
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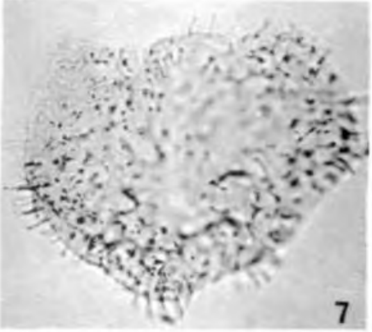
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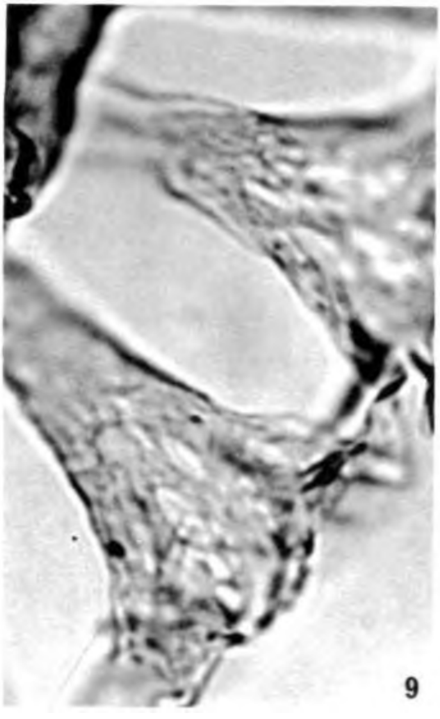
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Plate 10

Fig. 1. *Cribroperidinium cornutum* DAVEY, 1974. x 750. V. 60267(5).

Fig. 2. *Coronifera oceanica* COOKSON & EISENACK, 1958. A specimen in which the mid-dorsal paraplate is displaced (top right of picture) and which demonstrates the apical projection and antapical tubular process. x 550. V. 60275(1).

Figs. 3, 6. *Muderongia pannosa* n. sp. 3, holotype, a complete specimen. 6, paratype, a specimen with the operculum completely detached. Both x 750. 3: V. 60291(2), 6: V. 60291(1).

Fig 4. *Hystrichosphaeridium recurvatum* (WHITE, 1842) DAVEY & WILLIAMS, 1966b. x 430. V. 60256(3).

Figs. 5, 7. *Canninginopsis ? tabulata* (DAVEY & VERDIER, 1974) DUXBURY, 1977. 5 focussed on the dorsal surface to show the penitabular rows of spines. 7 focussed on the parasulcal notch. Both x 750. V. 60277(6).

Fig. 8. *Achomosphaera ramulifera* (DEFLANDRE, 1937) EVITT, 1963. Focussed on the ventral surface. x 750. V. 60279(1).


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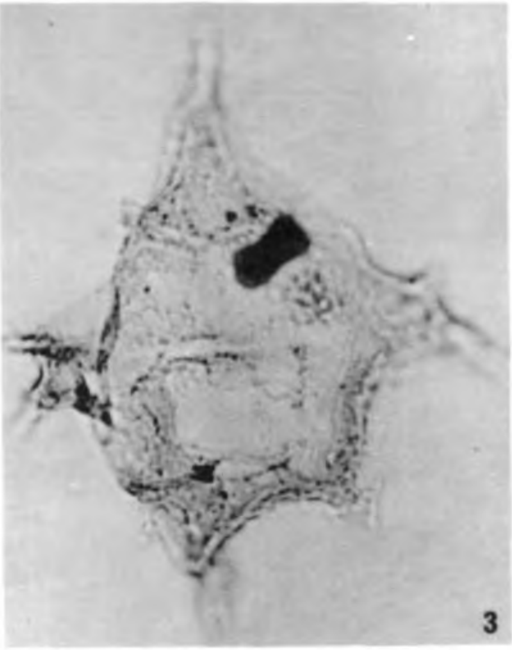
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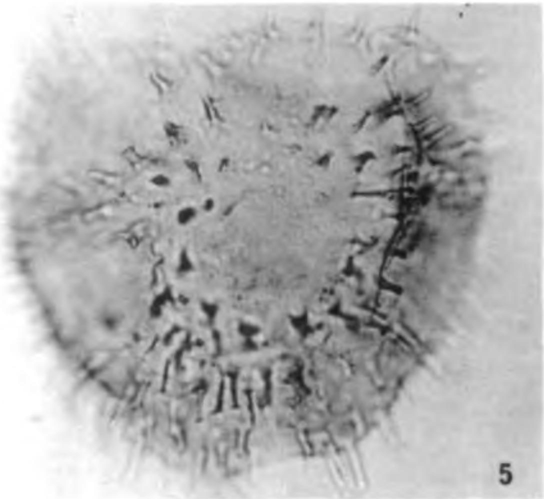
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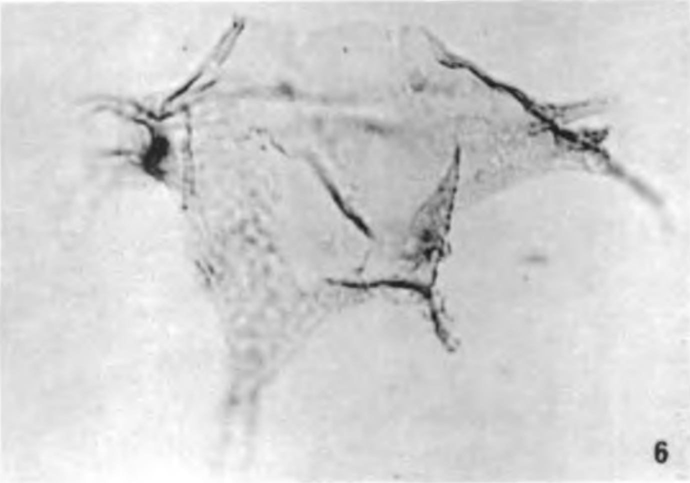
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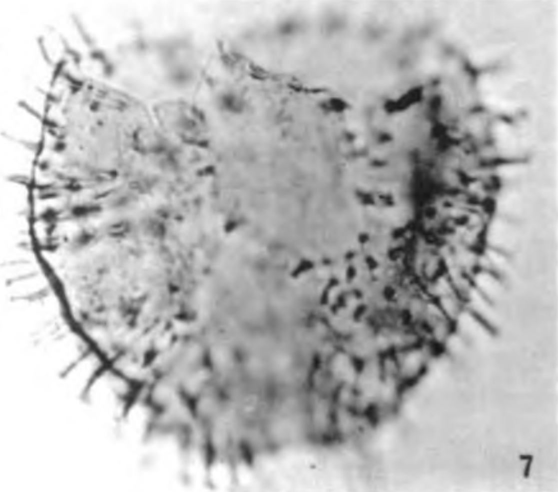
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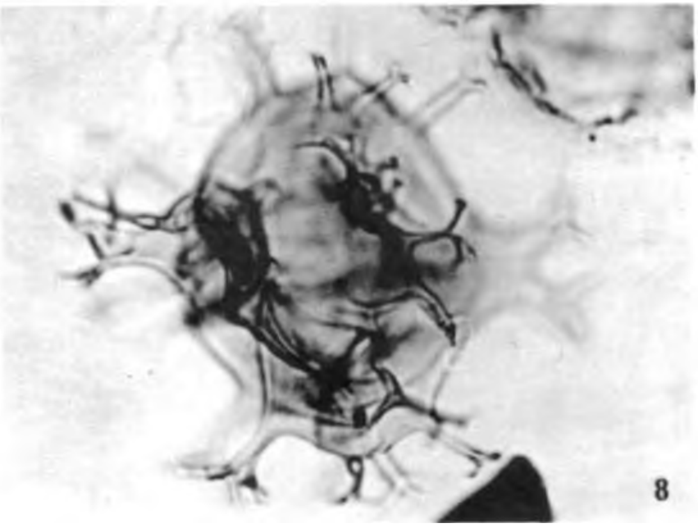
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Plate 11

Figs. 1, 2, 4. *Spiniferites speetonensis* n. sp. holotype. 1 focussed to show the large parasulcal hole, 2 focussed to show the single-paraplate archeopyle (top right of picture) and 4 focussed to show the fenestrate process terminations. All x 750. V. 60264(1).

Fig. 3. *Muderongia simplex* Alberti, 1961. A specimen with the operculum completely detached. x 750. V. 60282(1).

Fig. 5. *Gardodinium trabeculosum* (Gocht, 1959) Alberti, 1961. A specimen whose operculum is displaced but remains attached in the anterior parasulcal area. x 750. V. 60298(2).

Figs. 6, 9. *Callaiosphaeridium trycherium* n. sp. 9 holotype, 6 paratype. Each demonstrates the tubular paracingular processes and the high parasutural crests. Both x 750. 6: V. 60274(1), 9: V. 60263(2).

Fig. 7. *Subtilisphaera pirnaensis* (Alberti, 1959) Jain & Millepied, 1973. x 750. V. 60283(1).

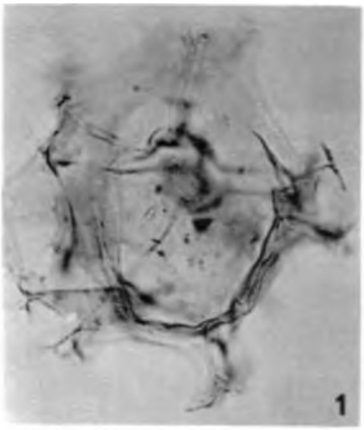
Fig. 8. *Wallodinium lunum* (Cookson & Eisenack, 1960) Lentin & Williams, 1973. x 750. V. 60279(2).

Fig. 10. *Spiniferites cingulatus* (Wetzel, 1933) Sarjeant, 1970. x 750. V. 60296(3).

Fig. 11. *Wallodinium elongatum* (Beju, 1971) n. comb. A split may be seen towards the apical pole of the endoblast. x 750. V. 60297(2).

Fig. 12. *Polysphaeridium laminaspinosum* Davey & Williams, 1966b. x 750. V. 60287(1).

Fig. 13. *Systematophora vetuscula* (Davey, 1974) Duxbury, 1977. x 750. V. 60281(2).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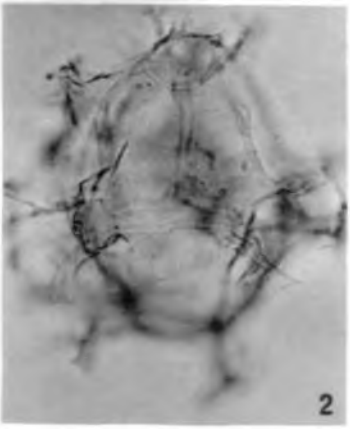
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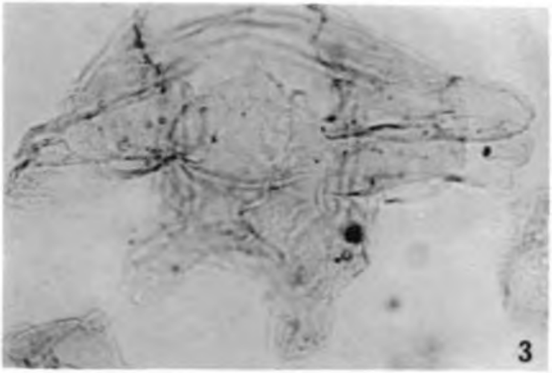
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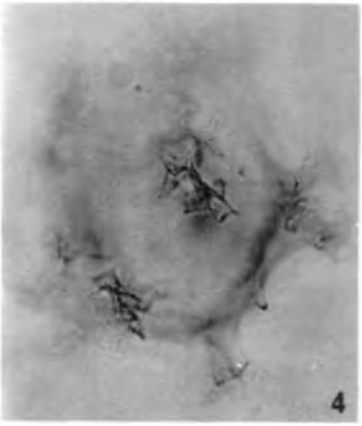
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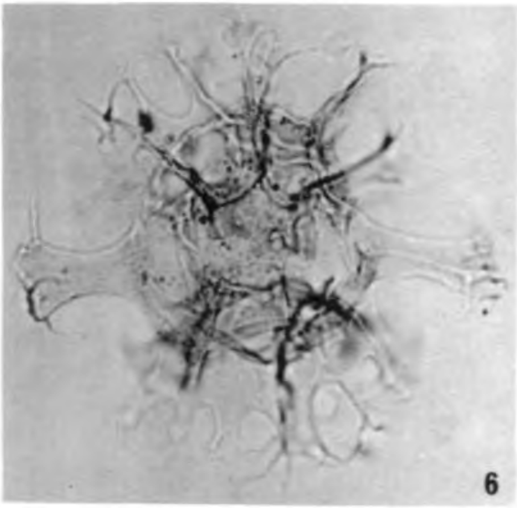
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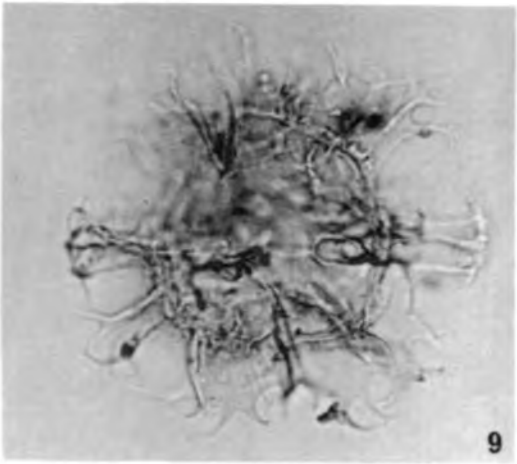
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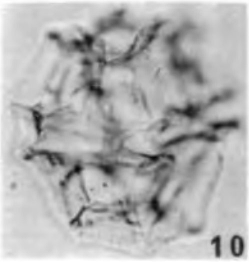
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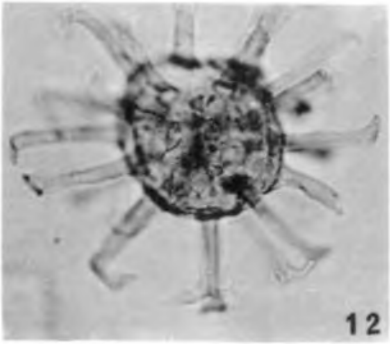
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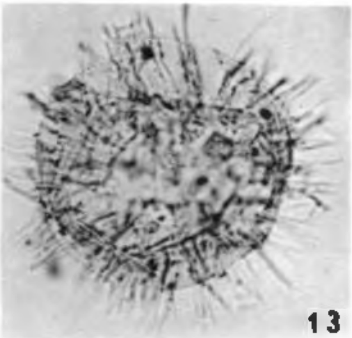
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Plate 12

Fig. 1. *Cauca parva* (ALBERTI, 1961) DAVEY & VERDIER, 1971. A specimen demonstrating well the low epicystal/hypocystal length ratio. x 750. V. 60287(2).

Fig. 2. *Kleithriasphaeridium fasciatum* (DAVEY & WILLIAMS, 1966b) DAVEY, 1974. x 750. V. 60263(3).

Fig. 3. *Florentinia interrupta* n. sp. holotype. x 750. V. 60256(4).

Figs. 4, 7. *Florentinia mantellii* (DAVEY & WILLIAMS, 1966b) DAVEY & VERDIER, 1973. 4 a specimen in lateral orientation. 7 a specimen viewed dorso-ventrally. 4 x 750, 7 x 450. V. 60256(4). 4: V. 60293(1), 7: V. 60256(5).

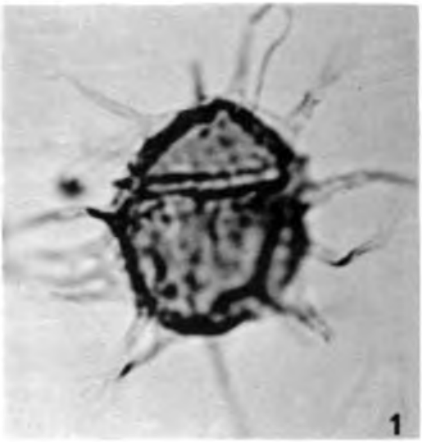
Fig. 5. *Kleithriasphaeridium simplicispinum* (DAVEY & WILLIAMS, 1966b) DAVEY, 1974. A specimen demonstrating the single-paraplate precingular archeopyle. x 750. V. 60277(7).

Fig. 6. *Heslertonia heslertonensis* (NEALE & SARJEANT, 1962) SARJEANT, 1966a emend. herein. A complete specimen with the epicyst displaced but attached in the parasulcal area. x 550. V. 60264(2).

Fig. 8. *Wallodinium krutzschii* (ALBERTI, 1961) HABIB, 1972. A specimen demonstrating the opercular "lid" which is often "hinged" on the edge of the pylome. x 750. V. 60280(2).

Fig. 9. *Batioladinium jaegeri* (ALBERTI, 1961) BRIDEAUX, 1975. The operculum is displaced and a crack may be seen between the apical and precingular paraplate series. x 750. V. 60286(4).

Fig. 10. *Pseudoceratium pelliferum* GOCHT, 1957. x 750. V. 60268(5).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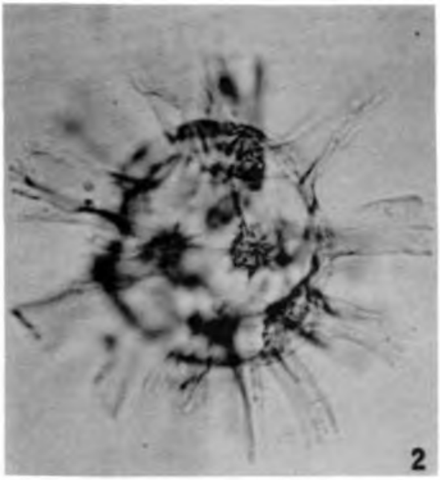
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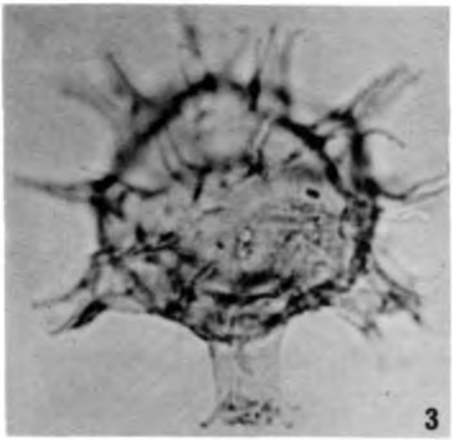
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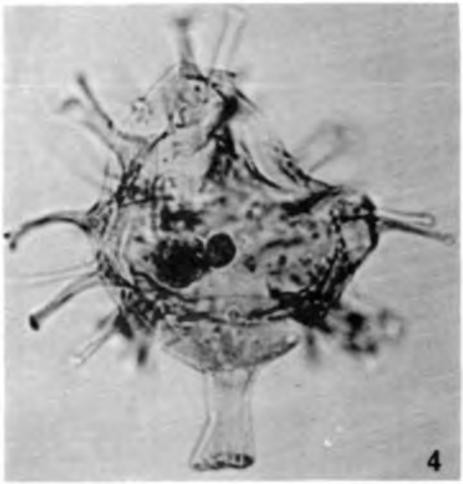
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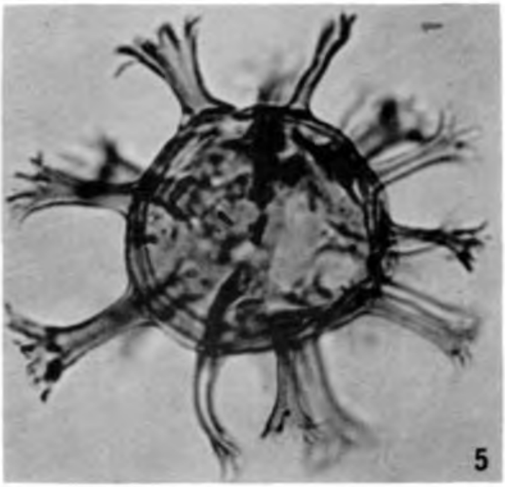
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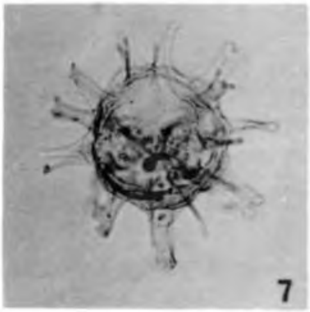
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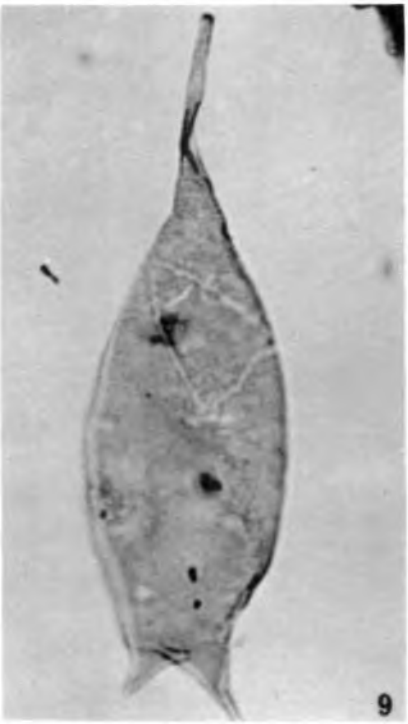
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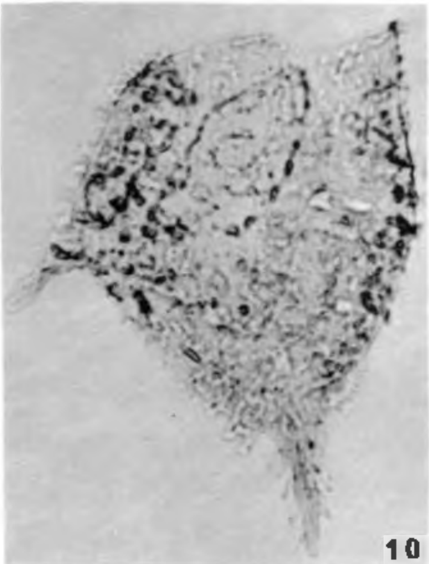
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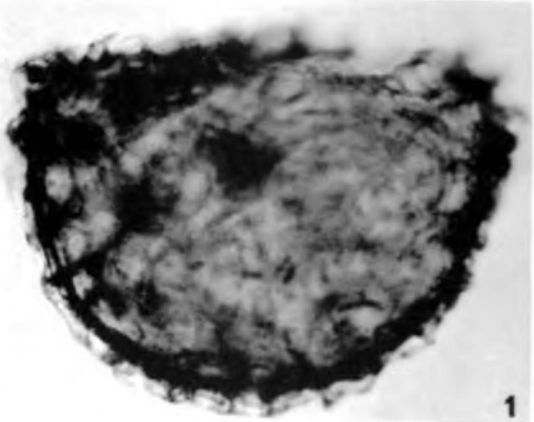
Plate 13

Figs. 1, 4.	*Cassiculosphaeridia magna* Davey, 1974. 1 shows the general body outline and 4 is focussed on the surface reticulum. Both x 750. V 60265(1).
Fig. 2.	*Trichodinium castaneum* (Deflandre, 1935) Clarke & Verdier, 1967. A specimen demonstrating the complete, even cover of intratabular spines which characterises the species. x 750. V. 60262(3).
Fig. 3.	*Gardodinium ordinale* Davey, 1974. The double rows of penitabular processes, which mark out the paratabulation on the endocyst, may be seen clearly in the epicyst. x 750. V. 60287(2).
Figs. 5, 6.	*Hystrichosphaeridium ? phoenix* n. sp. holotype. Both x 450. V. 60260(3).
Fig. 7.	*Batioladinium micropodum* (Eisenack & Cookson, 1960) Brideaux, 1975. A complete specimen with some displacement of the operculum. x 750. V. 60279(3).
Fig. 8.	*Spiniferites ramosus* (Ehrenberg, 1838) Mantell, 1854 subsp. *granosus* Davey & Williams, 1966a. V. 60256(6).
Fig. 9.	*Tanyosphaeridium* cf. *variecalamum* Davey & Williams, 1966b. x 750. V. 60279(4).
Fig. 10.	*Bacchidinium polypes* (Cookson & Eisenack, 1962) Davey, 1979a. x 750. V. 60267(6).
Fig. 11.	*Phoberocysta neocomica* (Gocht, 1957) Millioud, 1969. A specimen with the operculum completely detached. x 450. V. 60256(1).
Fig. 12.	*Hystrichodinium pulchrum* Deflandre, 1935. x 450. V 60290(1).
Fig. 13.	*Gonyaulacysta cassidata* (Eisenack & Cookson, 1960) Sarjeant, 1966a. Focussed to demonstrate the epicystal pericoel. x 750. V. 60285(1).
Fig. 14.	*Fromea amphora* Cookson & Eisenack, 1958. x 750. V. 60302(4).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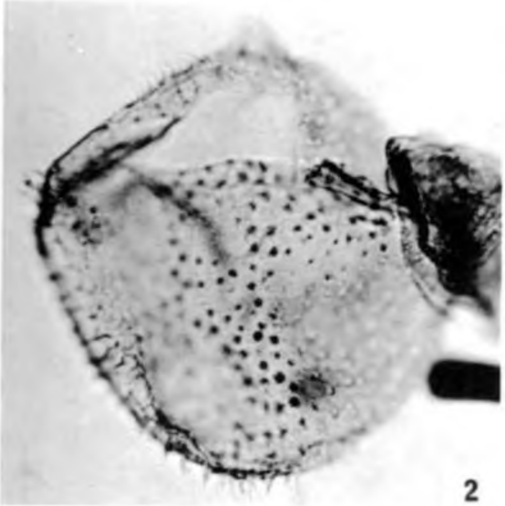
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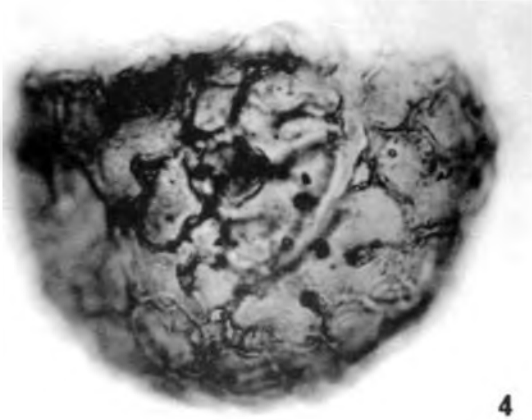
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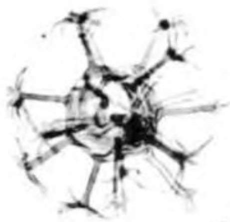
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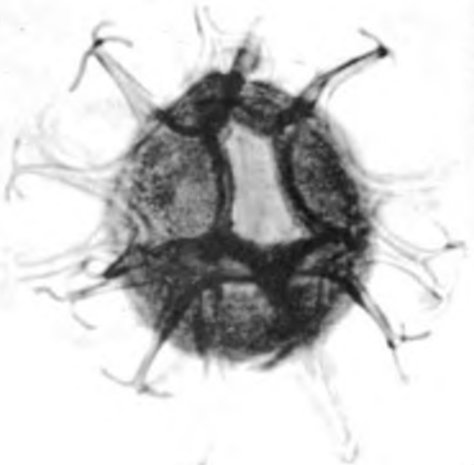
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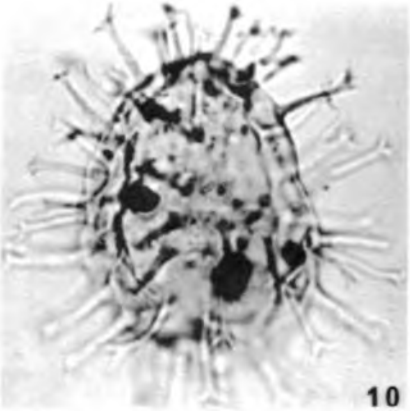
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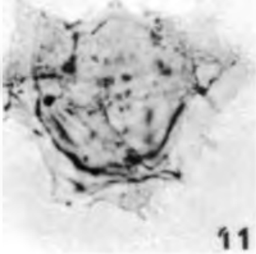
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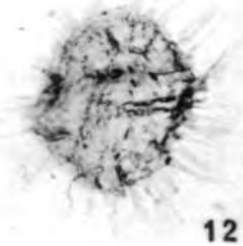
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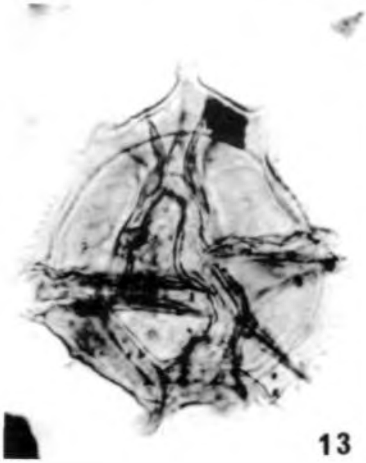
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