Hauterivian-Barremian dinoflagellate cyst assemblage from subsurface of Palar Basin, southern India

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A rich dinoflagellate cyst assemblage, with a few acritarch and spore-pollen taxa, has been recovered from core and cutting samples of 764.2 meters deep bore-hole drilled near Puduvoyal in Palar Basin, Chingleput District, Tamil Nadu, southern India. A total of 90 dinoflagellate cyst and 5 acritarch taxa have been documented. Their global geologic and geographic occurrences are tabulated to assess the age range of the subsurface sequence excluding the top 68 meters. Based on the following stratigraphically significant taxa, viz., *Aprobolocysta alata*, *A. eilema*, *Avellodinium falsificum*, *Batiacasphaera scrobiculata*, *B. subtilis*, *Coronifera oceanica*, *Cribroperidinium muderongense*, *Discorsia nanna*, *Exochosphaeridium bifidum*, *E. phragmites*, *Gagiella mutabilis*, *Gardodinium trabeculosum*, *Gonyaulacysta cassidata*, *Herendeenia alaskaensis*, *H. pisciformis*, *H. postprojecta*, *Kaiwaradinium scrutillinum*, *Kleithriasphaeridium eoinodes*, *Meiourogonyaulax bulloidea*, *Muderongia crucis*, *M. mcwhaei*, *M. simplex*, *M. staurota*, *Odontochitina operculata*, *Oligosphaeridium albertense*, *Palaeoperidinium cretaceum*, *Platycystidia eisenackii*, *Prolixosphaeridium parvispinum*, *Pseudoceratium anaphrissum*, *Sentusidinium aptiense* and *Tehamadinium tenuiceras*, an Early Cretaceous (Hauterivian-Barremian) age has been concluded.

Key words-Dinoflagellate cyst and acritarch, Hauterivian- Barremian, Palar Basin, India.

INTRODUCTION

THE Palar Basin is the southerly basin on the east coast of India (Text-fig. 1), located between the Cauvery Basin in the south and Krishna-Godavari Basin in the north. It is a comparatively small sedimentary basin covering an area of 4000 square kilometers on land, extending further into the offshore towards the east, occupying an area of 2800 square kilometers.

The geohistory of Palar Basin shows two major periods of non- deposition, the Late Permian to Jurassic and the Late Cretaceous. The Lower Cretaceous sediments in outcrop sequences are represented by older Sriperumbudur Beds (Neocomian) overlain by the Satyavedu Beds (Aptian). Their estimated thicknesses in the basin are 600 meters and 300 to 2000 meters respectively (Sastri *et al.* 1981, table 4). The Archean rocks form the basement (Text-fig. 1).

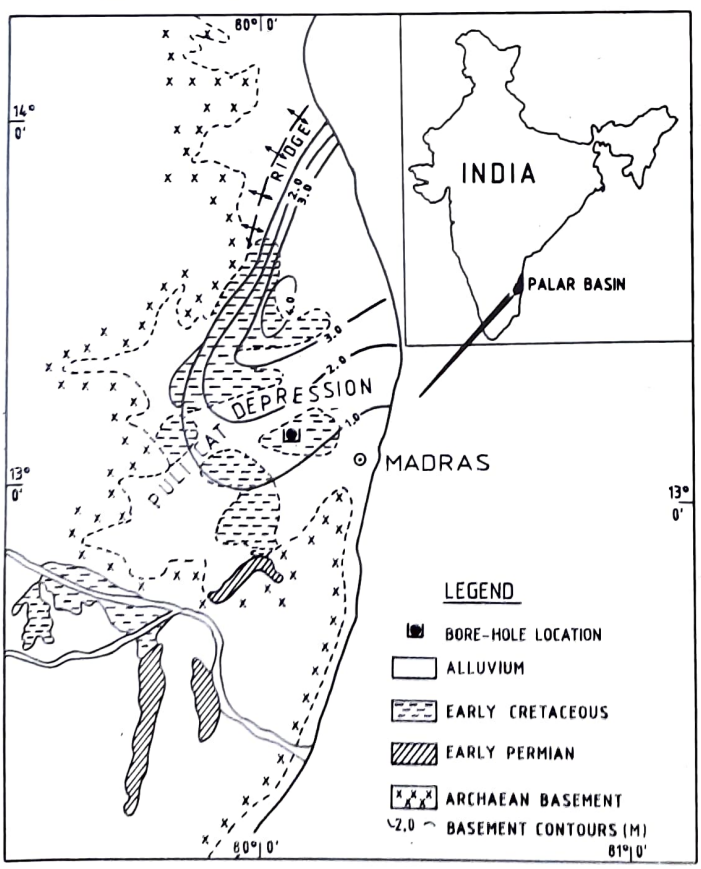
In spite of well developed Mesozoic sediments in several sedimentary basins of India, the records of Lower Cretaceous dinoflagellate cyst assemblages are very few. Jain and Subbaraman (1969) for the first time reported some Aptian - Lower Albian microplankton from Dalmiapuram Formation, Cauvery Basin. Later Jain (1977) documented these fossils in detail, precisely assigning Lower Albian age to the Dalmiapuram Formation.

Kumar (1986) and Mehrotra and Sarjeant (1986) have described dinoflagellate cyst assemblages from subsurface of Krishna- Godavari and Cauvery basins assigning Valanginian - Barremian and Valanginian - Albian ages to the sequences respectively. Recently Garg *et al.* (1988) have critically reviewed the age assignments of Kumar (1986) and Mehrotra and Sarjeant (1986) concluding that the Lower age limit of both the sequences is Hauterivian rather than Valanginian.

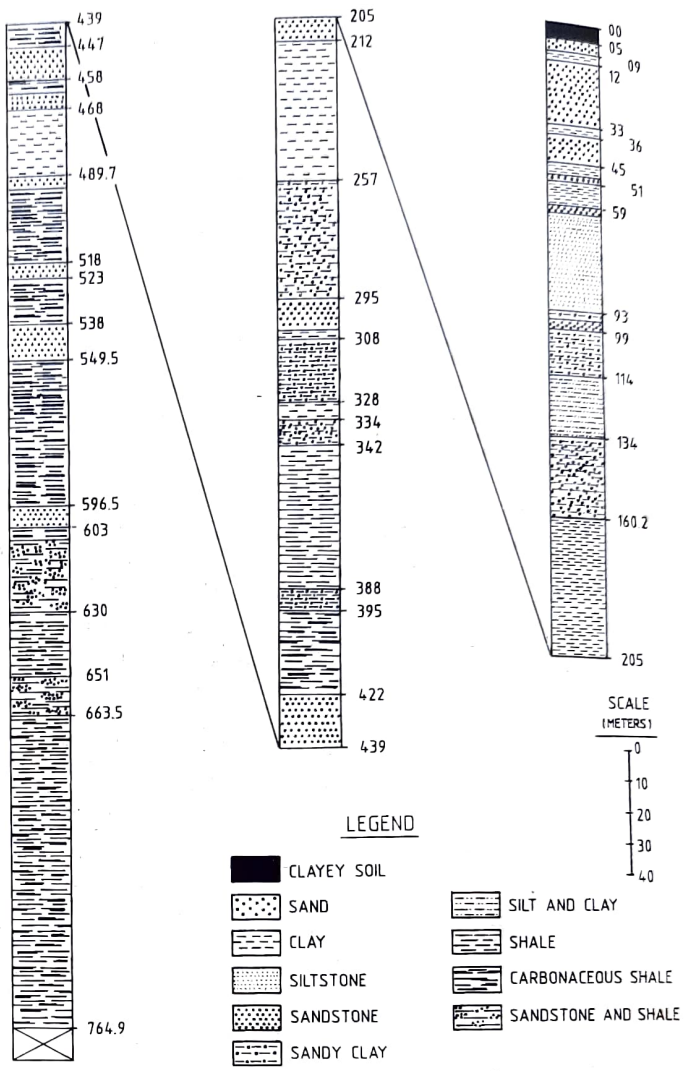
Khowaja-Ateequzzaman *et al.* (1988) for the first time reported a preliminary dinocyst assemblage from Palar Basin assigning Barremian age to the PUD- 1 bore-hole sequence, equating it with the *Aptea anaphrissa* Subzone of the *Odontochitina operculata* Zone, proposed by Davey (1979). The same data has been reproduced by Garg *et al.* (1988, p. 260 - 261; Table 3) in their review account of Jurassic and Lower Cretaceous dinoflagellate cysts from India. While doing so, Garg *et al.* (1988) inadvertantly committed some errors which are rectified here as follows: 1. For Khowaja-Ateequzzaman,

1988 a, b, in table 3, read Khowaja-Ateequzzaman *et al.*, 1988 a, b, 2. *Alterbidinium minor* reported from Palar Basin be deleted, 3. depth of Puduvoyal bore-hole reported as 760 meters deep on p. 262 should be read as 764.2 meters. On critical analysis we have found that the following taxa viz., *Druggidium jubatum*, *Ellipsoidictyum* cf. *E. reticulatum*, *Rhombodella vesca* and *Trabeculidium quinquetrum*, reported by Khowaja-Ateequzzaman *et al.* (1988 b) and Garg *et al.* (1988), are based on poorly preserved specimens. These constituent taxa are therefore, excluded from the present assemblage. The specimens attributed to *Cribroperidinium cornutum*, *Muderongia tetracantha*, *Pterodinium premnos* and *Rhynchodiniopsis fimbriata* are reallocated each to *Cribroperidinium muderongense*, *Muderongia crucis*, *Pterodinium aliferum* and *Cribroperidinium* edwardsii respectively.

The present dinoflagellate cyst and acritarch assemblage has been recovered from an exploratory bore-hole (PUD- 1) drilled near Puduvoyal (13^0 19" 30"N, 80^0 08" 50" E) in Chingleput District, Tamil Nadu (Text-fig. 1). It reached a depth of 764.2 meters. The complete lithology is projected in Text-figure 2. Major lithlogies met within the subsurface sequence are carbonaceous shale, clay, sandstone and siltstone. The upper 395 meters part of the sequence is more sandy and is almost devoid of carbonaceous shale.



Text-figure 1. Geologic and basement depth map of the Palar Basin (traced from Sastri *et al.* 1981, Fig. 9, p. 35), showing the location of studied bore-hole.



Text-figure 2. Litholog of Puduvoyal bore-hole, Palar Basin.

Fifty five palynological samples from 764.2 meters thick subsurface sequence (bore–hole), excluding the top 68 meters (Table 1), were collected. These samples are mostly side-wall cuttings (SWC). Only a single 3 meters (441.2 - 444.2 meters) conventional core (CC) sample has been analysed. Each SWC sample represents more or less 3 meters thick sequence collected at different levels (Table 1).

Standard maceration technique has been followed to isolate the organic walled microfossils avoiding alkali treatment. The type and figured slides are lodged in the museum of Birbal Sahni Institute of Palaeobotany, Lucknow. Location coordinates for the illustrated specimens refer to Olympus BH2 and are stated in millimeters.

Age of subsurface Dinoflagellate cyst and Acritarch assemblage

A rich palynological assemblage, represented by dinoflagellate cysts followed by less frequent acritarchs, spores and pollen, has been recovered from the cutting and bore-core samples of a 764.2 meters thick subsurface

Table 1. Showing position of samples each colected between different depths, in Puduvoyal bore-hole sequence, Palar Basin.

Sample No.	Depth in meters (bgl.)	Sample No.	Depth in meters (bgl.)
1.	68.0 - 72.0	28.	505.0 - 508.0
2.	114.0 - 117.5	29.	514.1 - 517.0
3.	135.8 - 139.0	30.	529.0 - 532.0
4.	139.0 - 141.9	31.	535.0 - 538.2
5.	164.0 - 166.3	32.	572.0 - 575.1
6.	178.5 - 182.0	33.	581.2 - 584.0
7.	190.7 - 194.0	34.	593.4 - 597.0
8.	200.0 - 202.9	35.	648.3 - 651.0
9.	212.0 - 215.1	36.	672.7 - 676.0
10.	221.2 - 224.0	37.	682.0 - 684.0
11.	233.4 - 236.0	38.	691.0 - 694.0
12.	251.7 - 255.0	39.	694.0 - 697.1
13.	261.0 - 263.9	40.	703.0 - 706.0
14.	288.3 - 292.0	41.	706.0 - 709.0
15.	318.8 - 322.0	42.	709.0 - 712.0
16.	349.3 - 353.0	43.	712.0 - 715.4
17.	367.6 - 371.0	44.	715.4 - 719.0
18.	371.0 - 373.7	45.	719.0 - 721.5
19.	373.7 - 376.0	46.	725.0 - 727.6
20.	383.0 - 385.9	47.	727.6 - 731.0
21.	385.9 - 388.0	48.	731.0 - 733.7
22.	392.0 - 395.0	49.	733.7 - 736.0
23.	422.5 - 426.0	50.	736.0 - 739.8
24.	431.6 - 435.0	51.	739.8 - 743.0
25.	441.2 - 444.2 (C.C.)	52.	743.0 - 745.9
26.	477.5 - 480.0	53.	745.9 - 749.0
27.	483.6 - 487.0	54.	752.0 - 755.0
		55.	761.0 - 764.2

(bore-hole) sequence of Palar Basin, southern India.

To assess the generalized age of the dinoflagellate cyst and acritarch assemblage, the constituent taxa irrespective of their stratigraphic distribution through the sequence, has been considered as a single unit.

A total of ninety dinoflagellate cyst and five acritarch species have been documented. Seventy seven microplankton previously recorded from different parts of the world have been thoroughly scanned for their stratigraphic distribution (Table 2), which significantly demonstrate that most of the constituents have Early Cretaceous age implication.

A closer look of geologic distribution of some taxa listed in Table 2 indicates that *Batiacasphaera asperata* and *Batioladinium varigranosum* range within Valanginian - Hauterivian, whereas *Cribroperidinium confossum* and *Impagidinium reductum* are restricted within Hauterivian. The records of these taxa are only a few, hence their stratigraphic significance remains open to question. Twenty three taxa, viz., *Tanyosphaeridium varicalamus, Coronifera oceanica, Exochosphaeridium bifidum, Odontochitina operculata, Exochosphaeridium phragmites, Gonyaulacysta cassidata, Palaeoperidinium cretaceum, Prolixosphaeridium parvispinum, Cribroperidinium muderongense, Kleithriasphaeridium eoinodes, Discorsia nanna, Pseudoceratium anaphrissum, Sentusidinium aptiense, Tehamadinium tenuiceras, Gardodinium trabeculosum, Herendeenia alaskaensis, H. postprojecta, Muderongia crucis, M. mcwhaei, M. staurota, Platycystidia eisenackii, Aprobolocysta alata* and *A. eilema* mark their first occurrence in Hauterivian extending within the Cretaceous, whereas six species, viz., *Aprobolocysta alata, A. eilema, Batiacasphaera subtilis, Herendeenia alaskaensis and Muderongia crucis*, range within Hauterivian - Barremian.

Another suite having the taxa, viz., *Avellodinium falsificum, Herendeenia pisciformis, Meiourogonyaulax bulloidea, Muderongia simplex, Gonyaulacysta exsanguia, Pterospermella aristotelesii* and *Kaiwaradinium scrutillinum* are long ranging terminating at Barremian. Apart from these, there are some, viz., *Oligosphaeridium albertense, Cleistosphaeridium huguoniotii, Prolixosphaeridium parvispinum* subsp. *deirense, Cribroperidinium sepimentum, Impagidinium phlyctaena, Circulodinium deflandrei, Disphaera tesselata* and *Odontochitina athabaskensis*, which have their oldest occurrance in Barremian. Taxa, *viz., Pterodinium cingulatum, Oligosphaeridium totum* and *Tehamadinium coummium* are still struggling for stratigraphic precision having been recorded once or twice.

In view of the above discussion, it is evident that the assemblage as a whole shows Hauterivian - Barremian aspect.

A correlation with Early Cretaceous dinoflagellate cyst and acritarch assemblages described from the austral region, specially covering Australia (Helby *et al.*, 1987; Backhouse, 1988; Burger, 1980) and Madagascar (Chen, 1978), indicates greater specific similarity than with boreal Early Cretaceous assemblages (Duxbury, 1977, 1980; Davey, 1974, 1979, 1982).

Occurrence of *Muderongia australis, Batioladinium jaegeri, Aprobolocysta alata, Dingodinium cerviculum, Apteodinium maculatum, Coronifera oceanica* and *Prolixosphaeridium parvispinum* in the present assemblage has distinct correlatable potential with *Aprobolocysta alata* and *Batioladinium jaegeri* zones of western Australia (Backhouse, 1988), ranging in age from Upper Hauterivian to Barremian. Helby *et al.* (1987) have proposed a palynological zonation scheme of the Australian Mesozoic including data of Papuan Basin of Papua New Guinea. They have established seven dinoflagellate superzones, of which a part of *Muderongia* Superzone ranging in age from Valanginian to Early Albian, is most correlatable. Occurrence of *Dingodinium cerviculum, Kaiwaradinium scrutillinum, Muderongia australis, Circulodinium* spp. and *Herendeenia postprojecta*

prefer comparison with *Muderongia testudinaria* interval and *Muderongia australis* Oppel zones ranging in age from Middle Hauterivian to Barremian.

A comparison with microplankton assemblage recorded from Barremian stratotype and paratype sections in south eastern France (Srivastava, 1984) containing 96 taxa reveals the presence of only seventeen common species, viz., *Canninginopsis colliveri, Cassiculosphaeridia reticulata, Coronifera oceanica*, Cribroperidinium edwardsii, Dingodinium cerviculum, Exochosphaeridium phragmites*, Gardodinium trabeculosum*, Hystrichodinium pulchrum, Kiokansium (Bacchidinium) polypes, Muderongia crucis**, M. mcwhaei, Nummus similis, Oligosphaeridium complex, Phoberocysta neocomica, Prolixosphaeridium parvispinum*, Pyxidiella (Batiacasphaera) scrobiculata** and *Tanyosphaeridium variecalamus*. The taxa marked with an asterisk have their earliest global occurrence in Hauterivian whereas M. crucis(**) is restricted within Hauterivian - Barremian.

The presence of *Odontochitina operculata* in the present assemblage is most significant. It has wide geographical distribution, both in northern and southern hemispheres, ranging in age from Barremian to Maastrichtian. Davey (1979, 1982) established *Odontochitina operculata* Zone based on data from northwest Europe correlating with boreal ammonite zones. He used the earliest and latest occurrence datums of several species to mark the Hauterivian - Barremian time span. Earliest occurrence of some common taxa, viz., *Discorsia nanna, Gardodinium trabeculosum, Coronifera oceanica, Odontochitina operculata, Pseudoceratium (Aptea) anaphrissum, Palaeoperidinium cretaceum* and the latest occurrence of *Muderongia simplex* and *Pseudoceratium (Aptea) anaphrissum* evidently suggest Hauterivian - Barremian age. The biostratigraphic analysis of this bore-hole sequence is in progress and will be published elsewhere.

SYSTEMATIC PALYNOLOGY

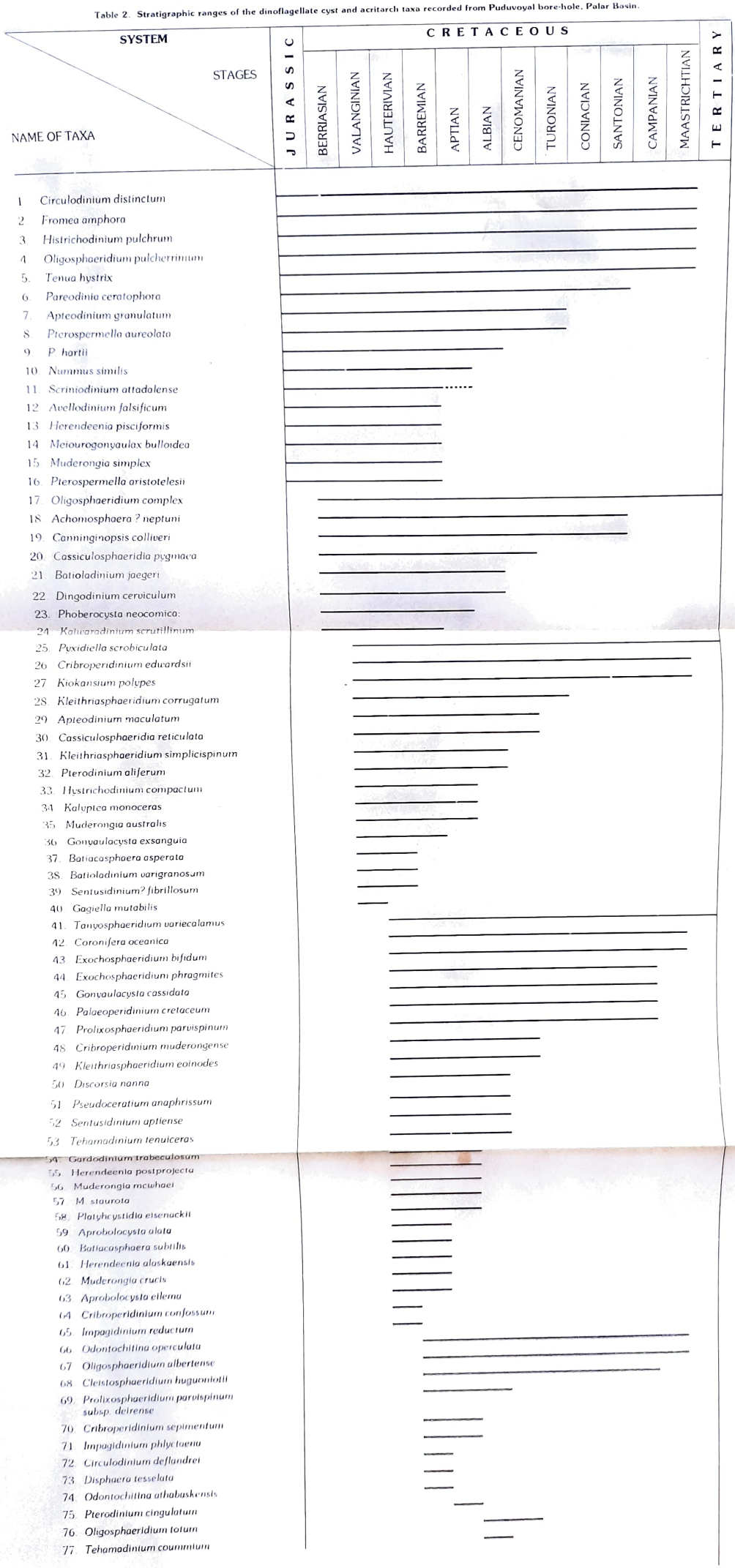
The present systematic account of dinoflagellate cysts and acritarchs includes revision of all earlier reported taxa from the same bore-hole of Palar Basin (Khowaja-Ateequzzaman *et al.* 1988 and Garg *et al.* 1988). The dimensions mentioned are related to studied specimens of the taxa reported herein. To avoid repetition, the descriptions of previously known taxa are avoided, instead care has been taken to project significant morphologic features through good quality illustrations using Nomarski Differential Interference Contrast photomicrographic system. The new and unassignable taxa to specific level are fully described.

Check list of dinoflagellate cyst and acritarch taxa

DINOFLAGELLATE CYSTS

Achomosphaera ?neptuni (Eisenack) Davey & Williams 1966
Achomosphaera sp. A
Achomosphaera sp. B
Aprobolocysta alata Backhouse 1987
A. eilema Duxbury 1977
Apteodinium granulatum Eisenack 1958 emend. Lucas-Clark 1987
A. maculatum Eisenack & Cookson 1960
Apteodinium sp. A
Archeotectatum reticulatum sp. nov.
Avellodinium falsificum Duxbury 1977
Batiacasphaera asperata Backhouse 1987
B. subtilis Stover & Helby 1987
Batioladinium jaegeri (Alberti) Brideaux 1975
B. varigranosum (Duxbury) Davey 1982
Canningia sp. A
Canninginopsis colliveri (Cookson & Eisenack) Backhouse 1988
Cassiculosphaeridia pygmaea Stevens 1987
C. reticulata Davey 1969
Circulodinium deflandrei Alberti 1961
C. distinctum (Deflandre & Cookson) Jansonius 1986
Cleistosphaeridium huguoniotii (Valensi) Davey 1969
Cleistosphaeridium sp. A
Coronifera oceanica Cookson & Eisenack 1958 emend. May 1980
Cribroperidinium confossum (Duxbury) Helenes 1984
C. edwardsii (Cookson & Eisenack) Davey 1969
C. muderongense (Cookson & Eisenack) Davey 1969
C. sepimentum Neale & Sarjeant 1962
Cribroperidinium sp. A
Dingodinium cerviculum Cookson & Eisenack 1958 emend. Khowaja-Ateequzzaman *et al.* 1990
Discorsia nanna (Davey) Duxbury 1977 emend. Khowaja-Ateequzzaman *et al.* 1985
Disphaera tesselata Srivastava 1984
Exochosphaeridium bifidum (Clarke & Verdier) Clarke *et al.* 1968
E. phragmites Davey *et al.* 1966
Gagiella mutabilis Backhouse 1988
Gagiella sp. A
Gardodinium trabeculosum (Gocht) Alberti 1961
Gonyaulacysta cassidata (Eisenack & Cookson) Sarjeant 1966
G. exsanguia Duxbury, 1977 emend. Harding 1990
Herendeenia alaskaensis (Stover & Evitt) Stover & Helby 1987
H. pisciformis (Cookson & Eisenack) Wiggins 1969
H. postprojecta Stover & Helby 1987
Hystrichodinium compactum Alberti 1961

Table 2. Stratigraphic ranges of the dinoflagellate cyst and acritarch taxa recorded from Puduvoyal bore-hole, Palar Basin.



H. pulchrum Deflandre 1935
Impagidinium phlyctaena Stover & Helby 1987
I. reductum Stover & Helby 1987
Kaiwaradinium scrutillinum Backhouse 1987
Kalyptea monoceras Cookson & Eisenack 1960
Kalyptea sp. A
Kiokansium polypes (Cookson & Eisenack) Below 1982
Kiokansium sp. A
Kleithriasphaeridium corrugatum Davey 1974
K. eoinodes (Eisenack) Davey 1974 emend. Sarjeant 1985
K. simplicispinum (Davey & Williams) Davey 1974
Leptodinium sp. A
Meiourogonyaulax bulloidea (Cookson & Eisenack) Sarjeant 1969
Muderongia australis Helby 1987
M. crucis Neale & Sarjeant 1962
M. mcwhaei Cookson & Eisenack 1958
M. simplex Alberti 1961
M. staurota Sarjeant 1966
Muderongia sp. A
Odontochitina athabaskensis Pocock 1962
O. operculata (O. Wetzel) Deflandre & Cookson 1955
Odontochitina sp. A
Odontochitina sp. B
Oligosphaeridium albertense (Pocock) Davey & Williams 1969
O. complex (White) Davey & Williams 1969
O. pulcherrimum (Deflandre & Cookson) Davey & Williams 1966
O. totum Brideaux 1971
Oligosphaeridium sp. A
Oligosphaeridium sp. B
Palaeoperidinium cretaceum Pocock 1962 emend. Davey 1970
Pareodinia ceratophora Deflandre 1947 emend. Gocht 1970
Phoberocysta neocomica (Gocht) Millioud 1969 emend. Helby 1987
Prolixosphaeridium parvispinum (Deflandre) Davey *et al.* 1969
P. parvispinum subsp. deirense (Davey *et al.*) Below 1982
Pseudoceratium anaphrissum (Sarjeant) Bint 1986 emend. Harding 1990
Pterodinium aliferum Eisenack 1958 emend. Sarjeant 1985
P. cingulatum (O. Wetzel) Below 1981
P. tuberculatum sp. nov.
Pyxidiella scrobiculata (Deflandre & Cookson) Cookson & Eisenack 1958
Scriniodinium attadelense (Cookson & Eisenack) Eiseack 1967
Sentusidinium aptiense (Burger) Burger 1980
S?. fibrillosum Backhouse 1988
Tanyosphaeridium variecalamus Davey & Williams 1966
Tehamadinium coummium (Below) Jan du Chêne *et al.* in Jan du Chêne *et al.* 1986 emend. Jan du Chêne *et al.* 1986
T. tenuiceras (Eisenack) Jan du Chêne *et al. in* Jan du Chêne *et al.* 1986
Tehamadinium sp. A
Tenua hystrix Eisenack 1958
Valensiella sp. A

ACRITARCHS
Fromea amphora Cookson & Eisenack 1958
Nummus similis (Cookson & Eisenack) Burger 1980
Platycystidia eisenackii (Mehrotra & Sarjeant) Backhouse 1988
Pterospermella aristotelesii (Ioannides *et al.*) Srivastava 1984
P. aureolata (Cookson & Eisenack) Eisenack 1972
P. hartii (Sarjeant) Eisenack *et al.* 1973

DESCRIPTION

Genus- *Achomosphaera* Evitt 1963

Achomosphaera ?neptuni (Eisenack) Davey & Williams 1966
Pl. 4, fig. 10; Pl. 6, fig. 11; Pl. 11, figs 13, 15

Dimensions
Size of cyst (excluding processes) — 68 - 84 X 50 - 70 μm
Length of processes — 18 - 30 μm

Geologic and geographic distribution–Berriasian-Valanginian, offshore SE Canada (Bujak & Williams, 1978), offshore Spain (Masure, 1988); Berriasian - Barremian, England (Duxbury, 1977); Valanginian - Hauterivian, Denmark (Davey, 1982); Hauterivian, Switzerland (Millioud, 1967), East Greenland (Piasecki, 1979); Hauterivian-Barremian, India (Garg *et al.*, 1988); Neocomian, Germany (Gocht, 1959) Late Neocomian, Australia (Moran, 1979); Barremian, England (Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981); Barremian - Aptian, Canada (Brideaux, 1977), N. Germany (Below, 1982d); Aptian, Germany (Eisenack, 1958), offshore northern Bay of Biscay (Davey, 1979b), offshore SW Africa (Below, 1984); Early Santonian, NW Germany (Yun, 1981), England (Lister & Batten, 1988).

Achomosphaera sp. A
Pl. 10, figs 7, 8; Pl. 11, figs 1, 4; Pl. 12, fig. 12

Description

Shape–Cyst subspherical.

Wall relationship–Periphragm and endophragm appressed between processes.

Wall features–Parasutural features faintly developed, surface finely granular bearing isolated processes, process tips trifurcate or bifurcate.

Paratabularion–Indicated by archaeopyle alone.

Archaeopyle–Precingular, Type P (3" only), operculum free.

Dimensions
Size of cyst (excluding processes) — 55 - 65 X 50 - 60 μm
Length of processes — 10 - 20 μm

Achomosphaera sp. B
Pl. 11, fig. 3

Description

Shape–Cyst subspherical.

Wall relationship–Periphragm and endophragm appressed between processes.

Wall features–Endophragm with sparsely placed coarse grana, periphragm smooth.

Paratabulation–Not discernible.

Archaeopyle–Precingular, type uncertain.

Dimensions
Size of cyst (excluding processes) — 45 - 55 X 45 - 52 μm
Length of processes — 8 - 15 μm

Genus- *Aprobolocysta* Duxbury 1977 emend. Duxbury 1980 emend. Mehrotra & Sarjeant 1986 emend. Pourtoy 1988

Aprobolocysta alata Backhouse 1987
Pl. 10, figs 6, 9

Dimensions
Size of endocyst — 70 - 80 X 52 - 60 μm
Height of periphragmal folds — upto 15 μm

Geologic and geographic distribution–Middle Hauterivian-Early Barremian, Australia (Backhouse, 1987, 1988).

Aprobolocysta eilema Duxbury 1977
Pl. 7, figs 11,12

Dimensions
Size of endocyst — 65 - 70 X 38 - 45 μm
Height of periphragmal folds — upto 20 μm

Geologic and geographic distribution–Middle Hauterivian-Barremian, Australia (Stover & Helby, 1987a, 1987b); Late Hauterivian, England (Duxbury, 1977).

Genus- *Apteodinium* Eisenack 1958 emend. Sarjeant 1985 emend. Lucas-Clark 1987

Apteodinium granulatum Eisenack 1958 emend. Lucas-Clark 1987
Pl. 4, fig. 6

Dimensions
Size of cyst — 60 - 68 X 52 - 60 μm
Length of apical protrusion — 3 - 5 μm

Geologic and geographic distribution–Late Jurassic, USSR (Vozzhennikova, 1967); Kimmeridgian, France (Riley & Sarjeant, 1977); Berriasian - Late Albian, Australia (Helby *et al.*, 1987); Late Valanginian - Hauterivian, Germany (Eisenack, 1958); Hauterivian, Poland (Alberti, 1961), Switzerland (Millioud, 1967); Hauterivian - Barremian, India (Garg *et al.*, 1988); Early Hauterivian, Germany (Alberti, 1961); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Barremian, England (Davey, 1974); Barremian - Aptian, Rumania (Baltes, 1969); Late Barremian, Germany (Alberti, 1961); Neocomian - Albian, offshore SE South Atlantic (Hedlund & Beju, 1977); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, England (Lister & Batten, 1988), Germany (Sarjeant, 1985), SW Morocco (Below, 1981); Early Aptian, offshore NW Australia (Wiseman & Williams, 1974),

Plate 1

(All photomicrographs in differential interference contrast x 500)

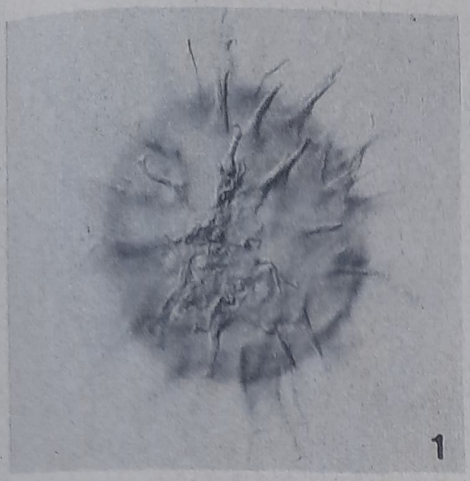
1- 3. *Exoehosphaeridium phragmites* Davey *et al* 1966; same specimen in three different foci, ventral high, ventral low and dorsal low respectively; slide no. BSIP 10806, coordinates: 11.1 x 155.0.

4, 6. *Kleithriasphaeridium simplicispinum* (Davey & Williams) Davey 1974; same specimen in two different foci; slide no. BSIP 10810, coordinates: 6.1 x 150.7.

5, 8, 11. *Kleithriasphaeridium corrugatum* Davey 1974; same specimen in three different foci; slide no. BSIP 10796, coordinates: 14.5 x 152.9.

7, 9. *Herendeenia postprojecta* Stover & Helby 1987; same specimen in two different foci, 7- ventral, 9- dorsal; slide no. BSIP 10777, coordinates: 2.1 x 150.0.

10, 12. *Kaiwaradinium scrutillinum* Backhouse 1987; same specimen in two different foci, 10- ventral high, 12- ventral low; slide no. BSIP 10808, coordinates: 13.5 x 147.8.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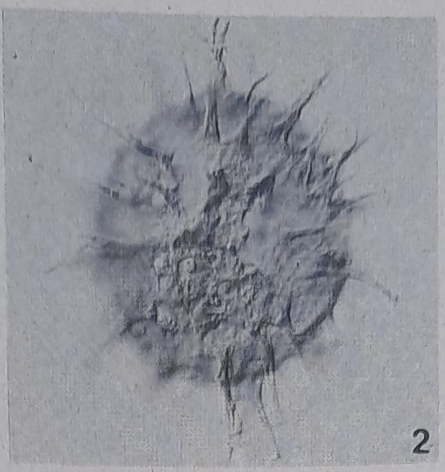
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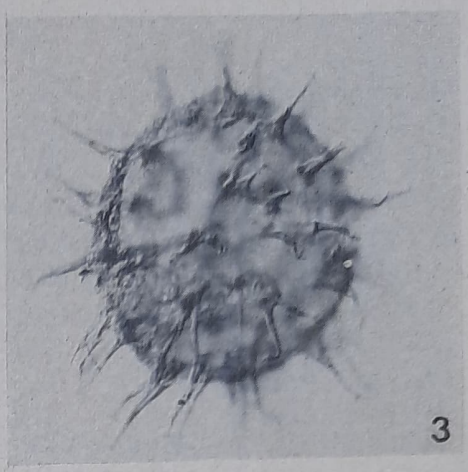
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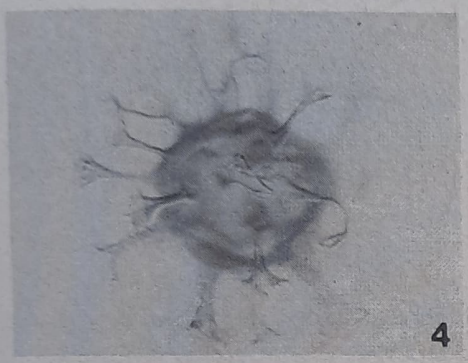
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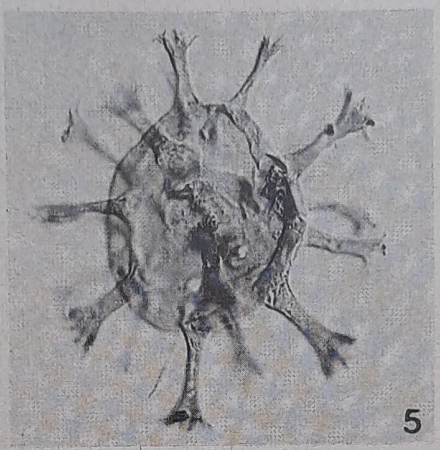
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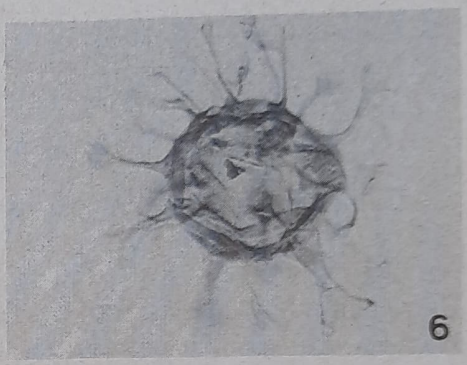
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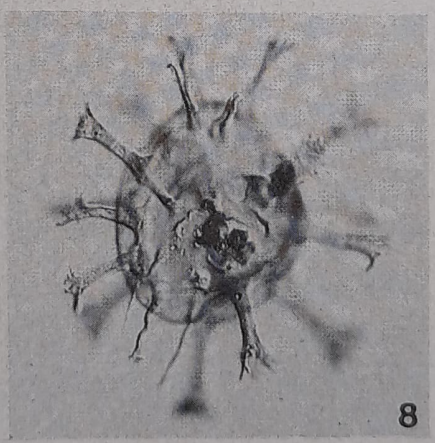
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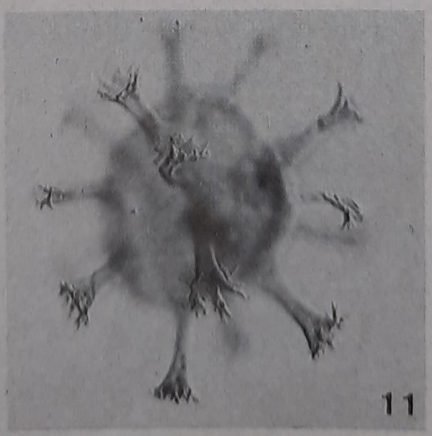
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Plate 1

Mecklenburg (Alberti, 1961); Aptian - Albian, N. Atlantic (Habib, 1972), Germany (Davey, 1982b); Albian, France (Foucher & Taugourdeau, 1975), offshore SE Canada (Beju & Williams, 1978), SE Oklahoma, USA (Hedlund & Norris, 1986); Albian - Cenomanian, England (Davey, 1969), offshore NE Bahamas (Habib, 1970); Late Albian - Cenomanian, France and Switzerland (Davey & Verdier, 1973); Cenomanian, France (Davey, 1969); Turonian, SW Africa (Davey, 1978).

Apteodinium maculatum Eisenack & Cookson 1960
Pl. 12, fig. 7

Dimensions	
Size of cyst	— 65 - 70 X 60 - 65 μm
Length of apical protrusion	— 3 - 5 μm

Geologic and geographic distribution–Valanginian - Hauterivian, Australia (Bujak, 1982); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987b); Middle Hauterivian - Aptian, Australia (Backhouse, 1987, 1988); Barremian - Aptian, England (Lister & Batten, 1988); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, Germany (Below, 1981a, 1982d); Aptian - Albian (Eisenack & Cookson, 1960), offshore northern Bay of Biscay (Davey, 1979b); Aptian - Cenomanian, offshore SW Africa (Below, 1984); Albian - Cenomanian, Australia (Norvick, 1976).

Apteodinium sp. A
Pl. 5, fig. 17

Description

Shape–Subspherical with an apical protuberance.
Wall relationship–Autophragm only.
Wall features–No parasutural features. Surface smooth.
Paratabulation–Indicated by archaeopyle alone.
Archaeopyle–Precingular, operculum free.

Dimensions	
Size of cyst	— 55 - 60 X 50 - 55 μm

Genus- *Archeotectatum* Habib 1972

Archeotectatum reticulatum sp. nov.
Pl. 4, fig. 5; Pl. 6, fig. 8

Holotype–Pl. 4, fig. 5; slide no. BSIP 10149.
Stratum & type locality–441.2-444.2 m, bgl., (Conventional core), Puduvoyal bore-hole, Palar Basin, Tamil Nadu, southern India.
Diagnosis–Cyst proximate, subspherical to rhomboidal with a short apical protuberance and a rounded antapex; no parasutural features; autophragm thick, spongy, reticulate; archaeopyle precingular, type P (3" only), operculum free.

Description

Shape–Cyst subspherical to rhomboidal, epicyst slightly elongate and tapering towards apex with a short apical protuberance, antapex rounded.
Wall relationship–Autophragm only.
Wall features–Autophragm thick and spongy with reticulation all over the cyst surface.
Paratabulation–Indicated by archaeopyle alone, rarely with a week paracingulum.
Archaeopyle–Precingular, type P (3" only), broad, operculum free.

Dimensions	Holotype	Range
Size of cyst	— 66 X 60 μm	60-75 X 55-65 μm

Comparison–*Archeotectatum reticulatum* sp. nov. differs from the monotypic species of the genus *A. sarjeantii* Habib 1972, in having reticulate autophragm.

Plate 2 →

(All photomicrographs in differential interference contrast x 500)

1-2. *Carpodinium granulatum* Cookson & Eisenack 1962 emend. Leffingwell & Morgan 1977; same specimen in two different foci, dorsal high and dorsal low respectively; slide no. BSIP 10778, coordinates: 15.8 x 145.3.

3-4. *Herendeenia pisciformis* (Cookson & Eisenack) Wiggins 1969; same specimen in two different foci, dorsal low and dorsal high respectively; slide no. BSIP 10779, coordinates: 6.5 x 146.0.

5, 7. *Avellodinium falsificum* Duxbury 1977; same specimen in two different foci; slide no. BSIP 10765, coordinates: 6.1 x 150.2.

6, 9. *Exochosphaeridium bifidum* (Clarke & Verdier) Clarke *et al.* 1968; same specimen in two different foci; slide no. BSIP 10806, coordinates: 3.5 x 168.0.

8, 10. *Oligosphaeidium totum* Brideaux 1971; same specimen in two different foci; slide no. 10807, coordinates: 9.0 x 153.2.

11, 13. *Oligosphaeridium complex* (White) Davey & Williams 1969; same specimen in two different foci; slide no. 10806, coordinates: 13.5 x 140.0.

12. *Gen et* sp. indet. A ; slide no. BSIP 10787, coordinates: 13.2 x 146.0.


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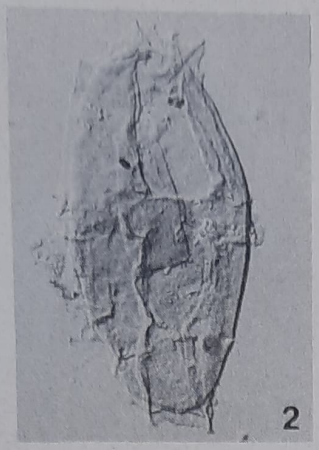
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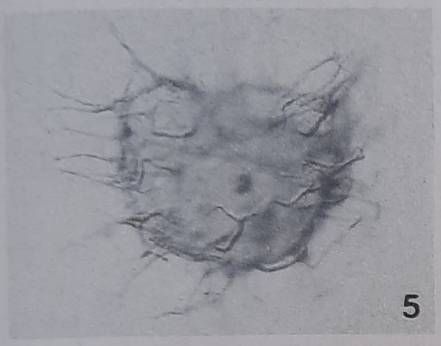
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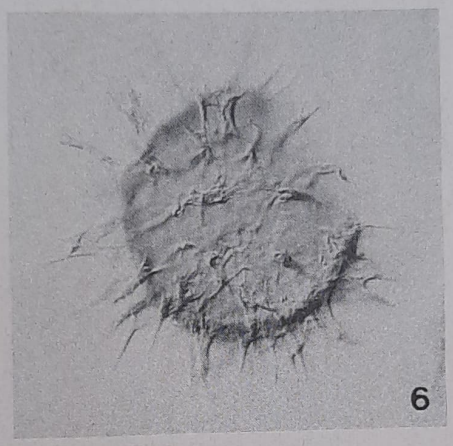
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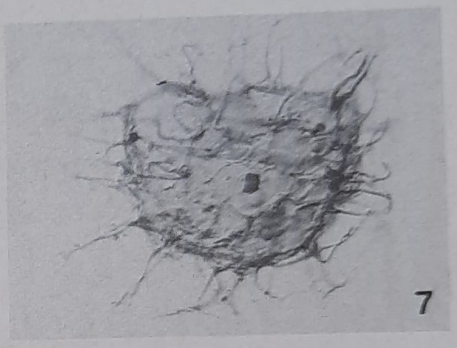
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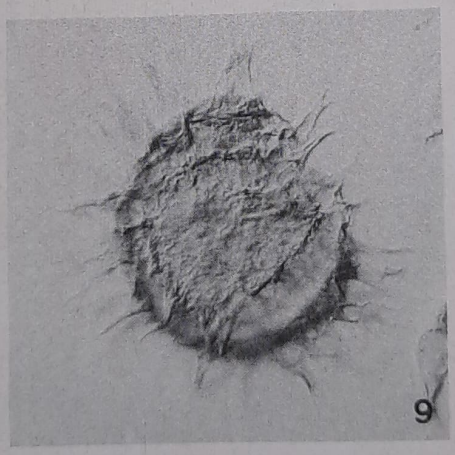
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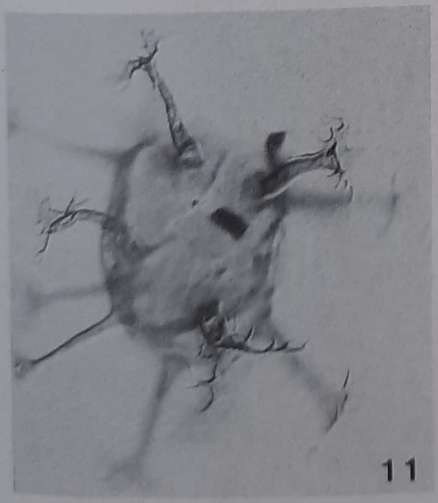
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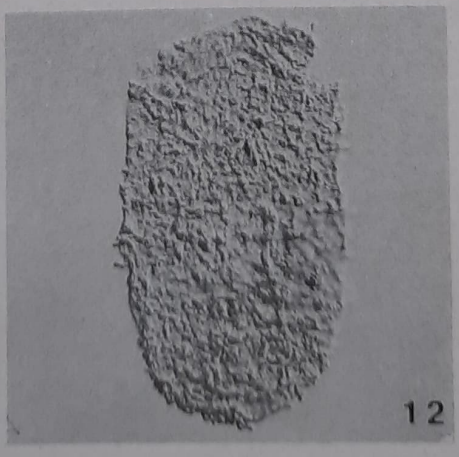
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Plate 2

Genus- *Avellodinium* Duxbury 1977 emend. Backhouse 1988

Avellodinium falsificum Duxbury 1977
Pl. 2, figs 5, 7; Pl. 5, fig. 12

Dimensions
Size of cyst (excluding processes) — 60 - 70 X 55 - 60 μm
Length of processes — 20 - 30 μm

Geologic and geographic distribution–Late Portlandian - Hauterivian, Denmark (Davey, 1982); Berriasian - Barremian, England (Duxbury, 1977); Valanginian - Late Barremian, England (Williams & Bujak, 1985); Barremian, England (Duxbury, 1980).

Genus- *Batiacasphaera* Drugg 1970

Batiacasphaera asperata Backhouse 1987
Pl. 6, fig. 1

Dimensions
Size of cyst — 65 - 70 X 60 - 65 μm

Geologic and geographic distribution–Valanginian - Early Hauterivian, Australia (Backhouse, 1987, 1988).

Batiacasphaera subtilis Stover & Helby 1987
Pl. 11, fig. 2

Dimensions
Size of cyst — 60 - 70 X 60 - 65 μm

Geologic and geographic distribution–Middle Hauterivian - Barremian, Aus tralia (Stover & Helby, 1987).

Genus - *Batioladinium* Brideaux 1975 emend. Pourtoy 1988

Batioladinium jaegeri (Alberti) Brideaux 1975
Pl. 7, fig. 15

Dimensions
Size of cyst — 160 - 180 X 25 - 35 μm
Length of apical horn — 95 - 105 μm
Length of antapical horns — 15 - 20 μm

Geologic and geographic distribution–Late Berriasian - Hauterivian, offshore SE Canada (Bujak & Williams, 1978); Hauterivian, E. Greenland (Piasecki, 1979); Hauterivian - Barremian, Libya (Thusu *et al.*, 1988); Barremian, England (Duxbury, 1980), France (Reneville & Raynaud, 1981; Srivastava, 1984); Barremian - Aptian, Australia (Backhouse, 1987, 1988); Late Barremian, Germany (Alberti, 1961); Late Barremian - Aptian, England (Lister & Batten, 1988), N. Germany (Below, 1982d); Late Neocomian - Aptian, Australia (Morgan, 1979); Aptian - Early Albian, England (Duxbury, 1983); Albian, France (Foucher, 1981).

Batioladinium varigranosum (Duxbury) Davey 1982
Pl. 11, fig. 11

Dimensions
Size of cyst — 75 - 90 X 30 - 45 μm
Length of antapical horns — 3 - 5 μm

Geologic and geographic distribution–Early Valanginian, offshore Spain (Masure, 1988); Valanginian - Hauterivian, England (Duxbury, 1977; Davey, 1982a).

Genus- *Canningia* Cookson & Eisenack 1960 emend. Dörhöffer & Davies 1980 emend. Below 1981 emend. Helby 1987

Canningia sp. A
Pl. 5, fig. 6

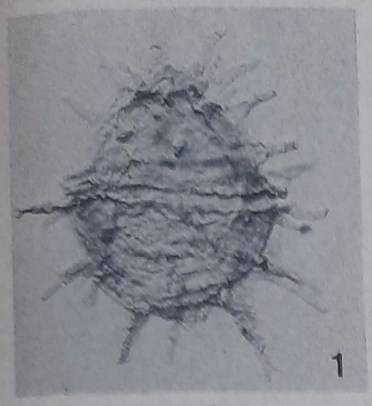
Description

Shape–Cyst lenticular with two unequal antapical lobes.
Wall relationship–Autophragm only.
Wall features–No parasutural features, surface smooth.

Plate 3

(All photomicrographs in differential interference contrast x 500)

1. *Hystrichodinium compactum* Alberti 1961; slide no. BSIP 10788, coordinates: 12.6 x 154.8.
2-3. *Gagiella mutabilis* Backhouse 1988; same specimen in two different foci dorsal and ventral respectively; slide no. 10803, coordinates: 15.5 x 157.9.
4. *Muderongia* sp. A; slide no. BSIP 10788, coordinates: 12.6 x 154.8.
5, 7, 8, 10. *Circulodinium distinctum* (Deflandre & Cookson) Jansonius 1986; same specimen in four different foci, 5- dorsal low, 7- ventral low, 8- dorsal high, 10- ventral high; slide no. BSIP 10788, coordinates: 21.1 x 159.0.
6, 9. *Prolixosphaeridium parvispinum* subsp. *deirense* (Davey *et al.*) Below 1982; same specimen in two different foci; slide no. BSIP 10796, coordinates: 16.5 x 135.0.
11, 14. *Pseudoceratium anaphrissum* (Sarjeant) Bint 1986; same specimen in two different foci, 11. dorsal, 14. ventral; slide no. BSIP 10806, coordinates: 18.2 x 150.2.
12-13. *Gagiella mutabilis* Backhouse 1988; same specimen in two different foci, dorsal and ventral respectively; slide no. BSIP 10785, coordinates: 7.3 x 148.3.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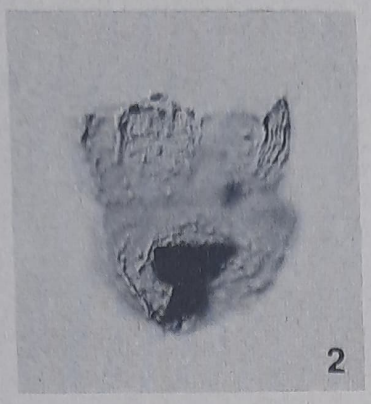
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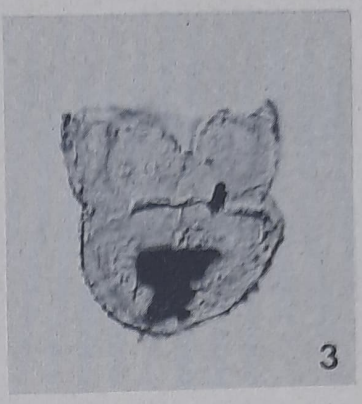
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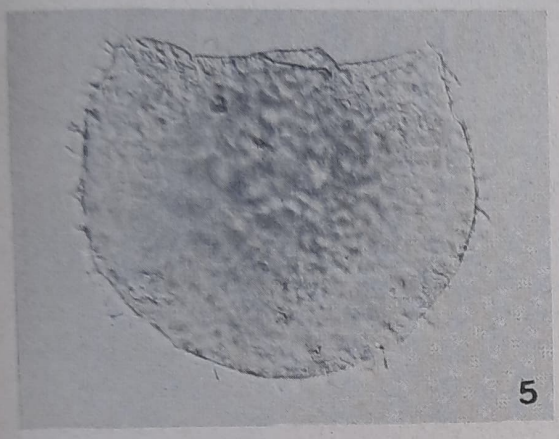
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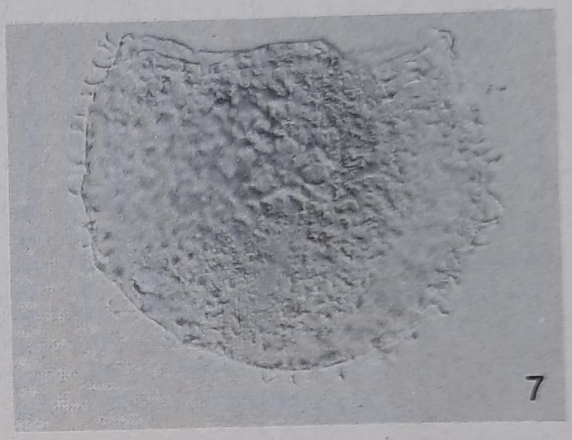
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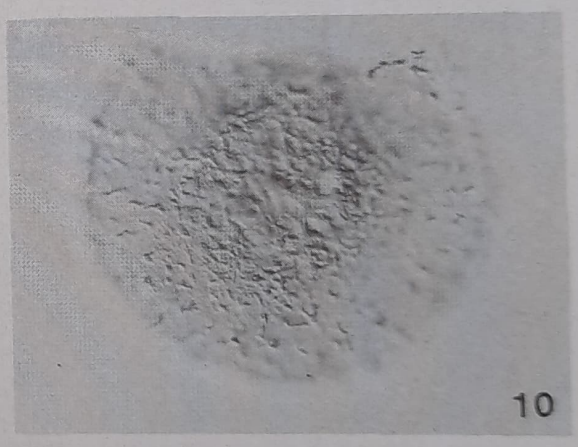
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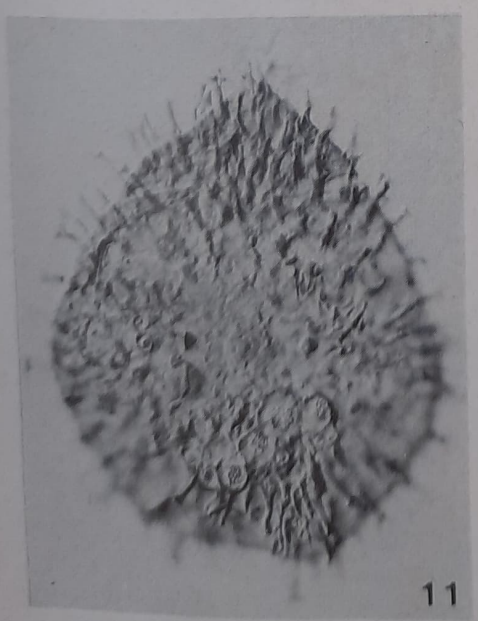
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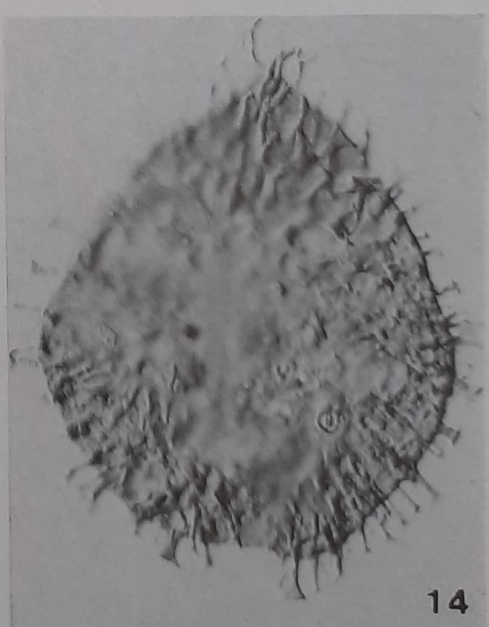
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Plate 3

Paratabulation–Indicated by archaeopyle alone.
Archaeopyle–Apical, type tA, operculum free.

Dimensions
Size of cyst — 60 - 65 X 50 - 55 μm

Genus- *Canninginopsis* Cookson & Eisenack 1962

Canninginopsis colliveri (Cookson & Eisenack) Backhouse 1988
Pl. 4, fig. 13

Dimensions
Size of cyst — 90 - 100 X 85 - 95 μm

Geologic and geographic distribution–Berriasian - Turonian, offshore SE Canada (Bujak & Williams, 1978); Hauterivian, SW Morocco (Below, 1981); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Middle Hauterivian - Cenomanian, Australia (Helby *et al.*, 1987); Barremian, France (Srivastava, 1984); Barremian - Aptian, Australia (Backhouse, 1988); Barremian - Albian, Rumania (Baltes, 1969); Aptian, Australia (Cookson & Eisenack, 1960a; Eisenack & Cookson, 1960; Kemp, 1976; Backhouse, 1987), France (Davey & Verdier, 1974), offshore NW Australia (Wiseman & Williams, 1974), offshore SW Africa (Davey, 1978), offshore northern Bay of Biscay (Davey, 1979b); Albian, France (Davey & Verdier, 1971), Canada (Singh, 1971), SE Oklahoma, USA (Hedlund & Norris, 1986); Early Cretaceous, Canada (Singh, 1964); Late Albian - Cenomanian, France (Davey & Verdier, 1973), Libya (Uwins & Batten, 1988); Cenomanian - Santonian, France (Clarke & Verdier, 1967; Azema *et al.*, 1981); Turonian, France (Robaszynski *et al.*, 1988).

Genus- *Cassiculosphaeridia* Davey 1969

Cassiculosphaeridia pygmaea Stevens 1987
Pl. 12, figs 2, 4

Dimensions
Size of cyst — 55 - 60 X 50 - 55 μm

Geologic and geographic distribution–Berriasian - Cenomanian, Australia (Stevens, 1987); Hauterivian - Early Aptian, Australia (Backhouse, 1988).

Cassiculosphaeridia reticulata Davey 1969
Pl. 5, fig. 14

Dimensions
Size of cyst — 50 - 55 X 55 - 60 μm

Geologic and geographic distribution–Valanginian - Hauterivian, Denmark (Davey, 1982a), Australia (Backhouse, 1988); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Late Neocomian - Aptian, Australia (Morgan, 1979); Barremian, France (Reneville & Raynaud, 1981; Srivastava, 1984); Aptian, offshore SW Africa (Below, 1984); Cenomanian, England (Davey, 1969).

Genus- *Circulodinium* Alberti 1961

Circulodinium deflandrei Alberti 1961
Pl. 9, fig. 14

Dimensions
Size of cyst — 75 - 85 X 65 - 75 μm

Geologic and geographic distribution–Late Barremian, NW Germany (Alberti, 1961).

→

Plate 4

(All photomicrographs in differential interference contrast x 500)

1. *Meiourogonyaulax bulloidea* (Cookson & Eisenack) Sarjeant 1969, slide no. BSIP 10804, coordinates: 3.0 x 164.0.
2. *Gardodinium trabeculosum* (Gocht) Alberti 1961; slide no. BSIP 10792, coordinates: 14.4 x 148.8 (apical horn is broken).
3. *Tanyosphaeridium variecalamus* Davey & Williams 1966; slide no. BSIP 10765, coordinates: 18.3 x 141.6.
4. *Fromea amphora* Cookson & Eisenack 1958; slide no. BSIP 10799, coordinates: 10.1 x 160.1.
5. *Archeotectatum reticulatum* sp. nov. (holotype); slide no. BSIP 10149, coordinates: 18.3 x 135.0.
6. *Apteodinium granulatum* Eisenack 1958 emend. Lucas-Clark, 1987; slide no. BSIP 10770, coordinates: 8.6 x 137.2.
7. 11. *Cribroperidinium edwardsii* (Cookson & Eisenack) Davey 1969; 7- in dorsal view; slide no. BSIP 10800, coordinates: 12.2 x 150.6; 11- in lateral view; slide no. BSIP 10800, coordinates: 8.8 x 135.5.
8. *Platycystidia eisenackii* (Mehrotra & Sarjeant) Backhouse 1988; slide no. BSIP 10810, coordinates: 2.9 x 149.7.
9. *Muderongia australis* Helby 1987, slide no. BSIP 10799, coordinates: 16.5 x 167.7.
10. *Achomosphaera ? neptuni* (Eisenack) Davey & Williams 1966; slide no. BSIP 10766, coordinates: 6.4 x 160.3.
12. *Muderongia crucis* Neale & Sarjeant 1962; slide no. BSIP 10806, coordinates: 2.0 x 166.0.
13. *Canninginopsis colliveri* (Cookson & Eisenack) Backhouse 1988; slide no. BSIP 8549, coordinates: 11.5 x 128.2.

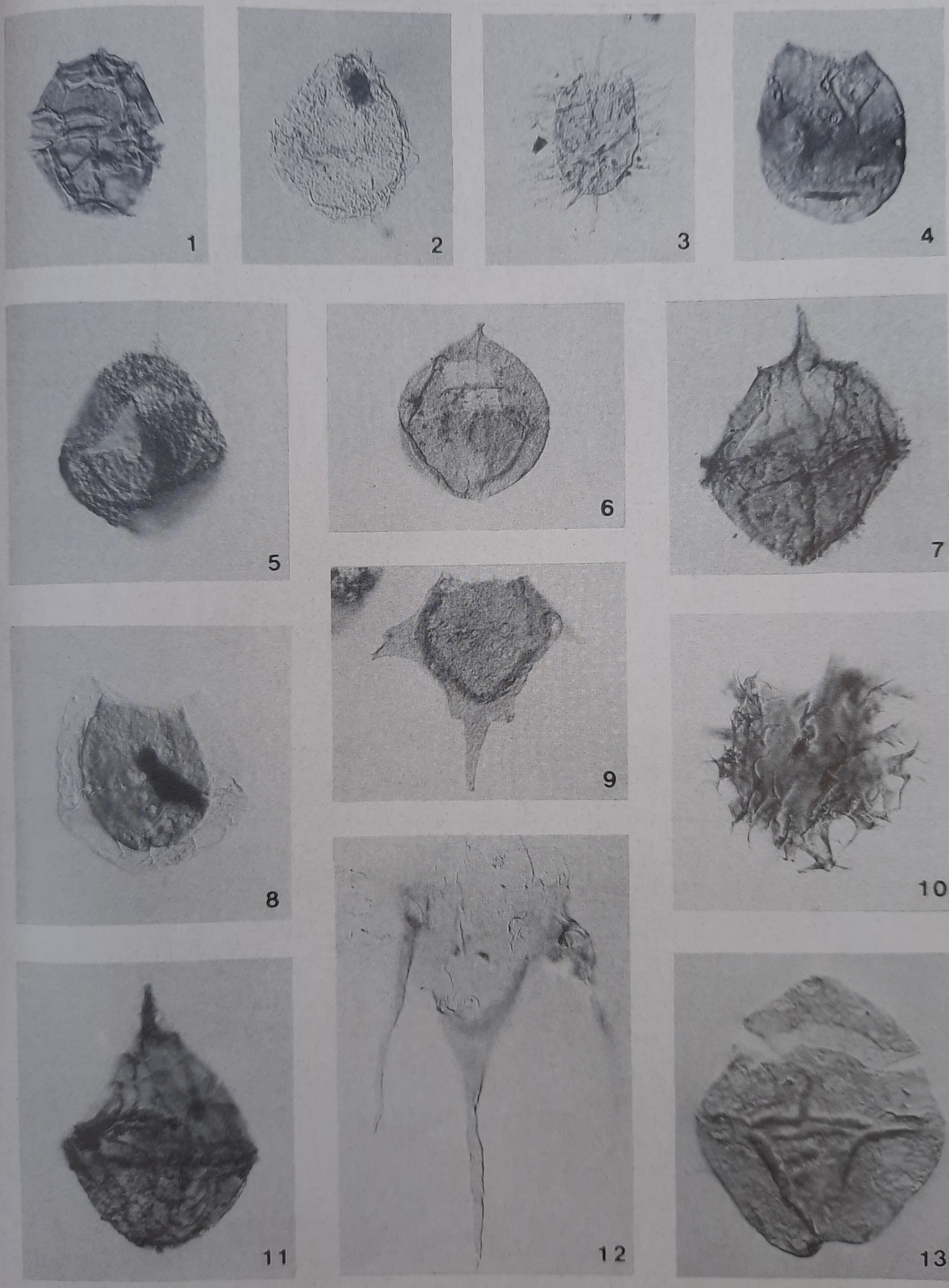

Plate 4

Circulodinium distinctum (Deflandre & Cookson) Jansonius 1986
Pl. 3, figs 5, 7, 8, 10; Pl. 8, fig. 10; Pl. 13, fig. 9

Dimensions
Size of cyst — 80 - 90 X 65 - 75 µm
Length of processes — 4 - 8 µm

Geologic and geographic distribution–Kimmeridgian, England (Ioannides *et al.*, 1976): Late Kimmeridgian - Barremian, Libya (Thusu *et al.*, 1988): Cretaceous, Canada (Manum & Cookson, 1964): Berriasian - Barremian, England (Duxbury, 1977): Berriasian - Maastrichtian, offshore SE Canada (Bujak & Williams, 1978); Valanginian - Hauterivian, Germany (Gocht, 1959); Valanginian - Cenomanian, Atlantic (Habib, 1972), offshore W. Africa (Williams, 1978): Hauterivian, E. Greenland (Piasecki, 1979), offshore Spain (Masure, 1988); Hauterivian - Barremian, India (Garg *et al.*, 1988); Hauterivian - Albian, Canada (Brideaux, 1977), SW Morocco (Below, 1981a); Barremian, England (Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981: Srivastava, 1984); Barremian - Albian, offshore NW Australia (Wiseman & Williams, 1974); Neocomian, Libya (Thusu & Van Der Eem, 1985); Neocomian - Aptian, USA (Hedlund & Beju, 1977); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, Australia (Cookson & Eisenack, 1960b), England (Lister & Batten, 1988), France and Switzerland (Millioud, 1969),Germany (Below, 1982d); Aptian - Early Albian, England (Duxbury, 1983); Aptian - Middle Albian, Canada (Brideaux & McIntyre, 1977); Aptian - Cenomanian, offshore SW Africa (Below, 1984); Albian, Rumania (Baltes, 1967), France (Davey & Verdier, 1971, 1974; Fouconnier, 1975; Foucher & Taugourdeau, 1975), Canada (Singh, 1971), India (Jain, 1977); Albian - Cenomanian, Australia (Cookson & Eisenack, 1962b), France (Davey & Verdier, 1973; Fouconnier, 1975); Albian - Cenomanian, Australia (Playford *et al.*, 1975), Libya (Uwins & Batten, 1988); Albian - Turonian, Madagascar (Herngreen *et al.*, 1982); Middle Cretaceous, Australia (Cookson & Eisenack, 1971); Cenomanian, Canada, England and France (Davey, 1969a), Australia (Norvick, 1976), offshore Angola Basin (Morgan, 1978); Cenomanian - Turonian, France (Robaszynski *et al.*, 1982), New Zealand (Mildenhall & Wilson, 1976); Cenomanian - Santonian, offshore Grand Banks (Williams & Brideaux, 1975); Cenomanian - Campanian, England (Clarke & Verdier, 1967); Senonian, Australia (Deflandre & Cookson, 1955), New Zealand (Wilson, 1976); Turonian, France (Foucher, 1982); Turonian - Santonian, Australia (Cookson & Eisenack, 1962b); Santonian, France (Azema *et al.*, 1981); Early Santonian, NW Germany (Yun, 1981); Santonian - Maastrichtian, Canada (McIntyre, 1974); Campanian, Canada (Harland, 1973); Campanian - Maastrichtian, Netherlands (Wilson, 1971); Maastrichtian, Canada (Felix & Burbridge, 1976).

Genus- *Cleistosphaeridium* Davey *et al.* 1966

Cleistosphaeridium huguoniotii (Valensi) Davey 1969
Pl. 9, fig. 13

Dimensions
Size of cyst — 50 - 55 X 45 - 50 µm

Geologic and geographic distribution–Barremian,

Plate 5

(All photomicrographs in differential interference contrast x 500)

1. *Coronifera oceanica* Cookson & Eisenack 1958 emend. May, 1980; slide no. BSIP 10798, coordinates: 10.5 x 163.0.
2. *Pareodinia ceratophora* Deflandre 1947 emend. Gocht, 1970; slide no. BSIP 10786, coorinates: 18.3 x 148.5.
3. Gen. *et* sp. indet. B; slide no. BSIP 10796, coordinates: 10.6 x 154.6.

4, 13. *Kiokansium polypes* (Cookson & Eisenack) Below 1982; 4- slide no. BSIP 8092, coordinates: 12.5 x 166.1; 13- slide no. BSIP 10765, coordinates: 4.6 x 151.1.

5. *Tanyosphaeriium variecalamus* Davey & Williams 1966; slide no. BSIP 8093, coordinates: 11.0 x 134.1
6. *Canningia* sp. A; slide no. BSIP 10802, coordinates: 20.6 x 147.4.
7. *Cribroperidinium confossum* (Duxbury) Helenes 1984; slide no. BSIP 10791, coordinates: 9.1 x 128.2.
8. *Dingodinium cerviculum* Cookson & Esenack 1958 emend. Khowaja-Ateequzzaman *et al.*, 1990; in dorsolateral view; slide no. BSIP 10150, coordinates: 16.9 x 131.8.
9. Gen. *et* sp. indet. C; slide no. BSIP 10793, coordinates: 18.3 x 165.9.
10. *Gagiella* sp. A; slide no. BSIP 10786, coordinates: 9.3 x 131.6.
11. Gen. *et* sp. indet. D; slide no. BSIP 10792, coordinates: 7.7 x 169.4.
12. *Avellodinium falsificum* Duxbury 1977; slide no. BSIP 10771, coordinates: 16.9 x 154.5.
14. *Cassiculosphaeridia reticulata* Davey 1969; slide no. BSIP 8092, coordinates: 11.7 x 153.3.
15. *Tehamadinium tenuiceras* (Eisenack) Jan du Chêne *et al.* in Jan du Chêne *et al.*, 1986; in dorsal view; slide no. BSIP 0777, coordinates: 17.5 x 136.2.
16. *Cleistosphaeridium* sp. A; slide no. BSIP 10796, coordinates: 5.6 x 152.0.
17. *Apteodinium* sp. A; slide no. BSIP 10801, coordinates: 17.2 x 158.2.

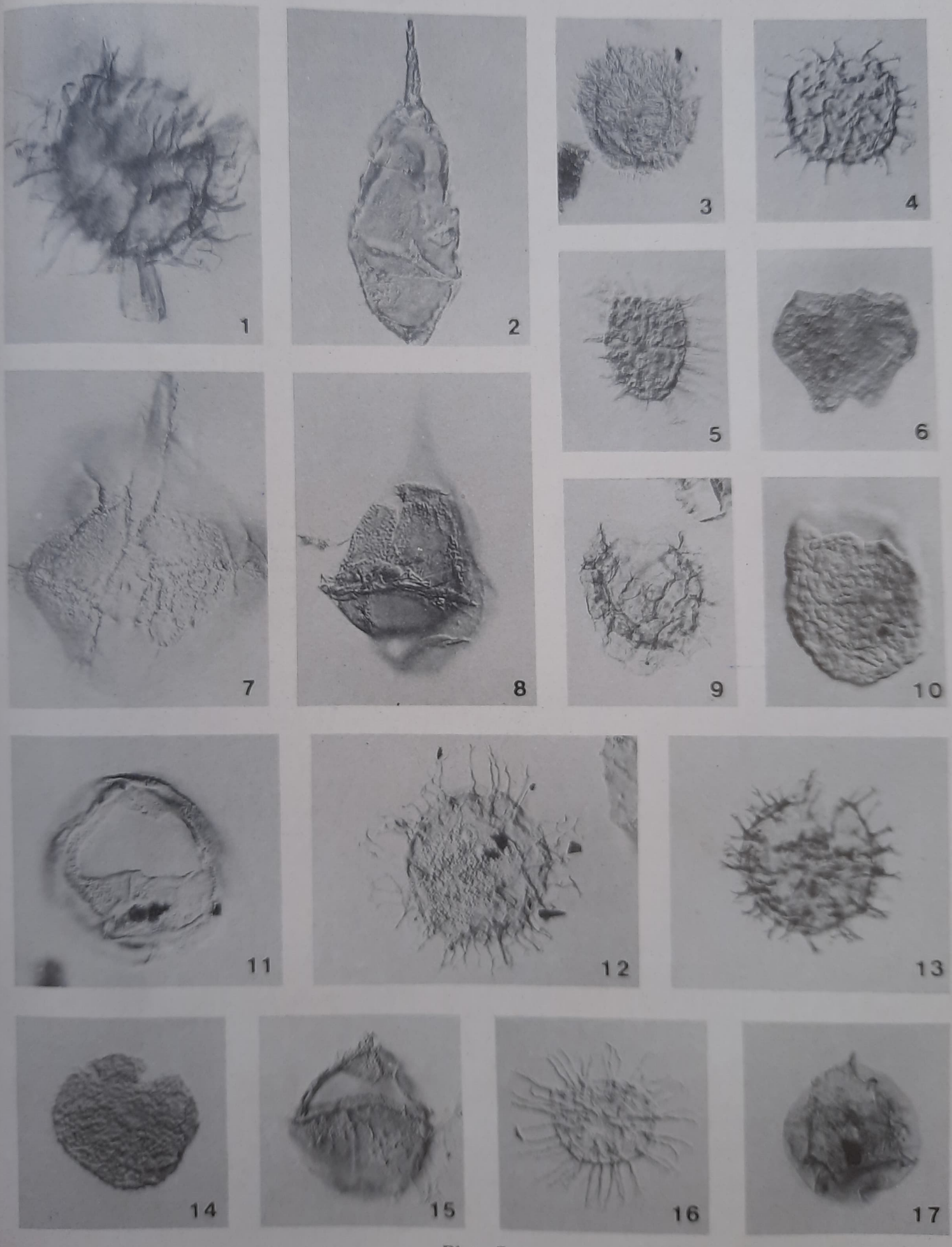

Plate 5

England (Davey, 1974); Aptian, England (Lister & Batten, 1988); Aptian - Early Albian, England (Duxbury, 1983); Albian - Cenomanian, France (Foucher & Taugourdeau, 1975); Cenomanian, France and USA (Davey, 1969a); Albian, France (Davey & Verdier, 1971); Albian - Cenomanian, England (Cookson & Hughes, 1964; Davey *et al.*, 1966; Clarke & Verdier, 1967; Davey, 1969a), Australia (Cookson & Eisenack, 1960b, 1969), Rumania (Baltes, 1963, 1966, 1967), France (Davey & Verdier, 1973; Foucher & Taugourdeau, 1975), Netherlands (Herngreen, 1978); Turonian, France (Foucher, 1974, 1976); Santonian - Early Campanian, Australia (Cookson & Eisenack, 1968).

Cleistosphaeridium sp. A
Pl. 5, fig. 16

Description

Shape–Cyst subspherical, skolochorate.

Wall relationship–Periphragm and endophragm appressed between processes or autophragm only.

Wall features–No parasutural features, surface smooth bearing more than 50 nontabular processes that are distally bifurcate, and primary furcation may be additionally bifurcate with closed ends.

Paratabulation–Indicated by archaeopyle alone.

Archaeopyle–Apical, operculum often free.

Dimensions	
Size of cyst (excluding processes)	— 35 - 40 X 35 - 40 μm
Length of processes	— 15 - 20 μm

Genus- *Coronifera* Cookson & Eisenack 1958 emend. Davey 1974 emend. May 1980 emend. Mao Shaozhi & Norris 1988

Coronifera oceanica Cookson & Eisenack 1958 emend. May 1980
Pl. 5, fig. 1; Pl. 9, fig. 7; Pl. 11, fig. 7

Dimensions	
Size of cyst	— 60 - 65 X 45 - 50 μm
Length of corona	— 18 - 24 μm
Breadth of corona	— 12 - 16 μm
Length of processes	— 18 - 20 μm

Geologic and geographic distribution–Cretaceous, Australia (Cookson & Eisenack, 1974); Middle Cretaceous, Australia (Cookson & Eisenack, 1968); Hauterivian - Barremian, England (Duxbury, 1977a), India (Garg *et al.*, 1988); Hauterivian - Aptian, France (Millioud, 1969); SW Morocco (Below, 1982a); Australia (Backhouse, 1987, 1988); Barremian, England (Davey, 1974), offshore NW Africa (Williams, 1978), England (Duxbury, 1980); France (Reneville & Raynaud, 1981; Srivastava, 1984); Barremian - Aptian N. Germany (Below, 1982d); Aptian - Cenomanian, SW Morocco (Below, 1982c); Aptian, England (Lister & Batten, 1988), France (Davey & Verdier, 1974), offshore W. Australia (Wiseman & Williams, 1974), offshore SW Africa (Davey, 1978); Aptian - Albian, offshore northern Bay of Biscay (Davey, 1979b), England (Duxbury, 1983); Aptian - Cenomanian, SW Morocco (Below, 1982c), offshore SW Africa (Below, 1984), Australia (Morgan, 1979); Albian, Australia (Cookson & Eisenack, 1958, 1969), England, (Davey, 1969a), France (Davey & Verdier, 1971), Madagascar (Herngreen *et al.*, 1982); Albian - Cenomanian, France (Foucher & Taugourdeau, 1975); Cenomanian, England (Cookson & Hughes, 1964; Davey, 1969a), Australia (Cookson & Eisenack, 1958;

Plate 6 →

(All photomicrographs in differential interference contrast x 500)

1. *Batiacasphaera asperata* Backhouse 1988; slide no. BSIP 10769, coordinates: 7.7 x 158.0.
2. *Meiourogonyaulax bulloides* (Cookson & Eisenack) Sarjeant 1969; slide no. BSIP 10793, coordinates: 4.6 x 162.0.
3. *Pterodinium aliferum* Eisenack 1958 emend. Sarjeant 1985; slide no. BSIP 10792, coordinates: 7.9 x 163.2.
4. *Batiacasphaera scrobiculata* (Deflandre & Cookson) Burger 1980; slide no. BSIP 10769, coordinates: 1.7 x 145.3.
5. *Tehamadinium* sp. A; slide no. BSIP 10781, coordinates: 6.4 x 130.3.
6. *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey & Williams 1966; slide no. BSIP 10806, coordinates: 10.4 x 140.0.
7. *Nummus similis* (Cookson & Eisenack) Burger 1980; slide no. BSIP 8094, coordinates: 18.0 x 148.0.
8. *Archeotectatum reticulatum* sp. nov.; slide no. BSIP 10149, coordinates: 19.8 x 165.0.
9. *Gagiella mutabilis* Backhouse 1988; slide no. BSIP 10811, coordinates: 13.2 x 147.8.
10. *Dingodinium cerviculum* Cookson & Eisenack 1958 emend. Khowaja-Ateequzzaman *et al.* 1990; in dorsolateral view; slide no. BSIP 10149, coordinates: 14.5 x 153.3.
11. *Achomosphaera neptuni* (Eisenack) Davey & Williams 1966; slide no. BSIP 10763, coordinates: 9.5 x 144.5.
12. *Muderongia staurota* Sarjeant 1966; slide no. 10765, coordinates: 18.8 x 152.0.
13. *Cribroperidinium sepimentum* Neale & sarjeant 1962; slide no. BSIP 10803, coordinates: 15.7 x 138.7.


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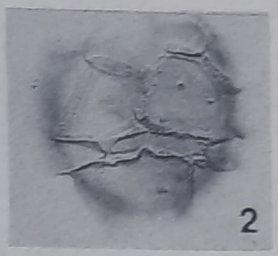
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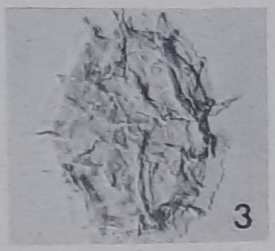
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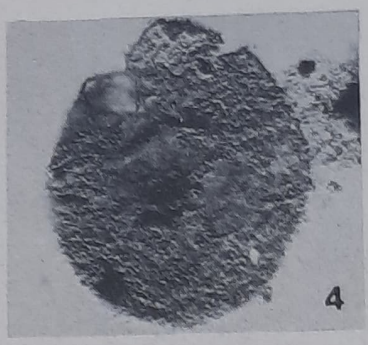
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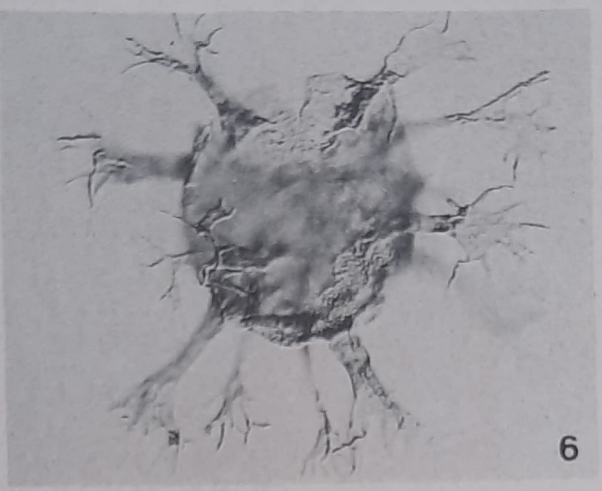
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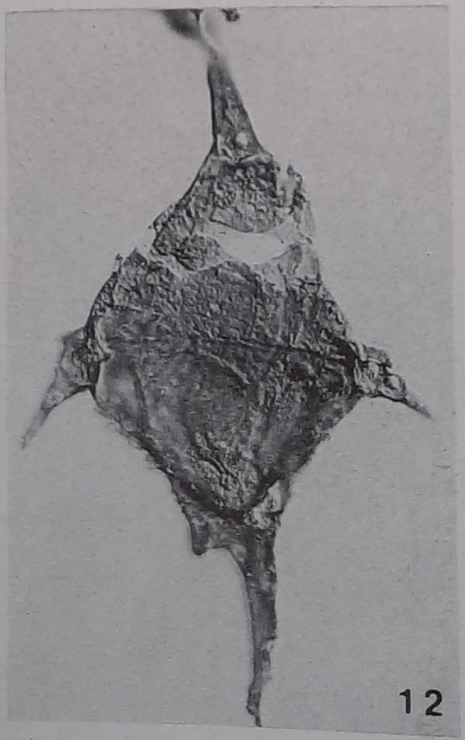
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Plate 6

Norvick, 1976), France (Davey, 1969; Foucher, 1979), Spain (Herngreen, 1980); Cenomanian - Turonian, France (Azema *et al.*, 1981); Turonian, France (Robaszynski *et al.*, 1988); Turonian - Campanian, France (Foucher, 1976); Coniacian, France (Foucher, 1972); Santonian, E. Canada (Williams, 1975), NW Germany (Yun, 1981); Campanian, Canada (Harland, 1973); Campanian - Maastrichtian, New Jersey (May, 1982); Maastrichtian, USA (Zaitzeff & Cross, 1970).

Genus- *Cribroperidinium* Neale & Sarjeant 1962 emend. Sarjeant 1983 emend. Helenes 1984

Cribroperidinium confossum (Duxbury) Helenes 1984
Pl. 5, fig. 7

Dimensions
Size of cyst — 100 - 120 X 90 - 100 μm

Geologic and geographic distribution–Hauterivian, England (Duxbury, 1977).

Cribroperidinium edwardsii (Cookson & Eisenack) Davey 1969
Pl. 4, figs 7, 11; Pl. 10, fig. 13

1988 b *Rhynchodiniopsis fimbriata* (Duxbury) Sarjeant 1982 *in* Khowaja-Ateequzzaman *et al.*, p. 84.

Dimensions
Size of cyst — 90 - 100 X 70 - 85 μm
Length of apical horn — 15 - 20 μm

Geologic and geographic distribution–Valanginian, France (Millioud, 1967); Valanginian - Barremian, England (Duxbury, 1977); Early Valanginian - Turonian, Australia (Helby *et al.*, 1987); Hauterivian, E. Greenland (Piasecki, 1979); Denmark (Davey, 1982a), offshore section shelf (Williams, 1975); Hauterivian - Barremian, Libya (Thusu *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987); Hauterivian - Albian, SW Morocco (Below, 1981); Hauterivian - Cenomanian, Libya (Uwins & Batten, 1988); Barremian, USSR (Vozzhennikova, 1967), England (Davey, 1974; Duxbury, 1980), France (Srivastava, 1984); Barremian - Aptian, N. Germany (Below, 1982d); Late Neocomiian - Aptian, Australia (Morgan, 1979); Barremian - Early Albian, offshore NW Australia (Wiseman & Williams, 1974); Aptian, Australia (Kemp, 1976), offshore SW Africa (Below, 1984); Early Aptian, England (Lister & Batten, 1988); Aptian - Albian, offshore northern Bay of Biscay (Davey, 1979b), England (Duxbury, 1983), Libya (Batten & Uwins, 1985); Aptian - Cenomanian, France (Verdier, 1975); Aptian and Turonian - Maastrichtian, offshore SW Africa (Davey, 1978); Albian, Canada (Brideau, 1971; Singh, 1971), France (Fouconnier, 1975); Albian - Cenomanian, France (Foucher & Taugourdeau, 1975; Davey & Verdier, 1973), Australia (Playford *et al.*, 1975), New Zealand (Wilson, 1976); Middle Albian - Cenomanian, offshore Angola Basin (Morgan, 1978); Cenomanian, Australia (Norvick, 1976); Albian - Turonian, Australia (Cookson & Eisenack, 1958); Middle Cretaceous, Australia (Cookson & Eisenack, 1968, 1971); Cenomanian - Campanian, England (Clarke & Verdier, 1967); Late Cretaceous, Italy (Corradini, 1972).

Cribroperidinium muderongense (Cookson & Eisenack) Davey 1969
Pl. 7, figs 6, 9, 10, 13

1988 b *Cribroperidinium cornutum* Davey, 1974 *in* Khowaja-Ateequzzaman *et al.*, p. 84.

Dimensions
Size of cyst — 100 - 120 X 80 - 90 μm

Geologic and geographic distribution–Hauterivian

Plate 7

(All photomicrographs in differential interference contrast x 500)

1. *Pterodinium cingulatus* (O. Wetzel) Below 1981; slide no. BSIP 10783, coordinates: 2.6 x 142.5.
2. *Impagidinium reductum* Stover & Helby 1987; slide no. BSIP 10150, coordinates: 18.4 x 140.3.
3. *Gagiella mutabilis* Backhouse 1988; slide no. BSIP 10776, coordinates: 9.5 x 140.5.

4-5. *Impagidinium phlyctaena* Stover & Helby 1987; same specimen in two different views, ventraland dorsal respectively; slide no. BSIP 10803, coordinates: 19.0 x 144.3.

6, 9, 10, 13. *Cribroperidinium muderongense* (Cookson & Eisenack) Davey 1969; 6 & 9- same specimen in two different views, 6- in dorsal, 9- in ventral; slide no: BSIP 8551, coordinates: 17.0 x 173.5; 10 & 13- same specimen in two different views; 10- in ventral, 13- in dorsal; slide no. BSIP 10799, coordinates: 16.7 x 149.2.

7-8. *Phoberocysta neocomica* (Gocht) Millioud 1969 emend. Helby 1987; 7- slide no. BSIP 10782, coordinates: 17.6 x 16.3; 8- slide no. BSIP 10805, coordinates: 13.2 x 156.2.

11-12. *Aprobolocysta eilema* Duxbury 1977; same specimen in two different foci, 11. dorsal, 12. ventral; slide no. BSIP 10786, coordinates: 4.5 x 130.2.

14, 16. *Oligosphaeridium albertense* (Pocock) Davey & Williams 1969; same specimen in two different views; slide no. BSIP 10803, coordinates: 12.0 x 128.0.

15. *Batioladinium jaegeri* (Alberti) Brideaux 1975; slide no. BSIP 10764, coordinates: 14.1 x 141.3.


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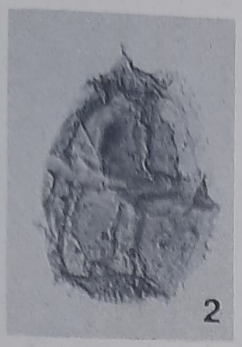
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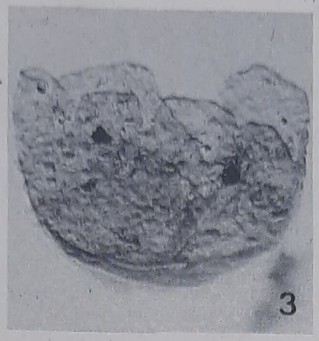
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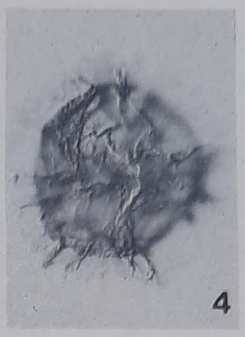
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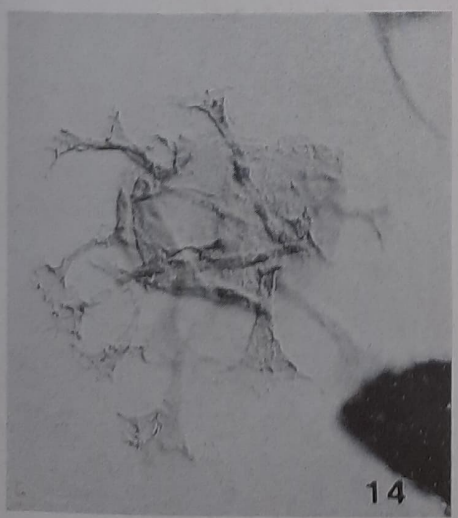
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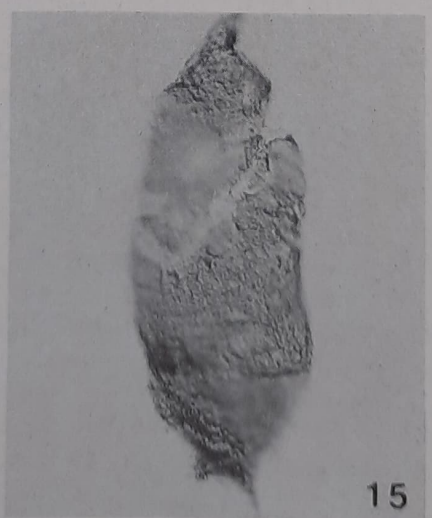
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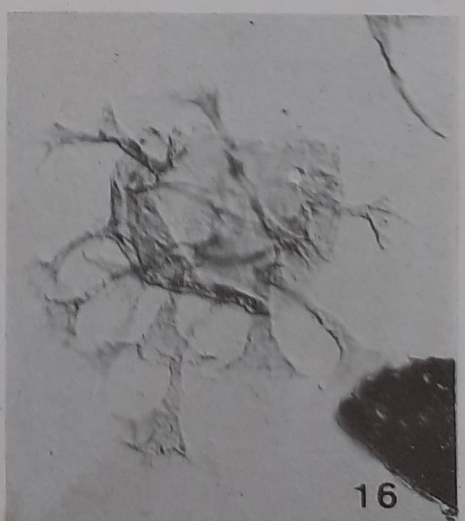
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Plate 7

- Barremian, India (Garg *et al.*, 1988); Aptian, Australia (Cookson & Eisenack, 1958); Cenomanian, Australia (Norvick, 1976); Early Santonian, NW Germany (Yun, 1981).

Cribroperidinium sepimentum Neale & Sarjeant 1962
Pl. 6, fig. 13

Dimension
Size of cyst — 120 - 130 X 100 - 110 μm

Geologic and geographic distribution–Barremian-Aptian, Libya (Uwins & Batten, 1988); Early Aptian, England (Lister & Batten, 1988).

Cribroperidinium sp. A
Pl. 8, fig. 12

Description

Shape–Cyst subspherical with a long apical horn.
Wall relationship–Autophragm only.
Wall features–Cyst wall perforate with parasutural ridges that are with serrate or spinulate crest at places specially in apical and antapical regions.
Paratabulation-Indicated by parasutural ridges; gonyaulacacean. Exact paratabulation formula could not be ascertained due to lack of specimens.
Archaeopyle–Precingular, Type P (3" only), operculum free.

Dimensions
Size of cyst — 135 - 150 X 80 - 100 μm
Length of apical horn — 70 - 80 μm

Genus- *Dingodinium* Cookson & Eisenack 1958 emend. Mehrotra & Sarjeant 1984 emend. Khowaja-Ateequzzaman *et al.* 1990

Dingodinium cerviculum Cookson & Eisenack 1958 emend. Khowaja–Ateequzzaman *et al.* 1990
Pl. 5, fig. 8; Pl. 6, fig. 10

Dimensions
Size of cyst — 80 - 118 X 40 - 75 μm

Geographic and geologic distribution–Berriasian, Canada (Williams & Bujak, 1976); Berriasian - Barremian, England (Duxbury, 1977); offshore SE Canada (Bujak & Williams, 1978); Valanginian - Aptian, offshore Spain (Masure, 1988); Hauterivian - Barremian, India (Garg *et al.*, 1988), Libya (Thusu *et al.*, 1988); Hauterivia - Aptian, India (Mehrotra & Sarjeant, 1984), Netherlands (Herngreen, 1978); Late Neocomian - Early Albian, Australia (Morgan, 1979); Middle Hauterivian - Aptian, Australia (Backhouse, 1987, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Middle Hauterivian - Early Albian, Australia (Helby *et al.*, 1987); Barremian, England (Sarjeant, 1966b), Germany (Alberti, 1961), France (Reneville & Raynaud, 1981; Srivastava, 1984); Late eocomian - Aptian, Australia (Ingram, 1967); Late Barremian - Early Aptian, England (Lister & Batten, 1988); Aptian, Australia (Cookson & Eisenack, 1958), Netherlands (Herngreen, 1978).

Genus- *Discorsia* Dubury 1977 emend. Khowaja-Ateequzzaman *et al.* 1985

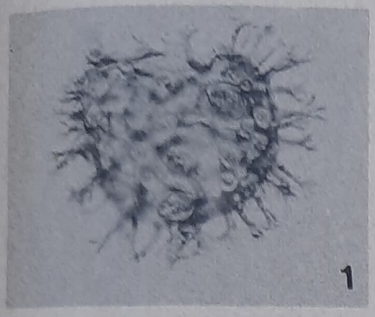
Discorsia nanna (Davey) Duxbury 1977 emend. Khowaja-Ateequzzaman *et al.* 1985
Pl. 12, figs 6, 9

Dimensions
Size of cyst (excluding processes) — 40 - 45 X 25 - 30 μm

Plate 8 →

(All photomicrographs in differential interference contrast x 500)

1. *Kiokansium polypes* (Cookson & Eisenack) Below 1982; slide no. BSIP, coordinates: 16.0 x 157.7.
2. *Tenua hystrix* Eisenack 1958; slide no. BSIP 10782, coordinates: 21.2 x 141.4.
3. *Oligosphaeridium* sp. A; slide no. BSIP 10799, coordinates: 13.2 x 149.3.
4. Gen. *et* sp. indet. E; slide no. BSIP 10787, coordinates: 14.5 x 164.0.
5. *Pterodinium tuberculatum* sp. nov. (holotype); slide no. BSIP 10150, coordinates: 18.3 x 143.3.
6. Gen. *et* sp. indet. F; slide no. BSIP 10780, coordinates: 16.4 x 155.0.
7. Gen. *et* sp. indet. G; slide no. BSIP 8553, coordinates: 15.5 x 128.0.
8. 13. *Muderongia simplex* Alberti 1961; 8- slide no. BSIP 10794, coordinates: 21.5 x 156.9; 13- slide no. BSIP 10781, coordinates: 9.4 x 149.5.
9. Gen. *et* sp. indet. H; slide no. BSIP 10785, coordinates: 16.9 x 153.7.
10. *Circulodinium distinctum* (Deflandre & Cookson) Jansonius 1986; slide no. BSIP 10781, coordinates: 4.5 x 164.0.
11. *Hystrichodinium pulchrum* Deflandre 1935; in dorsal view; slide no. BSIP 10801, coordinates: 8.9 x 146.6.
12. *Cribroperidinium* sp. A ; slide no. BSIP 10791, coordinates: 8.6 x 133.2.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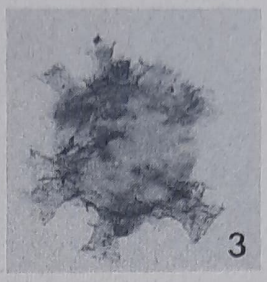
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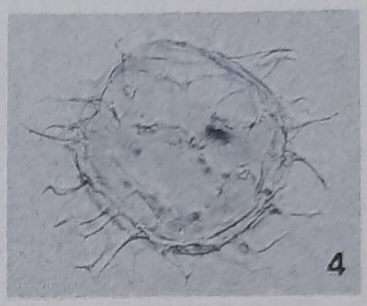
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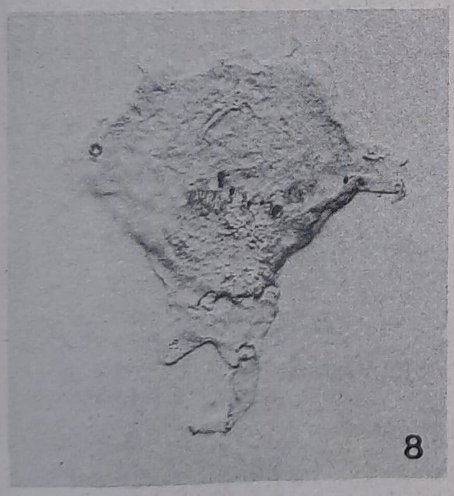
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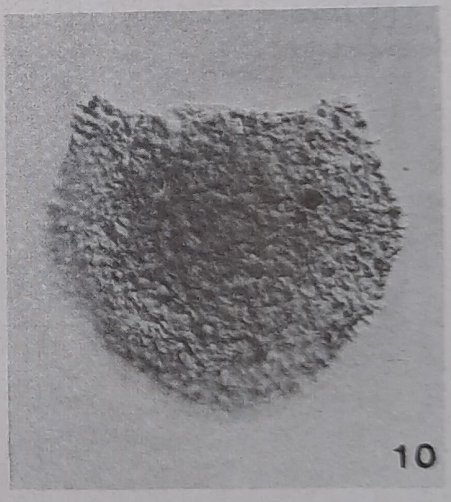
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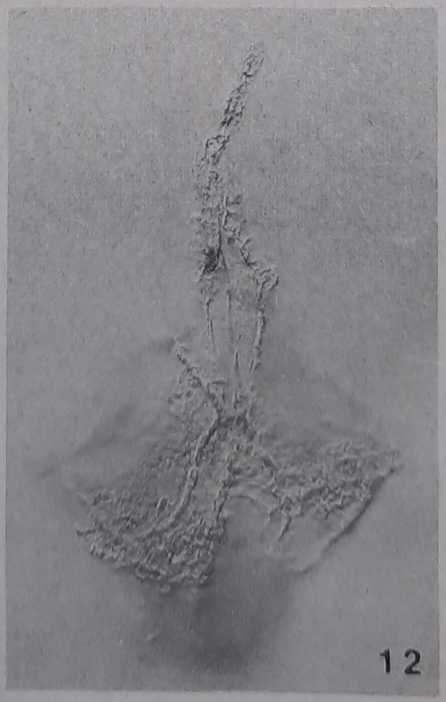
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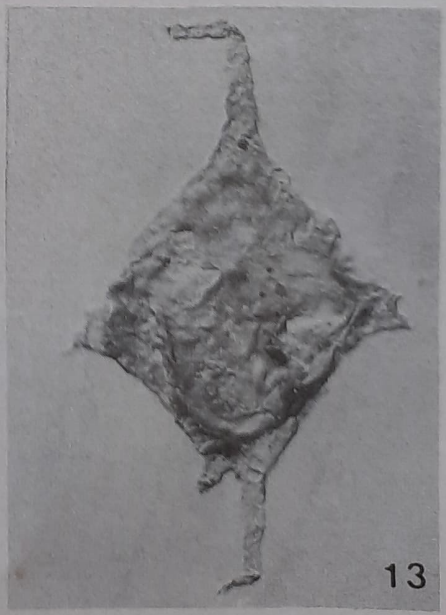
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Plate 8

Length of processes — 10 - 20 μm

Geologic and geographic distribution–Hauterivian, E. Greenland (Piasecki, 1979), Denmark (Davey, 1982a); Hauterivian - Barremian, India (Garg *et al.*, 1988); Late Neocomian - Albian, Australia (Morgan, 1979); Barremian, England (Davey, 1974); Duxbury, 1977, 1980); N. Germany (Below, 1982d); Aptian, offshore northern Bay of Biscay (Davey, 1979b); Early Aptian, England (Lister & Batten, 1988); Aptian - Early Albian, England (Duxbury, 1983), Germany (Davey, 1982b).

Genus- *Disphaera* Cookson & Eisenack 1960 emend. Norvick 1973

Disphaera tesselata Srivastava 1984
Pl. 13, figs 7, 8

Dimensions
Size of cyst — 65 - 75 X 65 - 75 μm

Geologic and geographic ditribution–Late Barremian, France (Srivastava, 1984)

Genus- *Exochosphaeridium* Davey *et al.* 1966

Exochosphaeridium bifidum (Clarke & Verdier) Clarke *et al.* 1968
Pl. 2, figs 6, 9

Dimensions
Size of cyst (excluding processes) — 65 - 70 X 60 - 63 μm
Length of apical process — 14 - 18 μm
Length of other processes — 12 - 22 μm

Geologic and geographic distribution–Hauterivian, offshore Denmark (Davey, 1982a); Hauterivian - Albian, Morocco (Below; 1982a); Barremian, England (Davey, 1974), France (Reneville & Raynaud, 1981; Srivastava, 1984); Aptian, offshore SW Africa (Davey, 1978; Below, 1984); Aptian - Albian, offshore Bay of Biscay (Davey, 1979b); Albian, England (Davey *et al.*, 1969), France (Davey & Verdier, 1971; Fouconnier, 1979), India (Jain, 1977), offshore Angola Basin (Morgan, 1978), offshore SE Canada (Bujak & Williams, 1978); Cenomanian, England (Davey *et al.*, 1979), France (Davey *et al.*, 1969; Fouconnier, 1979; Foucher, 1979); Turonian-Santonian, France (Azema *et al.*, 1981); Turonian-Maastrichtian, offshore SW Africa (Davey, 1978); Upper Cretaceous, Italy (Corradini, 1972).

Exochosphaeridium phragmites Davey *et al.* 1966
Pl. 1, figs 1-3

Dimensions
Size of cyst (excluding processes) — 65 - 70 X 60 - 65 μm
Length of apical process — 18 - 20 μm
Length of other processes — 15 - 25 μm

Geologic and geographic distribution–Hauterivian, Denmark (Davey, 1982a); Barremian, France (Reneville & Raynaud, 1981; Srivastava, 1984); Barremian - Aptian, England (Lister & Batten, 1988); Aptian, N. Germany (Below, 1982d); Late Aptian - Early Albian, Germany (Davey, 1982d); Aptian - Albian, offshore northern Bay of Biscay (Davey, 1979b); Aptian - Cenomanian, offshore SW Africa (Below, 1984); Albian - Cenomanian, England (Davey, 1969); Australia (Cookson & Eisenack, 1970), France (Foucher & Taugourdeau, 1975; Cenomanian, England (Davey *et al.*, 1966); Cenomanian - Santonian, France (Azema *et al.*, 1981); Turonian, France (Foucher, 1974; Robaszynski *et al.*, 1982); Early Santonian, NW Germany (Yun, 1981); Senonian, Australia (Cookson & Eisenack, 1970, 1974), Italy (Corradini, 1973).

Genus- *Fromea* Cookson & Eisenack 1958 emend. Yun 1981

Fromea amphora Cookson & Eisenack 1958
Pl. 4, fig. 4

Dimensions
Size of cyst — 70 - 80 X 50 - 60 μm

Geologic and geographic distribution–Ryazinian - Hauterivian, Denmark (Davey, 1982a); Hauterivian, E. Greenland (Piasecki, 1979); Hauterivian - Barremian, India (Garg *et al.*, 1988); Late Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Barremian, England (Duxbury, 1980), Libya (Thusu *et al.*, 1988); Upper Barremian, England (Sarjeant, 1966), Germany Alberti, 1961; Below, 1982d); Aptian, Canada (Pocock, 1980), northern Bay of Biscay (Davey, 1979b); Aptian - Early Albian, England (Duxbury, 1983); Late Aptian - Early Albian, Germany (Davey, 1982b); Aptian (?) - Cenomanian, Australia (Cookson & Eisenack, 1958; Morgan, 1979); Albian, Rumania (Baltes, 1967); Albian - Cenomanian, England (Cookson & Hughes, 1964; Davey, 1969); Albian - Campanian, offshore SE Canada (Bujak & Williams, 1978); Cenomanian, France (Davey, 1969); Upper Cretaceous, USSR (Vozzhennikova, 1967).

Genus- *Gagiella* Backhouse 1988

Gagiella mutabilis Backhouse 1988
Pl. 3, figs 2,3

Dimensions
Size of cyst — 65 - 70 X 55 - 75 μm
Width at
paracingular region — 40 - 45 μm

Geologic and geographic distribution–Valanginian, Australia (Backhouse, 1987, 1988).

Gagiella sp. A
Pl. 3, figs 12, 13; Pl. 6, fig. 9; Pl. 7, fig. 3

Description

Shape–Subspherical to ovoidal, slightly constricted at paracingular region forming three lobes, dorso-ventrally compressed with offset sulcul notch.

Wall relationship–Autophragm only.

n & Eisenack 1958 emend. Khowaja–Ateequzzaman et al. 1990
*Pl. 5, fig. 8; Pl. 6, fig. 10*No parasutural features, surface ornamented with sparsely placed regulae.

Paratabulation–Indicated by archaeopyle only.

Archaeopyle–Apical, Type tA, operculum free.

Dimensions
Size of cyst — 60 - 72 X 70 - 80 μm

Genus- *Gardodinium* Alberti 1961

Gardodinium trabeculosum (Gocht) Alberti 1961
Pl. 4, fig. 2; Pl. 9, fig. 3

Dimensions
Size of cyst — 80 - 90 X 50 - 55 μm
Length of apical horn — 20 - 25 μm

Geologic and geographic distribution–Hauterivian, NW Germany (Gocht, 1959; Alberti, 1961), Switzerland (Millioud, 1967); Hauterivian - Barremian, Libya (Thusu *et al.*, 1988); Late Hauterivian - Aptian, offshore SE Canada (Bujak & Williams, 1978); Middle Hauterivian - Early Barremian, England (Sarjeant, 1966b); Barremian, England (Duxbury, 1980), France (Reneville & Raynaud, 1981; Srivastava, 1984); Late Barremian - Early Aptian, N. Germany (Below, 1982d); Aptian, Canada (Pocock, 1980); Aptian - Albian, Australia (Morgan, 1979).

Genus- *Gonyaulacysta* Deflandre 1964 emend. Sarjeant 1969 emend. Stover & Evitt 1978 emend. Sarjeant 1982

Gonyaulacysta cassidata (Eisenack & Cookson) Sarjeant 1966
Pl. 12, fig. 10

Dimensions
Size of cyst — 75 - 90 X 60 - 75 μm

Geologic and geographic distribution–Hauterivian, England (Duxbury, 1977); Barremian, USSR (Vozzhennikova, 1967), England (Duxbury, 1980); Aptian, N. Germany (Below, 1982d), France (Davey & Verdier, 1974); Aptian - Albian, offshore Atlantic (Habib, 1972a); Late Aptian - Early Albian, Germany (Davey, 1982b); Aptian - Cenomanian, Australia (Eisenack & Cookson, 1960; Cookson & Eisenack, 1962; Morgan, 1979), France (Verdier, 1975), Netherlands (Herngreen, 1978); Albian, Rumania (Baltes, 1967), France (Davey & Verdier, 1971; Fouconnier, 1975; Foucher & Taugourdeau, 1975), Canada (Singh, 1971), offshore SE Canada (Bujak & Williams, 1978); Late Albian, England (Cookson & Hughes, 1964), offshore Angola Basin (Morgan, 1978); Albian, France (Davey & Verdier, 1973; Fouconnier, 1975); Cenomanian, England (Cookson & Hughes, 1964; Sarjeant, 1966; Clarke & Verdier, 1967; Davey, 1969), France (Davey, 1969; Davey & Verdier, 1973; Foucher & Taugourdeau, 1975), Australia (Norvick, 1976), SW Morocco (Below, 1981); Middle Cretaceous, Australia (Cookson & Eisenack, 1968); Santonian, NW Germany (Yun, 1981).

Gonyaulacysta exsanguia Duxbury 1977 emend. Harding 1990
Pl. 9, fig. 4

Dimensions
Size of cyst — 100 - 110 X 80 - 90 μm

Geologic and geographic distribution–Late Valanginian - Early Hauterivian, Australia (Backhouse, 1988); Hauterivian - Barremian, England (Duxbury, 1977).

Genus- *Herendeenia* Wiggins 1969

Herendeenia alaskaensis (Stover & Evitt) Stover & Helby 1987
Pl. 2, figs 1,2

Dimensions
Size of cyst — 85 - 95 X 40 - 50 μm

Geologic and geographic distribution–Late Hauterivian - Barremian, Alaska (Wiggins, 1969), Australia (Stover & Helby, 1987).

Herendeenia pisciformis (Cookson & Eisenack) Wiggins 1969
Pl. 2, figs 3,4

Dimensions
Size of autocyst — 75 - 80 X 40 - 50 μm
Height of ectophragmal crest — upto 8 μm

Geologic and geographic distribution–Late Jurassic, Australia (Cookson & Eisenack, 1958); Early Tithonian, Australia (Helby *et al.*, 1987); Late Hauterivian - Barremian, Alaska (Wiggins, 1969).

Herendeenia postprojecta Stover & Helby 1987
Pl. 1, figs 7, 9

Dimensions
Size of autocyst — 75 - 85 X 45 - 52 μm
Height of ectophragmal crest — upto 5 μm

Geologic and geographic distribution–Hauterivian - Aptian, Australia (Stover & Helby, 1987); Late Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Late Hauterivian - Aptian (Helby *et al.*, 1987); Middle Late Barremian - Aptian, Australia (Backhouse, 1988).

Genus- *Hystrichodinium* Deflandre 1935 emend. Sarjeant 1966 emend. Clarke & Verdier 1967

Hystrichodinium compactum Alberti 1961
Pl. 3, fig. 1

Dimensions
Size of cyst (excluding processes) — 55 - 60 X 45 - 50 μm
Length of processes — 10 - 25 μm

Geologic and geographic distribution–Valanginian, Germany (Alberti, 1961); Valanginian - Early Aptian, Australia (Backhouse, 1988).

Hystrichodinium pulchrum Deflandre 1935
Pl. 8, fig. 11

Dimensions
Size of cyst (excluding processes) — 60 - 70 X 42 - 50 μm
Length of processes — 30 - 40 μm

Geologic and geographic distribution–Portlandian - Hauterivian, offshore Denmark (Davey, 1982a); Portlandinian - Maastrichtian, offshore SE Canada (Bujak & Williams, 1978); Berriasian - Albian, England (Davey, 1974; Duxbury, 1977, 1983); Valanginian, NW Germany (Below, 1981b), Canada (Davey, 1974); Valanginian - Hauterivian, Netherlands (Millioud, 1967); Valanginian - Senonian, Germany (Gocht, 1959); Hauterivian, Switzerland (Alberti, 1961; Millioud, 1967); E. Greenland (Piasecki, 1979); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Hauterivian - Albian, Libya (Uwins & Batten, 1988); Hauterivian - Senonian, Germany (Alberti, 1961); Hauterivian - Maastrichtian, Europe (Michael, 1964; Foucher, 1972; Davey & Verdier, 1971; Corradini, 1973); Barremian, England (Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981; Srivastava, 1984), Germany (Below, 1982d); Neocomian, Germany (Gocht, 1959); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, Australia (Edgell, 1964); offshore Spain Masure, 1988); Aptian - Albian, offshore northern

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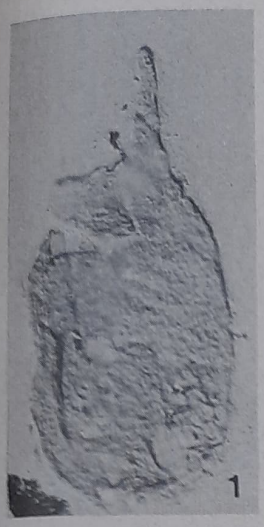
Plate 9 →

(All photomicrographs in differential interference contrast x 500)

1. *Pareodinia ceratophora* Deflandre 1947 emend. Gocht 1970; slide no. BSIP 10778, coordinates: 15.8 x 139.5.
2, 7. *Coronifera oceanica* Cookson & Eisenack 1958 emend. May 1980; 2- slide no. BSIP 10806, coordinates: 21.0 x 139.5; 7- slide no. BSIP 10795, coordinates: 10.2 x 137.6.
3. *Gardodinium trabeculosum* (Gocht) Alberti 1961; slide no. BSIP 10789, coordinates: 12.8 x 161.5.
4. *Gonyaulacysta exsanguia* Duxbury 1977; slide no. BSIP 10795, coordinates: 5.3 x 162.0.
5. *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey & Williams 1966; slide no. BSIP 10809, coordinates: 20.6 x 136.2.
6. Gen. *et* sp. indet. I; slide no. BSIP 10792, coordinates: 15.3 x 146.7.
8. *Oligosphaeridium totum* Brideaux 1971; slide no. BSIP 8553, coordinates: 5.5 x 133.3.
9. *Leptodinium* sp. A; slide no. BSIP 10774, coordinates: 5.4 x 144.5.
10. *Kleithriasphaeridium eoinodes* (Eisenack) Davey 1974 emend. Sarjeant, 1985; slide no. BSIP 10796, coordinates: 20.0 x 145.0.
11. *Kalyptea monoceras* Cookson & Eisenack 1960; slide no. BSIP 8092, coordinates: 11.0 x 149.1
12. *Oligosphaeridium* sp. B; slide no. BSIP 8094, coordinates: 20.3 x 136.6.
13. *Cleistosphaeridium huguoniotii* (Valensi) Davey 1969, slide no. BSIP 10150, coordinates: 14.5 x 155.5.
14. *Circulodinium deflandrei* Alberti 1961; slide no. BSIP 10801, coordinates: 7.5 x 155.5.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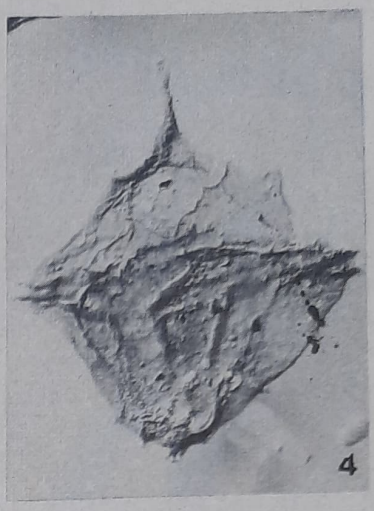
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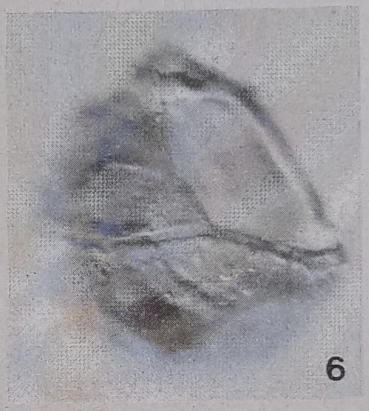
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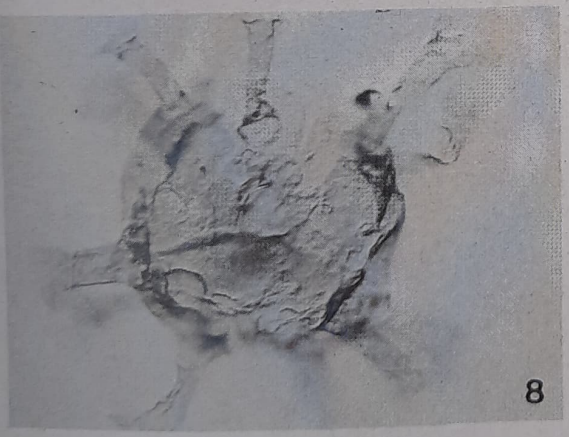
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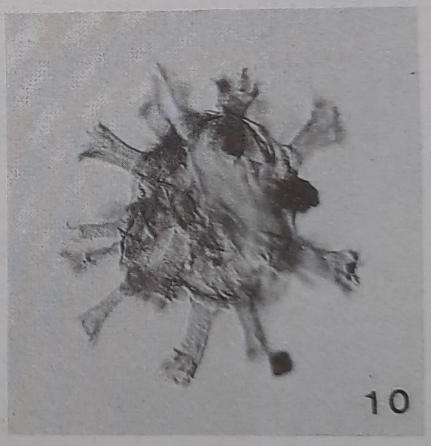
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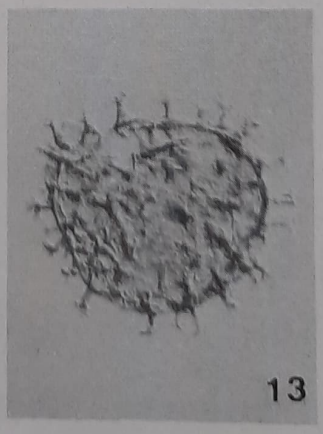
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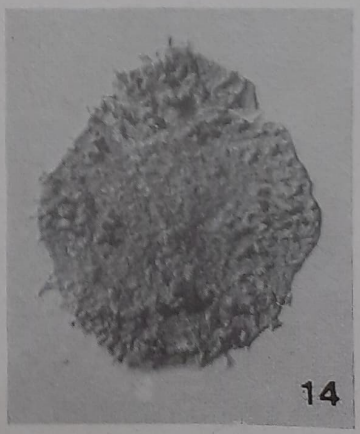
14

Plate 9

Bay of Biscay (Davey, 1979b); Germany (Davey, 1982b); England (Duxbury, 1983); Aptian - Cenomanian, offshore SW Africa (Below, 1984); Albian, India (Jain, 1977), Australia (Morgan, 1978), France (Davey & Verdier, 1971, 1973), England (Lister & Batten, 1988); Aptian - Early Albian, England (Duxbury, 1983); Middle Cretaceous, Canada (Manum & Cookson, 1964); Cenomanian, Australia (Norvick, 1976), Libya (Batten & Uwins, 1985); Cenomanian - Turonian, Italy (Serpagli, 1964), France (Azema *et al.*, 1981); Cenomanian - Santonian, England (Clarke & Verdier, 1967); Turonian, France (Foucher, 1974); Turonian - Campanian, France (Foucher, 1975); Coniacian, France (Foucher, 1971); Early Santonian, NW Germany (Yun, 1981); Senonian, France (Deflandre, 1935, 1936, 1940, 1952; Valensi, 1955), England (Wilkinson, 1846), Netherlands (De Witt, 1943); Santonian, NW Germany (Yun, 1981); Campanian, Poland (Gorka, 1963); Maastrichtian, Sweden (Kjellström, 1973).

Genus- *Impagidinium* Stover & Evitt 1978

Impagidinium phlyctaena Stover & Helby 1987
Pl. 7, figs 4, 5

Dimensions
Size of cyst (excluding crest) — 40 - 50 X 45 - 50 μm
Height of crest — upto 10 μm

Geologic and geographic distribution–Barremian - Early Aptian, Australia (Stover & Helby, 1987a, 1987b); Barremian - Aptian, Australia (Backhouse, 1988).

Impagidinium reductum Stover & Helby 1987
Pl. 7, fig. 2

Dimensions
Size of cyst — 65 - 70 X 40 - 45 μm

Geologic and geographic distribution–Middle Hauterivian, Australia (Stover & Helby, 1987).

Genus- *Kaiwaradinium* Wilson 1978

Kaiwaradinium scrutillinum Backhouse 1987
Pl. 1, figs 10, 12

Dimensions
Size of cyst (excluding processes) — 70 - 80 X 50 - 60 μm
Length of processes — 30 - 40 μm

Geologic and geographic distribution–Late Berriasian - Barremian, Australia (Helby *et al.*, 1987); Valanginian, Australia (Backhouse, 1988); Late Hauterivian - Barremian, Australia (Stover & Helby, 1987a 1987b).

Genus- *Kalyptea* Cookson & Eisenack 1960 emend. Wiggins 1975

Kalyptea monoceras Cookson & Eisenack 1960
Pl. 11, fig. 12

Dimensions
Size of cyst (excluding kalyptra) — 70 - 80 X 50 - 55 μm

Geologic and geographic distribution–Late Valanginian - Aptian, Australia (Backhouse, 1988); Early Aptian, England (Lister & Batten, 1988).

Kalyptea sp. A
Pl. 10, fig. 11

Description

Shape–Cyst oval with an apical horn and an outbuldge at the antapex.

Wall relationship–Autophragm only.

Wall features–No parasutural features. Autophragm surrounded with amorphous kalyptra.

Paratabulation–Indicated by archaeopyle alone.

Archaeopyle–Intercalary, operculum free, exact number of intercalary paraplates involved could not be ascertained due to lack of specimens.

Dimensions
Size of cyst (excluding kalyptra) — 90 - 100 X 55 - 60 μm

Genus- *Kiokansium* Stover & Evitt 1978 emend. Duxbury 1983

Kiokansium polypes (Cookson & Eisenack) Below 1982
Pl. 5, figs 4, 13; Pl. 8, fig. 1

Dimensions
Size of cyst — 38 - 45 X 35 - 40 μm
Length of processes — 18 - 25 μm

Geologic and geographic distribution–Valanginian - Barremian, offshore Spain (Masure, 1988); Hauterivian, E. Greenland (Piasecki, 1979), England (Harding, 1986); Hauterivian - Barremian, England (Duxbury, 1977), India (Garg *et al.*, 1988); Hauterivian - Albian, Morocco (Below, 1982a); Barremian, England (Davey, 1974; Duxbury, 1980), France (Srivastava, 1984); Barremian - Aptian, Canada (Brideaux, 1975); Late Barremian - Aptian, England (Lister & Batten, 1988); Aptian, offshore SW Africa (Below, 1984), N. Germany (Below, 1982d); Early Creataceos, Afghanistan (Ashraf, 1979); Aptian - Early Albian, England (Duxbury, 1983), Germany (Davey, 1982b); Aptian - Albian, Australia (Wiseman & Williams, 1974), offshore northern Bay of Biscay (Davey, 1979b); Aptian - Cenomanian, Canada

(Singh, 1971); Albian, Canada (Brideaux, 1975); Albian - Cenomanian, Australia (Cookson & Eisenack, 1962a), England (Cookson & Hughes, 1964), France (Fouconnier, 1979); Cenomanian, England and USA (Davey, 1969a), Australia (Norvick, 1976), France (Fouconnier, 1979); Turonian, France (Robaszynski *et al.*, 1982); Turonian - Maastrichtian, SW Africa (Davey, 1978); Santonian, NW Germany (Yun, 1981).

Kiokansium sp. A
Pl. 12, fig. 5

Description

Shape–Cyst subspherical.
Wall relationship–Autophragm only.
Wall features–No parasutural features, surface smooth bearing many nontabular solid processes with truncated distal ends.
Paratabulation–Indicated by archaeopyle alone.
Archaeopyle–Precingular, type uncertain, operculum free.

Dimensions
Size of cyst (excluding processes) — 45 - 50 X 45 - 50 μm
Length of processes — 8 - 12 μm

Genus- *Kleithriasphaeridium* Davey 1974

Kleithriasphaeridium corrugatum Davey 1974
Pl. 9, fig. 10

Dimensions
Size of cyst (excluding processes) — 45 - 50 X 40 - 45 μm
Length of processes — 20 - 30 μm

Geologic and geographic distribution–Valanginian - Barremian, England (Duxbury, 1977); Huterivian, Germany (Gocht, 1959; Piasecki, 1979); Hauterivian - Barremian, India (Garg *et al.*, 1988); Barremian, England (Davey, 1974); Cenomanian, Australia (Morgan, 1979); Santonian, NW Germany (Yun, 1981).

Kleithriasphaeridium eoinodes (Eisenack) Davey 1974 emend. Sarjeant 1985
Pl. 1, figs 5, 8, 11; Pl. 11, fig. 14

Dimensions
Size of cyst (excluding processes) — 55 - 65 X 45 - 55 μm
Length of processes — 20 - 35 μm

Geologic and geographic distribution–Hauterivian, France (Millioud, 1967), E. Greenland (Piasecki, 1979); Hauterivian - ? Aptian, offshore SE Canada (Bujak & Williams, 1978); Barremian, France (Reneville & Raynaud, 1981); Barremian - Aptian, offshore Spain (Masure, 1988), N. Germany (Below, 1982d), Australia (Backhouse, 1987, 1988); Aptian, Germany (Sarjeant, 1985), offshore SW Africa (Below, 1984); Aptian - Albian, Libya (Batten & Uwins, 1985); Aptian - Cenomanian, Australia (Morgan, 1979).

Kleithriasphaeridium simplicispinum (Davey & Williams) Davey 1974
Pl. 1, figs 4, 6

Dimensions
Size of cyst (excluding processes) — 40 - 45 X 40 - 45 μm
Length of processes — 15 - 25 μm

Geologic and geographic distribution–Valanginian - Hauterivian, Denmark (Davey, 1982a); Valanginian - Barremian, England (Duxbury, 1977); Hauterivian, Germany (Gocht, 1959); Greenland (Piasecki, 1979); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Barremian, England (Davey & Williams, 1966; Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981); Aptian, England (Lister & Batten, 1988); Aptian - Early Albian, England (Duxbury, 1983); Aptian - Albian, England (Davey, 1979b); Early Albian, India (Jain, 1977).

Genus- *Leptodinium* Klement 1960 emend. Sarjeant 1966 emend. Wall 1967 emend. Sarjeant 1969 emend. Stover & Evitt 1978 emend. Sarjeant 1982

Leptodinium sp. A
Pl. 9, fig. 9

Description

Shape–Cyst subpolygonal.
Wall relationship–Autophragm only.
Wall features–Surface smooth with lowly raised parasutural septa.
Paratabulation–Indicated by parasutural septa, gonyaulacacean, formula: 4', 6", 6c, 5"', 1p, 1"".
Archaeopyle–Precingular, type P (3" only), operculum free.

Dimensions
Size of cyst — 90 - 100 X 70 - 80 μm

Genus- *Meiourogonyaulax* Sarjeant 1966

Meiourogonyaulax bulloidea (Cookson & Eisenack) Sarjeant 1966
Pl. 4, fig. 1; Pl. 6, fig. 2

Dimensions	
Size of cyst	— 50 - 55 X 40 - 45 μm
Height of Crest	— 3 - 5 μm

Geologic and geographic distribution–Portlandian, Australia (Cookson & Eisenack, 1960b); Late Valanginian - Hauterivian, Australia (Backhouse, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987b); Barremian, England (Davey, 1974).

Genus- *Muderongia* Cookson & Eisenack 1958

Muderongia australis Helby 1987
Pl. 4, fig. 4

Dimensions	
Size of cyst (excluding operculum)	— 75 - 85 X 80 - 85 μm
Length of apical horn	— 40 - 50 μm
Length of antapical horn	— 35 - 40 μm
Length of lateral horns	— 15 - 20 μm

Geologic and geographic distribution–Late Valanginian - Aptian, Australia (Helby *et al.*, 1987); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Barremian, Australia (Helby, 1987); Barremian - Early Aptian, Australia (Backhouse, 1987, 1988).

Muderongia crucis Neale & Sarjeant 1962
Pl. 4, fig. 12

1988 b *Muderongia tetracantha* (Gocht) Alberti, 1961 in Khowaja-Ateequzzaman *et al.*, p. 84.

Dimensions	
Size of cyst (excluding operculum)	— 150 - 170 X 65 - 75 μm
Length of antapical horn	— 100 - 110 μm
Length of lateral horns	— 80 - 85 μm

Geologic and geographic distribution–Hauterivian, Denmark (Davey, 1982a); Late Hauterivian, England (Neale & Sarjeant, 1962); Barremian, England (Duxbury, 1980).

Muderongia mcwhaei Cookson & Eisenack 1958
Pl.12, fig. 15

Dimensions	
Size of cyst	— 180 - 210 X 100 - 130 μm
Length of apical horn	— 90 - 110 μm
Length of antapical horn	— 60 - 80 μm
Length of lateral horns	— 50 - 60 μm

Geologic and geographic distribution–Hauterivian - Barremian, India (Garg *et al.*, 1988); Barremian, England (Davey, 1974), France (Srivastava, 1984); Late Neocomian - Aptian, Australia (Morgan, 1979).

Muderongia simplex Alberti 1961
Pl. 8, figs 8, 13

Dimensions	
Size of cyst	— 130 - 150 X 90 - 100 μm
Length of apical horn	— 50 - 60 μm

Plate 10

(All photomicrographs in differential interference contrast x 500)

1, 5. *Sentusidinium ? fibrillosum* Backhouse 1988; same specimen in two different foci; 1- ventral, 5- dorsal; slide no. BSIP 10797, coordinates: 19.3 x 153.6.

2. *Tehamadinium tenuiceras* (Eisenack) Jan du Chêne *et al.* in Jan du Chêne *et al.* 1986; slide no. BSIP 10773, coordinates: 18.9 x 161.9.

3. *Oligosphaeridium* sp. A; slide no. BSIP 10800, coordinates: 23.0 x 141.0.

4. Gen. *et* sp. indet. J; slide no. BSIP 10788, coordinates: 15.0 x 133.9.

6, 9. *Aprobolocysta alata* Backhouse 1987; same specimen in two different foci, 6-ventral, 9-dorsal; slide no. BSIP 10804, coordinates: 9.2 x 138.8.

7, 8. *Achomosphaera* sp. A; same specimen in two different foci, dorsal and ventral respectively; slide no. BSIP 10798, coordinates: 16.0 x 149.8.

10. Gen. *et* sp. indet. K; slide no. BSIP 8094, coordinates: 19.5 x 166.0.

11. *Kalyptea* sp. A; slide no. BSIP 8092, coordinates: 15.8 x 129.0.

12. *Valensiella* sp. A; slide no. BSIP 10772, coordinates: 14.5 x 139.6.

13. *Cribroperidinium edwardsii* (Cookson & Eisenack) Davey 1969; slide no. BSIP 10794, coordinates: 17.4 x 155.2.

14-16. *Odontochitina* sp. A; 14 & 16- same specimen in two different foci; slide no. BSIP 10805, coordinates: 19.3 x 152.2; 15, slide no. BSIP 10807, coordinates: 18.2 x 161.1.


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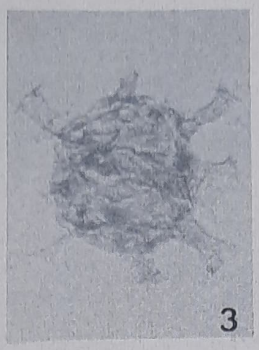
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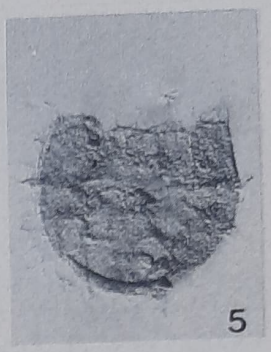
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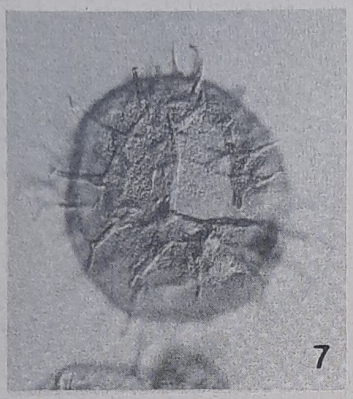
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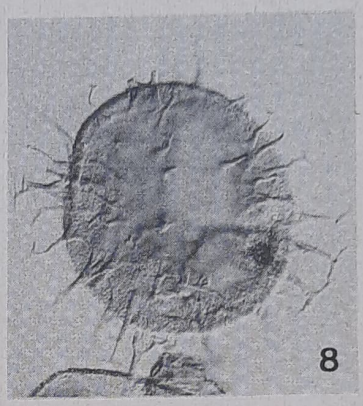
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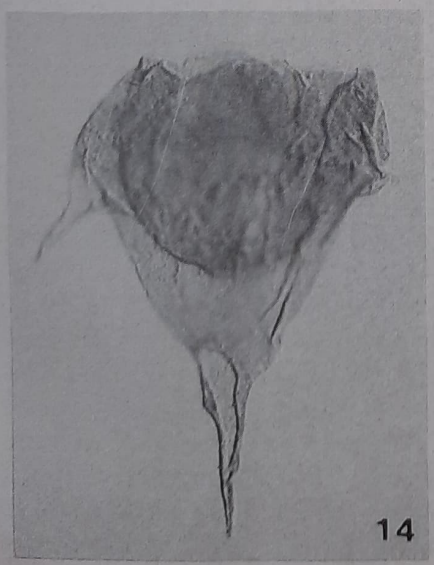
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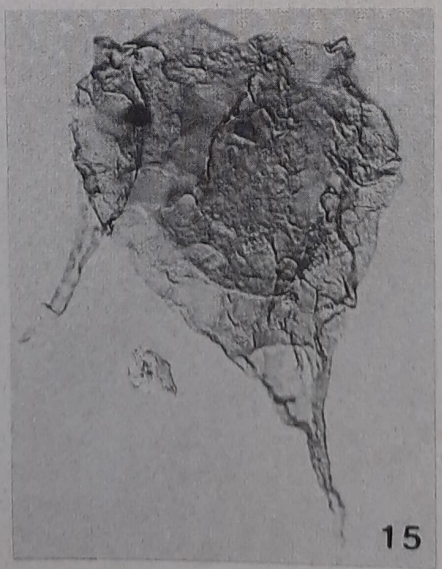
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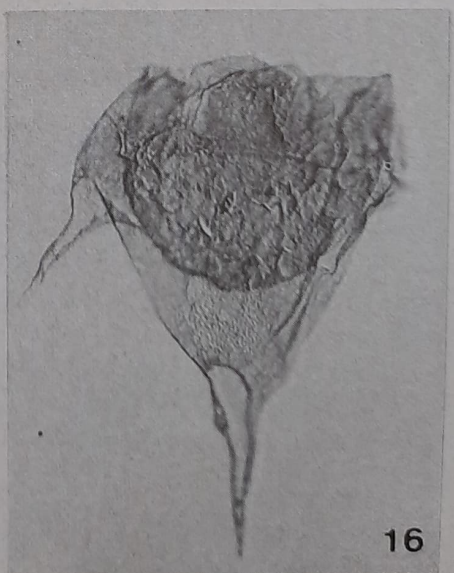
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Plate 10

Length of antapical horn	— 40 - 50 μm
Length of lateral horns	— 10 - 18 μm

Geologic and geographic distribution–Late-Tithonian - Hauterivian, Libya (Thusu *et al.*, 1988); Ryazanian - Hauterivian, Denmark (Davey, 1982a); Berriasian, Libya (Thusu & Van Der Eem, 1985); Late Berriasian - Middle Barremian, (Williams & Bujak, 1985); Portlandian - Barremian, offshore SE Canada (Bujak & Williams, 1978); Valanginian - Early Barremian, NW Germany (Alberti, 1961); Hauterivian, E. Greenland (Piasecki, 1979), England (Harding, 1986); Barremian, England (Duxbury, 1980), France (Reneville & Raynaud, 1981).

Muderongia staurota Sarjeant 1966
Pl. 6, fig. 12

Dimensions

Size of cyst	— 160 - 190 X 100 - 120 μm
Length of apical horn	— 65 - 90 μm
Length of antapical horn	— 60 - 70 μm
Length of lateral horns	— 30 - 40 μm

Geologic and Geographic distribution–Early Cretaceous, England (Sarjeant, 1966); Late Hauterivian, England (Harding, 1986); Hauterivian - Barremian, France (Millioud, 1969), England (Duxburry, 1977), India (Garg *et al.*, 1988), Libya (Thusu *et al.*, 1988); Barremian, England (Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981; Srivastava, 1984); Late Neocomian - Aptian, Australia (Morgan, 1979); Aptian, Australia (Wiseman & Williams, 1974; Kemp, 1976).

Muderongia sp. A
Pl. 3, fig. 4

Description

Shape–Cyst ceratioid with four short horns; an apical, two lateral and an antapical horn.

Wall relationship–Periphragm and endophragm appressed between processes.

Wall features–No parasutural features. Both periphragm and endophragm thin, periphragm finely granular, endophragm smooth.

Paratabulation–Indicated by archaeopyle alone.

Archaeopyle–Apical, Type tA, principal archaeopyle sutures zig zag, operculum free.

Dimensions

Size of cyst (excluding operculum)	— 80 X 50 μm
Length of antapical horn	— 35 μm
Length of lateral horns	— 20 - 25 μm

Genus- *Nummus* Morgan 1975

Nummus similis (Cookson & Eisenack) Burger 1980
Pl. 6, fig. 7; Pl. 13, fig. 2

Dimensions

Size of cyst	— 65 - 70 X 65 - 70 μm

Geologic and geographic distribution–Tithonian, Australia (Cookson & Eisenack, 1960b); Valanginian - Early Aptian, Australia (Backhouse, 1988); Hauterivian - Barremian, India (Garg *et al.*, 1988); Barremian, France (Srivastava, 1984).

Genus- *Odontochitina* Deflandre 1935 emend. Davey 1970 emend. Bint 1986

Odontochitina athabaskensis Pocock 1962
Pl. 13, fig. 10

Dimensions

Size of endocyst	— 70 - 80 X 60 - 65 μm
Length of apical horn	— 140 - 160 μm
Length of antapical horn	— 130 - 145 μm
Length of lateral horn	— 110 - 120 μm

Geologic and geographic distribution–Barremian, Canada (Pocock, 1962.)

Odontochitina operculata (O. Wetzel) Deflandre & Cookson 1955
Pl. 12, figs 13, 14

Dimensions

Size of endocyst	— 60 - 80 X 55 - 65 μm
Length of apical horn	— 160 - 200 μm
Length of antapical horn	— 140 - 170 μm
Length of lateral horn	— 110 - 120 μm

Geologic and geographic distribution–Hauterivian - Middle Albian, Canada (Brideaux, 1977); Hauterivian - Albian, offshore N. Atlantic (Habib, 1972); Hauterivian - Cenomanian, offshore W. Africa, (Bujak & Williams, 1978); Early Cretaceous, Australia (Deflandre & Cookson, 1955; Haskel, 1970), Canada (Singh, 1964), Afghanistan (Ashraf, 1979); Cretaceous, France (Deflandre, 1935); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987b); Barremian, England (Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981); Barremian - Aptian, Australia (Back-

house, 1988); Late Barremian - Aptian, England (Lister & Batten, 1988); Late Barremian - Early Aptian, N. Germany (Below, 1982d); Barremian - Albian, SW Morocco (Below, 1981); Barremian - Cenomanian, England (Sarjeant, 1966); Barremian - Campanian, offshore SE Canada (Bujak & Williams, 1978); Late Barremian - Senonian, Germany (Alberti, 1961); Aptian, Germany (Eisenack, 1958); Australia (Kemp, 1976), France (Davey & Verdier, 1973); Aptian - Early Albian, offshore NW Australia (Wiseman & Williams, 1974), England (Duxbury, 1983); Aptian - Middle Albian, Canada (Brideaux & McIntyre, 1975), offshore northern Bay of Biscay (Davey, 1979b), Germany (Davey, 1982b); Aptian - Cenomanian, France (Verdier, 1975); Libya (Uwins & Batten, 1988), Australia (Morgan, 1979), offshore SW Africa (Below, 1984); Aptian - Maastrichtian, offshore SW Africa (Davey, 1978); Albian, Rumania (Baltes, 1963, 1965, 1967a 1967b), USA (Hedlund & Norris, 1986), Canada (Valvolgi & Hills, 1969; Brideaux, 1971, Singh, 1971; Pocock, 1980), France (Davey & Verdier, 1971), offshore SW southern Atlantic (Hedlund, 1977), India (Jain, 1977), offshore Angola Basin (Morgan, 1978); Albian - Turonian, Australia (Cookson & Eisenack, 1958); Albian - Cenomanian, France (Foucher & Taugourdeau-Lantz, 1975), New Zealand (Wilson, 1976), Libya (Batten & Uwins, 1985); Middle Albian, Canada (Pocock, 1962); Late Albian - Cenomanian, Australia (Playford *et al.*, 1975); Cenomanian, Spain (Herngreen, 1980); Cenomanian - Turonian, New Zealand (Mildenhall & Wilson, 1976), France (Azema *et al.*, 1981; Davey & Verdier, 1973); Cenomanian - Campanian, England (Clarke & Verdier, 1967); Cenomanian, England, France, USA and Canada (Davey, 1970), offshore N. Atlantic (Habib, 1972), Australia (Norvick, 1976); Turonian, France (Foucher, 1974; Robaszynski et al., 1988); Turonian - Campanian, France (Foucher, 1976); Coniacian, France (Foucher, 1971; 1972); Senonian, France (Deflandre-Rigaud, 1955); Early Santonian, NW Germany (Yun, 1981); Santonian, offshore Grand Bank (Williams, 1975); Santonian - Maastrichtian, Canada (McIntyre, 1975); Campanian, Canada (Harland, 1973); USA (Harland, 1977); Ungarn (Goezan, 1962); Maastrichtian, Sweden (Kjellstrom, 1973); Belgium (Foucher & Robaszynski, 1977); Late Cretaceous, Germany (O. Wetzel, 1933), France (Deflandre, 1937; Deflandre & Courteville, 1939), Poland (Gorka, 1963), USSR (Vozzhennikova, 1967), Denmark (Wilson, 1971), Italy (Corradini, 1972), S. Atlantic (Harris, 1976).

Remarks–Agreeing with the view of Duxbury (1980, p. 138) that all pre-Barremian records of *Odontochitina operculata* are doubtful, we may further add that its suggested occurrences in long ranging (Hauterivian - Cenomanian) assemblages (Brideaux, 1977; Habib, 1972; Bujak, 1978; Stover & Helby, 1987b) does not necessarily conform Hauterivian age.

Odontochitina sp. A
Pl. 10 , figs 14 - 16

Description

Shape–Cyst inner body spherical to subspherical. Periphragm acquiring a ceratoid shape with three horns: an apical, an antapical and a third postcingular; horns short, distally pointed; antapical horn proximally expanded forming broad antapical pericoel; postcingular horn always smaller than apical and antapical horns; apical horn longest of the three horns.

Wall relationship–Cavate, periphragm and endophragm some times in contact at precingular region.

Wall features–No parasutural features. both periphragm and endophragm smooth.

Paratabulation–Indicated by archaeopyle alone.

Archaeopyle–Apical, Type A, principal archaeopyle sutures zig-zag, operculum free.

Dimensions

Size of endocyst	— 65 - 75 X 70 - 80 μm
Length of apical horn	— 92 - 105 μm
Length of antapical horn	— 50 - 62 μm
Length of postcingular horn	— 36 - 55 μm

Odontochitina sp. B
Pl. 11, fig. 10

Description

Shape–Endocyst subspherical. Pericyst acquiring ceratoid shape with three short horns: an apical, an antapical and a postcingular.

Wall relationship–Endophragm and periphragm appressed between processes.

Wall features–No parasutural features, both endophragm and periphragm smooth.

Paratabulation–Indicated by archaeopyle alone.

Archaeopyle–Apical, Type tA, principal archaeopyle sutures zig zag, operculum free.

Dimensions

Size of endocyst	— 60 - 78 X 45 - 63 μm
Length of apical horn	— 58 - 76 μm
Length of antapical horn	— 35 - 44 μm
Length of postcingular horn	— 35 - 42 μm

Genus- *Oligosphaeridium* Davey & Williams 1966 emend. Davey 1982

Oligosphaeridium albertense (Pocock) Davey & Williams 1969
Pl. 7, figs 14, 16

Dimensions
Size of cyst (excluding processes) — 65 - 65 X 50 - 55 µm
Length of processes — 20 - 25 µm

Geologic and geographic distribution–Barremian, France (Srivastava, 1984);Late Barremian - Early Aptian, N. Germany (Below, 1982d); Albian,USA (Hedlund & Norris, 1986); Barremian - Aptian (Brideaux, 1977); Barremian - Albian, Canada (Pocock, 1962); Aptian, Canada (Pocock, 1980); Albian, Canada (Brideaux, 1971, 1977); Turonian - Maastrichtian, Germany (Alberti, 1961); Early Santonian, NW Germany (Yun, 1981).

Oligosphaeridium complex (White) Davey & Williams 1969
Pl. 2, figs 11, 13

Dimensions
Size of cyst (excluding processes) — 40 - 45 X 45 - 50 µm
Length of processes — 24 - 35 µm

Geologic and geographic distribution–Cretaceous, England (White, 1842, 1844), Australia (Cookson & Eisenack, 1974); ; Early Cretaceous, Afghanistan (Ashraf, 1979); Early Cretaceous - Senonian, Australia (Deflandre & Cookson, 1955); Berriasian - Barremian, Libya (Thusu *et al.*, 1988); Valanginian, Norway (Bjaerke, 1978); Valanginian - Barremian, Germany (Gocht, 1959), England (Duxbury, 1977); Late Valanginian - Aptian, Australia (Backhouse, 1988); Valanginian - Cenomanian, offshore N. Atlantic (Habib, 1972), offshore NW Africa (Williams, 1978); Valanginian - Campanian, offshore SE Canada (Bujak & Williams, 1978); Hauterivian, Rumania (Baltes, 1963), Switzerland (Millioud, 1967, 1969), Denmark (Davey, 1982a), offshore Spain (Masure, 1988), S. England (Harding, 1986); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Hauterivian - Senonian, Australia (Cookson & Eisenack, 1958); Hauterivian - Albian, Rumania (Baltes, 1965); Hauterivian - Aptian, France (Millioud, 1969); Hauterivian - Cenomanian, SW Morocco (Below, 1982a), Libya (Uwins & Batten, 1988); Barremian, Germany (Michael, 1964), England (Davey, 1974; Duxbury, 1980), France (Reneville & Raynaud, 1981; Srivastava, 1984); Late Barremian - Aptian, England (Lister & Batten, 1988), N. Germany (Below, 1982d); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, Germany (Eisenack, 1958), offshore E. Canada (Williams, 1975), offshore SW Africa (Davey, 1978); Aptian - Early Albian, England (Duxbury, 1983); Aptian - Albian, offshore W. Australia (Wiseman & Williams, 1974), Senegal (Jain & Millepied, 1975), offshore northern Bay of Biscay (Davey, 1979b), Canada (Brideaux & McIntyre, 1979), offshore NW Africa (Below, 1984); Aptian - Albian, Libya (Batten & Uwins, 1985), Germany (Davey, 1982b); Albian, Canada (Singh, 1971; Brideaux, 1971; Pocock, 1980), USA (Hedlund & Norris, 1986), France (Davey & Verdier, 1971; Fouconnier, 1979), India (Jain & Taugourdeau-Lantz, 1973; Jain, 1977), offshore Angola Basin (Morgan, 1978); Albian - Cenomanian, England (Cookson & Hughes, 1964), Canada (Davey, 1969a), USA (Davey, 1969a), France (Foucher & Taugourdeau, 1975; Fouconnier, 1979); Albian - Turonian, England (Davey, 1969a); Middle Cretaceous - Late Cretaceous, Australia (Cookson &

Plate 11 →

(All photomicrographs in differential interference contrast except figs 6 & 10, x 500)

1, 4. *Achomosphaera* sp. A; same specimen in two different foci, 1-ventral, 4-dorsal; slide no. BSIP 10809, coordinates: 17.2 x 155.2.

2. *Batiacasphaera subtilis* Stover & Helby 1987; slide no. BSIP 10780, coordinates: 12.4 x 154.6.

3. *Achomosphaera* sp. B; slide no. BSIP 10149, coordinates: 21.2 x 158.0.

5, 8. *Tehamadinium coummium* (Below) Jan du Chêne *et al.* in Jan du Chêne *et al.* 1986 emend. Jan du Chêne *et al.* 1986; same specimen in two different foci, 5- dorsal, 8- ventral; slide no. BSIP 10794, coordinates: 7.2 x 143.9.

6. *Prolixosphaeridium parvispinum* (Deflandre) Davey *et al.* 1969; slide no. BSIP 10808, coordinates: 12.8 x 142.7.

7. *Coronifera oceanica* Cookson & Eisenack 1958 emend. May, 1980; slide no. BSIP 8093, coordinates: 20.1 x 153.5.

9. *Palaeoperidinium cretaceum* Pocock 1962 emend. Davey, 1970; slide no. BSIP 10806, coordinates: 16.2 x 153.1.

10. *Odontochitina* sp. B; slide no. BSIP 10150, coordinates: 16.0 x 157.9.

11. *Batioladinium variegranosum* (Duxbury) Davey 1982; slide no. BSIP, coordinates: 12.4 x 166.2.

12. *Kalyptea monoceras* Cookson & Eisenack 1960, slide no. BSIP 10799, coordinates: 15.8 x 139.5.

13, 15. *Achomosphaera ? neptuni* (Eisenack) Davey & Williams 1966; same specimen in two different foci; slide no. BSIP, coordinates: 15.8 x 153.0.

14. *Kleithriasphaeridium eoinodes* (Eisenack) Davey 1974, slide no. BSIP 10768, coordinates: 14.4 x 147.4.


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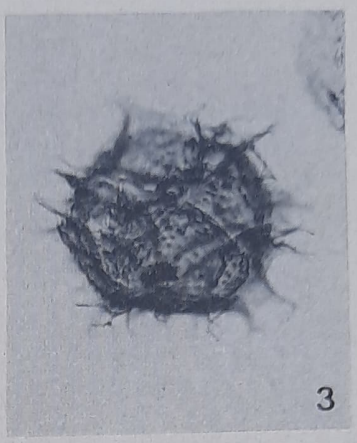
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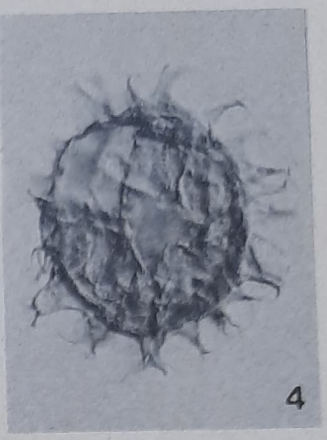
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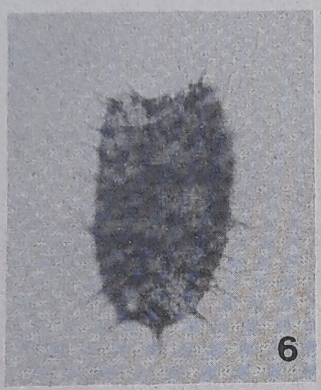
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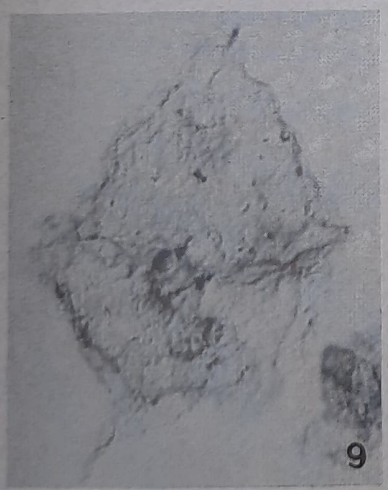
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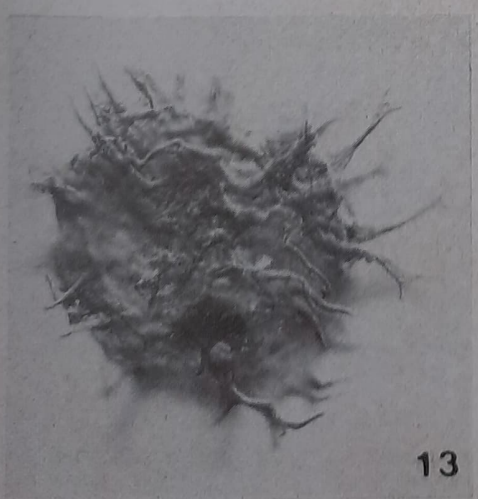
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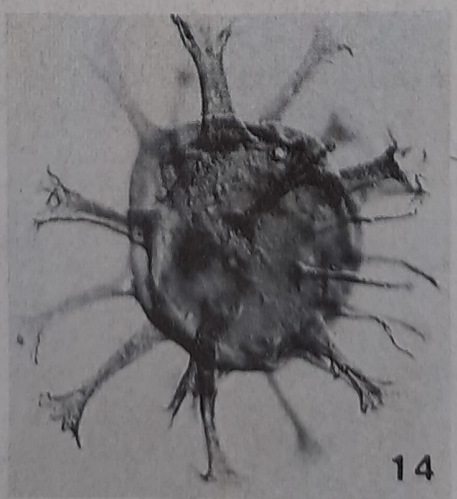
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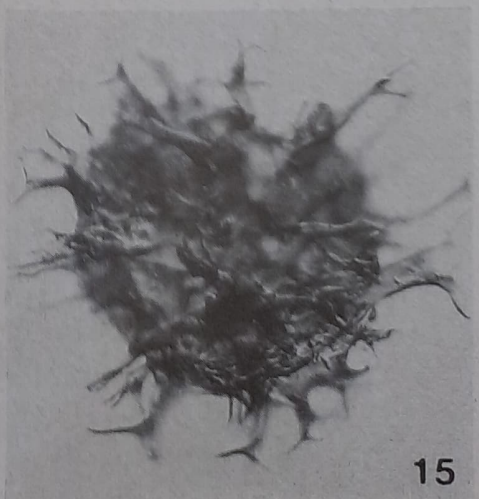
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Plate 11

Eisenack, 1974); Cenomanian, France (Firtion, 1952; Davey, 1969a; Foucher, 1979), Australia (Norvick, 1976); Cenomanian - Turonian, New Zealand (Mildenhall & Wilson, 1976), France (Azema *et al.*, 1981); Cenomanian - Santonian, Canada (Williams & Brideaux, 1975); Cenomanian - Campanian, England (Clarke & Verdier, 1967); Turonian, France (Foucher, 1974; Robaszynski *et al.*, 1988); Turonian - Senonian, Belgium (Lejeune-Carpentier, 1940); Turonian - Santonian, France (Foucher, 1976); Turonian - Maastrichtian, offshore SW Africa (Davey, 1978); Coniacian, France (Foucher, 1972); England (Davey & Williams, 1966); Santonian, offshore, E. Canada (Williams, 1975), NW Germany (Yun, 1981); Senonian, France (Corradini, 1973); Late Cretaceous, Italy (Corradini, 1972), Canada (McIntyre, 1974), offshore S. Atlantic (Harris, 1977), New Jersey (May, 1980); Danian, USA (Drugg, 1967); Eocene, Belgium (De Coninck, 1975); Oligocene - Eocene, India (Varma & Dangwall, 1964).

Oligosphaeridium pulcherrimum (Deflandre & Cookson) Davey & Williams 1966
Pl. 6, fig. 6; pl. 9, fig. 5

Dimensions
Size of cyst (excluding processs) — 60 - 70 X 55 - 65 μm
Length of processes — 25 - 40 μm

Geologic and geographic distribution–Kimmeridgian, England and France (Gitmez & Sarjeant, 1972); Portlandian - Coniacian, offshore SE Canada (Bujak & Williams, 1978); Late Valanginian - Aptian, Australia (Backhouse, 1988); Hauterivian, offshore E. Canada (Williams, 1975), offshore Spain (Masure, 1988), Switzerland (Millioud, 1967); Hauterivian - Barremian, India (Garg *et al.*, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Hauterivian - Albian, SW Morocco (Below, 1982a); Hauterivian - Cenomanian, Libya (Uwins & Batten, 1988); Barremian, England (Duxbury, 1980); Barremian - Albian, offshore W. Australia (Wiseman & Williams, 1974), Canada (Brideaux, 1977); Late Barremian - Early Aptian, England (Lister & Batten, 1988); Early Cretaceous, Australia (Deflandre & Cookson, 1955; Cookson & Eisenack, 1968); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, Senegal (Jain & Millepied, 1975), N. Germany (Below, 1982d), Canada (Brideaux & McIntyre, 1975), offshore SW Africa (Below, 1984), offshore northern Bay of Biscay (Davey, 1979b); Aptian - Early Albian, England (Duxbury, 1983), Libya (Batten & Uwins, 1985), Germany (Davey, 1982b); Albian, Canada (Brideaux, 1971; Singh, 1971),France (Fauconnier, 1979); Albian - Cenomanian, Australia (Cookson & Eisenack, 1971; Playford *et al.*, 1975); Cenomanian, Australia (Norvick, 1976), France (Foucher, 1979); Cenomanian - E. Turonian, New Zealand (Mildenhall & Wilson, 1976); Cenomanian - Coniacian, England (Clarke & Verdier, 1967); Turonian, France (Robaszynski *et al.*, 1982); Turonian - Coniacian, France (Foucher, 1976); Coniacian, offshore E. Canada (Wiseman & Williams, 1974); Santonian, NW Germany (Yun, 1981); Santonian - Campanian, Australia (Cookson & Eisenack, 1978); Campanian, Canada (Harland, 1973); Campanian - Maastrichtian, USA (Harris, 1977); Late Cretaceous, Canada (McIntyre, 1974); Danian, Australia (Heisecke, 1970); Eocene, England (Davey & Williams, 1966).

Oligosphaeridium totum Brideaux 1971
Pl. 2, figs 8, 10

Dimensions
Size of cyst (excluding processes) — 60 - 70 X 55 - 60 μm
Length of processes — 20 - 40 μm

Geologic and geographic distribution–Late Albian, Canada (Brideaux, 1971); Albian - Cenomanian, SW Canada (Bujak & Williams, 1978).

Oligosphaeridium sp. A
Pl. 8, fig. 3; Pl. 10, fig. 3

Description

Shape–Cyst subspherical.
Wall relationship–Periphragm and endophragm appressed between processes.
Wall features–No parasutural features, surface smooth bearing intratabular tubular processes that are short and broad, distally open with serrate tips.
Paratabulation–Indicated by intratabular processes, formula: 4', 6", 0c, 5"', 1p, 1"".
Archaeopyle–Apical, Type tA, operculum free.

Dimensions
Size of cyst (excluding processes) — 35 - 40 X 30 - 35 μm
Length of processes — 8 - 16 μm

Oligosphaeridium sp. B
Pl. 9, fig. 12

Description
Shape–Cyst oval.
Wall relationship–Periphragm and endophragm appressed between processes.
Wall features–No parasutural features, surface smooth bearing intratabulur tubular processes that are distally open and flared.

Paratabulation–Indicated by intratabular processes, gonyaulacacean, formula: 4', 6", 0c, 5"', 1p, 1"".

Archaeopyle–Apical, Type tA, operculum free

Dimensions	
Size of cyst (excluding processes)	— 50 - 55 X 40 - 50 μm
Length of processes	— 16 - 22 μm

Genus- *Palaeoperidinium* Deflandre 1935 emend. Sarjeant 1967

Palaeoperidinium cretaceum Pocock 1962 emend. Davey 1970
Pl. 11, fig. 9

Dimensions	
Size of cyst	— 70 - 80 X 55 - 65 μm
Length of left antapical horn	— 14 - 20 μm
Length of right antapical horn	— 8 - 12 μm
Length of apical horn	— 6 - 9 μm

Geologic and geographic distribution–Hauterivian - Albian, Canada (Brideaux, 1877), offshore W. Africa (Williams, 1978); Barremian, England (Davey, 1974), Libya (Thusu *et al.*, 1988); Barremian - Albian, SW Morocco (Below, 1981a); Barremian - Cenomanian, offshore SE Canada (Bujak & Williams, 1978); Late Neocomian - Cenomanian, Australia (Morgan, 1979);Late Barremian - Aptian, England (Lister & Btten, 1988); Early Cretaceous, Canada (Singh, 1964; Valvolgi & Hills, 1969); Aptian, offshore SW Africa (Davey, 1978), Libya (Uwins & Batten, 1988), Australia (Backhouse, 1988); Aptian - Early Albian, England (Duxbury, 1983), Germany (Davey, 192b); Aptian - Albian, Canada (Brideaux & McIntyre, 1975), England (Davey, 1979b); Albian, Canada (Davey, 1970; Brideaux, 1971; Singh, 1971), USA (Hedlund & Norris, 1986); Early Albian, India (Jain, 1977); Cenomanian, offshore Angola Basin (Morgan, 1978); Coniacian - Santonian, offshore Grand Banks (Williams & Brideaux, 1975); Cretaceous, Canada (Pocock, 1962).

Genus- *Pareodinia* Deflandre 1947 emend. Gocht 1970 emend. Johnson & Hills 1973 emend. Wiggins 1975 emend. Stover & Evitt 1978

Pareodinia ceratophora Deflandre 1947 emend. Gocht 1970
Pl.5, fig. 4; Pl. 9, fig. 1

Dimensions	
Size of cyst (excluding calyptra)	— 55 - 90 X 40 - 60 μm

Geologic and geographic distribution–Bajocian, France (Deflandre, 1947); Bajocian - Bathonian, France (Valensi, 1953); Bajocian - Late Tithonian, Australia (Helby *et al.*, 1987); Bajocian - Kimmeridgian, Rumania (Beju, 1971); Bathonian, Germany (Gocht, 1970); Gronland (Sarjeant, 1972), England (Sarjeant, 1976); Bathonian - Callovian, Germany (Alberti, 1961); Bathonian - Berriasian, Libya (Thusu *et al.*, 1988); Callovian, England (Sarjeant, 1959), France (Deflandre, 1947); Callovian - Oxfordian, England (Sarjeant, 1962a); Kimmeridgian, England (Ionnides *et al.*, 1976); Kimmeridgian - Oxfordian, offshore N. Atlantic (Habib, 1972); Oxfordian, England (Sarjeant, 1960, 1961, 1962b); Oxfordian - Neocomian, offshore SE southern America (Hedlund & Beju, 1977); Portlandian - Albian, offshore SE Canada (Bujak & Williams, 1978); Berriasian - Hauterivian, Switzerland (Millioud, 1969); Valanginian, Rumania (Baltes, 1963); Late Valanginian - Hauterivian, Australia (Backhouse, 1988); Hauterivian, SW Morocco (Below, 1981); Hauterivian - Barremian, England (Sarjeant, 1966), France (Millioud, 1969), India (Garg *et al.*, 1988), Libya (Uwins & Batten, 1988); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987b); Late Neocomian - Albian, Australia (Morgan, 1979); Aptian, offshore NW Australia (Wiseman & Williams, 1974), offshore SW Africa (Davey, 1978), England (Lister & Batten, 1988), N. Germany (Below, 1982d); Aptian - Albian, offshore northern Bay of Biscay (Davey, 1979b), Libya (Batten & Uwins, 1985); Albian, Canada (Singh, 1971); Early Santonian, NW Germany (Yun, 1981).

Genus- *Phoberocysta* Millioud 1969 emend. Helby 1987

Phoberocysta neocomica (Gocht) Millioud 1969 emend. Helby 1987
Pl. 7, figs 7, 8

Dimensions	
Size of endocyst	— 70 - 80 X 45 - 50 μm
Length of apical horn	— 40 - 55 μm
Length of antapical horn	— 30 - 40 μm
Length of lateral horns	— 20 - 30 μm

Geologic and geographic distribution–Early Cretaceous, England (Wall & Evitt, 1975); Berriasian - Valanginian, offshore Grand Bank (Williams, 1975), offshore SE and SW Canada (Bujak & Williams, 1978); Berriasian - Hauterivian, Germany (Millioud, 1969); Berriasian - Barremian, England (Duxbury, 1977), Libya (Thusu *et al.*, 1988); Valanginian - Hauterivian, Rumania (Baltes, 1969), Denmark (Davey, 1982a); Middle Valanginian -

Barremian, Australia (Helby *et al.*, 1987); Hauterivian, Germany (Gocht, 1957), E. Greenland (Piasecki, 1979), SW Morocco (Below, 1981); Hauterivian - Barremian, India (Garg *et al.*, 1988); Hauterivian - Aptian, France (Millioud, 1969); Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b), Poland and Bulgaria (Alberti, 1961); Barremian, England (Davey, 1974; Duxbury, 1980), offshore NW Australia (Wiseman & Williams, 1974), France (Reneville & Raynaud, 1981; Srivastava, 1984); Late Neocomian, Australia (Morgan, 1979); Aptian, England (Duxbury, 1983), offshore SW Africa (Below, 1984), S. England (Duxbury, 1983).

Genus- *Platycystidia* Cookson & Eisenack 1960

Platycystidia eisenackii (Mehrotra & Sarjeant) Backhouse 1988
Pl. 4, fig. 8

Dimensions	
Size of pericyst	— 70 - 80 X 65 - 70 µm
Size of endocyst	— 60 - 65 X 40 - 45 µm

Geologic and geographic distribution–Late Hauterivian - Early Aptian, Australia (Backhouse, 1988); Barremian, Australia (Stover & Helby, 1987); Aptian, India (Mehrotra & Sarjeant, 1984).

Genus- *Prolixosphaeridium* Davey *et al.* 1966 emend. Davey 1969

Prolixosphaeridium parvispinum (Deflandre) Davey *et al.* 1968
Pl. 11, fig. 6

Dimensions	
Size of cyst (excluding processes)	— 50 - 55 X 25 - 30 µm
Length of processes	— 15 - 18 µm

Geologic and geographic distribution–Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987b); Barremian, Canada (Brideaux, 1977), England (Davey, 1974), France (Reneville & Raynaud, 1981; Srivastava, 1984); Barremian - Aptian, France (Millioud, 1969), Australia (Backhouse, 1988); Barremian - Albian, SW Morocco (Below, 1982a); Late Neocomian - Early Cenomanian, Australia (Morgan, 1979); Aptian, France (Deflandre, 1937; Davey & Verdier, 1974), Australia (Cookson & Eisenack, 1958), offshore northern Bay of Biscay (Davey, 1979b), England (Lister & Batten, 1988); Aptian - Albian, offshore W. Australia (Wiseman & Williams, 1974); Aptian - Cenomanian, offshore SW Africa (Below, 1984); Early Albian, India (Jain, 1977); Albian, France (Davey & Verdier, 1971, 1973), USA (Hedlund & Norris, 1986); Early Santonian, NW Germany (Yun, 1981).

Prolixosphaeridium parvispinum subsp. *deirense* (Davey *et al.*) Below 1982
Pl. 3, figs 6, 9

Dimensions	
Size of cyst (excluding processes)	— 65 - 75 X 30 - 40 µm
Length of processes	— 10 - 15 µm

Geologic and geographic distribution–Uppermost Early Barremian - Early Aptian, France (Millioud, 1969); Middle Barremian, England (Davey *et al.*, 1966); Late Barremian - Early Aptian, N. Germany (Below, 1982d); Aptian, S. England (Duxbury, 1983), offshore SW Africa (Below, 1984); Albian, France (Davey & Verdier, 1971).

Plate 12 →

(All photomicrographsin differential interference contrast except figs 13- 15, x 500)

1. Gen. *et* sp. indet. L; slide no. BSIP 10784, coordinates: 12.5 x 148.6.
2. 4. *Cassiculosphaeridia pygmae* Stevens 1987; same specimen in two different foci; slide no. BSIP 10784; coordinates: 16.4 x 155.4.
3. *Sentusidinium aptiense* (Burger) Burger 1980; slide no. 10785, coordinates: 12.4 x 164.2.
5. *Kiokansium* sp. A; slide no. BSIP 10794, coordinates: 2.4 x 158.6.
6. 9. *Discorsia nanna* (Davey) Duxbury 1977 emend. Khowaja-Ateequzzaman *et al.* 1985; same specimen in two different foci; slide no. BSIP 8093, coordinates: 5.5 x 170.0.
7. *Apteodinium maculatum* Eisenack & Cookson 1960; slide no. BSIP 10150, coordinates: 18.4 x 140.3.
8. *Tanyosphaeridium variecalamus* Davey & Williams 1966; slide no. BSIP 10771, coordinates: 8.8 x 159.2.
10. *Gonyaulacysta cassidata* (Eisenack & Cookson) Sarjeant 1966, slide no. BSIP 10799, coordinates: 14.2 x 154.2.
11. Gen. *et* sp. indet. M; slide no. BSIP 1785, coordinates: 16.9 x 153.7.
12. *Achomosphaera* sp. B ; slide no. BSIP 10780, coordinates: 17.2 x 127.2.
13. 14. *Odontochitina operculata* (O. Wetzel) Deflandre & Cookson 1955; 13- slide no. BSIP 8093, coordintes: 15.2 x 164.2; 14- slide no. BSIP 10150, coordinates: 12.1 x 145.6.
14. *Muderongia mcwhaei* Cookson & Eisenak 1958, slide no. BSIP 8549, coordinates: 15.3 x 147.3.

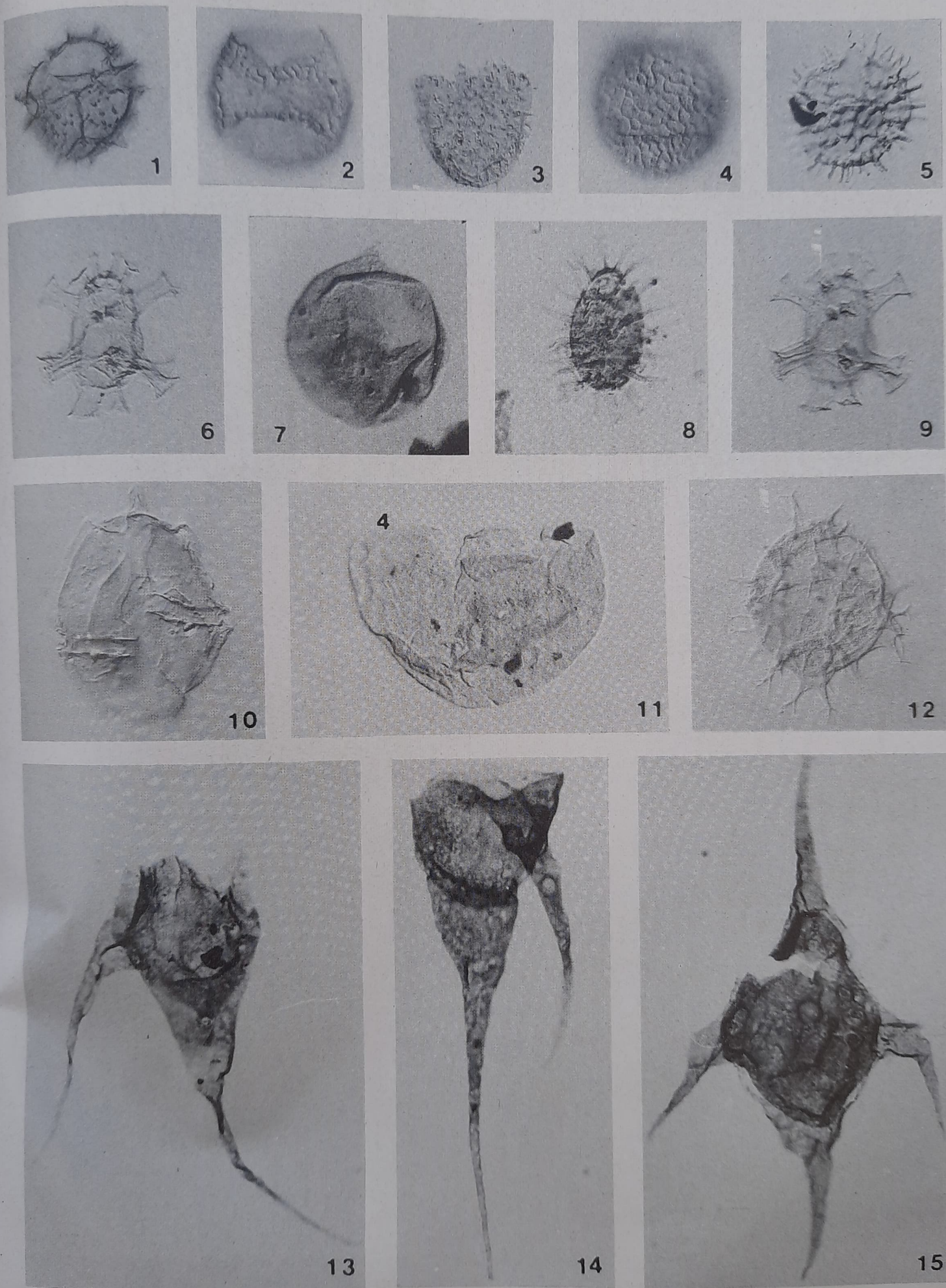

Plate 12

Genus- *Pseudoceratium* Gocht 1957 emend. Dörhöfer & Davies 1980 emend. Bint 1986 emend. Helby 1987

Pseudoceratium anaphrissum (Sarjeant) Bint 1986 emend. Harding 1990
Pl. 6, fig. 3

Dimensions
Size of cyst (excluding processes) — 100 - 120 X 95 - 105 µm
Length of processes — 6 - 18 µm

Geologic and geographic distribution–Hauterivian, SW Morocco (Below, 1981); Hauterivian - Barremian, Libya (Uwins & Batten, 1988); Hauterivian - Aptian, Germany (Alberti, 1961); Barremian, England (Davey, 1974; Duxbury, 1977, 1980; Sarjeant, 1966), Germany (Michael, 1964), Libya (Thusu & Van Der Eem, 1985; Thusu *et al.*, 1988); Barremian - Early Aptian, offshore SE Canada (Bujak & Williams, 1978); Aptian, Senegal (Jain & Millepied, 1975), Libya (Batten & Uwins, 1985); Early Albian, India (Jain, 1977).

Genus- *Pterodinium* Eisenack 1958 emend. Yun 1981 emend. Sarjeant 1985

Pterodinium aliferum Eisenack 1958 emend. Sarjeant 1985
Pl. 6, fig. 3

1988 b *Pterodinium premnos* Duxbury, 1980 *in* Khowaja-Ateequzzaman *et al.*, p. 84.

Dimensions
Size of cyst — 50 - 60 X 38 - 45 µm
Height of crest — 8 - 10 µm

Geologic and geographic distribution–Valanginian-Late Barremian, N. Germany (Below, 1981b, 1982d); Barremian, France (Reneville & Raynaud, 1981; Srivastava, 1984); Aptian, Germany (Eisenack, 1958); Albian, France (Davey & Verdier, 1971; Foucher & Taugourdeau, 1975); Canada (Doerenkamp *et al.*, 1976).

Pterodinium cingulatum (O. Wetzel) Below 1981
Pl. 7, fig. 1

Dimensions
Size of cyst — 50 - 60 X 50 - 55 µm
Height of crest — 4 - 8 µm

Geologic and geographic distribution–Aptian, England (Lister & Batten, 1988).

Pterodinium tuberculatum sp. nov.
Pl. 8, fig. 5

Holotype–Pl. 8, fig. 5; slide no. BSIP 10150.

Stratum & type locality– 441.2 - 444.2 m, bgl., (Conventional core), Puduvoyal bore-hole, Palar Basin, Tamil Nadu, southern India.

Diagnosis– Cyst ovoidal to ellipsoidal in shape, autophragm ornamented with tubercles, parasutures bear membranous crests with short spines on distal margins, paratabulation gonyaulacacean, exact formula not discernible, archaeopyle precingular, Type P(3" only), operculum free.

Description

Shape–Cyst ovoidal to ellipsoidal.

Wall relationship–Autophragm only.

Wall features–Autophragm thick, ornamented with closely placed tubercles, parasutures bear crests which is membranous with short spines at distal margin.

Paratabulation–Gonyaulacacean, exact formula could not be ascertained, the only source being parasutural crests is broken at places making it difficult to deduce the exact formula.

Archaeopyle–Precingular, Type P(3" only), operculum free.

Dimensions

	Holotype	Range
Size of body	— 58 X 40 µm	55 - 60 X 35 - 40 µm

Plate 13

(All hotomicrographs in differential interference contrast x 500)

1. *Pterospermella aureolata* (Cookson & Eisenack) Eisenack 1972; slideno. BSIP 10767, coordinates: 12.6 x 132.8.
2. *Nummus similis* (Cookson & Eisenack) Burger 1980; slide no. BSIP 10788, coordinates: 17.4 x 137.2.

3, 4. *Pterospermella aristotelesii* (Ioannides *et al.*) Srivastava 1984; 3- slide no. BSIP 10776, coordnates: 11.0 x 135.5; 4- slide no. BSIP 10795, coordinates: 10.7 x 132.0.

5. *Scriniodinium attadlense* (Cookson & Eisenack) Eisenack 1967; slide no. BSIP 10790, coordinates: 12.2 x 157.6.
6. Gen. et sp. indet. N; slide no. BSIP 10792, coordinates: 7.7 x 169.4.

7-8. *Disphaera tesselata* Srivastava 1984; 7- slide no. BSIP 10798, coordinates: 4.0 x 132.9; 8- slide no. BSIP 10787, coordinates: 14.2 x 153.2.

9. *Circulodinium distinctum* (Deflandre & Cookson) Jansonius 1986; slide no. BSIP 10775, coordinates: 6.7 x 163.6.
10. *Odontochitina athabaskensis* Pocock 1962; slide no. BSIP 10773, coordinates: 19.0 x 148.2.
11. *Pterospermella hartii* (Sarjeant) Eisenack *et al.* 1973; slide no. BSIP 10762, coordinates: 12.2 x 156.3.


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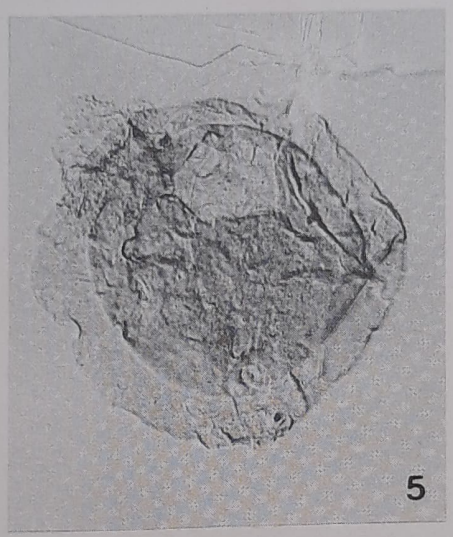
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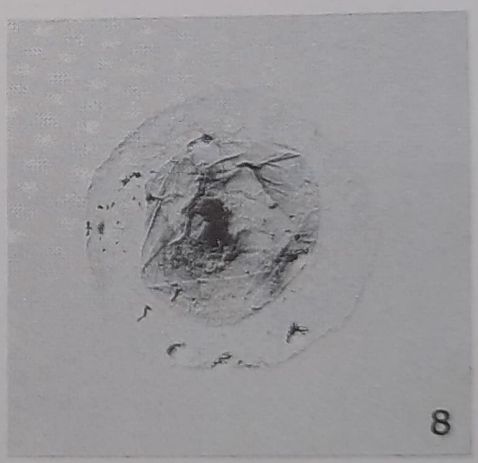
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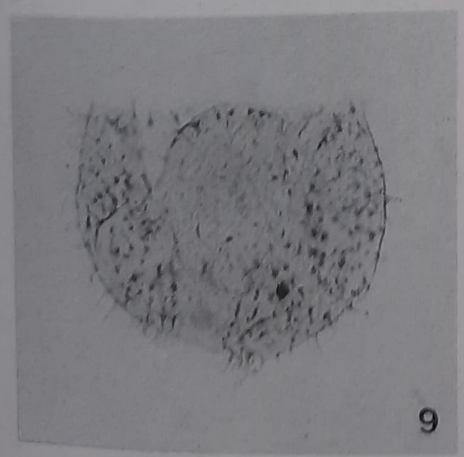
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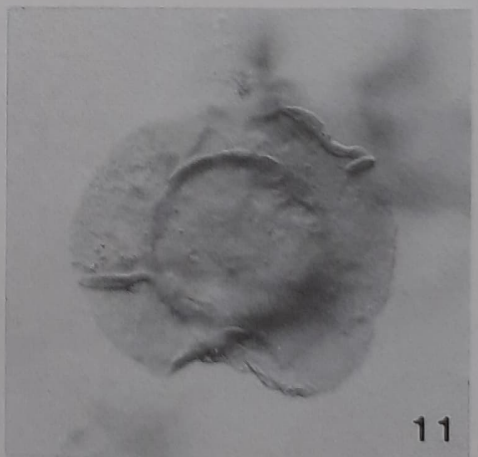
11

Plate 13

Height of crest — 6 μm 6 - 8 μm

Comparison–*Pterodinium tuberculatum* sp. nov. resembles *P. aliferum* Eisenack 1958 and *P. premnos* Duxbury 1980 in overall shape but differs in that spines on the crest margin and tuberculate autophragm.

Genus- *Pterospermella* Eisenack 1972

Pterospermella aristotelesii (Ioannides *et al.*) Srivastava 1984
Pl. 13, figs 3, 4

Dimensions
Size of cyst — 80 - 100 X 80 - 110 μm

Geologic and geographic distribution–Kimmeridgian, England (Ioannides *et al.*, 1977); Barremian, France (Srivastava, 1984).

Pterospermella aureolata (Cookson & Eisenack) Eisenack 1972
Pl. 13, fig. 1

Dimensions
Size of cyst — 140 - 160 X 120 - 130 μm

Geologic and geographic distribution–Portlandian - Valanginian, Denmark (Davey, 1982a); Valanginian - Early Barremian, Australia (Backhouse, 1988); Cenomanian - Early Turonian, Australia (Cookson & Eisenack, 1958).

Pterospermella hartii (Sarjeant) Eisenack *et al.* 1973
Pl. 13, fig. 11

Dimensions
Size of cyst — 60 - 75 X 70 - 80 μm

Geologic and geographic distribution–Oxfordian-Albian, England (Sarjeant, 1960; Gitmez & Sarjeant, 1972); Canada (Singh, 1971); Barremian, France (Srivastava, 1984).

Genus- *Pyxidiella* Cookson & Eisenack 1958

Pyxidiella scrobiculata (Deflandre & Cookson) Cookson & Eisenack 1958
Pl. 6, fig. 4

Dimensions
Size of cyst — 70 - 80 X 60 - 70 μm

Geologic and geographic distribution–Valanginian - Aptian, Australia (Burger, 1980); Santonian - Eocene, Australia (Deflandre & Cookson, 1955).

Genus- *Scriniodinium* Klement 1957

Scriniodinium attadelense (Cookson & Eisenack) Eisenack 1967
Pl. 13, fig. 5

Dimensions
Size of endocyst — 55 - 65 X 60 - 70 μm
Size of pericyst — 70 - 85 X 75 - 90 μm

Geologic and geographic distribution–Late Tithonian - Barremian, Australia (Helby *et al.*, 1987); Berriasian - Valanginian, California and N. Atlantic (Habib & Warren, 1973); Late Valanginian - Early Barremian, Australia (Backhouse, 1988); Hauterivian - Barremian, India (Garg *et al.*, 1988); ?Aptian, Australia (Cookson & Eisenack, 1958).

Genus- *Sentusidinium* Sarjeant & Stover 1978

Sentusidinium aptiense (Burger) Burger 1980
Pl. 12, fig. 3

Dimensions
Size of cyst — 55 - 65 X 40 - 45 μm
Length of spines — 3 - 5 μm

Geologic and geographic distribution–Late Neocomian - Late Albian, Australia (Morgan, 1980); Aptian, Australia (Burger, 1980).

Sentusidinium? fibrillosum Backhouse 1988
Pl. 10, figs 1, 5

Dimensions
Size of cyst — 50 - 60 X 45 - 50 μm

Geologic and geographic distribution–Late Valanginian - Hauterivian, Australia (Backhouse, 1988).

Genus- *Tanyosphaeridium* Davey & Williams 1966

Tanyosphaeridium variecalamus Davey & Williams 1966
Pl. 4, fig. 3; Pl. 5, fig. 5; PL. 12, fig. 8

Dimensions
Size of cyst (excluding processes) — 45 - 50 X 15 - 20 μm
Length of processes — 12 - 18 μm

Geologic and geographic distribution–Hauterivian - Aptian, offshore Spain (Masure, 1988); Barremian, England (Davey, 1974); France (Reneville & Raynaud, 1981; Srivastava, 1984); Aptian, England (Lister & Batten, 1988); Albian, Canada (Davey, 1969), France (Davey & Verdier, 1971); Albian - Early Palaeocene, offshore SE Canada (Bujak & Williams, 1978).

Genus- *Tehamadinium* Jan du Chêne *et al.* *in* Jan du Chêne *et al.* 1986

Tehamadinium coummium (Below) Jan du Chêne *et al.* in Jan du Chêne *et al.* 1986 emend.
Jan du Chêne *et al.* 1986
Pl. 11, figs 5, 8

Dimensions
Size of cyst — 60 - 65 X 55 - 60 μm

Geologic and geographic distribution–Albian, SW Morocco (Below, 1981).

Tehamadinium tenuiceras (Eisenack) Jan du Chêne *et al.* in Jan du Chêne *et al.* 1986
Pl. 5, fig. 15; pl. 10, fig. 2

Dimensions
Size of cyst — 55 - 60 X 55 - 60 μm

Geologic and geographic distribution–Middle Hauterivian - Barremian, Australia (Stover & Helby, 1987a, 1987b); Middle Hauterivian - Aptian, Australia (Backhouse, 1988); Late Barremian - Aptian, Germany (Alberti, 1961); Aptian, Australia (Cookson & Eisenack, 1962), SW Morocco (Below, 1981), France (Davey & Verdier, 1974), England (Lister & Batten, 1988), N. Germany (Below, 1982d); Aptian - Early Albian, England (Duxbury, 1983); Aptian - Albian, France (Verdier, 1975), offshore Atlantic (Habib, 1972); Late Aptian, Germany (Eisenack, 1958); Albian, France (Davey & Verdier, 1971; Fauconnier, 1975); Ypresian, Belgium (De Coninck, 1975).

Tehamadinium sp. A
Pl. 6, fig. 5

Description

Shape–Cyst subspherical witha short apical horn.
Wall relationship–Autophragm only.
Wall features–Surface pitted with parasutural ridges that are ornamented with scattered short spines.
Paratabulation–Indicated by parasutural ridges, gonyaulacacean, exact formula not known due to lack of specimens.
Archaeopyle–Precingular, Type 2P (2" + 3"), operculum free.

Dimensions
Size of cyst — 65 - 70 X 60 - 70 μm

Genus- *Tenua* Eisenack 1958 emend. Sarjeant 1968 emend. Pocock, 1972 emend. Sarjeant, 1985

Tenua hystrix Eisenack 1958
Pl. 8, fig. 2

Dimensions
Size of cyst — 40 - 45 X 40 - 45 μm
Length of spines — 3 - 5 μm

Geologic and geographic distribution–Kimmeridgian, Great Britain (Gitmez, 1970), France (Gitmez, 1970; Riley & Sarjeant, 1977); Portlandian - Barremian, offshore SE Canada (Bujak & Williams, 1978); Berriasian - Hauterivian, offshore Spain (Masure, 1988); Hauterivian - Barremian, India (Garg *et al.*, 1988), Libya (Uwins & Batten, 1988); Hauterivian - Albian, Canada (Brideaux, 1977); Late Neocomian - Cenomanian, Australia (Morgan, 1979); Aptian, Germany (Eisenack, 1958; Below, 1982d); Aptian - Cenomanian, offshore SW Africa (Below, 1984); Aptian - Maastrichtian, offshore SW Africa (Davey, 1978); Aptian - Albian, Canada (Brideaux & McIntyre, 1975), offshore northern Bay of Biscay (Davey, 1979b), Germany (Davey, 1982b); Early Albian, India (Jain, 1977); Cenomanian - Santonian, offshore Grand Bank (Williams & Brideaux, 1975).

Genus- *Valensiella* Eisenack 1963

Valensialla sp. A
Pl. 10, fig. 12

Description

Shape– Cyst ellipsoidal.
Wall relationship–Autophragm with thin ectophragm supported by muri.
Wall features–No parasutural features, autophragm ornamented with raised muri forming an irregular reticulum that is covered by a thin, continuous smooth ectophragm.
Paratabulation–Indicated by archaeopyle alone.
Archaeopyle–Apical, Type tA, operculum free or attached.

Dimensions
Size of cyst — 75 - 80 X 45 - 50 μm

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