A Systematic Illustrated Guide to Fossil Organic-walled Dinoflagellate Genera

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Friblastula utinensis. Originally described by Otto Wetzel in 1933 from a Cretaceous erratic flint in the Baltic region, this dinoflagellate cyst is now known from Maastrichtian sediments principally in North America and Europe.

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Abstract

The *Guide* assigns 276 genera of fossil dinoflagellates to the Orders Peridiniales, Dinophysidales, and Gymnodiniales. The Peridiniales are further subdivided into four suborders comprising 31 families. Each genus is illustrated by a line drawing at a standard magnification based in most cases on the illustration and description of the type species and holotype.

Introduction

The number of described fossil dinoflagellate taxa has increased dramatically since the mid-19th century (Downie and Sarjeant, 1965; Williams and Bujak, 1977a; Williams and Bujak, 1977b) with the last 10 to 15 years showing the greatest advance. During this period, however, taxonomic concepts have become stabilized and centre upon a few discrete characters which appear to be important for segregation of genera and higher level taxa (See Sarjeant, 1974, and Norris, 1978a, for a discussion of the development of higher level dinoflagellate cyst taxonomy since the 19th century.) Recent compilations (Evitt, 1975; Lentin and Williams, 1977b, 1978;) indicate in excess of 300 fossil genera and almost 2,000 fossil species of dinoflagellate cysts.

This explosion in fossil dinoflagellate taxonomy has rendered the Eisenack catalogue (Eisenack, 1964–1975) and the *Fichier Micropaléontologique Général* (Deflandre, and Deflandre-Rigaud, 1943–1974) essential tools for those attempting to trace original descriptions and illustrations of taxa and who do not have access to all the primary literature. Basionyms are almost exclusively used and few recombinations are referred to in those alphabetical listings of genera and species.

Our work facilitates the use of the existing catalogues and indices and improves understanding of the Class Dinophyceae by providing an illustrated guide to holotypes of type species of validly published fossil genera with organic-walled cysts. Generally, we include genera

with sufficiently clear characters to allow placement in families, although a few assigned "Incertae Familiae" are also illustrated.

All genera are illustrated by line drawings, either as facsimile reproductions of original figures (some with magnification changes) or by drafting from published photographs. The quality of the drafted figure is linked to the quality and details visible on the original photograph. It is apparent that some holotypes are poorly preserved or displayed. This must be taken into account in any taxonomic assessment of a genus which, however, is not the purpose of this *Guide*.

Fossil dinoflagellate genera excluded from this *Guide* are those with calcareous or siliceous walls, and those with less than the minimum characters available for familial placement (with certain exceptions) or those of doubtful dinophycean affinity. Junior synonyms are also omitted. Taxa now considered of subgeneric status are not included. In general, we were conservative in the selection of genera for illustration. Holotypes or topotype material, in most cases, have not been studied directly, thus requiring considerable caution in the interpretation of salient morphologic features. We believe that on restudy, some of the omitted genera will be capable of placement into the taxonomic scheme. Precipitous placement at this stage, however, would not serve any useful purpose, even though it became apparent during the preparation of the *Guide* that several taxa require emendation or recombination.

Abbreviations and Logograms

The families are listed herein with their salient morphologic features indicated by logograms (Norris, 1978a). Salient morphologic features of most fossil dinoflagellates, according to Norris (1978a), can be regarded as being dependent on up to six variables which are adequate for defining genera and higher taxa viz. degree of contraction, horns, archeopyle type, ornament distribution, special ornamental features, and tabulation. The following abbreviations are used for the variables in each category and are listed roughly in the order of ease of observation. They include terms used by Evitt et al. (1977), Norris (1978a), and by others that are listed in Williams, Sarjeant and Kidson (1973), together with some new terms that are discussed below. The terms selected for the variables are only some of the many available for describing dinoflagellate cyst morphology. They are adequate, however, for circumscribing taxonomically important features.

(i) degree of contraction (Text Fig. 1)

- Pc proximate — cavate
- Pa proximate — acavate (i.e. no pericoels developed)
- Ap apteate
- Sp spiniferate
- Ch chorate
- Ma marginate (see Fig. 165)

Some confusion is apparent in the usage of the term "proximochorate" as originally used by Downie and Sarjeant (1966: 15), for genera such as *Spiniferites* with low condensation ratios and sutural "outgrowths". The term suggests chorate cysts which have proximate characters. Yet, the main difference between proximate and chorate cysts is the development of a more or less spherical main body in the latter, whereas proximate cysts morphologically mimic the ambitus of the motile stage. Unfortunately, the term proximochorate has also been used for proximate cysts with low ornament, even though

this type of cyst requires separate characterization. To remove this uncertainty and ambiguity, Norris (1978a) chose the term spiniferate, to indicate cysts with an essentially spheroidal main body (i.e. with no clear relationship to the presumed shape of the parent theca) and prominent sutural processes, which may be connected proximally by linear elements or distally by trabeculae, or both. The processes are typically short (low condensation ratio). For proximate cysts with ornamentation of reduced length (i.e. the main body has a clear relationship to the presumed shape of the parent theca) the term apteate was introduced by Dörhöfer and Davies (1979). Apteate ornament in most cases is related to the plate configuration, i.e. intra- or penitabularly arranged.

Recent work on rhaetogonyaulacinean genera (Dörhöfer and Davies, 1979) shows that the development of endoblasts is a variable feature. Two-layered (or more) proximate cysts may or may not develop endoblasts, without any change in overall morphology. Therefore, Dörhöfer (in press) differentiates between cavate and acavate proximate cysts (Text fig. 1). It may be necessary ultimately to revise the proximate-cavate and proximate-acavate peridinialean families to express this variability more satisfactorily. At the moment, however, the distinction of phenotypic from genotypic variation in pericoelar development is difficult and its further application to taxonomy is not attempted here.

(ii) Horns (or unique processes in the cardinal positions)

- ap apical horn
- aa antapical horn
- 2aa two antapical horns
- 2cn two cingular horns
- pc one postcingular horn
- 2pc two postcingular horns

(iii) Archeopyle type

- A apical archeopyle
- I intercalary archeopyle
- P precingular archeopyle

Text figure 1 Dinoflagellate cyst types based on degree of contraction. Refer to text for explanation.

AIP epitrectal archeopyle or archeopyle comprising some plates of each series in the epitrect.

HA antapical archeopyle

DIS disintegration archeopyle

Disintegration archeopyles have been recognized and defined by Dörhöfer and Davies (1979) as forming by disintegration of the epitrect, initiated by splitting in the mid-dorsal intercalary position (usually between the apical and intercalary series) and subsequent progressive loss of the neighbouring plates. This type of archeopyle is characteristic for the earliest dinoflagellates of the family Rhaetogonyaulacaceae.

These principal types of archeopyles are adequate for most family logograms. Lower taxonomic levels require more elaborate formulas (see Norris, 1978a). We follow Norris (1978a: 303) in replacing the superscript bar in the archeopyle formula with round brackets in positions corresponding to each end of the bar.

(iv) Ornament distribution on the plate

sut sutural

pen penitabular

int intra-tabular (int-1 = one process per plate;
int-n = several processes per plate)

non non-tabular

abs absent

(v) Special ornamental features

trab trabeculate processes

pcel pericoelar connecting processes

akra akrate, i.e. ornament lacking or extremely reduced on cingulum

pcin pericingulate, i.e. sutural ornament exclusively or almost exclusively developed on cingulum

unpa unornamented pandasutural zone (or strongly reduced relative to intratabular elements elsewhere)

coro bearing a corona

(vi) Tabulation

The standard Kofoid plate numeration system and formula as adapted for cysts may be used. Alternatively, the common gonyaulacoid or peridinioid patterns (Norris, 1978a) are indicated "gon" or "per" respectively. "Sus" refers to suessoid tabulation (Norris, 1978a), most clearly and complexly developed in *Suessia* Morbey in which plate number is high and variable, the diagnostic character being an anterior intercalary series with at least three, usually fastigiate plates (i.e. posterior margins angular relative to cingulum). The earliest suessoid genera are characterized by a disintegration archeopyle, whereas advanced types developed intercalary archeopyles (Dörhöfer and Davies, 1979).

The following logograms of some well-known genera help to clarify this system. Further examples may be found in Norris (1978a, b). The logograms contain information

on up to six variables, each category being separated by a semicolon.

Alterbia Vozzh. emend. Lentin and Williams

Pc; ap, aa; l; sut-non-abs; pcin; per.

Gonyaulacysta Deflandre ex Norris and Sarjeant emend. Sarjeant

Pc-Pa; ap; P; sut; gon.

Wetzeliiella Eisenack emend. Lentin and Williams

Pc; ap, 2aa, 2cn; l; non-pen; per.

Hystrichosphaeridium Deflandre emend. Davey and Williams

Ch; A; int-l; gon.

Spiniferites Mantell emend. Sarjeant

Sp; P; sut; gon.

Classification

The revised classification of Norris (1978a, b), with emendations and additions by Dörhöfer and Davies (1979), is used to arrange illustrated genera in family groupings. This revised classification had its origins in the fundamental revision of existing fossil dinoflagellate families by Sarjeant and Downie (1974) and the principles proposed by them for adoption in the formulation of taxonomic units for dinoflagellates (Sarjeant and Downie, 1974: 13), viz. all stages of the life cycle should be used whenever possible in formulating and diagnosing taxa, both fossil and recent; a single epithet only is acceptable for identical fossil and living cysts, priority of publication determining the correct name; and the prime importance of salient morphologic features of fossil cysts in determining relationships and lineages.

Prior to Sarjeant and Downie's revision, no satisfactory suprageneric scheme was available. Many of the families recognized by Sarjeant and Downie were internally coherent but proved difficult to relate at higher taxonomic levels. Norris (1978a, b) examined these families in the light of improved understanding of tabulation patterns and archeopyle types. Of crucial importance to Norris's revision was the recognition of primitive but relatively complex tabulation in Triassic-Lower Jurassic dinoflagellates and the discrimination of earlier-evolved fastigiate intercalary plates from the later-evolved linteloid intercalary plates, any or all of the former contributing to archeopyle formation.

These observations led to recognition of the Rhaetogonyaulacineae, a suborder embracing the earliest and most primitive undoubted peridiniales in the Triassic and later Mesozoic. Although we do not reject the notion of distantly related dinoflagellate forerunners in the Palaeozoic (see Sarjeant, 1974: 98-103 for a discussion and leading references), neither can we accept unequivocally the supposed dinophycean characters of putative Lower Palaeozoic dinoflagellates. They remain for us

clearly defined acritarchs of doubtful affinity, with the exception of *Arpylorus* Calandra which appears to have some dinoflagellate-like features, but which are inadequate for familial placement.

The remaining three dinophycean suborders proliferated and eventually eclipsed the Rhaetogonyaulacineae in absolute taxonomic diversity in the late Mesozoic, although locally and regionally certain rhaetogonyaulacinean species continued to thrive or even dominate the phytoplankton (Dörhöfer and Davies, 1979; Dörhöfer, in press).

Examination of critical Jurassic and Cretaceous dinoflagellate assemblages allowed Dörhöfer and Davies (1979) to revise some aspects of Norris's classification. This included a fundamental reinterpretation and reassessment of certain rhaetogonyaulacinean genera, and the recognition of pseudoceratacean genera (included by Norris in the hystrichosphaeridiinean families Pseudoceratiaceae, Muderongiaceae, and Odontochitinaeae) as advanced and highly modified rhaetogonyaulacineans, the closest affinities being with the pareodiniaceans. The Muderongiaceae and Odontochitinaeae thereby are redundant.

Some of the deflandreinean families used here may require emendation on the basis of more detailed knowledge of tabulation, pericoel development, and archeopyle formation. Meanwhile, they are maintained pending further study.

The classification listed below incorporates these various changes and indicates by means of logograms the salient characters of each family, followed by references to illustrations in the *Guide*.

Division Pyrrhophyta Pascher, 1914
Class Dinophyceae Fritsch, 1929
Order Peridiniales Haeckel, 1894

A. Suborder Rhaetogonyaulacineae Norris, 1978b

1. Family Rhaetogonyaulacaceae Norris emend. Dörhöfer and Davies, 1979.
Pc-Pa; $\pm$ ap, $\pm$ aa; DIS; sut; sus. (Figs. 1–14).
2. Family Phallocystaceae Dörhöfer and Davies, 1979
Pc-Pa; $\pm$ ap, $\pm$ aa; l; abs-sut-int; sus (-5a). (Figs. 15–18).
3. Family Pareodiniaceae Gocht emend. Dörhöfer and Davies, 1979.
Pc-Pa; $\pm$ ap, $\pm$ aa; l; abs-sut; sus-gon (1-3a). (Figs. 19–26).
4. Family Pseudoceratiaceae Eisenack emend. Dörhöfer and Davies, 1979.
Pc-Pa; ap, 1-2aa, 1-2pc; Al; non-abs-pen; sus-gon. (Figs. 27–38).

B. Suborder Gonyaulacystineae Norris, 1978b

5. Family Gonyaulacystaceae Sarjeant and Downie

emend. Sarjeant and Downie, 1966.

Pa; $\pm$ ap; P; sut; gon. (Figs. 39–54).

6. Family Apteodiniaceae Eisenack emend. Sarjeant and Downie, 1974.
Pa; $\pm$ ap, $\pm$ aa; P; abs-non; $\pm$ pcin. (Figs. 55–67).
7. Family Spiniferitaceae Sarjeant and Downie emend. Sarjeant and Downie emend. Norris, 1978b.
Sp; $\pm$ ap; P; sut; gon. (Figs. 68–77).
8. Family Endoscriniaceae Vozzhennikova emend. Sarjeant and Downie, 1974.
Pc; $\pm$ ap, $\pm$ aa; P; sut-abs; pcin; gon. (Figs. 78–92).
9. Family Scrinocassiacae Sarjeant and Downie emend. Sarjeant and Downie, 1974.
Pc; $\pm$ ap; P; non; pcel. (Figs. 93–99).
10. Family Cordosphaeridiaceae Sarjeant and Downie emend. Norris, 1978b.
Ch; P; int (-l or -n) -pen; $\pm$ trab; gon. (Figs. 100–113).
11. Family Lingulodiniaceae Sarjeant and Downie, 1974.
Ch; $\pm$ ap; 1-5P; non. (Figs. 114–120).
12. Family Ctenidodiniaceae Sarjeant and Downie emend. Norris, 1978b.
Pa; $\pm$ ap; (AP); sut-non; gon. (Figs. 121–129).

C. Suborder Hystrichosphaeridiineae Norris, 1978b

13. Family Hystrichosphaeridiaceae Evitt emend. Sarjeant and Downie emend. Norris, 1978b.
Ch; $\pm$ aa; A; int-pen; $\pm$ trab; gon. (Figs. 130–152).
14. Family Cleistosphaeridiaceae Sarjeant and Downie, 1974.
Ch; A; non. (Figs. 153–158).
15. Family Florentiniaceae Harker and Sarjeant emend. Norris, 1978b.
Ch; $\pm$ aa; A+P; int (-l or -n); gon. (Figs. 159–163).
16. Family Areoligeraceae Evitt emend. Sarjeant and Downie, 1966.
Ma; A; non-pen; $\pm$ trab. (Figs. 164–166).
17. Family Lithodiniaceae Norris, 1978b.
Pa; $\pm$ ap; A; sut-pen; gon. (Figs. 167–181).
18. Family Batiacasphaeraceae Dörhöfer and Davies, 1979.
Pa; $\pm$ ap, $\pm$ aa; A; non; pcin. (Figs. 182–187).
19. Family Xiphophoridiaceae Sarjeant and Downie, 1966.
Sp; A; sut. (Figs. 188–190).
20. Family Senoniasphaeraceae Norris, 1978b.
Pc; $\pm$ ap, $\pm$ aa; A; sut-abs; $\pm$ pcin. (Figs. 191–199).
21. Family Membranilarnaciaceae Eisenack emend. Sarjeant and Downie, 1966.
Pc; $\pm$ ap; A; non; pcel. (Figs. 200–204).
22. Family Stephanelytraceae Stover, Sarjeant and Drugg, 1977.
Ap; A; sut-pen-non; coro. (Fig. 205).

D. Suborder *Deflandreineae* Eisenack emend. Norris, 1978b

23. Family Deflandreaceae Eisenack emend. Sarjeant and Downie, 1974.
Pc-Pa; $\pm$ ap, $\pm$ 2aa; l; sut-pen-abs; $\pm$ pcin; per. (Figs. 206–225).
24. Family Palaeoperidiniaceae Vozzhennikova emend. Sarjeant, 1967.
Pc-Pa; $\pm$ ap, $\pm$ aa; AIP; sut-pen-non-abs; per. (Figs. 226–234).
25. Family Wetzeliellaceae Vozzhennikova, 1961.
Pc; ap, 2aa, 2cn; l; non-pen; per. (Figs. 235–240).
26. Family Phthanoperidiniaceae Drugg and Loeblich, 1967.
Pa; ap, $\pm$ aa; l; sut-non-abs; per. (Figs. 241–255).
27. Family Ovoidiniaceae Norris, 1978b.
Pc; $\pm$ ap, $\pm$ aa; (AI); non-pcin; per. (Figs. 256–258).

E. Suborders *Incertae*

28. Family Ceratocoryaceae Stein, 1883.
Subfamily Thalassiphoroideae Gocht emend.
Sarjeant and Downie *stat. nov.* Norris, 1978b.
Pc; $\pm$ ap, $\pm$ aa; P; sut; l' $\pm$ la 5'' 4'' ' 1'' '. (Figs. 259–261).
29. Family Pyrophacaceae Lindemann emend. Steidinger and Davis, 1967.
Pc; 4HA; int; pcel. (Fig. 262).
30. Family Heteraulacacystaceae Drugg and Loeblich, 1967.
Pa; AIP; sut; 3' 7'' 5'' ' 3'' '. (Figs. 263–265).
31. Family Microdiniaceae Eisenack emend. Sarjeant and Downie emend. McLean, 1973a.
Pa; A; sut; 7'' 6'' ' 1p 1'' '. (Figs. 266–267).

Order Dinophysidales Stein, 1883

32. Family Nannoceratopsaceae Gocht, 1970b.
Pa; ap, aa; epitrectal archeopyle; non-abs. (Fig. 268).

Order Gymnodiniales Schütt, 1896

33. Family Dinogymniaceae Sarjeant and Downie, 1974.
Pa; ap, aa; A; non; pcin. (Fig. 269).
- Incertae Familiae* (Figs. 270–276)

Nomenclature

In general, the recent index to genera and species of Lentin and Williams (1977b) has been used as a valid nomenclatural base with the following exceptions:

- (a) Only genera with at least the minimum characters necessary for classification into families are illustrated. A few doubtfully affiliated genera, however, are also included in "Incertae Familiae".
- (b) Some genera recognized by us as synonymous are illustrated only by the senior synonym viz. *Alterbia-Senegalinium*; *Pentadinium-Planinosphaeridium*; *Thalassiphora-Erikania*.
- (c) Those genera indicated as synonymous or superfluous by Lentin and Williams (1977b) but which we consider may be distinct, are illustrated individually pending further study viz. *Dracodinium*; *Heliodinium*; *Imbatodinium*; *Komewuia*; *Palmnickia*; *Pluriarvalium*; *Soaniella*; *Trioperculodinium*.
- (d) Genera based only on the thecate stage are omitted.
- (e) Only genera with resistant organic-walled cysts are included, i.e. those with mineralized cyst walls are omitted.

How to Use the Guide

This *Guide* will, we hope, be helpful in assigning species to their appropriate generic and higher taxonomic groups. The following procedure may be used for this purpose.

- (i) Analyse the salient morphologic features of the unassigned species using a logogram to summarize selected features.
- (ii) If all elements of the logogram have been identified, this should allow placement in a suborder and family.
- (iii) Examine illustrations of the genera included in the family and select the most closely comparable genus or genera.
- (iv) Refer to the Eisenack catalogue or similar species compendia, for illustrations and descriptions of species assigned to the suspected genus or genera, and thence to the primary literature for further information. Because the Eisenack catalogue generally lists basionyms, it may be necessary to peruse Lentin and Williams (1977b, 1978, and earlier compilations) to ascertain the original generic assignment of some species before they can be located in the Eisenack catalogue.

Rapid location of a particular genus may be made by reference to the alphabetical list of genera below.

Alphabetical Check List of Families and Genera

The following list refers to families and genera selected for illustration in the *Guide*. The plates are arranged in taxonomic order; hence the plate explanations can be used as a taxonomic check list.

	Fig. No.		
<i>Accanthaulax</i> Sarjeant, 1968	39	<i>Cassiculosphaeridia</i> Davey, 1969a	183
<i>Achilleodinium</i> Eaton, 1976	100	<i>Cassidium</i> Drugg, 1967	184
<i>Achomosphaera</i> Evitt, 1963	68	<i>Catillopsis</i> Drugg, 1970	93
<i>Actinotheca</i> Cookson and Eisenack, 1960a	78	<i>Cauca</i> Davey and Verdier, 1971	123
<i>Adnatosphaeridium</i> Williams and Downie, 1966b	130	<i>Ceratiopsis</i> Vozzhennikova, 1963	209
<i>Aireiana</i> Cookson and Eisenack, 1965a	101	<i>Ceratocoryaceae</i> Stein, 1883	259–261
<i>Alterbia</i> Lentin and Williams, 1976	206	<i>Chatangiella</i> Vozzhennikova, emend. Lentin and Williams, 1976	210
<i>Amphidiadema</i> Lentin and Williams, 1976	207	<i>Chiropteridium</i> Gocht, 1960	165
<i>Amphorosphaeridium</i> Davey, 1969b	102	<i>Chlamydothorella</i> Cookson and Eisenack, 1958	200
<i>Amphorula</i> Dodekova, 1969	131	<i>Chytroeisphaeridia</i> (Sarjeant) Downie Evitt, and Sarjeant, emend. Pocock, 1972	57
<i>Andalusiella</i> Riegel, 1974	241	<i>Cladopyxidium</i> McLean, 1972	266
<i>Anthosphaeridium</i> Cookson and Eisenack, 1968	270	<i>Clathroctenocystis</i> Wiggins, 1972	169
<i>Apteodinium</i> Costa and Downie, 1976 stat. nov.		<i>Cleistosphaeridiaceae</i> Sarjeant and Downie, 1974	153–158
Lentin and Williams, 1977b	235	<i>Cleistosphaeridium</i> Davey, Downie, Sarjeant and Williams, 1966	153
<i>Aprobolocysta</i> Duxbury, 1977	27	<i>Cobricosphaeridium</i> Harland and Sarjeant, 1970	154
<i>Aptea</i> Eisenack, emend. Davey and Verdier, 1974	28	<i>Codoniella</i> Cookson and Eisenack, 1961a	80
<i>Apteodiniaceae</i> Eisenack, emend. Sarjeant and Downie, 1974	55–67	<i>Cometodinium</i> Deflandre and Courteville, 1939	272
<i>Apteodinium</i> Eisenack, 1958	55	<i>Comparodinium</i> Morbey, 1975	15
<i>Aquadulcum</i> Harland and Sarjeant, 1970	226	<i>Compositosphaeridium</i> Dodekova, 1974	134
<i>Araneosphaera</i> Eaton, 1976	103	<i>Conosphaeridium</i> Cookson and Eisenack, 1969	105
<i>Archeotectatum</i> Habib, 1972	56	<i>Cordosphaeridiaceae</i> Sarjeant and Downie, 1974	
<i>Areoligera</i> Lejeune-Carpentier, emend. Williams and Downie, 1966b	164	emend. Norris, 1978b	100–113
<i>Areoligeraceae</i> Evitt, emend. Sarjeant and Downie, 1966	164–166	<i>Cordosphaeridium</i> Eisenack, emend. Davey, 1969b	106
<i>Areosphaeridium</i> Eaton, 1971	132	<i>Coronifera</i> Cookson and Eisenack, emend. Davey, 1974	114
<i>Ascodinium</i> Cookson and Eisenack, 1960a	256	<i>Cribreridium</i> Neale and Sarjeant, emend. Davey, 1969a	42
<i>Ascostomocystis</i> Drugg and Loeblich, 1967	271	<i>Cryptarchaeodinium</i> Deflandre, emend. Gitmez, 1970	43
<i>Athigmatocysta</i> Duxbury, 1977	79	<i>Ctenidodiniaceae</i> Sarjeant and Downie, 1966	
<i>Avellodinium</i> Duxbury, 1977	69	emend. Norris, 1978b	121–129
		<i>Ctenidodinium</i> Deflandre, emend. Sarjeant, 1975a	124
<i>Bacchidinium</i> Davey, in press	104	<i>Cyclapophysis</i> Benson, 1976	107
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<i>Batiacasphaeraceae</i> Dörhöfer and Davies, 1979	182–187		
<i>Belodinium</i> Cookson and Eisenack, emend. Dodekova, 1975	167	<i>Danea</i> Morgenroth, 1968	108
<i>Biorbifera</i> Habib, 1972	121	<i>Dapcodinium</i> Evitt, 1961a	1
<i>Bourkidinium</i> Morgan, 1975	133	<i>Deflandrea</i> Eisenack, emend. Lentin and Williams, 1976	211
<i>Breodoxella</i> Norris, 1978b	122	<i>Deflandreaceae</i> Eisenack, emend. Sarjeant and Downie, 1974	206–225
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The recently published volume of systematic analyses of fossil dinoflagellates by Stover and Evitt (1978) is a valuable source of information on circumscriptions and limits of organic-walled genera, and effectively supplements the illustrations in this guide. They have erected the following new genera not included in this guide: *Aldorfia*, *Alisocysta*, *Balteocysta*, *Boreocysta*, *Corrudinium*, *Eatonicysta*, *Elytrocysta*, *Eucladinium*, *Eurydinium*, *Fibrocysta*, *Glaphyrocysta*, *Impagidinium*, *Kiokansium*, *Leberidocysta*, *Millioudodinium*, *Phelodinium*, and *Pontiadinium*.

By reference to new taxa "in press" it is not our intention to thereby validly publish these names. (See Article 34, International Code of Botanical Nomenclature.)

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All figures conform to the following magnifications:

Size Range	Scale	Magnification (Approx.)
<25 μm	Scale D	2000 $\times$
25 - 50 μm	Scale C	1000 $\times$
51 - 100 μm	Scale B	750 $\times$
> 100 μm	Scale A	500 $\times$

Scales are indicated in brackets behind the name of the type species; e.g. *Gonyaulacysta jurassica* (B). A 50 μm

bar corresponding to each scale (A, B, C, and D) is inserted on Plate I to facilitate measurements.

Whenever possible the respective holotype of the type species has been illustrated. In some cases illustrations of paratypes or schematic drawings are given instead, usually if the holotype did not clearly exhibit the generic features or if it was poorly illustrated originally. Following the scale, holotypes have been designated as "h", paratypes as "p", and schematic drawings as "s". e.g., *Gonyaulacysta jurassica* (B), h.

In general, no reference has been made to the literature on basionyms or emendations of the type species.

1. Family Rhaetogonyaulacaceae (1–14)

- Fig. 1** *Dapcodinium priscum* Evitt, 1961a (C), s; a. ventral, b. dorsal, c. apical, d. antapical.
Fig. 2 *Egmontodinium polyplacophorum* Gitmez and Sarjeant, 1972, (B), s; a. ventral, b. dorsal.
Fig. 3 *Hebecysta brevicornuta* Bujak and Fisher, 1976, (B); a. h, ventral, b. p, dorsal.
Fig. 4 *Heibergella asymmetrica* Bujak and Fisher, 1976, (B), h.
Fig. 5 *Luehndea spinosa* Morgenroth, 1970, (C), h.
Fig. 6 *Mendicodinium reticulatum* Morgenroth, 1970, (C), h.

1. Rhaetogonyaulacaceae

1. Family Rhaetogonyaulacaceae (cont.)

- Fig. 7** *Nelchinopsis kostromiensis* (Vozzhennikova) Wiggins, 1972, (B); a. h, dorsal, b. s, ventral, c. s, dorsal.
- Fig. 8** *Noricysta fimbriata* Bujak and Fisher, 1976, (C); a. h, ventral, b. s, ventral, c. s, dorsal.
- Fig. 9** *Rhaetogonyaulax rhaetica* (Sarjeant) Loeblich and Loeblich, 1968, (B); a. h, ventral, b. s, oblique ventral, c. s, dorsal.

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1. Family Rhaetogonyaulacaceae (cont.)

- Fig. 10** *Pluriarvalium osmingtonense* Sarjeant, 1962, (A), s; a. ventral, b. dorsal.
Fig. 11 *Subtilidinium minutum* Morgenroth, 1968, (D), s; a. ventral, b. dorsal.
Fig. 12 *Suessia swabiana* Morbey, 1975, (C), s;
Fig. 13 *Sverdrupiella septentrionalis* Bujak and Fisher, 1976, (B), h.
Fig. 14 *Valvaeodinium armatum* Morgenroth, 1970, (C), h.

2. Family Phallocystaceae (15–18)

Fig. 15 *Comparodinium koessenium* Morbey, 1975, (C), h.

Fig. 16 *Dodekovia syzygia* Dörhöfer and Davies, 1979, (C), h; a. ventral, b. dorsal.

Fig. 17 *Phallocysta eumekes* Dörhöfer and Davies, 1979, (C), s.

Fig. 18 *Susadinium scrofoides* Dörhöfer and Davies, 1979, (C), h; a. dorsal, b. ventral.

2. Phallocystaceae

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3. Family Pareodiniaceae (19–26)

- Fig. 19** *Broomea ramosa* Cookson and Eisenack, 1958, (A), h.
- Fig. 20** *Caligodinium amiculum* Drugg, 1970, (B), h.
- Fig. 21** *Cantulodinium speciosum* Alberti, 1961, (B), h.
- Fig. 22** *Glomodinium reticulopilosum* Dodekova, 1975, (C), h.
Gochteodinia villosa (Vozzhennikova) Norris, 1978b, not illustrated—refer to holotype in Vozzhennikova (1967), pg. 12, figs. 3a, b. pg. 5, fig. 1.
- Fig. 23** *Komewuia glabra* Cookson and Eisenack, 1960b (A), h.
- Fig. 24** *Moesiodinium raileanui* Antonescu, 1974, (C), h; a. dorsal, b. ventral.
- Fig. 25** *Paragonyaulacysta calloviensis* Johnson and Hills, 1973, (B), h; a. ventral, b. dorsal.
- Fig. 26** *Pareodinia ceratophora* Deflandre, 1947, (B), h.

3. Pareodiniaceae

4. Family Pseudoceratiaceae (27–38)

- Fig. 27** *Aprobolocysta eilema* Duxbury, 1977, (B), h.
Fig. 28 *Aptea polymorpha* Eisenack, 1958, (B); a. h, ventral, b. s, dorsal, c. s, ventral.
Fig. 29 *Canningia reticulata* Cookson and Eisenack, 1960b, (B), h.
Fig. 30 *Endoceratium ludbrookii* (Cookson and Eisenack) Loeblich and Loeblich, 1966, (A), h.
Fig. 31 *Heterosphaeridium conjunctum* Cookson and Eisenack, 1968, (A), h.

4. Pseudoceratiaceae

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4. Family Pseudoceratiaceae (cont.)

- Fig. 32** *Imbatodinium kondratjevi* Vozzhennikova, 1967, (A), h; a. dorsal, b. ventral.
Fig. 33 *Muderongia mcwhaei* Cookson and Eisenack, 1958, (A), h.
Fig. 34 *Odontochitina operculata* (O. Wetzel) Deflandre and Cookson, 1955, (A), s.
Fig. 35 *Odontochitinopsis molesta* (Deflandre) Eisenack, 1961, (B), h.
Fig. 36 *Phoberocysta neocomica* (Gocht) Millioud, 1969, (A), h.
Fig. 37 *Pseudoceratium pelliferum* Gocht, 1957, (A), h.
Fig. 38 *Xenascus ceratioides* (Deflandre) Lentin and Williams, 1973, (A), h.

5. Family Gonyaulacystaceae (39–54)

Fig. 39 *Acanthaulax venusta* (Klement) Sarjeant, 1968, (B), h.

Fig. 40 *Carpatella cornuta* Grigorovitch, 1969, (A), h.

Fig. 41 *Carpodinium granulatum* Cookson and Eisenack, 1962b, (B), h; a. ventral, b. dorsal.

Fig. 42 *Cribroperidinium sepimentum* Neale and Sarjeant, 1962, (B), h; a. oblique ventral, b. dorsal.

Fig. 43 *Cryptarchaeodinium calcaratum* Deflandre, 1939, (C), h.

Fig. 44 *Diacanthum hollisteri* Habib, 1972, (B), h; a. dorsal, b. ventral.

5. Gonyaulacystaceae

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5. Family Gonyaulacystaceae (cont.)

- Fig. 45** *Druggidium apicopaucicum* Habib, 1973, (B), h; a, ventral, b. dorsal.
- Fig. 46** *Gonyaulacysta jurassica* (Deflandre) Norris and Sarjeant, 1965, (B), h; a. ventral, b. dorsal.
- Fig. 47** *Herendeenia pisciformis* (Cookson and Eisenack) Wiggins, 1969, (B), s; a. dorsal, b. ventral.
- Fig. 48** *Heslertonia heslertonensis* (Neale and Sarjeant) Sarjeant, 1966, (B), h.
- Fig. 49** *Leptodinium subtile* Klement, 1960, (B), h; a. ventral, b. dorsal.

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5. Family Gonyaulacystaceae (cont.)

- Fig. 50** *Muratodinium fimbriatum* (Cookson and Eisenack) Drugg, 1970, (B), h.
Fig. 51 *Occisucysta balia* Gitmez, 1970, (B), h; a. ventral, b. oblique dorsal.
Fig. 52 *Prionodinium alaskense* Leffingwell and Morgan, 1977, (B), h; a. dorsal, b. ventral.
Fig. 53 *Pterodinium aliferum* Eisenack, 1958, (B), h.
Fig. 54 *Rhynchodiniopsis aptiana* Deflandre, 1935, (B), h; a. ventral, b. dorsal.

6. Family Apteodiniaceae (55-67)

- Fig. 55** *Apteodinium granulatum* Eisenack, 1958, (B), h.
Fig. 56 *Archeotectatum sarjeantii* Habib, 1972, (C), h.
Fig. 57 *Chytroeisphaeridia chytroeides* (Sarjeant) Downie and Sarjeant, 1965, (B), h.
Fig. 58 *Ellipsodinium rugulosum* Clarke and Verdier, 1967, (C), s.
Fig. 59 *Fusiformacysta salasii* Morgan, 1975, (A), h.
Fig. 60 *Kenleyia pachycerata* Cookson and Eisenack, 1965b, (B), h.
Fig. 61 *Lunatadinium dissolutum* Brideaux and McIntyre, 1973, (B), h.

6. Apteodiniaceae

6. Family Apteodiniaceae (cont.)

- Fig. 62** *Pyxidinopsis challengerensis* Habib, 1976, (B), h.
Fig. 63 *Speetonia delicatula* Duxbury, 1977, (B), h.
Fig. 64 *Tapeinosphaeridium pericompsum* Ioannides et al., 1977, (B), h.
Fig. 65 *Tectatodinium pellitum* Wall, 1967, (B), h.
Fig. 66 *Trichodinium pellitum* Eisenack and Cookson, 1960, (B), h.
Fig. 67 *Xenicodinium densispinosum* Klement, 1960, (B), h.

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7. Family Spiniferitaceae (68–77)

- Fig. 68** *Achomosphaera ramulifera* (Deflandre) Evitt, 1963, (B), h.
- Fig. 69** *Avellodinium falsificum* Duxbury, 1977, (B), p; a. ventral, b. dorsal. (Family placement is questionable.)
- Fig. 70** *Cannosphaeropsis utinensis* O. Wetzel, 1933, (A), h.
- Fig. 71** *Hapsidaulax margarethae* Sarjeant, 1975b, (C), h; a. antapical, b. apical.
- Fig. 72** *Hapsocysta peridictya* (Eisenack and Cookson) Davey, in press, (B), h.
- Fig. 73** *Heliodinium voigtii* (Alberti) Sarjeant, 1966, (B), h.

7. Spiniferitaceae

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7. Family Spiniferitaceae (cont.)

- Fig. 74** *Hystrichodinium pulchrum* Deflandre, 1935, (B), h; a. dorsal, b. ventral.
Fig. 75 *Hystrichogonyaulax cornigera* (Valensi) Sarjeant, 1969, (B); a. h, ventral, b. p, ventral.
Fig. 76 *Nematosphaeropsis balcombiana* Deflandre and Cookson, 1955, (B), h.
Fig. 77 *Spiniferites ramosus* (Ehrenberg) Mantell, 1854, (B), s.

8. Family Endoscriniaceae (78–92)

- Fig. 78** *Actinotheca aphroditae* Cookson and Eisenack, 1960a, (B), h.
Fig. 79 *Athigmatocysta glabra* Duxbury, 1977, (B), h; a. ventral, b. oblique dorsal.
Fig. 80 *Codoniella campanulata* (Cookson and Eisenack) Downie and Sarjeant, 1965, (B), h.
Fig. 81 *Dimidiadinium dangeardii* (Sarjeant) Brideaux, 1977, (B), h; a. ventral, b. dorsal.

8. Endoscriniaceae

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8. Family Endoscriniaceae (cont.)

- Fig. 82** *Endoscrinium galeritum* (Deflandre) Vozzhennikova, 1967, (B), h.
Fig. 83 *Glabridinium apatelum* (Cookson and Eisenack) Brideaux, 1977, (B), h.
Fig. 84 *Glossodinium dimorphum* Ioannides et al., 1977, (A); a. b, dorsal, b. s, dorsal.
Fig. 85 *Hystrichosphaeropsis ovum* Deflandre, 1935, (B), h.
Fig. 86 *Montanarocysta aemiliana* Corradini, 1973, (A), h.

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8. Family Endoscriniaceae (cont.)

- Fig. 87** *Psaligonyaulax deflandrei* Sarjeant, 1966, (B), h; a. ventral, b. dorsal.
Fig. 88 *Rottnestia borussica* (Eisenack) Cookson and Eisenack, 1961b, (B), h.
Fig. 89 *Scriniodinium crystallinum* (Deflandre) Klement, 1960, (B), h.
Fig. 90 *Stephodinium coronatum* Deflandre, 1936, (A), h.
Fig. 91 *Triblastula utinensis* O. Wetzel, 1933, (B), s; a. ventral, b. dorsal.
Fig. 92 *Tubotuberella rhombiformis* Vozzhennikova, 1967, (B), h.

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9. Family Scriniocassiaceae (93–99)

- Fig. 93** *Catillopsis abdita* Drugg, 1970, (B), h.
Fig. 94 *Cyclodictyon paradoxum* Cookson and Eisenack, 1958, (B), h.
Fig. 95 *Disphaeria macropyla* Cookson and Eisenack, 1960a (B), h.
Fig. 96 *Omatia montgomeryi* Cookson and Eisenack, 1958, (B), h.
Fig. 97 *Samlandia chlamydophora* Eisenack, 1954, (B), h.
Fig. 98 *Scriniocassis weberi* Gocht, 1964, (B), h.
Fig. 99 *Spongodinium delitiense* (Ehrenberg) Deflandre, 1936, (B), h.

9. Scriniocassiaceae

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10. Family Cordosphaeridiaceae (100–113)

Fig. 100 *Achilleodinium biformoides* (Eisenack) Eaton, 1976, (B), s; a. ventral, b. dorsal.

Fig. 101 *Aireiana verrucosa* Cookson and Eisenack, 1965a, (B); a. h, dorsal, b. (from Stover, 1975) s; dorsal.

Fig. 102 *Amphorosphaeridium fenestratum* Davey, 1969b, (B), h.

10. Cordosphaeridiaceae

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10. Family Cordosphaeridiaceae (cont.)

- Fig. 103** *Araneosphaera araneosa* Eaton, 1976, (A), h; a. ventral, b. dorsal.
Fig. 104 *Bacchidinium polypes* (Cookson and Eisenack) Davey, in press, (A), h.
Fig. 105 *Conosphaeridium striatoconus* (Deflandre and Cookson) Cookson and Eisenack, 1969, (B), h.
Fig. 106 *Cordosphaeridium inodes* (Klumpp) Eisenack, 1963, (A), h.
Fig. 107 *Cyclapophysis monmouthensis* Benson, 1976, (B), h.

10. Family Cordosphaeridiaceae (cont.)

- Fig. 108** *Danea mutabilis* Morgenroth, 1968, (A), h, dorsal.
Fig. 109 *Kleithriasphaeridium corrugatum* Davey, 1974, (B), h.
Fig. 110 *Lanternosphaeridium lanosum* Morgenroth, 1966, (A), h.
Fig. 111 *Palmnickia lobifera* Eisenack, 1954, (A), h.
Fig. 112 *Silicisphaera ferox* (Deflandre) Davey and Verdier, 1976, (B), s.
Fig. 113 *Turbiosphaera filosa* (Wilson) Archangelsky, 1969, (A), h.

11. Family Lingulodiniaceae (114–120)

- Fig. 114** *Coronifera oceanica* Cookson and Eisenack, 1958, (B), h.
Fig. 115 *Exochosphaeridium phragmites* Davey et al., 1966, (B), h.
Fig. 116 *Lingulodinium machaerophorum* (Deflandre and Cookson) Wall, 1967, (B), h.
Fig. 117 *Nexosispinum hesperum* Davey, in press, (B), h.
Fig. 118 *Operculodinium centrocarpum* (Deflandre and Cookson) Wall, 1967, (B), s.
Fig. 119 *Protoellipsodinium spinocristatum* Davey and Verdier, 1971, (C), h.
Fig. 120 *Trioperculodinium siculum* Drugg, 1970, (B), h.

11. Lingulodiniaceae

12. Family Ctenidodiniaceae (121–129)

- Fig. 121** *Biorbifera johnewingii* Habib, 1972, (C), h.
Fig. 122 *Breodoxella caperata* (Brideaux) Norris, 1978b, (B), h.
Fig. 123 *Cauca parva* (Alberti) Davey and Verdier, 1971, (C), h.
Fig. 124 *Ctenidodinium ornatum* (Eisenack) Deflandre, 1938, (B), s; a. ventral, b. dorsal.
Fig. 125 *Dichadogonyaulax culmula* (Norris) Loeblich and Loeblich, 1968, (B), h; a. oblique ventral, b. dorsal.
Fig. 126 *Energlynia kyrbasia* Sarjeant, 1976, (C), h.

12. Ctenidodiniaceae

12. Family Ctenidodiniaceae (cont.)

- Fig. 127** *Eodinia pachythea* Eisenack, 1936, (B), a. h, b. s, dorsal, c. s, ventral.
Fig. 128 *Toolongia medusoides* Cookson and Eisenack, 1960a, (B), h.
Fig. 129 *Wanaea spectabilis* (Deflandre and Cookson) Cookson and Eisenack, 1958, (B), p.

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13. Family Hystrichosphaeridiaceae (130–152)

- Fig. 130** *Adnatosphaeridium vittatum* Williams and Downie, 1966b, (B), h.
- Fig. 131** *Amphorula metaelliptica* Dodekova, 1969, (B), h; a. ventral, b. dorsal.
- Fig. 132** *Areosphaeridium diktyoplokus* (Klumpp) Eaton, 1971, (A), h.
- Fig. 133** *Bourkidinium granulatum* Morgan, 1975, (B), h.
- Fig. 134** *Compositosphaeridium costatum* (Davey and Williams) Dodekova, 1974, (B), s.
- Fig. 135** *Diphyes colligerum* (Deflandre and Cookson) Cookson, 1965, (B), h.

13. Hystrichosphaeridiaceae

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13. Family Hystrichosphaeridiaceae (cont.)

- Fig. 136** *Discorsia nanna* (Davey) Duxbury, 1977, (C), s; a. ventral, b. dorsal.
Fig. 137 *Distatodinium craterum* Eaton, 1976, (B), h.
Fig. 138 *Emmetrocysta urnaformis* (Cookson) Stover, 1975, (B), s; a. antapical, b. apical.
Fig. 139 *Epiplosphaera bireticulata* Klement, 1960, (B), h.
Fig. 140 *Hemiplacophora semilunifera* Cookson and Eisenack, 1965a, (B), h.

13. Family Hystrichosphaeridiaceae (cont.)

- Fig. 141** *Hystrichokolpoma cinctum* Klumpp, 1953, (B), s; a. ventral, b. dorsal.
Fig. 142 *Hystrichosphaeridium tubiferum* (Ehrenberg) Deflandre, 1937, (B), s.
Fig. 143 *Litosphaeridium siphoniphorum* (Cookson and Eisenack) Davey and Williams, 1966, (B), h.
Fig. 144 *Oligosphaeridium complex* (White) Davey and Williams, 1966, (A), s.
Fig. 145 *Peridictyocysta mirabilis* (Cookson and Eisenack) Cookson and Eisenack, 1974, (B), h.
Fig. 146 *Perisseiasphaeridium pannosum* Davey and Williams, 1966, (B), s.

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13. Family Hystrichosphaeridiaceae (cont.)

- Fig. 147** *Polystephanephorus calathus* (Sarjeant) Downie and Sarjeant, 1965, (B), h.
- Fig. 148** *Prolixosphaeridium parvispinum* (Deflandre) Davey et al., 1969, (C), h. (Refer to Davey and Verdier, 1974, pp. 636-7 for a discussion of the synonymy of the originally designated type species *P. deirense* with *P. parvispinum*.)
- Fig. 149** *Surculosphaeridium cribrotubiferum* (Sarjeant) Davey et al., 1966, (B), s; a. oblique ventral, b. dorsal.
- Fig. 150** *Systematophora areolata* Klement, 1960, (B), h; a. dorsal, b. ventral.
- Fig. 151** *Taeniophora iunctispina* Klement, 1960, (A), h.
- Fig. 152** *Tanyosphaeridium variecalamum* Davey and Williams, 1966, (B), h.

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14. Family Cleistosphaeridiaceae (153–158)

- Fig. 153** *Cleistosphaeridium diversispinosum* Davey et al., 1966, (B), h.
Fig. 154 *Cobricosphaeridium hebes* Harland and Sarjeant, 1970, (B), h.
Fig. 155 *Impletosphaeridium transfodum* Morgenroth, 1966, (C), h.
Fig. 156 *Kallosphaeridium brevibarbatum* De Coninck, 1969, (B), h.
Fig. 157 *Lingulasphaera spinula* Drugg, 1970, (B), h.
Fig. 158 *Polysphaeridium subtile* Davey and Williams, 1966, (B), h.

14. Cleistosphaeridiaceae

15. Family Florentiniaceae (159–163)

- Fig. 159** *Callaiosphaeridium asymmetricum* (Deflandre and Courteville) Davey and Williams, 1966, (B), h.
Fig. 160 *Eocladopyxis peniculata* Morgenroth, 1966, (C), h.
Fig. 161 *Florentinia laciniata* Davey and Verdier, 1973, (B), h.
Fig. 162 *Hemicystodinium zoharyi* (Rossignol) Wall, 1967, (C), h.
Fig. 163 *Homotryblum tenuispinosum* Davey and Williams, 1966, (B), h.

15. Florentiniaceae

16. Family Areoligeraceae (164–166)

Fig. 164 *Areoligera senonensis* Lejeune-Carpentier, 1938, (A), s.

Fig. 165 *Chiropteridium lobospinosum* (Gocht) Gocht, 1960, (A), h; a. dorsal, b. ventral.

Fig. 166 *Cyclonephelium compactum* Deflandre and Cookson, 1955, (B), h.

16. Areoligeraceae

17. Family Lithodiniaceae (167–181)

- Fig. 167** *Belodinium dysculum* Cookson and Eisenack, 1960b, (A), h.
- Fig. 168** *Canninginopsis denticulata* Cookson and Eisenack, 1962b, (B), h; a. ventral, b. dorsal.
- Fig. 169** *Clathroctenocystis elegans* Wiggins, 1972, (A), s; a. ventral, b. dorsal.
- Fig. 170** *Eisenackia crassitabulata* Deflandre and Cookson, 1955, (B), h; a. oblique dorsal, b. oblique ventral.
- Fig. 171** *Ellipsoidictyum cinctum* Klement, 1960, (B), h; a. dorsal, b. ventral.

17. Lithodiniaceae

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17. Family Lithodiniaceae (cont.)

- Fig. 172** *Fibradinium annetorpense* Morgenroth, 1968, (C), s; a. ventral, b. dorsal.
Fig. 173 *Gillinia hymenophora* Cookson and Eisenack, 1960a, (C), h.
Fig. 174 *Glyphanodinium facetum* Drugg, 1964, (C), s; a. ventral, b. dorsal.
Fig. 175 *Histiocysta palla* Davey, 1969a, (C), h; a. ventral, b. dorsal.
Fig. 176 *Histiophora ornata* Klement, 1960, (B), h; a. dorsal, b. ventral.
Fig. 177 *Horologinella lineata* Cookson and Eisenack, 1962a, (C), h; a. dorsal, b. ventral.
Fig. 178 *Lanterna bulgarica* Dodekova, 1969, (B), h; a. ventral, b. dorsal.

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17. Family Lithodiniaceae (cont.)

Fig. 179 *Lithodinia jurassica* Eisenack, 1935, (B), h; a. ventral, b. dorsal.

Fig. 180 *Parvulodinium clavatum* Dodekova, 1975, (C), h; a. ventral, b. dorsal.

Fig. 181 *Schematophora speciosa* Deflandre and Cookson, 1955, (B), h; a. dorsal, b. ventral.

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18. Family Batiacasphaeraceae (182–187)

- Fig. 182** *Batiacasphaera compta* Drugg, 1970, (B), h.
Fig. 183 *Cassiculosphaeridia reticulata* Davey, 1969a, (C), h.
Fig. 184 *Cassidium fragile* (Harris) Drugg, 1967, (B), h.
Fig. 185 *Epelidosphaeridia spinosa* (Cookson and Hughes) Davey, 1969a, (B), h.
Fig. 186 *Membranosphaera maastrichtica* Samoilovitch ex Norris and Sarjeant, 1965, (C), s.
Fig. 187 *Rhombodella natans* Cookson and Eisenack, 1962b, (B), h.

19. Family Xiphophoridiaceae (188–190)

- Fig. 188** *Dorocysta litotes* Davey, 1970, (C), h.
Fig. 189 *Raphidodinium fucatum* Deflandre, 1936, (B), h.

18. Batiacasphaeraceae

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19. Xiphophoridiaceae

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19. Family Xiphophoridiaceae (cont.)

Fig. 190 *Xiphophoridium alatum* (Cookson and Eisenack) Sarjeant, 1966, (A), h.

20. Family Senoniasphaeraceae (191–199)

Fig. 191 *Dingodinium jurassicum* Cookson and Eisenack, 1958, (B), h.

Fig. 192 *Duosphaeridium nudum* (Cookson) Loeblich and Loeblich, 1968, (B), h.

Fig. 193 *Palynodinium grallator* Gocht, 1970a, (A), s; a. apical, b. ventral, c. dorsal.

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20. Senoniasphaeraceae

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20. Family Senoniasphaeraceae (cont.)

- Fig. 194** *Parvocavatus tuberosus* Gitmez, 1970, (B), h; a. ventral, b. dorsal.
Fig. 195 *Polygonifera evitti* Habib, 1972, (C), h.
Fig. 196 *Senoniasphaera protrusa* Clarke and Verdier, 1967, (B), s.
Fig. 197 *Sirmiodinium grossii* Alberti, 1961, (B), h.
Fig. 198 *Trigonopyxidia ginella* (Cookson and Eisenack) Downie and Sarjeant, 1965, (B), h.
Fig. 199 *Wallodinium glaessneri* (Cookson and Eisenack) Leoblich and Leoblich, 1968, (A), h.

21. Family Membranilarnaciaceae (200–204)

- Fig. 200** *Chlamydophorella nyei* Cookson and Eisenack, 1958, (C), h.
Fig. 201 *Gardodinium trabeculosum* (Gocht) Alberti, 1961, (B), h.
Fig. 202 *Membranilarnacia leptoderma* (Cookson and Eisenack) Eisenack, 1963, (B), h.
Fig. 203 *Renidinium membraniferum* Morgenroth, 1968, (B), h.
Fig. 204 *Valensiella ovula* (Deflandre) Eisenack, 1963, (B), h; a. ventral, b. dorsal.

22. Family Stephanelytraceae (205)

- Fig. 205** *Stephanelytron redcliffense* Sarjeant, 1961a, (C), s; a. dorsal, b. ventral.

21. Membranilarnaciaceae

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22. Stephanelytraceae

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23. Family Deflandreaceae (206–225)

- Fig. 206** *Alterbia recticornis* (Vozzhennikova) Lentin and Williams, 1976, (B), h.
- Fig. 207** *Amphidiadema denticulata* Cookson and Eisenack, 1960a, (B), h.
- Fig. 208** *Bulbodinium seitzii* O. Wetzel, 1960, (A), h.
- Fig. 209** *Ceratiopsis leptoderma* Vozzhennikova, 1963, (A), h.
- Fig. 210** *Chatangiella niiga* Vozzhennikova, 1967, (A), h.
- Fig. 211** *Deflandrea phosphoritica* Eisenack, 1938, (A), h.
- Fig. 212** *Diconodinium multispinum* (Deflandre and Cookson) Eisenack and Cookson, 1960, (B); a. h, b. s, ventral, c. s, dorsal.
- Fig. 213** *Hexagonifera glabra* Cookson and Eisenack, 1961a, (B), h.

23. Deflandreaceae

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23. Family Deflandreaceae (cont.)

- Fig. 214** *Inversidinium exilimurum* McLean, 1973b, (B), h.
Fig. 215 *Isabelidinium korojonense* (Cookson and Eisenack) Lentin and Williams, 1977a (B), h.
Fig. 216 *Nelsoniella aceras* Cookson and Eisenack, 1960a, (B), h.
Fig. 217 *Palaeocystodinium golzowense* Alberti, 1961, (A), h.
Fig. 218 *Palaeohystrichophora infusorioides* Deflandre, 1935, (C), h.
Fig. 219 *Pseudodeflandrea gigantea* Alberti, 1959, (A), h.

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23. Family Deflandreaceae (cont.)

- Fig. 220** *Smolenskiella crassithec*a Vozzhennikova, 1967, (C), h.
Fig. 221 *Spinidinium styloniferum* Cookson and Eisenack, 1962b, (B), h.
Fig. 222 *Svalbardella cooksoniae* Manum, 1960, (A), h.
Fig. 223 *Trithyrodinium evittii* Drugg, 1967, (B), h.
Fig. 224 *Uvatodinium nasutum* Vozzhennikova, 1963, (B), h.
Fig. 225 *Xenikoon australis* Cookson and Eisenack, 1960a, (B), h.

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24. Family Palaeoperidiniaceae (226–234)

- Fig. 226** *Aquadulcum serpens* Harland and Sarjeant, 1970, (C), h.
Fig. 227 *Geiselodinium geiseltalense* Krutzsch, 1962, (A), h.
Fig. 228 *Ginginodinium spinulosum* Cookson and Eisenack, 1960a, (B), h.
Fig. 229 *Laciniadinium orbiculatum* McIntyre, 1975, (B), h.
Fig. 230 *Luxadinium primulum* Brideaux and McIntyre, 1975, (C), p.
Fig. 231 *Palaeoperidinium pyrophorum* (Ehrenberg) Sarjeant, 1967, (B), a. h.

24. Palaeoperidiniaceae

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24. Family Palaeoperidiniaceae (cont.)

Fig. 231 (cont.) *Palaeoperidinium pyrophorum*, (B), b. s. ventral, c. s. dorsal.

Fig. 232 *Saeptodinium gravattense* Harris, 1974, (B), h.

Fig. 233 *Subtilisphaera senegalensis* Jain and Millepied, 1973, (B), h.

Fig. 234 *Teneridinium magnoides* Krutzsch, 1962, (B), h.

25. Family Wetzeliellaceae (235–240)

- Fig. 235** *Apectodinium homomorphum* (Deflandre and Cookson) Lentin and Williams, 1977b, (B), h.
Fig. 236 *Dracodinium solidum* Gocht, 1955, (B), h.
Fig. 237 *Kisselovia ornata* Vozzhennikova, 1967, (C), h.
Fig. 238 *Rhombodinium draco* Gocht, 1955, (A), h.
Fig. 239 *Wetzeliella articulata* Eisenack, 1938, (A), h.
Fig. 240 *Wilsonidium tabulatum* (Wilson) Lentin and Williams, 1976, (A), h.

25. Wetzeliellaceae

26. Family Phthanoperidiniaceae (241–255)

- Fig. 241** *Andalusiella mauthei* Riegel, 1974, (A), s; a. dorsal, b. ventral.
Fig. 242 *Dioxya armata* Cookson and Eisenack, 1958, (B), h.
Fig. 243 *Leipokatium invisitatum* Bradford, 1975, (B), h.
Fig. 244 *Lejeunecysta hyalina* (Gerlach) Artzner and Dörhöfer, 1978, (A), h; a. dorsal, b. ventral.
Fig. 245 *Maduradinium pentagonum* Cookson and Eisenack, 1970, (A), h.
Fig. 246 *Muiradinium dorsispirale* (Churchill and Sarjeant) Harland and Sarjeant, 1970, (C), h; a. ventral, b. dorsal.

26. Phthanoperidiniaceae

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26. Family Phthanoperidiniaceae (cont.)

- Fig. 247** *Multispinula quanta* Bradford, 1975, (B), h.
Fig. 248 *Omanodinium alticinctum* Bradford, 1975, (A), h.
Fig. 249 *Phthanoperidinium amoenum* Drugg and Loeblich, 1967, (C), h; a. dorsal, b. ventral.
Fig. 250 *Pyxidiella pandora* Cookson and Eisenack, 1958, (C), h.
Fig. 251 *Selenopemphix nephroides* Benedek, 1972, (B), h.
Fig. 252 *Soaniella granulata* Vozzhennikova, 1967, (B), h.
Fig. 253 *Stelladinium readii* Bradford, 1975, (B), h.
Fig. 254 *Sumatradinium hispidum* (Drugg) Lentin and Williams, 1976, (B), h.
Fig. 255 *Vozzhennikovia apertura* (Wilson) Lentin and Williams, 1976, (B), h.

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27. Family Ovoidiniaceae (256–258)

- Fig. 256** *Ascodinium acrophorum* Cookson and Eisenack, 1960a, (B), h.
Fig. 257 *Balcattia cirrifera* Cookson and Eisenack, 1974, (B), h.
Fig. 258 *Ovoidinium verrucosum* (Cookson and Hughes) Davey, 1970, (B), h.

28. Family Ceratocoryaceae (259–261)

- Fig. 259** *Pentadinium laticinctum* Gerlach, 1961, (A), s; a. apical, b. antapical.
Fig. 260 *Romanodinium areolatum* Baltes, 1971, (B), h.
Fig. 261 *Thalassiphora pelagica* (Eisenack) Eisenack and Gocht, 1960, (A), p.

27. Ovoidiniaceae

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28. Ceratocoryaceae

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29. Family Pyrophacaceae (262)

Fig. 262 *Tuberculodinium vancampoe* (Rossignol) Wall, 1967, (B), s.

30. Family Heteraulacacystaceae (263–265)

Fig. 263 *Dinopterygium cladoides* Deflandre, 1935, (B), h.

Fig. 264 *Heteraulacacysta campanula* Drugg and Loeblich, 1967, (B), h; a. dorsal, b. ventral.

Fig. 265 *Tubidermodinium sulcatum* Morgenroth, 1966, (B), h; a. ventral, b. dorsal.

29. Pyrophacaceae

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30. Heteraulacacystaceae

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265b

31. Family Microdiniaceae (266–267)

Fig. 266 *Cladopyxidium septatum* McLean, 1972, (A), h; a. ventral, b. dorsal.

Fig. 267 *Microdinium ornatum* Cookson and Eisenack, 1960a, (C), h.

32. Family Nannoceratopsaceae (268)

Fig. 268 *Nannoceratopsis pellucida* Deflandre, 1938, (B), h.

33. Family Dinogymniaceae (269)

Fig. 269 *Dinogymnium acuminatum* Evitt et al., 1967, (B), h; a. dorsal, b. ventral.

31. Microdiniaceae

32. Nannoceratopsaceae

33. Dinogymniaceae

Incertae familiae

- Fig. 270** *Anthosphaeridium convolvuloides* Cookson and Eisenack, 1968, (B), h.
Fig. 271 *Ascostomocystis hydria* Drugg and Loeblich, 1967, (B), h.
Fig. 272 *Cometodinium obscurum* Deflandre and Courteville, 1939, (B), h.
Fig. 273 *Fromea amphora* Cookson and Eisenack, 1958, (B), h.
Fig. 274 *Muirella plioplax* Churchill and Sarjeant, 1963, (B), h; a. ventral, b. dorsal.
Fig. 275 *Paralecaniella indentata* (Deflandre and Cookson) Cookson and Eisenack, 1970, (B), a. s, b. h.
Fig. 276 *Phanerodinium cayeuxii* (Deflandre) Deflandre, 1937, (D), h; a. h, dorsal, b. p, dorsal.

Incertae familiae

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