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SOME DINOFLAGELLATE CYSTS FROM THE UPPER CRETACEOUS OF NORTHERN NATAL, SOUTH AFRICA

by Roger J. Davey

Abstract

Fossil dinoflagellate cysts are for the first time described from South Africa and occur in sediments of Campanian, Maastrichtian and possibly Danian age. The sedimentary samples are from a borehole in northern Natal. The systematic section includes the erection of seven new species; these constitute only a few of the many species found in the assemblages.

Introduction

The Cretaceous System of South Africa is poorly exposed and occurs intermittently in the coastal regions of Natal and the southern Cape Province. In southern Africa, as in many parts of the world, the Cretaceous era, and in particular the upper portion, is a period of marine transgression. In the southern Cape Province the sequence is dominantly non-marine, only becoming estuarine and finally marine in the uppermost beds. The northern Natal (Zululand) region, however, possesses the most complete succession of Cretaceous strata. Here several thousand feet of marine sediments are present and consist of a monotonous series of fine siltstones and mudstones.

The Cretaceous sediments are often very fossilferous and have yielded abundant pelecypod and ammonite remains. It is by the detailed study of the latter fossils that these sediments have been dated and indicate that the succession is practically complete from the Neocomian to the top of the Maastrichtian. Diagnostic Turonian fossils have not been identified but other evidences of a non-sequence at this time are lacking. A number of dinoflagellate species previously only described from the Danian have been found by the author; however, further research is required before the definite presence of this stage can be verified.

The research in progress deals with the dinoflagellate cysts, spores and pollens obtained from northern Natal, and an assessment of these fossils as stratigraphic indicators in this region will be made. The present paper describes some of the more interesting dinoflagellate cysts which have been encountered in the upper 1,000 feet of the Cretaceous sediments. The ammonites identified in these sediments (Keyser, personal communication) indicate that the Campanian and Maastrichtian stages are present; the foraminifera found (de Gasparis, personal communication) furthermore point to the presence of the Danian stage. As yet relatively little research has been performed on the dinoflagellate cysts of late Cretaceous and early Tertiary age and thus accurate geological dating using these microfossils is not possible. However, their detailed study at other

stratigraphic levels shows that they may be utilised for both local and regional stratigraphic correlation.

Dinoflagellates are a group of microscopic marine-planktonic algae which form cysts during one stage of their rather complex life-cycle. It is considered that all fossil dinoflagellates are, in fact, cysts and the vast majority possess a characteristically shaped opening—the archaeopyle—through which the organism excysted. The cyst itself is composed of a cellulose-like substance and is very resistant to most geological processes except strong oxidation and the moderate or high temperatures of metamorphism; they are abundant in most marine sediments, relatively easy to extract and, being planktonic, are of wide geographic distribution. Thus they are ideal as indices in stratigraphic correlation and should prove extremely useful in unravelling the Cretaceous stratigraphy of South Africa. The small size of the cysts, generally between 30 and 100 microns in diameter, makes them particularly useful in borehole correlation when samples are small and identifiable macrofossils are rarely obtained.

The earliest record of a dinoflagellate cyst, albeit rather dubious, is from the Silurian of North Africa (Calandra 1964). Permian forms have been identified (Tasch 1963) but they do not become abundant until the Jurassic. Thereafter, and at the present time, they form an important part of the microfossil content of all marine sediments. Recent research on the morphology, details of encystment and excystment and ecological distribution of modern dinoflagellates is greatly aiding micropalaeontologists in their studies of these interesting and stratigraphically important organisms (see Rossignol 1963, Evitt & Davidson 1964, Wall 1967).

Systematic Descriptions

During the last thirty years numerous dinoflagellate cyst species have been described and assigned to a large number of accurately defined and relatively stable genera. The classification above generic level, however, is still in a state of flux. Recently Sarjeant & Downie (1966) reviewed this classificatory problem and concluded that the term cyst-family should be used with primary emphasis given to overall form as defined by the terms proximate, chorate and cavate. These terms were considered to indicate the degree of contraction of the protoplasm within the motile dinoflagellate theca during the process of encystment. Recent evidence, however, from studies of modern dinoflagellates suggests that contraction did not take place during encystment (Wall, personal communication). Thus any classificatory scheme based primarily on this premise will have to be modified to some extent.

The classification of dinoflagellate cysts is comparable to that encountered in the study of fossil spores and pollens for, in both instances, species must be defined on a purely morphological basis and the resulting taxa are either form- or organ-genera or species. Detailed studies of modern dinoflagellates have shown that a single motile genus is capable of producing two or even three distinctive cyst types which, on the basis of their morphology, would be placed in different

form-genera and perhaps different cyst-families. Although a number of cyst genera have been related to present-day motile stages this would probably be impossible for the majority since they represent extinct forms. Cyst genera such as *Gonyaulacysta* and *Hystrichosphaera*, which have been related to the same motile-stage genus *Gonyaulax*, should be placed in the same cyst-family—the cyst-family Gonyaulacystaceae Sarjeant & Downie. Thus all the cyst genera included in this cyst-family are cysts of species belonging to the family Gonyaulacaceae Lindemann. Similarly the genera included in the cyst-family Deflandreaceae Eisenack are now recognised as cysts of the family Peridiniaceae Lindemann. Future research will undoubtedly identify further genera that should be placed in these two cyst-families while many of the cyst-families proposed by Sarjeant & Downie must be retained and perhaps always be of dubious affinities.

Of primary importance in cyst-family classification should be the cyst tabulation and the mode of archaeopyle formation. Proximate, chorate and cavate may be retained as purely descriptive terms but should not, at present, indicate degrees of protoplasm contraction during cyst formation.

Class: DINOPHYCEAE
Order: PERIDINALES
Cyst-Family: GONYAULACYSTACEAE Sarjeant & Downie emend.

AMENDED DIAGNOSIS

Dinoflagellate cysts possessing a two-layered wall; the outer layer may give rise to sutural crests or spines, or intratabular processes. These structures reflect a basic tabulation of 3′-4′ (5′), 0-2a, 6″, 6c, 5-6‴, 0-2p, 1⁗ plus a variable number of sulcal plates. Archaeopyle typically dorsal and precingular (3″) but may be apical or epitractal.

Genus: EISENACKIA Deflandre & Cookson 1955.

REVISED DIAGNOSIS

Proximate dinoflagellate cysts of spheroidal to ovoidal shape, with the reflected tabulation 4′, 6″, 6c, 6‴, 2p, 1⁗ plus 4-5 sulcal plate-areas. Plate-areas slightly raised and isolated from one another by a pattern of "channels" which are sutural in position. Cingulum helicoid; archaeopyle apical formed by the loss of all the apical plate-areas.

Eisenackia circumtabulata Drugg 1967.

Pl. 1, figs. 1, 2.

1967 *Eisenackia circumtabulata* Drugg: p. 15, pl. 1, figs. 12, 13.

DESCRIPTION

The test surface is finely pitted and this pitting may extend to the delicate membranes (up to 11μ high) which delineate the plate-areas. The tabulation is well developed and is typical of the genus; there are four sulcal plate-areas on

the hypotract. The apical archaeopyle has an angular margin, often possessing a sulcal notch. A single detached operculum of this species was identified and was composed of four plate areas (pl. 1, fig. 2).

Dimensions

Range: test diameter 35(41.2)48μ, maximum height of membranes 5(8)11μ. Number of specimens measured, 10.

Previous Occurrence

Danian; California, U.S.A. (Drugg 1967). Lower Eocene?; South Chile (Cookson & Cranwell 1967).

Remarks

E. circumtabulata was only found in the topmost sample examined. A form described as cf. *Eisenackia* sp. by Cookson & Cranwell (1967) is undoubtedly conspecific with *E. circumtabulata*. Cookson also records this species from Victoria, Australia.

Genus: HYSTRICHOSPHAERA (O. Wetzel) Deflandre 1937.

Hystrichosphaera granulata sp. nov.

Pl. 1, figs. 4-7.

Derivation of Name

Latin, *granosus*, granular—with reference to the granular outer layer of the test wall.

Diagnosis

A species of *Hystrichosphaera* with outer layer of central body densely granular; crests and processes also granular, particularly proximally. Processes are gonal in position and delicate; sutural crests low.

Holotype

Bernard Price Institute Colln. slide ZU2A/CA. Upper Cretaceous (Maastrichtian/Danian?).

Dimensions

Holotype: central body diameter 32 by 37μ, length of spines 10-11μ. Range: central body diameter 27(35.6)43μ, maximum length of processes 8(11.7)18μ. Number of specimens measured, 12.

Description

This species has an ovoidal test, always of a brown colour in the type material, sometimes with a small apical prominence. The wall is of a moderate thickness (c.1μ) and has a densely granular surface. The processes are slender,

bifurcate medially and normal again distally. The cingular and, more rarely, other processes are joined medially by a fine membrane. A trifurcate apical process may be present. The tabulation is distinct, except for the sulcal region, and is typical of the genus.

Remarks

The brown, densely granular test wall and delicate processes of *H. granulata* sp. nov. make this a readily distinguishable species. It may be compared with *H. ramosa* var. *ramosa* Davey & Williams which, however, has longer non-granular processes; the test wall of *H. scabrosa* Clarke & Verdier possesses rugae or scabrae, not granules.

Genus: HYSTRICHOSPHAERIDIUM Deflandre 1937.

Hystrichosphaeridium parvum sp. nov.

Pl. 1, fig. 8. Pl. 2, fig. 1.

Derivation of Name

Latin, *parvus*, small—with reference to the small size of this cyst.

Diagnosis

Cyst of small size possessing a smooth to lightly punctate test wall. Processes typically tubiform, all of approximately the same length, with serrate distal margins; they are of variable width and may be joined laterally by membranes. Apical archaeopyle typically present.

Holotype

Bernard Price Institute Colln. slide ZU3/C7. Upper Cretaceous (Campanian?/Maastrichtian).

Dimensions

Holotype: central body diameter 19 by 21μ, length of processes 5-7μ. Range: central body diameter 16(20.3)23μ, maximum length of processes 4.5(7.0)8μ. Number of specimens measured, 8.

Description

The processes are tubiform, widening distally and terminating with a denticulate or serrate margin. The width of the processes varies considerably on an individual, from 1 to 4μ. Rarely some of the processes are linked by connecting membranes which extend along the entire length of the processes. The processes are arranged in a circular manner around the test and are 20 to 25 in number. The antapical process is sometimes distinctively broad.

Remarks

H. parvum sp. nov. is similar to *H. patulum* Davey & Williams (1966b) in size and in the overall form of the processes. The processes of the latter species

are, however, greatly expanded distally, with an entire margin and may be divided into two types. ?*Hystrichosphaeridium* sp. A, as described by Drugg 1967, differs in the possession of furcate closed processes and ridges on the central body wall. The presence of membranes connecting the processes of some specimens of *H. parvum* gives them a *Cymatiosphaera*-like appearance.

Cyst-Family: MICRODINIACEAE Eisenack
Genus: MICRODINIUM Cookson & Eisenack 1960
Microdinium robustum sp. nov.
Pl. 1, fig. 3. Pl. 2, fig. 2.

Derivation of Name

Latin, *robustus*, thick-set—with reference to the thick test wall.

Diagnosis

A species of *Microdinium* possessing an ovoidal, thick-walled, lightly punctate test. Sutural crests low, sometimes forming chambers. Apical archaeopyle typically present.

Holotype

Bernard Price Institute Colln. slide ZU1/C4. Upper Cretaceous (Maastrichtian/Danian?).

Dimensions

Holotype: central body diameter 15 by 18μ, maximum height of crests 1.5μ. Range: central body length 17-20μ, width 14-17μ. Number of specimens measured, 7.

Description

The test wall is unusually thick (c.1μ) for such a small cyst. The sutural crests are low except where one abuts against another and here they may be up to 2μ in height. The crests, as in all tabulate cysts, consist of two layers of periphragm membrane. In this species they are usually joined throughout their height but occasionally, although they remain joined distally, they diverge proximally so forming a small chamber of, more or less, triangular shape. Two or more chambers may lie along a suture and are separated from each other by partitions. The tabulation appears to be that typical of this genus; the cingulum is relatively wide (4-6μ).

Remarks

M. robustum sp. nov. occurs only in the topmost sample examined. It is quite distinctive by virtue of its thick wall and characteristic sutural crests. The sutural chambers are comparable with those possessed by *M. veligerum* (Deflandre 1937).

Genus: GLYPHANODINIUM Drugg 1964

Glyphanodinium facetum Drugg 1964.

Pl. 2, figs. 4, 5.

1964 *Glyphanodinium facetum* Drugg: p. 238, figs. 1-6.

Description

The specimens of *G. facetum* from northern Natal are identical to the type material from the Danian of California. The cysts are brown and exhibit a tabulation outlined by sutural thickenings which occasionally give rise to membranous crests of up to 2μ in height. The archaeopyle is apical and is formed by the displacement of a single apical plate which typically remains attached on the ventral side of the epitract.

Dimensions

Range: central body length (with operculum in place) 27-30μ, without operculum in place 22-25μ; width 22-28μ. Number of specimens measured, 8.

Genus: OPERCULODINIUM Wall 1967

Operculodinium centrocarpum (Deflandre & Cookson 1955).

Pl. 2, fig. 6. Pl. 3, fig. 4. Pl. 4, fig. 5.

1955 *Hystrichosphaeridium centrocarpum* Deflandre & Cookson: p.272, pl. 8, figs. 3, 4.

1967 *Operculodinium centrocarpum* (Deflandre & Cookson); Wall: p.111, pl. 16, figs. 1, 2, 5 (see also for earlier references).

Description

The test is subspherical and possesses a densely granular surface from which arise numerous slender processes. The latter have relatively broad bases, taper gradually distally and terminate with two to five minute spines. Rarely the processes are joined medially by fine membranes but only occasionally can any process alignment be seen. The processes are fibrous; however the fibrosity may only be clearly seen on the broader, basal regions of the processes. Polar structures are absent. A precingular archaeopyle is present and has a rounded triangular outline.

Dimensions

Range: central body diameter 29(38.0)47μ, maximum length of processes 9-13μ. Number of specimens measured, 10.

Previous Occurrence

Oligocene, Germany (Gerlach 1961, Brosius 1963); Miocene, Australia (Deflandre & Cookson 1955); Miocene, Germany (Maier 1959): Recent, Caribbean Sea (Wall 1967).

Remarks

The Natal specimens, of Maastrichtian/Danian age, strongly resemble the type material from Australia except that they are of considerably smaller size—

the central body diameter in the type material is 54-80μ. The specimens, however, described by Wall (1967) from recent sediments are smaller and have a central body diameter from 40 to 56μ.

Operculodinium flucturum sp. nov.

Pl. 2, figs. 3, 7, 8.

Derivation of Name

Latin, *flucture*, undulate—with reference to the ridges of the test wall.

Diagnosis

Test subspherical; wall of moderate thickness bearing low vermicular ridges and tubercles. Spines numerous and arise from the surface structures. Spines of variable shape, mainly simple but sometimes joined medially; the simple spines are typically of an elongate conical form, capitate distally. Polar structures and tabulation absent. Archaeopyle precingular, of a rounded, triangular shape.

Holotype

Bernard Price Institute Colln. slide ZU1/C4. Upper Cretaceous (Maastrichtian/Danian?).

Paratype

Bernard Price Institute Colln. slide ZU1/C4.

Dimensions

Holotype: central body diameter 49 by 52μ, length of spines up to 7μ. Paratype: central body diameter 42 by 45μ, length of spines up to 6μ. Range: central body diameter 42(49.9)64μ, maximum length of spines 5-7μ. Number of specimens measured, 12.

Description

The test wall is of moderate thickness (1 to 2μ) and bears many irregularly arranged vermicular ridges which may be reduced in size to simple tubercles. The ridges and tubercles give rise to the numerous spines. The spines are delicate, typically simple each with a broad base (up to 4μ in width), narrowing rapidly to terminate with a truncate or capitate extremity. The more broadly conical spines may be fenestrate proximally. All spines of approximately equal height; spine alignment is absent. The rounded, triangular shape of the cyst opening is characteristic of a precingular archaeopyle.

Remarks

O. flucturum sp. nov. is similar to *O. israelianum* (Rossignol 1962) in overall form and basic conical shape of the spines but differs by the absence of the vermicular ornamentation. The type material of the latter species also possesses acuminate spines. *O. israelianum*, as described by Wall (1967) from recent Caribbean sediments, does possess capitate spines but again the characteristic ornamentation of *O. flucturum* is absent.

Cyst-Family: DEFLANDREACEAE Eisenack
Genus: DEFLANDREA Eisenack

Deflandrea pilosa sp. nov.
Pl. 3, figs. 2, 5.

Derivation of Name

Latin, *pilosus*, hairy—with reference to the ornamentation of hairs on the outer wall.

Diagnosis

Fusiform test having a thin outer wall which bears minute hairs and granules. Apical horn stout, blunt or rounded distally; single antapical horn asymmetrically placed, conical. Inner body large, in contact with the outer wall except in the apical and antapical regions. Cingulum moderately well developed, almost circular, broken by a sulcus which extends to the apex. Archaeopyle intercalary, the operculum typically remaining in position.

Holotype

Bernard Price Institute Colln. slide ZU4/C8. Upper Cretaceous (Campanian/Maastrichtian).

Dimensions

Holotype: overall length 57μ, width 46μ, inner body 38 by 42μ. Range: overall length 55(58.4)61μ, width 38(42.0)45μ. Number of specimens measured, 10.

Description

The minute hairs and granules are not densely arranged and are not aligned. The hairs are often stouter along the borders of the cingulum and may here be termed spines. The operculum is usually attached to the test along its antapical margin and thus remains in position. An interesting feature is that this species is scarcely stained by safranin.

Remarks

The overall form and the nature of the ornamentation easily distinguish *D. pilosa* sp. nov. from all previously described species.

Deflandrea Sp. 1.
Pl. 3, fig. 1.

Description

Two specimens of this species have been located. They are identical to *Diconodinium glabrum* Eisenack & Cookson 1960 (see p. 22) except that they possess a granular thick-walled inner body. A dorsal intercalary archaeopyle may also be present.

Figured Specimen

Bernard Price Institute Colln. slide ZU4/C3. Upper Cretaceous (Campanian/Maastrichtian).

Dimensions

Figured specimen: overall length 37μ, width 26μ, inner body 17 by 20μ.

Remarks

The form of the apical and antapical horns, together with the size of this species of *Deflandrea*, are identical to those of *Doconodinium glabrum* and indicate that the two forms are closely related. Evitt (1961) gave evidence that in certain species of *Deflandrea* an inner body is not present and when it is it may vary in size and wall thickness. Thus *D. glabrum* appears to be a more common form of *Deflandrea* Sp. 1 which for some reason did not form an inner body. It is extremely unlikely that the inner body has been lost at some period during or after fossilisation since the tests of *D. glabrum* appear to be intact. The two forms should be left at present in their respective genera but their close relationship should be kept in mind.

Genus: TRITHYRODINIUM Drugg 1967

Amended Diagnosis

Cavate cysts consisting of a two-layered inner body surrounded by a single layered outer wall which is produced into an apical and two antapical horns. Inner body subspherical, with opening formed by the removal of three intercalary plate-areas. Tabulation may be present. Archaeopyle dorsal intercalary (2a).

Type Species

T. evitti Drugg 1967. Danian; California.

Remarks

The diagnosis is amended to point out that the three intercalary plate-areas are lost from the inner body, not the outer wall, and therefore do not strictly constitute an archaeopyle. This genus is also now not restricted to species which lose the three plate-areas as a unit, since whether this is so or not is extremely difficult to determine unless detached opercula are studied. That the plate areas may be lost as a unit or as separate plates does not appear to be of generic importance. An opening or archaeopyle in the outer wall has, as yet, not been observed. This is undoubtedly due to the fineness of this wall which is often apparently absent or damaged to some extent.

The genus *Trithyrodinium* is very similar to *Deflandrea* and thus the former is tentatively placed in the cyst-family Deflandreaceae. They differ in that the form of the central body opening in the type species of *Deflandrea*, *D. phosphoritica* Eisenack, appears to be more or less apical, in contrast to the loss of three intercalary plate areas in *Trithyrodinium*.

Trithyrodinium fragile sp. nov.
Pl. 3, figs. 3, 6, 9.

Derivation of Name

Latin, *fragilis*, frail—with reference to the delicate outer membrane.

Diagnosis

Shell subspherical, consisting of a smooth brown inner body surrounded closely by a thin hyaline membrane which is produced into a small apical and two small antapical horns. The inner layer of the inner body is thin and colourless, the outer layer thick, brown and commonly possessing cresentic markings. Cingulum and sulcus rarely discernible.

Holotpye

Bernard Price Institute Colln. slide ZU2/AC1. Upper Cretaceous (Maastrichtian/Danian?).

Dimensions

Holotype: inner body diameter 45μ by 45μ, length of apical horn 8μ, length of antapical horns 4μ and 6μ. Range: inner body diameter 41(48.5)58μ. Number of specimens measured, 12.

Description

The outer membrane is extremely delicate and only occasionally are the apical and antapical horns discernible. Because of the fine nature of this membrane an archaeopyle has not been observed. The subspherical inner body typically possesses a network of curved areas devoid of the brown outer layer (pl. 3, fig. 9). It appears unlikely that curved portions of this layer have been lost but rather that at some stage the inner body has expanded and that the brown outer layer, being somewhat brittle, developed cresentic cracks. A large angular opening is developed on the dorsal epitractal surface of the inner body by the loss of three plate-areas. The shape and position of the latter indicate that they are anterior intercalary in position. The ventral surface is intact and on one specimen bears sulcal and also cingular depressions. The apical region of the inner body remains as an angular projection, or lingula, over the opening.

Remarks

T. fragile sp. nov. is a distinctive species and appears to be most closely related to *T. suspecta* (Manum & Cookson 1964). The latter, however, possesses a thick granular inner body wall. Unfortunately, since the outer membrane is commonly lost, *T. fragile* may be misidentified as a leiosphere-like dinoflagellate cyst possessing a large angular archaeopyle. However, the characteristic sculpture of the inner body will mitigate against this.

The two-layered nature of the inner body wall (the endophragm) is a demonstrable feature of this species and has previously been recorded by Manum (1960) when describing *Deflandrea phosphoritica* Eisenack. This feature is probably present in other species of *Deflandrea* but is extremely difficult to verify when the inner body wall is not sculptured or ornamented. The position of the archaeopyle in *Deflandrea* and *Trithyrodinium* is dorsal intercalary (2a) and refers solely to the angular pylome in the outer membrane, the periphragm. The angular pylome of the inner body may not be referred to as an archaeopyle and is here simply designated "inner body opening".

Other Species

The following species are here transferred to *Trithyrodinium* Drugg on the basis of the form of the inner body opening:

Trithyrodinium granulifera var. *tenuis* (Davey, in press), (as *Deflandrea granulifera* Manum var. *tenuis*) in *Bull. Brit. Mus. (Nat. Hist.) Geol.* (in press).

Trithyrodinium verrucosa (Manum 1963), p. 60 (as *Deflandrea verrucosa*) in *Norsk Polarinst., Arbök*, pp. 55-67.

Trithyrodinium suspectum (Manum & Cookson 1964), p. 9 (as *Hexagonifera suspecta*) in *Skr. norske Vidensk-Akad.*, No. 17, pp. 1-36.

Genus: PALAEOCYSTODINIUM Alberti 1961

Palaeocystodinium lidiae (Górka 1963) comb. nov.

Pl. 4, figs. 1, 2.

1963 *Leiofusa lidiae* Górka p. 37, pl. 5, fig. 6.

Amended Diagnosis

Fusiform cyst composed of two layers, the outer one being smooth or lightly punctate. Horns of approximately equal size and shorter than the length of the central body. The horns are sturdy, pointed distally, apparently flat, each possessing a longitudinal thickening or rib. They pass imperceptibly into the central body which is of elongate-ovoidal form and encloses an inner body of similar shape. Archaeopyle intercalary, of rounded trapezoidal shape. Tabulation rarely evident.

Holotype

Preparation C13, Laboratoire de Micropaléontologie de l'Université de Varsovie, Warsaw, Poland. Upper Cretaceous (Maastrichtian); Magnuszew, Poland.

Dimensions

Holotype: not known. Range of 3 specimens from type material: cyst length 150-210μ, width 42.5-52.5μ, length of horns 40-65μ. Range of Natal specimens: cyst length 169-197μ, width 37-50μ, central body length 72-117μ, length of horns 28-64μ. Number of specimens measured, 8.

Description

The cyst colour is consistently light to dark brown and appears to be a characteristic feature. The inner body is occasionally difficult to discern but never extends into the horns. Due to the large size of these cysts they are often distorted and the archaeopyle, although typically present, may be difficult to locate and may be mistaken for tear damage. An indistinct cingulum was present on one specimen but besides this single occurrence tabulation is apparantly absent.

Remarks

The specimens of *P. lidiae* from Natal are extremely similar to the type material from the Maastrichtian of Poland. This species was placed in the acritarch genus *Leiofusa* Eisenack by Górka since neither the bi-layered nature of the wall nor the characteristic intercalary archaeopyle were recorded. As stated above, these features are sometimes difficult to discern. Their presence does, however, indicate that this is a dinoflagellate species and belongs to the genus *Palaeocystodinium*.

The genus *Svalbardella* Manum (1960) is considered to differ from *Palaeocystodinium* by the presence of a well defined cingulum, occasionally a weak tabulation and blunted polar horns. *S. australina* Cookson (1965) may be differentiated from *P. lidiae* by the presence of a strongly developed inner body, subsidiary process on antapical horn and lack of hornal ribs.

Genus: DICONODINIUM Eisenack & Cookson 1960

Diconodinium glabrum Eisenack & Cookson 1960.
Pl. 3, figs. 7 and 8.

1960 *Diconodinium glabrum* Eisenack & Cookson: p. 3, pl. 1, fig. 11.

Description

The shell is fusiform, having a smooth thin wall and is divided into approximately equal halves by a well defined cingulum. The latter is circular and is broken on the ventral surface by a more or less strongly outlined sulcus. The apical horn appears to be solid and terminates distally with a concavity or a reduced bifurcation. The small sharply-pointed antapical process is situated to one side of the midline. An archaeopyle was not observed in any of the specimens. This species was not stained by safranin.

Dimensions

Range: overall length 32(35.2)38μ, width 22(25.1)30μ. Number of specimens measured, 8.

Remarks

The type material of *D. glabrum*, from the Albian and Cenomanian of Australia, has an unusually large size range—length 62-142μ, width 41-72μ.

Although the South African individuals of this species do not fall within this size range, they are identical in all other respects with the type material and, thus, at the moment differentiation purely on size criteria has not been attempted.

The overall form of the shell of *D. glabrum* suggests a close affinity with *Deflandrea* Sp. 1 (see p. 9) and thus the genus *Diconodinium* has been placed tentatively in the cyst-family Deflandreaceae.

Cyst-Family: FROMEACEAE Sarjeant & Downie 1966

Genus: CHYTROEISPHAERIDIA Sarjeant 1962.

Chytroeisphaeridia reticulata sp. nov.

Pl. 4, figs. 3, 4, 6.

DERIVATION OF NAME

Latin, *reticulatus*, net-like—with reference to the surface ornamentation.

DIAGNOSIS

An ovoidal to subspherical cyst possessing a thick wall which bears a fine reticulation, rarely granulation. Apical archaeopyle formed by the removal of a subangular to almost circular portion of the test.

HOLOTYPE

Bernard Price Institute Colln. slide ZU7/C5. Upper Cretaceous (Campanian/Maastrichtian).

DIMENSIONS

Holotype: test diameter 28μ by 27μ. Range: length (operculum removed) 21(28.3)36μ, width 18(26.5)35μ. Number of specimens measured, 10.

DESCRIPTION

The cyst wall is unusually thick (1-1.5μ) for the size of the test. The surface reticulation of the test wall is very delicate and may only be observed under high power. All specimens possess an archaeopyle, occasionally the operculum remaining in position, which is more or less circular to subangular in shape. Two specimens discovered have a densely granular wall and an angular archaeopyle with splits extending down between the reflected plates.

REMARKS

The thick wall and delicate reticulation differentiate *C. reticulata* sp. nov. from all previously described species of dinoflagellate cyst. The specimens possessing a granular test wall and a definitely angular archaeopyle may, at a later date, be transferred to a different species.

REFERENCES

For references on dinoflagellate cysts prior to 1963, readers are referred to Downie & Sarjeant (1964). Works published after 1963 are as follows:

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PLATE 1

Eisenackia circumtabulata Drugg

Fig. 1. Lateral view showing height of crests. Slide ZU1/C4. x 600.

Fig. 2. Detached operculum composed of four apical plates. Slide ZU1/C4. x 1200.

Microdinium robustum sp. nov.

Fig. 3. Dorsal surface of holotype. Slide ZU1/C4. x 1200.

Hystrichosphaera granulata sp. nov.

Fig. 4. Holotype—dorsal surface. Slide ZU2A/CA. x 600.

Fig. 5. Holotype—ventral surface. x 600.

Fig. 6. Holotype—medial section. x 600.

Fig. 7. Holotype—high magnification showing granulation of ventral surface. x 1200.

Hystrichosphaeridium parvum sp. nov.

Fig. 8. Slide ZU3/C7. x 1200.

PLATE 1

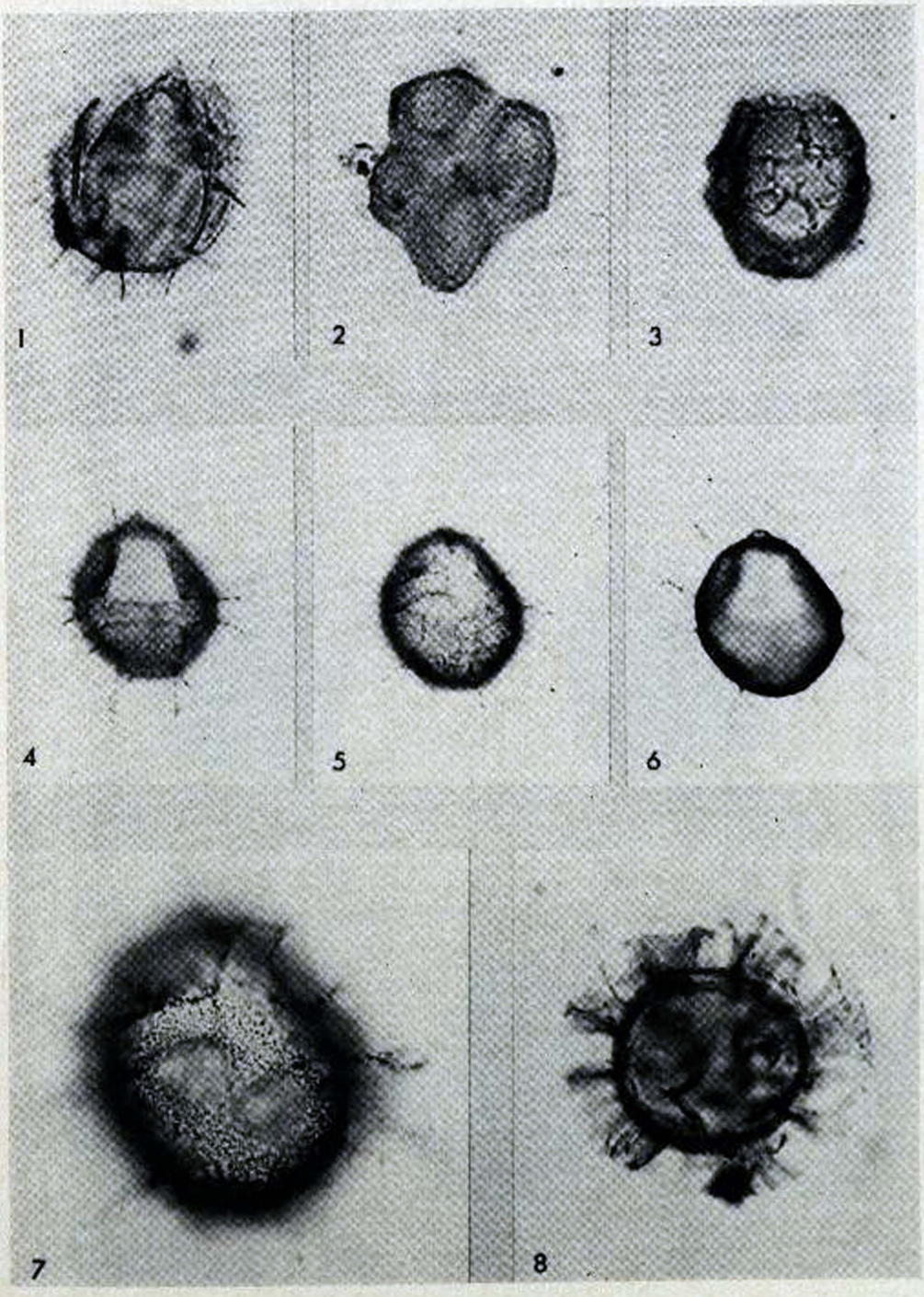


PLATE 2

Hystrichosphaeridium parvum sp. nov.

Fig. 1. Lateral view of holotype. Slide ZU3/C7. x 1200.

Microdinium robustum sp. nov.

Fig. 2. Medial section showing wall thickness and crests. Slide ZU1/C4. x 1200.

Operculodinium fluctuum sp. nov.

Fig. 3. Detached operculum showing vermicular ridges. Slide ZU1/C4. x 1500.

Fig. 7. Lateral view of holotype—archaeopyle to the north-west. Slide ZU1/C4. x 600.

Fig. 8. Paratype illustrating archaeopyle shape. Slide ZU1/C4 x 600..

Glyphanodinium facetum Drugg

Fig. 4. Lateral view with attached operculum. Slide ZU2A/C6A. x 1200.

Fig. 5. Lateral view with operculum absent. Slide ZU2A/C6. x 1200.

Operculodinium centrocarpum (Deflandre & Cookson).

Fig. 6. Detached precingular operculum. Slide ZU2A/C1. x 1500.

PLATE 2

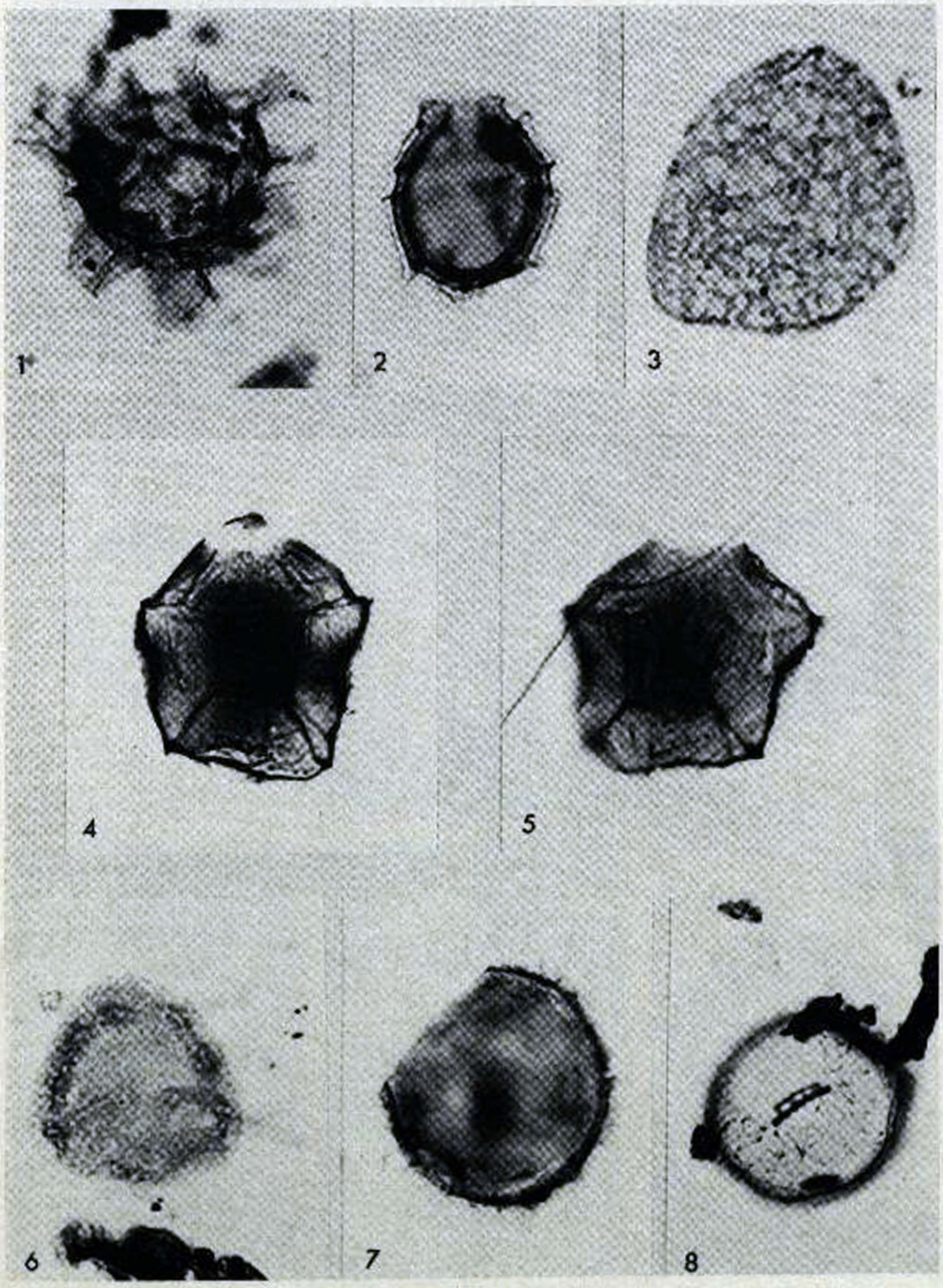


PLATE 3

Deflandrea sp. 1

Fig. 1. Slide ZU4/C3. x 1000. (Phase contrast).

Deflandrea pilosa sp. nov.

Fig. 2. Holotype. Slide ZU4/C8. x 700. (Phase contrast).

Fig. 5. High magnification of holotype showing periphragm spines x 1400. (Phase contrast).

Trithyrodinium fragile sp. nov.

Fig. 3. Dorsal surface showing large archaeopyle formed by the loss of three anterior intercalary plates. Slide ZU2A/C6A. x 600.

Fig. 6. Dorsal view of holotype showing faint apical horn. Slide ZU2A/C1. x 600.

Fig. 9. Specimen illustrating crescentic markings. Slide ZU2A/C1. x 600.

Operculodinium centrocarpum (Deflandre and Cookson).

Fig. 4. Slide ZU2A/C1. x 600.

Diconodinium glabrum Eisenack and Cookson.

Fig. 7. Slide ZU4/C8. x 1000 (Phase contrast).

Fig. 8. Slide ZU4/C8. x 1000 (Phase contrast).

PLATE 3

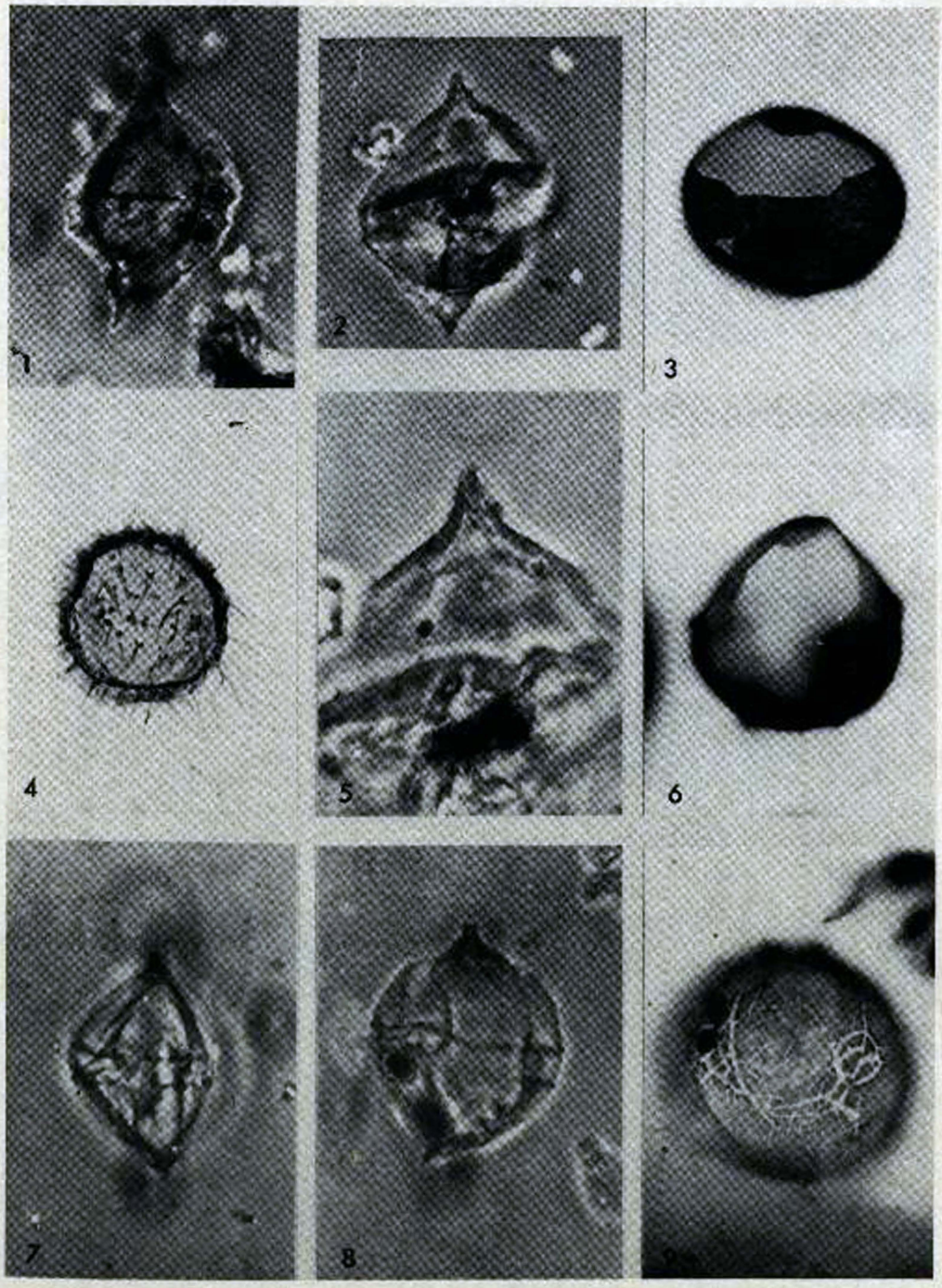


PLATE 4

Palaeocystodinium lidae (Górka)

Fig. 1. Specimen possessing intercalary archaeopyle. Slide ZU1/C4. x 475.

Fig. 2. Specimen with operculum in position; note rib on apical horn. Slide ZU4/C8. x 475.

Chytroeisphaeridia reticulata sp. nov.

Fig. 3. Holotype with attached operculum. Slide ZU5/C5. x 1200.

Fig. 4. Specimen with operculum absent. Slide ZU5/C5. x 1200.

Fig. 6. Specimen with attached operculum; note surface reticulation. Slide ZU5/C5. x 1200.

Operculodinium centrocarpum (Deflandre and Cookson).

Fig. 5. High magnification of specimen to show surface granulation. Slide ZU2A/C1. x 1200.

PLATE 4

