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DEPARTMENT OF MINES
SOUTH AUSTRALIA

PALAEONTOLOGY SECTION

TERTIARY NON-MARINE DINOFLAGELLATE CYST ASSEMBLAGES FROM AUSTRALIA

by

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CONTENTS

Rept.Bk.No.71/106
G.S.No.4681
D.M.No.773/71
Pal. Rept.12/71

Tertiary non-marine dinoflagellate cyst assemblages from Australia

by

Wayne K. Harris

ABSTRACT

Dinoflagellate cyst assemblages from Tertiary non-marine sediments from Australia are described, illustrated and compared with those from sediments immediately preceding the late Eocene transgression in South Australia. The non-marine cyst types are quite distinct morphologically from those in the "marginal marine" environment. Their diversity is low but they may dominate the acid insoluble microfossils. No acritarchs have been observed in any of the non-marine sediments. In contrast, assemblages from "marginal marine" sediments include acritarchs and dinoflagellate cyst species that are common also to the assemblages recovered from sediments of the open marine environment.

Low species diversity and relative frequency are the only factors that may be common to both types of assemblages.

Introduction

Frequently the palynologist is confronted with the problem of giving a definite answer to the question "is the sample marine or non-marine or what is the environment of deposition?" It is relatively simple to provide an answer to the extremes of an intergrading sequence. The open marine sediment will have obvious biological and lithological characters that will distinguish it from its member at the opposite end of the scale, the lacustrine or fluviatile sediment. But it is the fascinating and subtle environmental changes between these limits that provide the palynologist with interpretative difficulties.

In this paper I will examine the occurrence and characteristics of some non-marine dinoflogellate cyst assemblages and compare them with assemblages from two trangressive Eocene sequences, one in the Gambier Embayment of the Otway Basin, the other in the St.Vincent Basin.

Previous environmental studies.

Few environmental studies of organic walled microplankton like those of Wall (1965) from Lower Jurassic microfossils in Britain and Staplin's (1961) paper on reef controlled distribution of Devonian microplankton in Alberta, Canada, have been attempted in either marine or non-marine Tertiary sediments. Gocht's recent (1969) monograph on lower Tertiary assemblages from north west Germany however does provide useful data on distribution and frequency in the sections studied. There has been a very strong but nevertheless necessary bias towards taxonomic and biostratigraphic studies.

References to fossil non-marine dinoflagellate assemblages are even fewer and have been almost entirely concerned with Quaternary sediments. Harland and Sarjeant (1970) and Norris and McAndrews (1970) have recently summarised research on this group both fossil and recent. Important non-marine Quaternary assemblages from Australia have been described by the first two authors and by Churchill and Sarjeant (1962, 1963). We should note at this point, as Harland and Sarjeant have done, that the only reported previous occurrence of acritarchs in non-marine assemblages has been by Churchill and Sarjeant (op. cit) and by Sarjeant and Strachan (1968) and these have been in Quaternary sediments.

Whilst the life cycle, and in particular cyst formation, is known for several species of marine dinoflagellates, (Evitt and Davidson 1964; Evitt & Wall 1968; Wall and Dale 1967, 1968, 1970; Wall, Guillard & Dale 1967), the non-marine members have, with the exception of Peridinium limbatum (Stokes) from sub-Recent lake muds (Evitt & Wall, 1968), received little attention despite the fact that they are commonly found today in lakes, and reservoirs today and even in the laboratory water supply! Whilst not as diverse as their marine members they are relatively common and Smith (1960) records ten genera from the United States. It is generally agreed that fossil dinoflagellate cysts appear to be most abundant and most diverse in marine sediments and scarce of absent in brackish water and non-marine rocks.

Non-Marine Tertiary Assemblages

Dinoflagellate cysts have been recovered from several Tertiary sedimentary basins throughout Australia: in Queensland, the City of Brisbane area; in Tasmania, the Mt. Bischoff area; and in South Australia, the Frome Embayment and the Lake Eyre region of the Great Artesian Basin and the St. Vincent Basin.

City of Brisbane area

Harris (1965) reported two cyst types from borehole NS5 as Michystridium sp. (Type E) and aff. Deflandrea (Type A) sp. The top sample at 130ft. (39.6 m.) lies within the Corinda Formation and is a pyritic mudstone. Houston (1965) reports a non-marine fauna of Pallimnarchus pollens (Crocodilian) Ceratodus fosteri (Dipnoid) and indeterminate crocodilian, chelonian and fish remains and molluscs. The flora comprises, besides spores and pollen, indeterminate dicotyledonous leaves. The lower sample, 270ft. (82.3 m.) is from the Darra Formation and this Formation too has a fauna and flora of non-marine aspect that includes bore fragments, an indeterminate mutelid pelecypod, seeds, fern pinnules and dicotyledonous leaves. The age of these formations is Paleocene. Dinoflagellate cyst frequency varies from 10 to 70%.

Great Artesian Basin

Lower Tertiary sediments are widespread and have been named the Murnpeowie Formation. They consist of fluviatile sands and lacustrine mudstones with abundant leaf impressions. No marine faunas have been reported in sediments of this age. Their age is middle-upper Palaeocene.

Dinoflagellate cysts of two types A & B and comprise less than 5% of the sporomorph assemblage.

Murray Basin

P. [illegible]cene sediments of the Renmark Beds occupy only the central and deepest portion of this basin and have been observed in a number of wells from Waikerie to Loxton and A.A.O. Morkalla No.1 The lithotopes are fine sands, silts and mudstones and no marine faunas have been reported. Their age is middle-upper Paleocene. The dinoflagellate assemblage consists primarily of two species. A. [illegible] dominated by type B. Their frequency varies from less than 1% in some samples from Waikerie to more than 45% in Morkalla No.1.

St. Vincent Basin

During sand quarrying south of Adelaide and clay lens containing excellently preserved leaves, fruits, flowers, fungi and mites. The fauna and floral constituents have been outlined by Lange (1970) and McGowran, Harris & Lindsay (1970) have determined the age as Middle Eocene. The clay lens is interbedded with fluviatile sands and there is no marine fauna. Only one species of dinoflagellate cyst (Type C) has been recovered in percentages of the order of 5%.

Tasmania - Mt. Bischoff

Mudstones beneath basalt at Mt. Bischoff have yeilded only one species, Tye D in a frequency of 17%. Well preserved leaf remains are present but no marine fauna has been reported The age is upper Oligocene or lower Miocene.

Summary of characters of the assemblages.

a. No acritarchs have been observed in any of the samples.

b. The cyst types as described here are quite distinct in one or more morphological feature such as archeopyle development or wall character. These types have not been encountered in any marine sequence of comparable age in Australia.

c. Both capsulate and non-capsulate peridinioid forms are present.

d. Whilst species diversity is low, relative frequency with respect to other microfossils is very variable and cysts may be the dominant fossil group.

e. The evidence, both lithological and palaeontological is not inconsistent with the thesis that they are clearly of non-marine origin.

"Marginal marine" assemblages.

Within South Australia the major Eocene transgression which culminates in the deposition of marl facies of the Lacepede Formation in the Gambier Embayment of the Otway Basin and the Blanche Point Marls of the St. Vincent Basin is preceded by a clastic sequence which can be best described as "marginal marine" in the sense of Taylor (1964). Marginal marine sediments are those deposited "on the margins between land and sea, such as deltas, estuaries, lagoons and bays" (Taylor op. cit.).

Several bores in the Adelaide city area (loc. 9 on text figure) and from the northern part of the St. Vincent

Basin at Pt. Clinton (loc. 8) where the expression of the transgression is least, yield a characteristic cyst and acritarch assemblage in marginal marine sediments.
The stratigraphy and micropalaeontology of the Adelaide area has recently been published by Lindsay (1969). Assemblages are characterised by low species diversity and by a low (< 5%) microplankton/spore-pollen ratio. Components include Wetzeliella spp. Deflandrea phosphoritica Eisenack, Cordosphaeridium sp., Cymatiosphaera sp. and Paralecaniella indentata (Deflandre & Cookson) with cavate cysts dominating.

A similar pattern is emerging from the study of sediments of the Lacepede Formation in Observation Bores I & II (Hds. of Townsend and Ross respectively, loc. 10) in the Gambier Embayment. Marine influence is marked by the first appearance up section of Deflandrea phosphorita, Wetzeliella glabra Cookson, aff. Gonyaulacysta sp., Cymatiosphaera sp. and Paralecaniella indentata.

In summary the "marginal marine" assemblages are characterised by:

a. low frequency with respect to spores and pollen.
b. low diversity, increasing with increasing marine influence.
c. presence of acritarchs.
d. dominance of cavate and heavily sculptured proximate over chorate cysts.
e. the species are present in open marine sediments higher in the successions.

Thus non-marine and marginal marine cyst assemblages would appear to have only one point in common and that is they may have a low species diversity and a low relative frequency.

On all other points the assemblages are distinctive.

Non-marine Microplankton Cyst Taxonomy.

The taxonomic procedure adopted in this paper is similar to that o Norris and McAndrews (1970). It is felt that the cysts described here could be assigned to several new cyst genera because of their unique features. There is also little evidence to assign the cysts to extent genera although several are possibly derived from the genus Peridinium.

Descriptions

Type A cysts: Plate 1 figs. 1-4.

Salient features - cavate cysts of ovoid or peridinoid form. Endocorpus ovoidal, enclosed by the pericorpus which has a bulge on the epitract and two slight bulges of equal size at the antapex. Periphragm smooth as is the endophraghm. The helicoid laevorotary girdle is relatively wide. Archeopyle not observed.

Description - both the periphragm and endophragm are smooth to scabrate and do not show any features of tabulation or any indication of archeopyle formation. On many specimens at the apices there is a thickened plug, the function of which is not known. The degree of bulge,

and the accompanying indentation, in the antapical region is variable from almost no bulge to forms where the identation is 2-5μ deep. The epitract is more or less rounded but does show some development of an apical horn. The epitract and hypotract are of approximately equal sizes. The pericoel is 3-5μ wide and wider near the apical region. The girdle is 5-8 μ wide and the sulcal groove 5-8μ wide. The periphragm and endophragm are of approximately equal thickness, 0.5 μ

Dimensions - based on 10 specimens

Pericorpus : length 50-62 μ breadth 45-60 μ

Endocorpus : " 49-55 μ " 37-50 μ

Remarks - This cyst type is unusual in that no archeocopyle structure has been observed in any specimens. Some specimens have been observed minus the apical plug and part of the surrounding wall.

Type A cysts are common in Paleocene sediments of the Murray and Great Artesian Basins, and those of the Brisbane area.

Type B cysts: Plate 1 figs. 5-11.

Salient features - non-cavate cysts of strongly peridinioid form. The epitract is produced into a rounded horn and the antapex into two horns of approximately equal size. Cyst smooth to scabrate. Strongly marked and heli coid girdle. Archeopyle triangular in shape and operculum attached.

Description - Epitract 0.5μ thick strongly triangular in outline and larger than the hypotract. Antapical bulges variable in degree but usually formed by a deep depression in the mid-line. Girdle about 8 μ wide and often deeply depressed, 2-4 μ deep, strongly helicoid and laevorotary.

Vertical area depressed in the hypotract. Archeopyle large approximately 30 μ wide and 10-12 μ high. Probably formed by loss of a precingular plate. Operculum attached near margin of the ingulum.

Dimensions - 20 specimens

Length 55-68 μ breadth 48-55 μ

Remarks - Type B cysts are similar to those described from the Princetown Member as Deflandrea obliquipes but differ from this species in not having an endocorpus. Resemblance to certain cysts of marine Peridinium spp. (Wall & Dale, 1967) is striking. This cyst type is widely distributed in the Murnpeowie Formation of the Great Artesian Basin and the lower Renmark Beds of the Murray Basin.

Type C cysts: Plate 1, fig. 12, Plate 2 fig. 10.

Salient Features - Cavate cysts of ovoid form. Endocorpus and pericorpus ovoidal, breadth greater than length. Pericorpus and endocorpus have two slight antapical bulges. Endophragm slightly granulate and periphragm smooth to scabrate. Pericoel very narrow 1-2 μ wide and endophragm often closely adpressed to periphragm. No girdle or archeopyle observed.

Description - This type is distinctive in its shape and is often much folded. Both periphragm and endophragm are of equal thickness, 0.5 - 1 μ the fine ornament which is more prominent on the endophragm does not reflect any tabulation.

Dimensions - 10 specimens

Overall length 45-60 μ

" breadth 53-65 μ

Remarks - This species resembles closely in form the extant genus Glenodinum. Characteristically the cyst type described here offers little in the way of morphological criteria such as tabulation or archeopyle formation. Known only from the North Maslin Sands clay lens at Maslin Bay.

Type D cysts : Plate 2, figs. 1-5.

Salient features - cavate cysts of ovoidal to slightly peridinioid form. Endocorpus ovoidal enclosed by the pericorpus which has a weakly formed apical horn and two very small antapical bulges. Periphragm scabrate. Endophragm uniformly granulate. Tabulation not marked by ornament. Girdle indistinct or not marked. Archeopyle not observed. Apex provided with a thickened plug.

Description - Epitract rounded triangular in outline, and hypotract rounded or with two rather sharp antapical bulges separated by a wide indentation 7-10 μ Folding often obscures the antapical bulges giving either the impression of a rounder hypotract or one with a single antapical prominence. Pericoel variable, 2-5 μ wide and widest in the antapical and apical regions. Mostly the periphragm lies close to the endophragm. Periphragm and endophragm of approximately equal thickness, 0.5-1 μ. Archeopyle formed possibly by splitting between hypo-and epitracts.

Dimensions - 10 specimens

Overall length 45-62 μ

" breadth 42-58 μ.

Remarks - This cyst type resembles Type A cysts but is distinct in its ornament and shape of the hypotract. Both have a similar apical plug. Known only from the sediments at Mt. Bischoff.

Type B cysts: Plate 2, figs. 7-9.

Salient features - Proximo-chorate cysts of circular or ovoidal shape. Cyst wall two layered, very thin, the outer layer producing a dense network of appendages, hollow and anchor shaped. Archeopyle apical. Girdle not observed.

Description - cyst more or less circular except for ancheopyle region and shape modified by the dense array of appendages. These do not reflect any tabulation and are 4-5 μ long, 1.5-2.5 μ wide, hollow and branched at their extremities, closed distally and not communicate with endocoel Branches 2 or 3 and 2-3 μ long giving an "anchor" shape to the appendage. Archeopyle is presumably formed by the loss the apical plates and there is some suggestion of a sulcul notch in some specimens. Wall layers less than 1 μ thick.

Dimensions - 10 specimens

length (without appendages) - 22-35μ

breadth " 18-25μ

Remarks - This cyst type is possibly referable to the genus

Cleistosphaeridium. Davey et. al. It is only known from the Brisbane area and reaches a frequency of 4% of the total sporomorph-microplankton assemblage.

References:

Churchill, D.M. & Sarjeant, W.A.S. 1962.
Fossil dinoflagellates and hystrichospheres in Australian freshwater deposits.
Nature, 194:1094

Churchill, D.M. & Sarjeant, W.A.S. 1963.
Freshwater microplankton from Flandrian (Holocene) peats of south western Australia.
Grana Palynol., 3: 29-53.

Evitt, W.R., & Davidson, S.E. 1964.
Dinoflagellate studies, 1. Dinoflagellate cysts and thecae.
Stanford Univ. Publ., Univ. Ser., Geol. Sci., 10 (1): 1-12.

Evitt, W.R., & Wall, D., 1968.
Dinoflagellate studies IV. Theca and cysts of Recent freshwater Peridinium limbatum (Stokes) Lemmermann.
Ibid, 12(2): 1-15.

Gocht, H., 1969.
Formengemeinschaften Alttertiären Mikroplanktons aus Bohrproben des Erdölfeldes Meckelfeld bei Hamburg.
Palaeontographica B, 126 (1-3): 1-100.

Harland, R., & Sarjeant, W.A.S. 1970.

Fossil freshwater microplankton (Dinoflagellates and acritarchs) from Flandrain (Holocene) sediments of Victoria and Western Australia.

Proc. R. Soc. Vict., 83 (2): 211-234.

Harris, W.K., 1965.

Tertiary microfloras from Brisbane, Queensland.

Queensland Dept. Mines, Geol. Surv. Queensland, Rept., 10: 1-7.

Houston, B., 1965.

New and redefined names in Queensland stratigraphy

Queensland Govt. Min. Jrn., 66 (763): 221-222.

Lange, R.T., 1970.

The Maslin Bay flora, South Australia. 2. The assemblage of fossils.

N. Jb. Geol. Paläont Mh., 486-490, 1970.

Lindsay, J.M., 1969.

Cainozoic foraminifera and stratigraphy of the Adelaide Plains Sub-basin, South Australia.

Bull. geol. Surv. S. Aust., 42: 60p.

McGowran, B., Harris, W.K., Lindsay, J.M., 1970.

The Maslin Bay flora, South Australia. 1. Evidence for early Middle Eocene age.

N. Jb. geol. Paläont Mh., 481-485, 1970.

Norris, G. & McAndrews, J.H., 1970.

Dinoflagellate cysts from post-Glacial lake muds, Minnesota (U.S.A.).

Rev. Palaeobotan. Palynol., 10(2): 131-156.

Sarjeant, W.A.S., & Strachan, I., 1968.

Freshwater acritarchs in Pleistocene peats from Staffordshire, England.

Grana Palynol., 8: 204-209.

Smith, G.M., 1950.

The freshwater algae of the United States. 2nd Ed. 1-719. New York: McGraw-Hill.

Staplin, F.L., 1961.

Reef controlled distribution of Devonian microplankton in Alberta.

Palaeontology, 4: 393-424.

Taylor, D.J., 1964.

Foraminifera and the stratigraphy of the western Victorian Cretaceous sediments.

Proc. R. Soc. Vict., 77 (2): 535-602.

Wall, D., 1965.

Microplankton and spores from the Lower Jurassic of Britain.

Micropaleontology, 11: 151-190.

Wall, D., Guillard, R.R.L., & Dale B., 1967.

Marine dinoflagellate cultures from resting spores.

Phycologia, 6 (2): 83-86.

Wall, D., & Dale, B. 1967.

The resting cysts of modern marine dinoflagellates and their palaeontological significance.

Rev. Palaeobotan. Palynol., 2 (1/4): 349-354.

Wall, D., & Dale, B., 1968.
Modern dinoglagellate cysts and evolution of the Peridiniales.
Micropaleontology, 14 (3): 265-304.

Wall, D., & Dale, B., 1970.
Living hystrichosphaerid dinoflagellate spores from Bermuda and Puerto Rico.
Ibid, 16(1): 47-58.

Explanation to Text Figure.

Map of sample localities mentioned in text.

1. Lake Eyre Bore 20
2. E.A. Rudd Bore 5, Frome Embayment
3. Waikerie 27W Bore
4. A.A.O. Morkalla No.1 Well
5. Maslin Bay
6. Brisbane City area
7. Mt. Bischoff
8. Pt. Clinton
9. Adelaide City area.

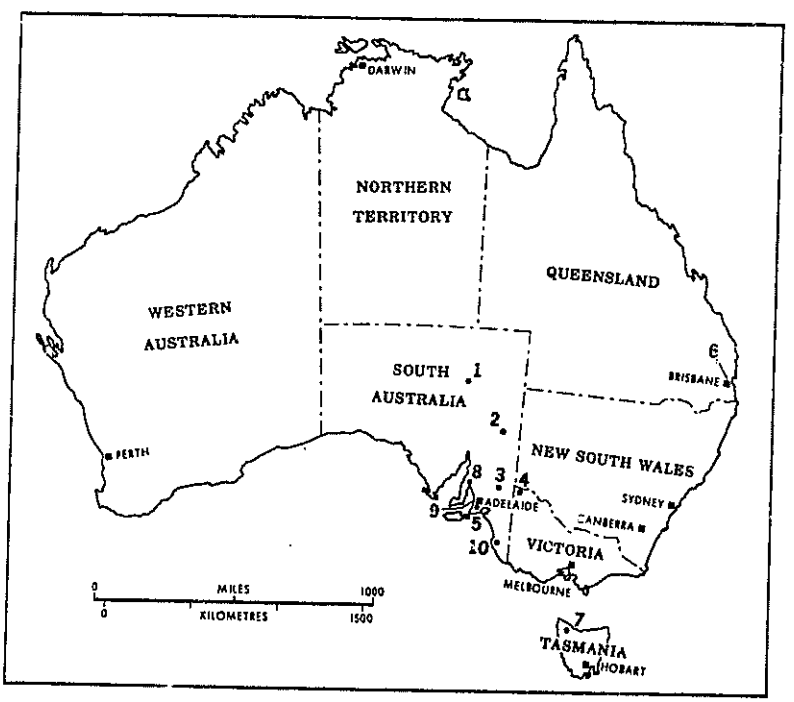


PLATE 1

All Figs. x 500 and all but figs. 4&5 by Nomarski differential interference contrast.

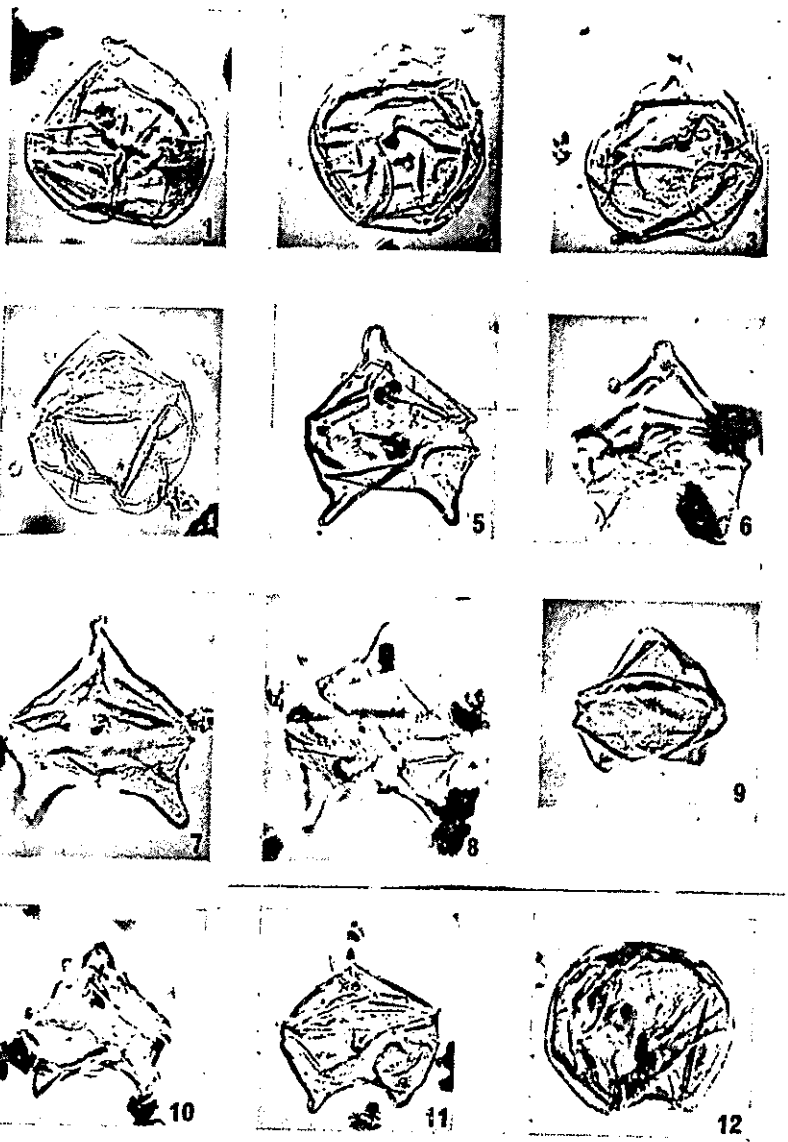
Fig. 1-4 Type A cysts Brisbane NS5, core at 270ft. (82.3m)

	Slide No.	Coords.
1.	S103/4	47.4, 104.7
2.	"	44.0, 102.7
3.	S103/3	48.9, 110.0
4.	S103/4	35.9, 100.8

Figs 5-11 Type B cysts A.A.O. Morkalla No.1 Well. Sidewall core at 1809ft. (551.4m)

5.	S2142/2	33.9, 103.5
6.	S2142/1	27.1, 95.9
7.	"	38.0, 104.5
8.	"	45.2, 95.7
9.	"	31.0, 103.2
10.	"	31.8, 107.1
11.	S2142/4	44.5, 107.2

12. Type D cyst. Mt. Bischoff, beneath balsalt.
S1021/4 27.2, 108.7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12

PLATE 2

Fig. 1-8 x 500, 10 & 11 x 1250

Fig. 1, 4, 5, 7, 8, 10 by Nomarski differential interference contrast.

Fig. 9 by Phase contrast

Fig. 1-6 Type D cysts. Mt. Bischoff, beneath basalt.

	Slide No.	Coords.
1	S102/5	43.8, 103.0
2	S1021/1	29.8, 99.0
3	S1021/1	40.2, 95.5
4	S1021/3	25.9. 106.9
5	S1021/3	27.1, 102.1
6	S1021/1	23.0, 106.2

Figs. 7-9 Type E cysts. Brisbane NS5, core at 270ft. (82.3m)

7	S103/1	34.4, 105.1
8	S103/4	46.2,108.5
9	"	"

Fig. 10, Type C cyst. Maslin Bay clay lines

S1308/1 37.1, 105.5


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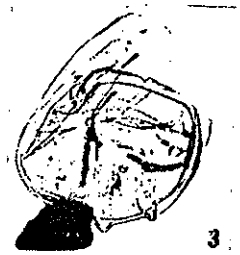
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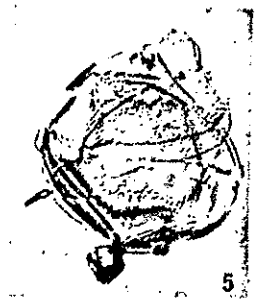
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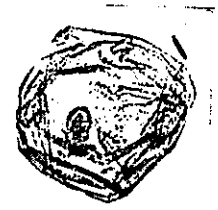
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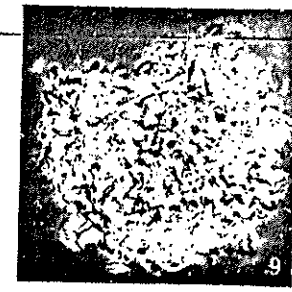
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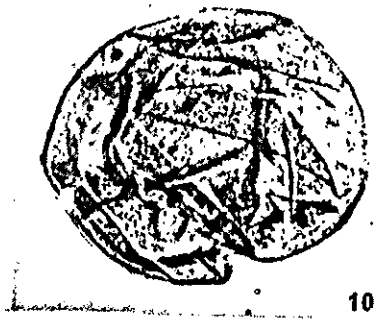
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