Antarctic Science 4 (3): 305–310 (1992)

Dinoflagellate cysts from the Rabot Member (Santa Marta Formation) of eastern James Ross Island

PAUL W. SUMNER

Centre for Palynological Studies, University of Sheffield, Mappin Street, Sheffield S1 3JD, UK

Abstract: Palynomorph assemblages dominated by dinoflagellate cysts are described from seventeen samples from the Rabot Member of the Santa Marta Formation at Ekelöf Point, eastern James Ross Island, Antarctic Peninsula. Although the assemblages are of relatively low diversity, the dinoflagellate cyst taxa recorded indicate a mid to late Campanian (Late Cretaceous) age. Changes in species diversity, dominance and gonyaulacacean ratio suggest a gradually reducing distance from shore during deposition, with a return to more offshore conditions towards the section top. A new species of dinoflagellate cyst, *Isabelidinium papillum,* is described.

Received 13 August 1991, accepted 19 December 1991

Key words: Campanian, dinoflagellate cysts, Ekelöf Point, Santa Marta Formation

Introduction

Sedimentary rocks, assigned to the Rabot Member of the Santa Marta Formation at Ekelöf Point, eastern James Ross Island (Fig. 1), were sampled to document the stratigraphical and palaeoenvironmental palynology. The Rabot Member was originally described as the Rabot Formation by Lirio *et al.* (1989); the type section is at Rabot Point, *c.* 10 km to the south-west of Ekelöf Point. A change in status of the formation to a member of the Santa Marta Formation was proposed by Crame *et al.* (1991). This member is believed to be a lateral equivalent of the Lachman Crags and Herbert Sound members, which are exposed in north-west James Ross Island. Lirio *et al.* (1989) reported the age of these sediments as late Campanian due to the presence of the ammonites *Metaplacenticeras* sp. and *Hoplitoplacenticeras* sp. at the type locality. Crame *et al.* (1991) reported a more diverse assemblage, largely confirming a Campanian age for the Rabot Member.

The sampled exposure at Ekelöf Point consists of 34.5 m of massive to weakly laminated, grey, silty mudstones, punctuated by several beds (up to 20 cm thick) of fine to medium grained tuff, largely altered to yellow-grey clay (Fig. 2). The mudstone units are strongly bioturbated and commonly contain "rosette" trace fossils. *Baculites rectus* and kossmaticeratid ammonites are present and suggest a possible early Campanian age for the section (Crame *et al.* 1991). Seventeen samples were collected from this section by Dr J.B. Riding on February 14th, 1989 and were processed using standard palynological techniques by British Geological Survey technical staff.

Previous palynological studies

The majority of published palynological studies on the Upper Cretaceous of the James Ross Island area are based on sediments from the Campanian–Palaeocene López de Bertodano Formation. These include Askin (1983, 1984, 1986, 1988), Baldoni & Barreda (1986), Crame *et al.* (1991), Palamarczuk *et al.* (1984), Pirrie & Riding (1988) and Pirrie *et al.* (1991). In contrast there has been less work on the Santa Marta Formation.

A pilot study, based on samples collected from James Ross Island, Dundee Island and Cape Longing, Antarctic Peninsula,

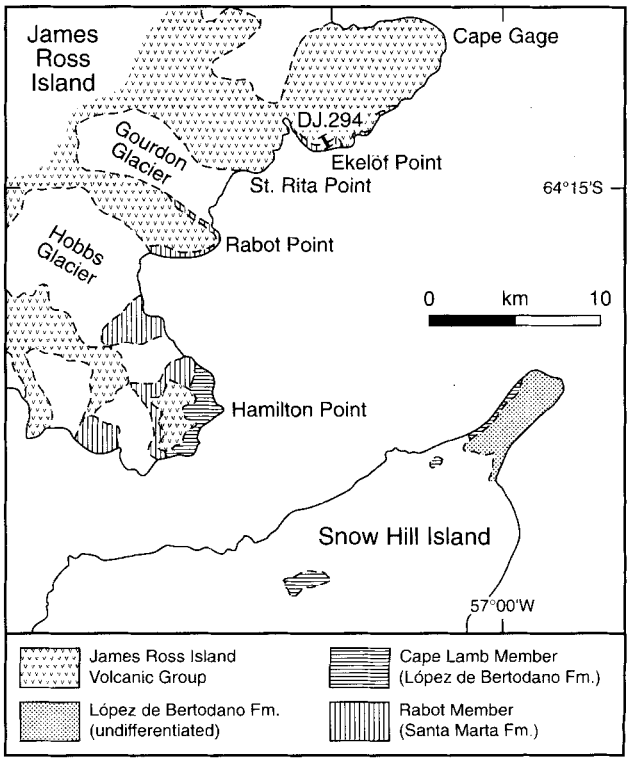

Fig. 1. Geological map of south-eastern James Ross Island, showing the location of the section sampled at Ekelöf Point (after Crame *et al.* 1991).

https://doi.org/10.1017/S0954102092000464 Published online by Cambridge University Press

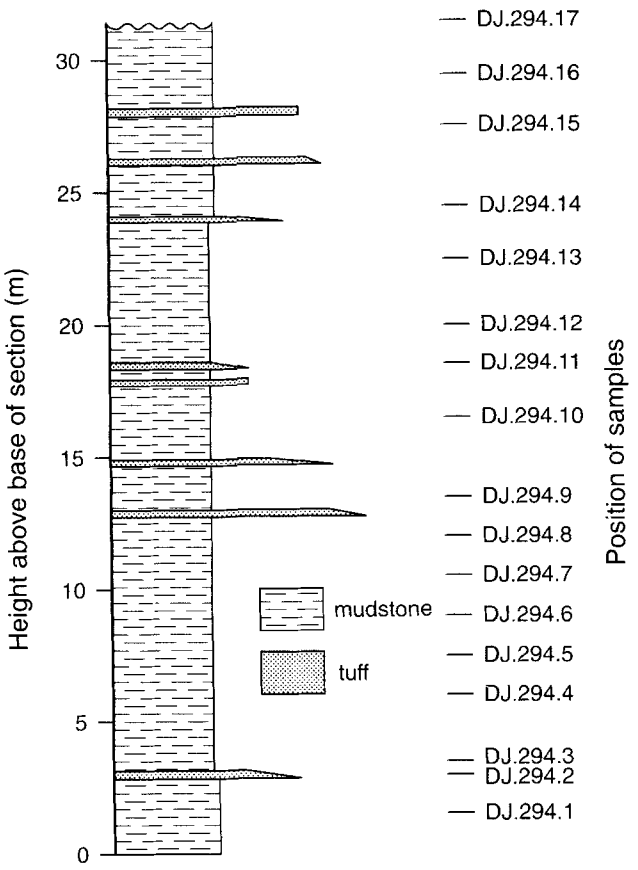

Fig. 2. Sedimentary log of the sampled section at Ekelöf Point (D. Pirrie, personal communication 1989).

was carried out by Dettmann & Thomson (1987) and included two samples from the lowermost Santa Marta Formation at Lachman Crags. Their study confirmed the presence of *Muderongia, Heterosphaeridium* and *Isabelidinium* dinoflagellate cyst floras (Helby *et al.* 1987).

Crame *et al.* (1991) reported dinoflagellate cyst assemblages from the Santa Marta Formation. Assemblages from the Lachman Crags Member included taxa characteristic of the *Odontochitina porifera* to *Xenikoon australis* interval zones of Helby *et al.* (1987), indicating an early Santonian–early Campanian age. The Herbert Sound Member yielded an assemblage suggesting a late Campanian–early Maastrichtian age. The assemblage described herein and another from Rabot Point including *Nelsoniella* spp., *Odontochitina* spp. and *Chatangiella* spp. were reported from the Rabot Member, suggesting a latest Santonian–late Campanian age.

Systematic palynology

The list of dinoflagellate cyst species extracted is given in Appendix I. One new species is described here.

Division PYRRHOPHYTA Pascher 1914

Class DINOPHYCEAE Fritsch 1929

Order PERIDINIALES Haeckel 1894

Genus: *Isabelidinium* Lentin & Williams 1977; emend. Marshall 1988

Type species: I. korojonense (Cookson & Eisenack 1958) Lentin & Williams 1977

Isabelidinium papillum sp. nov.

Fig. 3b & c

Derivation of name: Latin *papilla,* nipple, in reference to the apical protrusion which is a diagnostic feature of this species.

Holotype: Sample DJ.294.12/3, H59/2. Repository: B.A.S. Cambridge.

Diagnosis: A bicavate, peridinacean dinoflagellate cyst, generally oval in outline with a distinct equatorial bulge and spherical to oval endocyst. The periphragm possesses a short apical protrusion. The cyst shows no paracingulum or other evidence of tabulation except a steno-deltaform intercalary periarchaeopyle, corresponding to the 2a paraplate. The periphragm is smooth to finely granulate.

Description: A dinoflagellate cyst species with a bicavate wall relationship and a generally oval to elongate oval outline, bulging at the equator where the endophragm and periphragm are closely appressed. The endocyst is spherical to oval in outline. The cyst has a blunt conical epicyst with a prominent, hollow apical protrusion up to 14 μm in length. The antapex is often truncated, or less commonly shows slight development of two antapical horns, the left commonly showing stronger development. The only indication of paratabulation is the periarchaeopyle which is a single plate intercalary (type I), corresponding to the 2a paraplate, with a steno-deltaform shape. No endoarchaeopyle has been observed. The operculum is usually free. The surface of the cyst is smooth to finely granulate, many specimens posessing nontabular granular ornament towards the apex and antapex.

Remarks and comparisons: Isabelidinium papillum sp. nov. is similar in size and general outline to *I. pellucidum* and *I. korojonense,* but it possesses a relatively smaller endocyst than *I. pellucidum* and has a more rounded apex. It differs from *I. korojonenses* by lacking the distinctive serrated shoulders and having a more elongate archaeopyle shape. It differs from all other members of the genus by the posession of a distinctive

https://doi.org/10.1017/S0954102092000464 Published online by Cambridge University Press

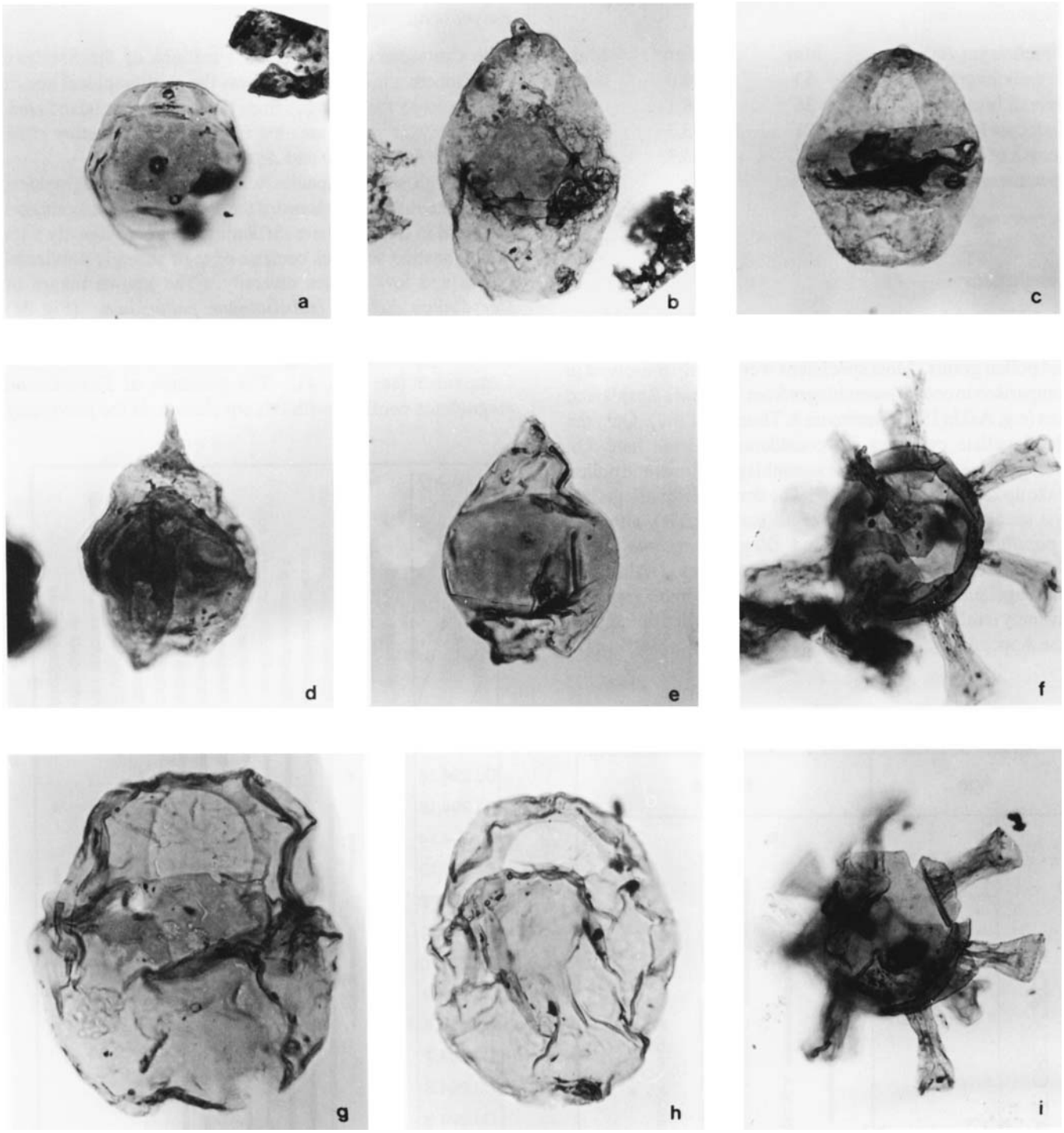

Fig. 3. Dinoflagellate cysts from the Rabot Member at Ekelöf Point. All photomicrographs are at a magnification of x 600 and are taken in transmitted light. **a.** *Isabelidinium cretaceum* (Cookson 1956) Lentin & Williams 1977, ventral view. DJ.294.3/1 M72 **b. c.** *Isabelidinium papillum* sp. nov. **b.** Holotype, ventral view. DJ.294.12/3, H59/2. **c.** Paratype, ventral view, low focus. DJ.294.12/1, D60/3. **d.** *Isabelidinium* cf. *ponticum* Marshall 1988, dorsal view. DJ.294.7/2, K58. **e.** *Isabelidinium pellucidum* (Deflandre & Cookson 1955) Lentin & Williams 1977, ventral view. DJ.294.1/2, J60. **f, i.** *Oligosphaeridium* sp. A, apical and lateral views respectively. **f.** DJ.294.1/2, U48/4. **i.** DJ.294.4/2 D52/1. **g. h.** *Isabelidinium ?* sp., ventral views. **g.** DJ.294.2/2, O49. **h.** DJ.294.2/3, E47.

https://doi.org/10.1017/S0954102092000464 Published online by Cambridge University Press

apical protrusion.

Dimensions (μm):	Min	Mean	Max
Overall length:	54	69.0	89
Overall breadth:	36	48.1	56
Endocyst length:	21	33.3	50
Length of apical protrusion:	2	3.7	14

Specimens measured: 30

Occurrence: DJ.294.1–17.

Conclusions

The 17 samples all yielded palynomorph assemblages comprising dinoflagellate cysts, acritarchs, pteridophyte spores and pollen grains. Most specimens were poorly preserved in comparison to coeval assemblages from the James Ross Island area (e.g. Askin 1983, Dettmann & Thomson 1987). Only the dinoflagellate cyst taxa are considered in detail here. On average these form 75% of the assemblages, spores and pollen make up 23% and acritarchs 2%. The dominant dinoflagellate cyst species is *Isabelidinium cretaceum* (32.3%), although *I. papillum* sp. nov. (13%) and *Oligosphaeridium* sp. A (7.3%) are also prominent in all samples. Although dinoflagellate cysts strongly dominate the assemblages, their diversity is relatively low, with 17 species recorded throughout (see Appendix I).

Palynostratigraphy

Late Cretaceous palynological zonations of the Southern Hemisphere can be used to assess the stratigraphical age of palynomorph assemblages from the James Ross Island area. Most relevant to this area are the zonations of Helby *et al.* (1987), Wilson (1984) and Askin (1986, 1988).

Although several species with perceived stratigraphical importance have been recorded the dinoflagellate assemblages recorded in this study are difficult to compare directly with these zonation schemes because of their strongly provincial nature and low species diversity. The known ranges of *Cerodinium diebelii, Isabelidinium pellucidum,* (Fig. 3e) *I. cretaceum* (Fig. 3a) and *Oligosphaeridium* sp. A (Fig. 3 f & i) suggest that the age of the material is mid to late Campanian (see Fig. 4). The presence of *Phelodinium magnificum* conflicts with this conclusion, as the previously

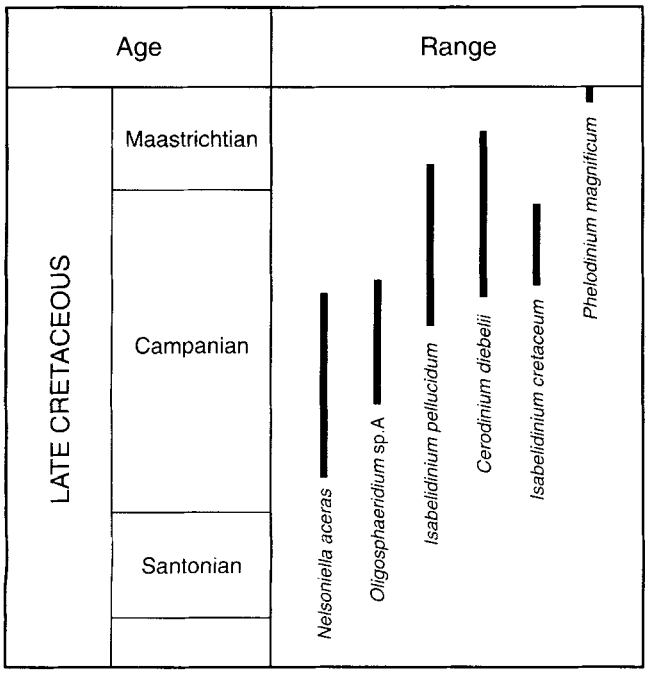

Fig. 4. Summary of the stratigraphical ranges of selected dinoflagellate cyst species recovered from Ekelöf Point (after Helby *et al.* 1987, Askin 1988, Marshall 1984).

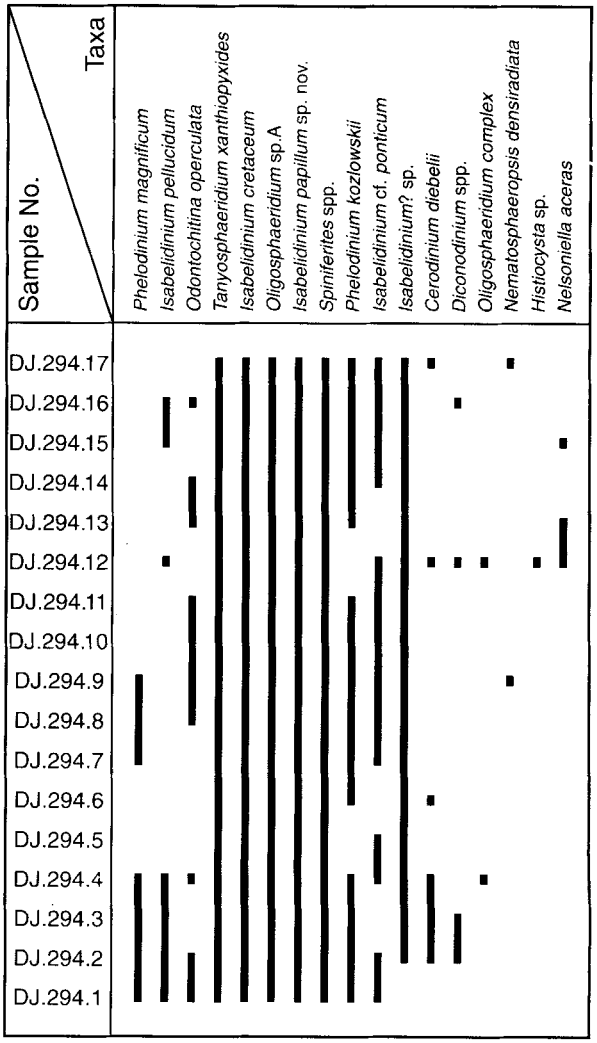

Fig. 5. Distribution of dinoflagellate cyst species in samples DJ.294.1–DJ.294.17, from Ekelöf Point.

https://doi.org/10.1017/S0954102092000464 Published online by Cambridge University Press

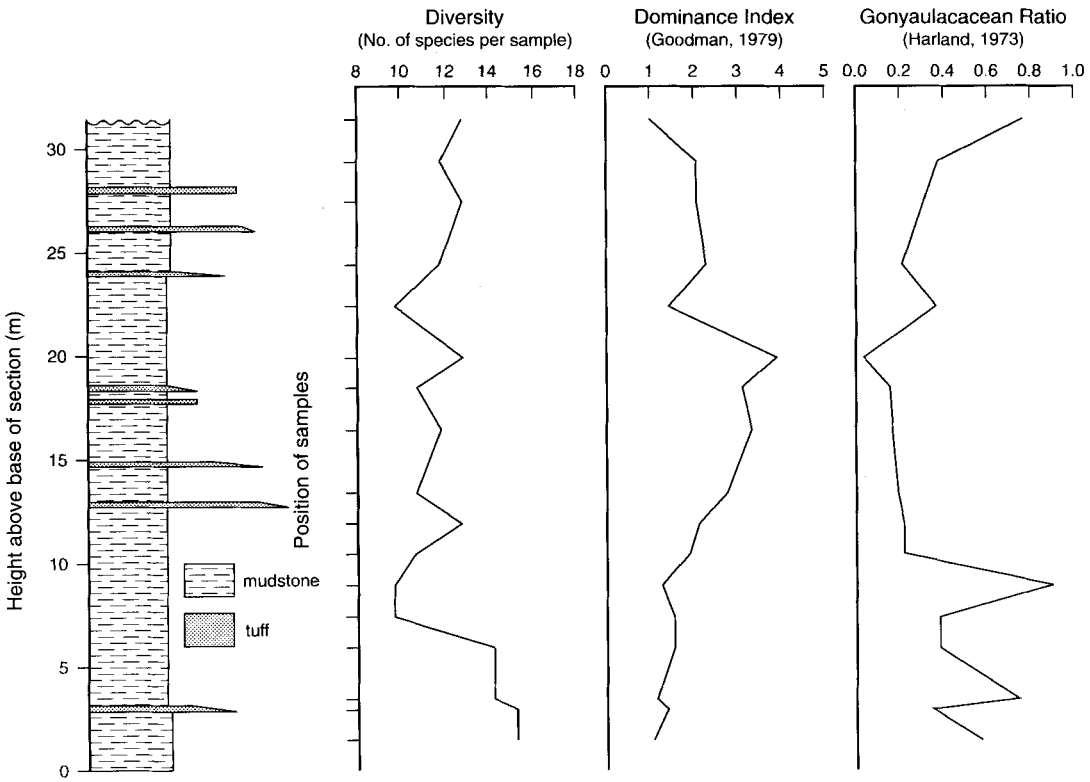

Fig. 6. Variation in selected palaeoenvironmental indicators throughout the sampled section.

reported first occurrence of this species is within the Maastrichtian (Askin 1988).

Both the macrofauna and stratigraphical position (underlying the late Campanian–early Maastrichtian López de Bertodano Formation) suggest that the Rabot Member can be no younger than late Campanian, and this evidence indicates that the inception of *P. magnificum* here may be an older event than previously reported. *Nelsoniella aceras,* which has a mid/late Campanian last occurrence, was present in three samples, with a single specimen present in each. Therefore, it is considered that this species may be reworked.

Throughout the section (Fig. 5) few dinoflagellate cyst species are restricted to a particular interval. Most occur in the majority of samples and changes in the assemblages cannot be used for further stratigraphical resolution within this section.

Palaeoenvironmental palynology

In contrast to the literature on the biostratigraphical use of dinoflagellate cysts, their use as indicators of palaeoenvironments has received less attention. Wall *et al.* (1977) detected trends in diversity of dinoflagellate cyst species along inshore to offshore transects in modern sediments using a "species richness index". The results showed a tendency for species diversity to increase offshore. Similar trends have been recognized in fossil assemblages by Goodman (1979) and Châteauneuf (1980). Goodman also recognized that dominance of assemblages by a single species showed the opposite trend, i.e. dominance (measured using a "dominance index") was higher for assemblages deposited in nearshore settings. Several authors (Downie *et al.* 1971, Harland 1973, Châteauneuf 1980) noticed trends in the relative abundancy of different dinoflagellate cyst species in assemblages from different localities of the same age which may relate to distance from shore. These trends relate to the relative abundancy of peridiniacean and gonyaulacacean species, the peridiniaceans being more characteristic of nearshore settings. Harland (1973) used a "gonyaulacacean ratio" to define this trend.

Fig. 6 shows the variation in selected palaeoenvironmental indicators (species diversity, dominance and gonyaulacacean ratio) throughout the Ekelöf Point section. Although there are relatively small variations in each of these parameters, the same general trend appears to occur in all three curves, possibly reflecting a relative change in the proximity of the palaeoshoreline during deposition. Samples DJ.294.1–6 have a relatively high gonyaulacacean ratio accompanied by lower dominance, suggesting relatively offshore conditions. Samples DJ.294.7–12 record a progressively reducing gonyaulacacean ratio and rising dominance values which may indicate a gradual reduction in distance from shore. There follows a return to relatively offshore characteristics from DJ.294.13–17. The diversity curve follows this general trend showing highest values in the lowest four samples, with a lower, but fluctuating, number of species further up the section. The average values of these indicators throughout the section (low diversity and

https://doi.org/10.1017/S0954102092000464 Published online by Cambridge University Press

gonyaulacacean ratio and high dominance) suggest a relatively nearshore setting during deposition of the sediments, which contrasts with the sedimentological and regional evidence for palaeoenvironment. There is no evidence for wave generated structures in the Rabot Member within the Rabot Point or Ekelöf Point sections, indicating water depths of greater than 150 m, and the Rabot Member is considered to be a distal equivalent of the Lachman Crags and Herbert Sound members (Crame *et al.* 1991). Consequently, adverse palaeoenvironmental conditions other than water depth *per se* may have affected the dinoflagellate cyst assemblages.

Acknowledgements

Thanks go to the British Geological Survey and British Antarctic Survey who provided processed samples for this project and a wealth of background geological information. I am also grateful to the staff and students of the Centre for Palynological Studies, University of Sheffield for their support.

References

For all systematic references not quoted below, see Lentin & Williams (1989).

Askin, R.A. 1983. Campanian palynomorphs from James Ross and Vega Islands, Antarctic Peninsula. *Antarctic Journal of the United States,* **18**, (5), 63-64.

Askin, R.A. 1984. Palynological investigations of the James Ross Island basin and Robertson Island, Antarctic Peninsula. *Antarctic Journal of the United States,* **19**, (5), 6-7.

Askin, R.A. 1986. Palynomorphs and depositional environment for upper Campanian sediments on Seymour Island, Antarctica. *Antarctic Journal of the United States,* **21**, (5), 73-74.

Askin, R.A. 1988. Campanian to Paleocene palynological succession of Seymour and adjacent islands, north-eastern Antarctic Peninsula. *In* Feldmann, R.M. & Woodbourne, M.O. *eds. Geology and paleontology of Seymour Island, Antarctic Peninsula.* Geological Society of America Memoir, No. 169, 131-153.

Baldoni, A.M. & Barreda, V. 1986. Estudio palinológico de las formaciones López de Bertodano y Sobral, isla Vicecomodoro Marambio, Antártida. *Boletim IG-USP, Serie Cientifica,* **17**, 89-98.

Châteauneuf, J-J. 1980. Palynostratigraphie et paléoclimatologie de l'Eocene supérieur et de l'Oligocene du Bassin de Paris (France). *Memoir du Bureau de Recherches Géologiques et Minières,* **16**, 1-360.

Crame, J.A., Pirrie, D., Riding, J.B. & Thomson, M.R.A. 1991. Campanian-Maastrichtian (Cretaceous) stratigraphy of the James Ross Island area, Antarctica. *Journal of the Geological Society of London,* **148**, 1125-1140.

Dettmann, M.E. & Thomson, M.R.A. 1987. Cretaceous palynomorphs from the James Ross Island area, Antarctica - a pilot study. *British Antarctic Survey Bulletin,* No. 77, 13-59.

Downie, C., Hussain, M.A. & Williams, G.L. 1971. Dinoflagellate cyst and acritarch associations in the Paleogene of southeast England. *Geoscience and Man,* **3**, 29-35.

Goodman, D.K. 1979. Dinoflagellate "communities" from the Lower Eocene Nanjemoy Formation of Maryland, U.S.A. *Palynology,* **3**, 169-190.

Harland, R. 1973. Dinoflagellate cysts and acritarchs from the Bearpaw Formation (Upper Campanian) of southern Alberta, Canada. *Palaeontology,* **16**, 665-706.

Helby, R.J., Morgan, R. & Partridge, A.D. 1987. A palynological zonation of the Australian Mesozoic. *In* Jell, P.A., *ed. Studies in Australian Mesozoic palynology.* Memoir of the Association of Australasian Palaeontologists, No. 169, 1-93.

Lentin, J.K. & Williams, G.L. 1989. Fossil dinoflagellates: Index to genera and species, 1989 edition. *American Association of Stratigraphic Palynologists Contributions Series,* No. 20, 473pp.

Lirio, J.M., Marenissi, S.A., Santillana, S.N., Marshall, P.A. & Rinaldi, C.A. 1989. Marambio Group at the south eastern part of James Ross Island, Antarctica. *Contribución del Instituto Antártico Argentino,* No. 371, 45pp.

Marshall, N.G. 1984. *Late Cretaceous Dinoflagellates from the Perth Basin, Western Australia.* Ph.D. thesis, University of Western Australia, 297pp. [Unpublished].

Palamarczuk, S., Ambrosini, G., Medina, F.A., Martinez Macchiavello, J.C. & Rinaldi, C.A. 1984. Las formaciones López de Bertodano y Sobral en la isla Vicecomodoro Marambio, Antártida. *Noveno Congreso Geológico Argentino Actas,* **1**, 399-419.

Pirrie, D. & Riding, J.B. 1988. Sedimentology, palynology and structure of Humps Island, northern Antarctic Peninsula. *British Antarctic Survey Bulletin,* No. 80, 1-19.

Pirrie, D., Crame, J.A. & Riding, J.B. 1991. Late Cretaceous stratigraphy and sedimentology of Cape Lamb, Vega Island, Antarctica. *Cretaceous Research,* **12**, 227-258.

Wall, D., Dale, B., Lohmann, G.P. & Smith, W.K. 1977. The environmental and climatic distribution of dinoflagellate cysts in modern marine sediments from regions in the North and South Atlantic oceans and adjacent seas. *Marine Micropaleontology,* **2**, 121-200.

Wilson, G.J. 1984. New Zealand Late Jurassic to Eocene dinoflagellate biostratigraphy—a summary. *Newsletters on Stratigraphy,* **13**, 104-117.

Appendix I. Dinoflagellate cyst species from the Rabot Member, Santa Marta Formation, Ekelöf Point

Cerodinium diebelii (Alberti 1959) Lentin & Williams 1987
Diconodinium spp.
Histiocysta? sp.
Isabelidinium? sp. Fig. 3g & h
Isabelidinium cretaceum (Cookson 1956) Lentin & Williams 1977 Fig. 3a
Isabelidinium papillum sp. nov. Fig. 3b & c
Isabelidinium pellucidum (Deflandre & Cookson 1955) Lentin & Williams 1977 Fig. 3e
Isabelidinium cf. *ponticum* Marshall 1988 Fig. 3d
Nelsoniella aceras Cookson & Eisenack 1960
Nematosphaeropsis densiradiata (Cookson & Eisenack 1962) Stover & Evitt 1978
Odontochitina operculata (O. Wetzel 1933) Deflandre & Cookson 1955
Oligosphaeridium complex (White 1842) Davey & Williams 1966
Oligosphaeridium sp. A (="*Anthosphaeridium wisemanii*" of Marshall 1984) Fig. 3f & i
Phelodinium kozlowskii (Gorka 1963) Lindgren 1984
Phelodinium magnificum (Stanley 1965) Stover & Evitt 1978
Spiniferites spp.
Tanyosphaeridium xanthiopyxides (O. Wetzel 1933) Stover & Evitt 1978