

# PALEONTOLOGICAL NOTES

*J. Paleont.*, 77(2), 2003, pp. 382–385  
Copyright © 2003, The Paleontological Society  
0022-3360/03/0077-382\$03.00

## NEOGENE OCCURRENCES OF THE MARINE ACRITARCH GENUS *NANNOBARBOPHORA* HABIB AND KNAPP, 1982 EMEND., AND THE NEW SPECIES *N. GEDLII*

MARTIN J. HEAD

Godwin Institute for Quaternary Research, Department of Geography, University of Cambridge, Downing Place, Cambridge CB2 3EN,  
United Kingdom, <mh300@cam.ac.uk>

THE STRATIGRAPHIC utility of small marine acritarchs in the Neogene has been known for more than a decade (e.g., de Vernal and Mudie, 1989). Their potential for biostratigraphy in the Cretaceous is also well known, and was elegantly elucidated by Habib and Knapp (1982) in a detailed scanning electron microscope (SEM) study from the western North Atlantic. Habib and Knapp erected 12 new acritarch genera including the acanthomorph genus *Nannobarbophora* and its three species *N. barbata* (the name of the type), *N. pistilla*, and *N. platforma*. A diagnostic feature of *Nannobarbophora* is the presence of spinules concentrated on, or restricted to, the surface of distally closed processes. Excystment is by a simple linear split (Habib and Knapp, 1982, p. 347).

The present study evaluates the taxonomy and biostratigraphy of Neogene species of *Nannobarbophora* by reappraising the literature and presenting new observations from the Miocene of Ocean Drilling Program (ODP) Hole 643A, Norwegian Sea (Fig. 1). The genus “*Svenkodinium*” Gedl, 1996, from the middle Miocene of Poland, is shown to be congeneric with, and junior to, *Nannobarbophora*. Two Neogene species of *Nannobarbophora* are now recognized, *N. walldalei* Head, 1996, and *N. gedlii* new species. The taxonomic and nomenclatural history of these species is clarified, and a better understanding of their biostratigraphy and widespread distribution is now attained. New observations of *N. walldalei* and *N. gedlii* n. sp. have required the emendation of *Nannobarbophora*.

### MATERIALS AND METHODS

Three samples from ODP Leg 104, Vøring Plateau, Norwegian Sea, were investigated: sample 104-643A-20X-7, CC, 15–17 cm (upper lower Miocene; Manum et al., 1989); and samples 104-644A-32-2; 135–137 cm and 104-644A-31-4; 35–37 cm (both lower upper Pliocene; Mudie, 1989; Fig. 1). Organic residues of these samples were supplied by P. J. Mudie. Their palynological processing is described in Mudie (1989) and includes sieving at 10 µm, while SEM and slide-making procedures follow Head (1993). Residues were investigated using a JEOL SEM at 15 kV (Fig. 2.9–2.14) and a Leica DMR light microscope fitted with a Leica DC300 digital camera (Fig. 2.1–2.8). The holotype and paratype of *Nannobarbophora gedlii* n. sp. are housed in the Invertebrate Section of the Department of Palaeobiology, Royal Ontario Museum, Toronto, under the catalog number ROM 56015.

### NEOGENE STUDIES OF *NANNOBARBOPHORA*

A distinctive morphotype from the upper Pliocene of eastern England (as *Nannobarbophora* sp. cf. *N. barbata* in Head, 1994, table 1) and upper Pliocene of the Singa section in Italy (as Acritarch sp. B in Versteegh, 1994, 1995; Versteegh and Zonneveld, 1994) provided the first evidence of the genus *Nannobarbophora* in the Neogene. This morphotype was shown to differ from previously described (Cretaceous) species of *Nannobarbophora* in

both its larger size and expanded, rootlike process bases, and was formally described as *Nannobarbophora walldalei* Head, 1996. This same species was subsequently reported from the upper Miocene (Messinian) of Morocco and Neogene of the Gulf of Mexico by Warny and Wrenn (1997) who proposed the name *Impletosphaeridium acropora*, unaware that a name already existed for this species. *Impletosphaeridium acropora* was synonymized with *Nannobarbophora walldalei* by Head in Head and Westphal (1999).

### THE GENUS “*SVENKODINIUM*” Gedl, 1996

Gedl (1996) in his study of lower middle Miocene dinoflagellates from Poland proposed the genus “*Svenkodinium*” for small spiny palynomorphs that he considered to be dinoflagellate cysts. He recorded three species and formally named two of them, “*S. minimum*” (the name of the type) and “*S. versteeghii*.” Although Gedl diagnosed the genus “*Svenkodinium*” as having an apical archeopyle, his many light microscope (LM) and SEM illustrations show no convincing evidence of dinoflagellate affinity. Instead, the process morphology shows unequivocally that the two formally named species “*S. minimum*” and “*S. versteeghii*” belong to the acritarch genus *Nannobarbophora*. Neither the name “*Svenkodinium*” nor those of its included species are validly published in Gedl (1996), as the institution where the type material is conserved was not specified (see ICBN Art. 37.6). Despite this irregularity, Gedl’s publication constitutes an important record of *Nannobarbophora* for the middle Miocene.

### DISCUSSION

Specimens of *Nannobarbophora* presently examined from the lower Miocene of the Norwegian Sea differ from *Nannobarbophora walldalei* in having processes that all arise from bases of approximately circular cross-section, rather than the rootlike process bases found on *N. walldalei*. These specimens are assigned to the new species *Nannobarbophora gedlii*. Of Gedl’s two formally named species, “*S. versteeghii*” is clearly conspecific with *N. gedlii* n. sp., extending the stratigraphic range of this species into the middle Miocene. Gedl’s other formally named species, “*S. minimum*,” is also considered conspecific with *Nannobarbophora gedlii* but has a more slender process morphology than is usual for this species.

Records of *Nannobarbophora* from the Neogene hence reveal the presence of two species, *Nannobarbophora walldalei* Head, 1996 having a known stratigraphic range of upper Miocene through lower Pleistocene, and *Nannobarbophora gedlii* n. sp. ranging from at least lower through middle Miocene. Detailed stratigraphic studies are needed to refine these ranges. It appears that *Nannobarbophora gedlii*, like *Nannobarbophora walldalei*, is associated with warm conditions (see below). Indeed, *Nannobarbophora* is common and widespread throughout the warmer

intervals of the Neogene in the North Atlantic region. Its demise in the earlier part of the Pleistocene is probably a consequence of North Atlantic cooling and increasing amplitude of climatic cycles. It is hoped that the present study will stimulate more interest in this genus and other small marine acritarchs of the Neogene.

## SYSTEMATIC PALEONTOLOGY

## Group ACRITARCHA Evitt, 1963

## Genus NANNOBARBOPHORA Habib and Knapp, 1982 emend.

*Nannobarbophora* HABIB AND KNAPP, 1982, p. 347.

“*Svenkodingium*” GEDL, 1996, p. 214.

*Type of genus*.—The holotype of *Nannobarbophora barbata* Habib and Knapp, 1982, pl. 4, figs. 5–6 from the lower Valanginian (Lower Cretaceous) of Deep Sea Drilling Project Site 105, western North Atlantic.

*Included species*.—*Nannobarbophora barbata* Habib and Knapp, 1982; *N. gedlii* n. sp.; *N. pistilla* Habib and Knapp, 1982; *N. platforma* Habib and Knapp, 1982; *N. walldalei* Head, 1996.

*Original description*.—Spheroidal to ellipsoidal, projectate acritarchs distinguished by spinate ornamentation either concentrated on, or restricted to, distally closed processes. Aperture, when present, simple, linear split. Wall single layer, thin (Habib and Knapp, 1982, p. 347).

*Emended diagnosis*.—Spheroidal to ellipsoidal, projectate acritarchs distinguished by spinate ornamentation either concentrated on, or restricted to, distally closed processes. Processes solid or hollow, not communicating with vesicle interior but sealed at base by vesicle wall. Excystment structure, when present, simple, linear split. Vesicle wall thin, no separation of layers between processes.

*Stratigraphic range*.—Berriasian (Lower Cretaceous) through lower Pleistocene; based on the ranges of *N. barbata* (Berriasian and lower Valanginian; Habib and Knapp, 1982) and *N. walldalei* (upper Miocene through lower Pleistocene; Head, 1998; this study).

*Discussion*.—The diagnosis is emended to include the internal nature of the processes, and the relationship of the processes to the vesicle interior.

*Svenkodingium* Gedl, 1996 is not validly published (see above), but would otherwise be considered a taxonomic junior synonym of *Nannobarbophora*.

## NANNOBARBOPHORA GEDLII new species

Figure 2.1–2.10

“*Svenkodingium versteeghii*” GEDL, 1996, p. 214, fig. 12K, L, 16c–h, I, M, P.

“*Svenkodingium minimum*” GEDL, 1996, p. 214, figs. 12J, 16a, b, i–k, N, R.

*Diagnosis*.—A large species of *Nannobarbophora* having vesicle diameter in excess of about 18  $\mu\text{m}$ , and mostly hollow processes that arise from bases of circular to elongate cross-section.

*Description*.—Vesicle (sensu Lister, 1970) spherical to subspherical, less than ca. 0.3  $\mu\text{m}$  thick; no visible stratification between processes. Wall surface smooth or may bear sparse, irregularly scattered granules, coni, or spinules. Processes rigid and erect, mostly hollow, distally closed, not communicating with vesicle interior but sealed at base by vesicle wall, regularly distributed, have morphology ranging from tapering and distally pointed, to cylindrical and flat-topped or evexate, to slightly bulbous; a range of morphologies usually present on single specimen. Process bases circular to elongate in cross-section, diameter up to about 2.5  $\mu\text{m}$ . Spinules present on all processes, usually concentrated on distal portion. Excystment apparently by simple split in vesicle wall.

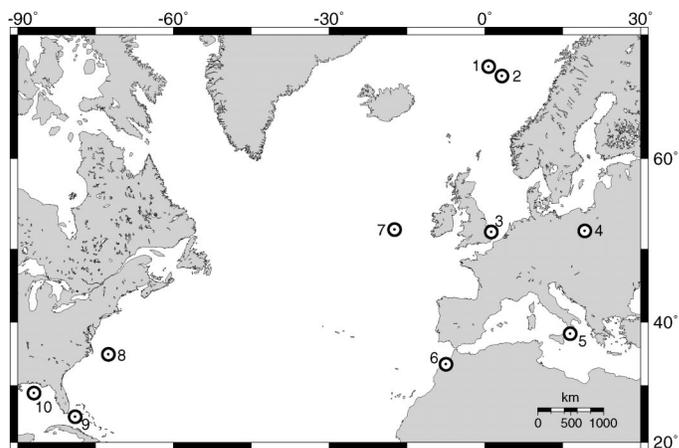


FIGURE 1—Miocene–lower Pleistocene records of the genus *Nannobarbophora*. 1, ODP Hole 643A, Vøring Plateau, Norwegian Sea (this study); 2, ODP Hole 644A, Vøring Plateau, Norwegian Sea (Head, 1996; this study); 3, eastern England (Head, 1994, 1996, 1998); 4, Korytnica Clays, Poland (Gedl, 1996); 5, Singa section, southern Italy (Versteegh, 1994, 1995; Versteegh and Zonneveld, 1994); 6, Bou Regreg Core, Morocco (Warny and Wrenn, 1997); 7, DSDP Hole 610A, King’s Trough (unpublished data); 8, DSDP Hole 603C (unpublished data); 9, Clino Core, Bahamas (Head and Westphal, 1999); 10, Eureka E67–134 Core, De Soto Canyon, Gulf of Mexico (Warny and Wrenn, 1997). These scattered records belie what was probably a widespread distribution in the North Atlantic region for *Nannobarbophora* during warmer intervals of the Neogene and early Pleistocene.

*Etymology*.—Named for Przemyslaw Gedl who was first to illustrate this species (Gedl, 1996).

*Holotype*.—Figure 2.1–2.4. Sample 104-643A-20X-7, CC, 15–17 cm. Slide 1. England Finder reference N41/1. ROM 56015. ODP Hole 643A, Vøring Plateau, Norwegian Sea. Upper lower Miocene (*Apteodinium spiridooides* zone of Manum et al., 1989).

*Measurements*.—Holotype: vesicle maximum diameter, 23  $\mu\text{m}$ ; process length, 2.5–5.5  $\mu\text{m}$ . Range: vesicle maximum diameter, 18(22.7)28  $\mu\text{m}$ , standard deviation, 2.9; average process length, 2.5(4.3)6.0  $\mu\text{m}$ , standard deviation, 0.88. Based on 22 partially compressed specimens.

*Material examined*.—Sample 104-643A-20X-7, CC, 15–17 cm, upper lower Miocene of the Norwegian Sea.

*Occurrence*.—Upper lower Miocene of the Norwegian Sea, and middle Miocene of Poland (as “*Svenkodingium versteeghii*” in Gedl, 1996). See Figure 1.

*Comparison*.—*Nannobarbophora barbata* Habib and Knapp, 1982, from the Lower Cretaceous of the western North Atlantic, differs from *N. gedlii* n. sp. in being smaller (vesicle diameter 5.5–9.0  $\mu\text{m}$ ), and in bearing proportionally larger spinules on the processes. *Nannobarbophora walldalei* Head, 1996, from the upper Pliocene of eastern England, differs from *N. gedlii* n. sp. in having at least some processes with rootlike bases, rather than the exclusively entire bases of *N. gedlii*, and also often a more densely granulate vesicle surface. Processes tend to be more slender and more solid in *N. walldalei* than in *N. gedlii*.

*Discussion*.—“*S. minimum*” and “*S. versteeghii*” are both considered conspecific with *N. gedlii* n. sp. “*S. versteeghii*” represents the typical morphology of *N. gedlii* n. sp., whereas “*S. minimum*” represents a morphological end member of the Norwegian Sea material in having more slender processes. The holotype of *N. gedlii* exemplifies the typical morphology but has a few slender processes characteristic of “*S. minimum*.”

A rich dinoflagellate assemblage accompanies *N. gedlii* n. sp. on the type slide. In addition to the zonal species *Apteodinium*

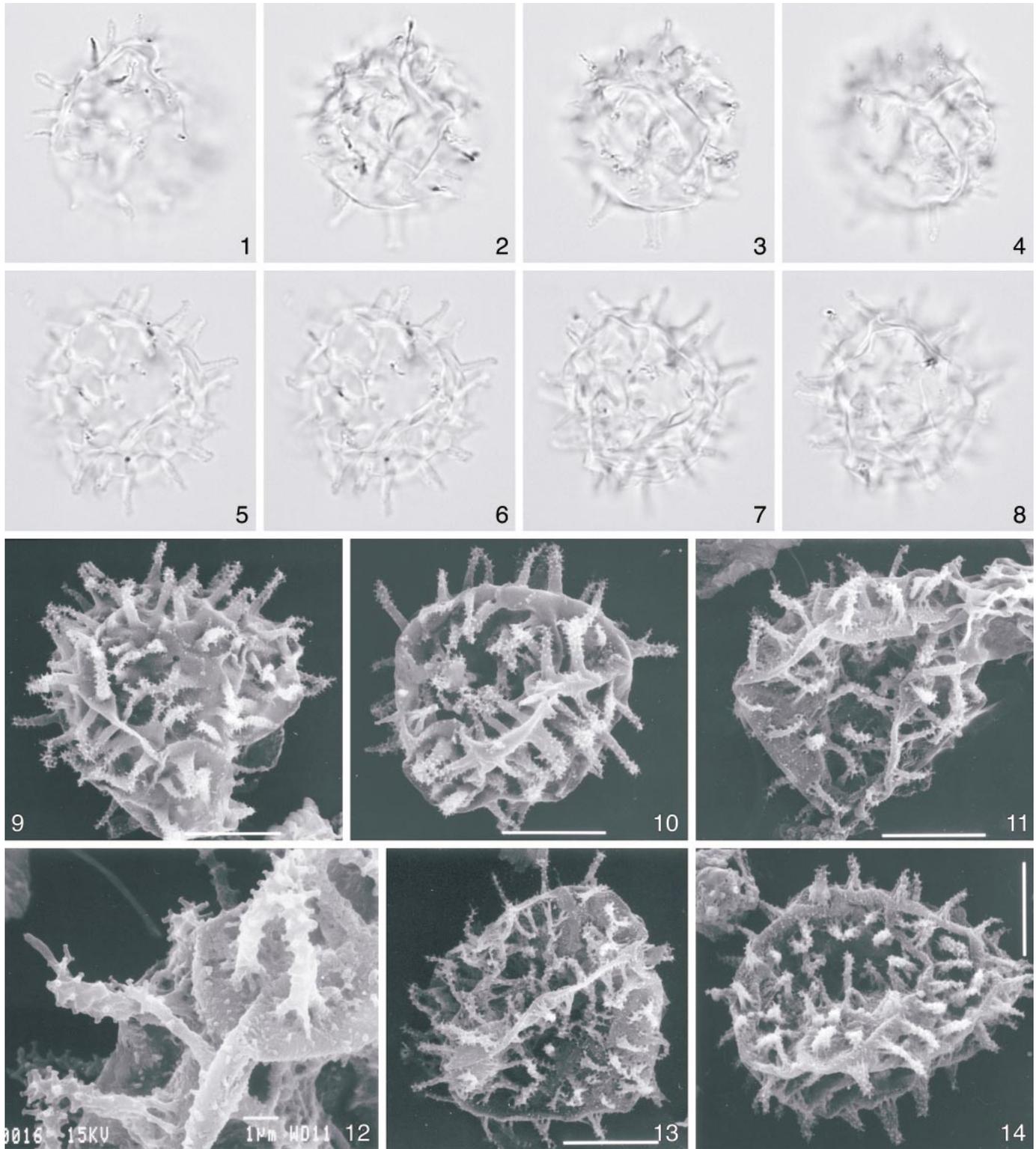


FIGURE 2—*Nannobarbophora gedlii* n. sp. (1–10) from the upper lower Miocene of ODP Hole 643A, Vøring Plateau, Norwegian Sea; and (11–14) *Nannobarbophora walldalei* Head, 1996 from the upper Pliocene of ODP Hole 644A, Vøring Plateau, Norwegian Sea. 1–8 are in bright field illumination; 9–14 are SEM photomicrographs; scale bars are 10  $\mu\text{m}$ , except 12 which is 1  $\mu\text{m}$ . 1–4, holotype, showing progressively lower foci from upper through lower surface; vesicle diameter 23  $\mu\text{m}$ ; Sample 104-643A-20X-7, CC, 15–17 cm; slide 1; England Finder reference N41/1; ROM 56015; 5–8, paratype, showing progressively lower foci from upper through lower surface; vesicle diameter 23  $\mu\text{m}$ ; Sample 104-643A-20X-7, CC, 15–17 cm; slide 1; England Finder reference R17/0; ROM 56015; 9, 10, different specimens from Sample 104-643A-20X-7, CC, 15–17 cm (both stub 3, film 10). 11–14, *Nannobarbophora walldalei* shown here for comparison; note the rootlike process bases characteristic of this species (from Head, 1996, fig. 17.12–17.15); 11, 12, lower and higher magnifications respectively of the same specimen, Sample 104-644A-32-2; 135–137 cm (stub 3, film 9); 13, Sample 104-644A-32-2; 135–137 cm (stub 3, film 8); 14, Sample 104-644A-31-4, 35–37 cm (stub 2, film 21).

*spiridoides*, the thermophilic species *Dapsilidinium pseudocolli-gerum* and *Tectatodinium pellitum* are present. Along with a similar thermophilic assemblage from the mid Miocene of Poland (Gedl, 1996), this suggests a warm-water association for *N. gedlii* n. sp.

NANNOBARBOPHORA WALLDALEI Head, 1996  
Figure 2.11–2.14

*Nannobarbophora* sp. cf. *N. barbata*. HEAD, 1994, table 1.  
Acritarch sp. B. VERSTEEGH, 1994, p. 164, append. 2. VERSTEEGH, 1995, p. 107, append. 2, pl. 6, figs. 3, 6. VERSTEEGH AND ZONNEVELD, 1994, p. 197, pl. 1, figs. 3, 6.  
*Nannobarbophora walldalei* HEAD, 1996, p. 565, 567, fig. 17.1–17.15. HEAD, 1998, pl. 3, fig. 15. HEAD in HEAD AND WESTPHAL, 1999, p. 20, fig. 14.10–14.15.  
*Impletosphaeridium acropora* WARNY AND WRENN, 1997, p. 302, 304, pl. 10, figs. 1–6.

**Occurrence.**—Lower upper Pliocene of the Norwegian Sea (Head, 1996; this study); upper Pliocene of eastern England (Head, 1996, 1998, and as *Nannobarbophora* sp. cf. *N. barbata*, in Head, 1994); upper Pliocene of Italy (as Acritarch sp. B in Versteegh, 1994, 1995; Versteegh and Zonneveld, 1994); lower Pliocene through lower Pleistocene of DSDP Hole 610A, eastern North Atlantic (M. J. Head, unpublished data); upper Miocene through lower Pleistocene of DSDP Hole 603C (M. J. Head, unpublished data); and upper lower Pliocene and upper Pliocene of the Bahamas (Head and Westphal, 1999). See Figure 1.

**Stratigraphic range.**—Presently known from upper Miocene through lower Pleistocene.

**Comparison.**—See for *Nannobarbophora gedlii* n. sp.

**Discussion.**—This species has been shown to have a tropical to warm- or mild-temperate paleoecological distribution (Head in Head and Westphal, 1999) and is associated with warmer isotopic intervals of the upper Pliocene in the Mediterranean (as Acritarch sp. B in Versteegh, 1994, 1995; Versteegh and Zonneveld, 1994).

ACKNOWLEDGMENTS

This research was initiated at the University of Toronto and completed in Cambridge. I am grateful to G. Norris (University of Toronto) for support from his NSERC operating grant, and P. J. Mudie (Geological Survey of Canada—Atlantic) for provision of residues from ODP Leg 104. Reviews by P. K. Strother (Boston College) and R. Wicander (Central Michigan University) are sincerely appreciated. I gratefully acknowledge receipt of a Visiting Fellowship at Wolfson College, Cambridge.

REFERENCES

DE VERNAL, A., AND P. J. MUDIE. 1989. Pliocene and Pleistocene palynostratigraphy at ODP Sites 646 and 647, eastern and southern Labrador Sea, p. 401–422. In S. P. Srivastava, M. Arthur, B. Clement et al. (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, 105. Ocean Drilling Program, College Station, Texas.

EVITT, W. R. 1963. A discussion and proposals concerning fossil dinoflagellates, hystrichospheres, and acritarchs, I. National Academy of Sciences, Washington, Proceedings, 49:158–164.

GEDL, P. 1996. Middle Miocene dinoflagellate cysts from the Korytnica Clays (Góry Swietokrzyskie Mountains, Poland). *Annales Societatis Geologorum Poloniae*, 66:191–218. [published after July, 1996].

HABIB, D., AND S. D. KNAPP. 1982. Stratigraphic utility of Cretaceous small acritarchs. *Micropaleontology*, 28:335–371.

HEAD, M. J. 1993. Dinoflagellate cysts, sporomorphs, and other palynomorphs from the upper Pliocene St. Erth Beds of Cornwall, southwestern England. *Paleontological Society Memoir 31 (Journal of Paleontology, 67[3]Supplement)*, 62 p.

HEAD, M. J. 1994. Morphology and paleoenvironmental significance of the Cenozoic dinoflagellate genera *Habibacysta* and *Tectatodinium*. *Micropaleontology*, 40:289–321.

HEAD, M. J. 1996. Paleoeological and taxonomic revision of late Cenozoic dinoflagellates from the Royal Society borehole at Ludham, eastern England. *Journal of Paleontology*, 70:543–570. [published July, 1996.]

HEAD, M. J. 1998. Marine environmental change in the Pliocene and early Pleistocene of eastern England: the dinoflagellate evidence reviewed. In T. Van Kolfschoten and P. Gibbard (eds.), *The Dawn of the Quaternary. Mededelingen Nederlands Instituut voor Toegepaste Geowetenschappen TNO*, 60:199–225.

HEAD, M. J., AND H. WESTPHAL. 1999. Palynology and paleoenvironments of a Pliocene carbonate platform: the Clino Core, Bahamas. *Journal of Paleontology*, 73:1–25.

LISTER, T. R. 1970. The acritarchs and chitinozoa from the Wenlock and Ludlow Series of the Ludlow and Millichope areas, Shropshire. *Palaeontographical Society Monographs*, 124(1):1–100.

MANUM, S. B., M. C. BOULTER, H. GUNNARSDOTTIR, K. RANGNES, AND A. SCHOLZE. 1989. Eocene to Miocene palynology of the Norwegian Sea (ODP Leg 104), p. 611–662. In O. Eldholm, J. Thiede, E. Taylor, et al. (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, 104. Ocean Drilling Program, College Station, Texas.

MUDIE, P. J. 1989. Palynology and dinocyst biostratigraphy of the late Miocene to Pleistocene, Norwegian Sea ODP Leg 104, Sites 642 to 644, p. 587–610. In O. Eldholm, J. Thiede, E. Taylor, et al. (eds.), Proceedings of the Ocean Drilling Program, Scientific Results, 104. Ocean Drilling Program, College Station, Texas.

VERSTEEGH, G. J. M. 1994. Recognition of cyclic and non-cyclic environmental changes in the Mediterranean Pliocene: a palynological approach. *Marine Micropaleontology*, 23:147–183.

VERSTEEGH, G. J. M. 1995. Palaeoenvironmental changes in the Mediterranean and North Atlantic in relation to the onset of northern hemisphere glaciations (2.5 Ma B.P.)—a palynological approach. Published doctoral dissertation; CIP Gegevens Koninklijke Bibliotheek, Den Haag, 134 p.

VERSTEEGH, G. J. M., AND K. A. F. ZONNEVELD. 1994. Determination of (palaeo-)ecological preferences of dinoflagellates by applying detrended and canonical correspondence analysis to Late Pliocene dinoflagellate cyst assemblages of the south Italian Singa section. *Review of Palaeobotany and Palynology*, 84:181–199.

WARNY, S. A., AND J. H. WRENN. 1997. New species of dinoflagellate cysts from the Bou Regreg Core: a Miocene–Pliocene boundary section on the Atlantic Coast of Morocco. *Review of Palaeobotany and Palynology*, 96:281–304.

ACCEPTED 2 OCTOBER 2002