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Morozovella protocarina: a new species of Palaeocene planktonic Foraminiferida

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ABSTRACT–Detailed study of the Palaeocene *Morozovella* lineage of Deep Sea Drilling Project Sites 577 (Shatsky Rise, North Pacific) and 527 (Walvis Ridge, South Atlantic) have revealed a distinct morphological stage transitional between *M. angulata* (White) and *M. velascoensis* (Cushman & Ponten). This stage is characterised by the development of the first peripheral pseudo-keel of the Cenozoic Globigerinidae and is named *Morozovella protocarina*. The biostratigraphic application of this species clarifies problems of recognising the Late Palaeocene planktonic foraminiferal zones.

INTRODUCTION

Members of the Palaeocene *Morozovella* lineage are widely used zonal indicators in the tropical latitudes (Berggren *et al.*, 1985; Berggren & Miller, 1988; Toumarkine & Luterbacher, 1985). The lineage originates from a subbotinid ancestor in the Danian and evolves via several intermediate morphologies to the species *M. velascoensis* in the late Palaeocene.

Corfield & Granlund (1988) have examined the phylogenetic development of this lineage using morphometric techniques and have identified an intermediate morphology between *M. angulata* (the marker species for Zone P3a) and *M. velascoensis* (the marker species for zone P5) which is also easily recognisable using the ordinary light microscope. Separate species-level status is here proposed for this morphotype.

STRATIGRAPHY AND MICROPALAEONTOLOGY

DSDP Site 577 was drilled in 2685m water depth on the Shatsky Rise, North West Pacific (Figure 1). The position of this site close to the western margin of the sub-tropical gyre and above the Calcite Compensation Depth (CCD) combine to provide a wide species diversity of tropical planktonic foraminifera with good preservation. In total 118.8m of unlithified nannofossil oozes were recovered at Site 577. The section is interrupted by an unconformity at 60m below sea floor, where sediments of middle Miocene age lie atop Middle Eocene strata, and also at 91 mbsf, in the Late Palaeocene.

Morozovella protocarina first appears at 102.5 mbsf and last occurs at 86.8 mbsf. Using a timescale developed from the available magnetostratigraphic, nannofossil and carbon isotopic data as described by Corfield (1987) this gives an age estimate for the first

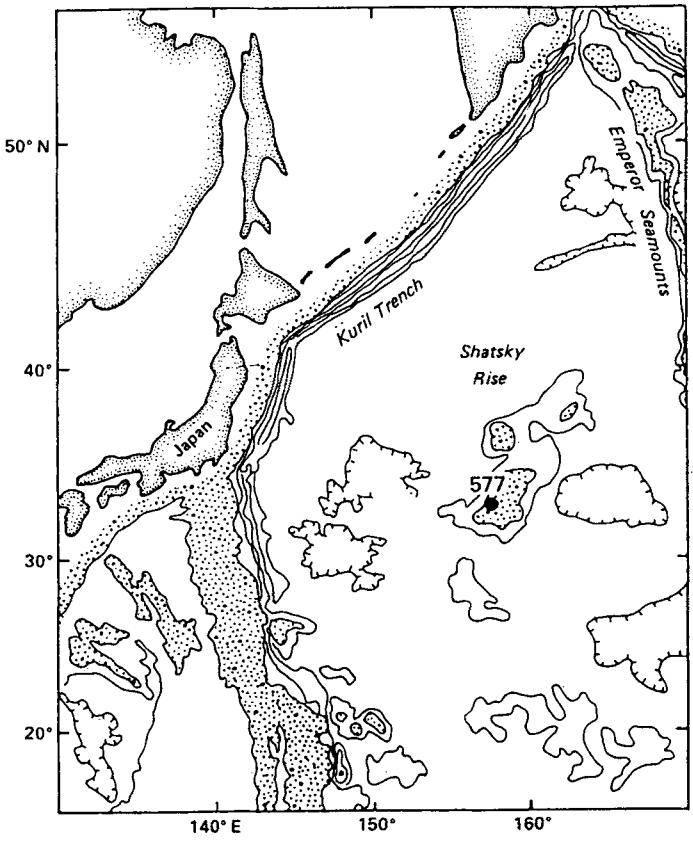


Fig. 1. Location map of DSDP Site 577 (modified after Wright, 1985).

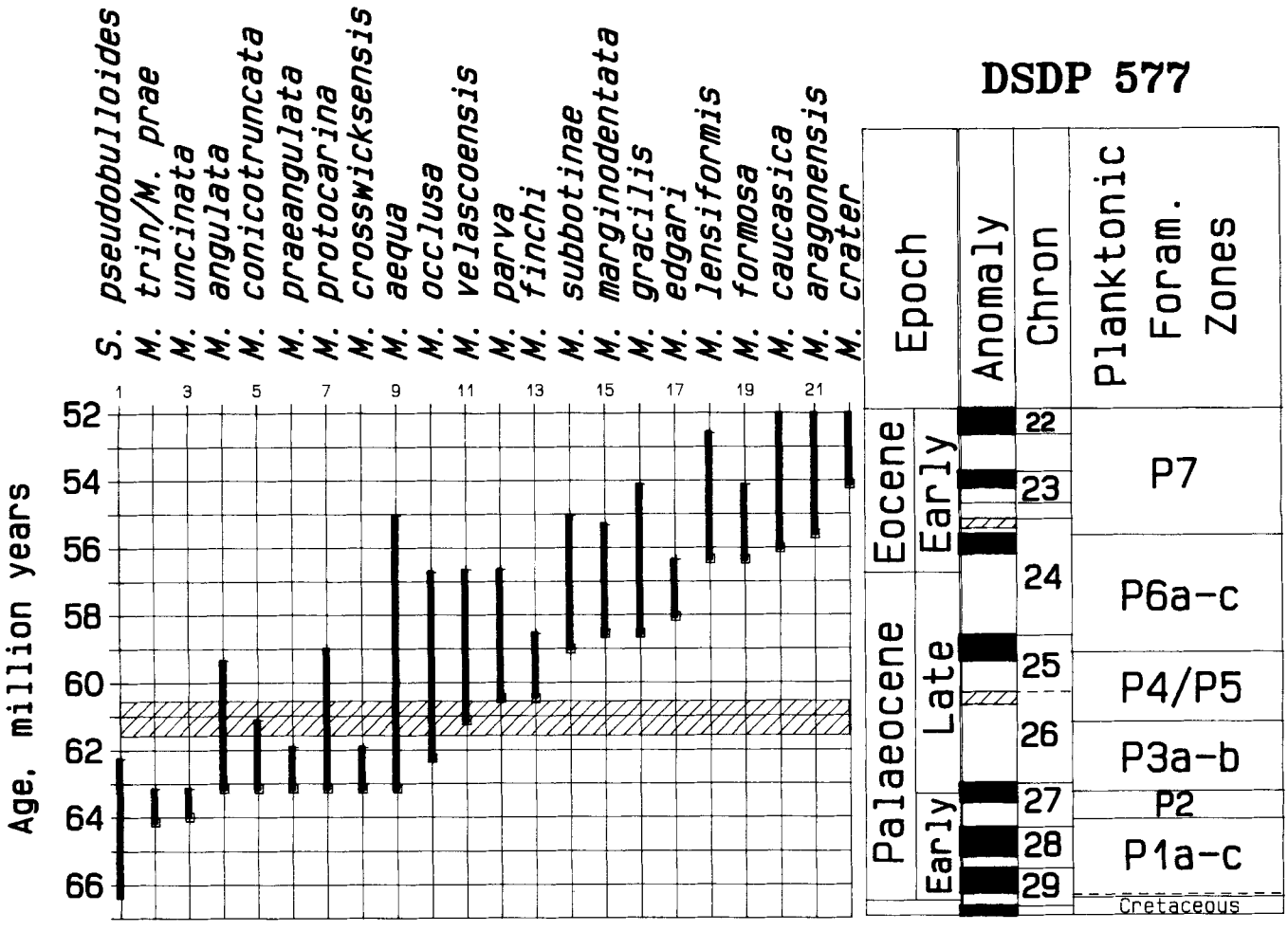


Fig. 2. Range chart of *Morozovella* species in the Palaeocene and Early Eocene of DSDP 577. The new species *M. protocarina* is shown. Cross-hatching indicates the position of the Late Palaeocene unconformity discussed in the text.

appearance datum of this species of 63.1Ma (Chron 27N) and 59.0Ma (Chron 25N) for the last occurrence datum. Figure 2 illustrates the range of this species in relation to the other Palaeocene morozovellids at this site together with the marine magnetic anomaly chronology of Berggren *et al.* (1985). The holotype and paratypes of *Morozovella protocarina* are deposited in the Sedgwick Museum, University of Cambridge.

SYSTEMATIC PALAEONTOLOGY

Family Globigerinidae
Sub-Family Truncorotaloidinae
Genus *Morozovella*
Morozovella protocarina sp. nov. (Plate 1)
(Pl. 1, Figs. 1–12)

Derivation of name. Proto, first and carina, keel. This is the first Tertiary planktonic foraminiferan with a keel of muricae.

Diagnosis: A species of *Morozovella* with a pseudo-keel of muricae which does not cross chamber margins, with mounds of muricae on umbilical shoulders.

Holotype. Plate 1, Figs. 1, 2, 9, 10, 11, 12 (Catalogue No. SM ×17998).

Paratypes. Plate 1, Fig. 3, (Cat. No. SM ×17996), Fig. 4, (SM ×17999), Fig. 5, (SM ×17990), Juvenile paratypes Fig. 6 (SM ×18001), Fig. 7, (SM ×18004), Fig. 8, (SM ×18009).

Type locality and horizons. Deep Sea Drilling Project Site 577, Lat. 32° 26.51′, Lon. 157° 43.40′. Core 11, Section 6, 30–31cm. 100.1 metres below sea floor. Late Palaeocene.

Description. Test a low trochospiral. Five to six chambers in the final whorl, increasing gradually in size. Aperture umbilical-extraumbilical. Axial periphery possesses a pseudo-keel comprised of closely appressed muricae. This pseudo-keel does not run across chamber margins. The umbilical shoulders of the test show concentrations of muricae which form mounds. The maximum diameter of the holotype is

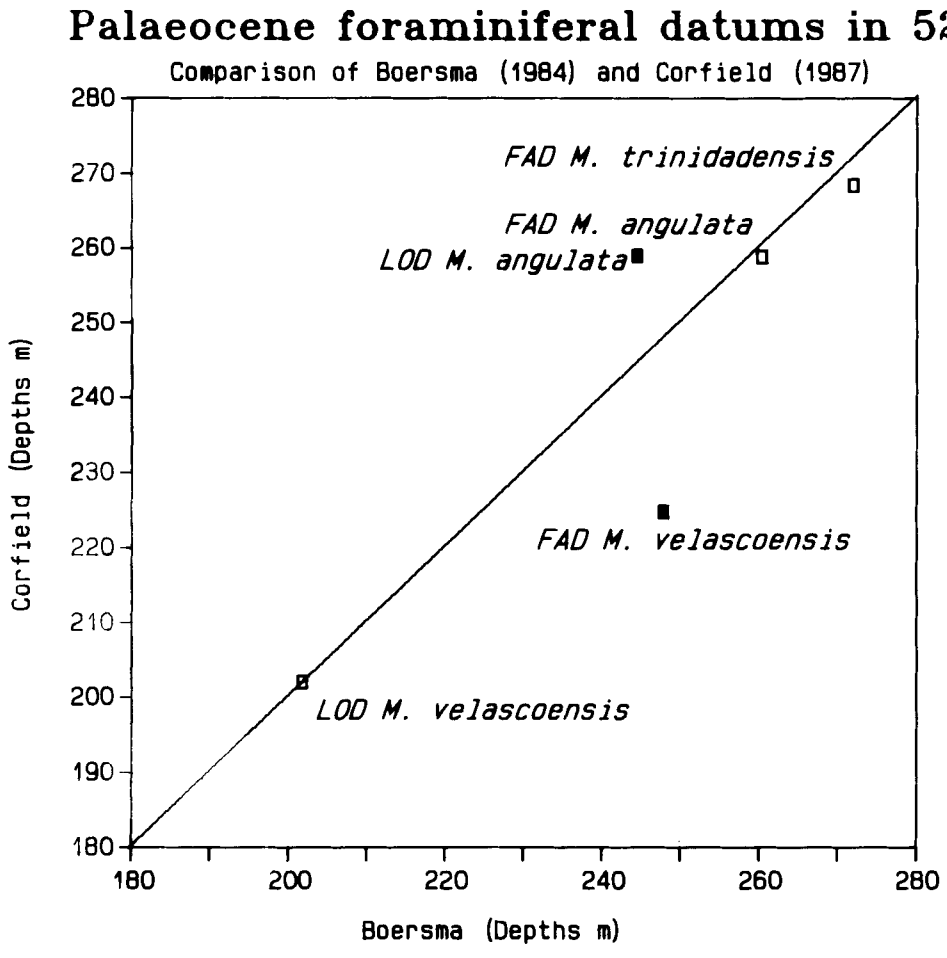


Fig. 3. Comparative depth estimates of some biostratigraphically important morozovellid datum levels from DSDP 527 from Boersma (1984) and Corfield (1987). The agreement is close except for the LOD of *M. angulata* and the FAD of *M. velascoensis*.

400 μm from the tip of the final chamber to the tip of the antepenultimate chamber in umbilical view. Detailed size data are given in Plate 1.

The term pseudo-keel is used to distinguish this structure from the true keel of Neogene *Globorotalia* which is formed as part of the primary chamber wall. The pseudo-keel is formed by the packing together of muricae which are part of the secondary calcification.

Remarks. This species forms part of the structural transition from *Subbotina pseudobulloides* of the Early Palaeocene to *Morozovella velascoensis* of the Late Palaeocene (Fig. 1 in Corfield & Granlund, 1988). In terms of phylogenetic development it lies between the species *Morozovella angulata* and *Morozovella velascoensis*. *M. angulata sensu stricto* does not possess the pseudo-keel of muricae or the mounds of muricae on the umbilical shoulders, whereas *M. velascoensis* possesses a pseudo-keel that runs completely around the margin of the organism as well as well-developed umbilical muricae that form characteristic horns.

Plate 1 in Corfield & Granlund (1988) illustrates a paratype of the new species in relation to the other Palaeocene morozovellids. Comparison of Figs. 11 & 12 and Figs. 13 & 14 in this Plate clearly shows that the species *protocarina* has not as well a developed pseudokeel as *velascoensis*. In the terminology of Blow (1979), the pseudokeel of *protocarina* is a 'circumcameral muricocarina' (a rim that does not cross chamber sutures) while that of *velascoensis* is a 'peripheral test muricocarina' (the pseudo-keel does cross chamber sutures). Comparison of *M. angulata* (Plate 1, Figs. 15 & 16 of Corfield & Granlund, 1988) with *M. protocarina* (Plate 1, Figs. 11 & 12 of Corfield & Granlund, 1988) illustrates that the former species does not possess a pseudo-keel. Similarly, *M. protocarina* exhibits an intermediate stage in the development of the umbilical muricae between *M. angulata* and *M. velascoensis*.

This new species corresponds to those morphotypes thought by Blow (1979), to lie at the most ornate end of

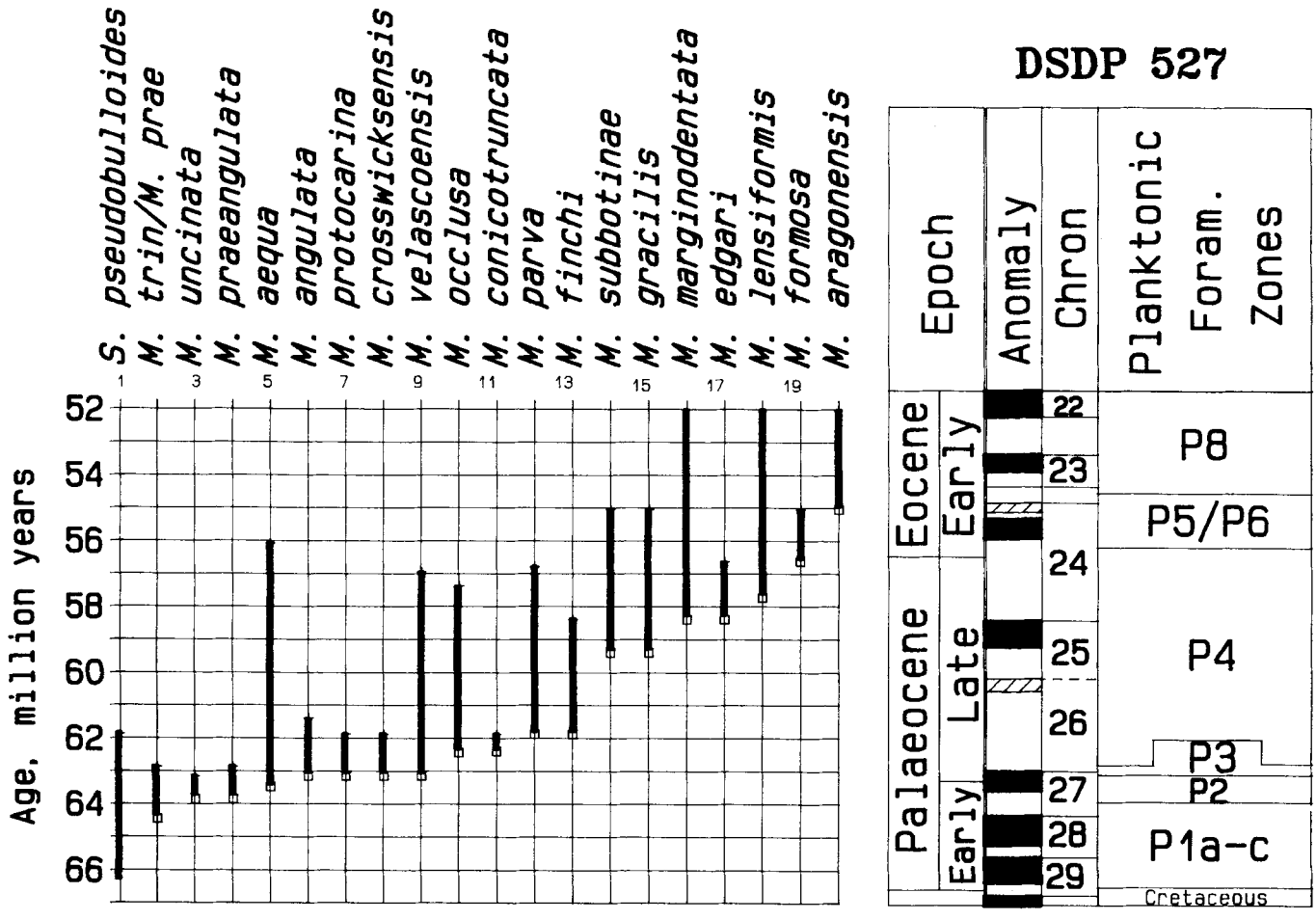


Fig. 4. Range chart of *Morozovella* species in the Palaeocene and Early Eocene of DSDP 527.

the spectrum of variation associated with *M. angulata*. I believe that the features associated with this form are sufficiently well developed to warrant individual specific status.

A comparison was made between the biostratigraphy of Site 527 as performed by the shipboard biostratigrapher (Boersma, 1984) and Corfield (1987). For all planktonic foraminiferal datums except the LOD of *M. angulata* and the FAD of *M. velascoensis* the agreement of depth and age estimates between the two authors was very close (Figure 3). In contrast the identification of the LOD of *M. angulata* and the FAD of *M. velascoensis* was poor. This suggests that the two authors were employing different species concepts in the identification of these two important datums. This discrepancy may be attributed to the large variation which is associated with the transition from *M. angulata* to *M. velascoensis*. This suggests that the new taxon described here is of value in describing and circumscribing this morphologically transitional form.

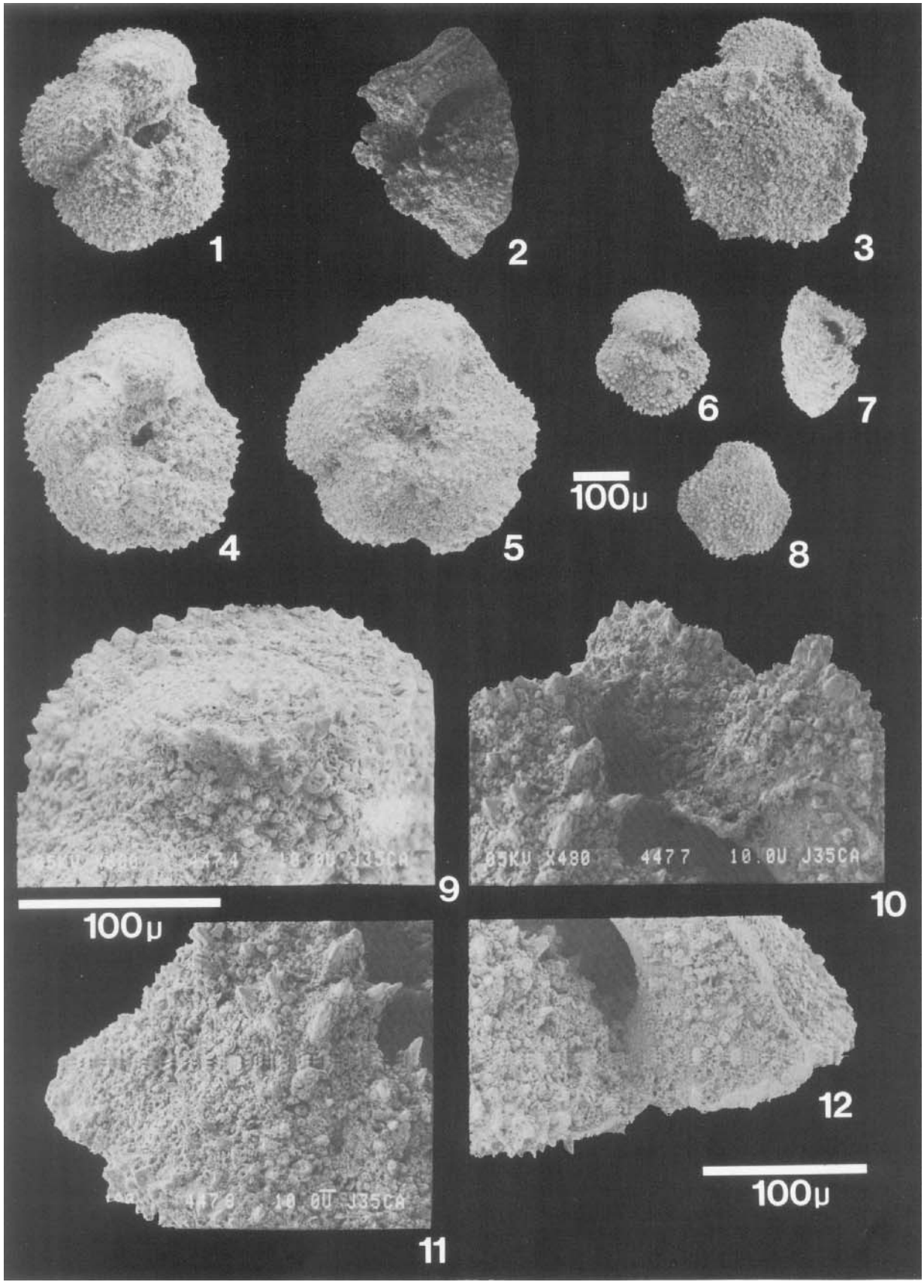
Fig. 4 illustrates the ranges of the Palaeocene and Early Eocene morozovellids in the Atlantic DSDP Site 527 using the same timescale as that used for Figure 2. It is clear that the FAD of *M. protocarina* is isochronous between the two sites. The range of this species however is much shorter in this temperate site, with an LOD of 61.9Ma in 527 compared with 59.0Ma in 577.

This new species is the first of the Tertiary planktonic foraminifera to acquire a keel composed of muricae. This accounts for the choice of the name *protocarina* (proto = first, carina = keel).

M. protocarina is also significant from an evolution-

Explanation of Plate 1

Fig. 1. *Morozovella protocarina* sp. nov. Holotype, umbilical view. Fig. 2. Holotype, side view. Fig. 3. Paratype, spiral view. Fig. 4. Paratype, umbilical view. Fig. 5. Paratype, umbilical view. Fig. 6. Juvenile, umbilical view. Fig. 7. Juvenile, side view. Fig. 8. Juvenile, spiral view. Fig. 9. High power of final chamber of holotype showing pseudokeel and partially developed unbilical muricae, umbilical view. Fig. 10. High power of umbilical muricae of holotype, oblique view. Fig. 11. High power of pseudokeel on early chambers of final whorl of holotype, oblique view. Fig. 12. High power of pseudokeel on final chamber of holotype, oblique view.


1
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ary point of view. It is ancestral to the Late Palaeocene morozovellids *M. velascoensis, M. finchi* and *M. occlusa* (Corfield & Granlund, 1988), and, in addition, is a contributor to the peak in taxonomic turnover at 63.5Ma referred to as Turnover A by Corfield & Shackleton (1988). This peak represents the initial burst of speciation within the planktonic foraminifera as they recolonised the early Tertiary oceans following the extinctions at the Cretaceous/Tertiary boundary.

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