

NEW EARLY MIOCENE SPECIES OF *SPHENOLITHUS*
DEFLANDRE, 1952 FROM THE NORTH ATLANTIC OCEAN

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Introduction

Sphenoliths are key biostratigraphic markers in the Early Miocene (Rio *et al.*, 1990; Fornaciari *et al.*, 1990; Fornaciari & Rio, 1996; de Kaenel & Villa, 1996). We describe herein two new species, *Sphenolithus procerus* and *Sphenolithus tintinnabulum* from the Early Miocene sediments of DSDP Leg 82, Site 563 (Bougault *et al.*, 1985), located in the North Atlantic Ocean on the west flank of the mid-Atlantic Ridge.

In the studied cores, the major lithologies are foraminifer-nannofossil ooze and chalk. Preservation of coccoliths is moderate and the assemblages are reasonably diverse. The new taxa were found within cores 15 to 13 in the CN1c and CN2 Zones of Okada & Bukry (1980), equivalent to Zones NN2 and NN3 of Martini (1971). Detailed quantitative biostratigraphic results of the total assemblage at Site 563 will appear elsewhere (Maiorano & Monechi, in prep.).

In this note, the morphological features of *S. multispinatus* sp. nov. (= *S. multispinatus* Fornaciari *et al.*, 1990, nomen nudum), *S. cometa* de Kaenel & Villa, 1996 and *S. disbelemnus* Fornaciari & Rio, 1996 have also been described, because of their importance in the evolution of sphenoliths during the Early Miocene. In particular, the taxonomic features of *S. multispinatus* have been defined. This species has been differentiated from *S. cometa* based on its different morphology and stratigraphic range (Figure 1).

S. disbelemnus, *S. procerus*, *S. cometa*, *S. tintinnabulum* and *S. multispinatus* have also been recognised in the equatorial Indian Ocean ODP Site 758, where their stratigraphic distributions appeared comparable with those observed at Site 563 (Maiorano, 1996).

The sphenoliths described herein can be easily differentiated with the light microscope, although they appear to be related by a common feature: they all have the apical spine formed by multiple elements rather than a single unit; however the orientation and extent of the apical elements, as well as the morphology of the proximal shield and its size in relation to the apical spine, are diagnostic for the identification of the species. At present, there is no clear evidence of intergradational morphotypes among the described sphenoliths and no phylogenetic relationships have been inferred here.

Family SPHENOLITHACEAE Deflandre, 1952
Genus *Sphenolithus* Deflandre in Grassé, 1952

Sphenolithus procerus sp. nov.
Plate 1, Figures 1-3

Diagnosis: A species of *Sphenolithus* with a short proximal shield and an extended apical spine composed of elements parallel to the long axis of the sphenolith.

Description: In cross-polarised light (XPL), in the 0° position, the apical spine is divided in two by a median extinction band. At the base of the apical spine, a cycle of very short lateral elements can be recognised. At 45° to the polarisation direction, the apical spine shows a three-part arrangement similar to *S. dissimilis* Bukry & Percival, 1971 and loses the extinction band.

Differentiation: *S. procerus* differs from *S. dissimilis* by having a more-developed apical spine instead of an equivalent height between proximal shield and apical spine, and from *S. multispinatus* by having less divergent elements of the apical spine. It is differentiated from *S. cometa* by its shorter proximal shield and thinner apical spine.

Size: About 4-6µm long; the proximal shield is about half the height of the apical spine.

Derivation of name: From Latin *procerus*, slender.

Occurrence: *S. procerus* has a restricted range within the Early Miocene Zone NN2 of Martini (1971) and Zone CN1c of Okada & Bukry (1980); the first specimens are documented above the first occurrences (FOs) of *S. disbelemnus* and of *S. cometa*. It ranges up to the upper part of Zone NN2, above the last occurrence (LO) of *S. cometa*.

Holotype: Plate 1, Figure 3, DSDP Site 563, 14-6-120cm.

Type locality: DSDP Site 563, North Atlantic Ocean.

Range: Early Miocene, Zone NN2.

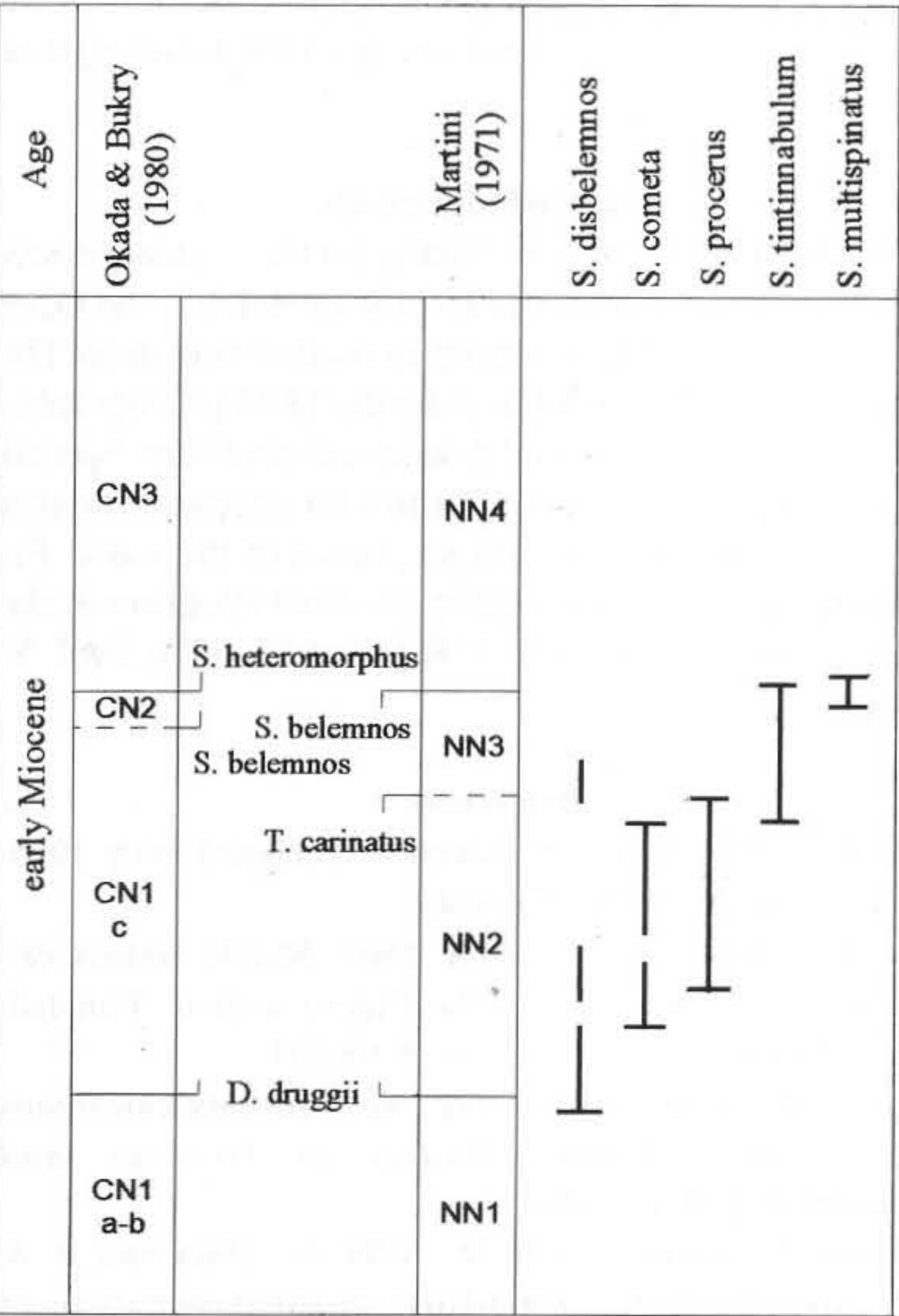


Figure 1: Stratigraphic distribution of selected sphenoliths at DSDP Site 563. Biozonal boundaries are traced according to Maiorano & Monechi (in prep.).

Sphenolithus tintinnabulum* sp. nov.*Plate 1, Figures 4-6**

Diagnosis: A species with a distinctive triangular outline and a very short and multipartite apical spine.

Description: The proximal shield is both wider and higher than the apical spine. When oriented at 45° to the polarisation plane, a very short apical spine is visible, sometimes showing a three part arrangement. It shows intermediate characteristics between *S. disbelemnus* and *S. belemnus*; the apical spine is similar to the former and the proximal shield to the latter.

Differentiation: *S. tintinnabulum* differs from *S. disbelemnus* by its distinctive triangular outline and wider proximal shield. It is differentiated from *S. belemnus* Bramlette & Wilcoxon, 1967 by the multispinate structure and the length of the apical spine.

Size: About 2-4 µm long.

Derivation of name: From Latin *tintinnabulum*, small bell.

Occurrence: The species is recorded in the upper part of Zone CN1c and in the CN2 Zone. First occurrences of *S. tintinnabulum* have been documented in the upper part of Zone NN2; the species partly co-occurs with *S. belemnus* and highest occurrences are recorded slightly above the LO of *S. belemnus*.

Holotype: Plate 1, Figure 4, DSDP Site 563, 13-3-120cm.

Type locality: DSDP Site 563, North Atlantic Ocean.

Range: Upper Zone NN2 and Zone NN3.

Sphenolithus multispinatus* sp. nov.*Plate 1, Figures 14-16**

Sphenolithus multispinatus Fornaciari et al., 1990, p.254, pl.3, figs 1-3 (nomen nudum).

Diagnosis: A species of *Sphenolithus* with a short, wide proximal shield and a divergent apical spine.

Description: This sphenolith is characterised by a triangular proximal shield which is about half the height of the apical spine. In XPL, in the 0° position, the apical spine can be seen to be formed from multiple divergent elements. In the 45° position, the multipartite apical spine is birefringent. Lateral elements, perpendicular or oblique to the median axis of the sphenolith, can be recognised.

Size: About 6-7 µm long.

Differentiation: *S. multispinatus* differs from *S. cometa* by having a distinctive laterally-extended proximal shield and a more-divergent apical spine.

Occurrence: The species is present in the Early Miocene NN3-NN4 Zones; it first occurs just below the LO of *S. belemnus* and disappears slightly above the FO of *S. heteromorphus* Deflandre, 1953.

Holotype: Plate 1, Figure 14, DSDP Site 563, 12CC-8cm.

Type locality: DSDP Site 563, North Atlantic Ocean.

Range: Upper Zone NN3 and lower Zone NN4.

Sphenolithus cometa* de Kaenel & Villa, 1996*Plate 1, Figures 11-13**

non *Sphenolithus multispinatus* Fornaciari et al., 1990, p.254, pl.3, figs 1-3.

Remarks: This species has a narrow proximal shield and a divergent apical spine which is higher than the proximal shield. *S. cometa* appears to have intermediate charac-

teristics between *S. disbelemnus* and *S. multispinatus*; the morphology of the proximal shield is similar to *S. disbelemnus* and the multipartite and extended apical spine resembles that of *S. multispinatus*. According to de Kaenel & Villa (1996), *S. multispinatus* of Fornaciari et al. (1990) may be synonymous with *S. cometa*. However, we noted that *S. cometa*, compared to *S. multispinatus*, has a narrower and higher proximal shield. Moreover, the two species have different stratigraphic ranges: *S. cometa* is recorded only within Zone NN2 and last occurs before the FO of *S. belemnus*.

Range: Early Miocene Zone NN2.

Sphenolithus disbelemnus* Fornaciari & Rio, 1996*Plate 1, Figures 7-8**

Sphenolithus dissimilis-*Sphenolithus belemnus* intergrade Rio et al., 1990, pl.12, figs 2A-C.

Sphenolithus aubryae de Kaenel & Villa, 1996, pl.11, figs 16-18.

Remarks: The recently described *S. disbelemnus* is a distinctive sphenolith easily identified between crossed nicols. The diagnostic features of the species appear to be the orientation of the proximal elements, which are parallel to the long axis of the sphenolith, and the very short and multipartite apical spine, which is about half the height of the proximal shield. *S. disbelemnus* differs from *S. belemnus* by having a shorter and multipartite apical spine and parallel sides to the proximal shield. It differs from *S. dissimilis* by having a narrower proximal shield and shorter apical spine, and from the similar *S. tintinnabulum* by the wider proximal shield.

Range: At Site 563, *S. disbelemnus* first occurs in the uppermost NN1 Zone and ranges up to the lower part of NN3.

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References

- Bougault, H., Cande, S.C. & Scientific Shipboard Party 1985. Site 563. *IRDSDP*, 82: 279-324.
- Bramlette, M.N. & Wilcoxon, J.A. 1967. Middle Tertiary calcareous nannoplankton of the Cipero section, Trinidad, W.I.. *Tulane Studies in Geology*, 5: 93-131.
- Bukry, D. & Percival, S.F. 1971. New Tertiary calcareous nannofossils. *Tulane Studies in Geology and Paleontology*, 8: 123-146.
- Fornaciari, E., Raffi, I., Rio, D., Villa, G., Backman, J. & Olafsson, G. 1990. Quantitative distribution pattern of Oligocene and Miocene calcareous nannofossils from western equatorial Indian Ocean. *Proceedings of the ODP, SR*, 115: 237-254.

- Fornaciari, E. & Rio, D. 1996. Latest Oligocene to early middle Miocene quantitative calcareous nannofossil biostratigraphy in the Mediterranean region. *Micropaleontology*, **42**(1): 1-36.
- de Kaenel, E. & Villa, G. 1996. Oligocene-Miocene calcareous nannofossil biostratigraphy and paleoecology from the Iberia Abyssal Plain. *Proceedings of the ODP, SR*, **149**: 79-145.
- Maiorano, P. 1996. Biostratigrafia a nannofossili calcarei di successioni torbiditiche mioceniche nell'Appennino meridionale e di successioni pelagiche (DSDP e ODP) mediterranee ed extra-mediterranee. *PhD thesis*, Università degli Studi di Bari: 177pp.
- Maiorano, P. & Monechi, S. In preparation. Quantitative calcareous nannofossil biostratigraphy of Early-Middle Miocene sediments from Leg 82 DSDP Site 563 (North Atlantic Ocean).
- Martini, E. 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation. In: A. Farinacci (Ed.). *Proceedings of the II Planktonic Conference, Roma, 1970*, **II**: 739-785.
- Okada, H. & Bukry, D. 1980. Supplementary modification and introduction of code numbers to the low-latitude coccolith biostratigraphic zonation (Bukry, 1973; 1975). *Marine Micropaleontology*, **5**: 321-325.
- Rio, D., Fornaciari, E. & Raffi, I. 1990. Late Oligocene through early Pleistocene calcareous nannofossils from western equatorial Indian Ocean (Leg 115). *Proceedings of the ODP, SR*, **115**: 175-235.

PLATE 1

SEM (Scanning Electron Microscope). Scale bar = 1 μ m
All light micrographs x3125, except 9 and 10 which are x2500

Figs 1-3: *Sphenolithus procerus* sp. nov.. DSDP Site 563, 14-6, 120cm. 1. XPL 0°; 2. XPL 45°. 3. Holotype SEM; Neg. DGG95-14.

Figs 4-6: *Sphenolithus tintinnabulum* sp. nov.. DSDP Site 563, 13-3, 120cm. 4. Holotype SEM; Neg. DGG95-12. 5. XPL 0°; 6. XPL 45°.

Figs 7-8: *Sphenolithus disbelemnus* Fornaciari & Rio. DSDP Site 563, 14-7, 35cm. 7. XPL 0°; 8. XPL 45°.

Figs 9-10: *Sphenolithus dissimilis* Bukry & Percival. DSDP Site 563, 16-4, 120cm. 9. XPL 0°; 10. XPL 45°.

Figs 11-13: *Sphenolithus cometa* de Kaenel & Villa. DSDP Site 563, 14-6, 120cm. 11. SEM. 12. XPL 0°; 13. XPL 45°.

Figs 14-16: *Sphenolithus multispinatus* sp. nov.. DSDP Site 563, 12CC, 8cm. 14. Holotype SEM; Neg. DGG94-12. 15. XPL 0°; 16. XPL 45°.

PLATE 1

