Larger benthic Foraminifera of the type Maastrichtian

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Key words – larger benthic foraminifera, Maastrichtian, Maastricht, the Netherlands.
Brief descriptions are presented of species of larger benthic foraminifera found in the type area of the Maastrichtian, supported by an identification key.

Contents

Introduction

Benthic foraminifera are abundant in the Limburg chalks. Early workers like Lamarck, d'Orbigny and d'Archiac visited the area, and described species from the region. Several workers, mainly Dutch, published monographs on them in the Twentieth Century, including Schijfsma (1946), Visser (1951) and Hofker (1966). Jan Hofker also published over 70 separate papers dealing with species or species groups. In these publications he regularly adjusted his own earlier findings, due to progressing insights or availability of better-preserved material.

Larger benthic foraminifera are highly specialised protists that secrete a skeleton. The extant species host photosynthetic algae as symbionts. This form of symbiosis is only profitable in warm, oligotrophic seas within the photic zone. In modern seas symbiont-bearing foraminifera are restricted to areas with a minimum sea surface temperature of 16° C in the coldest month (Langer & Hottinger, 2000).

Although it is hardly possible to prove that fossil larger benthic foraminifera were symbiont-bearing, by means of analogy and the functional morphology of the test, it is almost certain that the seven taxa discussed in this chapter were all housing zooxanthellates. Being highly specialized, these protists are also sensitive to deterioration of environmental conditions. Major biotic turnovers occurred 3-4 times in the Cretaceous-Recent. Assemblages containing symbiont-bearing foraminifera were probably present in the Early Cretaceous, Late Cretaceous and the entire Cenozoic. These might have evolved from opportunistic stock or because endo-symbiosis newly evolved in one or more families.

The morphology of taxa in the Maastrichtian shows great similarity to modern assemblages. The external morphology of *Siderolites calcitropoides* is very similar to the extant *Baculogypsinoides*, which is smaller and typical of deeper water environments (20-50 m) on solid substrates, commonly those with cryptic spaces where they attach to coral rubble, stones or coralline algae. Other extant calcarinids typically have an epiphytic life-style, either on or attached to seagrass stems or to macro-algae (Renema, 2006, 2008). *Orbitoides apiculata* and *Lepidorbitoides* have a more flattened, lenticular morphology and probably lived in even deeper water environments. *Siderolites laevigata* and *Omphalocyclus macropora* have no exact extant equivalents, but the spines of the former species and the robust shape of the other imply a relatively shallow water, high-energy environment, probably in seagrass meadows (Renema, 2010).

The life cycle of foraminifera is an alternation of sexual and asexual generations. The sexual generation (B-form, microsphere) has a small initial chamber (proloculus) and, especially in larger benthic foraminifera, grows larger than the asexual generation (A-form, macrosphere). Some of the larger benthic foraminifera suppress the microspheric generation and survive on successive macrospheric generations.

The following key distinguishes the larger benthic foraminifera of the type Maastrichtian. Only specimens that are not attached to a substrate and that are larger than 0.5 mm are included. Note that some specimens of so-called smaller benthic foraminifera can reach a large size. These are not included here.

1. Test globular, usually with spines.
   a. Spines rounded, the surface covered by longitudinal ribs, except for the tips of the spines (only visible in well preserved specimens). ..... *Siderolites calcitrapoides*
   b. Spines flattened, commonly connected and forming a flange around the test. Central part of the spines is covered with pustules, like the central part of the test. The sides of the spines are formed by small oblique striae. ..... *Siderolites laevigata*
2. Test lenticular, round without spines.
   a. Thickness of the test increases towards the periphery. Large pores and no pustules visible on the outside of the test. Margin thick and rounded, with a row of apertures in the middle. ..... *Omphalocyclus macropora*
   b. Test thickest in the central part, with pustules and usually no visible pores.
      i In vertical cross-section: equatorial chambers very thin, of similar height from centre to margin of the test. ..... *Lepidorbitoides minor*
      ii In vertical cross-section: equatorial chambers thicker, increasing in height from the centre towards the margin of the test.
         I. In vertical cross-section with pillars, test asymmetrical ... *Orbitoides apiculata*
         II. In vertical cross-section without pillars, nucleoconch makes up most of the symmetrical test ..... *Orbitoides brinkae*

Systematic palaeontology

Class Foraminifera Eichwald
Order Lituolida Lankester
Superfamily Lituolacea de Blainville
Family Lituolidae de Blainville
Subfamily Lituolinae de Blainville
Genus *Lituola* Lamarck

Type species – *Litulites nautiloidea* Lamarck, 1816.

***Lituola senoniensis* (Hofker, 1949)**
Pl. 1, fig. 10.

Description – Test planispiral with somewhat protruding chamber walls. Three to four tight, involute whorls, leaving a broad umbillicus. Chambers numerous, up to 24 in the last whorl, long and narrow. No canal system, agglutinated walls thick, micro-granular. Diameter 0.3-0.8 mm, thickness 0.10-0.22 mm.

Stratigraphy – First appears in the Nekum Member and is more abundant in the Meersen Member. This species has also been found in Paleocene sedimentary rocks, but this occurrence probably represents reworked specimens.

Remarks – When first described, this species was placed in the genus *Peneroplis* because of the very similar internal and external morphology. In the original description, Hofker (1949) even considered that his new species was synonymous with an extant species, *Peneroplis pertusus* (Forskål). Only when better-preserved specimens became available did the micro-granular texture of the (agglutinated) test walls become clear.

Order Rotaliida Delage and Hérouard
Superfamily Orbitoidacea Schwager
Family Orbitoididae Schwager
Subfamily Orbitoidinae Schwager
Genus *Orbitoides* d'Orbigny

Type species – *Lycophris faujasii* Defrance , 1823.

Remarks – *Orbitoides* is characterised by a lenticular test shape, with a more or less acute test margin. The equatorial layer increases in thickness from the centre to the margin of the test.

***Orbitoides apiculata* Schlumberger, 1902**
Pl. 2, figs. 1, 5.

Description – Test round, one side flattened, the other showing a distinct umbilicus. Surface on the outside with regularly spaced, small pustules. Macrosphere diameter

2.5-3.0 mm, thickness 1.2-1.8 mm. Microsphere diameter up to 13 mm, thickness 2.0 – 2.5 mm.

Stratigraphy – *Orbitoides apiculata* occurs in the top of the Nekum Member (Kanne Horizon) and base of the Meerssen Member (Caster Horizon), that is, zone L of Hofker (1966).

Remarks – Although the macrospheric generation has been extensively described and discussed in many studies, the much larger microspheric generation has received little attention. However, since both *Orbitoides* species regularly occur together in the type Maastrichtian deposits, it is difficult to separate the microspheric generation.

***Orbitoides brinkae* Visser, 1951**
Pl. 2, fig. 2.

Description – Test round, one side more convex than the other. Periphery rounded. Surface ornamented with few, small pustules. In horizontal section most of the test is formed by the very large nucleoconch. Macrosphere: diameter 0.7-1.3 mm, thickness 0.35-0.7 mm. Microsphere: not known (see remark about the previous species).

Stratigraphy – *Orbitoides brinkae* occurs in the top of the section, in the upper part of the Nekum Member and the Meerssen Member.

Subfamily Omphalocyclinae Vaughan
Genus *Omphalocyclus* Bronn

Type species – *Omphalocyclus macropora* (Lamarck, 1816).

***Omphalocyclus macropora* (Lamarck, 1816)**
Pl. 2, fig. 3.

Description – Test biconcave to discoidal, centrally depressed, with the thickest part at 67 to 75 % of the diameter. Test margin rounded, with a single or double row of apertures. In vertical section the equatorial and lateral chambers are hardly distinguishable. Only one row of lateral chambers is present on each side of the median layer. The test reaches its largest thickness at about two-thirds of the radius, giving it a typical 'bow-tie' appearance. Diameter of the macrospheric generation 0.8-2.0 mm, of the microspheric generation up to 5 mm.

Stratigraphy – *Omphalocyclus* occurs in the top of the Nekum Member and is locally abundant in the Meerssen Member.

Family Lepidorbitoididae Vaughan
Subfamily Lepidorbitoidinae Vaughan
Genus *Daviesina* Smout

Type species – *Daviesina khatiyahi* Smout, 1954.

***Daviesina fleuriausi* (d'Orbigny, 1826)**
Pl. 1, fig. 1.

Description – Test round, biconvex; large specimens have a strongly flattened last whorl. The periphery of large specimens is thickened. Sutures distinct, elevated and curved backwards. The surface of the test is covered by pustules, which are largest in the centre and indistinct in the last whorl. Diameter 0.4-1.7 mm, thickness 0.2-0.5 mm.

Stratigraphy – The first occurrence of *Daviesina* is in the Laumont Horizon (Nekum Member) and it extends to the top of the Maastrichtian.

Genus *Lepidorbitoides* A.Silvestri

Type species – *Lepidorbitoides socialis* Leymerie, 1851.

***Lepidorbitoides minor* (Schlumberger, 1902)**
Pl. 2, fig. 4.

Description – Test round, biconvex with a rounded to acute periphery. Surface covered by fine pustules. Equatorial layer very thin and of equal height in vertical section. The lateral chamberlets are equally well developed on either side of the equatorial layer and are very elongated. Micro- and macrosphere diameters 0.6-2.0 mm, thickness 0.5-0.9 mm.

Stratigraphy – *Lepidorbitoides minor* occurs in the Emael Member and above.

Remarks – Unlike *Orbitoides* spp. and many other larger benthic foraminifer genera, there is no size difference between the macro- and microspheric generation of *L. minor*. The microspheric generation can only be recognised by the arrangement of the initial chambers; only one in about one hundred specimens is microspheric.

Superfamily Rotaliacea Ehrenberg
Family Calcarinidae Schwager
Genus *Siderolites* Lamarck

Type species – *Siderolites calcitrapoides* Lamarck, 1799.

***Siderolites calcitrapoides* Lamarck *in* Faujas de Saint Fond, 1799**
Pl. 1, figs. 2, 3, 5, 6, 8, 9.

Description – Test globular, with 2-10 round spines. Sides of the test rounded. Test covered by pustules (diameter 15-25 µm). Chambers and sutures are not visible from the outside. Spines commonly in one plane around the periphery and with longitudinal ribs. In vertical section chambers are arranged planispiral with 2-3 rows of lateral chamberlets. Diameter including spines up to 4 mm (microsphere) or up to 2 mm (macrosphere).

Stratigraphy – *Siderolites calcitrapoides* has been found in the Schiepersberg Member and above, but is especially abundant in the Nekum Member.

Siderolites laevigatus (d'Orbigny, 1826)

Pl. 2, figs. 4, 7.

Description – Test flattened, with 0-11 ventrally compressed spines, which commonly are fused together, forming a flange around the test. Sides of the test sharp. Test covered by coarse pustules (diameter 60-80 μm). Chambers and sutures are not visible from the outside. Spines in one plane around the periphery, covered with pustules in the central part and oblique striae on the sides and distal part. Proloculus of the macrosphere large (0.4-0.5 mm), diameter including spines up to 5 mm (microsphere) or up to 2.5 mm (macrosphere).

Stratigraphy – This species has only been found in Nekum Member, where it can be very abundant.

Remarks – *Siderolites calcitrapoides* and *S. laevigata* have variously been treated as one very variable or as two difficult to distinguish species. We treat them as two separate species, but do not exclude the possibility that they are end members of one variable plexus.

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Plate 1

Fig. 1. *Daviesina fleuriausi* (d'Orbigny, 1826). (a) External view, RGM 18847; (b) horizontal section, RGM 18906; (c) vertical section, RGM 66907.

Figs. 2, 3, 5, 6, 8, 9. *Siderolites calcitrapoides* Lamarck *in* Fujas de Saint Fond (1801).
Figs. 2, 5, 6. External views (RGM 581 078).
Figs. 3, 8. Horizontal thin sections. (3) RGM 581 079; (8) RGM 18920.
Fig. 9. Vertical thin section (RGM 581078).

Figs. 4, 7. *Siderolites laevigata* (d'Orbigny, 1826).
Fig. 4. Horizontal thin section, RGM 581 077.
Fig. 7. RGM 581 076. (a) External view; (b) detail of spine.

Fig. 10. *Lituola senoniensis* (Hofker, 1949). (a) External view (RGM 18814); (b) horizontal thin section (RGM 18912); (c) vertical thin section (RGM 18913).

All scale bars are 1 mm unless stated otherwise.

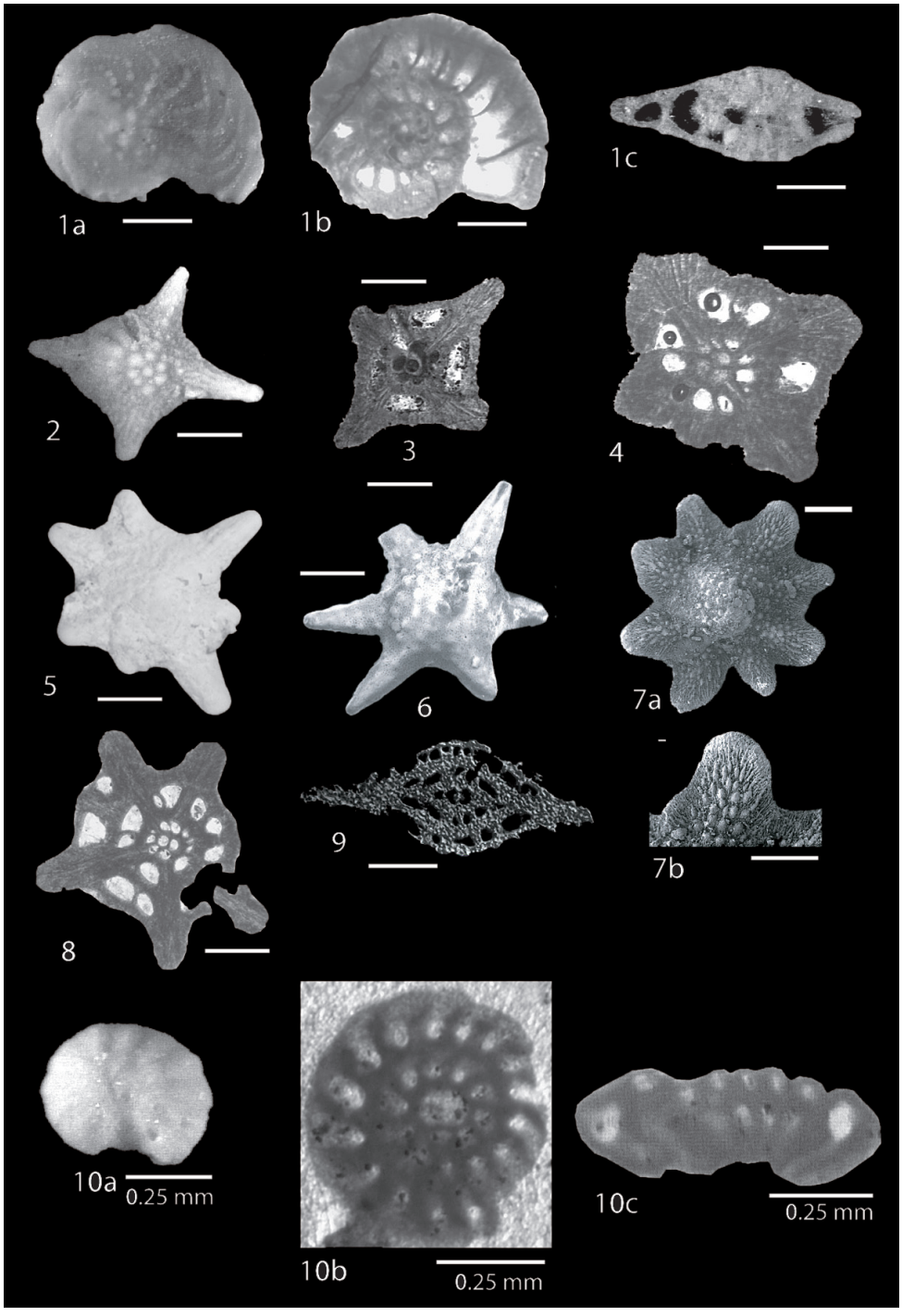
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Plate 2

Figs. 1, 5. *Orbitoides apiculata* Schlumberger, 1902.
Fig. 1. (a) Microsphere, RGM 581 074; (b) horizontal section through macrosphere (RGM 18918); (c) vertical section through macrosphere (RGM 18919).
Fig. 5 (a) Microsphere, RGM 581 074. Specimen showing recovery from breakage.

Fig. 2. *Orbitoides brinkae* Visser, 1951. (a) External view of macrosphere, RGM 18820; (b) horizontal section of macrosphere, RGM 18920; (c) vertical section through macrosphere, RGM 18921.

Fig. 3. *Omphalocyclus macropora* (Lamarck, 1816). (a) Macrosphere, RGM 581 075; (b) side view, RGM 581 075.

Fig. 4. *Lepidorbitoides minor* (Schlumberger, 1902). (a) External view, RGM 18818; (b) horizontal section, RGM 18818; (c) vertical section, RGM 18923.

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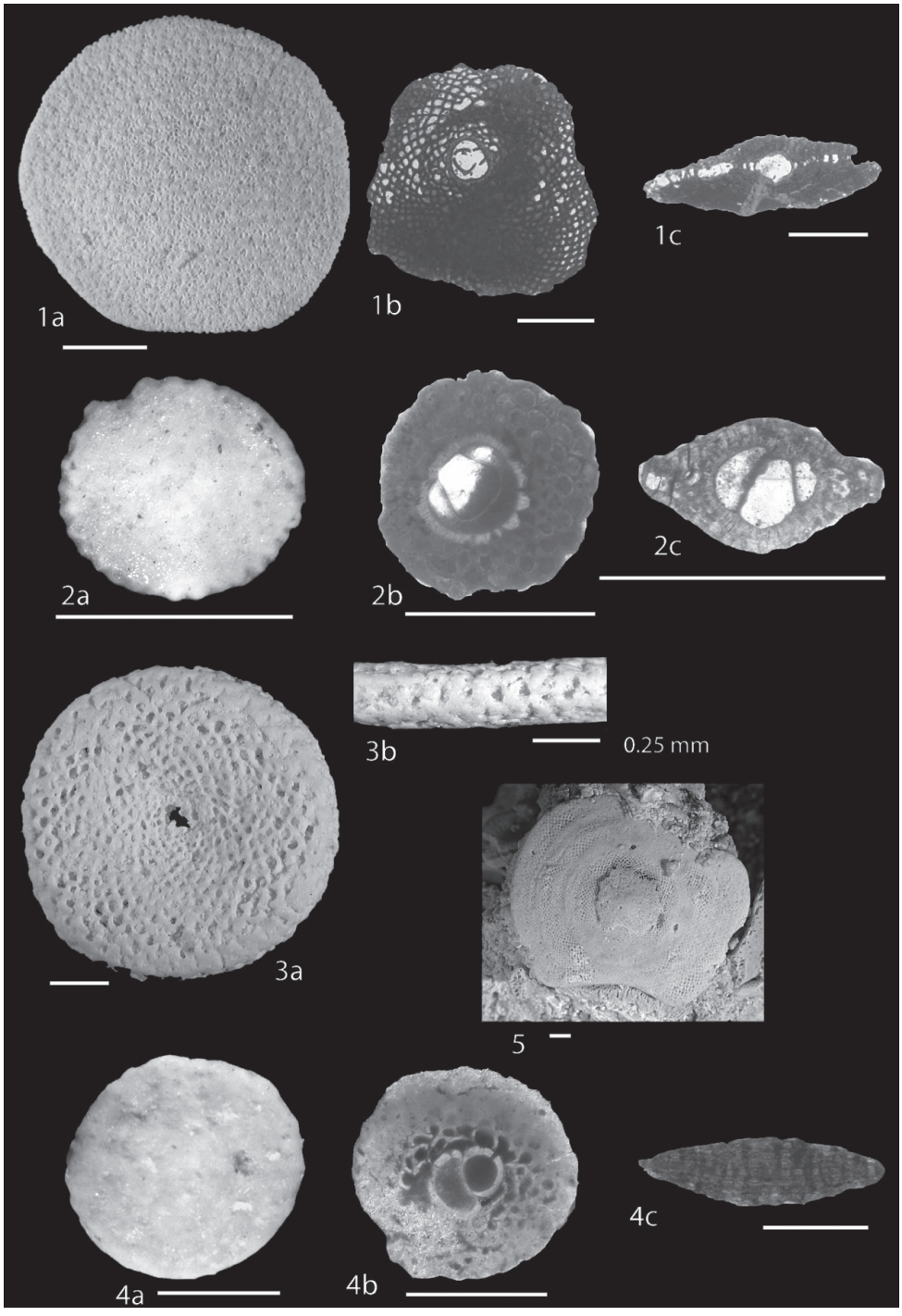
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