

The gastropod fauna of the Luchtbal Sand Member (Lillo Formation, Zanclean, Early Pliocene) of the Antwerp region (Belgium)

Robert Marquet¹ & Bernard Landau²

¹Institut royal des Sciences naturelles, Sciences de la Terre, Vautierstraat 31, 1000 Brussels, Belgium.

²International Health Centres, Av. Infante D. Henrique, Areias São João, 8200 Albufeira, Portugal; e-mail: bernielandau@sapo.pt

Received 23 September 2004; revised version accepted 30 June 2005

The gastropod fauna of the Luchtbal Sand Member (Antwerp region, Belgium) is listed based on the collections of the IRSNB, and new material collected in Doel (Oost-Vlaanderen, Belgium) and Antwerp. Fourteen species are new for the Pliocene of Belgium; one species is described as new: *Capulus deurganckensis* nov. sp. *Xenophora scaldensis* Glibert, 1958 is redescribed and a lectotype is designated. The total fauna amounts to 157 gastropod species, which make the Luchtbal Member the most species-rich Pliocene unit of Belgium. Only 29% of these species are still living today, which is insufficient for actualistic palaeoecological reconstructions. 46% of the species are endemic to the Pliocene or to the Neogene of the North Sea Basin.

KEY WORDS: Pliocene, Luchtbal Sand Member, Belgium, Gastropoda, new taxon.

Introduction

The Luchtbal Sand Member was described as the lowermost part of the Pliocene Lillo Formation by de Heinzelin (1955c) following Leriche (1912). A type section and locality (Tweede en Derde Havendok in Antwerp, 10 to 8 m below the natural land surface) were proposed by De Meuter & Laga (1976), who also gave a diagnosis of the deposit. Vandenberghe *et al.* (1998) estimated the age of the Luchtbal Sand Member as late Zanclean (± 3.5 Ma), based on benthic foram association B11, benthic mollusc association BM22A and otholith zone 18 (Vincken, 1988). During the 19th and the beginning of the 20th century, the Luchtbal Sand Member was often exposed during extensions of the Antwerp harbour on the right bank of the Scheldt River. De Heinzelin (1950a, 1950b, 1955a, 1955b) described the stratigraphy and the rich molluscan association at the Boudewijnsluis section in the 1940's. His findings were partly published by Glibert (1957a-c; 1958a-c; 1959a, b; 1960). Later taxonomic studies on the Boudewijnsluis material were performed by Marquet (1996: Triphoridae; 1997, 1998a: turrid gastropods and 2001: Seilinae). Additional Luchtbal material was collected by van der Mark around 1964 at the B1-B2 Havendok section; his material is deposited in the NNM Naturalis, Leiden, The Netherlands.

Today, only a small part of the type area of the Luchtbal Sand Member remains northeast of Antwerp, covered by a

thick layer (10 to 20 m) of sediment dredged from the Scheldt River, and subsequently built over. The last time the Luchtbal Sand Member was exposed on the right bank of the Scheldt River was during the 1970's, when a junction between the Amerikadok and Vijfde Havendok was created in the Noordkasteel area of Antwerp. The material collected was never published. Further material, dredged from the Scheldt River and deposited at various localities in the Antwerp harbour area between 1960 and 1995 is available. These sediments are often composed of *ex-situ* Luchtbal and Oorderen Sand Member sediments and faunas. The Luchtbal sands are characterised by the presence of large numbers of *Ditrupa* sp. and of characteristic bivalve species, listed by Marquet (2005, p. 119).

During the works on the left Scheldt bank harbour at Kallo (Beveren), no Luchtbal deposits were found until recently (Marquet, 1995). However, derived yellow sandstones containing large numbers of the bivalve *Palliolium gerardi* (Nyst, 1835) were often encountered in the basal shell bed of the Oorderen Sand Member, proving that the Luchtbal Sand Member had been present but had been destroyed by erosion. Also massive numbers of *Ditrupa* sp. were observed in these sandstones.

In March 2000, a wedge of Luchtbal Sand Member was discovered *in-situ* in the Deurganckdok exposures at Doel (municipality Beveren), extending for about 1 km length (see Marquet, 2002).

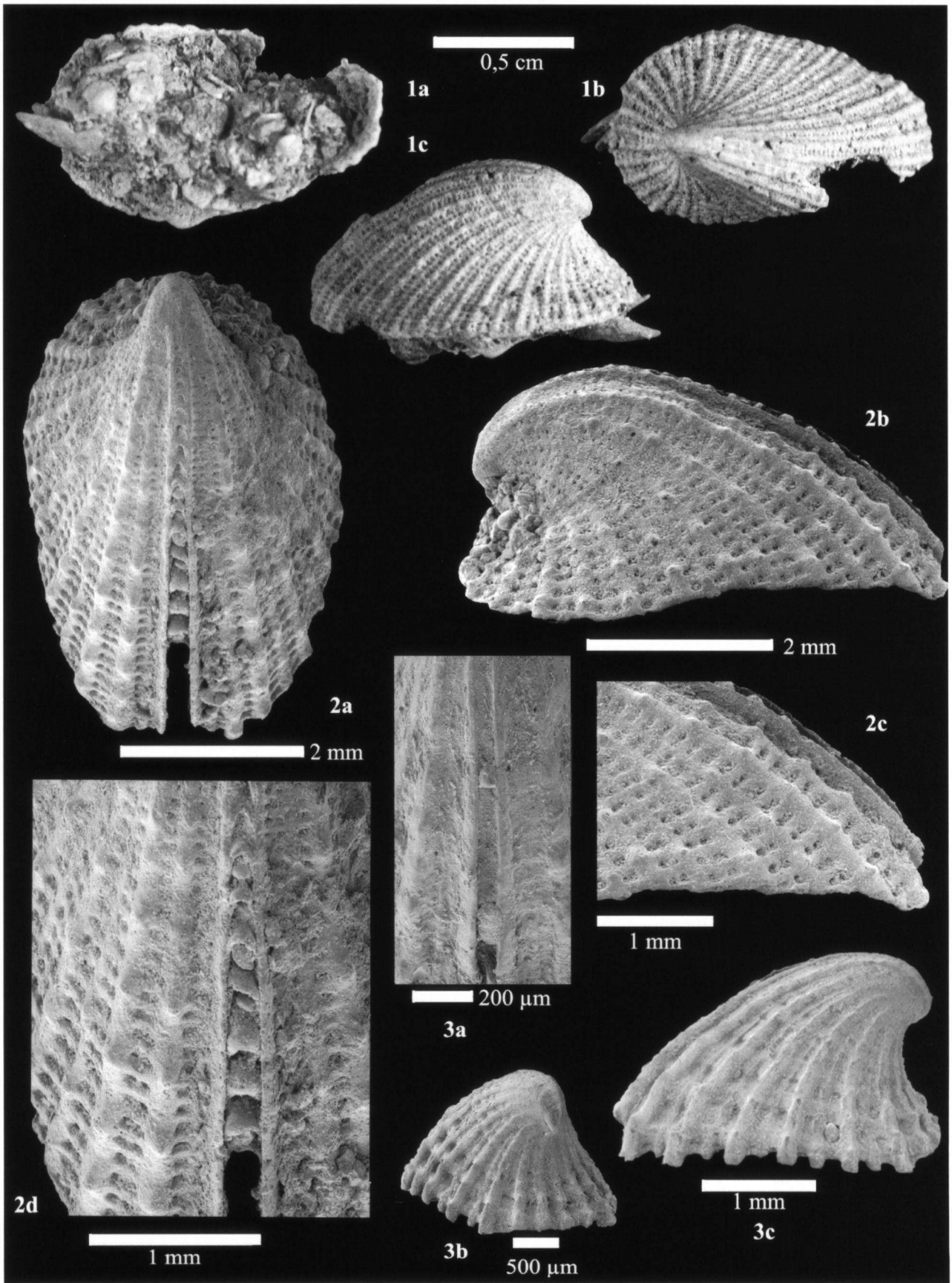


Figure 1.

Figure 1.

1. *Emarginula adriatica* Costa, 1829. Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6949.
2. *Emarginula plioaspersa* Sacco, 1897. Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6950.
3. *Emarginula* sp. Deurganckdok, Doel. Luchtbal Sand Member. Coll. BLP.

The level was about 1 m thick at the northern quay of the dock and consisted there of yellow sand at the base, often eroding deeply into the Kattendijk Formation, with burrows filled with Luchtbal Sand extending up to 1 m into this Formation. This lower part yielded a species-rich molluscan fauna, accompanied by many *Ditrupa* tubes. It was topped by slightly consolidated sandstones with abundant stacked valves of *Palliolium gerardi* (Nyst, 1835), together with a large number of bryozoa, few sea urchins and scarce gastropods. This upper part was only found at the southern quay of the dock. Bivalvia, Scaphopoda and Amphineura from this exposure were included in the works of Marquet (2002, 2004). The Deurganckdok exposure of Luchtbal Sand Member contained several gastropod species new to the Belgian fauna. The aim of the present paper is to assess the Luchtbal Sand Member gastropods found in the exposures at Doel (Deurganckdok), Antwerp (Noordkasteel), and the species in dredged material probably originating from this Member. For the location of the cited exposures see Marquet (1997a, fig. 1), for the extension of the Luchtbal Sand in the Deurganckdok, see fig. 11.

Material and methods

This study is based principally on material collected by Robert Marquet (Antwerp), further indicated as RM, to be transferred to the Institut royal des Sciences naturelles, Brussels (IRSNB) in the near future, from Doel, Noordkasteel and dredged from the Scheldt River. Further material from Doel and dredged material is in the collections of L. Ceulemans (Brussels, Belgium, coll. LC), from Doel in that of B. Landau (Albufeira, Portugal, coll. BLP), A. Ratincx (Antwerp, Belgium, coll. AR.), B. Roest (The Netherlands, BR). Furthermore, material from the B1-B2 Havendok, collected by van der Mark, housed in the NNM Naturalis (Leiden, The Netherlands, coll. NNM, indicated with RGM numbers) is included. Also the older collections in the IRSNB were examined.

Systematic palaeontology

Class	Gastropoda Cuvier, 1797
Subclass	Orthogastropoda Ponder & Lindberg, 1995
Order	Vetigastropoda Salvini-Plawén & Haszprunar, 1987
Superfamily	Fissurelloidea Fleming, 1822
Family	Fissurellidae Fleming, 1822
Subfamily	Emarginulinae Gray, 1834
Genus	<i>Emarginula</i> Lamarck, 1801

***Emarginula adriatica* Costa, 1829**

Fig. 1/1a-c

- *1829 *Emarginula adriatica* Costa, p. 122, fig. 12.
- 1916 *Emarginula adriatica* Costa - Cerulli-Irelli, p. 217, pl. 24, figs 35-36.
- 1923 *Emarginula elongata* Costa - Harmer, p. 778, pl. 62, fig. 9.
- 1949 *Emarginula elongata* Da Costa - Glibert, pl. 1, fig. 9.
- 1964 *Emarginula elongata* Costa - Brébion, pl. 1, figs 7-8.
- 1984 *Emarginula adriatica* Costa - Piani, p. 200, figs 13-20.
- 1990 *Emarginula adriatica* Costa - Poppe & Goto, p. 67, pl. 2, fig. 17.
- 1994 *Emarginula adriatica* Costa - Giannuzzi-Savelli *et al.*, p. 46, figs. 73-74.
- 2003 *Emarginula adriatica* Costa - Landau *et al.*, p. 19, pl. 3, figs 1-3.

Locus typicus — Adriatic Sea.*Stratum typicum* — Recent.*Material* — IRSNB IST 6949 (leg. RM): 1 specimen, Doel, Deurganckdok; Luchtbal Sand Member.*Dimensions* — Height 2.4 mm, aperture 12.3 x 7.4 mm (incomplete).

Description — Medium-sized shell, oval in outline (width of aperture more than half of length), posterior part broader than anterior. Apex strongly pointed, close to posterior border. Posterior side nearly straight, anterior clearly convex. Anterior side with slit, running nearly to the apex, open for about a quarter of its length, remaining part with distinct scales. Ornament consisting of about 40 sharp primary axial ribs, with one weaker secondary rib in between. Concentric ornament weaker, forming weak scales between, and faint tubercles on the axials.

Discussion — Harmer (1923) mentioned the presence of *Emarginula elongata* in the Pliocene Coralline Crag Formation of the British Isles. This name however, according to Sabelli *et al.*, 1990, is a synonym of *Emarginula octaviana* Coen, 1839 and was preoccupied by *Emarginula elongata* DeFrance, 1819 (= *Subemarginula elongata*, Eocene of France). *Emarginula octaviana* clearly differs from our material by the smaller number of axial ribs (about half), while its apex points less forward; it is clearly figured by Giannuzzi-Savelli *et al.* (1994, p. 46, fig. 77). Most of the earlier records from the Mediterranean of *E. elongata* are more similar to *E. adriatica* than *E. octaviana*.

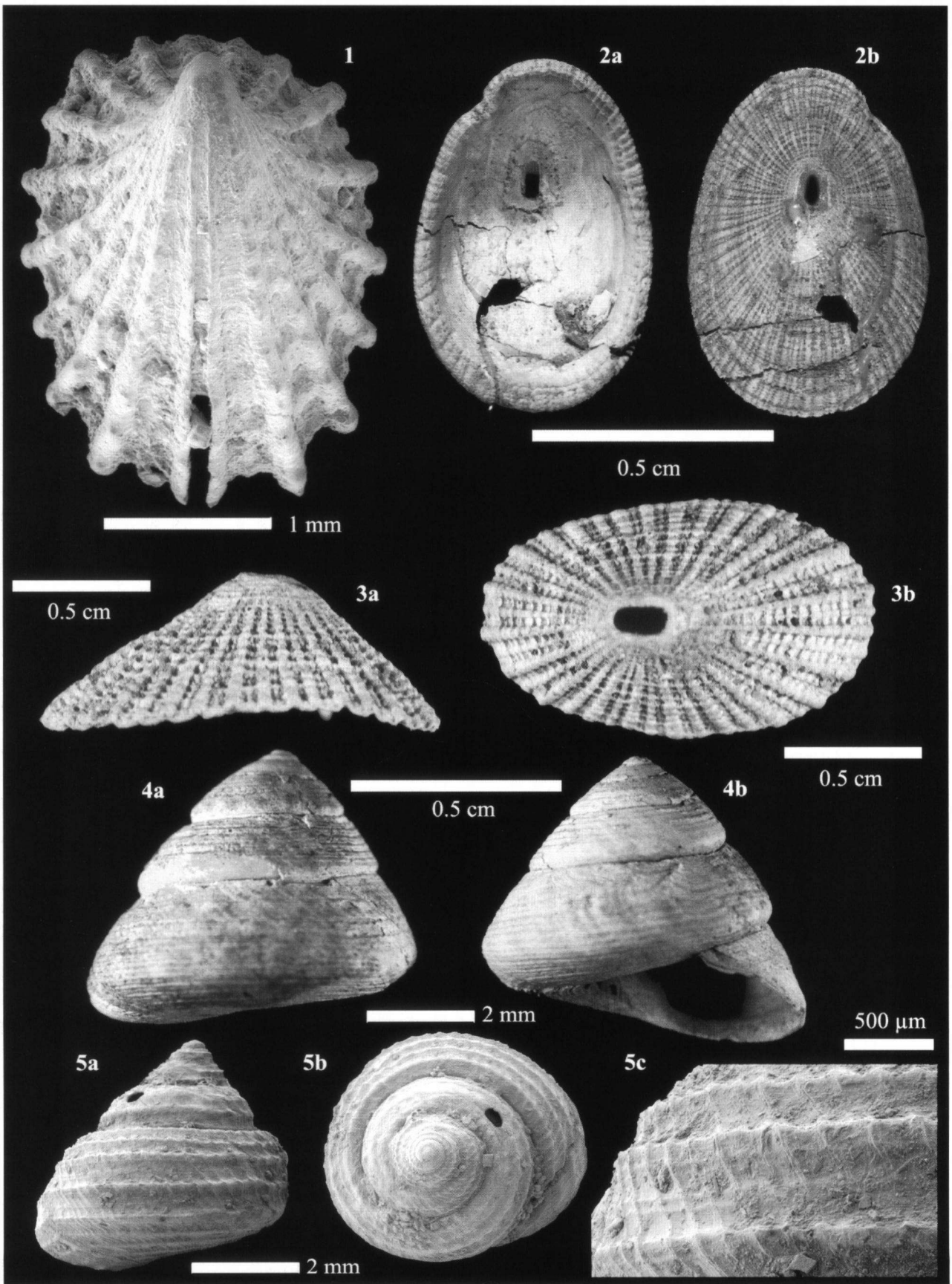


Figure 2.

Figure 2.

1. *Emarginula* sp. Deurganckdok, Doel. Luchtbal Sand Member. Coll. BLP.
2. *Diodora italica* (Defrance, 1820). Antwerp, junction Vijfde Havendok-Amerikadok. Luchtbal Sand Member. IRSNB IST 6951.
3. *Diodora graeca* (Linnaeus, 1758). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6952.
4. *Gibbula* (*Steromphala*) *cineroides* (Wood, 1842). Antwerp, Vijfde Havendok. Luchtbal Sand Member. IRSNB IST 6953.
5. *Gibbula* (*Colliculus*) *crassistriata* (Bell in Wood, 1882). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6954.

This is also the case for most of the Pliocene varieties of *E. elongata* 'Costa', figured by Sacco (1897, pl. 2) and some of his *Emarginula cancellata* varieties on the same plate.

Occurrence — This is the first record of *Emarginula adriatica* for the Neogene of Belgium; it is rare in the Luchtbal Sand Member at Doel, where one specimen was found. It is also known from the British Coralline Crag Formation. For its general distribution, see Landau *et al.* (2003, p. 20).

***Emarginula plioaspera* Sacco, 1897**

Fig. 1/2 a-d

*1897 *E. elongata* var *plioaspera* Sacco, p. 15, pl. 2, figs 22,23.

Locus typicus — Zinola, Liguria, Italy.

Stratum typicum — "Astigiano", probably Zanclean, Early Pliocene.

Material — IRSNB IST 6950 (leg. RM): 1 specimen, Deurganckdok, Doel; Luchtbal Sand Member. Coll. RM: 1 specimen, Vrasenedok, Kallo; Kattendijk Fm., *Petalocochus* level.

Dimensions — Height 2.91 mm, aperture 5.2 x 3.63 mm.

Description — Small, elongate oval shell. Umbo pointed, near posterior border. Largest width before apex. Slit present, open to one quarter from umbo; remaining part closed, with about 15 clearly distinct scales. Ornament consisting of about 20 axial ribs, with a single nearly equally strong secondary rib in between. Between the primary ribs, numerous concentric ribs are present; these form very distinct tubercles when crossing the primary ribs.

Discussion — Although originally described as a variety of *Emarginula adriatica* Costa, 1829, we consider *E. plioaspera* a distinct species. The latter has fewer primary ribs (about half), bearing distinct tubercles, and the umbo lies closer to the posterior margin. We consider these differences significant enough for separation at the species level.

Occurrence — The species is new for the North Sea Basin, having been found previously only in the type area. Its distribution is limited to the Zanclean Kattendijk Formation and Luchtbal Sand Member.

***Emarginula* sp.**

Figs. 1/3 a-c, 2/1

Material — Coll. BLP: 1 specimen, Deurganckdok, Doel; Luchtbal Sand Member.

Dimensions — Height 1.95 mm, aperture 2.79 x 2.20 mm.

Description — Small shell, with regular oval outline; L/W ratio of aperture 1.2. Apex pointed, nearly reaching the concave posterior margin; anterior margin is convex. A slit is present, reaching nearly to the aperture that is open for a quarter of its total length and smooth. The ornament consists of 20 strong axial ribs, with a very weak secondary rib in between. The concentric ornament is rather thick, especially distinct between the axials and forming square tubercles on them.

Discussion — This species shows a superficial resemblance to *Emarginula punctura* Wood, 1814, described from the Coralline Crag Formation of East Anglia, but it clearly differs by the absence of pits in the surface. Furthermore, only one secondary rib is present between each pair of primary ribs, instead of three to four. *Emarginula rosea* Bell, 1824, also has a single secondary rib, but the primary ribs lie closer together and the umbo reaches beyond the posterior shell margin. In *E. rosea* the slit shows clear squamae, instead of being smooth as in *E. sp.* *Emarginula fissura reticulata* Sowerby, 1813 has thirty primary ribs, its apex lies much closer to the centre of the shell, the slit shows squamae and the concentric ornament is markedly stronger. The unidentified *Emarginula* species reported here is possibly an undescribed species, however our single specimen from Doel is very small and probably not adult, and insufficient for describing a new taxon.

Occurrence — One specimen was found in the Luchtbal Sand Member of Doel.

Subfamily Diodorinae Gray, 1821

Genus *Diodora* Gray, 1821

***Diodora graeca* (Linnaeus, 1758)**

Fig. 2/3a-b

- *1758 *Patella graeca* Linnaeus, p. 784.
- 1803 *Patella apertura* Montagu, p. 491, pl. 13, fig. 10.
- 1853 *Fissurella nodosa* Eichwald, p. 138, pl. 6, fig. 16.
- 1853 *Fissurella Graeca* Linnaeus - Hörnes, p. 642, pl. 50, fig. 27.

- 1897 *Fissurella (Glyphis) graeca* (Linnaeus) - Sacco, p. 8, pl. 1, figs 16, 17.
 1916 *Fissurella graeca* Linnaeus - Cerulli-Irelli, p. 210, pl. 24, figs. 8-17.
 1923 *Fissurella graeca* Linnaeus - Harmer, p. 770, pl. 61, fig. 18.
 1960 *Diodora (Diodora) graeca* Linnaeus - Kojumdjieva & Strachimirov, p. 84, pl. 28, fig. 10.
 1960 *Diodora (Diodora) graeca* (Linné) - Malatesta, p. 49, pl. 1, fig. 2.
 1964 *Diodora apertura* Montagu - Brébion, pl. 1, fig. 12.
 1966 *Fissurella (Diodora) graeca* Linné - Strausz, p. 29, pl. 76, figs 7-14.
 1974 *Diodora apertura* Montagu - Malatesta, p. 161, pl. 28, fig. 10.
 1975 *Diodora (Diodora) graeca* (Linnaeus) - Bałuk, p. 26, pl. 1, figs 12-14.
 1988 *Diodora graeca* Linné - Graham, p. 70, fig. 17.
 1990 *Diodora graeca* (Linné) - Poppe & Goto, p. 66, pl. 2, fig. 14.
 1992 *Diodora graeca* (Linné) - Cavallo & Repetto, p. 34, fig. 12.
 1994 *Diodora graeca* (Linnaeus) - Giannuzzi-Savelli *et al.*, p. 42, figs 56-58.
 2003 *Diodora graeca* (Linnaeus) - Landau *et al.*, p. 26, pl. 4, fig. 4.

Locus typicus — Greece.

Stratum typicum — Recent.

Material — IRSNB IST 6952 (leg. RM): 1 specimen, Doel Deurganckdok; Luchtbal Sand Member. Coll RM: 4 specimens, same locality and level.

Dimensions — Height 5.7 mm, aperture 14.4 x 8.6 mm.

Description — Medium-sized patelliform shell, aperture elongate oval; shell moderately elevated, with straight anterior slope and convex to slightly concave posterior. Apical aperture at one third behind the anterior margin. Interior of oval aperture thickened. Ornament consisting of about 30 primary axial ribs, with a single secondary and a single or more tertiary ribs in between. Concentric lamellae are distinctly developed. Apertural margin crenate, well visible at the outside.

Discussion — This species was documented from the Katendijk Formation and the Oorderen Sand Member by Marquet (1995, 1998b). This was an error; the beforementioned specimens belong to *Diodora italica* (Defrance, 1820) treated below. Both species occur in the Luchtbal Sand Member, *D. graeca* at Doel and *D. italica* in the localities on the right bank of the Scheldt River.

Occurrence — The species is rare in the Luchtbal Sand Member of Doel and in the British Red Crag Formation; for its further distribution, see Landau *et al.* (2003, p. 26). Its sudden appearance and extinction in the Pliocene of the North Sea Basin is puzzling. From the Miocene of the North Sea Basin, Glibert (1952, p. 6, pl. 1, fig. 2) men-

tioned the presence of *D. apertura* (= *D. graeca*), but according to Janssen (1984, p. 120) this is *Diodora subcostaria* (d'Orbigny, 1820), characterised by the different internal shape of the apical aperture. *Diodora graeca* occurs in Badenian (Miocene, Paratethys) deposits of Poland (Bałuk, 1975), but this population was already extinct long before the arrival of *D. graeca* in the North Sea Basin, consequently it could not have migrated from there. It is more likely that North Sea immigrants derive from the Atlantic somewhere during the Pliocene.

Diodora italica (Defrance, 1820)

Fig. 2/2a-b

- *1820 *Fissurella italica* Defrance, p. 79.
 ?1848 *Fissurella graeca* Linné - Wood, p. 168, pl. 18, fig. 4.
 1872 *Fissurella costaria* - Wood, p. 90, pl. 7, fig. 29.
 1878 *Fissurella graeca* Linné - Nyst, pl. 2, fig. 2.
 1881 *Fissurella graeca* Linné - Nyst, p. 111.
 1897 *Fissurella (Glyphis ?) italica* Defrance - Sacco, p. 8, pl. 1, figs 18-23.
 1916 *Fissurella italica* Defrance - Cerulli-Irelli, p. 209, pl. 23, figs. 19-35, pl. 24, figs 1-7.
 1960 *Fissurella (Lucapina) italica* Defrance - Cossmann & Peyrot, p. 48, pl. 2, figs 57-59.
 1923 *Fissurella italica*, Defrance - Harmer, p. 771, pl. 61, fig. 17.
 1949 *Diodora italica* Defrance - Glibert, p. 22, pl. 1, fig. 15, pl. 2, fig. 1.
 1957b *Diodora apertura dorsata* Monterosato [sic] - Glibert, p. 7.
 1960 *Diodora (Diodora) italica* (Defrance) - Malatesta, p. 50, pl. 1, fig. 3.
 1962 *Diodora italica* Defrance - Glibert, p. 14.
 1965 *Diodora apertura* (Montagu) - van Regteren Altena *et al.*, p. 58, pl. 1, fig. 7.
 1966 *Fissurella (Diodora) italica* Linné - Strausz, p. 29, pl. 76, figs 15-16.
 1974 *Diodora italica* Defrance - Malatesta, p. 162, pl. 13, fig. 2.
 1975 *Fissurella (Diodora) italica* Defrance - Fekih, p. 87, pl. 28, fig. 15.
 1985 *Diodora (Diodora) italica* Defrance - González Delgado, p. 52, pl. 1, figs 4-6.
 1990 *Diodora italica* (Defrance) - Da Silva, p. 6, pl. 1, figs 1-3.
 1990 *Diodora italica* (Defrance) - Poppe & Goto, p. 66, pl. 2, fig. 14.
 1992 *Diodora italica* (Defrance) - Cavallo & Repetto, p. 34, fig. 13.
 1994 *Diodora italica* (Defrance) - Giannuzzi-Savelli *et al.*, p. 42, figs 59-60.
 1995 *Diodora graeca* (Linné) - Marquet, p. 60, pl. 2, fig. 1.
 1998b *Diodora graeca* (Linnaeus) - Marquet, p. 24, text-fig.
 2001 *Diodora (Diodora) italica* (Defrance) - Da Silva, p. 74, pl. 2, figs 3-4.
 2003 *Diodora italica* (Defrance) - Landau *et al.*, p. 26, pl. 4, fig. 5.

Locus typicus — Italy.

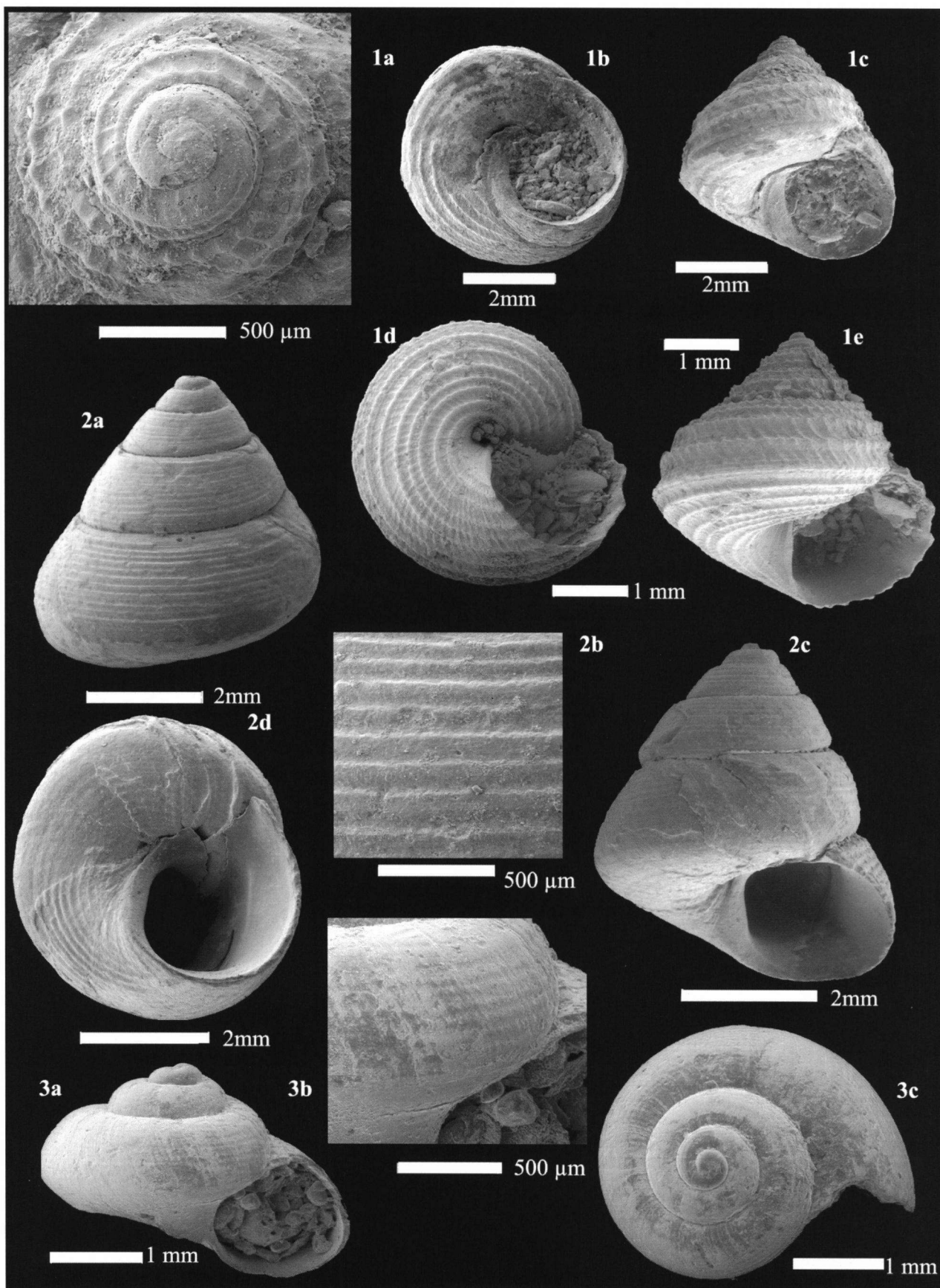


Figure 3.

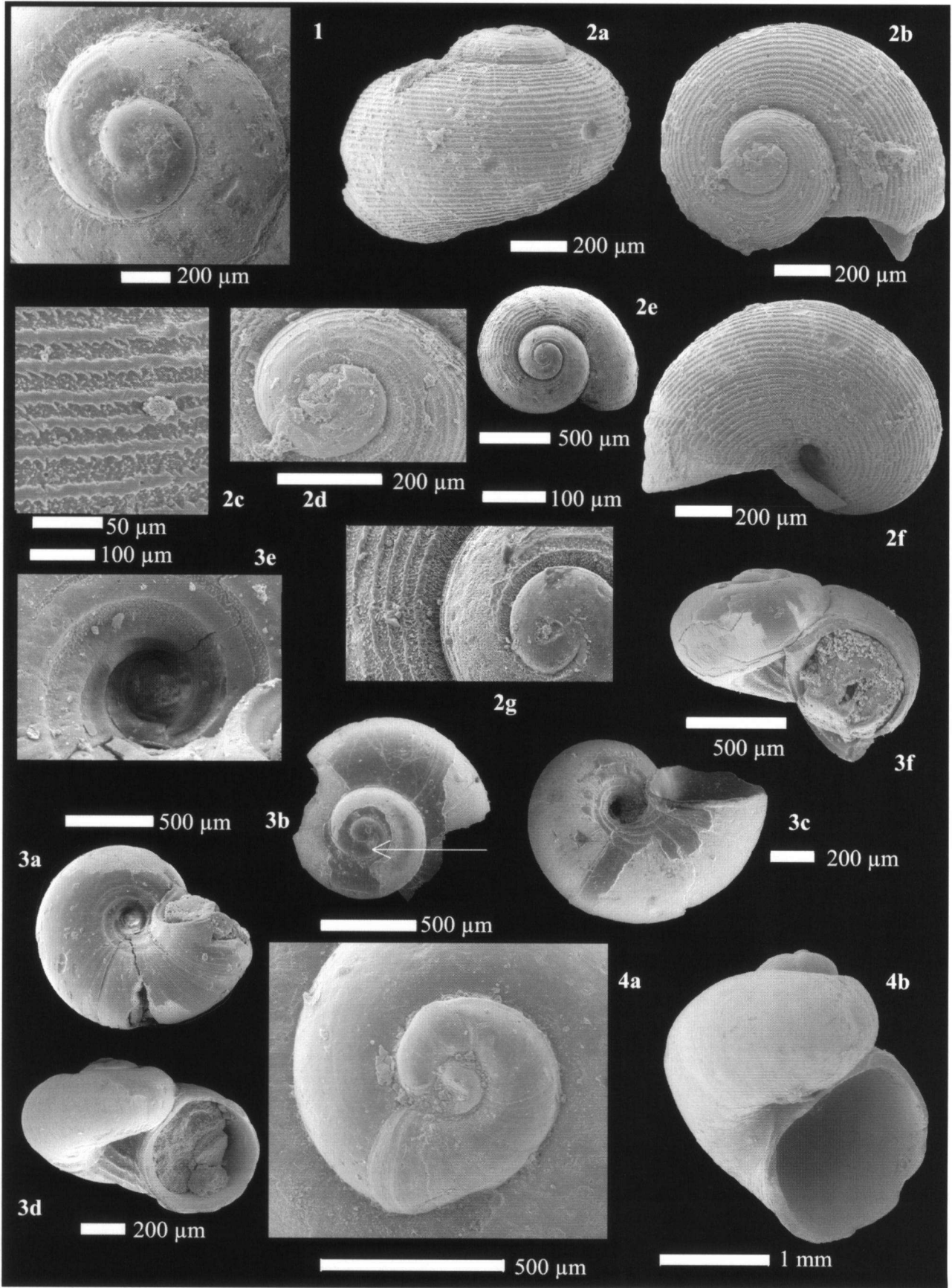


Figure 4.

Figure 3.

1. *Gibbula (Colliculus) crassistriata* (Bell in Wood, 1882). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6955.
2. *Gibbula (Colliculus) woodi* (Harmer, 1923). Antwerp, Noorderlaan, dredged material. Luchtbal Sand Member? IRSNB IST 6956 (3/2 a, b), 6979 (3/2 c, d).
3. *Margarites belli* (Harmer, 1923). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6957.

Figure 4.

1. *Margarites belli* (Harmer, 1923). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6957.
2. *Dikoleps cutleriana* (Clark, 1848). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6958 (4/2 a-d, f), 6959 (4/2 e-g).
3. *Cirsonella romettensis* (Granata, 1877). a, e, f: Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6960. b, c, d: Deurganckdok, Doel. Oorderen Sand Member, *Cultellus* level. Coll. BR.
4. Skeneidae indet. Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6961.

Stratum typicum — Recent.

Material — IRSNB IST 6951 (leg. RM): 1 specimen, Antwerp Noordkasteel, Luchtbal Sand Member.

Dimensions — Height 15.0 mm, aperture 43.3 x 30.0 mm.

Description — Rather large but relatively low patelliform shell, oval in outline, with an apical aperture at one third behind the anterior shell margin. Anterior margin straight, posterior only slightly convex. Apical aperture oval, strongly thickened at the inside. Muscle scars also often distinct. Ornament consisting of about 60 to 80 axial ribs, which are unequal in size but can not be divided clearly into primary and secondary ribs. Intercostal areas are narrow; concentric ornament is relatively weak, never forming scales. Apertural margin crenate, visibly mostly at the shell's interior.

Discussion — This species clearly differs from *Diodora graeca* (Linnaeus, 1758) by the larger size, the relatively flatter shell (this character is however very variable), the presence of more axial ribs, the poorly distinguishable primary and secondary ribs, the weaker concentric ornament lacking scales and the less distinctly crenate outer edge of the apertural margin. The internal thickening of the aperture also seems stronger in fully adult shells of *D. apertura* than in *D. graeca*.

Occurrence — The species is rare in the Kattendijk Formation, the Luchtbal Sand Member and the Oorderen Sand Member from Antwerp. In the North Sea Basin it is also known from Dutch Pliocene beach material and in the British Coralline Crag Formation. For its further distribution, see Landau *et al.* (2003, p. 27). Juvenile specimens are relatively higher than adults, such as the specimen figured here (Fig. 2/2). Juveniles resemble *D. graeca* in shape, but their ornament always differs (see above). Miocene specimens from the French Touraine ('Pontilevian') are never as large as Pliocene specimens and their shape consequently remains relatively higher. There are no Miocene records of *D. italica* from the North Sea Basin, suggesting it did not arrive in the North Sea Basin until the Early Pliocene. This possibly correlates with the breakthrough of the Channel in the Early Pliocene as proposed by van Vliet-Lanoë *et al.* (2002). The species has a continuous record in Atlantic

France from the Early Miocene (Aquitainian, Aquitaine region) through the Middle Miocene ("Pontilevian", Langhian, Touraine region) until the Late Miocene ("Redonian", Tortonian, Anjou region). Its isolated Paratethyan occurrence in the Early Miocene of Hungary (Strausz, 1966) is somewhat enigmatic and this material should be reconsidered. *Diodora subcostaria* (d'Orbigny, 1820), from the Miocene of France and the North Sea Basin, strongly resembles *Diodora italica* in ornament, and may form part of the same evolutionary lineage.

Superfamily Trochoidea Rafinesque, 1815
 Family Skeneidae Clark, 1851
 Genus *Dikoleps* Hoisaeter, 1968

***Dikoleps cutleriana* (Clark, 1848)**

Fig. 4/2a-g

- 1983 *Tubiola cutleriana* (Clark) - Rolan Mosquera, p. 100, text-fig. 40.
- 1983 *Dikoleps cutleriana* (Clark) - van Aartsen *et al.*, p. 121, fig. 42.
- 1988 *Skenea cutleriana* (Clark) - Graham, p. 134, fig. 45.
- 1994 *Dikoleps cutleriana* (Clark) - Giannuzzi-Savelli *et al.*, p. 106, fig. 353.

Locus typicus — Mediterranean.

Stratum typicum — Recent.

Material — IRSNB IST 6958, 6959 (leg. RM), Doel, Deurganckdok; Luchtbal Sand Member.

Dimensions — 4/2a, b, c, d, f: height 0.834 mm, width 1.05 mm; 4/2e, g: height 0.90 mm, width 1.14 mm.

Description — Very small turbiniform shell, height usually less than width, with rounded whorls. Protoconch smooth, consisting of 1.25 whorls, delimited by a distinct prosocline ridge. Ornament of adult shell starting with about five spiral ribs, which are narrower than the intercostal spaces. The number of spiral ribs increases to about 50 on the body whorl. They are of equal strength, and slightly narrower than the intercostal spaces and continue into the umbilicus.

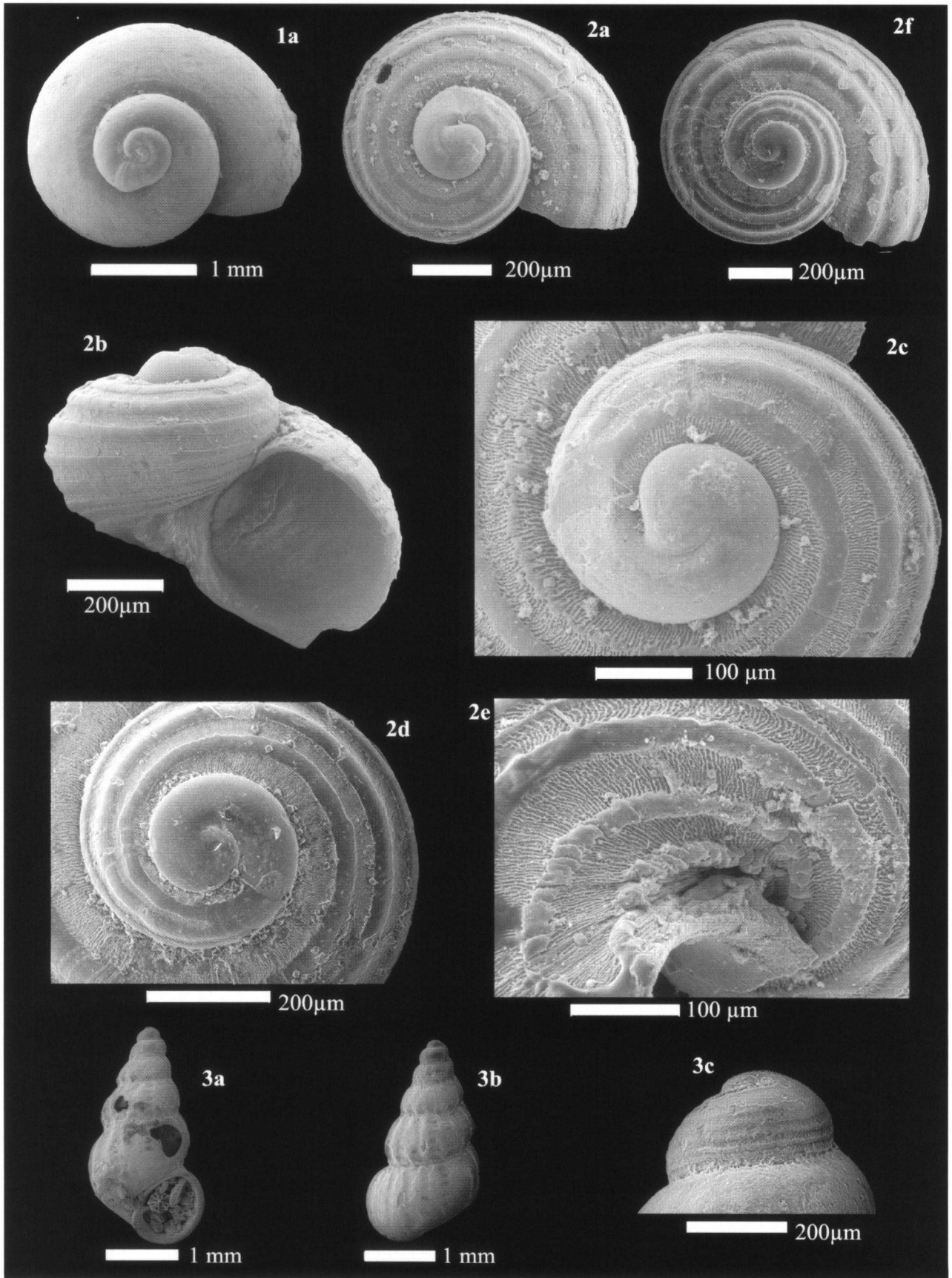


Figure 5.

Figure 5.

1. Skeneidae indet. Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6961.
2. *Lodderena sphaeroideum* (Wood, 1842). a, b, c, e: Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6962. d, f: Deurganckdok, Doel. Oorderen Sand Member, *Cultellus* level. Coll. BR.
3. *Alvania whitleyi* (Bell, 1898). B1-B2 Kanaaldok, Antwerp. Luchtbal Sand Member. RGM 550 001.

A microsculpture is present, consisting of irregular backward pointing spines at the abapical side of the ribs. Between the ribs, small tubercles are present. The suture is very deep, the sutural ramp covered with microscopic tubercles. The umbilicus is distinct but narrow.

Discussion — The H/W ratio of this species is variable: most specimens are rather flat, but Graham (1988) figures a distinctly higher specimen than those found in Doel. The heavy concentric ornament and narrow umbilicus clearly differentiate this species from all other Skeneidae present in the Pliocene of Belgium.

Occurrence — Only two specimens were found in the Luchtbal Sand Member of the Deurganckdok exposure. It is the first record of the species for the Pliocene of the North Sea Basin and possibly the first fossil record. The species now seems to live in rather shallow waters, has an Atlantic-Mediterranean distribution; its northern limits are SW England, Ireland and the Hebrides (Graham, 1988).

Genus *Lodderena* Iredale, 1924

***Lodderena sphaeroideum* (Wood, 1842)**

Fig. 5/2a-f

- *1842 *Turbo sphaeroideum* Wood, p. 533.
- 1848 *Turbo sphaeroideum* Wood - Wood, p. 122, pl. 15, fig. 9.
- 1872 *Turbo sphaeroideum* Wood - Wood, p. 86.
- ?1923 *Cyclostrema sphaeroideum* (Wood) - Harmer, p. 752, pl. 60, fig. 15.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6962 (leg. RM): 1 specimen, Doel, Deurganckdok; Luchtbal Sand Member. Coll. BR: 1 specimen same locality, Oorderen Sand Member, *Cultellus* level.

Dimensions — 5/2a, b, c, e: height 0.66 mm, width 0.778 mm; 5/2d, f: height 0.90 mm, width 1.14 mm.

Description — Very small, turbiniform shell consisting of about three tumid whorls with a distinct, impressed suture. Protoconch smooth, tumid, consisting of 1 whorl, which is clearly delimited by a slightly prosocline, curved ridge; left side of protoconch less curved than right. First quarter

whorl of teleoconch smooth, only with microsculpture in the subsutural depression. Then first a narrow abapical spiral, closely followed by two broader adapical ones, develop. Body whorl with six to nine spirals; adapically broader than intercostal spaces, abapical on the shell base narrower. These spiral ribs are smooth except for the three abapical ribs that surround the umbilicus, which possess tubercles. The latter are strongest on the abapical spiral. Between the spiral ribs, a microsculpture of dense irregular, straight prosocline axial lines is present. Umbilicus narrow and deep.

Discussion — This species is attributed to the genus *Lodderena* because of the presence of three periumbilical scaly ribs and because of the protoconch shape, which is slightly flattened to one side, although the shell certainly is not planispiral (see Warén, 1991, p. 135). Warén (1980, pl. 1, fig. 7-9) figured a specimen, labelled "*Cyclostrema sphaeroideum* (Wood, 1842) by Jeffreys, collected on the Travailleur expedition, noting that it probably did not belong to Wood's species. Landau *et al.* (2003) figured a similar Early Pliocene shell from Estepona, Spain and attributed its authorship erroneously to Jeffreys. This is a quite different species, which is much higher instead of rather flat, with more tumid whorls and axial ribs between the spirals instead of a granular microsculpture; the adult ornament starts after the protoconch with axial ribs instead of spirals. The Recent material figured by Warén and the Estepona specimens probably belong to the genus *Parviturbo* Pilsbry & McGinty, 1945. This species already bears the name *Turbo lecointrae* Dollfus & Dautzenberg, 1899 (p. 218, pl. 9, figs 5-6), after material from the Touraine (France) 'Pontilevian'. It is abundant in some localities in the 'Redonian' of Brittany (France) and figured in an unpublished PhD thesis by Brébion (1964, pl. 3, fig. 17). The name of this species should therefore be *Parviturbo lecointrae* (Dollfus & Dautzenberg, 1899) and its range encompasses the Middle and Late Miocene ('Pontilevian' and 'Redonian') of Atlantic France, the Early Pliocene (Zanclean) of Estepona (Spain) and living in the eastern Atlantic Ocean between the Bay of Biscay, the Sargasso Sea and Senegal.

Occurrence — *Lodderena sphaeroideum* (Wood, 1842) is a species from the Coralline Crag Formation of Gedgrave and Sutton, now found for the first time in the Luchtbal Sand Member in Belgium. Harmer (1923) mentioned the species from the Atlantic Pliocene of St. Erth, Cornwall, but as far as can be judged from his very poor figure this specimen is smooth and it could belong to any other species of the Skeneidae. As discussed above, material mentioned under the same name from France, Spain and the

Atlantic is not conspecific, so *L. sphaeroideum* is an endemic North Sea basin species.

Genus *Cirsonella* Angas, 1877

***Cirsonella romettensis* (Granata, 1877)**

Fig. 4/3a-f

- 1874 *Turbo romettensis* Seguenza MS - Jeffreys, p. 113 (*nomen nudum*).
*1877 *Oxysteles romettensis* Granata, p. 5.
1883 *Cithna adamsi* Jeffreys, p. 111.
1889 *Cyclostrema funnazzensis* de Gregorio, p. 285.
1980 *Tharsis romettensis* Seguenza ms, Jeffreys - Warén, p. 18, pl. 3, figs 1-2.
1992 *Cirsonella romettensis* (Granata) - Warén, p. 160, figs 4c, 9e, 11c-e, 12a.
1994 *Cirsonella romettensis* (Seguenza) - Giannuzzi-Savelli *et al.*, p. 116, fig. 350.
1996 *Cirsonella romettensis* (Seguenza) - Palazzi & Villari, p. 246, fig. 107.
2003 *Cirsonella romettensis* (McGinty) - Landau *et al.*, p. 38, pl. 8, fig. 8.

Locus typicus — Rometta, Sicily, Italy.

Stratum typicum – Unnamed beds, Early Pleistocene.

Material — IRSNB IST 6960 (leg. RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member. Coll BR, 2 specimens, Deurganckdok, Oorderen sand Member, *Cultellus* level.

Dimensions — 4/3 a, e, f: height 0.66 mm, width 0.778 mm; 4/3 c, d: height 0.753 mm, width 1.08 mm; 4/3b: height 0.820 mm, width 1.08 mm (damaged).

Description — Very small, turbiniform shell with low spire and two and a half tumid whorls, protoconch included. Suture deep, but without subsutural incision. Protoconch consisting of two and a quarter tumid whorls, appearing smooth, but with very small, irregular granules under high magnification; protoconch/teleoconch boundary marked by a ridge; cross section about 250 µm. Aperture entire, detached, nearly circular except for the short, straight columellar lip. Teleoconch nearly smooth, except for three to four strong spirals around the umbilicus and for very fine prosocline growth lines. Between the spirals, granular microsculpture is present. Umbilicus deep, wide in the specimens studied.

Discussion — No adult specimens of this species were found. These have a very characteristic umbilicus, nearly closed by an expansion of the columellar lip. Furthermore, they are relatively higher and the whorls are less tumid, with a shallow suture. Warén (1992, fig. 11 c-e) figures growth stages of the species. Juveniles are very similar to those of *Skenea (Lissospira) basistriata* (Jeffreys, 1877), a

species occurring in the Kattendijk Formation (see Marquet, 1995, pl. 6, fig. 2). The main difference, according to Warén (1992, p. 160) is the size of the protoconch, which measures 250-290 µm in *Cirsonella romettensis* and 400-550 µm in *Skenea basistriata*. As can be seen in specimen Fig. 4/3b, in which the protoconch limit is indicated by an arrow, it is comparable in size to *C. romettensis*.

Occurrence — The species is here mentioned for the first time for the North Sea Basin. Only a few specimens were found in the Luchtbal and Oorderen Sand Members of Doel. It is a southern, Lusitanian and Mediterranean species and its northern limit was until now the Bay of Biscay. For its general distribution, see Landau *et al.* (2003, p. 38).

Skeneidae indet.

Fig. 4/4a-b, 5/1a

Material — IRSNB IST 6961 (leg. RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member.

Dimensions — Height 2.82 mm, width 2.44 mm.

Description — Small, naticiform shell, consisting of three and a half whorls, which are tumid, except for the adapical part on the last whorls; suture deeply incised. Protoconch large, about 500 µm in cross section, consisting of two and a half whorls. These are smooth and considerably broaden towards the protoconch-teleoconch boundary, which is marked by a sharp ridge. Protoconch and teleoconch smooth. Aperture oval, except at the parietal side, which is straight, higher than broad, detached, not thickened. Umbilicus very narrow, with a ridge running into it.

Discussion — None of the known Mediterranean or Atlantic Skeneidae shows the combination of a large protoconch, broadening towards the end, lack of any sculpture and a narrow umbilicus. Even its genus cannot be identified with certainty. Insufficient material is available to describe this taxon as a new species. There is a superficial resemblance between this species and the Recent Northern Atlantic species *Skenea trochoides* (Friele, 1876) and *Skenea peterseni* (Friele, 1877), both figured by Warén (1991, figs 2e, 2g, 6e and 3f, 4a-b, 6d respectively). Both, however, have a more rounded aperture and their protoconch does not widen significantly towards the protoconch-teleoconch boundary.

Occurrence — Only a single specimen was found in the Luchtbal Sand Member at Doel, Deurganckdok.

Family Trochidae Rafinesque, 1815
Subfamily Margaritinae Stolizcka, 1868
Genus *Margarites* Gray, 1847

***Margarites belli* (Harmer, 1923)**

Fig. 3/3 a-c, 4/1

- *1923 *Eumargarita belli* Harmer, p. 751, pl. 60, fig. 12.
1957b *Margarites belli* Harmer - Glibert, p. 10, pl. 1, fig. 4.

Locus typicus — Boyton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6957 (leg. RM), Deurganckdok, Luchtbal Sand Member. Coll RM, 3 specimens, same locality and unit.

Dimensions — Height 1.98 mm, width 3.37 mm.

Description — Rather small, turbiniform shell, broader than high with deep suture and up to seven rounded whorls. Protoconch consisting of a smooth bulbous nucleus of half a whorl and a smooth protoconch II, consisting also of half a whorl and clearly delimited by a strong, prosocline ridge from the teleoconch. After the protoconch/teleoconch boundary, two very smooth abapical spirals develop. On subsequent whorls, the number of spirals increases, to 12 on the body whorl. These spirals partially continue on the shell base, but are absent around the wide umbilicus. The spiral ribs are very faint and broader than the intercostal spaces. The aperture is ovate.

Discussion — This species strongly resembles *Margarites trochoides* Wood, 1842, figured by Marquet (1995, pl. 3, fig. 4), but the latter has a more rounded aperture, a slightly higher spire and almost lacks the spiral ornament, except around the umbilicus, which is the only smooth area in *Margarites belli*. Both probably form an evolutionary lineage.

Occurrence — *Margarites belli* exclusively occurs in the Luchtbal Sand Member in Belgium, but very rarely. The only other localities known are in the Coralline Crag Formation of East Anglia. *Margarites trochoides* is not uncommon in the Kattendijk Formation.

Subfamily Gibbulinae Stolizcka, 1868
Genus *Gibbula* Risso, 1826
Subgenus *Colliculus* Monterosato, 1888

***Gibbula (Colliculus) crassistriata* (Bell in Wood, 1882)**
Fig. 2/5a-c, 3/1a-e

- *1882 *Margarita crassistriata* Bell in Wood, p. 10, pl. 1, fig. 15.
1923 *Margarites crassistriata* (Bell) - Harmer, p. 749, pl. 60, fig. 8.
1965 *Margarites crassistriata* (Bell in Wood) - van Regteren Altena *et al.*, p. 8, pl. 2, fig. 11.
1995 *Gibbula (Colliculus) crassistriata* (Bell in Wood) - Marquet, p. 69, pl. 5, fig. 4.
1998b *Gibbula (C.) crassistriata* (Bell in Wood) - Marquet, p. 46, unnumbered text-fig.

Locus typicus — Boyton, East Anglia, United Kingdom.

Stratum typicum — “? Crag”, presumably Red Crag Formation, Late Pliocene.

Material — IRSNB IST 6955, 6956 (leg. RM): 2 specimens, Doel, Deurganckdok, Luchtbal Sand Member. Coll RM, 2 specimens, same locality and unit.

Dimensions — 2/5 a-c, 3/1 a-c: height 4.53 mm, width 4.95 mm; 3/1d, e: height 3.90 mm, width 3.73 mm.

Description — See Marquet (1995, p. 69, pl. 5, fig. 4). Although it is partially eroded, so that no microsculpture can be seen anymore, the limit of the protoconch of one specimen can be recognised. It is slightly larger than one whorl and not clearly delimited. The teleoconch ornament starts with an abapical spiral close to the suture, followed a quarter of a whorl later by prosocline axial ribs and later again by an adapical spiral. One whorl after the onset of the teleoconch sculpture, spirals and axials begin to form tubercles. Fig. 3/1 d, e shows a juvenile specimen, in which the umbilicus is still open, while the axial ornament on the basal part is more developed than in adult shells.

Occurrence — This species has been found before in Belgium only in the Oorderen Sand Member. It is slightly less rare in the Luchtbal Sand Member of Doel.

***Gibbula (Colliculus) woodi* (Harmer, 1923)**
Fig. 3/2 a-d

- 1848 *Trochus montacuti* Wood - Wood, p. 129, pl. 14, fig. 1.
1878 *Trochus montagui* Wood - Nyst, pl. 7, fig. 3.
1881 *Trochus montagui* Wood - Nyst, p. 109.
*1923 *Trochus (Gibbula) woodi* Harmer, p. 736, pl. 69, figs 14-16.
1957b *Gibbula (Colliculus) woodi* Harmer - Glibert, p. 20, pl. 1, fig. 17.

Locus typicus — Orford, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6956, 6979 (leg. RM), Antwerp, industrial area near Noorderlaan, dredged, presumably from the Luchtbal Sand Member. Coll RM, 2 specimens, same locality and unit. Coll. RM, 2 specimens, Antwerp Noordkasteel, Luchtbal Sand Member.

Dimensions — 3/2 a, b: height 5.26 mm, width 5.08 mm; 3/2 c, d: height 5.15 mm, width 4.50 mm.

Description — Medium-sized, turbiniform species, nearly triangular in side view, with about five flat whorls. Suture slightly incised. Protoconch unknown. Ornament solely consisting of about 15 spiral ribs, which are nearly twice as

broad as the intercostal areas. On the shell base, 12 slightly stronger spiral ribs occur. Aperture nearly round, with straight columellar lip. Umbilicus closed by thickened and expanded columellar lip.

Discussion — Species of the subgenus *Colliculus* are common in the Pliocene of Belgium, including *Gibbula* (*C.*) *beetsi* van Regteren Altena, 1954 (Luchtbal to Kruisschans Member), *G. (C.) obconica nehalenniae* van Regteren Altena, 1954 (Luchtbal and Oorderen Member), *G. (C.) obconica obconica* (Wood, 1842) (Kattendijk Formation), *G. (C.) petala* Marquet, 1998 (same) and *G. (C.) crassistriata* (Bell in Wood, 1852) (Luchtbal and Oorderen Member) (see Marquet, 1995). *Gibbula (C.) woodi* (Harmer, 1923) clearly differs from all these species in having flat whorls, with a shallow suture and a triangular cross section. Furthermore, all other species have tubercles on their spiral ornament, which can become very heavy, lacking in *G. woodi*.

Occurrence — This species is limited to the Luchtbal Sand Member in Belgium and the Coralline Crag Formation in Britain. No specimens have been found in the Luchtbal Member in Doel.

Subgenus *Steromphala* Gray, 1848

***Gibbula (Steromphala) cineroides* (Wood, 1842)**

Fig. 2/4a-b

- *1842 *Trochus cineroides* Wood, p. 531.
- ?1848 *Trochus cineroides* Wood - Wood, p. 131, pl. 14, fig. 8b.
- 1923 *Trochus (Gibbula) cineroides* (Wood) - Harmer, p. 730, pl. 58, fig. 24.
- 1957b *Gibbula (Steromphala) cineroides* Wood - Glibert, p. 17, pl. 1, fig. 12.

Locus typicus — Walton-on-the-Naze, East Anglia, United Kingdom.

Stratum typicum — Red Crag Formation, Piacenzian, Late Pliocene.

Material — IRSNB IST 6953 (leg. RM): 1 specimen, Vijfde Havendok, Antwerp, Luchtbal Sand Member. Coll RM: 1 specimen, same locality and Member.

Dimensions — Height 14.1 mm, width 18.2 mm.

Description — Medium-sized, thick-shelled, nearly rectilinear conical shell, with apical angle of 90°. Whorls nearly flat-sided, tending to become imbricate, suture shallow; body whorl rounded abapically. Ornament consisting of about 15 broad spiral ribs on the body whorl, which are unequally strong. The intercostal spaces form narrow incisions between the spirals. They contain very faint prosocline lines. Tubercles lacking on the spiral ribs. Shell base

with 10 spiral ribs, which are stronger than those on the whorls. Aperture ovate, with an indistinct columellar tubercle. Umbilicus narrow, but surrounded by a broad depression.

Discussion — The shells figured and described by Wood (1848) as *Trochus cineroides* differ markedly from those figured by Harmer (1923), Glibert (1957b) and in this paper, in having strong tubercles on the spirals and rather tumid whorls. It could be that Wood's (1848) figures and description are based on specimens of *Gibbula (Steromphala) octosulcata* (Nyst, 1835), which differs from the present species in these characters. The umbilicus of *G. cineroides* reported here is nearly completely closed, which is not the case in Wood's (1848) material, while the tubercles figured by Wood are much stronger than those of Nyst's species. Wood (1848) did not mention the occurrence of *G. octosulcata* in the British Pliocene, although Harmer (1923) does. None of the Trochidae present in the Pliocene of Great Britain or Belgium really fit Wood's (1848) figure and description. Here, the subsequent description of Harmer is followed, but the possibility exists that the species will have to be renamed.

Occurrence — In Belgium, the species is present in the Luchtbal Sand Member, but only from the right Scheldt bank. In Britain, the species seems to be found solely in the Red Crag Formation, which is surprising since the fauna of the Luchtbal Sand Member is closest to that of the Coralline Crag Formation.

- Subclass Orthogastropoda Ponder & Lindberg, 1995
- Superorder Caenogastropoda Cox, 1959
- Order Sorbeoconcha Ponder & Lindberg, 1997
- Suborder Hypsogastropoda Ponder & Lindberg, 1997
- Superfamily Rissoidea Gray, 1847
- Family Rissoidae Gray, 1847
- Subfamily Rissoinae Gray, 1847
- Genus *Alvania* Risso, 1826

***Alvania zetlandica* (Montagu, 1815)**

Fig. 6/1a-d

- *1815 *Turbo zetlandica* Montagu, p. 94, pl. 13, fig. 3.
- 1848 *Rissoa zetlandica*, Montagu - Wood, p. 101, pl. 11, fig. 7.
- 1895 *Rissoa (Flemingia) zetlandica* (Montagu) - Sacco, p. 30.
- 1914 *Rissoa (Flemingia) zetlandica* Montagu - Cerulli-Irelli, p. 194, pl. 15, figs 48, 49.
- 1920 *Manzonia zetlandica* (Montagu) - Harmer, p. 622, pl. 50, figs 51, 52.
- 1946 *Alvania (Taramellia) zetlandica* (Montagu) - Beets, p. 36.
- 1965 *Alvania (Alvania) zetlandica* (Montagu) - van Regteren Altena *et al.*, p. 13, pl. 4, fig. 37.
- 1978 *Alvania zetlandica* (Montagu) - Fretter & Graham, p. 180, figs 154, 155.

- 1987 *Manzonina (Flemellia) zetlandica* (Montagu) - Moolenbeek & Faber, p. 166, figs 45, 49-51.
 1988 *Manzonina zetlandica* (Montagu) - Graham, p. 252, fig. 98.
 1990 *Alvania zetlandica* (Montagu) - Poppe & Goto, p. 102, pl. 12, fig. 31.
 1996 *Alvania zetlandica* (Montagu) - Warén, p. 225, fig. 17a.
 1997 *Alvania zetlandica* (Montagu) - Di Geronimo & La Perna, pl. 2, fig. 2.
 1997 *Alvania zetlandica* (Montagu) - Giannuzzi-Savelli *et al.*, p. 112, figs. 476-479, 480d.
 2004 *Alvania zetlandica* (Montagu) - Landau *et al.*, p. 45, pl. 9, fig. 4.

Locus typicus — “Isle of Noss, Zetland” (Shetland), United Kingdom.

Stratum typicum — Recent.

Material — IRSNB IST 6963 (leg. RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member. Coll BLP (leg. MG), 1 specimen, same locality and Member.

Dimensions — 6/1 a, b height 3.45 mm, width 2.19 mm; 6/1 c, d: height 2.63 mm, width 1.79 mm.

Description — Small, rissoiform shell with an elevated spire and deep, angular suture. Protoconch not preserved in the material. Teleoconch with about five whorls. Ornament consisting of equally strong axial and spiral elements, forming rather weak tubercles at the intersections. On the body whorl, 14 axials and 5 spirals are present in the most complete specimen. Spirals and axials form rectangles or hexagons, which are covered by a very dense spiral microsculpture, which however could be lost due to wear. Aperture elongate oval, entire and with strongly thickened margin. Umbilicus closed.

Discussion — Among the Rissoidae present in the Doel and Kallo sections, only *Alvania beani* (Hanley in Thorpe, 1844) shows some resemblance (see Marquet, 1997b, pl. 2, fig. 6). The latter clearly differs, however, by its shallow suture and more numerous axial and spiral ribs.

Occurrence — Only two heavily damaged and worn specimens were collected in the Luchtbal Sand Member of Doel; they are the first specimens recorded in the Pliocene of Belgium. In Britain, the species has been found in the Coralline and the Red Crag Formations. Material is also known from The Netherlands, collected from boreholes and from beaches (Beets, 1946; van Regteren Altena *et al.*, 1965). For its general distribution, ranging from Early Pliocene to Recent, see Landau *et al.* (2004, p. 45).

***Alvania whitleyi* (Bell, 1898)**

Fig. 5/3 a-c

- *1898 *Rissoa whitleyi* Bell, p. 153.

- 1925 *Alvania whitleyi* (Bell) - Harmer, p. 606, pl. 50, fig. 40.
 1997b *Alvania (Alvania) whitleyi* (Bell) - Marquet, p. 13, pl. 3, fig. 1.

Locus typicus — St. Erth, Cornwall, United Kingdom.

Stratum typicum — St. Erth Beds, Pliocene.

Material — RGM 550 001 (leg. van der Mark): 1 sp, B1-B2 Kanaaldok, Antwerp (1964), Luchtbal Sand Member. IRSNB IST 5890: 1 specimen, Kruisschans Zeesluis, Oorderen, Antwerp; Oorderen Sand Member?

Dimensions — Height 3.22 mm, width 1.66 mm.

Description — See Marquet (1997b, p. 13).

Discussion — This is the second specimen of this rare species from the Antwerp region. It is strongly eroded, making it nearly unrecognisable, but the typical shape of the shell, the small, round aperture and the spiral ornament of the protoconch allow identification.

Occurrence — The first specimen of *Alvania whitleyi* (Bell, 1898) collected in Antwerp originated from the basal crag of the “Scaldisien”, which Marquet (1997b) attributed to the basal crag of the Oorderen Sand Member. It could however have derived from the Luchtbal Sand Member. The second specimen, described here, is certainly from the Luchtbal Sand Member.

Superfamily Capuloidea Fleming, 1822
 Family Capulidae Fleming, 1822
 Subfamily Capulinae Wenz, 1840
 Genus *Capulus* Montfort, 1810

***Capulus deurganckensis* nov. sp.**

Fig. 6/4 a-f

- 1872 *Pileopsis ungaricus* var. *sinuosus* Brocchi - Wood, p. 88, pl. 7, fig. 26.
 1878 *Pileopsis ungaricus* var. *sinuosus* Brocchi - Nyst, pl. 7, fig. 26.
 1881 *Pileopsis ungaricus* var. *sinuosus* Brocchi - Nyst, p. 118.
 1923 *Brocchia sinuosa* (Brocchi) - Harmer, p. 768, pl. 61, fig. 10.
 1958a *Brocchia sinuosa* Brocchi - Glibert, p. 23.

Locus typicus — Deurganckdok, Doel, municipality Beveren, prov. Oost-Vlaanderen, Belgium.

Stratum typicum — Luchtbal Sand Member, Lillo Formation, late Zanclean, Early Pliocene.

Material — Holotype - IRSNB IST 6964 (leg. RM). Paratype: IRSNB IST 6965 (leg. RM).

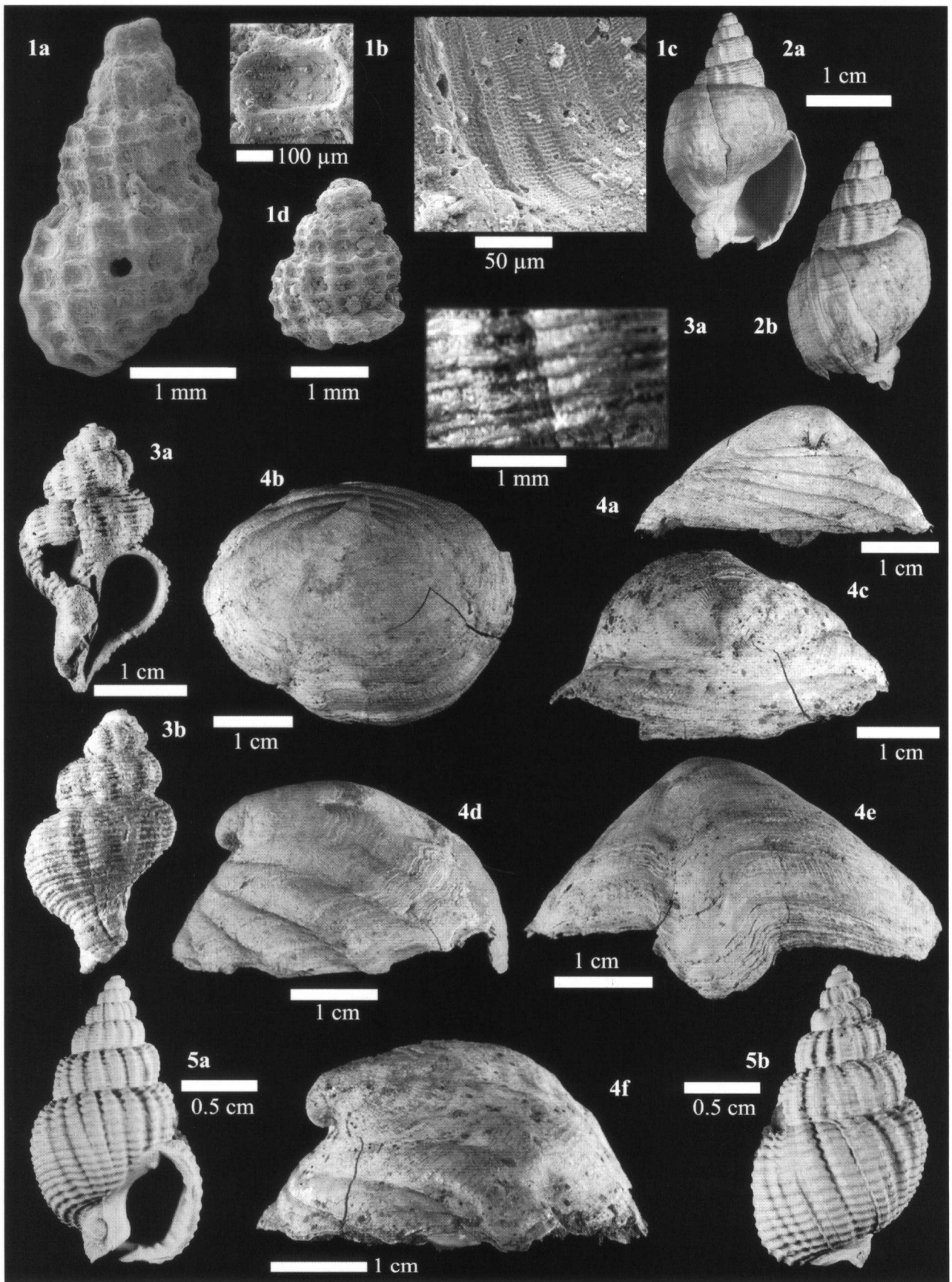


Figure 6.

Figure 6.

1. *Alvania zetlandica* (Montagu, 1815). a, b, d: Deurganckdok, Doel. Luchtbal Sand Member. Coll. BLP. c: Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6963.
2. *Nassarius (Uzita) reticosus* (Sowerby, 1815). Antwerp, Noorderlaan, dredged material. Luchtbal Sand Member? Coll. LC.
3. *Coralliophila (Pseudomurex) bracteata* (Brocchi, 1814). Antwerp, Noorderlaan, dredged material. Luchtbal Sand Member? Coll. LC.
4. *Capulus deurganckensis* nov. sp. a, b, d, e: **holotype** Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6964. c, e: **paratype 1** Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6965. f: **paratype 2** Deurganckdok, Doel. Luchtbal Sand Member. Coll. BLP.
5. *Nassarius (Uzita) spectabilis vandewouweri* (Glibert, 1959). Antwerp, Noorderlaan, dredged material. Luchtbal Sand Member? IRSNB IST 6966.

Other material: Coll. RM: 5 specimens; IRSNB n.n.: see Nyst (1881, pl. 7, fig. 26). Coll. BLP (leg. MG): Landau *et al.* (2004, pl. 15, fig. 2).

Dimensions — Holotype: height 17.6 mm, aperture 39.0 x 31.3 mm; Paratype1: height 17.4 mm, aperture 41.1 x 34.5 mm.

Derivatio nominis — Named after the type locality.

Diagnosis — A *Capulus* species with a paucispiral protoconch of one whorl, with spiral plicae on the whole shell that are most distinct before the umbo.

Description — Large shell, with a smooth protoconch, delimited by a thin ridge and consisting of only one whorl. Protoconch diameter 770 µm, with a large nucleus (diameter 289 µm). Complete shell about two whorls. Shape very variable, oval in outline, aperture broader than wide. Apertural margin very irregular, probably following the outline of the substrate. Umbo very close to anterior margin, at about one eighth of total apertural width. Anterior margin rather straight. Seen in side view, to the right of the umbo, the shell more or less strongly bulges and lowers gently to abruptly at the posterior end. Ornament of three to six deep incisions and plicae, which run nearly over the complete shell, but are especially distinct before the umbo. Furthermore, a large number of fine axial ribs is present. Concentric ribs are mostly fine, some becoming stronger than the axial sculpture.

Discussion — As mentioned in Landau *et al.* (2004, p. 69), this species clearly differs from the Mediterranean Pliocene *Capulus sinuosus* (Brocchi, 1814) in having a paucispiral protoconch with one instead of two and a half whorls. Furthermore, in the Mediterranean species the plicae nearly run straight, while in the new species they form a clear spiral. Axial ornament is nearly absent and the umbo nearly or completely overhangs the anterior apertural margin. *Capulus sinuosus* (Brocchi, 1814) is probably conspecific with *Capulus laevis* (Bronn, 1831). *Capulus ungaricus* (Linnaeus, 1758) also shows some resemblance to the new species, but its protoconch consists of two and a quarter whorls, with a very tiny nucleus, its shell shape is much more regular and spiral plicae are lacking.

Similar species have been considered as a separate genus, *Brocchia* Bronn, 1827. Beu (2004) argued that the 'plicae' seen on the posterior slope of specimens included in the

genus *Brocchia* by all European taxonomists were a xenomorphic sculpture associated with a living mode on pectinid bivalves; specimens living on smooth pectinids would lack plicae whereas those living on ribbed pectinid species would develop plicae with sharp digitations at the shell margin corresponding to the ribs of the pectinid. Certainly the series illustrated for the species *Capulus danieli* (Cosse, 1858) from New Zealand is convincing, showing forms that would certainly have been considered within the genus *Brocchia*. However, this raises some questions within the Pliocene North Sea Basin and European faunas; specimens with plicae are lacking in the Oorderen or Kruisschans Sand Members of Kallo and Doel, although smooth as well as ribbed Pectinidae abound in these Members, as well as in the Luchtbal Sand Member. The most common pectinid in the Luchtbal Sand Member is the smooth *Pseudamussium gerardi* (Nyst, 1835). Also in Recent European populations comparable specimens are lacking, despite the continued presence of both *Capulus* and pectinids in the Recent fauna. We provisionally accept the synonymy of *Brocchia* with *Capulus*, noting that the observations made by Beu (2004), whilst convincing for *Capulus danieli* are not as obvious in the European faunas. Beu (2004) suggested that *Capulus hungaricus* and *Brocchia sinuosa* might be conspecific. We do not agree with this synonymy for our material. There are differences in the size of their protoconch (Landau *et al.*, 2004) and in the thickness of the shell and surface ornament.

Marquet (1997c, 1998b) figured another type of shell from Doel and Kallo (Oorderen Sand Member) under the name of *Brocchia sinuosa* (Brocchi, 1814). It differs from *Capulus deurganckensis* nov. sp. in having a triangular shape, with the umbo distinctly surpassing the apertural margin. The axial ribs are finer. The plicae are distinct only to the right of the umbo when seen from above and they run irregularly, not in a spiral. This species occurs in the Oorderen Sand Member. It has been figured under different names by Wood and Harmer and its correct name is *Capulus partimsinuosa* (Wood, 1848). Synonyms are: *Capulus militaris* var. *partim-sinuosa* Wood (1848, p. 156, pl. 17, fig. 3 a-b, non 3c-f), *Brocchia plicata* Harmer (1923, p. 769, pl. 61, fig. 11), *Brocchia partim-sinuosa* (Wood) in Harmer (1923, p. 769, pl. 61, fig. 12) and *Capulus ? incertus* Bell (1870, p. 216), *Brocchia incerta* (Bell) in Harmer (1923, p. 770, pl. 61, figs 13-14).

Occurrence — *Capulus deurganckensis* nov. sp. is an endemic North Sea Basin species.

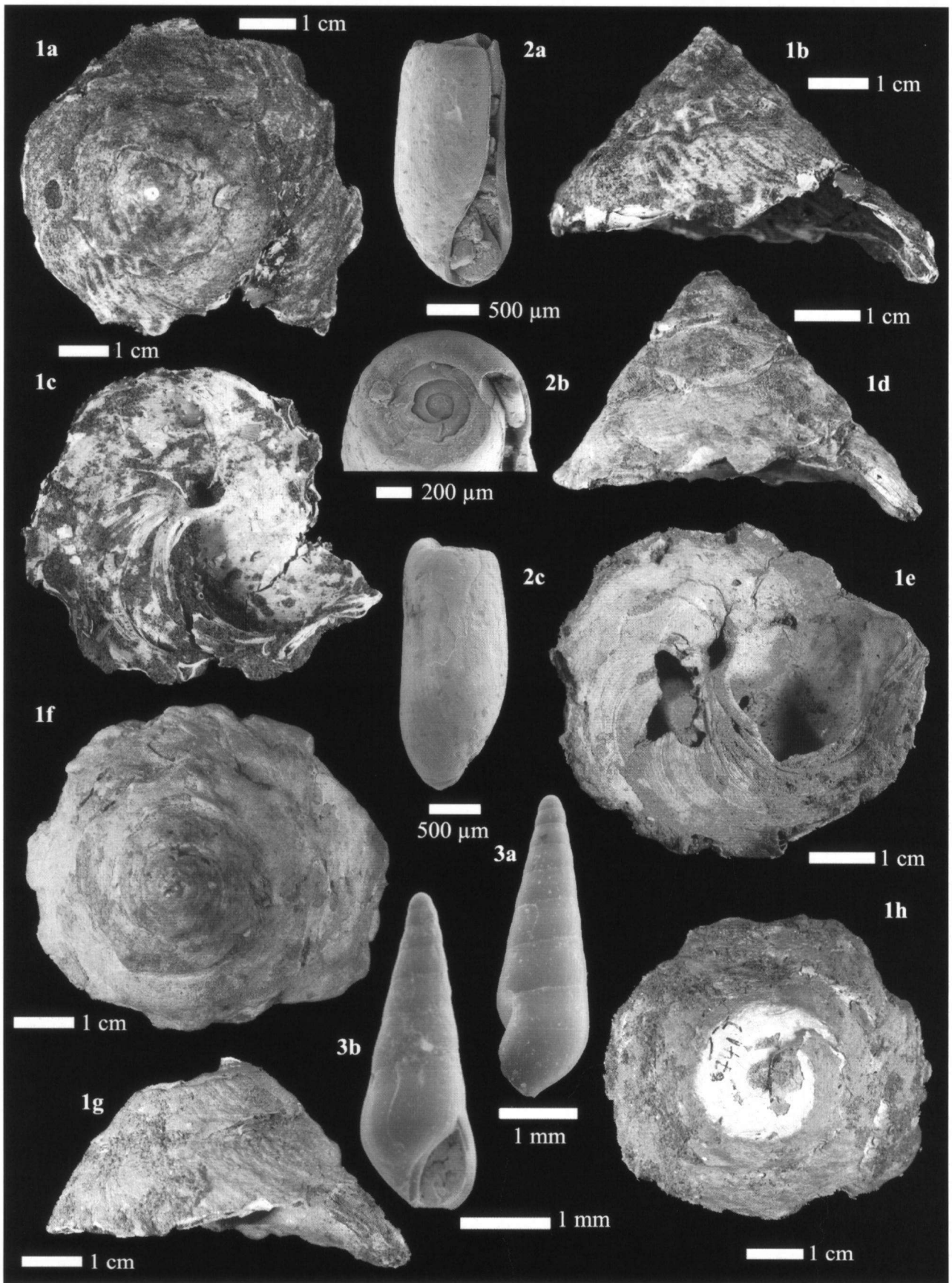


Figure 7.

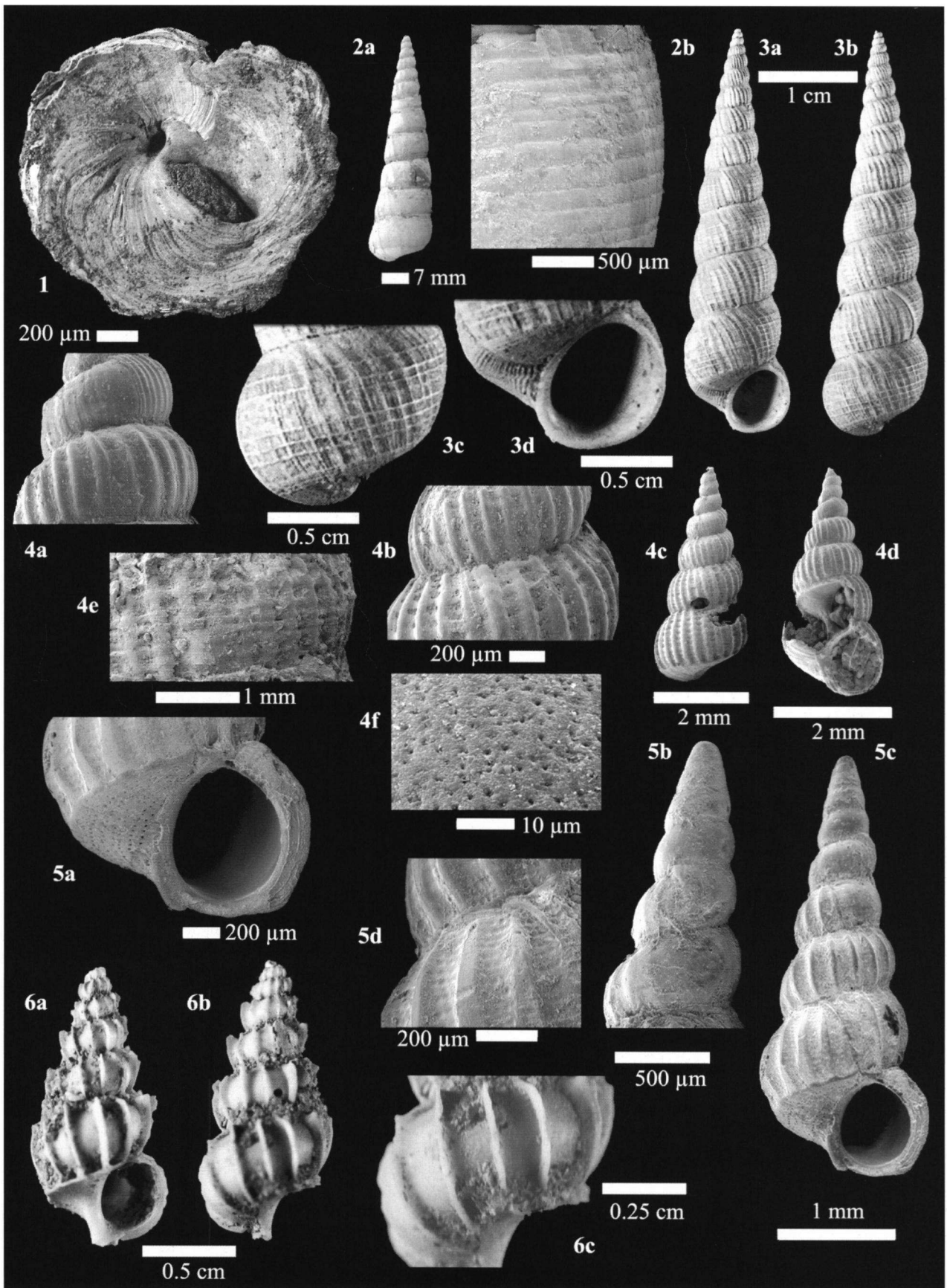


Figure 8.

Figure 7.

1. *Xenophora scaldensis* Glibert, 1958. d, e, f: Antwerp, junction Vijfde Havendok-Amerikadok. Luchtbal Sand Member. IRSNB IST 6967. a, b, c: Antwerp, junction Vijfde Havendok-Amerikadok. Kattendijk Formation. IRSNB IST 6968. g, h: Antwerp, Ring Highway exit Borgerhout. Derived Pliocene. IRSNB IST 6969.
2. *Retusa truncatula* (Bruguère, 1792). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6970.
3. *Polygyreulima glabella* (Wood, 1848). B1-B2 Kanaaldok, Antwerp. Luchtbal Sand Member. RGM 550 003.

Figure 8.

1. *Xenophora scaldensis* Glibert, 1958. Antwerp, Ring Highway exit Borgerhout. Derived Pliocene. IRSNB IST 6969.
2. *Acirsa (Hemiacirsa) penepolaris* (Wood, 1872). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6971.
3. *Amaea cancellata* (Brocchi, 1814). Deurganckdok, Doel. Oorderen Sand Member, *Cultellus* level. Coll. SM.
4. *Amaea woodi* (Deshayes, 1861). Deurganckdok, Doel. Luchtbal Sand Member. coll. IRSNB IST 6972.
5. *Opalia (Nodiscala) obtusicastrata* (Wood, 1848) Deurganckdok, Doel. Luchtbal Sand Member. Coll. BLP.
6. *Epitonium frondosum* (Sowerby, 1829). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6973.

In Belgium it is limited to the Luchtbal Sand Member, while the figured British records are from the Coralline Crag Formation. Harmer (1923, p. 768) also mentions records from the Red Crag Formation, but his identification has to be checked.

Superfamily Xenophoroidea Troschel, 1852
Family Xenophoridae Philippi, 1853
Genus *Xenophora* Fischer von Waldheim, 1807

***Xenophora scaldensis* Glibert, 1958**

Fig. 7/1 a-h, 8/1

- 1946 *Xenophora (Xenophora) cf. deshayesi* (Michelotti) - Beets, p. 46.
- 1958a *Xenophora deshayesi* Michelotti subsp. *scaldensis* Glibert, p. 24.
- 1997 *Xenophora scaldensis* Glibert - Marquet, p. 72, pl. 1, fig. 7.
- 1998b *Xenophora scaldensis* Glibert - Marquet, p. 80, text-fig.

Locus typicus — Province Antwerp, Belgium.

Stratum typicum — Luchtbal Sand Member, Early Pliocene.

Type material — Glibert (1958a) originally included in his *Xenophora deshayesi* Michelotti, sp. 1847 subsp. *scaldensis* only Pliocene material, from the Kattendijk Formation and the Luchtbal Sand Member, without designating a type. Glibert (1963, p. 24) tried to rectify this, but unfortunately chose a Miocene specimen as “holotype”: the specimen figured by Glibert (1952, pl. 5, figs 3a, b). This action is not conforming to the International Code of Zoological Nomenclature (ICZN). Any subsequent designated type specimen would be a lectotype. A lectotype can only be selected from a syntypical series and the Miocene material does not belong to this series. Therefore, a lectotype was chosen and its designation will be proposed to the ICZN. *Material* — IRSNB IST 6967 (leg. RM) Junction Vijfde Havendok-Amerikadok, Antwerp; Luchtbal Sand Member. IRSNB IST 6968 (leg. RM), Junction Vijfde Havendok-

Amerikadok, Antwerp; Kattendijk Formation, *Ditrupa-Glycymeris* bed. IRSNB IST 6969 (leg RM), Ring Highway near exit Borgerhout, Antwerp; derived mixed Pliocene beds. Coll RM: 3 fragments, Junction Vijfde Havendok-Amerikadok, Antwerp; Luchtbal Sand Member. Coll RM: 4 juvenile specimens, Deurganckdok, Doel; Luchtbal Sand Member. Coll. RM: 2 specimens, Junction Vijfde Havendok-Amerikadok, Antwerp; Kattendijk Formation, *Ditrupa-Glycymeris* bed. Coll. RM: 1 specimen, Ring Highway near exit Borgerhout, Antwerp; derived mixed Pliocene beds. Coll RM: 1 fragment, Kallo, Oorderen Sand Member, basal crag (probably derived). Coll NNM: 4 specimens, Antwerp dock works, level unknown, probably Luchtbal Sand Member. Coll IIRSNB: 20 specimens from the Kattendijk Formation and 18 specimens from the Luchtbal Sand Member of different localities.

Dimensions — 7/1 d-f: height 42.6 mm, width 58.6 mm; 7/1 a-c: height 39.9 mm, width 63.5 mm; 1g, h, 8/1: height 35.6 mm (incomplete), width 58.5 mm.

Diagnosis — Medium-sized *Xenophora* with an apical angle of about 80°, few attachments near the suture, ornament only consisting of very irregular axial ribs and shell base with curved growth lines, which become sinuous near the aperture.

Description — Shell triangular in cross section. Apical angle about 80°. Shell broader than high, height 62-72% of width. At least seven whorls are present, but the protoconch is lacking in all material studied. Suture very shallow, with short flange on last whorl. Whorls straight. Few attachments are present, mainly near the abapical suture. Sculpture only consisting of very strong, irregular prosocline plicae, which are more or less well developed and terminate occasionally before reaching a suture. Aperture small, ovate. Umbilicus wide, oval, bordered by the glossy columellar lip of the aperture. Basal sculpture consisting of dense irregular growth lines, which are rounded to slightly angular halfway and end in a sinuous curve near the aperture.

Discussion — Glibert (1963) supposed his “holotype” from Borgerhout (Antwerp) could originate from the Late Miocene Deurne Sand Member of the Diest Formation. This

Member yields only few gastropod species in Borgerhout, mostly Epitoniidae. The remaining molluscan fauna is especially rich in calcitic Pectinidae and Ostreidae, so it is very improbable that a complete aragonitic *Xenophora* would be found. Xenophoridae are only found as steinkerns at that locality in the “Sables à Héterocètes” sandstone, also belonging to the Diest Formation. The specimen figured by Glibert (1952) still contains black, glauconitic sediment, excluding the “Sables à Héterocètes” sandstone and the derived Pliocene crag above it as origin. It probably was found in the Antwerp Sand Member, as Glibert (1952) originally supposed. This Member contains two species of Xenophoridae, which clearly differ from *X. scaldensis* and were well-figured by Janssen (1984) from the Middle Miocene from Miste (The Netherlands). The first, *X. deshayesi* (Michelotti, 1847), becomes much larger than *X. scaldensis*, but remains relatively flatter and the area around the very narrow or closed umbilicus is convex. The second species, *X. burdigalensis* (de Grateloup, 1847) comes closer in size and shape to *X. scaldensis*, but its umbilicus is always closed by a callus. The growth lines on the base of the shell make an angle of nearly 90° at three quarters distance from the umbilicus; they gently curve in the Pliocene species. The “holotype” of *X. scaldensis* designated by Glibert (1963) probably belongs to this taxon.

Several other European Pliocene *Xenophora* species are known. The species occurring in the Italian Pliocene (Siena Basin) were reviewed by Manganelli *et al.* (2004). *Xenophora crispa* (König, 1825) from the Pliocene to Recent of the Mediterranean and adjacent Atlantic remains smaller, has more material attached on its shell, and has very distinct tubercles on the shell base and angular basal growth lines. *Xenophora infundibulum* (Brocchi, 1814) (Mediterranean Pliocene) has a completely closed umbilicus covered by callus, very few attachments, strong basal ornamentation and very distinct interrupted axial sculpture above the sharply protruding carina. *Xenophora plioitalica* (Sacco, 1896) (Mediterranean Pliocene) is broad and flat and resembles *Xenophora deshayesi* (Michelotti, 1847) very much in ornament; it could be a Pliocene descendant of the latter species. *Xenophora davolii* Manganelli, Spadini & Cianfanelli, 2004 is more than three times larger, it has strongly angular whorls with a sharply keeled peripheral flange and its umbilicus is closed.

Ponder (1983, p. 18) gave a diagnosis of *Xenophora*. Shell characters include: the narrow peripheral flange, which is simple and non porcellaneous ventrally, the umbilicus is moderate to closed and foreign objects are attached to all whorls and usually occupy more than one third of the dorsal surface. The Belgian Pliocene species concurs with all characters mentioned; only the extent of the attachment of foreign objects is rather variable, some of the specimens are covered for less than one third. This, however, is also the case in *Xenophora infundibulum* (Brocchi, 1814), which Ponder (1983) includes in the same genus.

Suborder Ptenoglossa Gray, 1853
Superfamily Jantinoidea Lamarck, 1810

Family Aclididae Sars, 1878
Genus *Aclis* Lovén, 1846

Aclis ascaris (Turton, 1822)

Fig. 9/1a-b

- 1842 *Alvania supra-nitida* Wood, p. 534.
1848 *Alvania ascaris* Turton - Wood, p. 99, pl. 12, fig. 11.
1914 *Aclis supranitida* Wood - Cerulli-Irelli, p. 243, pl. 21, figs 37-41.
1922 *Aclis supranitida* (Wood) - Harmer, p. 868, pl. 65, fig. 24.
1965 *Aclis minor* (Brown) - van Regteren Altena *et al.*, p. 21, pl. 8, fig. 77.
1983 *Aclis ascaris* (Turton) - Rolan Mosquera, p. 189, text-fig.
1988 *Aclis ascaris* (Turton) - Graham, p. 505, fig. 213.
1997c *Aclis ascaris* (Turton) - Marquet, p. 84, pl. 4, fig. 2.
1998b *Aclis ascaris* (Turton) - Marquet, p. 113, unnumbered text-fig.
1999 *Aclis ascaris* (Turton) - Giannuzzi-Savelli *et al.*, p. 58, figs 102-105.

Locus typicus — Great Britain.

Stratum typicum — Recent.

Material — IRSNB IST 6974 (leg. RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member. Coll. BR: 1 specimen, Kallo, Verrebroekdok, Kattendijk Formation, *Petalococonchus* bed.

Dimensions — Height 1.57 mm, width 0.715 mm.

Description — See Marquet (1997c, p. 84) and Marquet (1998b, p. 113). To these descriptions the following can be added. The protoconch/teleoconch boundary is delimited sharply by a strongly curved sinusoid, slightly prosocline, line, after which the teleoconch ornament develops instantaneously. The adult spirals are very narrow, only one-third the width of the intercostal spaces, but sharply delimited. The aperture is elongately ovate rather than rounded as in the fragmentary juvenile specimen figured by Marquet (1998b).

Occurrence — Until now the species had been found in Belgium only in the Oorderen Sand Member. Its range is extended to include the Luchtbal Sand Member and the Kattendijk Formation (*Petalococonchus* bed).

Family Epitoniidae Berry, 1910
Subfamily Epitoniinae Berry, 1910
Genus *Opalia* H. & A. Adams, 1853
Subgenus *Nodiscala* de Boury, 1889

Opalia (Nodiscala) obtusicostata (Wood, 1848)

Fig. 8/5a-d

- *1848 *Scalaria obtusicostata* Wood, p. 95, pl. 8, fig. 21.

- 1920 *Scala (Pliciscala) obtusicostata* (Wood) - Harmer, p. 554, pl. 68, figs 24-25.
1958a *Opalia (Pliciscala) obtusicostata* Wood - Glibert, p. 11, pl. 2, fig. 7.
1965 *Opalia (Pliciscala) obtusicostata* (Wood) - van Regteren Altena *et al.*, p. 19, pl. 7, fig. 68.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — Coll. BLP: 1 specimen, Deurganckdok, Luchtbal Sand Member.

Dimensions — Height 3.61 mm, width 1.41 mm.

Description — Elongate shell, consisting of more than 10 whorls. Suture deeply incised, whorls tumid. Height of multispiral protoconch 1.37 mm, consisting of about seven tumid, smooth whorls. The teleoconch ornament starts with an axial rib. On the body whorl, 16 strong, nearly orthocone axial ribs are present. They are about as broad as the intercostal spaces. Between the axial ribs, circa 15 very shallow spiral ribs are present, slightly broader than the intercostal spaces. The aperture is entire, nearly circular. Base of body whorl delimited by a carina, abapical of the axial and spiral ornament. Below this carina, 10 spiral rows of pits are present; above, no pits occur.

Occurrence — This species is extremely rare: only one specimen was found in the Luchtbal Sand Member of Doel. Its range also seems limited to this Member and to the British Coralline Crag Formation. The material, mentioned by van Regteren *et al.* (1965) from The Netherlands was collected *ex-situ* on beaches.

Genus *Amaea* H. & A. Adams, 1853

***Amaea woodi* (Deshayes, 1861)**

Fig. 8/4a-f

- 1848 *Scalaria cancellata* Brocchi - Wood, p. 95, pl. 8, fig. 22.
*1861 *Scalaria woodi* Deshayes, p. 339.
1920 *Scala (Clathroscala) woodi* Deshayes - Harmer, p. 552, pl. 48, figs 10-11.
1952 *Scala (Clathroscala) cancellata* Brocchi - van Der Burg, p. 51, pl. 3, fig. 2.
1958a *Amaea (Clathroscala) woodi* Deshayes - Glibert, p. 12.
1965 *Amaea (Clathroscala) woodi* (Deshayes) - van Regteren Altena *et al.*, p. 19, pl. 7, fig. 71.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6972 (leg. RM): 1 specimen, Deurganckdok, Luchtbal Sand Member. Coll. RM: 1 fr., same locality and Member.

Dimensions — Height 4.19 mm, width 1.78 mm.

Description — Medium-sized species, rather broad (H/W ratio 2.35), with tumid whorls and deep suture. Protoconch incomplete in our material, multispiral, with at least four tumid smooth whorls, which have a microsculpture of irregular pits. Their width increases slower than that of the teleoconch whorls. Ornament starting with closely packed axial ribs that become separated on subsequent whorls. On the second teleoconch whorl, spiral ribs appear between the axials. The axials remain distinct, about as broad as the intercostal spaces. They are nearly opisthocline, but turn prosocline near the abapical suture. On the body whorl of the figured specimen, 20 axials and about 20 much less distinct spirals are present. The shell base is not delimited by a keel. The shell is smooth except for growth lines. Aperture entire, nearly circular, but pointed adapically.

Discussion — This species clearly differs from "*Opalia obtusicostata* (Wood, 1848) by the presence of more axial ribs, the absence of a basal keel and from lines of pits on the base. The specimen figured is juvenile, a fragment collected attains a height of 13.7 mm. *Amaea cancellata* (Brocchi, 1814) also occurs in the North Sea Basin. It was mentioned by Harmer (1920) from the Coralline Crag Formation, but one almost perfect specimen has been found recently at Doel (Deurganckdok), Oorderen Sand Member, *Cultellus* level (coll. SM). This species differs from *A. woodi* (Deshayes, 1864) by its ornament: the axial ribs are finer and equal in strength to the spiral ribs, while the shell base is not smooth but covered by dense spiral ribs (Fig. 8/3a-d). *Amaea cancellata* is new for the Pliocene of Antwerp.

Occurrence — *Amaea woodi* (Deshayes, 1861) is very rare in the Luchtbal Sand Member of Doel and other localities in Belgium. One specimen was found by the authors (RM) in the Oorderen Sand Member of Doel. In Britain, it occurs in the Coralline Crag Formation, in The Netherlands it has been found in beach material.

Genus *Acirsa* Mörch, 1857

Subgenus *Hemiacirsa* de Boury, 1890

***Acirsa (Hemiacirsa) penepolaris* (Wood, 1872)**

Fig. 8/2a, b

- *1872 *Turritella ? penepolaris* Wood, p. 53, pl. 4, fig. 20.
1879 *Turritella (Mesalia) penepolaris* Wood - Wood, p. 26, pl. 2, fig. 14.
1920 *Scala (Plesioacirsa) chatwini* Harmer, p. 557, pl. 48, figs 38-39.
1958b *Acirsa (Plesioacirsa) penepolaris* Wood - Glibert, p. 10.

1997c *Acirsa (Hemiacirsa) aff. penepolaris* (Wood) - Marquet, p. 85, pl. 4, fig. 3.

1998b *Acirsa (Hemiacirsa) cf. penepolaris* (Wood) - Marquet, p. 116, unnumbered text fig.

Locus typicus — Orford, East Anglia, United Kingdom.

Stratum typicum — Corraline Crag Formation, Early Pliocene.

Material — IRSNB IST 6971 (leg. RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member. Coll. RM: 15 fr. and specimens, same locality and unit. Coll. AR: 1 specimen, Kallo, Vrasenedok, *ex-situ*.

Dimensions — Height 19.3 mm, width 4.8 mm.

Description — Elongate, very slender (H/W ratio > 4), with about 12 nearly flat-sided whorls separated by a shallow suture. Protoconch indistinguishable from teleoconch by wear in the material examined. Teleoconch ornament consisting of about 20 spiral ribs of unequal strength, but always much broader than the very narrow intercostal incisions. Shell base smooth. Aperture oval, pointed above, forming an angle between columellar and parietal lip.

Discussion — This species differs clearly from both aforementioned *Amaea* species by its narrow shell, low whorls, and especially by the absence of axial ornament. The specimen figured by Marquet (1997c, pl. 4, fig. 3) lacks these ribs due to wear.

Occurrence — The specimen mentioned in Marquet (1997) was collected *ex-situ*. *Acirsa penepolaris* is not very rare in the Luchtbal Sand Member of Doel; it also occurs in the Kattendijk Formation (Glibert, 1958a). In Britain it is found in the Coralline and Red Crag Formations.

Genus *Epitonium* Röding, 1798

***Epitonium frondosum* (Sowerby, 1829)**

Fig. 8/6a-c

- *1829 *Scalaria frondosa* Sowerby, p. 149, pl. DLXXVII, fig. 1.
- 1848 *Scalaria frondosa* Sowerby - Wood, p. 92, pl. 8, fig. 15.
- 1914 *Scala (Spiniscalia) frondosa* Sowerby - Cerulli-Irelli, p. 226, pl. 20, fig. 41.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6973 (leg. RM): 1 specimen, Deurganckdok, Luchtbal Sand Member. Coll. RM: 3 fr., same locality and Member.

Dimensions — Height 15.3 mm, width 6.7 mm.

Description — Shell with at least eight tumid whorls (no complete specimens available). Suture deep, shell relatively broad and rapidly increasing in width. Body whorl with 12 axial ribs. These are very sharp, nearly orthocline to slightly prosocline and they cover the whorls from suture to suture. The axials are thin and much narrower than the intercostal areas (less than a quarter). A sharp, detached spine is present at about one fifth of a whorl below the adapical suture. Aperture circular.

Discussion — The nature of this species has been poorly understood. Wood (1848) mentioned the presence of 9 to 10 axial ribs, but said also that too many (about 15) were drawn on his figure (pl. 8, fig. 15). *Scala (Lamelliscalia) frondosa* Sowerby as figured in Harmer (1920) is much broader than the real *Epitonium frondosum*, the ribs are strongly prosocline and it is clear that the specimens figured belong to *Epitonium foliaceum* instead. Harmer's (1920) *Scala (Nobiliscalia) belgica* (a synonym of *Epitonium foliaceum*), figured in pl. 48, fig. 26, is too much worn to allow unambiguous identification. It originates from Selsey, a locality yielding only Late Pleistocene fossils. Also the ribs of the specimen figured are too thick to belong to *Epitonium foliaceum*. So probably this specimen is wrongly identified, but its preservation is too poor to allow certain identification. *Epitonium f. frondiculum* (Wood, 1842) differs from *E. frondosum* in having more ribs (about 15), which are much broader (half of the intercostal spaces). The spines are less clearly detached and lie closer to the adapical suture. The whorls increase in width less rapidly than in *E. frondosum*. *Epitonium foliaceum* (Sowerby, 1825) has about eight ribs on the last whorl. These are markedly prosogyrate. The shell is relatively broader in relation to height than *E. frondosum*.

Occurrence — *Epitonium frondosum* is known with certainty only from the British Coralline Crag Formation and from the Luchtbal Sand Member of Belgium. Very similar specimens were figured by Cerulli-Irelli (1914) from the Early Pleistocene of Monte Mario, Rome, Italy, but no Pliocene material is known from the Mediterranean.

Superfamily Eulimoidea H. & A. Adams, 1853
 Family Eulimidae H. & A. Adams, 1853
 Genus *Polygireulima* Sacco, 1892

***Polygireulima glabella* (Wood, 1848)**

Fig. 7/3a-b

- *1848 *Eulima glabella*, Wood, p. 95, pl. 19, fig. 2.
- 1872 *Eulima glabella* Wood - Wood, p. 27, pl. 7, fig. 4.
- 1923 *Eulima glabella* Wood - Harmer, p. 844, pl. 64, fig. 27.
- 1969 *Melanella (Polygireulima) glabella* (Wood) - Janssen, p. 156, pl. 2, fig. 5, pl. 8, fig. 2.
- 1984 *Balcis (Polygireulima) glabella* (Wood) - Janssen, p.

178, pl. 51, fig. 8.

- 2001 *Melanella (Polygyreulima) glabella* (Wood, 1848) - Wienrich, p. 465, pl. 75, fig. 8, pl. 76, fig. 1.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — RGM 550 002 (leg. VDM): 2 specimens, BI-B2 Kanaaldok, Antwerp, Luchtbal Sand Member. RGM 550 003, 1 specimen, same locality and unit.

Dimensions — Fig. 7/3a: height 3.97 mm, width 1.20 mm; Fig. 7/3b: height 3.63 mm, width 1.36 mm.

Description — Small, elongate shell, consisting of about eight smooth whorls. Width about 35% of height, shell broadening towards the last whorl. Whorls very slightly tumid, especially abapically. The first three whorls are slightly obliquely oriented in respect with the shell's axis, subsequent whorls are straight. The suture is indistinct. The height of the body whorl is about one third the height of the entire shell. Apex blunt, protoconch indistinguishable. Aperture ovate, pointed above, with strong anal sinus and peripheral bulge. Columellar side markedly thickened.

Discussion — At least four other eulimid species occur in the Pliocene of Antwerp. *Eulima glabra* (Da Costa, 1778) is much narrower, larger, with a straight outer lip. *Melanella alba* (Da Costa, 1778) also is much larger, relatively broader, slightly carinate, with a less curved outer lip. *Vitreulima philippii* (Rayneval & Ponzi, 1854) is of the same size, but always very clearly curved and narrower (see variation as shown in Giannuzzi-Savelli *et al.*, 1999, figs 312-319). *Crinophteiros collinsi* (Sykes, 1903) is the closest resembling species, but the body whorl is relatively higher, the shell is broader (width about 40% of height) and the whorls are flatter. The Recent Atlantic-Mediterranean *Polygyreulima sinuosa* (Scacchi, 1836) has more whorls, a higher aperture and less tumid whorls (see Graham, 1988, fig. 227).

Occurrence — *Polygyreulima glabella* (Wood, 1848) is found from the Miocene onwards. Janssen (1969, 1984) and Wienrich (2001) mention its occurrence in the Dutch Miste Bed and the German Reinbek Stufe. It also occurs in the Antwerp Sand Member, Berchem Formation (coll. RM, unpublished). It has been found in the Coralline Crag Formation of East Anglia, U.K. This is the first record from the Pliocene of Belgium.

Order Neogastropoda Thiele, 1929
Superfamily Muricoidea Rafinesque, 1815
Family Coralliophilidae Chenu, 1859
Genus *Coralliophila* H. & A. Adams, 1853
Subgenus *Pseudomurex* Monterosato, 1872

***Coralliophila (Pseudomurex) bracteata* (Brocchi, 1814)**
Fig. 6/3a-c

- *1814 *Murex bracteatus* Brocchi, p. 409, pl. 9, fig. 3.
1904 *Murex (Pseudomurex) bracteatus* Brocchi - Sacco, p. 23, pl. 6, fig. 34.
1904 *M. bracteatus* var. *miopericarinata* Sacco - Sacco, p. 24, pl. 6, fig. 35.
1944 *Coralliophila (Pseudomurex) cf. bracteatus* (Brocchi) var. *miopericarinata* Sacco - van Voorthuyzen, p. 75, pl. 6, figs 17, 24-25.
1955 *Coralliophila (Pseudomurex) bracteata* (Brocchi) - Rossi Ronchetti, p. 192, fig. 101.
1964 *Coralliophila (Pseudomurex) bracteata* (Brocchi) - Anderson, p. 245, pl. 21, fig. 179.
1978 *Murex bracteatus* Brocchi - Pinna & Spezia, p. 145, pl. 30, fig. 1.
1984 *Coralliophila (Pseudomurex) bracteata* (Brocchi) - Janssen, p. 226, pl. 61, fig. 2.
1992 *Coralliophila bracteata* (Brocchi) - Cavallo & Repetto, p. 98, fig. 219.
1995 *Coralliophila (Pseudomurex) bracteata* (Brocchi) - Bałuk, p. 233, pl. 25, figs 6-7.
2000 *Coralliophila bracteata* (Brocchi) - Chirli, p. 48, pl. 19, figs. 5-8.
2001 *Coralliophila (Pseudomurex) bracteata* (Brocchi) - Wienrich, p. 473, pl. 77, fig. 8, pl. 94, figs. 4-5.

Locus typicus — "Piacentino", Italy.

Stratum typicum — Unnamed beds, Neogene.

Material — Coll. LC: 1 specimen, Antwerp, industrial area near Noorderlaan, dredged, presumably from the Luchtbal Sand Member.

Dimensions — Height 29.0 mm, width 15.5 mm.

Description — Medium-sized, muriciform, thick-shelled species. Suture deep, whorls tumid, with a subsutural platform. Protoconch not present in the studied specimen. Ornament consisting of spiral ribs, up to 25 primary ribs on body whorl, with a weaker secondary rib in between. Inter-costal spaces about as wide as primary ribs. On the spirals, numerous rectangular tubercles are present, which can develop into small scales. Siphonal canal short, open, with a narrow pseudumbilicus.

Discussion — This species is very variable in shape and size, but its ornament is always characteristic. No other species in the Luchtbal Sand Member shows any resemblance.

Occurrence — *Coralliophila bracteata* has hitherto not been recorded from the North Sea Basin Pliocene. It is rare in the Mediterranean Pliocene (Spain, France and Italy). The sole specimen at hand was found *ex-situ*, but the presence of typical Luchtbal Member Mollusca like *Pseudamussium gerardi* (Nyst, 1835) and of large numbers of *Ditrupa* sp. make a Luchtbal origin likely. In the North Sea Basin, the species is known from various Middle Miocene

localities, where it is present in small numbers. In Belgium, it is present in the Zonderschot Sand Member (Berchem Formation, coll. RM). It seems to lack in the French Atlantic 'Redonian' and 'Pontilévien', but occurs in the 'Badenian' deposits of Poland (Korytnica) and Paratethyan localities in Hungaria, Austria and Romania. This distribution seems to point to faunal exchange between the Paratethys and the North Sea Basin through Poland.

Family Nassariidae Iredale, 1916
Genus *Nassarius* Dumeril, 1806
Subgenus *Uzita* H. & A. Adams, 1853

***Nassarius (Uzita) spectabilis vandewouweri*
(Glibert, 1959)**

Fig. 6/5a-b

- 1878 *Nassa pygmaea* Lamarck - Nyst, pl. 2, fig. 8.
- 1881 *Nassa pygmaea* Lamarck - Nyst, p. 26.
- *1959a *Hinia (Uzita) vandewouweri* Glibert, p. 23, pl. 3, fig. 17.
- 1976 *Nassarius spectabilis vandewouweri* - Adam & Glibert, p. 43, pl. 2, fig. 5; pl. 6, figs 7-8.
- 1997 *Nassarius (Uzita) spectabilis vandewouweri* (Glibert) - Marquet, p. 98.
- 1998b *Nassarius (Uzita) spectabilis vandewouweri* (Glibert) - Marquet, p. 149, unnumbered text-fig.

Locus typicus — Austruweel, Antwerp, Belgium.

Stratum typicum — Luchtbal Sand Member, Lillo Formation, Early Pliocene.

Material — IRSNB IST 6966 (leg. RM): 1 specimen, Antwerp, industrial area near Noorderlaan, dredged, presumably from the Luchtbal Sand Member. Coll. RM: 4 specimens, same locality and Member. Coll. RM: 3 specimens; Doel, Deurganckdok; Luchtbal Sand Member. Coll. IRSNB IST 5005 (holotype).

Dimensions — Height 20.5 mm, width 11.3 mm.

Description — see Marquet (1997c, p. 98) and Marquet (1998, p. 149).

Discussion — The specimens figured here and in Marquet (1998) illustrate the variability of the species. The illustrated specimens have a stronger parietal tooth and the axial sculpture lies closer together than in the specimen figured by Marquet (1998). Typical for the species is however always the very small aperture, in relation to shell height.

Occurrence — The species is relatively more common in the Luchtbal Sand Member than in the Oorderen Sand Member, in which it has been found previously in Kallo.

***Nassarius (Uzita) reticosus* (Sowerby, 1815)**

Fig. 6/2a-b

- *1815 *Buccinum reticosum* Sowerby, p. 17, pl. 110, fig. 2.
- 1843 *Buccinum elongatum* Sowerby - Nyst, p. 572, pl. 45, figs 1-3.
- 1848 *Nassa reticososa* Sowerby - Wood, p. 33, pl. 3, fig. 10.
- 1878 *Nassa reticososa* Sowerby - Nyst, pl. 2, fig. 4.
- 1881 *Nassa reticososa* Sowerby - Nyst, p. 22.
- 1914 *Nassa (Uzita) reticososa* (Sowerby) - Harmer, p. 61, pl. 3, figs 4, 14-19.
- 1920 *Nassa (Uzita) reticososa* (Sowerby) - Harmer, p. 517, pl. 46, figs 1-7, 9-11.
- 1946 *Nassarius reticosus* (Sowerby) - Beets, p. 85.
- 1959a *Hinia (Uzita) reticososa* Sowerby - Glibert, p. 24.
- 1965 *Nassarius (? Hinia) reticosus* (Sowerby) - van Regteren Altena *et al.*, p. 33, pl. 14, fig. 135 (*pars*).
- 1976 *Nassarius reticosus* (Sowerby) - Adam & Glibert, p. 56, pl. 2, fig. 9; pl. 6, fig. 6.
- 1979 *Hinia reticososa* (Sowerby) - Geys & Marquet, p. 74, pl. 30, fig. 2.
- 1993 *Hinia reticososa* (Sowerby) - Marquet, p. 92.
- 1997c *Nassarius (Uzita) reticosus* (Sowerby) - Marquet, p. 98, pl. 12, fig. 5.
- 1998b *Nassarius (Uzita) reticosus* (Sowerby) - Marquet, p. 151, unnumbered text-fig.

Locus typicus — Holywell near Ipswich, East Anglia, United Kingdom.

Stratum typicum — Red Crag Formation, Late Pliocene.

Material — Coll. LC: 1 specimen, Antwerp, industrial area near Noorderlaan, dredged, presumably from the Luchtbal Sand Member. Coll. RM: 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member.

Dimensions — Height 29.0 mm, width 15.5 mm.

Description — See Marquet (1997c, p. 98), Marquet (1998b, p. 151). The specimen figured here belongs to the form *deformis*, also mentioned by Wood (1848, pl. 3, fig. 10f). It has five regularly coiled whorls, but the body whorl is oriented oblique in respect with the earlier whorls and is furthermore angular and flat-sided. The ornament fades on the body whorl; only growth lines and irregular plicae remain. The *deformis* form only represents intraspecific variation; it is not a separate taxon. Two incisions seem to mark repairs of the shell, possibly after attack by a crab. The specimen from Doel has the normal ornament for the species.

Occurrence — The *deformis* form is recorded here for the first time from Belgium. *Nassarius (Uzita) reticosus* (Sowerby, 1815) is very rare in the Luchtbal Sand Member. It is increasingly common in the Oorderen Sand Member, to become a dominant member of the molluscan fauna in the Kruisschans Sand Member. In the Merksem Sand Member it is rarer. Specimens from the Kattendijk Formation of this species referred to by Glibert (1959a) probably belong to a different, still unidentified species.

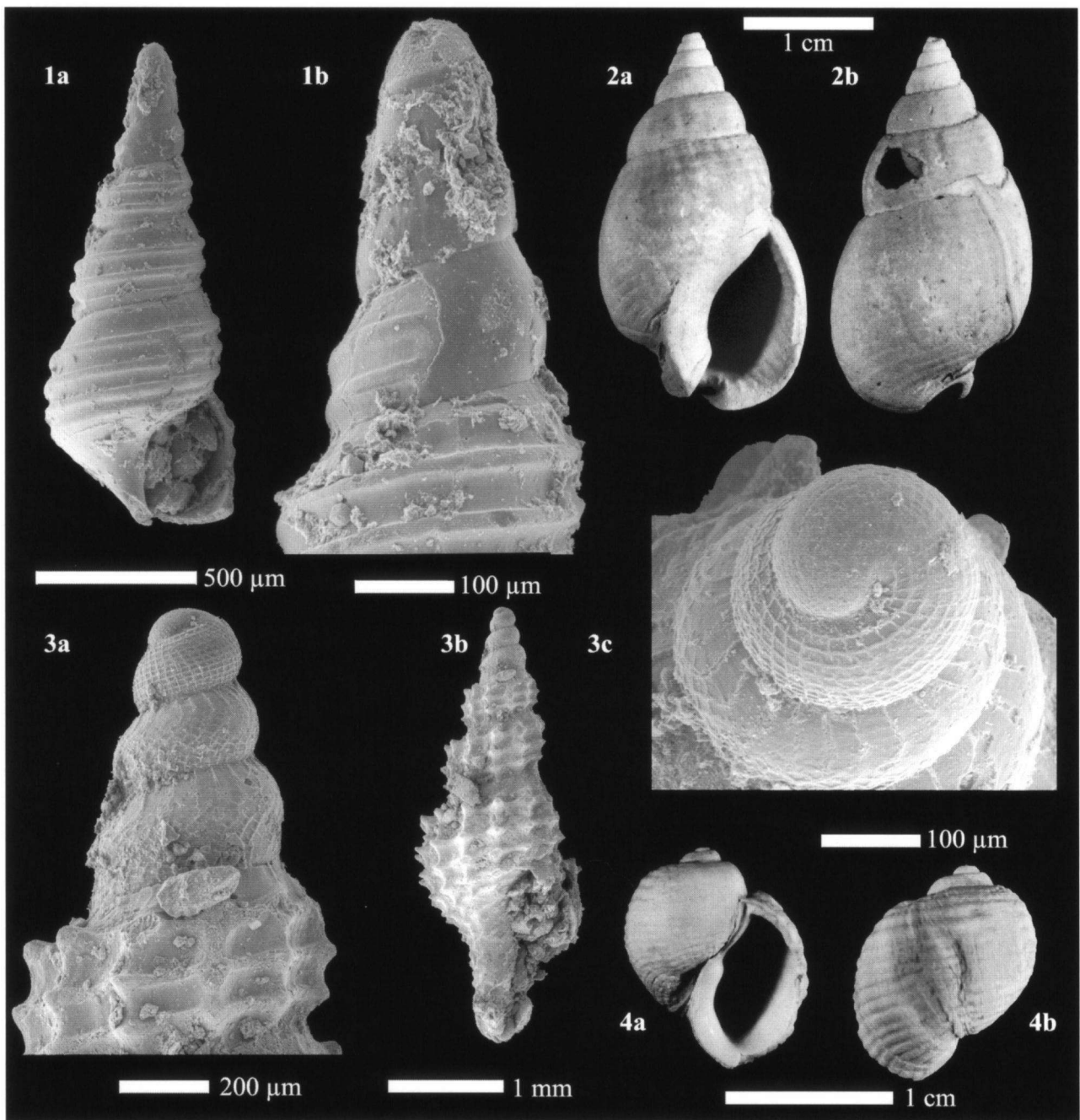


Figure 9.

1. *Aclis ascaris* (Turton, 1819). Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6974.
2. *Amyclina* sp. Antwerp, Noorderlaan, dredged material. Luchtbal Sand Member? IRSNB IST 6975.
3. *Raphitoma* (*R.*) *antonjansei* Marquet, 1998. Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6976.
4. *Phasianema sulcatum* Wood, 1842. Antwerp, Noorderlaan, dredged material. Luchtbal Sand Member? IRSNB IST 6977

Wood (1848) mentioned *N. reticosus* was very common in the Red Crag Formation, whilst Harmer (1920, p. 517) recorded it as rare in the stratigraphically older Coralline Crag Formation.

Genus *Amyclina* Iredale, 1916

***Amyclina* sp.**
Fig. 9/2a-b

Material — IRSNB IST 6975 (leg. RM): 1 specimen, Antwerp, industrial area near Noorderlaan, dredged, presumably from the Luchtbal Sand Member.

Dimensions — Height 17.5 mm, width 9.2 mm.

Description — This is a medium-sized, fusiform, thick-shelled nassariid, relatively broad, with slightly tumid whorls and shallow suture, consisting of about seven whorls. H/W ratio circa 0.47. Greatest width slightly below adapical end of aperture. The ornament is very weak, consisting of eight spiral ribs, which are much broader than the intercostal spaces. They are rather irregular and distinct only at the ad- and abapical parts of the body whorl, the area in between is nearly smooth. The most adapical spiral is more deeply incised, resulting in a slight subsutural depression. Axial ornament is only seen on the apertural side of the shell; it consists of about seven broad ribs, distinct near the adapical suture, forming tubercles when crossing the spiral ornament; the axials fade towards the shell base. The H of the aperture is about half the H of the shell. The distinct outer lip is thickened, and a narrow inner lip callus is developed. A varix is present on each whorl. Fifteen plicae are present in the outer lip. The ad- and abapical plicae are most distinct. The second most abapical plica is stronger developed as a blunt tooth, the adapical-most is smaller and lies deeper in the shell. Siphonal canal very short. The protoconch is not preserved in the only specimen at hand.

Discussion — This species could be new, but the uncertainty of its stratigraphic origin as well as the single specimen available preclude a description. A similar species was figured by Brébion (1964, pl. 10, figs 34-39) as *Amyclina* cf. *lambertiei* Peyrot, 1926 from the 'Redonian' of Brittany, France. The original illustrations of the latter species (Peyrot, 1926, pl. 3, figs 84-86) from the 'Sallomacian' of the Aquitaine Basin (France) shows a shell with less tumid whorls, shallower suture, stronger, more regular spiral ornament and a relatively broader callus. There is also a slight resemblance to very worn specimens of *Nassarius (Telasco) lamellilabrus* (Nyst, 1835) (see Marquet, 1997c, pl. 7, fig. 10), which has a relatively higher aperture, a narrower shell and less tumid whorls.

Family Conidae Fleming, 1822
 Subfamily Daphnellinae Deshayes, 1863
 Genus *Raphitoma* Bellardi, 1847
 Subgenus *Raphitoma* Bellardi, 1847

***Raphitoma (Raphitoma) antonjanssei* Marquet, 1998 nom. emmend.**

Fig. 9/3a-c

- 1872 *Pleurotoma hystrix* Jan - Wood, p. 41, pl. 6, fig. 3.
- 1878 *Pleurotoma hystrix*, Jan - Nyst, pl. 3, fig. 13.
- 1881 *Pleurotoma hystrix*, Jan - Nyst, p. 46.
- 1915 *Clathurella hystrix* (Jan) - Harmer, p. 240, pl. 28, figs 24-25.
- 1946 *Raphitoma hystrix* (Jan) - Beets, p. 107.
- 1960 *Raphitoma hystrix* (Jan) - Glibert, p. 17, pl. 4, fig. 18.
- 1965 *Raphitoma hystrix* (Cristofori & Jan) - van Regteren

Altena *et al.*, p. 42, pl. 18, fig. 171.

*1998a *Raphitoma (Raphitoma) antonjanssei* Marquet, p. 274, pl. 3, fig. 1.

1998b *Raphitoma (Raphitoma) antonjanssei* Marquet - Marquet, p. 181, unnumbered text-fig.

Locus typicus — B2 Havendok, Antwerp, Belgium.

Stratum typicum — Luchtbal Sand Member, Early Pliocene.

Material — IRSNB IST 6976 (leg. RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member. IRSNB IST 6313 (holotype), IST 4378 (paratype), Antwerp, "Scaldisien"; IRSNB: for further material see Marquet 1998a, p. 275, table 15.

Dimensions — Height 3.99 mm, width 1.57 mm.

Description — See Marquet (1998a, p. 274) and Marquet (1998b, p. 181). The protoconch of the juvenile specimen figured in Fig. 9/3 is better preserved than the protoconch of the holotype. The nucleus consists of half a whorl, with weak, mainly spiral sculpture. The subsequent two and a quarter protoconch whorls have eleven strong spiral riblets, crossed by irregular axials. The remaining protoconch whorls also show a spiral ornament, but with predominant adapical axial ribs, while the rest of the whorl is covered by irregular prosocline and opisthocline threads.

Discussion — The name *antonjanssenei*, which was given originally to this species, is incorrect, because it is derived from Janse; therefore, it has to be changed into *antonjanssei*. The protoconch is multispiral, clearly different from that of *Raphitoma hystrix* (de Christofori & Jan, 1832).

Distribution — This seems to be an endemic North Sea Basin Pliocene species, found in the Kattendijk Formation and in the Luchtbal, Oorderen and Kruisschans Members of the Lillo Formation. Specimens from the British Craggs with intact protoconch have not been found, so their identification remains uncertain.

Subclass Heterobranchia Gray, 1840
 Order Heterostropha Fischer, 1885
 Superfamily Pyramidelloidea Gray, 1840
 Family Amathinidae Ponder, 1988
 Genus *Phasianema* Wood, 1842

***Phasianema sulcatum* Wood, 1842**

Fig. 9/4a-b

- *1842 *Phasianema sulcata* Wood, p. 535, pl. 5, fig. 15.
- 1848 *Fossarus sulcatus* Wood var. *lineolatus* - Wood, p. 121, pl. 8, fig. 23a, b, aa.
- 1878 *Fossarus sulcatus* Wood - Nyst, pl. 6, fig. 20.
- 1881 *Fossarus sulcatus* Wood var. β *lineolatus* - Nyst, p. 91.

- 1921 *Fossarus sulcatus* (Wood) - Harmer, p. 670, pl. 53, fig. 35.
1956 *Phasianema sulcata* Wood - van Regteren Altena, p. 64.
1958a *Phasianema sulcatum* Wood - Glibert, p. 17, pl. 2, fig. 12.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6977 (leg. RM): 1 specimen, Antwerp, industrial area near Noorderlaan, dredged, presumably from the Luchtbal Sand Member.

Dimensions — Height 11.3 mm, width 9.0 mm.

Description — Medium-sized shell of about four whorls. Protoconch heterostrophic and submerged, tonnoid-shaped, broad, with very low spire. The H of the body whorl is about 94% of H of the shell. Suture deep, whorls strongly inflated. Ornament consisting of 16 very broad, irregular spiral ribs, which are much broader than the shallow intercostal spaces. Umbilicus narrow, but open. Aperture high, oval, with a distinct columellar callus. Near the adapical end of this callus, a blunt parietal tooth occurs.

Discussion — The specimen figured here has a distinctly lower spire than those figured by Glibert (1958a), Wood (1848) and Harmer (1921). However, the shape and number of axial ribs is the same, and it is possible that previous illustrations represented juvenile shells. It differs clearly from *Phasianema zelandica* (Bloklander, 1949), figured by Marquet (1997c, p. 110, pl. 10, fig. 7), by its fewer and broader ribs and by its higher aperture, which is more regularly oval. *Phasianema zelandica* has been found in Kallo only in the Oorderen Sand Member, but according to Glibert (1958a) it should be present in the Kattendijk Formation and in the Luchtbal Sand Member as well. *Phasianema woodi* van Regteren Altena, 1956, which has been found only in the British Coralline Crag Formation, has even less spiral ribs (8 to 10).

Occurrence — *Phasianema sulcatum* Wood, 1842, is known only from the North Sea Basin. It has been found in the British Coralline Crag Formation and in the Kattendijk Formation and the Luchtbal Sand Member in Belgium.

Subclass Opisthobranchia Milne-Edwards, 1848
Order Cephalaspidea Fischer, 1883
Superfamily Retusoidea Thiele, 1931
Family Retusidae Thiele, 1931
Genus *Retusa* Brown, 1827

***Retusa truncatula* (Bruguière, 1792)**
Fig. 7/2a-c

- *1792 *Bulla truncatula* Bruguière, p. 377.
1836 *Bulla truncatula* Bruguière - Philippi, p. 122, pl. 7, fig. 21.
1844 *Bulla truncatula* Bruguière - Philippi, p. 96.
1848 *Bulla truncata* Adams - Wood, p. 176, pl. 31, fig. 3.
1856 *Bulla truncata* Adams - Hörnes, p. 621, pl. 50, fig. 5.
1897 *Retusa truncatula* - Sacco, p. 40, pl. 3, figs 78-79.
1910 *Tornatina (Retusa) truncatula* (Bruguière) - Cerulli-Irelli, p. 34, pl. 3, figs 69-72.
1923 *Utriculus truncatulus* (Bruguière) - Harmer, p. 794, p. 63, fig. 1.
1933 *Tornatina (Retusa) truncatula* Bruguière - Peyrot, p. 209, pl. 12, figs 52-53.
1928 *Tornatina truncatula* Bruguière - Friedberg, p. 544, pl. 36, figs 1-2.
1952 *Retusa (Retusa) truncatula* Bruguière - Glibert, p. 393.
1960 *Retusa (Retusa) truncatula* Bruguière - Glibert, p. 393, pl. 15, fig. 3.
1962 *Retusa* (s.s.) *truncatula* Bruguière - Glibert, p. 54.
1966 *Retusa truncatula* Bruguière - Strausz, p. 474, pl. 74, figs 27-29.
1988 *Retusa truncatula* (Bruguière) - Thompson, p. 34, fig. 8.
1990 *Retusa truncatula* (Bruguière) - Poppe & Goto, p. 194, pl. 37, fig. 5.
1992 *Retusa truncatula* (Bruguière) - Cavallo & Repetto, p. 166, fig. 474.
1993 *Retusa (Retusa) truncatula* (Bruguière) - Da Silva, p. 276.
2005 *Retusa* cf. *truncatula* (Bruguière) - Vandenberghe *et al.*, p. 30.

Locus typicus — Europe.

Stratum typicum — Recent.

Material — IRSNBIST 6970 (leg RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member.

Dimensions — Height 2.52 mm, width 1.2 mm.

Description — Small, involute shell. The protoconch is involute. Teleoconch consisting of about four whorls that are flat-sided, with a slight central constriction. The top of the shell is flat or slightly concave. The outer lip extends above the top plane. The aperture is very narrow adapically, broadening in the abapical third of the shell. Ornament, including growth lines, are absent.

Discussion — This species differs from the *Cylichnina* species found in the Pliocene of Belgium by its flat-sided, nearly tubular shell and by the outer lip that extends above the apex. Furthermore, the shell is smooth. Only a single whorl is visible on adult *Cylichna cylindracea* (Pennant, 1777) specimens. Furthermore, that species is much larger and shows clear microsculpture.

Occurrence — *Retusa truncatula* has not been found in Doel or Kallo previously. The species is known at least from the Middle Miocene to Recent in the Atlantic,

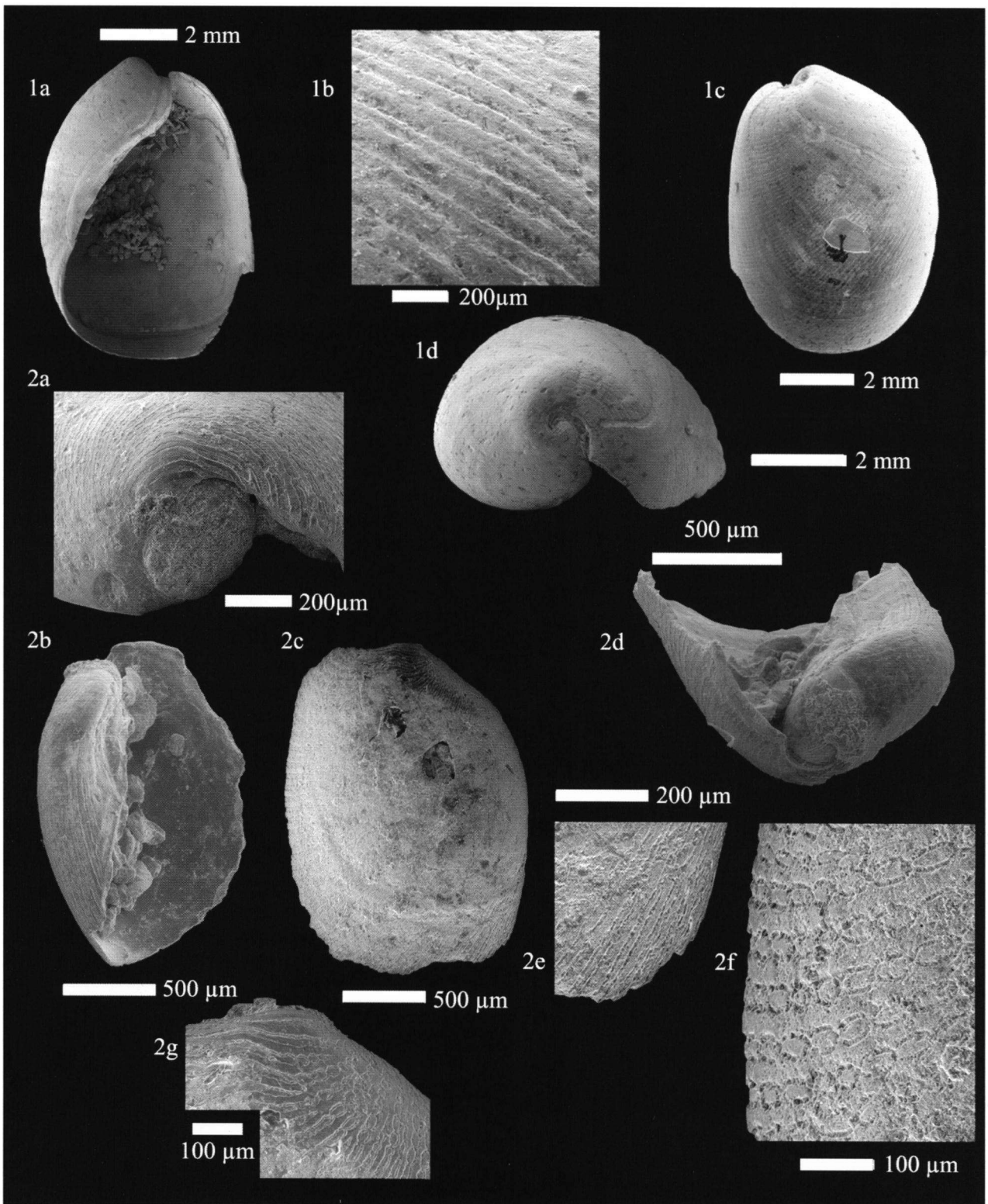


Figure 10.

1. *Philine quadrata* Wood, 1839. Deurganckdok, Doel. Luchtbal Sand Member. IRSNB IST 6978.

2. *Philine intricata* Monterosato, 1884. B1-B2 Kanaaldok, Antwerp. Luchtbal Sand Member. RGM 550 005.

the Mediterranean and the Paratethys, but North Sea Basin records start only in the Pliocene. In Belgium it has been found in Miocene Campine boring material, considered as belonging to the "Breda Formation" (Vandenberghe *et al.* 2005). The species has been reported from depths between 0 to 200 m, between Norway in the north to the Canary Islands and the Mediterranean in the south and southeast.

Superfamily Philinoidea Gray, 1850
Family Philinidae Gray, 1850
Genus *Philine* Ascanius, 1772

Philine quadrata (Wood, 1839)

Fig. 10/1a-d

- *1839 *Bullaea quadrata* Wood, p. 461, pl. 7, fig. 1.
- 1848 *Bullaea quadrata* Wood - Wood, p. 179, pl. 21, fig. 9.
- 1952 *Philine quadrata* (Wood) - van der Burg, p. 52, pl. 3, fig. 11.
- 1960 *Philine quadrata* Wood - Glibert, p. 25, pl. 4, fig. 30.
- 1988 *Philine quadrata* (Wood) - Thompson, p. 64, fig. 23.
- 1995 *Philine quadrata* (Wood) - van der Linden, p. 75, figs 18, 22-23.
- 1997c *Philine quadrata* (Wood) - Marquet, p. 115.
- 1998b *Philine quadrata* (Wood) - Marquet, p. 217.

Locus typicus — Sutton, East Anglia, United Kingdom.

Stratum typicum — Coralline Crag Formation, Early Pliocene.

Material — IRSNB IST 6978 (leg RM): 1 specimen, Doel, Deurganckdok, Luchtbal Sand Member.

Dimensions — Height 8.13 mm, width 6.65 mm.

Description — See Marquet (1997c, p. 115).

Discussion — This is the first nearly complete specimen from Doel, although its ornament is somewhat eroded. Usually, the spiral lines are composed of chain-like rows of round impressions but in the material studied here they are reduced to simple spirals, with occasional remnants of the impressions.

Occurrence — Rare in the Kattendijk Formation and the Luchtbal Sand Member of Antwerp; Coralline Crag Formation in Britain. Recent distribution see Marquet (1997c, p. 115).

Philine intricata Monterosato, 1884

Fig. 10/2a-g

- *1884 *Philine intricata* Monterosato, p. 47.
- 1897 *Philine desmotis* Watson, p. 237, fig. 5.
- 1905 *Philine intricata* Monterosato - Sykes, p. 332, fig.

1994 *Philine intricata* Monterosato - van der Linden, p. 41, figs 1-6.

1995 *Philine intricata* Monterosato - van der Linden, p. 73.

Locus typicus — Palermo, Sicily, Italy; 60-90 m depth.

Stratum typicum — Recent.

Material — RGM 550 004 (leg. VDM): 2 specimens, BI-B2 Kanaaldok, Antwerp, Luchtbal Sand Member. RGM 550 005, 1 specimen, same locality and unit.

Dimensions — Fig. 10/2b: H 1.82 mm, W 1.34 mm; fig. 10/2a, c-g: H 2.06 mm, W 1.54 mm.

Description — Tiny, very fragile, involute rhomboidal shell, slightly rounded above, basal side nearly straight, consisting of one whorl. On the umbo, a narrow ridge is present, separating an oval, smooth part from the remainder of the shell. Aperture very large, narrowing near the umbo. Ornament consisting of about 50 spiral grooves. These consist of elongate hexagonal impressions in the central part of the shell; near the shell base, the incisions become narrower and the hexagonal pattern is lost. Near the umbo the ornament becomes much more pronounced, sinuous and the hexagons are only visible on part of the incisions.

Discussion — Four other species of Philinidae occur in the Pliocene of Antwerp. *Philine scabra* (Müller, 1776) is much larger than *P. intricata* and has an elongate shape. *Philine ventrosa* (Wood, 1839) is of comparable size, but has a rugose reticulate ornament. *Philine denticulata* (Adams, 1800) is smooth, devoid of surface sculpture. *Philine quadrata* (Wood, 1839) is larger, its shape is subquadrate and it has about 90 rows of circular pits.

Occurrence — This species has been found as a fossil only in the Pliocene Luchtbal Sand Member of Antwerp as earlier mentioned by van der Linden (1995). Today, it has a southern distribution: the Mediterranean, the Atlantic from Brittany, France to Cape Verde, the Azores, Madeira and the Canary Islands.

Discussion and conclusions

The gastropod fauna of the Luchtbal Sand Member contains at least 157 species (Table 1). The status of 5 species (*Capulus hungaricus* (Linnaeus, 1758), *Capulus unguis* (Sowerby, 1816), *Scalaspira alveolata* (Sowerby, 1829), *Nucella incrassata* (Sowerby, 1825) and *Spinucella tetragona* (Sowerby, 1823)) recorded from the Luchtbal member is uncertain: The Luchtbal Sand Member, Kattendijk Formation and Oorderen Sand Member share 49 species. The Luchtbal Sand Member shares a further 44 species with the Oorderen Sand Member and 31 with the Kattendijk Formation. Twenty-eight species have been found only in the Luchtbal Sand Member. The exact distribution

of 4 species is uncertain. Most of the 28 species, characteristic of the Luchtbal Sand Member, also occur in the British Coralline Crag Formation.

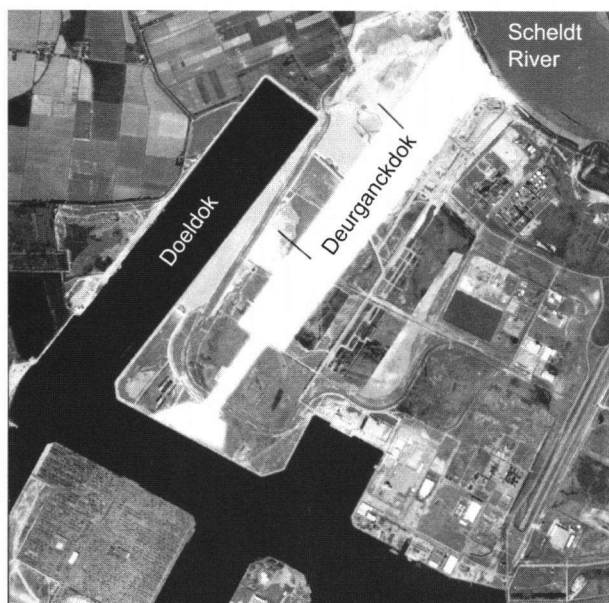


Figure 11. Location of the Luchtbal Sand Member exposure on an aerial photograph of the Deurganckdok, Doel.

The entire mollusc fauna of the Luchtbal Sand Member includes at least 277 species: 157 gastropod, 117 bivalve, 1 amphineuran and 2 scaphopod species (Table 2). There is a large difference in species longevity amongst the bivalves and gastropods: 51% of bivalve species found in the Luchtbal Sand Member are extant, whilst only 29% of the gastropods occur today. As a result, the bivalve assemblage is more useful for actualistic reconstruction of Pliocene environments including depth. The bathymetry of the Luchtbal Sand Member deposit was estimated at 35–45 m by Marquet (2004). The number of extant Gastropoda with known bathymetric range is too small to add further information.

The longevity of the bivalve species (mean 10.7 Ma: Marquet, 2004), however, makes them less useful stratigraphically than gastropod species, which survive for an average of 1.0 Ma. However, the limited geographic range of most species reduces their usefulness; 46% of the Gastropoda and 27% of the Bivalvia are endemic to the North Sea Basin. Consequently, they can only be used for intra-basinal correlations. The limited species duration of gastropods appears to be correlated with a shift towards a benthic larval life-cycle as represented in a diminished number of protoconch whorls.

Acknowledgements

We are greatly indebted to the “Ministerie van de Vlaamse Gemeenschap, Afdeling Zeeschelde” and the staff members of the T.V. Deurganckdok for their permission to work at

Doel. A. Dhondt, J. Van Goethem and K. Wouters allowed us to use the resources of the “Institut royal des Sciences naturelles de Belgique”, especially of its collections and SEM. F. Wesselingh allowed us to study the NNM Naturalis collection. The photography is the work of J. Cilis (SEM, IRSNB), M. Wagenaar and M. Grigis. The authors thank L. Ceulemans, M. Grigis, S. Mermuys and G. Roest for their help in the field and for use of their collections. We are especially grateful to F. Wesselingh and R. Janssen who commented critically on the text.

References

- Aartsen, J.J. van, Menkhorst, H.P.M. & Gittenberger, E. 1983. The marine Mollusca of the Bay of Algeiras, Spain, with general notes on *Mitrella*, Marginellidae and Turridae. *Basteria*, Supplement 2: 1-135.
- Adam, W. & Glibert, M. 1976. Observations sur le “groupe” de *Nassarius clathratus* (Born, 1778) (Mollusca, Prosobranchia). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie*, 51: 1-69.
- Anderson, H.-J. 1964. Die Miocene Reinbek-Stufe in Nord- und Westdeutschland und ihre Mollusken-Fauna. *Fortschritte in der Geologie von Rheinland und Westfalen*, 14: 31-368.
- Bahuk, W. 1975. Lower Tortonian Gastropods from Korytnica, Poland. Part I. *Palaeontologia Polonica*, 32: 1-186.
- Bahuk, W. 1995. Middle Miocene (Badenian) gastropods from Korytnica, Poland. Part II. *Acta Geologica Polonica*, 45: 153-255.
- Beets, C. 1946. The Pliocene and lower Pleistocene Gastropods in the collections of the Geological Foundation in the Netherlands (with some remarks on other Dutch collections). *Mededeelingen van de Geologische Stichting, C, IV*, 1, 6: 1-66.
- Bell, A. 1870. On some new or little-known Shells of the Crag Formations. *Annals and Magazine of Natural History*, 4: 213-217.
- Bell, A. 1898. On the Pliocene shell-beds at St. Erth. *Transactions of the Geological Society of Cornwall*, 12: 111-166.
- Beu, A.G. 2004. Marine Mollusca of the oxygen isotope stages of the last 2 million years in New Zealand. Part 1: Revised generic positions and recognition of warm-water and cool-water migrants. *Journal of the Royal Society of New Zealand*, 34: 111-265.
- Brébion, P. 1964. Les Gastéropodes du Rédonien et leur signification. Paris. 775 pp. (unpublished PhD thesis).
- Brocchi, G. 1814. *Conchiologia fossile subapennina con osservazione geologiche sugli Apennini & sul suolo adiacente. Tomo Secondo*. 712 pp. Stamperia Reale, Milano.
- Bruguière, J.G. 1792. *Encyclopédie méthodique ou par ordre des matières. Histoire naturelle des vers, des mollusques*. 2. Panckoecke, Paris, pp. 345-758.
- Burg, W.J., van der 1952. Over enige tot nu toe uit het middenplioceen van Nederland onbekende molluskensoorten. *Basteria*, 16: 49-64.
- Cavallo, O. & Repetto, G. 1992. Conchiglie Fossili del Roero. Atlante Iconografico. *Memorie dell'Associazione Naturalistica Piemontese*, 2: 1-251.
- Cerulli-Irelli, S. 1910. Fauna malacologica mariana. Parte 4. *Paleontographia Italica. Memorie di paleontologia*, 16: 23-70.
- Cerulli-Irelli, S. 1914. Fauna malacologica mariana. Parte 6. *Paleontographia Italica. Memorie di paleontologia* 18: 141-

- 170.
- Cerulli-Irelli, S. 1916. Fauna malacologica mariana. Parte 8. *Paleontographia Italica. Memorie di paleontologia*, 22: 71-220.
- Chirli, C. 2000. *Malacofauna Pliocenica Toscana; vol. 2; Superfamiglia Muricoidea*. C. Chirli, Firenze, 142 pp.
- Cossmann, M. & Peyrot, A. 1916. Conchologie néogénique de l'Aquitaine. *Actes de la Société Linnéenne de Bordeaux*, 69: 157-365.
- Costa, O.G. 1829. *Catalogo sistematico e ragionato dei testacei delle Due Sicilie. Tipografia della Minerva*, Napoli, 8+ 132 pp.
- Defrance, J.L.M. 1804-1845. Dictionnaire des Sciences naturelles dans lequel on traite méthodiquement les différentes êtres de la nature. Paris, 61 volumes.
- Deshayes, G.P. 1861. *Description des animaux sans vertèbres découverts dans le bassin de Paris pour servir de supplément à la description des coquilles fossiles des environs de Paris comprenant une revue générale de toutes les espèces actuellement connues. Tome Deuxième*. Baillière, Paris. Pp. 1-432.
- Eichwald, E. 1853. *Lethaea Rossica ou Paléontologie de la Russie. Dernière période*. Schweizerbart, Stuttgart: 533 pp.
- Fekih, M. 1975. Paléocologie du Pliocène marin au Nord de la Tunisie. *Annales des Mines et de Géologie*, 27: 1-195.
- Friedberg, W. 1928. *Mollusca miocenica Poloniae. Pars I (Gastropoda et Scaphopoda)*. Museum Imienica Dzieduszyckich 5: 441-361.
- Geys, J. & Marquet, R. 1979. Veldatlas van de Cenozoische fossielen van België. Deel 1. Neogeen. *Publicatie van de Belgische Vereniging voor Paleontologie*, 2: 1-123.
- Giannuzzi-Savelli, R., Pusateri, F., Palmeri, A. & Ebreo, C. 1994. *Atlante delle conchiglie marine del Mediterraneo. Vol. I (Archaeogastropoda)*. La Conchiglia, Rome. 125 pp.
- Giannuzzi-Savelli, R., Pusateri, F., Palmeri, A. & Ebreo, C. 1999. *Atlante delle conchiglie marine del Mediterraneo. Vol. III. Evolver*, Rome. 128 pp.
- Glibert, M. 1949. Gastropodes du Miocène moyen du Bassin de la Loire. Première Partie. *Institut royal des Sciences naturelles de Belgique. Memoires*, 2 série, 30: 1-240.
- Glibert, M. 1952. Gastropodes du Miocène moyen du Bassin de la Loire. Deuxième Partie. *Institut royal des Sciences naturelles de Belgique. Memoires*, 2 série, 46: 1-450.
- Glibert, M. 1957a. Pélécypodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Première note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 33: 1-40.
- Glibert, M. 1957b. Gastropodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Première note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 33: 1-27.
- Glibert, M. 1957c. Pélécypodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Deuxième note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 33: 1-28.
- Glibert, M. 1958a. Gastropodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Deuxième note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 34: 1-36.
- Glibert, M. 1958b. Tableau stratigraphique des mollusques du Néogène de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 34: 1-19.
- Glibert, M. 1958c. Pélécypodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Troisième note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 34: 1-27.
- Glibert, M. 1959a. Gastropodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Troisième note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 35: 1-36.
- Glibert, M. 1959b. Pélécypodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Quatrième note (Fin). *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 35: 1-24.
- Glibert, M. 1960. Gastropodes du Diestien, du Scaldisien et du Merxemien de la Belgique. Quatrième note. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 36: 1-44.
- Glibert, M. 1962. Les Euthyneura et Pulmonata fossiles du Cénozoïque étranger des collections de l'Institut royal des Sciences naturelles de Belgique. *Institut royal des Sciences naturelles de Belgique. Memoires*, 2 série, 70: 1-140.
- Glibert, M. 1963. Les Mesogastropoda fossiles du Cénozoïque étranger des collections de l'Institut royal des Sciences naturelles de Belgique. Deuxième partie. *Fossariidae à Ficiidae (inclus)*. *Institut royal des Sciences naturelles de Belgique. Memoires*, 2 série, 73: 1-154.
- González-Delgado, J.A. 1985. Estudio sistemático de los Gasterópodos del Plioceno de Huelva (SW de España). I: Archaeogastropoda. *Studia Geologica Salamanticensia*, 20: 45-77.
- Graham, A. 1988. Molluscs: prosobranch and pyramidellid gastropods: keys and notes for the identification of the species. Synopses of the British Fauna (n.s.), 2e ed. *The Linnean Society of London & The Estuarine and Brackish-Water Sciences Association, E.J. Brill/Dr. W. Backhuys*, Leiden. 662 pp.
- Granata, J. Grillo 1877. *Description de quelques espèces nouvelles ou peu connues*. S. Marchese, Napoli. 15 pp.
- Gregorio, A. de 1889. Esame di taluni Molluschi vivente e terziari del Bacino Mediterraneo. *Naturalista Siciliano*, 8: 275-292.
- Harmer, F.W. 1914-1918. *The Pliocene mollusca of Great Britain, being supplementary to S.V. Wood's Monograph of the Crag Mollusca*. Volume I. Monographs of the Palaeontographical Society, London. Pp. 1-200 (1914), pp. 201-302 (1915), pp. 303-461 (1918).
- Harmer, F.W. 1920-1925. The Pliocene mollusca of Great Britain, being supplementary to S.V. Wood's Monograph of the Crag Mollusca. Volume II. Monographs of the Palaeontographical Society, London. Pp. 485-652 (1920), pp. 653-704 (1921), pp. 705-856 (1923), pp. 857-900 (1925).
- Heinzelin, J. de 1950a. Stratigraphie pliocène et Quaternaire observée au Kruisschans. I. - Analyse stratigraphique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 25: 1-38.
- Heinzelin, J. de 1950b. Stratigraphie pliocène et Quaternaire observée au Kruisschans. II. - Conclusions. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 25: 1-22.
- Heinzelin, J. de 1955a. Deuxième série d'observations stratigraphiques au Kruisschans. Coupes de l'écluse Baudouin. I. - Analyse stratigraphique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 31: 1-29.
- Heinzelin, J. de 1955b. Deuxième série d'observations stratigraphiques au Kruisschans. Coupes de l'écluse Baudouin. II. - Conclusions. *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, 31: 1-14.
- Heinzelin, J. de 1955c. Considérations nouvelles sur le Néogène de l'Ouest de l'Europe. *Bulletin de la Société belge de Géologie*, 64: 463-476.
- Hörnes, M. 1851-1870. Die fossilen Mollusken des Tertiär-Beckens von Wien. *Abhandlungen der kaiserlichen und königlichen Geologischen Reichsanstalt*, 3: 209-296 (1853), 461-736 (1856).
- Janssen, A.W. 1969. Beiträge zur Kenntnis des Miozäns von Dingden und seiner Molluskenfauna 2. *Geologica et Paläon-*

- tologica*, 3: 153-193.
- Janssen, A.W. 1984. *Mollusken uit het Mioceen van Winterswijk-Miste. Een inventarisatie met beschrijving en afbeeldingen van alle aangetroffen soorten*. Koninklijke Nederlandse Natuurhistorische Vereniging, Nederlandse Geologische Vereniging & Rijksmuseum van Geologie en Mineralogie, Amsterdam. 451 pp.
- Jeffreys, J.G. 1874. Some remarks on the mollusca of the Mediterranean. *Report of the fortythird meeting of the British Association for the Advancement of Science*, 1873: 111-116.
- Jeffreys, J.G. 1883. On the mollusca procured during the "Lightning" and "Porcupine" Expeditions 1868-1870 (Part VI). *Proceedings of the Zoological Society of London*, 1883: 88-115.
- Kojumdgieva, E.M. & Strachimirov, B. 1960. Les fossiles de Bulgarie VII; Tortonien. Académie des Sciences de Bulgarie, Sofia. 317 pp. [in Bulgarian].
- Landau, B., Marquet, R. & Grigis, M. 2003. The Early Pliocene Gastropoda (Mollusca) of Estepona, Southern Spain. Part 1: Vetigastropoda. *Palaeontos*, 3: 1-87.
- Landau, B., Marquet, R. & Grigis, M. 2004. The Early Pliocene Gastropoda (Mollusca) of Estepona, Southern Spain. Part 2: Orthogastropoda, Neotaenioglossa. *Palaeontos*, 4: 1-108.
- Leriche, M. 1912. Le Néogène des environs d'Anvers. Réunion extraordinaire du 27 août au 6 septembre. *Bulletin de la Société Géologique de France*, 4e serie, 12: 725-727.
- Linden, J. van der 1994. *Philine intricata* Monterosato, 1884, an overlooked species from the North-East Atlantic and the Mediterranean Sea (Gastropoda, Opisthobranchia: Philinidae). *Basteria*, 58: 41-48.
- Linden, J. van der 1995. Philinidae dredged by the CANCAP expeditions (Gastropoda, Opisthobranchia). *Basteria*, 59: 65-84.
- Linnaeus, C. 1758. *Systema naturae. Editio decima, reformata. Tomus I*. Impensis direct. Laurentii Salvii, Holmiae, 376 pp.
- Malatesta, A. 1960. Malacofauna pleistocenica di Grammichele (Sicilia). *Memorie per Servire alla Carta Geologica d'Italia*, 12: 1-196.
- Malatesta, A. 1974. Malacofauna pliocenica Umbra. *Memorie per Servire alla Carta Geologica d'Italia*, 13: 1-498.
- Manganelli, G., Spadini, V. & Cianfanelli, S. 2004. The xenophorid gastropods of the Mediterranean Pliocene: the record of the Siena Basin. *Bollettino della Società Paleontologica Italiana*, 43: 409-451.
- Marquet, R. 1993. The molluscan fauna of the Kruisschans Member (Lillo Formation, Late Pliocene) in the Antwerp area (Belgium). *Contributions to Tertiary and Quaternary Geology*, 30: 83-104.
- Marquet, R. 1995. Pliocene Gastropod faunas from Kallo (Oost-Vlaanderen, Belgium) - Part 1. Introduction and Archaeogastropoda. *Contributions to Tertiary and Quaternary Geology*, 32: 53-85.
- Marquet, R. 1996. The family Triphoridae in the Neogene of Belgium (Mollusca, Gastropoda). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, 66: 137-149.
- Marquet, R. 1997a. The Pliocene turrid Gastropods of Belgium. Part 1: Drillidae, Turridae, Conidae (genus *Bela*). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, 67: 119-151.
- Marquet, R. 1997b. Pliocene Gastropod faunas from Kallo (Oost-Vlaanderen, Belgium) - Part 2. Caenogastropoda: Potamidiidae to Tornidae. *Contributions to Tertiary and Quaternary Geology*, 34: 9-29.
- Marquet, R. 1997c. Pliocene Gastropod faunas from Kallo (Oost-Vlaanderen, Belgium) - Part 3. Caenogastropoda: Aporrhaidae to Muricidae, and Part 4. Buccinidae to Helicidae. *Contributions to Tertiary and Quaternary Geology*, 34: 69-149.
- Marquet, R. 1998a. The Pliocene turrid Gastropods of Belgium. Part 2: Conidae (genera *Asthenotoma*, *Comarmondia*, *Cytharella*, *Mangelia*, *Lusitanops*, *Raphitoma* and *Philbertia*). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, 68: 263-287.
- Marquet, R. 1998b. De Pliocene gastropodenfauna van Kallo (Oost-Vlaanderen, België). *Publicatie van de Belgische Vereniging voor Paleontologie*, 17: 1-246.
- Marquet, R. 2001. A study of some Neogene European species of Seilinae (Cerithiopsidae, Gastropoda). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, 71: 195-208.
- Marquet, R. 2002. The Neogene Amphineura and Bivalvia (Protobranchia and Pteriomorphia) from Kallo and Doel (Oost-Vlaanderen, Belgium). *Palaeontos*, 2: 1-99.
- Marquet, R. 2004. Ecology and evolution of Pliocene bivalves from the Antwerp Basin. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, 74: 205-212.
- Marquet, R. 2005. The Neogene Bivalvia (Heterodonta and Anomalodesmata) and Scaphopoda from Kallo and Doel (Oost-Vlaanderen, Belgium). *Palaeontos*, 5: 1-142.
- Meuter, F.J. de & Laga, P.G. 1976. Lithostratigraphy and biostratigraphy based on benthic foraminifera of the Neogene deposits of northern Belgium. *Bulletin de la Société belge de Géologie*, 85: 133-152.
- Montagu, G. 1803. *Testacea Brittanica, or natural history of British shells, marine, land and fresh-water, including the most minute: systematically arranged and embellished with figures*. Romsey, London, 37+606 pp.
- Monterosato, T. di 1884. *Nomenclatura generica e specifica di alcune conchiglie Mediterranee*. Palermo. 152 pp.
- Nyst, P.H. 1843. Description des coquilles et des polypiers fossiles des terrains tertiaires de la Belgique. *Mémoires couronnés de l'Académie royale de Bruxelles*, 17: 1-676.
- Nyst, P.H. 1878-1881. Conchyliologie des terrains Tertiaires de la Belgique. *Annales du Musée royal d'Histoire naturelle de Belgique*, 3: 1-262 (1881), pls. 1-28 (1878).
- Palazzi, S. & Villari, A. 1996. Malacofauna batiale plio-pleistocenica dell' Messinese 2. Capo Milazzo. *Naturalista Siciliana*, IV, 30: 237-279.
- Peyrot, A. 1926. Conchologie néogénique de l'Aquitaine (Suite). *Actes de la Société Linnéenne de Bordeaux*, 78: 199-256.
- Peyrot, A. 1933. Conchologie néogénique de l'Aquitaine. *Actes de la Société Linnéenne de Bordeaux*, 84: 129-288.
- Philippi, R.A. 1836. *Enumeratio molluscorum Siciliae cum viventium tum in tellure tertiari fossilium, quae in itinere suo observavit*. S. Schroppii, Berolini. 267 pp.
- Philippi, R.A. 1844. *Enumeratio molluscorum Siciliae cum viventium tum in tellure tertiari fossilium, quae in itinere suo observavit. Vol. Secunda*. E. Anton, Halis Saxonum: 303 pp.
- Piani, P. 1984. Revisione del genere *Emarginula* Lamarck, 1801 in Mediterraneo. Atti Simposio: sistematica dei Prosobranchi del Mediterraneo, 1982. *Lavori della Società Italiana di Malacologia*, 21: 193-238.
- Pinna, G. & Spezia, L. 1978. Catalogo dei tipi del Museo Civico di Storia Naturale di Milano; I. I tipi di Gastropodi fossili. *Atti de la Società Italiana de Scienze naturale e Museo Civico di Storia Naturale di Milano*, 119: 125-180.
- Ponder, W.F. 1983. Xenophoridae of the World. *The Australian*

- Museum Memoir*, 17: 1-121.
- Poppe, G.T. & Goto, Y. 1990. *European Seashells. Volume 1 (Polyplacophora, Caudofoveata, Solenogastera, Gastropoda)*. Christa Hemmen Verlag, Wiesbaden. 352 pp.
- Regteren Altena, C.O. van 1956. The genus *Phasianema* in the Pliocene of Western Europe. *Basteria*, 20: 62-64.
- Regteren Altena, C.O. van, Bloklander, A. & Pouderoyen, L.P. 1965. *De fossiele schelpen van de Nederlandse stranden en zeegeten. Eerste deel, tweede druk*. Nederlandse Malacologische Vereniging, Lisse. 55 pp.
- Rolan Mosquera, E. 1983. *Moluscos de la Ria di Vigo. Gasteropodos*. Velograf, Santiago de Compostella. 383 pp.
- Rossi Ronchetti, C. 1955. I tipi della "Conciliologie fossile subapennina" di G. Brocchi. *Rivista Italiana di Paleontologia e Stratigrafia*, 5: 91-259.
- Sabelli, B., Giannuzzi-Savelli, R. & Bedulli, B. 1990. *Annotated check-list of Mediterranean marine Mollusks. Vol. 1*. Edizioni Libreria Naturalistica Bolognese, Bologna: 348 pp.
- Sacco, F. 1895. *I Molluschi dei terreni terziari del Piemonte e della Liguria. Vol. 18*. Memorie della Reale Accademia delle Scienze, Carlo Claussen, Torino: 1-51.
- Sacco, F. 1897. *I Molluschi dei terreni terziari del Piemonte e della Liguria. Vol. 22*. Memorie della Reale Accademia delle Scienze, Carlo Claussen, Torino: 1-130.
- Sacco, F. 1904. *I Molluschi dei terreni terziari del Piemonte e della Liguria. Parte XXX. (Aggiunte e correzioni)*. Memorie della Reale Accademia delle Scienze, Carlo Claussen, Torino: 1-203.
- Silva, Marques, C.A.P.F. da 1990. Moluscos pliocénicos da região de Caldas da Rainha, Marinha Grande, Pombal (Portugal). I. Archaeogastropoda. Fissurellidae. *Publicações Ocasionalis da Sociedade Portuguesa de Malacologia*, 15: 1-10.
- Silva, Marques, C.A.P.F. da 1993. *Gastéropodes Pliocénicos Marinhos de Vale de Freixo (Pombal, Portugal). Sistemática, Tafonomia, Paleoecologia*. Unpublished MSc thesis, Faculdade de Ciências da Universidade de Lisboa. 312 pp.
- Silva, Marques, C.A.P.F. da 2001. *Gastéropodes Pliocénicos Marinhos de Portugal: Sistemática, Paleoecologia, Paleobiologia, Paleogeografia*. Unpublished PhD thesis, Faculdade de Ciências da Universidade de Lisboa, Lisbon. 747 pp.
- Sowerby, J. 1816-1818. *The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or Shells which have been preserved at various times and depths in the earth*. Part 2. Benjamin Merdith, London. 251 pp.
- Sowerby, J. de C. 1829. *The mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or Shells which have been preserved at various times and depths in the earth*. Part 6. Richard Taylor, London. 250 pp.
- Strausz, L. 1966. *Die miozän-mediterranen Gastropoden Ungarns*. Akadémiai Kiadó, Budapest. 692 pp.
- Sykes, E.R. 1905. On the Mollusca procured during the Porcupine expeditions. Supplementary note. Part II. *Proceedings of the Malacological Society of London*, 6: 322-332.
- Thompson, T.E. 1988. Molluscs: Benthic Opisthobranchs (Mollusca: Gastropoda). *Synopses of the British fauna*: 1-355.
- Vandenbergh, N., Laga, P., Steurbaut, E., Hardenbol, J. & Vail, P.R. 1998. Tertiary sequence stratigraphy at the southern border of the North Sea Basin in Belgium. *SEPM Special Publication*, 60: 119-154.
- Vandenbergh, N., Laga, P., Louwye, S., Vanhoorne, R., Marquet, R., De Meuter, F., Wouters, K. & Hagemans, H.W. 2005. Stratigraphic interpretation of the Neogene marine-continental record in the Maaseik well (49W0220) in the Roer Valley Graben, NE Belgium. *Memoirs of the Geological Survey of Belgium*, 52: 1-39.
- Vliet-Lanoë, B. van, Vandenbergh, N., Laurent, M., Laignel, B., Lauriat-Rage, A., Louwye, S., Mansy, J.-L., Mercier, D., Hal-légouët, B., Laga, P., Laquement, F., Meilliez, F., Michel, Y., Moguedet, G. & Vidier, J.-P. 2002. Palaeogeographic evolution of northwestern Europe during the Upper Cenozoic. *Geodiversitas*, 24: 511-541.
- Vincken, R. (ed.) 1988. The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, Reihe A, 100: 1-508.
- Voortuysen, J.H. van 1944. Miozäne Gastropoden aus dem Peelgebiet (Niederlande) (Rissoidae-Muricidae, nach Zittel's Einteilung 1924). *Mededeelingen van de Geologische Stichting*, C, IV, 1, 5: 1-116.
- Warén, A. 1980. Marine Mollusca described by John Gwyn Jeffreys, with the location of the type material. *Conchological Society of Great Britain and Ireland*, Special Publication, 1: 1-60.
- Warén, A. 1991. New and little known mollusca from Iceland and Scandinavia. *Sarsia*, 76: 53-124.
- Warén, A. 1992. New and little known "Skeneimorph" gastropods from the Mediterranean Sea and the adjacent Atlantic Ocean. *Bollettino Malacologico*, 28: 149-248.
- Warén, A. 1996. Mollusca from Iceland and Scandinavia. Part 3. *Sarsia*, 81: 197-245.
- Watson, R.B. 1897. On the marine mollusca of Madeira. *Journal of the Linnean Society of London, Zoology*, 26: 233-327.
- Wienrich, G. 2001. *Die Fauna des marinen Miozäns von Kevelaer (Niederrhein). Band 3. Gastropoda bis Cancellariidae*. Backhuys, Leiden, pp. 386-639.
- Wood, S.V. 1839. On the fossil shells from the Crag. *The Magazine of Natural History, New Series*, 3: 460-465.
- Wood, S.V. 1842. A Catalogue of Shells from the Crag. *The Magazine of Natural History, New Series*, 9: 455-462 and 527-544.
- Wood, S.V. 1848. *A monograph of the Crag mollusca, or, description of shells from the Middle and Upper Tertiaries of the east of England. Part 1. Univalves*. The Palaeontographical Society, London, 1-12 + 1-208 pp.
- Wood, S.V. 1851-1860. *A monograph of the Crag mollusca, or, description of shells from the Middle and Upper Tertiaries of the east of England. Part 2. Bivalves*. The Palaeontographical Society, London, pp. 1-150, pls. 1-12 (1851), pp. 151-216, pls. 13-20 (1853), pp. 217-342, pls. 21-31 (1857), note 1-2 (1861).
- Wood, S.V. 1872. *Supplement to the monograph of the Crag mollusca, with description of shells from the Upper Tertiaries of the east of England. Volume 3. Univalves and Bivalves*. The Palaeontographical Society, London, 1-31 + 1-99 pp.
- Wood, S.V. 1879. *Second supplement to the monograph of the Crag mollusca, with description of shells from the Upper Tertiaries of the east of England. Volume 4*. The Palaeontographical Society, London. 58 pp.
- Wood, S.V. 1882. *Third supplement to the monograph of the Crag mollusca, with description of shells from the Upper Tertiaries of the east of England. Volume 5*. The Palaeontographical Society, London. 24 pp.

Species	<1960	Doel	Noord Dreg	KFm	OSM	Occ.
<i>Emarginula fissura reticulata</i> Sowerby, 1813	x	c	x	x	x	R
<i>Emarginula adriatica</i> Costa, 1829		vr			-	R
<i>Emarginula plioaspera</i> Sacco, 1897		vr			x	
<i>Emarginula</i> sp.	?	vr			-	
<i>Emarginula crassa crassalta</i> Wood, 1874	x	r			x	R
<i>Diodora graeca</i> (Linnaeus, 1758)		r			-	R
<i>Diodora italica</i> Defrance, 1820	x		x		x	R
<i>Lepeta scaldensis</i> van Regteren Altena, 1954	x	r	x	x	-	N
<i>Dikoleps cutleriana</i> (Clark, 1848)		vr			-	R
<i>Lodderena sphaeroideum</i> (Wood, 1842)		vr			-	N
<i>Cirsonella romettensis</i> (Granata, 1877)		vr			-	R
Skeneidae indet.		vr			-	
<i>Margarites belli</i> (Harmer, 1923)	x	r			-	N
<i>Solariella maculata</i> Wood, 1842	x	c	x	x	x	N
<i>Calliostoma zizyphium</i> (Linnaeus, 1758)	x	r			x	R
<i>Calliostoma kickxi</i> (Nyst, 1835)		r			x	N
<i>Calliostoma simile</i> (Sowerby, 1818)	x		x	x	-	N
<i>Calliostoma occidentale</i> (Mighels & Adams, 1842)	x	c			x	R
<i>Gibbula cineroides</i> (Wood, 1842)	x		x	x	-	N
<i>Gibbula octosulcata</i> (Nyst, 1835)	x	r		x	x	N
<i>Gibbula beetsi</i> van Regteren Altena, 1954	x	vr		x	-	N
<i>Gibbula crassistriata</i> (Bell in Wood, 1882)		vr			-	N
<i>Gibbula obconica nehalenniae</i> van Regteren Altena, 1954	x	c	x	x	-	N
<i>Gibbula woodi</i> (Harmer, 1923)	x		x	x	-	N
<i>Tenagodus obtusus</i> (Schumacher, 1817)		r			x	R
<i>Bittium rubanocinctum</i> Glibert, 1958	x			x	-	N
<i>Turritella incrassata incrassata</i> Sowerby, 1814	x	vc	x	x	x	
<i>Cingula inusitata</i> (Beets, 1946)	x	c			x	N
<i>Rissoa obsoleta</i> Wood, 1842	x		x		x	N
<i>Alvania beani</i> (Hanley in Thorpe, 1844)	x				x	R
<i>Alvania whitleyi</i> (Bell, 1898)	x				?	
<i>Alvania zetlandica</i> (Montagu, 1815)		vr			-	R
<i>Obtusella intersecta</i> (Wood, 1857)		vr			-	x
<i>Circulus striatus</i> (Philippi, 1836)	x				x	R
<i>Circulus supranitidus</i> (Wood, 1842)	x				-	x
<i>Caecum mamillatum</i> Wood, 1842	x	vc			-	N
<i>Caecum glabrum</i> (Montagu, 1803)		vr			-	x
<i>Tornus belgicus</i> (Glibert, 1949)	x		x		-	x
<i>Aporrhais scaldensis</i> van Regteren Altena, 1954	x	r	x		x	N
<i>Aporrhais pespelecani</i> (Linnaeus, 1758)	x			x	-	R
<i>Trichotropis borealis</i> Broderip & Sowerby, 1823	x	r			-	R
<i>Calyptraea chinensis</i> (Linnaeus, 1758)	x	c	x		x	R
<i>Capulus ungaricus</i> (Linnaeus, 1758)	?			?	?	x
<i>Capulus unguis</i> (Sowerby, 1816)	?				x	x
<i>Capulus doelensis</i> nov. sp.	x	c			-	-
<i>Xenophora scaldensis</i> Glibert, 1958	x	vr	x		x	-
<i>Petalonochus glomeratus</i> (Linnaeus, 1758)	x	vc			x	R
<i>Bivonia triqueter</i> (Bivona, 1832)	x	c			x	R
<i>Velutina virgata</i> (Wood, 1848)	x				-	-
<i>Neosimnia leathesia scaldisia</i> Schilder, 1933	x				-	x
<i>Trivia retusa</i> (Sowerby, 1832)	x			x	-	-
<i>Trivia testudinella</i> (Wood, 1842)	x		x	x	-	-
<i>Trivia c. coccinelloides</i> (Sowerby, 1823)	x	c	x	x	-	x
<i>Erato pernana</i> Sacco, 1894	x				x	-
<i>Erato cypraeola brittanica</i> Schilder, 1933	x				x	x
<i>Euspira catena</i> (da Costa, 1778)	x	vc	x	x	x	R
<i>Euspira cirriformis gottschei</i> (Kautsky, 1925)	x	r			x	-
<i>Euspira hemiclausa</i> (Sowerby, 1824)		c			x	x
<i>Euspira exvarians</i> (Sacco, 1891)	x				-	x
<i>Natica crassa</i> Nyst, 1843	x	vc	x		x	x
<i>Galeodea bicatenata</i> (Sowerby, 1813)	x	vr	x		x	x

<i>Ficus conditus subintermedius</i> (d'Orbigny, 1852)	x	vr		x	x	-	
<i>Cerithiopsis barleei</i> (Jeffreys, 1887)	x	r			x	-	R
<i>Krachia zelandica</i> (Beets, 1946)		vr	x		x	-	N
<i>Cerithiopsis subulata</i> (Wood, 1848)	x				x	x	
<i>Seila suttonensis</i> Marquet, 2001	x	c			x	-	N
<i>Laiocochlis woodi</i> van Regteren Altena, 1954	x	r	x		-	-	N
<i>Marshallora adversa</i> (Montagu, 1803)	x	r	x		x	x	R
<i>Obesula scaldensis</i> Marquet, 1996	x				x	-	N
<i>Inella vandermarki</i> Marquet, 1996	x				-	-	N
<i>Aclis ascaris</i> (Turton, 1822)		vr			x	x	R
<i>Amaea woodi</i> (Deshayes, 1861)	x	vr			-	-	
<i>Acirsa penepolaris</i> (Wood, 1872)	x	r			?	-	N
<i>Opalia obtusicostata</i> (Wood, 1848)	x	vr			-	-	N
<i>Cirsotrema fimbriosum fimbriosum</i> (Wood, 1842)	x	vr		x	x	-	
<i>Cirsotrema funiculus</i> (Wood, 1872)	x	vr			?	?	
<i>Epitonium f. frondiculum</i> (Wood, 1842)	x	c		x	-	x	
<i>Epitonium frondosum</i> (Sowerby, 1829)		r			-	-	
<i>Epitonium subulata</i> (Sowerby, 1823)	x	c			x	-	
<i>Epitonium foliaceum</i> (Sowerby, 1825)	x	c		x	-	x	
<i>Epitonium clathratulum minuta</i> (Sowerby, 1823)		c			-	x	R
<i>Epitonium hennei</i> (Nyst, 1871)	x				x	-	N
<i>Eulima glabra</i> (Da Costa, 1778)	x	r			x	x	R
<i>Balcis alba</i> (Da Costa, 1778)	x	r		x	x	-	R
<i>Polygireulima glabella</i> (Wood, 1848)	x						
<i>Pterynotus canhami</i> (Wood, 1872)	x			x	-	x	N
<i>Pterylopsis binominata</i> (Stadt in Cossmann, 1919)				x	x	x	N
<i>Trophon muricatus</i> (Montagu, 1803)	x	c	x	x	x	x	R
<i>Scalaspira alveolata</i> (Sowerby, 1829)	?				-	-	
<i>Nucella incrassata</i> (Sowerby, 1825)	?				-	-	
<i>Spinucella tetragona</i> (Sowerby, 1823)				?	-	x	
<i>Coralliophila bracteata</i> (Brocchi, 1814)				x	-	-	
<i>Atractodon elegans</i> (Charlesworth, 1837)		r	x		x	x	N
<i>Buccinum undatum</i> (Linnaeus, 1758)			x		-	x	R
<i>Liomesus dalei</i> (Sowerby, 1825)	x	r			x	x	N
<i>Colus cordatus</i> (Bell, 1871)	x				-	x	
<i>Fusinus cf. lamellosus</i> (Borson, 1821)	x				x	-	
<i>Amyclina labiosa</i> (Sowerby, 1825)	x	r			-	x	
<i>Amyclina spec.</i>				vr	-	-	
<i>Nassarus consociatus</i> (Wood, 1848)	x	r			x	x	
<i>Nassarius dollfusi</i> (Harmer, 1914)	x			x	-	x	N
<i>Nassarius lamellilabrus</i> (Nyst, 1835)	x	r			-	x	N
<i>Nassarius ligustica</i> (Bellardi, 1871)	x				-	-	
<i>Nassarius scaldisianus</i> Adam & Glibert, 1976	x				-	x	N
<i>Nassarius spectabilis vandewouweri</i> (Glibert, 1959)	x			x	-	x	
<i>Nassarius reticosus</i> (J. Sowerby, 1815)	x			x	-	x	
<i>Pterygia sulculata</i> (Wood, 1878)	x	r		x	-	-	N
<i>Mitrella scaldensis</i> (van Regteren Altena, 1956)	x		x	x	x	x	N
<i>Vexillum ebenus</i> (Lamarck, 1811)	x				x	-	R
<i>Scaphella lamberti</i> (Sowerby, 1816)	x	r	x		x	x	
<i>Cancellaria harmeri</i> Glibert, 1960	x	vr			x	x	N
<i>Sveltia jonkaireana</i> (Nyst, 1835)	x	c		x	x	x	N
<i>Babylonella wouweri</i> (Harmer, 1916)	x		x	x	-	-	N
<i>Babylonella veneranda</i> (Beets, 1946)	x		x	x	-	-	N
<i>Babylonella gracilentia</i> (Wood, 1872)	x	r	x	x	x	x	N
<i>Brocchinia mitraeformis parvula</i> (Beyrich, 1856)	x				x	-	
<i>Gemmula antwerpiensis</i> (Vincent, 1890)	x	vr	x	x	-	x	N
<i>Fusiturris porrecta</i> (Wood, 1848)	x				-	-	N
<i>Acamptogenotia intorta nysti</i> Glibert, 1954	x		x	x	x	-	
<i>Cerodrillia nysti</i> (Harmer, 1815)	x	r	x	x	x	x	N
<i>Spirotropis c. confusa</i> (Seguenza, 1880)		vr			x	x	
<i>Asthenotoma ornata</i> (Defrance, 1826)	x	r		x	-	x	
<i>Cytharella substriolata</i> (Harmer, 1915)	x	r	x	x	x	x	N
<i>Cytharella vandewouweri</i> (Glibert, 1960)	x				-	x	N

<i>Bela belgica</i> (van Regteren Altena, 1959)	x	r	x	x	-	x	N
<i>Bela gliberti</i> Marquet, 1997	x			x	x	x	N
<i>Bela antwerpiensis</i> Marquet, 1997	x	r	x		x	x	N
<i>Bela tenuistriata</i> (Bell, 1871)	x	r	x	x	x	x	N
<i>Bela consimilis</i> (Harmer, 1915)	x		x	x	-	x	N
<i>Mangelia gracilior</i> (Bell, 1871)	x				-	x	N
<i>Comarmondia gracilis</i> (Montagu, 1803)	x	r		x	-	x	R
<i>Philbertia pseudoleufroyi</i> Marquet, 1998	x		x	x	-	x	N
<i>Raphitoma antonjanssei</i> Marquet, 1998	x	r			x	x	N
<i>Raphitoma perpulchra</i> (Wood, 1848)	x	c	x	x	-	x	N
<i>Terebra i. inversa</i> (Nyst, 1845)	x	c		x	-	x	N
<i>Terebra canalis</i> Wood, 1842		r			-	x	N
<i>Pyramidella laeviuscula</i> Wood, 1842		r			x	-	
<i>Chrysallida stefanisi</i> (Jeffreys, 1869)	x	r			x	-	R
<i>Chrysallida indistincta</i> (Montagu, 1808)		vr	x		-	x	R
<i>Eulimella acicula</i> (Philippi, 1836)	x				x	x	R
<i>Odostomia conoidea</i> (auct ? Brocchi, 1814)	x		x		x	x	?
<i>Brachystomia eulimoides</i> (Hanley, 1844)		vr			-	x	R
<i>Turbonilla internodula</i> (Wood, 1848)	x	r			x	x	R
<i>Turbonilla filosa</i> Wood, 1842	x				-	-	N
<i>Turbonilla senistriata</i> (Wood, 1879)	x	r			-	x	N
<i>Turbonilla kendalli</i> Bell in Harmer, 1920	x				x	-	
<i>Phasianema sulcata</i> Wood, 1842	x			x	-	-	N
<i>Phasianema zelandica</i> (Bloklander, 1949)	x				-	x	N
<i>Acteon noae</i> Sowerby, 1822	x		x		x	x	N
<i>Acteon tornatilis</i> (Linnaeus, 1758)	x	r			x	-	R
<i>Acteon subulatus</i> Wood, 1842	x	r			x	-	N
<i>Acteon levidensis</i> Wood, 1842	x	r			x	-	N
<i>Cylichnina elongata conuloidea</i> (Wood, 1851)	x	r			x	x	
<i>Retusa truncatula</i> (Bruguière, 1792)	x	vr			x	?	R
<i>Volvulella acuminata</i> (Bruguière, 1792)	x				x	x	R
<i>Ringicula buccinea</i> (Brocchi, 1814)	x	c	x		x	x	R
<i>Ringicula ventricosa</i> (Sowerby, 1824)	x				-	-	
<i>Philine scabra</i> (Müller, 1776)	x				-	x	R
<i>Philine quadrata</i> (Wood, 1839)		r			x	-	R
<i>Philine intricata</i> Monterosato, 1884	x						R
<i>Roxania utriculus</i> (Brocchi, 1814)	x				x	x	R
<i>Cylichna cylindracea</i> (Pennant, 1777)	x	c	x		x	x	R
<i>Scaphander lignarius</i> (Linnaeus, 1758)	x	c	x		x	x	R
<i>Spiratella atlanta</i> (Linnaeus, 1758)			x		x	x	R

Table 1. List of gastropod species occurring in the Luchtbal Sand Member. <1960: material listed by Glibert (1958b), with additions of Marquet (1996; 1997 a, b, c; 1998 a, b, c; 2001) and D1-D2 Havendok in NNM; Doel: collected in the Deurganckdok section in Doel; Noord: collected in Antwerp, junction 5e Havendok-Amerikadok at the Noordkasteel; Dreg: material dredged from the Scheldt River, possibly originating from the Luchtbal Sand Member; Kfm: also occurring in the Kattendijk Formation; OSM: also occurring in the Oorderen Sand Member; Occ.: occurrence; R: to Recent, N: North Sea Basin endemic species; x present; r rare; c common; vr very rare.

	Number of species	Percentage Extant	Percentage NSB endemic
Bivalvia	117	51	27
Gastropoda	157	29	46
Amphineura	1		
Scaphopoda	2		
Total	277		

Table 2. Number of species, percentage of still living and of endemic species in the Luchtbal Sand Member. NSB North Sea Basin.