

A revision of the gastropod fauna of the Boom Clay Formation (Rupelian, Early Oligocene) in Belgium, 1. Vetigastropoda and Caenogastropoda to Eulimoidea

R. Marquet

Royal Belgian Institute for Natural Sciences, dept. Palaeontology. Author's postal address: Constitutiestraat 50, 2060 Antwerp, Belgium; Robert.Marquet@hotmail.be.

Received 14 November 2015, revised version accepted 20 March 2016

Systematics of the gastropod species belonging to the subclasses Vetigastropoda, Cocculiniformia and Caenogastropoda to the Eulimoidea are described. Specimens were collected in recent surveys by the author and non-professional collectors by processing bulk sampling of the various septarian levels. Twenty-one species were encountered. One species, mentioned by Glibert (1957), was not found during the present survey. Thirteen species had not been found previously in the Boom Clay Formation and seven of these are introduced as new herein: *Moelleriopsis krylovi* nov. sp., *Cocculina (C.) reinecke* nov. sp., *Cochlis deborgeri* nov. sp., *Alvania (Arsenia) goolaertsi* nov. sp., *Alvania (Arsenia) vanremoorteli* nov. sp., *Vermetus dufraigni* nov. sp. and *Niso (N.) leenaertsi* nov. sp. The distribution of the species over the investigated septarian levels is summarised in a table. The remaining gastropod groups will be dealt with in a forthcoming paper.

KEY WORDS: Gastropoda, Boom Clay Formation, septarian levels, systematics, new species.

Introduction

The mollusc fauna of the Rupelian Boom Clay Formation in Belgium was first described by Nyst (1835, 1845) and de Koninck (1837). Glibert (1955) described some new or rare species from the clay and Glibert (1957) revised the complete mollusc fauna.

The various members and levels of the Boom Clay Formation were, however, only described later by Vandenberghe (1978) and refined by Vandenberghe & Laga (1986) and Vandenberghe & Van Echelpoel (1988). Nowadays, three members and a large number of beds are distinguished. For an actual overview of the lithostratigraphy, see Maréchal & Laga (1988) and Maréchal (1991). In parts of the Boom Clay Formation containing septarian nodules (S beds), concentrations of Mollusca occur. Mollusca are collected exclusively from the septarian levels, not from intermediate clays. Three beds yielded the bulk of the material studied herein: S30, S41 and S50. In one locality, the Ceulemans clay-pit at Niel, province of Antwerp, often large pieces of wood are preserved in the S30 bed of the Terhagen Member in a sandy instead of clayey matrix, which yielded unexpected species for the Boom Clay Formation. Glibert (1957) was unable to specify the vertical distribution of species, as his material was collected by hand picking, so that the smaller species escaped attention. For the present work more than ten tons of sediment from the various levels were processed,

the results of which make a revision of Glibert's papers necessary.

Material and methods

Marquet (2010) revised the bivalve fauna of the Boom Clay Formation. Details of the material and methods used can be found in this work, together with the lithostratigraphical subdivision of the Belgian Oligocene (fig. 2), compared to that of Glibert (1957) in fig. 1. The localities sampled are given in fig. 3 of the same paper and the position of the various S (septarian) beds in fig. 4. Fig. 1 in the present paper gives the sample sites. Also a sample of beds transitional to the Chattian deposits from the Mol shaft digging for an underground laboratory (Haijntink & Davies, 1998) was studied. The material described herein is housed in the collection of the present author and will be added to the collections studied by Glibert (1957) in RBINS, and some additional specimens from in the private collections of L. Dufraign, G. De Borger and R. Vanremoorter were studied as well. Type material of earlier described species is only mentioned if seen by the present author. Specimens mentioned in the author's collection will in future sometimes be found destroyed by pyrite oxidation. For numbers of specimens and localities of specimens in the RBINS collection, see Glibert (1957).

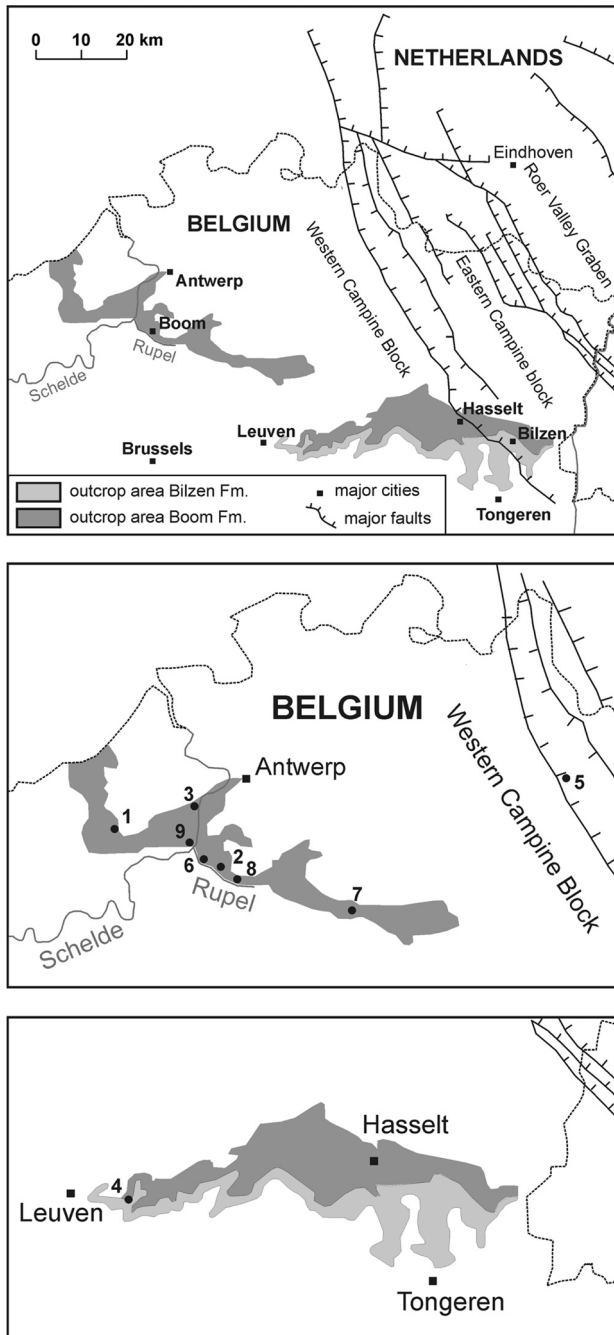


Figure 1. Outcrop of Oligocene deposits in Belgium (changed after Van Simaey & Vandenberghe, 2006), with localities mentioned in the text (in alphabetical order). 1 = Belsele and Sint Niklaas, 2 = Boom, 3 = Kruikebe, 4 = Lubbeek, 5 = Mol, 6 = Niel, 7 = Putte, 8 = Rumst + Terhagen, 9 = Steendorp.

Systematic descriptions

Systematics follows Bouchet & Rocroi (2005) and WoRMS (2015). For species discussed in Marquet *et al.* (in press), on the mollusc fauna of the Grimmertingen Sand Member of the Sint Huibrechts Hern Formation (Rupelian), only additional data are given. In many instances protoconchs are better preserved in the fresh material from the

Boom Clay than on specimens from the Grimmertingen Sand Member and in such cases they are illustrated and described herein.

Abbreviations:

- S[nr] septarian bed number.
 RM author's collection, to be deposited in RBINS.
 RBINS Glibert's (1957) collection at the Royal Belgian Institute for Natural Sciences, Brussels and material newly deposited in the type collection.
 IST Acronym used in the RBINS, meaning 'Invertébrés du Secondaire et du Tertiaire'.
 H height of shell.
 W width of shell.
 L length of shell.
 D diameter of shell.

Classis Gastropoda Cuvier, 1797
 Subclassis Vetigastropoda Salvini-Plawen, 1985
 Superfamilia Trochoidea Rafinesque, 1815
 Familia Solariellidae Powell, 1951
 Genus and subgenus *Solariella* Wood, 1842

Type species – *Solariella maculata* Wood, 1842.

***Solariella (Solariella) bernaysi* Glibert, 1955**
 Plate 1, fig. 1

- 1955 *Solariella bernaysi* Glibert, p. 4.
 1957 *Solariella bernaysi* Glibert, 1955 – Glibert, p. 48, pl. 4, fig. 9.

Locus typicus – Kontich, province of Antwerp, Belgium.

Stratum typicum – Boom Clay Formation, level unknown (Rupelian, Early Oligocene).

Type material – Holotype RBINS IST 4701.

Material examined – Niel, S50: 1 (RM); Kruikebe, S50: 1 (Pl. 1, fig. 1), H 1.5 mm, W 2.1 mm (RBINS IST 7674).

Description – Small, fragile shell of $3\frac{1}{2}$ whorls, almost one and a half times wider than high. Glibert (1957) illustrated more complete shells than the ones found in this survey; width and height of his specimens are nearly equal. Spire occupying about half shell height. Protoconch of $1\frac{1}{2}$ whorls. Protoconch 1 perpendicular to shell axis, with irregular punctae in its initial part, then with two fine spiral lines. The teleoconch sculpture starts with five strong, gradually distributed spirals. Teleoconch whorls convex. Suture deep, with a very indistinct sub-sutural platform. Ornamentation of later teleoconch whorls consisting of numerous distinct spiral ribs, much narrower than their interspaces. These are crossed by weaker axial riblets, especially distinct on the upper part of the whorls, fading downwards. Aperture rounded, occupying less than half shell height. Umbilicus narrow, spiral

ribs in umbilicus not seen in our material.

Occurrence – Glibert (1957) recorded this species from the Boom Clay of Kontich. In the present study, we only found two specimens, both in the S50 septarian level. The species is exclusively known from the material specified herein.

Superfamilia Seguenzioidea Verrill, 1884
Familia Seguenziidae Verrill, 1884
Genus *Moelleriopsis* Bush, 1897

Type species – *Moelleriopsis abyssicola* Bush, 1897.

***Moelleriopsis krylovi* nov. sp.**

Plate 1, fig. 2

Locus typicus – Niel, province of Antwerpen, Belgium.

Stratum typicum – Boom Clay Formation, Putte Member, S50 septarian level (Rupelian, Early Oligocene).

Type material – Holotype (Pl. 1, fig. 2) RBINS IST 7645; H 1.3 mm, W 1.5 mm; paratype from Kruikebe, S50 RBINS IST 7646; paratype from Kruikebe, S50 RBINS IST 7647; paratype from Kruikebe, S50 RBINS IST 7648.

Additional material – Kruikebe S50, 8 specimens (RM).

Derivatio nominis – This species is named after Dr A. Krylov (Polargeo, Saint Petersburg, Russia).

Description – Small, fragile species, wider than high, with *c.* 2½ convex whorls. Protoconch smooth, flattened, of ¾ whorl, delimited by a sharp incision. Whorls with a subsutural platform separated by a carina of two close-set, threadlike spirals starting at the protoconch boundary and rapidly weakening adaperturally. In other specimens, two adapertural spirals remain. The convex shell part below the carina is smooth. In and around the wide open umbilicus 4 to 6 spirals are present. There is no axial ornamentation. The aperture is round, occupying *c.* 65% of the shell height.

Discussion – The genus *Moelleriopsis* Bush, 1897 has not previously been recognised in the Oligocene of the North Sea Basin. In the Mayence Basin, Germany (Alzey Formation) and in French Stampian deposits *Skenea oligocaenica* (Cossmann & Lambert, 1884) occurs, illustrated by Lozouet (2012, p. 270, fig. 173/18-21). This species lacks the carina on the last whorl and has more, but finer umbilical spirals. The material of the same species from the Mayence Basin, illustrated by Gürs (1995, pl. 5, fig. 11) looks relatively higher than the French material. In the Mayence Basin also *Skenea andersoni* R. Janssen, 1978 is found (Gürs, 1995, p. 42, pl. 5, fig. 12, pl. 64, fig. 3). This species has a much lower spire than the present new species and its aperture is relatively higher. From Miocene sediments of Winterswijk, Miste, The Nether-

lands (Miste Bed, Aalten Member) *Skenea minuta* A.W. Janssen, 1967, renamed *Skenea ariejansseni* Schnetler, 2005, is recorded, which, however, is much more tumid and has no teleoconch spirals, except for two in the umbilicus (see A.W. Janssen, 1984, p. 127, pl. 6, fig. 7). In the same level and locality a *Tubiola* sp. 1 is found, which more closely resembles the Oligocene species, but has no teleoconch spirals and less spirals in the umbilicus (see A.W. Janssen, 1984, p. 128, pl. 6, fig. 3). A species from the Recent Mediterranean fauna is *Moelleriopsis mesanensis* (G. Seguenza, 1876) (see Giannuzzi-Savelli *et al.*, 1994, p. 108, fig. 361), which strongly resembles the present new species in shape, but has just one spiral, situated immediately above the umbilicus and there are only faint umbilical spirals. *Cirsonella romettensis* (Granata, 1877), a Recent species from the Bay of Biscay and the Mediterranean (see Warén, 1992, p. 160, figs 4c, 9E, 11C-E, 12A) has fine spirals on the abapical part of the teleoconch, but those in the umbilicus are weaker than those on the new species.

Occurrence – This species was found only rarely in our survey, exclusively in the S50 septarian horizon.

Subclassis Cocculiniformia Haszprunar, 1987
Superfamilia Cocculinoidea Dall, 1882
Familia Cocculinidae Dall, 1882
Genus and subgenus *Cocculina* Dall, 1882

Type species – *Cocculina rathbuni* Dall, 1882.

***Cocculina (Cocculina) reinecke* nov. sp.**

Plate 1, figs 3, 4

Locus typicus – Kobrow, Thomas sand-pit, Mecklenburg, Germany.

Stratum typicum – Sternberger Gestein (Early Chattian, Late Oligocene).

Derivatio nominis – Named after Prof. Dr T. Reinecke, who donated the sieving residue containing the holotype.

Type material – Holotype (Pl. 1, fig. 3), L 3.4 mm, D 3.1 mm, H 2.7 mm (RBINS IST 7649); paratype from Niel, S30 (Pl. 1, fig. 4), L 2.5 mm, D 2.2 mm, H 2.4 mm (lost by pyrite oxydation); paratype from Niel, S30 (RBINS IST 7651).

Additional material – Niel, S30 (sand around wood): 15 (RM).

Description – Small, rather high, capuliform shell. Umbo pointed, close to the posterior margin, but not extending beyond the posterior shell margin. Aperture oval. Anterior dorsal slope convex, posterior one concave to nearly straight. A few growth lines are conspicuous, most are weak. Radial ornament of numerous distinct, rather irregular, often interrupted riblets, as wide or wider than

the intercostal spaces. Protoconch lacking in all specimens available.

Discussion – From the Magdeburg area, Germany, a resembling species was described: *Acmaea (Tectura) schreiberi* Welle, 2009 (p. 85, pl. 1, figs 2-3). This species, however, has finer radial ornament and the umbo is less protruding. From the German Mayence Basin *Cocculina papyracea* (Sandberger, 1861) was described, illustrated by Gürs (1995, p. 35, pl. 4, fig. 4). This species is smooth and the umbo is positioned closer to the centre of the shell. Two further, similar species were introduced from Danish Chattian deposits by Schnetler & Beyer (1990). In *Lepetella helgae* Schnetler & Beyer, 1990 (p. 53, pl. 1, fig. 9) the umbo extends beyond the shell margin and the aperture is circular. The anterior part of the shell is convex, the posterior straight. The exterior is smooth, apart from growth lines. *Lepetella jyttae* Schnetler & Beyer, 1990 (p. 53, pl. 1, fig. 10) has an oval aperture, widest in the anterior part of the shell. Height is about equal to half the largest diameter. The apex is at 5/6th of total length. Anterior dorsum convex, posterior one straight. Juvenile specimens have distinct growth lines, but from 3 mm below the protoconch about 20 distinct concentric ribs are present that are about equally wide as their intercostal spaces. Radial ribs are weaker and more close-set near the aperture; primary and secondary radials are present. *Cocculina (C.) megapolitana* (Wiechmann, 1868) from German Chattian deposits (R. Janssen, 1978b, pl. 9, fig. 11) is smooth and relatively higher than our new species. *Cocculina (C.) ditmeri* (Anderson, 1964) from the North Sea Basin Miocene (A.W. Janssen, 1984, pl. 6, fig. 1) has a much finer ornament and its apex is closer to the centre of the shell.

Subclassis Caenogastropoda Cox, 1960
Ordo Hypsogastropoda Ponder & Lindberg, 1997
Subordo Littorinimorpha Thiele, 1928
Superfamilia Capuloidea Fleming, 1822
Familia Capulidae Fleming, 1822
Genus and subgenus *Capulus* de Montfort, 1810

Type species – *Patella ungarica* Linnaeus, 1758.

***Capulus (Capulus) elegantulus* Speyer, 1864**

- 1864 *Capulus elegantulus* Speyer, p. 46, pl. 41, fig. 1.
1867 *Pileopsis (Capulus) elegantula* Speyer – von Koenen, p. 118, pl. 7, fig. 12.
1941 *Capulus elegantulus* Speyer – Görge, p. 148.
1952 *Capulus elegantulus* Speyer 1864 – Görge, p. 79.
1957 *Capulus elegantulus* Speyer, 1864 – Glibert, p. 53.
1978a *Capulus elegantulus* Speyer 1864 – R. Janssen, p. 83.
1978b *Capulus (Capulus) elegantulus* Speyer 1864 – R. Janssen, p. 189, pl. 14, fig. 79.
1996 *Capulus (Capulus) elegantulus* Speyer 1864 – Moths *et al.*, p. 25, pl. 10, fig. 3.
1998 *Capulus (Capulus) elegantulus* Speyer, 1864 – Welle p. 20, pl. 3, figs 5-6.

- 2011 *Capulus elegantulus* Speyer, 1864 – Müller, p. 26, pl. 7, figs 3-4.

Locus typicus – Söllingen near Jerxheim, Braunschweig, Germany.

Stratum typicum – Grey, glauconitic sands (Oligocene, Chattian A) (R. Janssen, 1979, p. 10).

Material studied – The sole known specimen from Mol is destroyed as a result of pyrite oxydation.

Occurrence – In the Boom Clay Formation, the species has been found once in the -225 m bed at Mol. Glibert (1957) additionally mentioned only localities in the Voort Sand Formation (Chattian). Most references of this species are from the Chattian, but it has also been recorded from the earliest Oligocene Latdorf Beds in Germany (Müller, 2011).

Superfamilia Ficoidea Meek, 1864
Familia Ficidae Meek, 1864
Genus and subgenus *Ficus* Röding, 1798

Type species – *Murex ficus* Linnaeus, 1758.

***Ficus (Ficus) concinna* (Beyrich, 1854)**

Plate 2, fig. 1

- 1957 *Ficus concinnus* [sic] Beyrich, sp. 1854 – Glibert, p. 60.
in press *Ficus concinna* (Beyrich, 1854) – Marquet *et al.*, pl. 3, fig. 1.

Material studied – Kruikebe, S50: 17; Kruikebe, S60: 1; Mol, -225 m: 1, Niel, S30(?): 8; Rumst, S50: 4 (all RM). Rumst, S50: 1 (Pl. 2, fig. 1), H 4.3 mm, W 3.1 mm (RBINS IST 7652).

Note – For a more extended synonymy and description, see Marquet *et al.* (in press).

Description – Rather fragile, bulbous shell with a rather long siphonal canal. The suture is distinct. Shell width is less than half of the height. The protoconch is available on the present material, consisting of 2½ smooth, rather flat whorls separated from the teleoconch by a distinct ridge. Teleoconch ornament starting gradually with at the onset of very fine spiral riblets. A quarter of a whorl later axial ribs appear. The adult shell is covered with numerous prosocline axial ribs, crossed by a large number of spiral ribs. The spirals are slightly stronger than the axial elements. Both axial and spiral riblets are much narrower than their interspaces. On the short siphonal canal, only weaker spirals are present.

Occurrence – This species is rather rare in the S30, S50 and Mol -225 m beds. It occurs from the Grimmertingen Sand and ‘Latdorf Stufe’ in Germany onwards and is

represented during the whole Oligocene of the North Sea Basin, inclusive of the Chattian. Glibert (1957) recorded it from the Berg Sand Member, the Boom Clay Formation and the Chattian Voort Formation. It is supposed to form part of an evolutionary lineage with the Early Miocene (*e.g.* Edegem Sand Member) to Pliocene (*e.g.* Kattendijk Formation) species *Ficus condita* (Brongniart, 1823), which has a similar reticulate ornament and a similar protoconch, but reaches considerably larger dimensions, with a longer siphonal canal and its shell is less wide in relation to height.

Superfamilia Naticoidea Guilding, 1834
 Familia Naticidae Guilding, 1834
 Subfamilia Naticinae Guilding, 1834
 Genus *Euspira* Agassiz in Sowerby, 1838

Type species – *Natica glaucinoides* J. Sowerby, 1812.

***Euspira helicina achatensis* (de Koninck, 1837)**

- 1957 *Natica (Lunatia) achatensis* (Recluz) de Koninck, sp. 1837 – Glibert, 57, pl. 6, fig. 12.
 1969 *Natica (Lunatia) aohatensis* Köninck – Cadée, p. 40.
 in press *Euspira helicina achatensis* (de Koninck, 1837) – Marquet *et al.*, pl. 3, fig. 4.

Note – For a complete description and synonymy, see Marquet *et al.* (in press).

Material studied – Kruikebe, S30: 1; Kruikebe, S41: 6; Kruikebe, S50: >100; Kruikebe, S60: 32; Lubbeek, Terhagen Member: 1; Mol, -225m: 54; Niel, S30: 5; Niel, S41: 1; Niel, S50: 74; Rumst, S30: 3; Rumst, S41: 3; Rumst, S50: 76; Steendorp, S30: 3 (all RM).

Occurrence – This species is common in all septarian levels of the Boom Clay and in the -225 m level at Mol. Glibert (1957, p. 57) recorded it also from the Grimmeringen Sand Member, the Berg Sand Member and the Voort Formation (Chattian). It has recently (*e.g.* by Welle, 1998, p. 26) been considered to be a synonym of *Euspira helicina* (Brocchi, 1814), a species occurring in the Italian Pliocene. Here, Miocene North Sea Basin material is considered to belong to *Euspira protracta* (von Eichwald, 1830) (see A.W. Janssen, 1984, p. 197, pl. 55, figs 6-8), while the North Sea Basin subspecies *Euspira helicina hemiclausa* (J. de C. Sowerby, 1824) starts from the Early Pliocene Kattendijk Formation onwards (Marquet, 1998, p. 95, textfig.). The nominal subspecies *Euspira helicina helicina* is restricted to the Mediterranean Pliocene.

Genus *Cochlis* Röding, 1798

Type species – *Cochlis flammea* Röding, 1798 (= *Nerita vittata* Gmelin, 1791).

***Cochlis deborgeri* nov. sp.**

Plate 2, figs 2, 3

Locus typicus – Niel, Ceulemans claypit, province of Antwerp, Belgium.

Stratum typicum – Boom Clay Formation, Terhagen Member, S30 bed (Rupelian, Early Oligocene).

Derivatio nominis – Named after Mr. G. De Borger, who collected the type material.

Type material – Holotype (Pl. 2, fig. 2), H 23.6 mm, W 23.8 mm (RBINS IST 7653); paratype from the type locality and level (Pl. 2, fig. 3), H 22.7 mm, W 23.0 mm (RBINS IST 7654).

Additional material – G. De Borger collection: 3 specimens from the type locality and level.

Description – Rather large, solid, bulbous shell, slightly wider than high. Protoconch not preserved. Spire occupying 30% of total shell height. Whorls very tumid, suture distinct. Surface smooth, apart from growth lines, that occasionally become quite distinct on the last whorl. Aperture semicircular, wide. A columellar callus is present, widening above the umbilicus. Umbilicus wide, with a weak funiculus, ending in a tubercle on the columellar side of the aperture.

Discussion – This is the first *Cochlis* species appearing in the North Sea Basin. During the Miocene several species occur, but it is difficult to separate them without protoconch or operculum. Three species are recorded at Winterswijk, Miste, Achterhoek, The Netherlands. *Cochlis hoernesi* (Fischer & Tournouer, 1873) resembles the new species closely (see A.W. Janssen, 1984, p. 201, pl. 56, figs 6-9, pl. 57, fig. 9), but it is relatively wider, with the apertural margin strongly bulging to the right and the columellar callus is straight. The umbilicus is narrower and the funiculus occasionally is strongly developed. *Cochlis neglecta* (Mayer, 1858) (see A.W. Janssen, 1984, p. 202, pl. 57, figs 5-7, 12), which occurs also in the German Chattian (see R. Janssen, 1978b, p. 195, pl. 14, fig. 84), differs clearly in being much higher in relation to width and in having a much narrower umbilicus. *Cochlis tigrina* (Defrance, 1825) from the North Sea Basin Miocene (see A.W. Janssen, 1984, p. 203, pl. 57, figs 1-4, 10, ?11) is relatively wider and the abapical side of the shell is straight instead of convex as on the new species. In the Pliocene of the North Sea Basin *Cochlis crassa* (Nyst, 1845) occurs (see Marquet, 1998, p. 98, textfig.). This species is relatively higher and has a subsutural depression.

Occurrence – The new species is known only from the S30 bed of the type locality.

Superfamilia Rissoidae Gray, 1847

Familia Rissoidae Gray, 1847

Subfamilia Rissoinae Gray, 1847
Genus *Alvania* Risso, 1826
Subgenus *Arsenia* Monterosato, 1891

Type species – *Turbo punctura* Montagu, 1803.

***Alvania (Arsenia) goolaertsii* nov. sp.**

Plate 2, fig. 4

Locus typicus – Shaft digging for underground laboratory, Mol, at -225 m, province of Antwerp, Belgium.

Stratum typicum – Boom Clay Formation (Oligocene, Rupelian, transitional to Chattian).

Type material – Holotype (Pl. 2, fig. 4), H 1.9 mm, W 1.3 mm (RBINS IST 7655); paratype from the type locality and level (RBINS IST 7654).

Derivatio nominis – Named after Mr Stijn Goolaerts, who donated the types.

Description – Small, elongated shell with very tumid whorls narrowing near distinct suture. Shell width about 65% of height. Last whorl occupying two thirds of total height. Protoconch only partly preserved, showing a microornament of punctae and fine, interrupted spiral lines; transition to teleoconch eroded. Adult ornament consisting of equally strong spiral and orthocline axial riblets, both much narrower than their intercostal spaces and together forming a reticulate pattern. There are 10 gradually distributed spirals present. The number of axial ribs is around 20, they lack on the base of the last whorl. Apertural margin not preserved, a distinct callus, on which the spiral ribs may remain visible, is present.

Discussion – A number of species of the subgenus *Arsenia* has been described from the North Sea Basin Oligocene. *Alvania (Arsenia) multicostata* (Speyer, 1864) from the Söllingen Chattian, was illustrated by Tembrock (1964, pl. 7, fig. 6). It has a much coarser ornamentation, with very strong ribs and varices. This name, however, should according to R. Janssen (1978b, p. 157, pl. 11, figs 30-32) be replaced by that of the synonym *Alvania (Arsenia) semperi* Wiechmann, 1871, as it is preoccupied by *Rissoa multicostata* C.B. Adams, 1850. The differences between the specimens identified with this name by R. Janssen (1978b) are large and they might represent different species. The shell of his pl. 11, fig. 30, as *Alvania (Arsenia) semperi*, is shorter and relatively wider than our new species, and its suture is much shallower. The specimen illustrated by R. Janssen (1978b, pl. 11, fig. 31) resembles *Alvania goolaertsii* nov. sp. more closely, but it is less wide, without narrowing towards the suture and the axial and spiral ribs differ in strength. The specimen on his plate 11, fig. 32 is identical with *Alvania (Arsenia) multicostata* as illustrated by Tembrock (1964) and should consequently be named *Alvania (Arsenia) semperi* Wiechmann, 1871. According to Gründel (1997, p. 3, fig. 2) the first teleoconch whorls of

Alvania semperi are smooth, but his illustration is not a SEM image.

Occurrence – This new species is exclusively known from its type locality.

***Alvania (Arsenia) vanremoorteli* nov. sp.**

Plate 2, fig. 5

Locus typicus – Kruikebeke, Argex (formerly Gralex) clay-pit, province of Oost Vlaanderen, Belgium.

Stratum typicum – Boom Clay Formation, Putte Member, S50 bed (Rupelian, Early Oligocene).

Type material – Holotype (Pl. 2, fig. 5), H 2.7 mm, W 2.1 mm (RBINS IST 7657); paratype from the type locality (RBINS IST 7658); paratype from the type locality (RBINS IST 7659); paratype from the type locality (RBINS IST 7660).

Additional material – Kruikebeke, S50: 6 (RM).

Derivatio nominis – Named after W. Van Remoortel, who donated material of other species from Niel.

Description – Small, elongated species with a protoconch of 1¼ whorls. Nucleus smooth, then with 5 and near the teleoconch 8 slightly irregular spiral grooves. Protoconch delimited by a distinct axial incision. Teleoconch of three further whorls. Shell width about 75% of height. Last whorl occupying two thirds of total shell height. Teleoconch whorls very tumid, suture distinct. There are 14 spiral and 50 axial riblets, of equal strength and much narrower than their interspaces, together forming a reticulate pattern of rectangles. The axial elements fade away abapically, but do not disappear completely, lying close together near the umbilicus. Aperture oval, with a thickened margin. Umbilicus narrow, but open.

Discussion – This species resembles the preceding one closely in shape and adult ornament, but has spirals instead of punctae on its protoconch and the shape of the last whorl is more tumid. The species also resembles *Alvania rupeliensis* Tembrock, 1964, which was well-illustrated by Gürs & Moths (2002, p. 258, pl. 3, fig. 3); however, this species has a much weaker ornamentation and smooth protoconch whorls.

Occurrence – Only known as a rare occurrence in the S50 bed at Kruikebeke.

Superfamily Truncatelloidea Gray, 1840
Familia Elachisinidae Ponder, 1985
Genus *Pseudocirsope* Boettger, 1907

Type species – *Lacuna (Pseudocirsope) galeodina* Boettger, 1907.

***Pseudocirsope confusa* (Kadolsky, 1973)**

Plate 3, fig. 1

1973 *Lacuna (Pseudocirsope) confusa* Kadolsky, p. 44, fig. 13.*Locus typicus* – Waldböckelheim, Heimberg, Mayence Basin, Germany.*Stratum typicum* – ‘Unterer Meeressand’, Alzey Formation (Rupelian, Early Oligocene).*Material examined* – Kruikebe, S50: 13; Niel, S30: 2; Niel, S50: 4; Rumst, S50: 9 (all RM). Kruikebe, S50 (Pl. 3, fig. 1), H 3.7 mm, W 2.1 mm (RBINS IST 7661).*Description* – Small, egg-shaped shell. Protoconch not preserved. Teleoconch with five moderately convex whorls, with distinct suture. Shell width about 55% of height, last whorl about half of total shell height. Shell surface smooth. Aperture oval, pointed above, straight abapically. A narrow separation is present on the columellar side between the apertural margin and the last whorl.*Occurrence* – This species is new for the Boom Clay Formation; it occurs rarely in the S30 and rather frequently in the S50 beds, especially at Kruikebe. Until now this species was exclusively known from its type locality.***Pseudocirsope pusilla* (von Koenen, 1892)**

Plate 3, fig. 2

1892 *Lacuna pusilla* von Koenen, p. 851, pl. 55, fig. 14.
1964 *Lacuna eburnaeformis* – Tembrock, p. 323 (pars, non Sandberger, 1859).
1973 *Cirsope (Pseudocirsope) pusilla* (Koenen 1892) – Kadolsky, p. 41, fig. 10.*Locus typicus* – Latdorf, Sachsen-Anhalt, Germany.*Stratum typicum* – Latdorf Beds (Rupelian, Early Oligocene).*Material examined* – Niel, S50: 1 (RM); Kruikebe, S50: 1 (Pl. 3, fig. 2), H 2.9 mm, W 2.4 mm (RBINS IST 7662).*Description* – Small, conical shell with 4 convex whorls, separated by a distinct suture. Shell width slightly more than 80% of total height. Protoconch not preserved. Teleoconch surface with broad spiral lines separated by very fine intercostal spaces, in which even finer axial lines may be present. In some specimens, the spirals do not cover the centre of the last whorl, in others they are continuous over the entire height. Aperture large, oval, pointed abapically. A wide umbilicus is present. Abapically, the umbilicus is lined by a solid spiral rib, on which the spiral ornament continues. On the columellar part of the abapical side, the apertural rim is everted.*Occurrence* – Previously only known only from its type locality it is now recorded for the first time from the Niel and Kruikebe S50 beds.

Superfamilia Stromboidea Rafinesque, 1815

Familia Aporrhaidae Gray, 1850

Subfamilia Arrhaginae Popenoe, 1983

Genus and subgenus *Arrhoges* Gabb, 1868*Type species* – *Chenopus occidentale* Beck, 1847.***Arrhoges (Arrhoges) speciosus* (von Schlotheim, 1820)**

Plate 3, fig. 3

- 1820 *Strombites speciosus* von Schlotheim, p. 155.
1845 *Rostellaria Sowerbyi* (Sow.) – Nyst, p. 559, pl. 44, fig. 4 (non Sowerby).
1858 *Chenopus speciosus* Schloth. sp. – Sandberger, pl. 10, fig. 9.
1860 *Chenopus speciosus* Schloth. sp. – Sandberger, p. 188.
1864 *Chenopus speciosus* Beyr. (spec. Schloth.) – Speyer, p. 166, pl. 31, figs 1-3.
1867 *Aporrhais speciosa* Schloth. – von Koenen, p. 14.
1884 *Chenopus speciosus*, Schloth. – Cossmann & Lambert, p. 173.
1913 *Aporrhais speciosa* var. *unisinuata* Speyer – Harder, p. 74.
1913 *Aporrhais speciosa* var. *megapolitana* Beyrich – Harder, p. 74, pl. 6, figs 1-2.
1941 *Aporrhais speciosa* Schloth. var. *Margerini* de Koninck – Görge, p. 142.
1943 *Arrhoges (Arrhoges) speciosa* (Schlotheim) – Albrecht & Valk, p. 50, pl. 1, figs 24-25 (pars).
1952 *Drepanocheilus (Arrhoges) speciosus margerini* (Koninck 1838) – Görge, p. 81.
1952 *Drepanocheilus (Arrhoges) speciosus megapolitana* (Beyrich 1853) – Görge, p. 82.
1952 *Aporrhais speciosa* f. *margerini* de Koninck, sp. 1837 – Glibert, p. 68, pl. 5, fig. 6.
1954 *Drepanocheilus (Arrhoges) speciosus* Schlotheim, 1820 – Glibert & de Heinzelin, p. 361 (pars).
1957 *Drepanocheilus (Arrhoges) speciosus* Schlotheim, sp. 1820 forme *speciosus* s.s. – Glibert, p. 55, pl. 5, fig. 1a, b.
1957 *Drepanocheilus (Arrhoges) speciosus* Schlotheim, sp. 1820 f. *margerini* de Koninck, sp. 1837 – Glibert, p. 55, pl. 5, fig. 1c-f.
1957 *Drepanocheilus (Arrhoges) speciosus* Schlotheim, sp. 1820 f. *unisinuatus* Sandberger, sp. 1863 – Glibert, p. 56, pl. 5, fig. 1g.
1962 *Aporrhais speciosa* (Schlotheim 1820) – Hölzl, p. 148.
1962 *Aporrhais speciosa* aff. *megapolitana* Beyrich 1820 – Hölzl, p. 149.
1962 *Aporrhais speciosa* cf. *unisinuatus* (Sandberger 1863) – Hölzl, p. 150.
1969 *Drepanocheilus speciosus* (Schlotheim) - f. *margerini* (Koninck) – Cadée, p. 40.

- 1973 *Drepanocheilus speciosus* (Schlotheim, 1820) – Báldi, p. 268, pl. 30, figs 3, 4, pl. 31, figs 3, 4.
 1973 *Arrhoges (Arrhoges) speciosus* (Schlotheim, 1820) – Kuster-Wendenburg, p. 81, pl. 5, fig. 82.
 1975 *Aporrhais speciosa* (Schlotheim, 1920) – van den Bosch *et al.*, p. 66, pl. 2, fig. 5.
 1978a *Drepanocheilus (Arrhoges) speciosus* (Schlotheim 1820) – R. Janssen, p. 191.
 1978b *Drepanocheilus (Arrhoges) speciosus* (Schlotheim 1820) – R. Janssen, p. 82.
 1990 *Drepanocheilus (Arrhoges) speciosus* (von Schlotheim 1820) – Schnetler & Beyer, p. 48.
 1991 *Drepanocheilus speciosus* (Schlotheim, 1820) – Müller & Welle, p. 183.
 1996 *Drepanocheilus (Arrhoges) speciosus* (Schlotheim, 1820) – Moths *et al.*, p. 26, pl. 11, fig. 2.
 1997 *Drepanocheilus (Arrhoges) margerini* (de Koninck 1837) – Gründel, p. 5, pl. 1; figs 3-5 (non de Koninck).
 1998 *Drepanocheilus (Arrhoges) speciosus* (Schlotheim, 1820) – Welle, p. 23, pl. 3, figs 8-11.
 1999 *Drepanocheilus (Arrhoges) speciosus* (Schlotheim, 1820) – Duckheim *et al.*, p. 36.
 2000 *Arrhoges margerini* (Koninck, 1838) – Moths, p. 19, pl. 3, fig. 3.
 2008 *Drepanocheilus (Arrhoges) speciosus* (von Schlotheim, 1820) – Schnetler & Palm, p. 29, pl. 3, fig. 9.
 2009 *Arrhoges speciosus* (Schlotheim, 1820) – Welle, p. 113, pl. 5, fig. 5.
 2012 *Aporrhais speciosa* (Schlotheim, 1820) – Lozouet, p. 286, fig. 186, 1-6.
 in press *Arrhoges (Arrhoges) speciosus* (von Schlotheim, 1820) – Marquet *et al.*, p. ..., pl. 4, fig. 4.

Material studied – Kruikebe, S30: 1; Kruikebe, S50: 11; Kruikebe, S60: 22; Lubbeek, S20: 1; Niel, S20: 4; Niel, S30: 8; Niel, S50: 3; Rumst, S30: 9; Rumst, S41: 1; Rumst, S50: 1; Sint Niklaas, S10: 1; Steendorp, S20: 22; Steendorp, S30: 8; Steendorp, S41: 5 (all RM). Rumst, S50, 1 fragment of apical whorls with protoconch (Pl. 3, fig. 3), H 2.78 mm, W 1.78 mm (RBINS IST 7663).

Description – See Glibert (1957) who, however, did not describe the protoconch. This consists of 2½ smooth, convex whorls; the nucleus is depressed. Teleoconch ornamentation starts with about 12 fine spiral riblets, regularly spaced over the whorl height, soon followed by even finer axial lines.

Discussion – The variability within this species is considerable. Between juvenile and adult specimens the difference is large (see the young specimens from the Grimmertingen Sand Member in Marquet *et al.* (in press, pl. 4, fig. 4). Surprisingly in the Boom Clay septarian levels predominantly adults, with well developed callus, are found.

Occurrence – This species is represented in the entire Boom Clay Formation sequence. It is known from the complete Oligocene interval, starting with the Grim-

merlingen Sand Member and continuing during the Chattian and the Early Miocene Edegem Sand Member (Glibert, 1952, 1957). The species has an extensive horizontal and vertical distribution, including the German, Dutch and French Early Oligocene and the Danish, German and Hungarian Late Oligocene (see synonymy).

Superfamilia Tonnoidea Suter, 1913
 Familia Tonnidae Suter, 1913
 Subfamilia Cassinae Latreille, 1825
 Genus *Galeodea* Link, 1807

Type species – *Buccinum echinophorum* Linnaeus, 1758.

Galeodea nodosa depressa (von Buch, 1831)

- 1831 *Cassidaria depressa* von Buch, p. 61, pl. 4, figs 5-7.
 1835 *Cassidaria ? Nysti* Nyst, p. 32, pl. 5, fig. 39.
 1845 *Cassidaria ? Nysti* Nyst, p. 564, pl. 44, fig. 5.
 1854 *Cassidaria depressa* Buch – Beyrich, p. 482, pl. 9, fig. 1.
 1860 *Cassidaria depressa* v. Buch – Sandberger, pl. 19, fig. 7.
 1861 *Cassidaria depressa* v. Buch – Sandberger, p. 195.
 1863 *Cassidaria depressa* var. *Nysti* – Speyer, p. 60.
 1867 *Cassidaria nodosa* Sol. – von Koenen, p. 85.
 1941 *Cassidaria nodosa* Solander – Görges, p. 129.
 1952 *Cassidaria nodosa* (Solander, 1766) – Görges, p. 85.
 1957 *Cassidaria depressa* von Buch, 1831 – Glibert, p. 59, pl. 6, fig. 13.
 1962 *Phalium nodosum* (Solander 1766) – Hölzl, p. 158, pl. 9, fig. 5.
 1969 *Cassidaria depressa* Buch – Cadée, p. 40.
 1973 *Cassidaria nodosa* (Solander, 1766) – Kuster-Wendenburg, p. 92, pl. 6, fig. 88.
 1978a *Cassidaria (Cassidaria) nodosa* (Solander 1766) – R. Janssen, p. 91.
 1997 *Cassidaria nodosa* (Solander 1766) – Gründel, p. 7, textfig. 3, pl. 1, figs 9-10.
 2000 *Mambrinia depressa* (Buch, 1831) – Moths, p. 21, pl. 3, fig. 5.

Locus typicus – Clay-pit at Kenow, Mecklenburg, Germany.

Stratum typicum – ‘Rupelton’ (Rupelian, Early Oligocene).

Material studied – Kruikebe, S50: 2; Kruikebe, S60: 3; Rumst, S30: 1; Rumst, S50: 1; Steendorp, S30: 3 (all RM).

Description – See Glibert (1957, p. 59, pl. 6, fig. 13).

Discussion – This species is here considered to be different from *Galeodea n. nodosa* (Solander in Brander, 1766), which is known from the Grimmertingen Sand Member (Marquet *et al.*, in press pl. 5, figs 2-3), by its

more slender shell and less numerous tubercles. However, both clearly belong to a single evolutionary lineage and are therefore given subspecific rank.

Occurrence – This species is rare in the Boom Clay Formation and only known from the S30 and S50 beds and in small numbers only. Outside Belgium the species is known from the German ‘Rupelton’ as well as from Rupelian sediments in the Mayence Basin.

Genus *Echinophoria* Sacco, 1890

Type species – *Buccinum intermedium* Brocchi, 1814.

***Echinophoria rondeleti* (de Basterot, 1825)**

- 1825 *Cassis Rondeleti* de Basterot, p. 51, pl. 3, fig. 22, pl. 4, fig. 13.
- 1913 *Cassis megapolitana* Beyrich – Harder, p. 75.
- 1957 *Semicassis (Echinophoria) rondeleti* Basterot, sp. 1853 – Glibert, p. 59, pl. 5, fig. 2.
- 1969 *Semicassis (Echinophoria) rondeleti* (Basterot) – Cadée, p. 40.
- 1975 *Phalium (Semicassis) rondeleti* (Basterot, 1853) – van den Bosch *et al.*, p. 66, pl. 3, fig. 2.
- 2008 *Phalium (Echinophoria) rondeleti* (Basterot, 1853) – Schnetler & Palm, p. 30, pl. 3, fig. 12.

Original localities – Léognan and Dax, Aquitaine Basin, France.

Stratum typicum – ‘Falun’ (Burdigalian, Early Miocene).

Note – No material of this species was found during the present survey; Glibert (1957), however, listed 7 specimens from the Boom Clay Formation.

Occurrence – This species occurs during the Early Oligocene (but only after deposition of the Grimmeringen Sand Member) and continues during the Late Oligocene of the North Sea Basin and Early Miocene of the French Aquitaine Basin.

Familia Ranellidae Gray, 1854

Subfamilia Cymatinae Iredale, 1913

Genus *Sassia* Bellardi, 1872

Type species – *Triton appenninica* Sassi, 1827.

***Sassia flandrica* (de Koninck, 1837)**

Plate 3, fig. 4; Textfig. 1

- 1913 *Tritonium flandricum* de Koninck sp. – Harder, p. 75, pl. 6, fig. 3.
- 1957 *Charonia (Sassia) flandrica* Koninck, sp., 1837 – Glibert, p. 60, pl. 4, fig. 20.
- 1969 *Charonia (Sassia) flandrica* (Koninck) – Cadée, p. 40.

1975 *Charonia (Sassia) flandrica* (de Koninck, 1838) – van den Bosch *et al.*, p. 66, pl. 2, fig. 7.

2008 *Sassia flandrica* (de Koninck, 1837) – Schnetler & Palm, p. 31, pl. 3, fig. 13.

in press *Sassia flandrica* (de Koninck, 1837) – Marquet *et al.*, p., pl. 5, fig. 7.

Locus typicus – Bazel (= Basele), province of Oost Vlaanderen, Belgium.

Stratum typicum – Boom Clay Formation, level not known (Rupelian, Early Oligocene).

Type material – Lectotype (‘Holotype’ in Glibert, 1957, p. 60) RBINS IST 3869. Because Glibert (1957) did not figure this specimen, it is included here as Fig. 2.

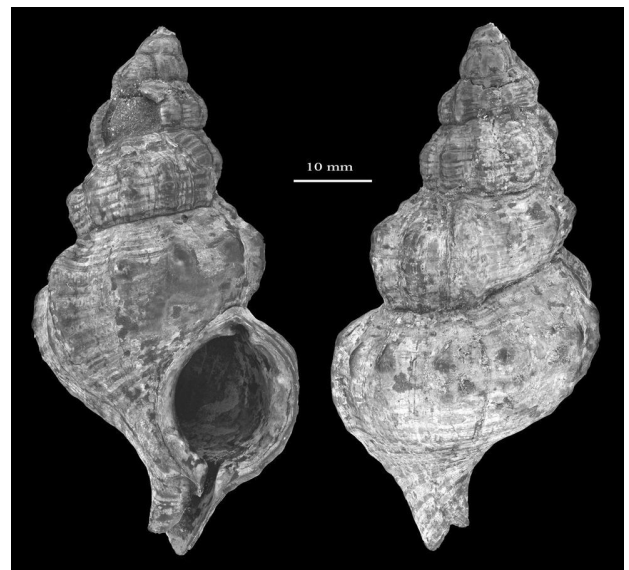


Figure 2. Lectotype of *Sassia flandrica* (de Koninck, 1837), RBINS IST 3869. Bazel, Boom Clay Formation.

Material studied – Kruibeke, S30: 1; Kruibeke, S50: 1; Niel, S30: 3; Rumst, S30: 2; Rumst, S50: 1; Steendorp, S20: 1 (all RM. Kruibeke, Argex clay-pit, S50: 1 juvenile specimen (Pl. 3, fig. 4), H 3.5 mm, W 2.7 mm (RBINS IST 7664).

Note – For full synonymy and description of the teleoconch, see Marquet *et al.* (in press, pl. 5, fig. 7).

Description – The protoconch is multispiral, with 3 to 3½ whorls. Protoconch I has irregular punctae, the following whorls are smooth. The last protoconch whorls bear four fine, widely separated spiral lines. The protoconch is separated from the teleoconch by a fine, slightly prosocline axial line.

Occurrence – This species is not very common in the Boom Clay Formation and was collected from the S20, S30 and S50 beds. Glibert (1957), however, listed 450 specimens. This demonstrates clearly the difference between

collecting by hand picking of large, attractive specimens, and bulk sample processing. The species is also known from the Grimmertingen Sand Member onwards, and occurs during the German and Dutch earliest Oligocene and the Chattian of the entire North Sea Basin.

Superfamilia Vermetoidea Rafinesque, 1815
Familia Vermetidae Rafinesque, 1815
Genus *Vermetus* Daudin, 1800

Type species – *Vermetus adansonii* Daudin, 1800.

***Vermetus dufraigni* nov. sp.**

Plate 3, figs 5, 6

Locus typicus – Mol, shaft digging for underground laboratory, province of Antwerp, Belgium.

Stratum typicum – Transitional strata between the Boom Clay and the Voort Formation, -225 m (Rupelian, Early Oligocene).

Type material – Holotype (Pl. 3, fig. 6), 3.9 x 3.1 mm (RBINS IST 7665); paratype Kruibeke, S50, 7.8 x 2.2 mm, (RBINS IST 7666); paratype Kruibeke S50 (RBINS IST 7667), paratype Kruibeke S50 (RBINS IST 7668).

Other material – Kruibeke, S50: 20; Mol, -225 m: 18; Niel, S50: 12; Rumst, S50: 7 (all RM).

Derivatio nominis – Named after Mr L. Dufraign, for his participation in the field work.

Description – Rather small but solid, irregularly formed shell, only initially and/or occasionally somewhat regularly coiled or even straight, existing of an in cross section triangular, calcareous tube with a row of somewhat spiny tubercles on one of the sides. Protoconch smooth, intucked. The specimens are strikingly yellow in colour.

Discussion – From the Late Miocene Deurne Sand Member to the Early Pliocene Kattendijk Formation of Belgium, a similar species occurs in the Antwerp region: *Vermetus triqueter* (Bivona, 1832). However, this species differs in having longer spines along the margins and a different protoconch, which is not intucked. In the earliest Oligocene Latdorf Stufe several species of this genus occur: *Vermetus bilobatus* (von Koenen, 1891, p. 735, pl. 41, fig. 12), *Vermetus dilatatus* (von Koenen, 1891, pl. 41, fig. 13), *Vermetus fasciatus* (von Koenen, 1891, pl. 41, fig. 14), *Vermetus helicoides* (von Koenen, 1891, p. 740, pl. 41, figs 15-16), *Vermetus filifer* (von Koenen, 1891, p. 739, pl. 41, fig. 17) and *Vermetus foliaceus* (von Koenen, 1891, p. 733, pl. 41, fig. 17), which all are usually regularly coiled and have an entirely different ornamentation of strong or weak concentric ribs or (in the last mentioned species) no ornament at all. *Vermetus mammillata* (von Koenen, 1891, p. 740, pl. 41, figs 19-21) and *Vermetus varicosa* (von Koenen, 1891), the latter well illustrated by Müller

(2011, p. 26, pl. 8, figs 23-25) are usually more or less regularly coiled and they may have concentric varices, but no tubercles.

Occurrence – The species is rather common in the -225 m level at Mol and in the S50 bed at Kruibeke, Niel and Rumst.

Superfamilia Xenophoroidea Troschel, 1852
Familia Xenophoridae Troschel, 1852
Genus *Tugurium* Fischer, 1879
Subgenus *Trochotugurium* Sacco, 1896

Type species – *Tugurium borsoni* Sismonda, 1847.

***Tugurium (Trochotugurium) scrutarium* (Philippi, 1843)**

- 1843 *Trochus scrutarius* Philippi, p. 22, 55, 74, pl. 3, fig. 37.
- 1836 *Trochus agglutinans* Lamk. – Nyst, p. 27 (non Lamarck).
- 1845 *Trochus agglutinans* Lamk. – Nyst, p. 376, pl. 35, fig. 18 (pars, non Lamarck).
- 1859 *Xenophora Lyelliana* Bosq. – Sandberger, pl. 12, fig. 10.
- 1860 *Xenophora Lyelliana* Bosquet – Sandberger, p. 134.
- 1864 *Xenophora Lyelliana* Bosq. – Speyer, p. 281.
- 1869 *Xenophora scrutaria* Phil. – Speyer, p. 170, pl. 23, figs 5-8.
- 1867 *Xenophora scrutaria* Phil. – von Koenen, p. 112.
- ? 1884 *Xenophora scrutaria* Phil. – Cossmann & Lambert, p. 131.
- 1941 *Xenophora scrutaria* Philippi – Görges, p. 146.
- 1952 *Tugurium (Trochotugurium) scrutarium* (Philippi 1843) – Görges, p. 81.
- 1954 *Tugurium (Trochotugurium) scrutarium* – Glibert & de Heinzelin, p. 361, pl. 5, fig. 19.
- 1957 *Tugurium (Trochotugurium) scrutarium* Philippi, sp. 1843 – Glibert, p. 54.
- 1962 *Xenophora (Trochotugurium) scrutaria* (Philippi 1843) – Hölzl, p. 147, pl. 8, fig. 19.
- 1973 *Tugurium (Trochotugurium) lyelliana* (Bosquet, 1842) – Kuster-Wendenburg, p. 79, pl. 5, fig. 80.
- 1978a *Tugurium (Trochotugurium) scrutarium* (Philippi 1843) – R. Janssen, p. 84.
- 1978b *Tugurium (Trochotugurium) scrutarium* (Philippi, 1843) – R. Janssen, p. 191.
- 1987 *Tugurium (Trochotugurium) scrutarium* (Philippi, 1843) – Schnetler & Beyer, p. 204.
- 1996 *Tugurium (Trochotugurium) scrutarium* (Philippi, 1843) – Moths *et al.*, p. 25, pl. 10, fig. 5.
- 1997 *Tugurium (Trochotugurium) scrutarium* (Philippi 1843) – Gründel, p. 4.
- 1998 *Tugurium (Trochotugurium) scrutarium* (Philippi, 1843) – Welle, p. 22, pl. 23, fig. 3.
- 2000 *Xenophora scrutaria* (Philippi, 1843) – Moths, p. 19, pl. 3, fig. 1.
- 2009 *Xenophora cf. scrutaria* (Philippi, 1843) – Welle, p. 116.

? 2012 *Xenophora* cf. *scrutaria* – Lozouet, p. 288, fig. 186 (16-18).

Locus typicus – Willems Höhe near Kassel, Hessen, Germany.

Stratum typicum – ‘Kasseler Meeressand’, Chattian, Late Oligocene.

Material studied – Kruikebeke, S60: 1; Niel, S30: 1 (RM).

Description and illustrations – See Glibert (1957) and Glibert & de Heinzelin (1954).

Occurrence – *Tugurium scrutarium* is rare in the S30 and S60 beds of the Boom Clay Formation. It is also present in the Berg Sand Member, in the Ruisbroek Sand Member and in the Chattian Voort Formation. In Germany it is further known from the Mayence Basin Alzey Formation and from Chattian deposits. It has also been recorded from the French Paris Basin Stampien, but specimens illustrated by Lozouet (2012, figs 186/16-18) as *Xenophora* cf. *scrutaria*, from Auvers-Saint-Georges, seem to be relatively higher and their whorls are flatter than in the North Sea Basin material; they may represent a separate species.

Superfamilia Epitonioida Berry, 1910 (1812)

Familia Epitoniidae Berry, 1910 (1812)

Genus *Turriscala* de Boury, 1890

Type species – *Scala torulosa* Brocchi, 1814.

***Turriscala rudis* (Philippi, 1843)**

Plate 3, fig. 7

- 1843 *Scalaria rudis* Philippi, p. 21, pl. 3, fig. 27.
- 1859 *Scalaria recticosta* Sandberger, pl. 11, fig. 4.
- 1860 *Scalaria recticosta* Sandb. – Sandberger, p. 119.
- 1867 *Scalaria rudis* Phil. – von Koenen, p. 109, pl. 2.
- ? 1869 *Scalaria rudis* Phil. – Speyer, p. 336, non pl. 35, fig. 4.
- 1941 *Scalaria rudis* Philippi – Gorges, p. 143.
- 1952 *Turriscala (Turriscala) rudis* (Philippi 1843) – Gorges, p. 72, pl. 2, fig. 54.
- 1954 *Opalia (Rudiscala) recticosta* Sandberger, sp. 1863 – Glibert & de Heinzelin, p. 358, pl. 6, fig. 8.
- 1957 *Opalia (Rudiscala) pusilla* Philippi, sp., 1843 f. *recticosta* Sandberger, sp. 1863 – Glibert, p. 52, pl. 4, fig. 14.
- 1973 *Turriscala (Rudiscala) recticosta* (Sandberger, 1859) – Kuster-Wendenburg, p. 56, pl. 3, fig. 45.
- 1978a *Turriscala (Turriscala) rudis* (Philippi 1843) – R. Janssen, p. 73.

Locus typicus – Willems Höhe near Kassel, Hessen, Germany.

Stratum typicum – ‘Kasseler Meeressand’ (Chattian, Late Oligocene).

Material studied – Mol, -225 m level: 2 (RM). Niel, S30 (Pl. 3, fig. 7), H 11.2 mm, W 5.0 mm (RBINS IST 7669).

Description – Solid, elongated species with moderately convex whorls, suture distinct. Protoconch not preserved in the available material. Ornament on the last whorl of 10 strong, slightly prosocline axial ribs, narrower than their intercostal spaces. In between very fine spirals are visible. The axial elements end on a clearly separated basal disk. Fine spirals may be present on the disk as well. Aperture round, its margin coinciding with the last radial element; callus distinct, separated from the base by a groove.

Discussion – *Opalia rudis* (Philippi, 1843) has been interpreted by many authors as a senior synonym of *Opalia recticosta* (Sandberger, 1863) (e.g. Glibert, 1957), but in our opinion the differences are sufficient to consider them independent species. *Opalia recticosta* has more orthocline, more close-set axial ribs and its spiral elements are much stronger (see R. Janssen, 1978b, pl. 12, fig. 57).

Occurrence – The species is very rare in the S50 bed of the Boom Clay Formation and in the -225 m level at Mol. Furthermore, it is present in the Berg Sand Member (Glibert & de Heinzelin, 1954). It occurs also in the German Mayence Basin Alzey Formation.

Superfamilia Eulimoidea Philippi, 1853

Familia Eulimidae Philippi, 1853

Genus and subgenus *Niso* Risso, 1826

Type species – *Niso eburnea* Risso, 1826.

***Niso (Niso) leenaertsii* nov. sp.**

Plate 3, fig. 8

Locus typicus – Kruikebeke, Gralex clay-pit, province of Oost Vlaanderen, Belgium.

Stratum typicum – Boom Clay Formation, Putte Member, S50 bed (Rupelian, Early Oligocene).

Type material – Holotype (Pl. 3, fig. 8), H 7.4 mm, W 3.2 mm (RBINS IST 7670); paratype from Kruikebeke, S50 (RBINS IST 7671); paratype from Kruikebeke, S50 (RBINS IST 7672).

Additional material – Rumst, S50: 1; Niel, S50: 9; Kruikebeke, S50: 27; Kruikebeke, S60: 1 (all RM).

Derivatio nominis – Named after Mr J. Leenaerts, for his support during the field work at various localities.

Description – Rather small, solid, conical shell with eight flat whorls and a shallow suture. Shell width slightly less than 45% of height. Last whorl occupying almost half of total height. Protoconch not preserved. Last whorl with a very slight carina demarcating the base of the shell. Shell

surface glossy, without any ornament present. Aperture oval, pointed above and below. A narrow callus is present. Umbilicus small, but open.

Discussion – Several other *Niso* species occur during the Oligocene of the North Sea Basin. *Niso minor* Philippi, 1843 from the German Late Oligocene Chattian is slightly more slender, with a narrower aperture and a wider umbilicus (see R. Janssen, 1978a, pl. 13, fig. 78). *Niso turris* von Koenen, 1865, illustrated by Welle (1998, pl. 23, fig. 1) is wider and has a clearly angular last whorl. *Niso acuta* (von Koenen, 1891) (see Marquet *et al.*, in press, pl. 7, fig. 6) from the earliest Rupelian Latdorf Formation and from the Grimmertingen Sand Member is less slender, with a much wider umbilicus, bordered by a spiral rib.

Occurrence – This is a rare species in the Boom Clay Formation, solely occurring in the S50 and S60 beds.

Genus and subgenus *Melanella* Bowdich, 1822

Type species – *Melanella dufresnii* Bowdich, 1822.

***Melanella (Melanella) cf. auriculata* (von Koenen, 1867)**
Plate 3, fig. 9

- 1867 *Eulima auriculata* von Koenen, p. 103, pl. 7, fig. 3.
- 1870 *Eulima subula* d'Orbigny – Speyer, p. 70, pl. 12, figs 6-8 (*non* d'Orbigny).
- 1870 *Eulima emersa* Speyer, p. 70, pl. 12, fig. 3.
- 1872 *Eulima subula* d'Orbigny – Koch & Wiechmann, p. 114 (*non* d'Orbigny).
- 1891 *Eulima auriculata* – von Koenen, p. 633, pl. 42, figs 14-15.
- 1943 *Melanella (Polygyreulima) auriculata* (von Koenen) – Albrecht & Valk, p. 40, pl. 3, figs 61-8, pl. 22, figs 891-894.
- 1952 *Melanella subula* (Orbigny 1852) – Görges, p. 74, pl. 2, figs 55-56 (*non* d'Orbigny).
- 1954 *Melanella (Polygyreulima) auriculata* – Glibert & de Heinzelin, p. 359, pl. 6, fig. 12.
- 1978b *Eulima emersa* Speyer, 1870 – R. Janssen, p. 187, pl. 13, fig. 76.
- 1987 *Eulima (Eulima) emersa* Speyer, 1870 – Schnetler & Beyer, p. 204.
- 1990 *Eulima (Eulima) emersa* Speyer, 1870 – Schnetler & Beyer, p. 48.
- 1998 *Melanella (Melanella) auriculata* (Koenen, 1867) – Welle, p. 17, pl. 22, figs 7-8.
- 2009 *Melanella cf. auriculata* (Koenen, 1867) – Welle, p. 118.

Original localities – Latdorf, Calbe an der Saale, Atzendorf, Wolmirsleben, Helmstedt (all Germany).

Stratum typicum – 'Latdorf Stufe', Early Oligocene or Annenberg or Gehlberg Formation, Late Eocene (Helmstedt).

Material studied – Kruikebeke, S50: 1 (Pl. 3, fig. 9), H 2.3 mm, W 0.6 mm (RBINS IST 7673).

Description – Small, fragile, strongly elongated species. Shell width 25% of height. Eight whorls are present; these are flat, except rounded abapical part of last whorl. Shell straight. Suture indistinct. Protoconch smooth, not clearly delimited, damaged in all specimens at hand. Aperture damaged, with a distinct callus at the abapical columellar side.

Discussion – This specimen is with doubt assigned to *Melanella (Melanella) auriculata* (von Koenen, 1867), because of its general shape, which is very similar to that illustrated by Welle (1998). However, the most important features protoconch and aperture, are to poorly preserved for a reliable identification.

Occurrence – The species is not previously recorded from the Boom Clay Formation; we just found a single specimen in the S50 bed. In The Netherlands, Germany and Denmark it is known from the 'Rupelton' and from Chattian deposits.

Familia Aclididae G.O. Sars, 1878
Genus and subgenus *Aclis* Lovén, 1846

Type species – *Alvania supranitida* Wood, 1842.

***Aclis (Aclis) vetusta* Wiechmann, 1874**
Plate 3, fig. 10

- 1874 *Aclis vetusta* Wiechmann, 200, pl. 9, fig. 1.
- 1952 *Cerithiopsis supraoligocaenica* Görges, p. 70, pl. 2, figs 52-53.
- 1978a *Aclis (Aclis) supraoligocaenica* (Görges 1852) – R. Janssen, p. 77.
- 1978b *Aclis (Aclis) vetusta* Wiechmann 1874 – R. Janssen, p. 184, pl. 13, fig. 70.
- 1990 *Aclis (Aclis) vetusta* Wiechmann, 1878 – Schnetler & Beyer, p. 48.
- 1996 *Aclis (Aclis) vetusta* Wiechmann, 1878 – Moths *et al.*, p. 23, pl. 5, fig. 5.
- 2000 *Aclis (Aclis) vetusta* Wiechmann, 1878 – Moths, p. 33, pl. 10, fig. 6.

Locus typicus – Krefeld, Nordrhein-Westphalen, Germany.

Stratum typicum – 'Grafenberger Sande' (Chattian, Late Oligocene).

Material studied – Kruikebeke, S50: 3 (RM). Kruikebeke, S50, 1 (Pl. 3, fig. 10), H 2.3 mm, W 1.2 mm), lost as a result of pyrite oxydation.

Description – Elongated, conical, fragile shell, about half as wide as high, the last whorl occupies one third of total shell height. Protoconch of one and a half smooth, bul-

bous whorls. The boundary with the teleoconch is formed by an indistinct axial line. Teleoconch of approximately five rounded whorls, separated by a distinct suture. Teleoconch ornament starts with two distinct spiral ribs on mid whorl, increasing in number to five on the last whorl, gradually distributed and much narrower than their interspaces. A sixth spiral on the last whorl delimits the smooth base of the shell and is situated close to the fifth middle whorl spiral. Between and on the primary elements, very fine secondary spirals can be seen at large magnification. Aperture slightly oval, with a thickened callus on the abapical part of the columellar side.

Discussion – From the German Chattian of the Kassel area *Aclis (Stilbe) proneglecta* R. Janssen (1978a, p. 77, pl. 2, fig. 7) was described, but this species differs in lacking ornament. R. Janssen (1978a) considered *Aclis vetusta* Wiechmann, 1874 to be a *nomen oblitum*, but the name has been used also later, e.g. by R. Janssen (1978b) and Schnetler & Beyer (1990). The specimen of *A. vetusta* illustrated by R. Janssen (1978b) has more angular whorls and the spirals are thicker, but this could fall within the range of variability of the species. *Aclis guersi* (Welle, 2009, p. 119, pl. 6, fig. 2) differs from the new species in being smooth.

Occurrence – This species is extremely rare in the S50 bed at Kruikebeke. It has been recorded also from German and Danish Chattian deposits.

Conclusions

The distribution of 21 species discussed herein over the various levels of the Boom Clay Formation in Belgium is specified in Table 1.

The occurrence in the Boom Clay Formation of a single species, *Echinophoria rondeleti* (de Basterot, 1825), reorded by Glibert (1957) from this unit, was not confirmed during the present survey. On the other hand, 12 species reorded herein had not previously been found in the Boom Clay Formation. Of these, 7 are new for science and described herein.

Two of the septaria beds yielded a larger number of species compared to the other ones: S30 with 10 species and S50 with 14 species. One species, *Cocculina reineckekei* nov. sp., was found exclusively in sand around a tree trunk in the S30 level at Niel.

The distribution of the species is comparable to the results of Marquet (2010, table 1) for the Boom Clay Forma-

Species	Belsele-Waas Member	Terhagen Member			Putte Member		Mol
	S10	S20	S30	S41	S50	S60	
<i>Solariella (Solariella) bernaysi</i> Glibert, 1955					x		
<i>Moelleriopsis krylovi</i> nov. sp.					x		
<i>Cocculina reineckekei</i> nov. sp.			x				
<i>Capulus (Capulus) elegantulus</i> Speyer, 1864							x
<i>Ficus (Ficus) concinna</i> (Beyrich, 1854)			x		x	x	x
<i>Euspira helicina achatensis</i> (de Koninck, 1837)	x		x	x	x	x	x
<i>Cochlis deborgeri</i> nov. sp.			x				
<i>Alvania (Arsenia) goolaertsi</i> nov. sp.							x
<i>Alvania (Arsenia) vanremoorteli</i> nov. sp.					x		
<i>Pseudocirslope confusa</i> (Kadolsky, 1973)			x		x		
<i>Pseudocirslope pusilla</i> (von Koenen, 1892)					x		
<i>Arrhoges (Arrhoges) speciosus</i> (von Schlotheim, 1820)	x	x	x	x	x	x	
<i>Galeodea nodosa depressa</i> (von Buch, 1831)			x		x	x	
<i>Echinophoria rondeleti</i> (de Basterot, 1825)							
<i>Sassia flandrica</i> (de Koninck, 1837)		x	x		x		
<i>Vermetus dufreigni</i> nov. sp.					x		x
<i>Tugurium (Trochotugurium) scrutarium</i> (Philippi, 1843)			x			x	
<i>Turriscala rudis</i> (Philippi, 1843)			x				x
<i>Niso (Niso) leenaertsi</i> nov. sp.					x	x	
<i>Melanella (Melanella) cf. auriculata</i> (von Koenen, 1867)					x		
<i>Aclis (Aclis) vetusta</i> Wiechmann, 1874					x		
Total number of species: 21	2	2	10	2	14	6	6

Table 1. Distribution of the species in the various septarian beds, as recorded herein.

tion bivalve assemblages, in which S30 with 16 species and S50 with 18 species (out of a total of 39) were demonstrated to be the beds with the most diverse mollusc fauna. A comparison of the entire mollusc fauna of the Boom Clay with other deposits and strata will be given in a forthcoming paper.

Acknowledgements

First I wish to thank those persons who allowed me to study their collected materials, assisted with the field work or donated specimens, namely Messrs T. Reinecke, G. Deborger, S. Goolaerts, W. Van Remoortel and L. Dufrain. Mrs A. Folie and Mr L. Cilis (both RBINS) are thanked for making the photograph of Textfig. 1 and the SEM images, respectively. I am also grateful to the editor of this journal, for his numerous improvements to the text of the manuscript, and to Mr K.I. Schnetler (Stevnstrup, Denmark) and Dr M.C. Cadée (Leiden, The Netherlands) who read the manuscript.

References

- Albrecht, J.C.H. & Valk, W. 1943. Oligocäne Invertebraten von Süd-Limburg. *Mededeelingen van de Geologische Stichting C-IV-1* (3): 1-163, pls 1-27.
- Anderson, H.-J. 1959. Die Gastropoden des jüngeren Tertiärs in Nordwestdeutschland, 1. Prosobranchia, Archaeogastropoda. *Meyniana* 8: 37-81, figs 1-5.
- Báldi, T. 1973. *Mollusc fauna of the Hungarian Upper Oligocene (Egerian). Studies in stratigraphy, palaeoecology, paleogeography and systematics*. Budapest (Akadémiai Kiadó): 511 pp, pls 1-5.
- Basterot, B. de 1825. Description géologique du bassin tertiaire du sud-ouest de la France. *Mémoires de la Société d'Histoire naturelle de Paris* 2: 1-100, pls 1-7.
- Beyrich, E. 1853-1856. Die Conchylien des norddeutschen Tertiärgebirges. *Zeitschrift der deutsche geologische Gesellschaft* 5: 273-358, pls 4-8 (1853), 6: 408-500, pls 9-14 (1854), 726-781, pls 15-18 (1854), 8: 21-88, pls 1-10 (1856), 553-588, pls 15-17 (1856).
- Bosch, M. van den, Cadée, M.C. & Janssen, A.W. 1975. Lithostratigraphical and biostratigraphical subdivision of Tertiary deposits (Oligocene-Pliocene) in the Winterswijk-Almelo region (eastern part of the Netherlands). *Scripta Geologica* 29: 1-167, pl. 1-23, table 1-10, figs 1-36.
- Bouchet, P. & Rocroi, J.P. 2005. Classification and Nomenclator of Gastropod Families. *Malacologia* 47(1-2): 1-397.
- Buch, L. von 1831. Über zwei neue Arten von Cassidarien in den Tertiär-Schichten von Mecklenburg. *Abhandlungen der königlichen Akademie der Wissenschaften zu Berlin* (1828): 61-71, pls 1-4.
- Cadée, M.C. 1969. Een overzicht van de Rupelienfauna uit de E3 Scheldetunnel te Antwerpen. *Mededelingen van de Werkgroep voor Tertiaire en Kwartaire Geologie* 6 (1-2): 39-45, 1 map, 8 figs.
- Cossmann, M. & Lambert, J. 1884. Étude paléontologique et stratigraphique sur le terrain Oligocène marin aux environs d'Étampes. *Mémoires de la Société Géologique de France* (3)3: 1-187, pls 1-6.
- Giannuzzi-Savelli, R., Pusateri, F., Palmeri, A. & Ebreo, C. 1994. *Atlante delle conchiglie marine del Mediterraneo*, 1. Roma (La Conchiglia): 125 pp, figs 1-395.
- Glibert, M., 1952. Faune malacologique du Miocène de la Belgique 2 Gastropodes. *Mémoires de l'Institut royal des Sciences naturelles de Belgique* 121: 1-197, pls 1-19.
- Glibert, M. 1955. Quelques espèces nouvelles ou mal connues de l'Oligocène moyen et supérieur de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique* 31(86): 1-7.
- Glibert, M. 1957. Pélécytopodes et gastropodes du Rupélien et du Chattien de la Belgique. *Institut royal des Sciences naturelles de Belgique, Mémoire* 137: 1-98, pls 1-6.
- Glibert, M. & de Heinzelin, J. 1954. *L'Oligocène inférieur belge. Volume Jubilaire Victor Van Straelen*, 1. Bruxelles (Institut royal des Sciences naturelles de Belgique): 281-438, pl. 1-7.
- Görge, J. 1941. Die Oberoligocänfauna von Rumeln am Niederrhein. *Decheniana* 100A: 115-186, pls 1-3.
- Görge, J. 1952. Die Lamellibranchiaten und Gastropoden des oberoligozänen Meeressandes von Kassel. *Abhandlungen des Hessischen Landesamtes für Bodenforschung* 4: 1-134, pls 1-3.
- Gründel, J. 1997. Die Gastropodenfauna des Rupels von Amsdorf (westlich Halle). The gastropods from the Rupelian of Amsdorf (near Halle). *Palaeontographica*: A 243(1-6): 1-36, figs 1-21, pls 1-6.
- Gürs, K. 1995. *Revision der marinen Molluskenfauna des Unteren Meeressandes (Oligozän, Rupelium) des Mainzer Beckens*. PhD thesis University Mainz Germany: 314 pp, 64 pls (unpublished).
- Gürs, K. & Moths, H. 2002. Neues zu den Rissoiden (Mollusca, Gastropoda) aus dem Rupelium (Oligozän) des Mainzer Becken und des Nordseebeckens. *Courrier Forschungs-Institut Senckenberg* 237: 255-273, figs 1-6, pls 1-3.
- Hajtink, B. & Davies, C. 1998. In situ testing in underground research laboratories for radioactive waste disposal. Proceedings of a cluster seminar held in Alden Biesen, Belgium, 10 and 11 December 1997. Luxembourg (Office for Official Publications of the European Communities): viii + 339 pp.
- Harder, P. 1913. Die oligocaene Lag i Jaernbanegennemskæringene ved Århus Station. *Danmarks geologiske Undersøgelse* (II) 22: 1-140.
- Hözl, O. 1962. Die Molluskenfauna der oberbayerischen marinen Oligozänmolasse zwischen Isar und Inn und ihre stratigraphische Auswertung. *Geologica Bavarica* 50: 1-275, figs 1-13, pls 1-12.
- Janssen, A.W. 1984. *Mollusken uit het Mioceen van Winterswijk-Miste. Een inventarisatie, met beschrijvingen en afbeeldingen van alle aangetroffen soorten*. Amsterdam (Koninklijke Nederlandse Natuurhistorische Vereniging, Nederlandse Geologische Vereniging, Rijksmuseum van Geologie en Mineralogie): 451 pp., text-figs 1-7, pls 1-82.
- Janssen, R. 1978a. Die Scaphopoden und Gastropoden des Kasseler Meeressandes von Glimmerode (Niederhessen). *Geologisches Jahrbuch* 41: 1-195, figs 1-3, pls 1-7.
- Janssen, R. 1978b. Die Mollusken des Oberoligozäns (Chat-

- tium) im Nordsee-Becken, 1. Scaphopoda, Archaeogastropoda, Mesogastropoda. *Archiv für Molluskenkunde* 100(1-3): 137-227, pls 9-13.
- Kadolsky, D. 1973. Die vorpliozänen Littorinidae und Lacunidae Mitteleuropas (Gastropoda: Prosobranchia). *Archiv für Molluskenkunde* 103(1-3): 31-62, figs 1-30.
- Koenen, A. von 1867. Das marine Mittel-Oligocän Norddeutschlands und seine Molluskenfauna, 1. *Palaeontographica* 16(2): 53-128, pls 1-7.
- Koenen, A. von 1891. Das Norddeutsche Unter-Oligocän und seine Mollusken-Fauna, 3. Naticidae – Pyramidellidae – Eulimidae – Cerithidae – Turritellidae. *Abhandlungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten* 10: 575-817, pls 40-52.
- Koenen, A. von 1892. Das norddeutsche Unter-Oligocän und seine Mollusken-Fauna, 4. Rissoidae – Littorinidae – Turbinidae – Haliotidae – Fissurellidae – Calyptraea – Patelidae. *Gastropoda Opisthobranchiata. Gastropoda Polyplacophora. Abhandlungen zur geologischen Specialkarte von Preussen und den Thüringischen Staaten* 10: 818-1004, pls 53-62.
- Koninck, L. de 1837. Description des coquilles fossiles de l'argile de Basele, Boom, Schelle, etc... *Nouvelles Mémoires de l'Académie des Sciences et Belles-Lettres de Bruxelles* 11: 1-37, pls 1-4.
- Kuster-Wendenburg E., 1973. Die Gastropoden aus dem Meeressand (Rupelium) des Mainzer Tertiärbeckens. *Abhandlungen des Hessischen Landesamtes für Bodenforschung* 67: 1-170, pls 1-8.
- Lozouet, P. (coord.) 2012. *Stratotype Stampien*. Paris (Muséum national d'Histoire naturelle). Biotope Mèze: 461 pp, figs 1-290.
- Maréchal, R. 1991. A new lithostratigraphic scale for the Paleogene of Belgium. *Abstracts 3rd Biannual Joint Meeting Regional Committees on Northern Palaeogene and Northern Neogene Stratigraphy, Gent*, 9-13 September 1991: 2 p., 1 fig.
- Maréchal, R. & Laga, P. 1988. *Voorstell lithostratigrafische in-deling van het Paleogeen*. Brussel (Nationale Commissies voor Stratigrafie, Commissie Tertiair, Belgische Geologische Dienst): 208 pp.
- Marquet, R. 1998. De Pliocene gastropodenfauna van Kallo (Oost-Vlaanderen, België). *Publicatie van de Belgische Vereniging voor Paleontologie v.z.w.* 17: 1-246, many textfigs.
- Marquet, R. 2010. Reassessment of the Bivalvia (Mollusca) from the Boom Formation (Rupelian, Oligocene) of Belgium, with description of new species. *Bulletin de l'Institut royal des Sciences naturelles de Belgique. Sciences de la Terre* 80: 253-282, figs 1-4, pls 1-3.
- Marquet, R., Laporte, J. & Lenaerts, J. in press. A systematic study of the Gastropoda (Mollusca) from the Grimmertingen Sand Member (Early Oligocene). – *Palaeontos*.
- Moths, H. 2000. *Die Molluskenfauna im Rupelton der Ziegeleitongrube Malliss im Wanzeberg (südwestl. Mecklenburg-Vorpommern)*. Malliss (Regionalmuseum des Amtes Malliss, Mecklenburg-Vorpommern): 58 pp, figs 1-12, pls 1-22.
- Moths, H., Montag, A. & Grant, A. 1996. Die Molluskenfauna des oberoligozänen 'Sternberger Gesteins', 1. *Erratica. Monographien zur Geschiebekunde* 1: 3-62, figs 1-8, pls 1-14.
- Müller, A. 2011. Der Steinbruch Mammendorf NW Magdeburg – ein Felslitoral der unteroligozänen Nordsee. *Geologica Saxonica*: 57: 1-118, figs 1-24, pls 1-19.
- Müller, A. & Welle, J. 1991. Mollusken aus dem Mitteloligozän des Schachtes Sophia Jacoba 8 (Erkelenz, NW-Deutschland). *Decheniana*, Beihefte 30: 149-211, figs 1-2, pls 1-4.
- Nyst, P.H. 1835. *Recherches sur les coquilles fossiles de la province d'Anvers*. Brussels (Périchon): 36 pp, pls 1-5.
- Nyst, P.H. 1845. *Description des coquilles et des polypiers fossiles des terrains tertiaires de la Belgique*. Brussels (Académie royale de Belgique): 675 pp, pl. 1-48.
- Philippi, R.A., 1843. *Beiträge zur Kenntniss der Tertiärversteinerungen des nordwestlichen Deutschlands*. Kassel (T. Fischer): 85 pp., 4 pls.
- Sandberger, F. 1858-1863. *Die Conchylien des Mainzer Tertiärbeckens*. Wiesbaden (Kreidel) (1-2): 1-72 (1858), (3): 73-112 (1859), (4): 113-152 (1860), (5-6): 153-232 (1861), (7): 233-272 (1862), (8): 272-458 (1863), pls 1-10 (1858), pls 11-15 (1859), pls 16-20 (1860), pls 21-30 (1861), pls 31-35 (1862).
- Schlotheim, E.F. von 1820. *Die Petrefactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung seiner Sammlung versteinierter und fossiler Überreste des Thier- und Pflanzenreichs der Vorwelt erläutert*. Gotha (Becker): 437 pp, pls 1-15.
- Schnetler, K.I. 2005. The Mollusca from the stratotype of the Gram Formation (Late Miocene, Denmark). – in: Roth, F. & Hoedemakers, K. (eds.) *The Geology and Palaeontology of the Gram Formation (Late Miocene) in Denmark*, 1. *Palaeontos* 7: 62-190.
- Schnetler, K.I. & Beyer, C. 1987. A Late Oligocene (Chattian B) mollusc fauna from the clay-pit of Galten Brickworks at Nørre Vissing, Jylland, Denmark. *Contributions to Tertiary and Quaternary Geology* 24(3): 193-224, figs 1-7, pls 1-3.
- Schnetler, K.I. & Beyer, C. 1990. A Late Oligocene (Chattian B) molluscan fauna from the coastal cliff at Mogenstrup, North of Skive, Jutland, Denmark. *Contributions to Tertiary and Quaternary Geology* 27(2-3): 39-81, figs 1-3, pls 1-2.
- Schnetler, K.I. & Palm, E. 2008. The molluscan fauna of the Late Oligocene Branden Clay/Denmark. *Palaeontos* 15: 1-92.
- Speyer, O. 1863-1869. Die Conchylien der Casseler Tertiärbildungen. *Palaeontographica* 9(3-5): 91-141, pls 18-22, 153-198, pls 30-34 (1863), 16 (5): 175-218 (1867); 16(7): 297-339 (1869), 19 (2, 4): 47-101, 159-202 (1870).
- Tembrock, M.L. 1964. Einige Beispiele von Faziesabhängigkeit bei tertiären Gastropoden. *Berichte der Geologischen Gesellschaft in der Deutschen Demokratischen Republik für das Gesamtgebiet der geologischen Wissenschaften* 9(3): 311-418, pls 3-8.
- Van Simaey, S. & Vandenberghe, N. 2006. Rupelian. In: Dejonghe, L. (editor) *Current status of chronostratigraphic units named from Belgium and adjacent areas. Geologica Belgica*, 9 (1-2): 73-93.
- Vandenberghe, N. 1978. Sedimentology of the Boom Clay (Rupelian) in Belgium. *Verhandelingen van de Koninklijke Akademie voor Wetenschappen, Letteren en Schone Kunsten van België* 40(147): 1-137, many figs.
- Vandenberghe, N. & Laga, P. 1986. The septaria of the Boom Clay (Rupelian) in its type area in Belgium. *Aardkundige Mededelingen* 3: 229-238.

- Vandenbergh, N. & Echelpoel, E. Van 1988. Field guide to the Rupelian stratotype. *Bulletin de la Société belge de Géologie* 96(4) (1987): 325-337.
- Warén, A. 1992. New and little known 'Skeneomorph' gastropods from the Mediterranean Sea and the adjacent Atlantic Ocean. *Bollettino Malacologico* 27(10-12): 149-247, fig. 1-47, figs 1-47.
- Welle, J. 1998. Oligozäne Mollusken aus dem Schacht 8 der Bergwerksgesellschaft Sophia Jacoba bei Erkelenz (Nieder-rheinische Bucht). *Leipziger Geowissenschaften* 4: 1-137, pls 1-31.
- Welle, J. 2009. Die Molluskenfauna des Magdeburger Sandes (Rupelium s. str.) aus dem Stadtgebiet von Magdeburg (Sachsen-Anhalt), 2. Amphineura und Gastropoda. *Abhandlungen und Berichte für Naturkunde* 32: 83-211, pls 1-12.
- Wiechmann, C.M. 1874. Conchylien der Tertiärzeit. *Jahrbuch der deutschen Malakozoologische Gesellschaft* 1: 199-207.
- WoRMS, 2015. World Register of Marine Species, 2014. Accessed at <http://www.marinespecies.org/aphia.php>.

Plate 1

1. *Solariella (Solariella) bernaysi* Glibert, 1955. Kruikebeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7679.
2. *Moelleriopsis krylovi* nov. sp., **holotype**. Niel, Ceulemans clay-pit, province of Antwerp, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7645.
3. *Cocculina (Cocculina) reinecke* nov. sp., **holotype**. Kobrow, Thomas sand-pit, Mecklenburg, Germany. Sternberger Gestein, Chattian, Late Oligocene. RBINS IST 7650.
4. *Cocculina (Cocculina) reinecke* nov. sp., **paratype**. Niel, Ceulemans clay-pit, province of Antwerp, Belgium. S30 bed, Boom Clay Formation, Terhagen Member, Rupelian, Early Oligocene. Lost due to pyrite oxydation.

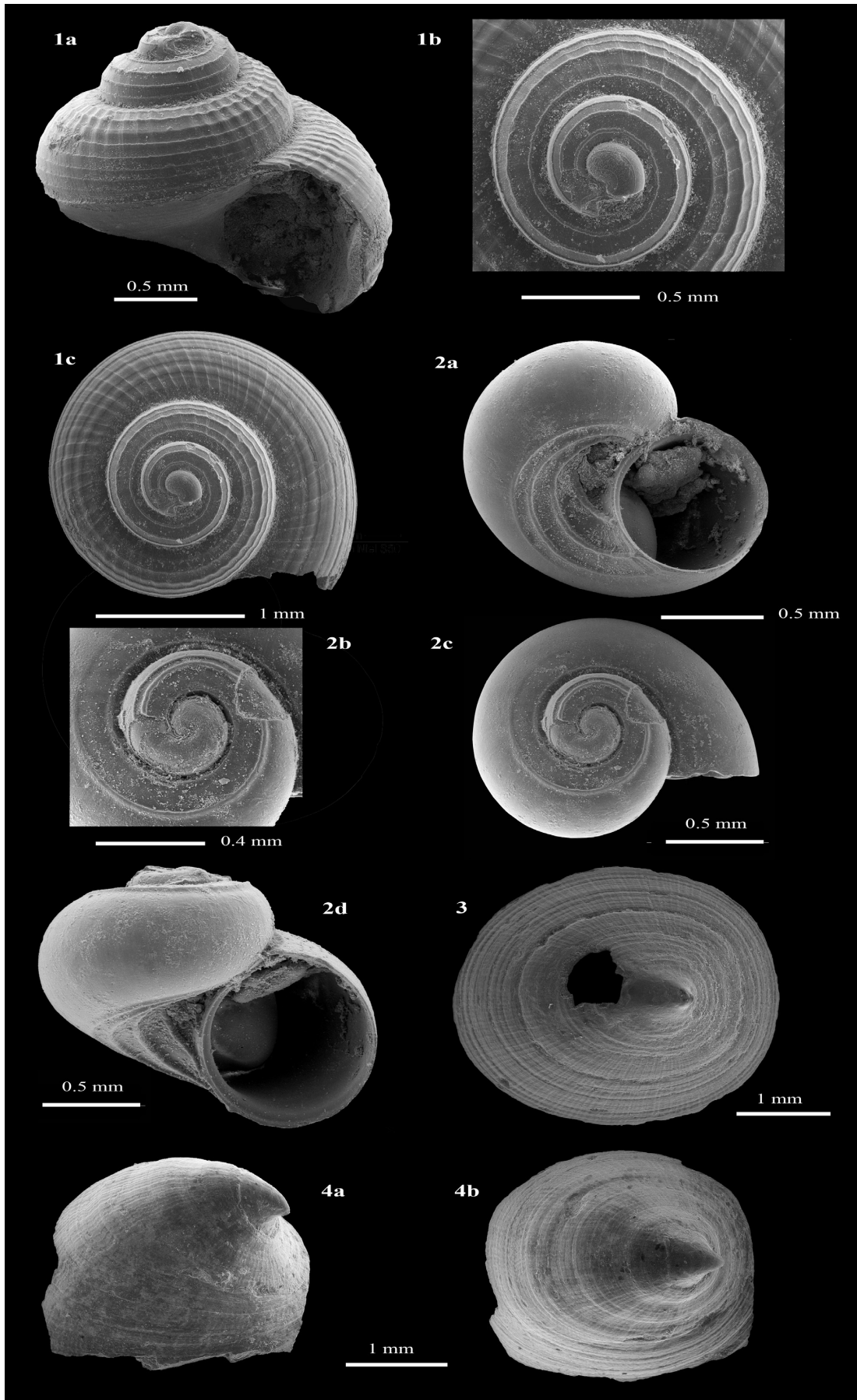


Plate 1

Plate 2

1. *Ficus (Ficus) concinna* (Beyrich, 1854). Rumst, Wienerberger clay-pit, province of Antwerp. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7652.
2. *Cochlis deborgeri* nov. sp., **holotype**. Niel, Ceulemans clay-pit, province of Antwerp, Belgium. S30 bed, Boom Clay Formation, Terhagen Member, Rupelian, Early Oligocene. RBINS IST 7653.
3. *Cochlis deborgeri* nov. sp., **paratype**. Niel, Ceulemans clay-pit, province of Antwerp, Belgium. S30 bed, Boom Clay Formation, Terhagen Member, Rupelian, Early Oligocene. RBINS IST 7654.
4. *Alvania (Arsenia) goolaerti* nov. sp., **holotype**. Mol, shaft digging for underground laboratory, -225 m level, province of Antwerp, Belgium. Boom Clay Formation, transitional layers to Chattian deposits. RBINS IST 7655.
5. *Alvania (Arsenia) vanremoorteli* nov. sp., **holotype**. Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7657.

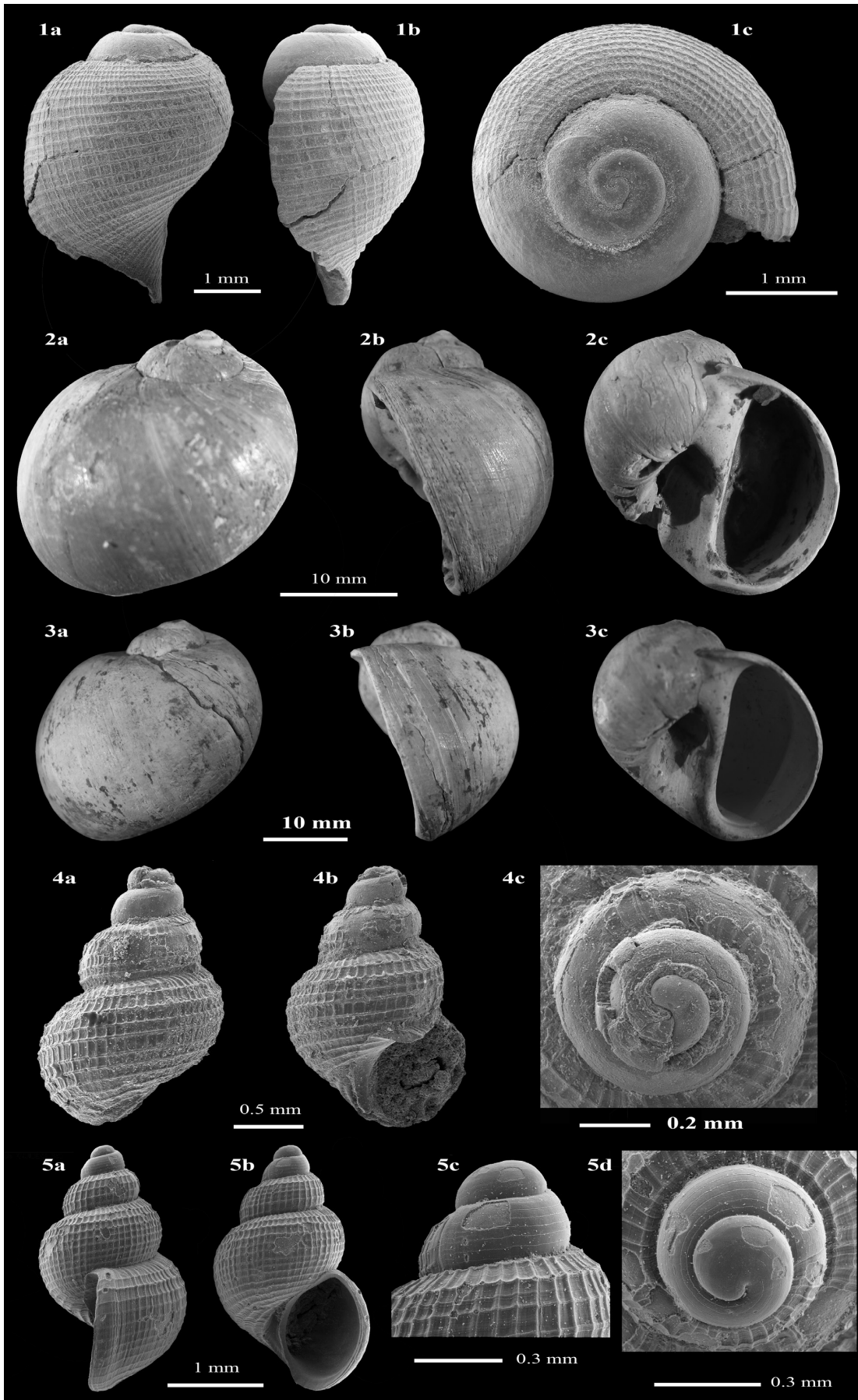


Plate 2

Plate 3

1. *Pseudocirsope confusa* (Kadolsky, 1973). Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7661.
2. *Pseudocirsope pusilla* (von Koenen, 1892). Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7662.
3. *Arrhoges (Arrhoges) speciosus* (von Schlotheim, 1820), apical whorls. Rumst, Wienerberger clay-pit, province of Antwerp, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. Coll. RBINS IST 7663.
4. *Sassia flandrica* (de Koninck, 1837). Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7664.
5. *Vermetus dufraigni* nov. sp., **holotype**. Mol, shaft digging for underground laboratory, -225 m level, province of Antwerp, Belgium. Boom Clay Formation, transitional layers to Chattian deposits. RBINS IST 7665.
6. *Vermetus dufraigni* nov. sp., **paratype**. Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7666.
7. *Turriscala rudis* (Philippi, 1843). Niel, Ceulemans clay-pit, province of Antwerp, Belgium. S30 bed, Boom Clay Formation, Terhagen Member, Rupelian, Early Oligocene. RBINS IST 7669.
8. *Niso (Niso) leenaertsi* nov. sp., **holotype**. Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7670.
9. *Melanella (Melanella) cf. auriculata* (von Koenen, 1867). Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, Rupelian, Early Oligocene. RBINS IST 7673.
10. *Aclis (Aclis) vetusta* Wiechmann, 1874. Kruibeke, Argex clay-pit, province of Oost Vlaanderen, Belgium. S50 bed, Boom Clay Formation, Putte Member, disintegration Rupelian, Early Oligocene. Specimen lost due to pyrite oxydation.

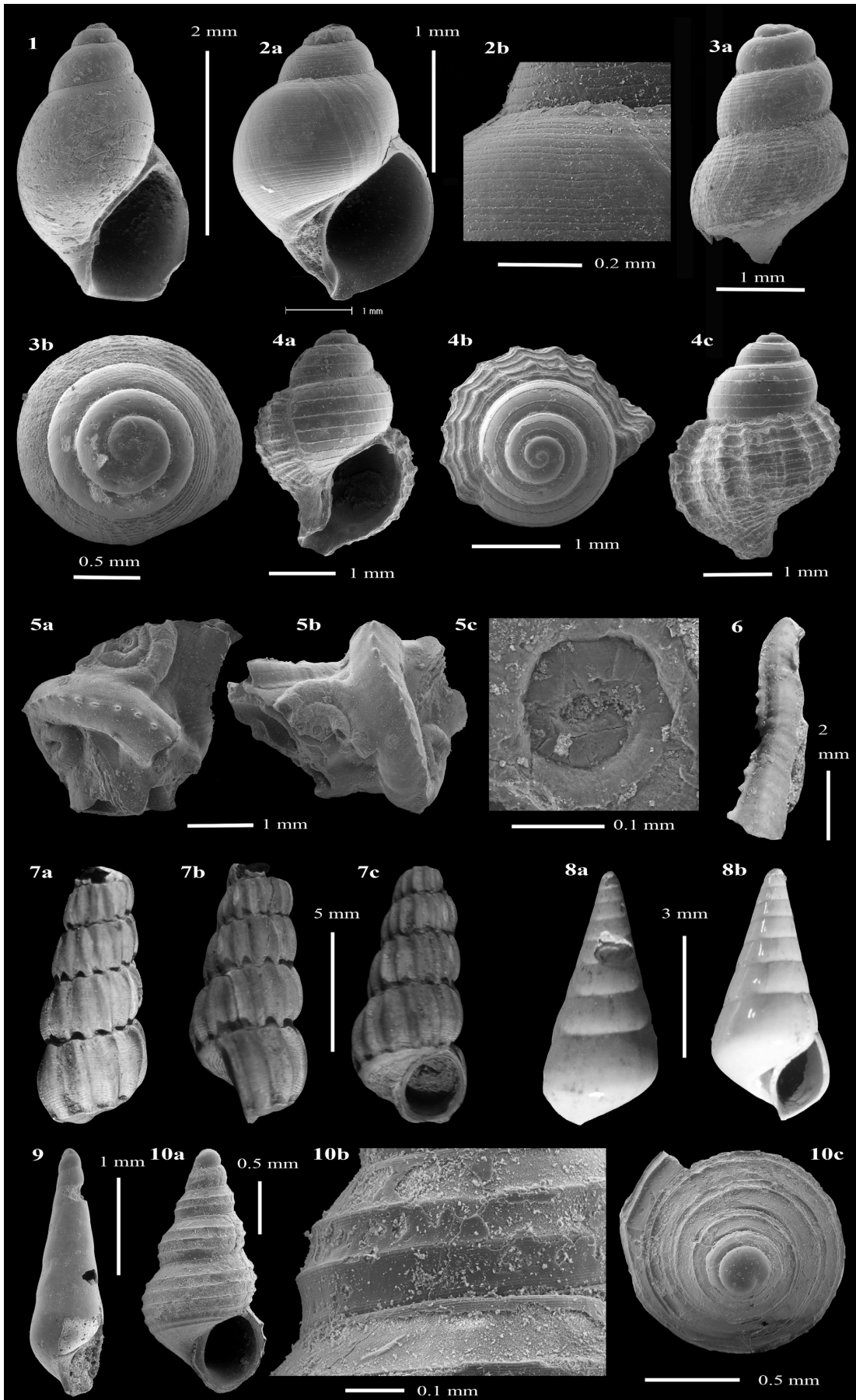


Plate 3