

The family Triphoridae in the Neogene of Belgium (Mollusca, Gastropoda)

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Abstract

The taxonomy of the Neogene Triphoridae of Belgium is revised. From the Pliocene, the species *Marshallora adversa* (MONTAGU, 1803), *Triphora radiospirata* sp. nov., *Triphora antwerpiensis* sp. nov., *Obesula scaldensis* sp. nov., *Norephora pliocaenica* sp. nov., *Subuliphora fritschi* (VON KOENEN, 1882), *Inella vandermarki* sp. nov., and *Metaxia metaxae* (DELLE CHIAJE, 1828) are described from the Kattendijk Formation and the Luchtbal and Oorderen Sand Members. Three Miocene species are studied: *Subuliphora fritschi* (VON KOENEN, 1882), *Triphora borealis* KAUTSKY, 1925 and *Metaxia degrangei* (COSSMANN & PEYROT, 1922).

Key-words: Triphoridae, Gastropoda, Mollusca - taxonomy - Neogene - Belgium.

Résumé

La taxinomie des Triphoridae du Néogène belge est révisée. Dans le Pliocène, les espèces *Marshallora adversa* (MONTAGU, 1803), *Triphora radiospirata* sp. nov., *Triphora antwerpiensis* sp. nov., *Obesula scaldensis* sp. nov., *Norephora pliocaenica* sp. nov., *Subuliphora fritschi* (VON KOENEN, 1882), *Inella vandermarki* sp. nov., et *Metaxia metaxae* (DELLE CHIAJE, 1828) sont décrites du Formation de Kattendijk et des Sables de Luchtbal et d'Oorderen. Trois espèces miocènes sont étudiées: *Subuliphora fritschi* (VON KOENEN, 1882), *Triphora borealis* KAUTSKY, 1925 et *Metaxia degrangei* (COSSMANN & PEYROT, 1922).

Mots-clefs: Triphoridae, Gastropoda, Mollusca - taxinomie - Néogène - Belgique.

Introduction

During more than twenty years, the dock works in Kallo have yielded a very interesting, well preserved and diverse Pliocene fauna. It contains a large number of mollusc taxa, which are new for the Pliocene of Belgium or even undescribed. MARQUET (1984, 1993) described the mollusc fauna of the Kattendijk Formation and the Kruisshans Sand Member of this locality. HOEDEMAKERS & MARQUET (1992) summarised the stratigraphy of the area. Now, in a number of papers, the mollusc fauna of the different strata of Kallo is being revised systematically. The family Triphoridae proved to contain a high number of taxa, new for Belgium.

Metro works, tunnel works and other temporary exposures in the city of Antwerp, as well as excavations in Wilrijk and Zonderschot, made by the "Belgische Vereniging voor Paleontologie" (Belgian Association for Palaeontology) yielded important new Miocene material, from the Antwerp, Zonderschot, as well as Edegem Sand Members. Part of these exposures was described by MARQUET (1991).

Also the Neogene material of this family, kept in the "Institut royal des Sciences naturelles de Belgique", Brussels, from other localities and from the "Nationaal Natuurhistorisch Museum", Leiden, The Netherlands, was studied.

Abbreviations used

Coll. AJ.: collection Anton Janse, RM: R. Marquet, KBIN: Institut royal des Sciences naturelles de Belgique, NNM: Nationaal Natuurhistorisch Museum.

sp. : specimens, fr.: fragments, H: height, W: width.

Systematic position

Phylum Mollusca
Classis Gastropoda CUVIER, 1797
Order Neotaenioglossa HALLER, 1882
Superfamily Triphoroidea GRAY, 1847
Family Triphoridae GRAY, 1847
Subfamily Triphorinae GRAY, 1847
Triphora-group

The subfamily Triphorinae can, according to MARSHALL (1983 p. 6) be divided into a *Triphora*-group and an *Inella*-group, characterised as follows "Simultaneous appearance of spirals 1-3, with spiral 1 weak throughout, is a major difference separating most of the *Inella*-group from other Triphorinae, in which spirals 1-3 commence and remain at more or less similar size, or in which spiral 2 commences late", but this division has not yet been formalised in nomenclature.

Genus *Marshallora* BOUCHET, 1985
Marshallora adversa (MONTAGU, 1803)
 Pl. 1, Fig. 1.

SYNONYMY

- 1848 *Cerithium adversum* MONT. - WOOD, p. 72, pl. 8 fig. 8.
 1878 *Cerithium perversum*, L. - NYST, pl. 6 fig. 7 (non LINNAEUS, 1758).
 1881 *Cerithium perversum*, L. - NYST, p. 76-77 (non LINNAEUS, 1758).
 1918 *Triforis perversa* (LINNE) var. *adversa* (MONTAGU) - HARMER, p. 425, pl. 41 fig. 25.
 1946 *Triphora (Triphora) perversa adversa* (MONTAGU, 1803) - BEETS, p. 48.
 1958 *Triphora perversa* LINNE, sp 1758 - GLIBERT, p. 10 (non LINNAEUS, 1758).
 1965 *Triphora perversa* (LINNAEUS, 1758) - VAN REGTEREN ALTENA et al., p. 18-19, pl. 6 fig. 67 (non LINNAEUS, 1758).
 1978 *Triphora adversa* MONTAGU, 1803 - BOUCHET & GUILLEMOT, p. 350, fig. 1, 7, 11, 15, 16, 20.
 1982 *Triphora adversa* (MONTAGU, 1803) - FRETTER & GRAHAM, p. 380-382, fig. 270-272.
 1985 *Marshallora adversa* (MONTAGU, 1803) - BOUCHET, p. 45-49, fig. 4, 12, 21, 32, 34.
 1988 *Triphora adversa* (MONTAGU, 1803) - GRAHAM, p. 480-481, fig. 202 a, b.

ORIGINAL DESCRIPTION

MONTAGU (1803) (*Murex*): p. 271; from Locmiquel, Golfe de Morbihan, France; Recent (neotype).

MATERIAL

Vrasenedok, Kallo, Oost-Vlaanderen, Belgium; *Petalocochnus* layer, Kattendijk Fo., lower Pliocene: coll. KBIN no IRScNB IST 6239: 1 fr.; Verrebroekdok, Kallo, Oost-Vlaanderen, Belgium; Oorderen Sand Member, Lillo Fo., middle Pliocene (*Atrina* layer): coll. RM; same locality and Member (*Cultellus* layer): coll. RM: 2 fr.; B2 Kanaaldok, Antwerp; Luchtbal Sand Member, Lillo Fo., middle Pliocene: coll. AJ: 12 fr.; Antwerp Boudewijnsluis, Belgium; Kattendijk Fo: coll. KBIN: 8 fr; same; Luchtbal Sand Member: coll. KBIN: 3 fr.; same; Oorderen Sand Member: coll. KBIN: 1 sp.; Antwerp, "Scaldisien": coll. KBIN: 5 fr.; Antwerp Mercantile Docks: Luchtbal Sand Member: coll. KBIN: 5 sp.; Antwerp Oorderen; Oorderen Sand Member; coll. KBIN: 3 sp.; Antwerp Austruweel; Luchtbal Sand Member: coll. KBIN: 5 sp.; same, "Scaldisien" base: coll. KBIN: 1 specimen; Antwerp; "Diestien" (= Kattendijk Fo.): coll. KBIN: 2 fr.; Antwerp Kattendijk; Kattendijk Fo.: coll. KBIN: 1 fr.; Antwerp Afrikadok; Kattendijk Fo.: coll. KBIN: 1 fr; Antwerp Kanaaldok B1, 21-21,80 m; Luchtbal Sand Member: coll. NNM RGM 395.967: 7 fr.; same locality and layer: coll. AJ: 11 fr.

SIZE

a. H: 8 mm, W: 2 mm; b. H: 2 mm, W: 1 mm (top fragment).

DESCRIPTION

Small, turriculate, spindle shaped, sinistral shell with very short siphonal canal and rounded quadrangular aperture. Whorls not tumid, suture undep. Last whorl narrows in

comparison with the penultimate one. The protoconch comprises a finely granulated nucleus and three and a half larval whorls. Larval whorls with two spiral striae on their lower part, the adapical one weaker than the basal one. Spirals crossed by fine, uninterrupted axial striae. On the teleoconch, which consists of about twelve whorls, this ornament is suddenly replaced by two rows of interconnected tubercles. From the tenth teleoconch whorl onwards, a row of tubercles appears in between. Last whorl with three spirals, crossed by weaker axials, with tubercles on the points of intersection and with two basal spirals without tubercles.

DISCUSSION

The identification of this species is not completely certain, because *Marshallora adversa*, *Cheirodonta pallescens* (JEFFREYS, 1867) and *Similiphora similior* (BOUCHET & GUILLEMOT, 1978) are nearly indistinguishable on shell characters alone. The fossil specimens differ from *Cheirodonta pallescens* in having three, in stead of five, rows of granules behind the peristome. This species is rare in the Kattendijk Formation, less so in the Luchtbal Sand Member and in the *Atrina* and *Cultellus* layers of the Oorderen Sand Member. *Monophorus perversus* (LINNAEUS, 1758) is an exclusively Mediterranean species (BOUCHET & GUILLEMOT, 1978). The protoconch of the Kallo specimens seems to be slightly larger than that of Recent specimens, figured by BOUCHET (1985). *Marshallora adversa* now ranges from Spain to Norway. GLIBERT (1949) figured a specimen from Pontlevoy, Touraine, France, Pontilevien, middle Miocene, as "*Triphora perversa*". The protoconch is missing, but it looks more like *M. adversa* than as *Monophorus perversus*, because the middle row of tubercles appears at about the tenth teleoconch whorl, although this individually variable character is insufficient for identification. The identity of *Triphora adversa miocaenica* COSSMANN & PEYROT, 1921, from the Aquitaine middle Miocene is difficult to ascertain, because the protoconch is unknown. The same applies to FRIEDBERG's (1954) "*Triforis perversa* L.", from the Polish middle Miocene. The first certain appearance of *M. adversa* is in the Redonien (upper Miocene) of Sceaux-d'Anjou, Maine & Loire, France (coll. RM), where complete specimens were found. Specimens of *M. adversa* without protoconch are impossible to separate from *Triphora radiospirata* nov. sp. They differ however slightly in the general shell shape and in the later appearance of the middle teleoconch spiral.

Genus *Triphora* BLAINVILLE, 1828 s. l.

Triphora radiospirata sp. nov.

Pl. 1, Fig. 5.

DIAGNOSIS

Triphora species with very fine axial sculpture on the spiral ribs of the protoconch, in which the second teleoconch spiral appears on the fifth whorl.

GENERIC ATTRIBUTION

It is nearly impossible to place species of the *Triphora*-group in a genus, with shell characters alone. Therefore, the new species is here included in *Triphora* sensu lato.

LOCUS TYPICUS

Vrasenedok, Kallo, municipality of Beveren, province of Oost-Vlaanderen, Belgium; x = 140,850, y = 216, 700 (see map in HOEDEMAKERS & MARQUET, 1993).

STRATUM TYPICUM

Kattendijk Formation, lower Pliocene; *Petalococonchus* layer.

DERIVATIO NOMINIS

radiospirata: because in the protoconch, axial sculpture is present on the spiral ribs.

SIZE

a. Holotype: H: 4.3 mm, W: 1.6 mm; b. paratype: H: 3.0 mm, W: 2.0 mm; c. paratype: H: 5.1 mm, W: 2.2 mm.

MATERIAL

HOLOTYPE: IRScNB IST 6244; paratypes: IRScNB IST 6245, 6252 coll. NNM RGM 395.968: 23 fr.; coll AJ: 40 fr.; coll RM: 60 fragments; other material: Antwerp, Kaai 319; Kattendijk Formation: coll. NNM RGM 395.969: 17 fr.

DESCRIPTION

Holotype consists of protoconch and five teleoconch whorls. Shell sinistral, regularly broadening, turruculate, with rather deeply incised suture and flat whorls. Last whorl broadest. Protoconch paucispiral. First protoconch whorl rather high, with nearly flat apex, lined by a keel, and a spiral below the keel. On the second whorl, the keel forms an upper, weaker spiral. Very fine axial striae appear on the lowest spiral, but not between both protoconch spirals; they can only be observed in perfect specimens. The sculpture remains the same on the next one and a half whorls, but with axial striae on the upper spiral as well. The teleoconch starts abruptly with the appearance of interconnected tubercles on both spirals, which remain equally strong. On the fifth teleoconch whorl, a very weak second spiral appears between both others. It becomes gradually stronger, but it reaches only on the last whorl the same strength as both others. Aperture rounded quadrangular, with narrow callus and short siphonal canal. On the last whorl, three rather vague new spirals appear. Upper one very slightly tuberculated, both others smooth, lowest one on the upper part of the siphonal canal.

DISCUSSION

This species occurs rather frequently in the *Petalococonchus* layer of the Kattendijk Formation of Kallo. *Triphora radiospirata* differs clearly from the other two sinistral Triphoridae in the Kattendijk Formation by the second teleoconch spiral, which appears last. A number of Recent *Inella* species (which are found mainly in the Paci-

fic) have a similar protoconch with few whorls, but none has axial striae on the spiral ribs (see figures in MARSHALL (1983)). The Eocene *Inella elatior* (VON KOENEN, 1891) has a larger nucleus and axial sculpture above, instead of on the spirals (see GRÜNDEL (1975 fig. 7)). *Triphora* (s.l.) *conoidalis* CERULLI-IRELLI, 1912, from the Italian Pliocene, has more or less the same shell form as *T. radiospirata*, while also the middle teleoconch spiral appears last, but the shell base is smooth and basal spirals lack. The protoconch from this species is not known.

Triphora antwerpiensis sp. nov.

Pl. 1, Fig. 6.

DIAGNOSIS

Triphora species with paucispiral protoconch, ornamented with two equal spiral ribs and with tubercles, adapically from the upper spiral, and with the middle teleoconch spiral appearing on the sixth whorl.

GENERIC ATTRIBUTION

See *Triphora radiospirata* sp. nov.

LOCUS TYPICUS

Antwerp, Belgium.

STRATUM TYPICUM

"Scaldisien", probably Oorderen Sand Member, Lillo Formation, Middle Pliocene.

DERIVATIO NOMINIS

antwerpiensis after the type locality.

SIZE

H: 7 mm, W: 1.8 mm.

MATERIAL

Holotype: IRScNB IST 6246.

DESCRIPTION

The only specimen is a complete, sinistral, turruculate, regularly broadening shell, consisting of twelve whorls. The whorls are flatsided, with an incised suture. The last whorl the broadest. The protoconch paucispiral. The first whorl with nearly flat, very low apex, delimited by a keel. On the second whorl occur two equally strong spiral ribs. Adapical of the upper spiral, axial tubercles are present; the spirals are smooth. The second whorl with same sculpture. On the next whorl, the teleoconch sculpture starts abruptly with the appearance of two rows of interconnected tubercles. Their axial connections strongly obtuse in relation to the shell axis. On the sixth teleoconch whorl, a middle spiral appears, which becomes gradually stronger; on the ninth whorl, it is as strong as both others. Aperture rounded quadrangular, with narrow callus and short siphonal canal. On the last whorl, three strong, smooth spirals appear, the lowest one on the upper edge of the siphonal canal.

DISCUSSION

This species strongly resembles *Triphora radiospirata*, from which its teleoconch is nearly indistinguishable. The arrangement of the spiral sculpture of the protoconch and the equality of the protoconch spirals in *Triphora antwerpiensis* allow however to differ them clearly. It is not impossible that both types form an evolutionary lineage. The Australian species *Inella intercalaris* MARSHALL, 1983 has a similar protoconch. On its teleoconch however, four to five spirals are present on each whorl.

Triphora borealis KAUTSKY, 1925

Pl. 1, Fig. 4.

SYNONYMY

- 1848 *Triphora perversa* LINN. var. *borealis* nov. var. - KAUTSKY (1925): p. 85, pl. 7 fig. 8.
 1848 *Triphora perversa* (LINNE) - SORGENFREI (1958): p. 171-172, pl. 32 fig. 106 (non LINNAEUS).
 1848 *Triphora (Triphora) perversa* (LINNE 1758) - ANDERSON (1960): p. 98-99, pl. 9 fig. 7 (non LINNAEUS).
 1848 *Triphora perversa* (LINNAEUS, 1758) - JANSSEN (1967): p. 138 (non LINNAEUS).
 1848 *Biforina (Oriforina) aff. praeversa* GRÜNDEL, 1975 - JANSSEN (1984): p. 258-259, pl. 49 fig. 12-13 (non GRÜNDEL?).

ORIGINAL DESCRIPTION

KAUTSKY (1925) (*Triphora*): p. 85, pl. 7 fig. 8; from Hemmoor near Stade, Hanover, Germany; Hemmoor Stufe, middle Miocene.

GENERIC ATTRIBUTION

None of our specimens shows of a non-eroded protoconch nucleus, so its generic attribution is uncertain.

MATERIAL

Kennedytunnel, Antwerp, Belgium; Edegem Sand Member, Berchem Formation, lower Miocene: IRScNB IST 6247: 1 fr.; coll RM: 2 fr.; Miste, Winterswijk, Achterhoek, The Netherlands; Miste Sand Member, Hemmoor Stufe, middle Miocene: coll. RM: 7 fragments; same locality and layer: NNM: 2 sp.; Antwerp, Kennedytunnel; Edegem Sand Member, layer 3-5: coll. NNM: 25 fr.; Dingden, Westfalen, FRG; Dingdener Feinsand, Reinbek Stufe: coll. NNM: 17 fr.; Beeringen, Peel, The Netherlands; 114-159 m: 6 fr: coll. NNM.

SIZE

H: 5.2 mm, B: 2.3 mm.

DESCRIPTION

Small, turriculate, sinistral shell with shallow suture and flat whorls. The most complete specimen consists of ten teleoconch whorls. A protoconch is present in some of the Miste shells. It consists of two embryonic whorls and four younger whorls. These four whorls have two spiral ribs, the lowest much stronger than the adapical one. The abapical one forms a keel. Axial striae are present from the adapical to the adapical end on every whorl, but they

are slightly vaguer on the abapical part and they can nearly disappear there on the last protoconch whorl. Transition to the teleoconch sharp; the lowermost spiral becomes thicker, the upper one disappears and reappears higher on the whorl. Only on the fourth teleoconch whorl occurs a very weak middle spiral between both original ones. This second spiral remains the weakest. On the last whorl, the adapical spiral is the strongest. Tubercles on the spirals interconnected by very weak axial ribs. Aperture rounded quadrangular, with a callus, siphonal canal short. On the base of the last whorl, three more spirals appear: the upper slightly tuberculated and connected with the axials, the middle one very slightly tuberculated and the lowest one, which runs on the siphonal canal, smooth.

DISCUSSION

Very rare in the Edegem Sand Member in Belgium, where it coexists with *Subuliphora fritschi*, whose upper, instead of middle teleoconch spiral however appears last. *T. borealis* strongly resembles the Recent Mediterranean *M. perversus* (LINNAEUS, 1758), as figured in BOUCHET (1984 fig. 20, 21). The teleoconch sculpture is nearly the same, especially on the last whorl, but the middle spiral appears later in the Recent species. Furthermore, *M. perversus* has one protoconch whorl less and axial sculpture lacks between both spirals, not under the abapical one. *T. borealis* was with doubt united by JANSSEN (1984) with the upper Oligocene species *Monophorus praeversa* (GRÜNDEL, 1975). *M. praeversa* however has a more reduced axial sculpture on the protoconch, while both protoconch spirals are nearly equally strong. It is not impossible, if *T. borealis* proves to have the cruciform tubercles on the first protoconch whorl, which characterise *Monophorus*, that *M. praeversa*, *M. borealis* and *M. perversus* represent an evolutionary lineage, although the Recent species occurs only in the Mediterranean and not in the Atlantic or the North Sea. Study of Miocene material from France (Touraine and Aquitaine) could possibly clarify this further.

Genus *Obesula* JOUSSEAUME, 1898?*Obesula scaldensis* sp. nov.

Pl. 2, Fig. 6,7.

DIAGNOSIS

Obesula species with a paucispiral protoconch, consisting of two whorls, the second keeled, the second teleoconch spiral appearing between the fourth and the sixth whorl.

GENERIC ATTRIBUTION

Obesula has a similar protoconch, which can be paucispiral, with one keel and with the second teleoconch spiral appearing last, but the typical hemispherical granules on the first protoconch whorls could not be observed in our more or less eroded specimens. Other possible attributions for this species are: *Cheirodonta*, which has however two spiral ribs on the protoconch, *Triphora*, which

differs by the presence of axial protoconch ribs, *Nototriphora*, which has two spiral threads and uninterrupted axial riblets on the second protoconch whorl and the South Australian genus *Aclophoropsis*, which has nearly the same protoconch and teleoconch as *Obesula*.

LOCUS TYPICUS

Antwerp, Belgium; Kanaaldok B1.

STRATUM TYPICUM

Luchtbal Sand Member, Lillo Formation, lower middle Pliocene; between 21 and 21,80 m.

DERIVATIO NOMINIS

After the Scheldt River (Scaldis), because the holotype was found in dockworks to the Scheldt.

MATERIAL

Holotype: coll. NNM RGM 395.965; paratype: same locality and stratum, coll. AJ; Antwerp (Oorderen), Oorderen Sand Member: IRScNB IST 6251; same locality and layer, coll. KBIN: 2 specimens; Antwerp, Boudewijnsluis; 14.25 - 14.90 m, "Scaldisien, Zone à *Isocardia cor*" (probably Luchtbal Sand Member, judging from the conservation and the sediment in the shells): coll. KBIN: 10 fr.

SIZE

a. holotype: H: 2.3 mm, W: 1.1 mm; b. H: 4.4 mm, W: 1.7 mm.

DESCRIPTION

Small, turriculate, rather broad shell. The holotype consists of seven teleoconch whorls and the protoconch. Whorls flat, with a slightly incised suture. Middle whorls broader than last one. Protoconch paucispiral and consisting of a globular nucleus and one younger, keeled whorl. Both whorls smooth. On the transition to the teleoconch, the keel is replaced by a spiral rib, lying slightly lower than the keel. Half a whorl later, the spiral becomes tuberculated. Half a whorl later again, an upper spiral appears. Between the fourth and sixth teleoconch whorl, a middle spiral is formed, which remains weaker even on the last whorl. Aperture quadrangular, with a clear callus. Outer lip with clear anal sinus. Siphonal canal very short. On the base of the last whorl, three smooth spirals are visible; the lowest runs on the upper side of the siphonal canal.

DISCUSSION

This species shows an overall resemblance to *Marshallora adversa* (MONTAGU, 1803), which has however a multispiral protoconch with axial sculpture, while the middle teleoconch spiral appears much later. The Recent Mediterranean *Obesula marisnostri* BOUCHET, 1982 has a protoconch with five whorls and only two smooth basal spirals. The Recent Pacific species *Obesula mamillata* (VERCO, 1909) and *Obesula profundior* MARSHALL, 1983 have also a paucispiral protoconch, but with three whorls, while on the third, axial sculpture is present.

Inella-group

Genus *Norephora* GRÜNDEL, 1975

Norephora pliocaenica sp. nov.

Pl. 1, Fig. 2.

DIAGNOSIS

Norephora species with paucispiral protoconch, on which axial sculpture completely lacks.

GENERIC ATTRIBUTION

The genus *Norephora* was introduced by GRÜNDEL (1975) for Triphoridae with more or less reduced axial sculpture on the protoconch and three spirals on the teleoconch, with the upper one being the weakest or appearing last. MARSHALL (1983) placed *Norephora* in synonymy with *Inella*. *Norephora* is here used for species of the *Inella*-group, in which the axial protoconch sculpture is reduced. The genera *Inella*, *Hypotriphora* and *Magnosinister* have also paucispiral protoconch and an *Inella* type of teleoconch sculpture, so the species could also belong to these genera. The genus *Norephora* is known only from Oligocene and Pliocene strata in the North Sea basin.

LOCUS TYPICUS

Vrasenedok, Kallo, municipality of Beveren, province of Oost-Vlaanderen, Belgium; x = 140,850, y = 216, 700 (see map in HOEDEMAKERS & MARQUET, 1993).

STRATUM TYPICUM

Kattendijk Formation, lower Pliocene; *Petalococonchus* layer.

DERIVATIO NOMINIS

pliocaenica: from the Pliocene, because *Norephora* species were until now only known from Oligocene strata.

SIZE

a. Holotype: H: 4 mm, W: 2 mm; b. paratype: H: 2.3 mm, W: 1.8 mm.

MATERIAL

Holotype: IRScNB IST 6240; paratypes: IRScNB IST 6241; coll. NNM RGM 395.970: 6 fragments; coll. RM: 2 fr.; coll. AJ: 11 fragments; other material: Antwerp; Kattendijk Fo.: coll. KBIN: 3 fr; Antwerp, Kaai 271; Kattendijk Formation: coll. NNM RGM 395.971: 1 sp.

DESCRIPTION

The holotype consists of the protoconch and five and a half teleoconch whorls. No complete specimens are known. Shell sinistral, turriculate, with an shallow suture and flat whorls. Last whorl broadest. Protoconch paucispiral, nucleus smooth and flattened. Next whorl with a clear lower spiral and an, in the beginning weaker, upper spiral which becomes equally strong on the next whorl. Both lie on the lower half of the whorl, the uppermost at about halfway. Axial sculpture absent. After two and a half whorls, the teleoconch starts with the appearance of tubercles on the spirals. Upper spiral lies on the upper part

of the whorl by then. Tubercles interconnected by axial ribs. On the fourth teleoconch whorl, a very weak upper spiral appears, which becomes tuberculated on the fifth whorl. Aperture rounded quadrangular, with narrow callus and very short siphonal canal. Two smooth spirals appear on last whorl, upper one much stronger than the lower. Siphonal canal smooth.

DISCUSSION

This species is rare in the Kattendijk Formation of Kallo. Only in one other locality have specimens been collected. Miocene *Subulphora fritschi* (von KOENEN, 1882) (pl. 1 fig. 3) differs in its protoconch, which possesses more whorls and axial sculpture. Oligocene *Norephora granulata* (STRAUCH, 1967) (figured in STRAUCH, 1976 pl. 1 fig. 13, 14, 16) also has strongly reduced axial ribs on the protoconch, but the number of protoconch whorls is about six. Eocene "*Norephora (N.) elatior* (von KOENEN, 1891), which GRÜNDEL (1975) also included in the same genus, has a weaker second spiral on the teleoconch and belongs consequently to another genus.

Genus *Subulphora* LASERON, 1958

Subulphora fritschi (von KOENEN, 1882)

Pl. 1, Fig. 3.

SYNONYMY

- 1882 *Cerithium Fritschi* - von KOENEN, p. 271-272, pl. 6 fig. 19a-c.
 1925 *Triphora Fritschi* v. KOEN. - KAUTSKY, p. 84-85, pl. 7 fig. 7.
 1944 *Triphora (Triphora) fritschi* (von KOENEN) - VAN VOOR-
 THUYSEN, p. 30-31, pl. 12 fig. 16-19.
 1960 *Triphora (Triphora) fritschi* (von KOENEN 1882) - AN-
 DERSON, p. 97, pl. 9 fig. 6, pl. 12 fig. 6, 6a.
 1967 *Triphora fritschi* (KOENEN, 1882) - JANSSEN, p. 138,
 pl. 10 fig. 4.
 1984 *Norephora (Norephora) fritschi* (von KOENEN, 1882) -
 JANSSEN, p. 159-160, pl. 7 fig. 5, pl. 49 fig. 14.

ORIGINAL DESCRIPTION

von KOENEN (1882) (*Cerithium*): p. 271-272, pl. 6 fig. 19a-c; from Dingden, Westfalen, Germany; Dingdener Feinsand, Reinbek Stufe, upper Miocene.

GENERIC ATTRIBUTION

von KOENEN's (1882) "*Cerithium Fritschi*" is placed in the Indo-Pacific genus *Subulphora*, because of the similarity of its protoconch with that of the type species of the genus, *Subulphora rutilans* (HERVIER, 1897), as figured by MARSHALL (1983, fig. 12J).

MATERIAL

BVP excavation near Ter Weyde, Wilrijk, prov. Antwerp, Belgium; Edegem Sand Member, Berchem Formation, lower Miocene: coll. RM: 7 fr.; Kennedytunnel, Antwerp, Belgium; same Member: coll. RM: 12 fr.; metrostation Schijnpoort, Antwerp, Belgium; *Panopea* bed, Antwerp Sand Member, Berchem Formation, middle Miocene: coll. RM: 20 fr.; same

locality, same Member, *Turritella eryna* bed: coll. RM: 2 fr.; BVP excavation, Zonderschot, Heist-Op-Den-Berg, prov. Antwerp, Belgium; Zonderschot Sand Member, Berchem Formation, middle Miocene: IRScNB IST 6242, 6243: 2 fr.; coll. RM: 10 fr.; Antwerp Kennedytunnel; layer 3-5, Edegem Sand Member: coll. NNM RGM 182.545: 236 fr.; Dingden, Westfalen, FRG; Dingdener Feinsand, Reinbek Stufe: coll. NNM: 29 sp.; Twistringen, FRG; Reinbek Clay Member: coll. NNM: 7 sp.; Beeringen, Peel, The Netherlands; 119-159 m: coll. NNM: 30 sp.; Miste, Winterswijk, Achterhoek, Nederland; Miste Sand Member, Hemmoor Formation: coll. NNM: 2 sp.; Antwerp, B1-B2 Kanaaldok, Belgium; Luchtbal Sand Member, Lillo Formation, middle Pliocene: coll. NNM RGM 395.968: 4 sp.

SIZE

a. top fragment: H: 3.4 mm, W: 1.1 mm; b: H: 5.5 mm, W: 1.9 mm.

DESCRIPTION

Small, turriculate, sinistral shell with mostly flat whorls and very shallow suture. Fragment fig. 3a consists of six protoconch and six teleoconch whorls. Both embryonic whorls tumid, with irregular spirals, connected by fine, irregular axial striae. Four following protoconch whorls with two equally strong and well delimited spiral ribs on their lower part. Spirals crossed by numerous fine axial striae, which may run from adapical to abapical margin; on the last whorl, the axials reach from adapical margin to lowermost spiral. At the end of the protoconch, the lower spiral continues, while the upper one stops and a new one starts slightly higher. Between first and second teleoconch whorl, a third spiral rises above both others, but remains weaker till the last whorl. On the spirals, tubercles are present, interconnected by axial ribs, which are lower than the spirals. Aperture rounded quadrangular, siphonal canal short. On the base of the last whorl, two smooth spirals appear, the lower much weaker than the upper one; both closely together, far from the siphonal canal.

DISCUSSION

This species occurs in the lower and middle Miocene of Belgium, but always rather rare. In the Pliocene Luchtbal Sand Member, four badly preserved, but recognisable specimens were collected. It has also been found in the whole German Miocene and in Dutch middle Miocene strata. The Antwerp specimens are rather variable: in some specimens, the suture is deeper and the teleoconch sculpture is more irregular than in the majority. However, no protoconch was found associated with this rarer type of shell, so it is not certain if they really belong to the same species. Already von KOENEN (1882) mentioned the presence of this species in the Edegem Sand Member in Belgium, but GLIBERT (1952) did not confirm this occurrence. The teleoconch sculpture of the species resembles that of the *Strobiliger species*, figured by BOUCHET (1985) and BOUCHET & WARREN (1993). The relation of *S. fritschi* with *Triphora (s. l.) eugeniae* (BOETTGER, 1901), from the Miocene of Central Europe, which is figured in STRAUZ (1966) on Hungarian specimens, re-

mains to be clarified. In *T. eugeniae* the upper spiral also appears last, but a protoconch seems never to have been figured.

Genus *Inella* BAYLE, 1874 s. l.

Inella vandermarki nov. sp.

Pl. 2, Fig. 4, 5.

DIAGNOSIS

An *Inella* species with a paucispiral protoconch, consisting of three smooth whorls, in which the upper teleoconch spiral appears between the second and the fourth teleoconch whorl, and with reduced axial teleoconch sculpture.

GENERIC ATTRIBUTION

The smooth protoconch of the new species differs from the usual *Inella* type, but because of the late appearance of the upper spiral, it is included here in that genus. Reduction of the axial sculpture can also occur in *Inella* species, for example in *Inella intercalaris* MARSHALL (1983, fig. 12 A-D). *Inella vandermarki* looks, by the lack of axial teleoconch sculpture, also superficially like a *Viriola* species, but *Viriola* has a *Triphora* type sculpture and a different protoconch. Possibly a new genus is needed to accommodate this species.

LOCUS TYPICUS

Antwerp, Belgium; Kanaaldok B1.

STRATUM TYPICUM

Luchtbal Sand Member, Lillo Formation, lower middle Pliocene; between 21 and 21,80 m.

DERIVATIO NOMINIS

After Mr. VAN DER MARK, who collected the holotype.

MATERIAL

Holotype: coll. NNM RGM 395.966; other material: Antwerp, Van de Vin Dock, Belgium; *Palliolum gerardi* layer, Luchtbal Sand Member, Lillo Formation, lower middle Pliocene: IRScNB IST 6248: 1 fr.

SIZE

Holotype: H: 4 mm, W: 1.5 mm; other specimen: H: 12.5 mm; W: 3 mm.

DESCRIPTION

Rather large, turriculate, regularly broadening shell. Whorls flat, but the suture is sunken and consequently clearly visible. The fragment from the Van de Vin Dock consists of thirteen teleoconch whorls, without protoconch. The holotype consists of the protoconch and six and a half whorls. The protoconch is composed of three whorls, the first one lacks partially. They are swollen, tumid, brilliant, smooth, with deep suture. Teleoconch less brilliant. Two spiral ribs appear suddenly. On the second (holotype) or the fourth (Van de Vin Dock specimen) teleoconch whorl, an upper spiral appears, which remains always weaker than both others. On the twelfth

whorl, a very weak fourth spiral is barely visible on the Van de Vin Dock specimen, just above the abapical suture. Spirals slightly narrower than intercostal spaces. Axial sculpture absent, but sparse weak tubercles occur irregularly on the spirals. Aperture small, nearly circular; the last whorl lacks in both specimens.

DISCUSSION

This species shows a superficial resemblance with *Laio-cochlis sinistrata* (NYST, 1835), but the whorls of that species are more tumid, the spirals are narrower and more numerous and the protoconch is completely different. At the same shell width, axial ribs are still present under the protoconch in *L. sinistrata*. *Viriola carinata* (TALAVERA, 1975) is a West African Recent species in which second spiral appears last, while the spirals are clearly tuberculated up to the fourth teleoconch whorl (BOUCHET, 1985 fig. 2). Another, undescribed *Inella* species with similar protoconch and teleoconch sculpture is present in the Redonien of Sceaux-d'Anjou, dept. Maine-et-Loire, France (coll. RM). It differs from *Inella vandermarki* in having an even more paucispiral protoconch and by the absence of a sunken suture.

Subfamily Metaxiinae MARSHALL, 1977

Genus *Metaxia* MONTEROSATO, 1884

Metaxia degrangei (COSSMANN & PEYROT, 1922)

Pl. 2, Fig. 1, 2.

SYNONYMY

1848 *Newtoniella* (?) *degrangei* nov. sp. - COSSMANN & PEYROT (1922): p. 297-298, pl. 7 fig. 18-19.

1848 *Cerithiella degrangei* (COSSMANN & PEYROT 1922) - ANDERSON (1964): p. 210, pl. 13 fig. 125.

1848 ? *Cerithiella* (s. lat.) *degrangei* (COSSMANN & PEYROT 1922) - JANSSEN (1967): p. 138.

ORIGINAL DESCRIPTION

COSSMANN & PEYROT (1922) (*Newtoniella*): p. 297-298, pl. 7 fig. 18-19 (not 19-20 as stated by the authors!), from Uzeste, dept. Gironde, France; Aquitanien, lower Miocene.

MATERIAL

Kennedytunnel, Antwerp, Belgium; Edegem Sand Member, Berchem Formation, lower Miocene: coll. RM: 12 fr; same locality: coll. NNM RGM 182.542: 80 specimens.

SIZE

H: 4.5 mm, W: 1 mm.

DESCRIPTION

Small, extremely slender, dextral turriculate shell, with deep suture and tumid whorls. The most complete specimen consists of sixteen whorls. Protoconch composed of five and a half whorls. Nucleus tumid, with zigzag lines; most specimens are too eroded to show them, but on the figured specimen, they are preserved near the abapical

suture. Other protoconch whorls tumid; on the lower half of the youngest ones, a keel is present. Axial sculpture consists of numerous fine, continuous, regular striae, which run opisthocline above the keel and prosocline below. Beginning of teleoconch sharply delimited by a sinuous line. Four spirals start immediately and remain till the last whorl. On the last whorl, a fifth spiral, which forms a basal keel, is also present. The spirals become stronger from adapical on, third one the strongest, fourth and fifth weaker. Spirals narrower than intercostal areas. They are crossed by twelve less clearly delimited axial ribs on the last whorl, forming tubercles on the points of intersection. Aperture rounded oval. Shell base flattened, with fine axial lines and a weak, smooth spiral around the siphonal canal. Siphonal canal extremely short.

DISCUSSION

This species is new for the Miocene of Belgium. It is obvious, that it belongs to the genus *Metaxia*, as already supposed by JANSSEN (1967), because of the zigzag spirals on the protoconch. This part of the holotype however is lacking, so it is not completely certain if it really belongs to COSSMANN & PEYROT's species. Material from the type locality with protoconch is not known. Specimens from the same age, from another locality in the Aquitaine basin (Saint Martin d'Oney, dept. Landes, France; IRScNB IST 6249) however agree completely with the Belgian material. The teleoconch of both the French and Belgian material is very similar to that of the Recent *Metaxia metaxa* (DELLE CHIAJE, 1828), which has however fewer protoconch whorls, while the abapical protoconch axial sculpture is irregular and discontinuous. FRIEDBERG (1954) mentions the presence of "*Cerithiopsis metaxa*" in the Polish middle Miocene, without however figuring or describing a protoconch. Two species of the genus *Metaxia* occur in the middle Miocene (Pontilevien) of the French Loire basin. *M. turoniensis* (GLIBERT, 1949) resembles the Recent *M. metaxa* strongly, but differs in its coarser teleoconch sculpture and consequently smaller rectangular depressions between axials and spirals. Its shell base is like that of *M. degran-gei*, but the whorls are less tumid, the suture is less deep and the sculpture differs in the same characters as from the Recent species. *M. quadrilineata* (MAYER in IVOLAS & PEYROT, 1900) has more widely separated and less well delimited axial sculpture; it possesses furthermore three smooth spirals on the shell base; however, the protoconch of none of those species is known.

Metaxia aff. *metaxa* (DELLE CHIAJE, 1828)
Pl. 2, Fig. 3.

SYNONYMY

- 1848 *Cerithium metaxa*? DELLE CHIAJE - WOOD (1848): p. 71, pl. 8 fig. 6.
1848 *Cerithiopsis (Metaxia) rugulosa* - CERULLI-IRELLI (1912): p. 150, pl. 23 fig. 52.

- 1848 *Cerithiopsis Metaxae* (DELLE CHIAJE) - HARMER (1918): p. 422, pl. 41 fig. 16-19.
1848 *Cerithiopsis metaxa* (DELLE CHIAJE, 1828) - FRETTER & GRAHAM (1982): p. 369-370, fig. 259-261.
1848 *Metaxia metaxae* (DELLE CHIAJE, 1828) - BOUCHET (1985): p. 15-17, fig. 14, 18.
1848 *Cerithiopsis metaxa* (DELLE CHIAJE, 1828) - GRAHAM (1988): p. 470, fig. 198.

ORIGINAL DESCRIPTION

DELLE CHIAJE (1828) (*Murex*): p. 222, pl. 49 fig. 29-31; from Naples, Italy; neotype from Calvi, Corse, France; Recent.

MATERIAL

Vrasenedok, Kallo, Oost-Vlaanderen, Belgium; Kattendijk Formation, *Petalococonchus* layer: IRScNB IST 6250: 1 fr.; coll RM: 6 fr.

SIZE

H: 5 mm, W: 2 mm (damaged).

DESCRIPTION

Small, turriculate, dextral shell with short siphonal canal, consisting of about fifteen whorls in complete specimens. Protoconch not preserved in the Kallo material. It consists of two embryonic whorls, with zigzag lines and one and a half whorls with axial lines above and irregular lines below. Teleoconch whorls tumid, suture deep. Sculpture consisting of five spirals on the last and four spirals on the other teleoconch whorls. These are crossed by weaker axials, which causes the formation of tubercles on the points of intersection, especially on the second, third and fourth spiral.

DISCUSSION

This species is rare in the *Petalococonchus* layer of the Kattendijk Formation in Kallo. It has been collected in the British Coralline Crag, but this is the first record for Belgium. No complete specimen with protoconch is present in the material studied, which makes the identification uncertain. The species ranges now from the Shetlands to the Mediterranean.

Conclusions

Pliocene Triphorinae from the North Sea basin differ from their Recent Atlantic-Mediterranean relatives significantly in their larval development and consequently in their mode of dispersion. All fourteen Recent species, belonging to this subfamily and described by BOUCHET (1985) and BOUCHET & WARREN (1993) possess a planktonic protoconch. In our Pliocene, only *Monophorus adversa* has a similar protoconch, while *Norephora plio-caenica*, *Triphora radiospirata*, *Triphora antwerpiensis*, *Inella vandermarki* and *Obesula scaldensis* have a lecithotrophic one. It could be significant, that the only plankto-

trophic species is also the only survivor in the Recent fauna. All other species seem to have had a limited distribution. These species show a certain resemblance in protoconch development with some Recent Australian species, studied by MARSHALL (1983). Also in the French Redonien, several undescribed species with a similar protoconch seem to exist. These genera could represent an ancient stock, which, by its lecithophic mode of dispersion, split up into a large number of local species with a short time range.

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Explanation of Plates

PLATE 1

- Fig. 1 — *Marshallora adversa* (MONTAGU, 1803). a. Vrasenedok, Kallo, province Oost Vlaanderen; *Atrina* layer, Oorderen Sand Member, Lillo Formation, middle Pliocene. b. Same locality, *Petalococonchus* layer, Kattendijk Formation, lower Pliocene. a. Coll. RM, b. IRScNB IST 6239. a. X 11, b. X 50.
- Fig. 2 — *Norephora pliocaenica* sp. nov. a, b. Holotype IRScNB IST 6240; c. Paratype IRScNB IST 6241. Vrasenedok, Kallo, province Oost Vlaanderen; *Petalococonchus* layer, Kattendijk Formation, lower Pliocene. a. X 12,5, b. X 41, c. X 20.
- Fig. 3 — *Subuliphora fritschi* (von KOENEN, 1882). Zonderschot, Heist-Op-Den-Berg, province Antwerp; Zonderschot Sand Member, Berchem Formation, middle Miocene. a, c. IRScNB IST 6242, b. IRScNB IST 6243. a. X 36, b. X 8,4, c. X 100.
- Fig. 4 — *Triphora borealis* KAUTSKY, 1925. Kennedytunnel, Antwerp, province Antwerp; Edegem Sand Member, Berchem Formation, lower Miocene. IRScNB IST 6240. a. x 14, b. x 22, c. x 50.
- Fig. 5 — *Triphora radiospirata* sp. nov. a. Paratype IRScNB IST 6245. b. Holotype IRScNB IST 6244. c. IRScNB IST 6252. Vrasenedok, Kallo, province Oost Vlaanderen; *Petalococonchus* layer, Kattendijk Formation, lower Pliocene. a. X 14, b. X 50, c. X 18.
- Fig. 6 — *Triphora antwerpiensis* sp. nov. Antwerp, province Antwerp; "Scaldisien", probably Oorderen Sand Member, Lillo Formation, middle Pliocene. IRScNB IST 6246. a. x 11, b. x 45.

PLATE 2

- Fig. 1 — *Metaxia degrangei* (COSSMANN & PEYROT, 1922). Kennedytunnel, Antwerp, province Antwerp; Edegem Sand Member, Berchem Formation, lower Miocene. NNM RGM 182.542 a. X 11, b. x 41, c. X 200.
- Fig. 2 — *Metaxia degrangei* (COSSMANN & PEYROT, 1922). Saint Martin d'Oney, dept. Landes, France; Aquitanian Formation, lower Miocene. IRScNB IST 6249. a. X 12, b. X 80, c. X 320.

- Fig. 3 — *Metaxia* aff. *metaxa* (DELLE CHIAJE, 1828). Vrasenedok, Kallo, province Oost Vlaanderen; Petaloconchus layer, Kattendijk Formation, lower Pliocene. IRScNB IST 6250. X 9,8.
- Fig. 4 — *Inella vandermarki* sp. nov. Holotype NNM RGM 395.965 Kanaaldok B1, Antwerp, province Antwerp; Luchtbal Sand Member, Lillo Formation, lower middle Pliocene. a. X 32, b. X 200.
- Fig. 5 — *Inella vandermarki* sp. nov. Van de Vin Dock, Antwerp, province Antwerp; *Palliolum gerardi* layer, Luchtbal Sand Member, Lillo Formation, lower middle Pliocene. IRScNB IST 6248. X 6.
- Fig. 6 — *Obesula scaldensis* sp. nov. Holotype NNM RGM 395.965 Kanaaldok B1, Antwerp, province Antwerp; Luchtbal Sand Member, Lillo Formation, lower middle Pliocene. X 48.
- Fig. 7 — *Obesula scaldensis* sp. nov. Paratype IRScNB IST 6251. Oorderen, Antwerp, province Antwerp; Oorderen Sand Member, Lillo Formation, middle Pliocene. a. X 15, b. X 17.

Plate 1.

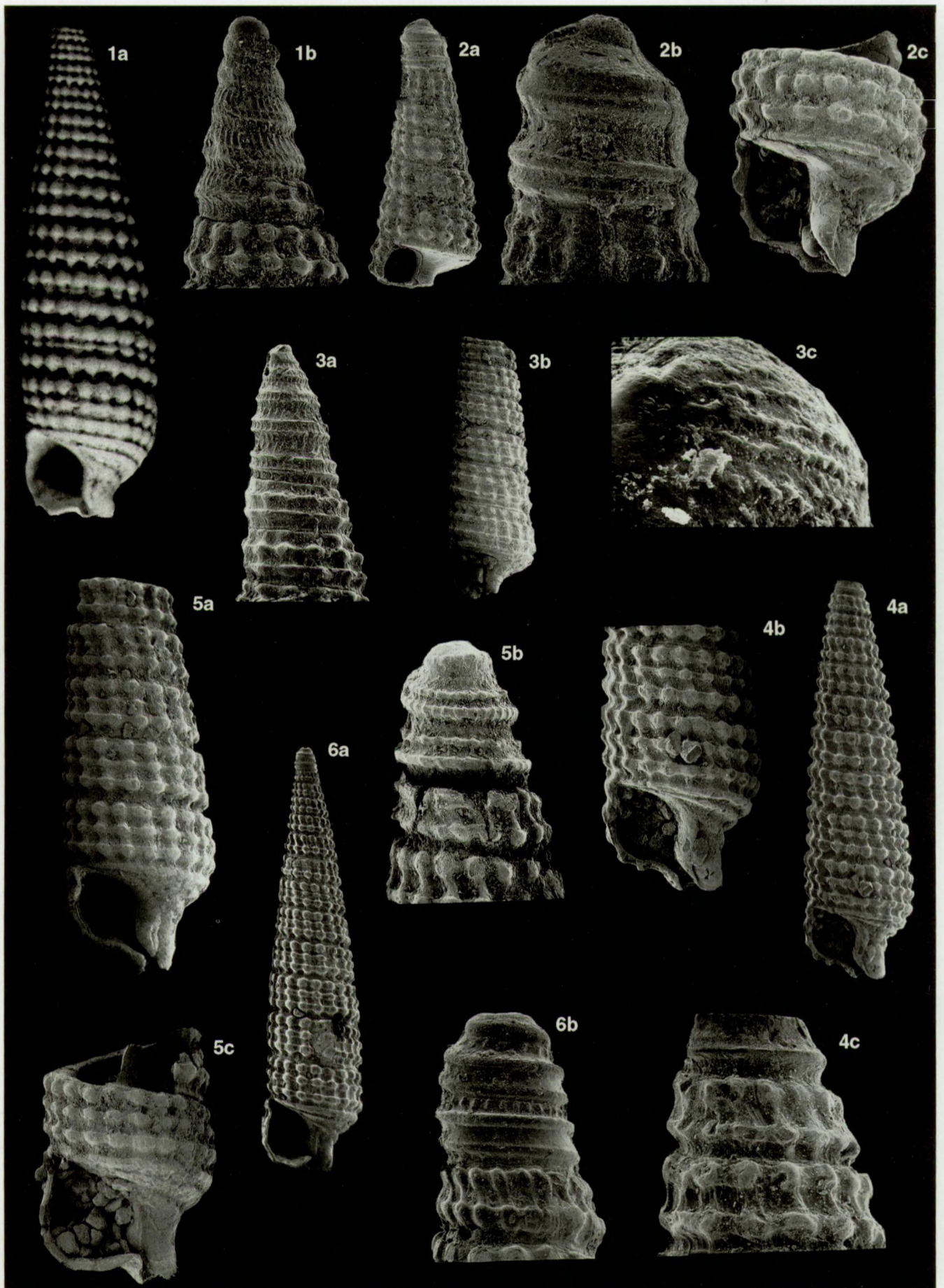


Plate 2.

