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Terrestrial, freshwater and brachyhaline Gastropoda from the Lower Miocene deposits of Oberdorf (Styria, Austria)

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(With 8 plates)

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Abstract

A fauna of 26 taxa of gastropods is described from Ottnangian (Lower Miocene) deposits of Oberdorf in Bärnbach near Köflach (Styria, Austria). *Tropidomphalus rotundus*, *Triptychia ederae*, *Pleurodonte norica*, *Palaeoglandina dactylina*, *Serrulella hoeckae* and *Pseudidyla schultzi* are described as new species. *Klikia devexa robusta* is introduced as new subspecies. The fauna derives from a river and the adjacent wetland habitats as well as from the subtropical woodland of the hinterland.

Keywords: Gastropoda, ecology, Lower Miocene, Neogene, Western Styrian Basin

Zusammenfassung

Eine Gastropodenfauna mit 26 Taxa wird aus dem Ottnangium von Oberdorf in Bärnbach bei Köflach (Steiermark, Österreich) beschrieben. *Tropidomphalus rotundus*, *Triptychia ederae*, *Pleurodonte norica*, *Palaeoglandina dactylina*, *Serrulella hoeckae* und *Pseudidyla schultzi* werden als neue Arten beschrieben. *Klikia devexa robusta* wird als neue Unterart eingeführt. Die Lebensräume waren Feuchtbiotope und Wälder einer Flusslandschaft sowie der subtropische Wald des Hinterlandes.

Introduction

Previous investigations in the opencast mine Oberdorf in Bärnbach near Köflach (Styria, Austria) focused on Lower Miocene remains of plants and vertebrates. Therefore, a rich flora (KOVAR-EDER 1996, 1998; KOVAR-EDER & MELLER 2001, MELLER 1996, 1998) and several vertebrates were recorded (DAXNER-HÖCK 1998). In addition, molluscs were collected by KOVAR-EDER, MELLER and DAXNER-HÖCK during these research efforts (DAXNER-HÖCK, HAAS & MELLER 1998). Due to the scattered occurrence, no detailed information on the taphonomy and local distribution of the mollusc fauna has been documented. This enables only a generalised paleoecological interpretation of the fauna, and this paper thus focuses on systematic aspects.

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Collection

The described material is stored in the collection of the Natural History Museum of Vienna (NHMW, Geological-Paleontological Department). Comparisons with extant relatives of the fossil taxa are based on the collection of the Zoological Department of the NHMW.

Geological setting and stratigraphy

The opencast mine Oberdorf in Bärnbach was described in detail by DAXNER-HÖCK, HAAS & MELLER (1998: 3, Abb. 1). At the section Oberdorf, which lies within the Neogene Styrian Basin, Lower Miocene deposits of the Köflach/Voitsberg Formation crop out. The idealised log, presented by DAXNER-HÖCK, HAAS & MELLER (1998: 9, Abb. 5), shows a thick main lignite seam and thinner lignite intercalations in the overlying sediments. Most specimens were collected at the sample points O3, which lays under a coal seam by 100 m, and from O4, which is situated approximately 110 m under two coal layers of the log. These molluscs were embedded in a limnic sediment and therefore synchron allochthonous fossilized.

The age of the mollusc-bearing part of the section Oberdorf is dated as Ottnangium (mammal zone MN 4; see DAXNER-HÖCK, HAAS, MELLER & STEININGER, 1998, MAURITSCH & SCHOLGER, 1998 and STEININGER et al. 1998).

Systematic part²

Class: Gastropoda

Subclass: Prosobranchia

Order: Vetigastropoda

Superfamily: Neritoidea

Family: Neritidae

Subfamily: Neritinae

Genus: *Agapilia* HARZHAUSER & KOWALKE, 2001

Agapilia cf. *picta* (FÉRUSAC, 1820)

(pl. 1, figs. 1-3)

- 1820 *Nerita picta* FÉRUSAC: Fossiles pl. 2, fig. 4-7.
- 1840 *Nerita picta* FÉRUSAC – GRATELOUP: 109, pl. 1, figs. 13-17.
- 1848 *Nerita pachii* PARTSCH – HÖRNES: 23, Nr. 341 [nomen nudum].
- 1856 *Nerita picta* FÉRUSAC – HÖRNES: 535, pl. 47, fig. 14a-c.
- 1967 *Clithon (Vittoclithon) pictus pachii* (HÖRNES) – TEJKAL et al.: 192, pl. 9b, figs. 3-6.
- 2002 *Agapilia pachii* (HÖRNES) – HARZHAUSER: 67, Taf.1, fig. 6-8.

Material: 6 specimens, Oberdorf, Ostmulde, sample O4 (NHMW 2003z0086/0001-0004).

Measurements: width 2.2-2.4, height 2.4-2.8 mm

² arranged after MILLARD 1999 and FALKNER et al. 2001

Description: Shell with blister-like protoconch. Weakly convex whorls with depression below the suture, causing a slightly angulated outline and pagoda-like shape. A characteristic pattern of dark wavelike lines covers the surface. Most shells display a delicate pattern of thin lines with weak irregularities, but two specimens developed a pattern that is reminiscent of a toothed wheel (pl. 1, fig. 3).

Remarks: FÉRUSSAC (1820) illustrated a specimen from Dax (France), and GRATELOUP (1839) gave a description and published several variations of this species. In the Central Paratethys, *Agapilia picta* is mentioned from brachyhaline deposits especially from the Lower Miocene Karpatian stage (TEJKAL et al. 1967; HARZHAUSER & KOWALKE 2001; HARZHAUSER 2002). Generally, the studied material resembles that from the Korneuburg Basin (Lower Austria) but the specimens from Oberdorf are distinctly smaller. At both localities many specimens bear a marked depression and they are similar to the variation of figure 17 given by GRATELOUP (1840). The observed variability of the colour pattern is also described from Recent relatives of the species (MEINHARDT 1997).

One specimen from Oberdorf exhibits a conical hole (pl. 1, fig. 1a), which is clearly a trace of gastropod predation (compare HOFFMANN et al. 1974; KABAT 1990). Its shape and the position exclude an interpretation as an effect of shell abrasion.

Superfamily: Littorinoidea

Family: Pomatiidae

Genus: *Pomatias* STUDER, 1789

***Pomatias* sp.**

(pl. 1, figs. 4a, b)

Material: 1 operculum from Oberdorf, Ostmulde O4 (NHMW 2003z0086/0005).

Measurements: 8.2 x 7.2 mm

Description: A calcified operculum of an adult specimen, exhibiting five increments of growth.

Remarks: The genus *Pomatias* is rarely recorded from the Lower Miocene (e.g. STWORZEWICZ 1995). In Tuhořice (Bohemia, Czech Republic), one single specimen was found by KLIKA (1891). The material of Oberdorf also has yielded one operculum. This may reflect the ecological conditions, as this taxon was probably not a wetland dweller.

The outline of the peristome allows a cautious allocation of the operculum. The Oligocene *Pomatias antiquum* (BRONGNIART) develops a nearly circular operculum (see DESHAYES 1864: pl. 58, fig. 4; SANDBERGER 1859: pl. 1, fig. 3). A rather similar species from the Oligocene of the Wiesbaden area (Germany) is described by KADOLSKY (1989) as *Pomatias moguntinum*.

Pomatias bisulcatum (ZIETEN), mentioned from Poland by STWORZEWICZ (1995), exhibits an oval and more slender aperture. A similar specimen from the Lower Miocene of Germany is stored in the collection of the NHMW. In *Pomatias consobrinum* (MAYER) from the Badenian of Zwiefalten the outline of the peristome is nearly circular and the

operculum is smaller (SCHLICKUM 1976: pl. 1, fig. 3). *Pomatias conicum* (KLEIN) from the Sarmatian and Pannonian develops smaller and has convex opercula (see LUEGER 1981; HARZHAUSER & KOWALKE 2002). Only in *Pomatias turonicum* WENZ from the Lower Miocene of France (see PEYROT 1932: pl. 18, fig. 4; *Pomatias squamosum* is a synonym of *Pomatias turonicum* !) and of Austria (Korneuburg Basin, Laa/Thaya; Karpatian), the outline is broad ovoid (see BINDER 2002: pl. 1, fig. 4) and thus is reminiscent of the operculum from Oberdorf. Therefore, so the operculum may belong to *Pomatias turonicum*.

Order: Basomatophora

Superfamily: Lymnaeoidea

Family: Lymnaeidae

Genus: *Lymnaea* LAMARCK, 1799

***Lymnaea dilatata* (NOULET, 1854)**

(pl. 1, fig. 7)

- 1854 *Limnaea dilatata* NOULET – NOULET: 107.
 1923 *Radix (Radix) socialis dilatata* (NOULET) – WENZ: 1277.
 1932 *Limnaea dilatata* NOULET – PEYROT: 248, pl. 15, fig. 7, 8.
 2002 *Lymnaea dilatata* (NOULET) – BINDER: 165, Taf. 1, Fig. 7a, b.

Material: 2 specimens and several fragments (NHMW 1988/0134/0067, 0068; 1992/0002/0001).

Measurements: height: 2.9 mm; width: 1.4 mm

Description: The shell displays 5 whorls with a strongly increasing last one. Apparently is the nearly smooth surface. However the last whorl bears flat ribs.

Remarks: This species is common in the Lower and Upper Miocene (compare MAILLARD 1892; MILLER 1900; SCHLICKUM 1976). The taxonomy of the genus *Lymnaea* in the Neogene is discussed by BINDER (2002).

Genus: *Galba* SCHRANK, 1803

***Galba* sp.**

(pl. 1, figs. 5, 6)

Material: 1 compressed specimen: Oberdorf (NHMW 1992/0002/0002); 3 damaged specimens and several fragments: Oberdorf, Ostmulde, sample O4 (NHMW 2003z0086/0008-0010).

Measurements: height: approx. 10 mm; width: approx. 6 mm

Description: The shell has 3.5 distinctly convex whorls; the last whorl is broadened and markedly larger than the fusiform spire. The surface bears small, delicate ribs, which can unite into bands.

Remarks: These fragments resemble *Galba minor* (THOMAE), which was described and figured by SANDBERGER (1850; 1858: 70, Taf. 7, fig. 6) from the Mainz Basin and by KLIKA (1891: 196, fig. 102) from Tuhovice. The flat ribs on the surface blended into bands are very characteristic. Especially the above-mentioned compressed specimen exhibits this feature. *Galba dupuyiana* (NOULET), which was described by DOLLFUS (1916) and FISCHER (2000), seems to be related but differs by very deep sutures and its somewhat more slender shape. *Galba halavatsi* WENZ from the Upper Neogene is even more slender (compare HALAVATS 1911: pl. 3, fig. 13).

Superfamily: Planorbioidea

Family: Planorbidae

Genus: *Planorbarius* FRORIEP, 1806

***Planorbarius cornu* (BRONGNIART, 1810)**

(pl. 2, figs. 2-3)

- 1810 *Planorbis cornu* BRONGNIART – BRONGNIART: 371, pl. 22, fig. 6.
 1874 *Planorbis cornu* BRONGNIART – SANDBERGER: 347, Taf. 18, Fig. 12.
 1891 *Planorbis cornu* BRONGNIART – KLIKA: 106, Fig. 103.
 1923 *Coretus cornu cornu* (BRONGNIART) – WENZ: 1426-1449.

Material: 2 well-preserved specimens from Oberdorf (NHMW 1988/0134/0072 + 0073), 3 additional specimens (1988/0134/0071, 0078, 1989/0054/0024), 2 damaged specimens and several fragments from Oberdorf, Ostmulde, sample O4 (NHMW 2003z0086/0006, 0007), and from Oberdorf, Ostmulde, sample O3 (NHMW 2003z0087/0003).

Measurements: height: 5 mm, width: 17 mm

Description: The discoidal shell consists of 3.5 whorls with distinct spiral lines and ribs, being best developed in juvenile specimens (see pl. 2, fig. 3). The protoconch is blister-like. The sutures of the convex and moderately increasing whorls are deep.

Remarks: This species is abundant in Oberdorf and is also found in the deposits of the so-called Süßwassermolasse in Germany (SCHLICKUM 1970).

Genus: *Gyraulus* CHARPENTER, 1837

***Gyraulus dealbatus* (BRAUN, 1851)**

(pl. 2, figs. 1a-c)

- 1851 *Planorbis dealbatus* - BRAUN: 1134.
 1874 *Planorbis (Gyraulus) dealbatus* BRAUN - SANDBERGER: 492, pl. 25, fig. 10.
 1923 *Gyraulus (Gyraulus) trochiformis dealbatus* (A. BRAUN) – WENZ: 1591.
 1972 *Gyraulus (Gyraulus) trochiformis dealbatus* (BRAUN) – ČTYROKY: 79, pl.5, figs. 2-9.
 1973 *Gyraulus trochiformis dealbatus* (BRAUN) – STEININGER et al.: 451, pl. 9, figs. 11a, b.

Material: 2 specimens, 2 fragments (NHMW 1992/0002/0003, 0004, 0025)

Measurements: height: 0.8 mm; width: 2.3 mm

Description: Discoidal shell with 2.5 weakly convex whorls and sunken spire. The last whorl increases strongly. On the periphery of the last whorl a blunt keel and delicate growth ridges appear.

Remarks: *Planorbis dealbatus* BRAUN was often cited, but the description of this species is very short (BRAUN in WALCHER 1851). SANDBERGER (1874) gave a more detailed description and a figuration of this snail. He emphasized the strongly increasing last whorl as a character of this species. The identification of the specimen from Oberdorf follows this description and moreover the illustration. Further, SANDBERGER (1874) described and illustrated *Planorbis (Gyraulus) declivis* (BRAUN) with narrow whorls and less expanded, flattened last whorl. THOMAE (1845) has described a similar species as *Planorbis applanatus* without illustration. REUSS (1849: 38, pl. 4, fig. 8) introduced a specimen with narrow and slowly increasing whorls as *Planorbis applanatus* THOMAE, but mentioned the differences of his specimen. In contrast, KLIKA (1891: 107, fig. 104 a, b) described a similar specimen as *Planorbis declivis* BRAUN. WENZ (1923) interpreted this name as a synonym of *G. applanatus* and assigned both taxa - *G. applanatus* and *G. dealbatus* - as subspecies of *Gyraulus trochiformis* (STAHL). The variability of the representatives of the genus *Gyraulus* is high (compare MOAYEDPOUR 1977). Hence, relations between these two taxa cannot be decided until more material is analyzed.

Gyraulus dealbatus is also mentioned from the Ottnangian of the Molasse Basin (see ČTYROKY 1972; STEININGER et al. 1973). REICHENBACHER (1989) has figured a similar specimen. Other species differ by a sharp keel, e.g. *Gyraulus goussardianus* (NOULET sensu BOURGUIGNAT) from the Middle Miocene (compare FISCHER 2000).

Order: Archaeopulmonata

Superfamily: Ellobioidea

Family: Carychiidae

Genus: *Carychium* O.F. MÜLLER, 1774

***Carychium nouleti* BOURGUIGNAT, 1857**

(pl. 3, fig. 2)

1923 *Carychium nouleti nouleti* BOURGUIGNAT – WENZ: 1195.

1977 *Carychium (Saraphia) nouleti* BOURGUIGNAT 1857 – STRAUCH: 162, Taf. 15, Fig. 24-27, Taf. 20, Fig. 83.

1999 *Carychium nouleti* BOURGUIGNAT 1857 – STWORZEWICZ: 269, fig. 19-22.

Material: 1 specimen, Oberdorf (NHMW 1992/0002/0005), 1 fragment, Oberdorf, Ostmulde, sample O4 (NHMW 2003z0086/0011).

Measurements: height: 1.7 mm; width: 0.75 mm

Description: A fusiform shell with 3.5 convex whorls and deep sutures. The last whorl is not enlarged and the palatal margin of the aperture is rather straight. The outer and inner lip of the thickened and reflected peristome are separated by a groove. Palatal fold and the columellar fold are knob-like and well visible; a distinct, oblique parietal fold is developed. The surface is covered by fine striae and faint spiral lines. The internal lamella (noticeable in the fragment) is partly broken and the internal columellar fold is simple without an expanded part.

Remarks: The internal folds are used for a reliable determination. The damaged specimen exhibits at the left side an expanded internal parietal lamella and a simply curved, not thickened internal columellar lamella, but these features are too weak for an identification. Therefore, the external features of the shell must be considered as well.

Carychium antiquum (A. BRAUN) has a thicker shell and the outline is ovoid. *Carychium (Saraphia) pachytilus* SANDBERGER is similar but has distinct ribs (see STRAUCH 1977: 161, pl. 14, figs. 21-22) and its last whorl is ascending (see SANDBERGER 1974: 715, pl. 27, fig. 12, and STWORZEWICZ 1999: 271, fig. 23). *Carychium (Saraphia) pseudotetrodon* STRAUCH differs by a strong columellar tooth. In *Carychium (Saraphia) schlickumi* STRAUCH a tapering margin of the peristome on the basis near the columellar fold is existing (compare STRAUCH 1977). *Carychium (Saraphia) suevicum* BOETTGER differs by the elongated shape of the shell. *Carychium (Saraphia) sandbergeri* HANDMANN differs by its slender shape. *Carychium (Carychium) rhenanum* STRAUCH differs by the well-rounded peristome. *Carychium (Carychium) tetradon* PALADILHE has a conical spire and less rounded whorls. *Carychium schwageri* (REUSS), *Carychium prisyzhnyaki* STWORZEWICZ and *Carychium achimsulci* STWORZEWICZ differ by having distinct ribs. *Carychium (Carychiella) eumecron* BOURGUIGNAT differs by the elongated shape of the shell and the large penultimate whorl (compare STWORZEWICZ 1999).

Carychium (Saraphia) nouleti BOURGUIGNAT has an indistinct palatal fold (see STWORZEWICZ 1999: 271, fig. 21), and the last whorl is only minimally ascending (compare STRAUCH 1977: 162, pl. 15, figs. 24-27). These features can be observed in the specimen of Oberdorf. *Carychium nouleti* is described from the Miocene from Poland (STWORZEWICZ 1999), from the Middle Miocene of France (see BOURGUIGNAT 1881; DOLLFUS 1916: 358; FISCHER 2000), from Germany (SCHLICKUM 1976) and from the Upper Miocene of Greece (SCHÜTT 1976).

Order: Stylomatophora

Superfamily: Pupilloidea

Family: Vertiginidae

Genus: *Vertigo* O. F. MÜLLER, 1774

***Vertigo* sp.**

(pl. 3, figs. 1a, b)

Material: 2 fragments (NHMW 1992/0002/0006, 0024)

Measurements: height: approx. 2.2 mm; width: 1.6 mm

Description: The shell is cylindrical with obtuse spire. A parietal tooth is present, and the palatal margin of the peristome has a shallow depression.

Remarks: KLIKA (1891) has described and figured several representatives of this genus from the Early Miocene. The outline is similar to *Vertigo callosa* (REUSS), but the shell from Oberdorf is damaged, especially the aperture with the teeth. A reliable determination is therefore not possible.

Family: Buliminidae

Genus: *Napaeus* ALBERS, 1850

***Napaeus cf. complanatus* (REUSS, 1849)**

(pl. 5, figs. 2a, b)

1849 *Bulimus complanatus* – REUSS: 29, pl. 3, fig. 4.

1891 *Buliminus (Medaea?) complanatus* REUSS – KLIKA: 69, fig. 64.

Material: 1 fragment consisting of the penultimate and the last whorl (NHMW 1992/0002/0007).

Measurements: Only fragments available.

Description: The whorls are flattened with shallow sutures and the umbilicus is narrow but distinct. The margin of the peristome is thickened and reflected, and the edge of the columellar region is weakly curved. The surface of the shell exhibits flat growth-ridges.

Remarks: Several related species are documented from the European Oligocene and Miocene (see DESHAYES 1864; KLIKA 1891; MAILLARD 1892). *Napaeus complanatus* (REUSS) from Tuhořice is very similar but the columellar margin of that species is straight. The specimen of Oberdorf has a curved margin on the columellar area and is somewhat larger.

Superfamily: Zonitoidea

Family: Zonitidae

Genus: *Miozonites* PFEFFER, 1929

Miozonites sp.

(pl. 3, figs. 5a, b, 6)

Material: 9 damaged shells (NHMW 1988/0134/0017, 0018, 0023, 0024, 0035, 0036; 1989/0054/0014-0015, 1992/0002/0023) and a fragment with the protoconch (1992/0002/0008).

Measurements: height: approx. 14 mm; width: approx. 20 mm

Description: The protoconch has ribs (pl. 3, fig. 6). The following whorls of the teleoconch are narrow with deep sutures, moderately convex and form a domed spire. The periphery bears a blunt keel and the shell outline is convex.

Remarks: The protoconch is smaller than that of *Miozonites haidingeri* (REUSS), described from Tuhořice (compare KLIKA 1891). The outline of the shell is reminiscent of *Miozonites costatus* (SANDBERGER) from Zwiefaltendorf (see SCHLICKUM 1976: pl. 5, fig. 66).

Superfamily: Gastrodontoidea

Family: Oxychilidae

Genus: *Aegopinella* LINDHOLM, 1926

***Aegopinella denudata* (REUSS, 1849)**
(pl. 3, fig. 4)

1849 *Hyalina denudata* REUSS: 21: 1, fig. 1.

1891 *Hyalina denudata* REUSS – KLIKA: 28, fig. 19.

Material: 1 fragment (NHMW 1988/0134/0039)

Measurements: height: approx. 2 mm, width: 4.4 mm

Description: Discoidal shell with a broad protoconch and 3.5 smooth teleoconch whorls.

Remarks: The fragment fully agrees with a specimen of *Aegopinella denudata* (REUSS, 1849) from Tuhovice (see KLIKA 1891: 28) which is stored in the NHMW.

Family: Discidae

Genus: *Discus* FITZINGER, 1833

***Discus neumaieri* SCHLICKUM, 1964**
(pl. 3, figs. 3a, b)

1964 *Discus (Discus) neumaieri* SCHLICKUM: 17-18, pl. 2, fig. 4.

1973 *Discus (Discus) neumaieri* SCHLICKUM – STEININGER et al.: 453, pl.9, fig. 14.

Material: 6 fragments (NHMW 1988/0134/0015, 1992/0002/0009 + 0010).

Measurements: Only damaged specimens available, width: > 2.4 mm

Description: Smooth, blister-like protoconch. The following whorls increase regularly and bear curved ribs along the entire whorl.

Remarks: The protoconch is very large compared to related species. *Discus multicostatus* (THOMAE) described from Tuhovice is similar, but differs in its more rapidly increasing whorls (see KLIKA 1891: 39, figs. 31a-d). Furthermore the ribs on the base are slightly weaker (REUSS: 1868: 81).

Superfamily: Parmacelloidea

Family: Milacidae

Genus: *Milax* GRAY, 1855

***Milax* ? sp.**

Material: 2 specimens (NHMW 1992/0002/0016)

Measurements: length: 3.5 mm, width: 2.8 mm

Description: The thick shelled fragment has a strongly convex nucleus which is flattened in the front.

Superfamily: Limacoidea

Family: Limacidae

Genus: *Limax* LINNAEUS, 1758

***Limax* ? sp.**
(pl. 3, fig. 8)

Material: Several specimens (NHMW 1992/0002/0011 + 0012)

Measurements: length: 4.5 mm; width: 2.7 mm

Description: The fossils exhibit a flat plate with the characteristically asymmetric nucleus.

Remarks: The diagnostic features of the diverse families of slugs are internal features such as the genital organs (see WIKTOR & LIKHAREV 1979). Therefore, taxa are often difficult to distinguish even on a generic level. Furthermore, the plates are variable (compare WIKTOR 1973).

***Limax* ? sp.**
(pl. 3, fig. 9)

Material: 1 specimen (NHMW 1992/0002/0013)

Measurements: length: 2.9; width: 1.7 mm

Description: The shell is short with a lateral nucleus. The margin at the posterior end is distinctly expanded.

Family: Agriolimacidae

Genus: *Deroceras* RAFINESQUE, 1820

***Deroceras* ? sp.**
(pl. 3, fig. 7)

Material: 2 specimens (1992/0002/0014 + 0015)

Measurements: length: approx. 5 mm

Description: The delicate plate of this slug differs from *Limax* by its thin structure. On the posterior margin the nucleus is indistinctly visible.

Superfamily: Clausilioidea

Family: Triptychidae

Genus: *Triptychia* SANDBERGER, 1874

***Triptychia ederae* nova species**
(pl. 4, figs. 1, 2, 5)

Material: holotype (NHMW 1988/0134/0045), paratypes (NHMW 1988/0134/0041-0044, 0046-0054, 0055, 0057), 14 fragments (NHMW 1989/0054/0001-0013, 2003z0086/0012).

Measurements: height: approx. 38 mm, width: 13 mm

Derivatio nominis: In honor of Dr. Johanna Kovar-Eder, who has recovered many of the specimens for this study.

Locus typicus: Opencast mine Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene

Diagnosis: The shell has the bulbous shape like a club.

Description: The outline of the shell resembles a slender bulb, the apex is blunt. The 14 flattened whorls are separated by shallow sutures and increase in breadth. The first 3 whorls lack a distinct sculpture, but the following have irregular ribs. The aperture is rounded except for the thin sinulus with a thickened and detached mouth-edge. Slightly oblique and distinctly curved parietal lamella. In the opposite position, the upper columellar lamella expands, but ends before the margin. The lower columellar lamella is steeply expanded and plate-like.

Remarks: *Triptychia maxima* (GRATELOUP 1827) differs from this species by the upper columellar lamella, which extends upwards to the mouth-edge (see GRATELOUP 1838; PEYROT 1932).

Triptychia obliquiplicata (SANDBERGER) from Hřusovany, which is stored in the collection of the NHMW, differs by the aperture margin, which is closely attached to the last whorl. The protoconch in both species is very similar (compare BINDER 2002: 170, pl. 9, fig. 2).

Family: Clausilidae

Subfamily: Serrulinae

Genus: *Serrulella* NORDSIECK, 1981

***Serrulella hoeckae* nova species**

(pl. 4, fig. 4)

Material: holotype: 1 fragment with the aperture preserved (NHMW 1992/0002/0017), paratype: 1 spire fragment (NHMW 1992/0002/0018).

Measurements: height of the aperture: 2.1 mm; width: 1.45 mm

Derivatio nominis: In honor of Dr. Gudrun Daxner-Höck, who has supported this study.

Locus typicus: Opencast mine Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene

Diagnosis: A *Serrulella* with a rather expanded aperture and an ascending lower lamella.

Description: The sinulus is well rounded and the interlamellar area exhibits 5 folds. The margin of the columellar-region, which is thickened and reflected, is distinctly expanded in the upper part and therefore builds an irregular rectangular outline at the margin of the peristome. The bifid lower lamella ascends to the peristome margin. A branch of this lamella turns upwards and the other turns downwards. This is followed by a small

fold and the obliquely ascending, bifid subcollumellar lamella. A shallow groove is located basally and on the palatal margin are knobs and folds. The lower palatal fold is marked and obliquely ascending. The protoconch is large and the following whorls exhibit the beginning of a sculpture of delicate ribs.

Remarks: The outline and the ascending lower palatal fold is different from related species such as *Serrulella multiplicata* NORDSIECK, *Serrulastra ptycholarynx* (BOETTGER, 1877), *Serrulastra brandti* (SCHÜTT) (see SCHÜTT 1967) and *Serrulastra trolli* NORDSIECK. *Serrulastra laevissima* differs by a lack of sculpture (see NORDSIECK 1981).

Genus: *Pseudidyla* O. BOETTGER, 1877

***Pseudidyla schultzi* nova species**

(pl. 4, figs. 3a, b)

Material: holotype: 1 peristome with the aperture (NHMW 1992/0002/0019), paratypes: several spire fragments (NHMW 1992/0002/0020).

Measurements: aperture height: 2.4 mm; aperture width: 1.6 mm.

Derivatio nominis: In honor of Dr. Ortwin Schultz, who supported the work of the author.

Locus typicus: Opencast mine Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene

Diagnosis: Shell with an expanded peristome margin and an elongated sinulus.

Description: The surface of the last whorl is covered by acute ribs. The thickened and reflected mouth-edge is detached from the shell and builds a broad lip with an oval outline.

The sinulus is apparently elongated and turned upwards. The parietal-lamella forms the borderline of the sinulus and is distinctly separated from the mouth-edge. Below the sinulus the margin is narrow and the following part is reflected and broadly expanded. The interlamellar area with 3 folds is expanded on the right side. The lower-lamella is expanded adversely and followed below by 4 folds. The columellar lamella has 2 branches. A groove is located basally and a palatal-fold ascends obliquely. This is followed above by small, indistinctly developed folds. *Pseudidyla* possesses a smaller protoconch than *Serrulella* and the following whorls are not as broad.

Remarks: The specimens from Oberdorf differ from the related species in the Karpatian and Badenian by the elongated sinulus (compare *Pseudidyla polyptyx* (O. BOETTGER 1877: 91, pl. 3, figs. 3, 5a-d and BINDER 2002: 171, pl. 3, fig. 5). *Pseudidyla moersingensis* (SANDBERGER), described from Zwiefaltendorf (SCHLICKUM 1976), and *Pseudidyla boettgeri* NORDSIECK (compare NORDSIECK 1981) differ by the rounded peristome.

Superfamily: Oleacinoidea

Family: Spiraxidae

Subfamily: Euglandininae

Genus: *Palaeoglandina* WENZ, 1914

Palaeoglandina dactylina nova species
(pl. 4, figs. 6a-b)

Material: holotype: NHMW 1988/0134/0070, paratypes: 3 specimens (NHMW 1988/0134/0034, 0069; 1989/0054/0025)

Derivatio nominis: The shape of the shell resembles a date, the fruit of *Phoenix dactylifera* L.

Dactylus means date in medieval Latin.

Locus typicus: Opencast mine Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene.

Diagnosis: Shell with a conical spire and thickened ultimate whorl reminiscent of a date.

Measurements: height: approx. 14 mm, width: approx. 6 mm

Description: Blister-like protoconch; the following 4 feebly convex whorls bear ribs. The outline of the shell is conical fusiform. On the increasing last whorl, ribs are developed only in the upper part of the shell, whereas the remaining surface is smooth.

Remarks: *Palaeoglandina cordieri* (DESHAYES) differs by the sculpture (see SANDBERGER 1974: Taf. 13). *Palaeoglandina taurinensis* (SACCO, 1897: 35, pl. 2, figs. 3a, b) and *Palaeoglandina gracilis* (ZIETEN) are more slender and have a higher spire. Fragments from the Karpatian of the Korneuburg Basin in Lower Austria are very similar (see BINDER 2002: 172, pl. 2, figs. 4a, b; 5a, b; 6; pl. 3, fig. 3). *Palaeoglandina porrecta* (GOBANZ, 1854) of the Badenian, described from Rein (Styria), and *Palaeoglandina inflata* (REUSS) from Tuhořice are thicker. *Palaeoglandina costellata* (NOULET) has an elongated base (see MAILLARD 1892) and the spire is thicker and the ribs are expanded to the underside (see MAILLARD 1892: pl. 1, fig. 2).

Superfamily: Helicoidea

Family: Helicellidae

Subfamily: Helicellinae

Helicellinae indet. spec.

(pl. 5, figs. 3a, b)

Material: 1 fragment of the spire (NHMW 2003z0087/0001)

Measurements: width: approx. 6.8 mm

Description: The fragment has a nearly smooth protoconch like a blister and the following whorls increase regularly with deep sutures. The sculpture consists of characteristic irregular rugose ridges.

Remarks: PFEFFER (1929) gave a similar description of the ridges on the surface of *Titthodomus*. However this genus differs by the shallow sutures. FISCHER & WENZ (1914) and MOAYEDPOUR (1977) described fully preserved specimens of *Titthodomus*. The fragmentary preservation of the Oberdorf specimen allows no identification.

Family: Helicidae

Subfamily: Ariantinae

Genus: *Helicigona* RISSO, 1826

***Helicigona* sp.**

(pl. 5, figs. 1a-c)

Material: 1 fragment (NHMW 2003z0087/0002)

Measurements: width: approx. 9.5 mm

Description: Only 2 whorls and the basal part are preserved. The peristome margin is thickened and reflected, the umbilicus is moderately wide. The upper part of the shell surface bears a reticulate sculpture and simple pits deriving from hairs. The lower part is covered by growth-ridges.

Remarks: The pits are characteristic for *Helicigona*. Comparable is the recent *Helicigona fuchsi* KNIPPER, 1939 from S. Albania (compare SUBAI 1995), but the shell of that species is larger. Otherwise, the mouth-edge and the umbilicus are similar and the surface bears hairs.

Subfamily: Helicininae

Genus: *Megalotachea* PFEFFER, 1929

***Megalotachea* cf. *turonensis* (DESHAYES, 1831)**

(pl. 5, fig. 4)

1831 *Helix asperula* Nob. – DESHAYES: 251.

1831 *Helix turonensis* Nob. – DESHAYES: 251.

1971 *Megalotachea turonensis* (DESHAYES, 1831) – TRUC: 284, pl. 15, fig. 2.

2002 *Megalotachea turonensis* (DESHAYES) – BINDER: 175.

Material: 1 damaged and strongly compressed specimen (NHMW 1992/0002/0021) from Oberdorf O4

Measurements: diameter 25 mm

Description: Large protoconch has smooth surface, and 3.5 strongly increasing teleoconch whorls bear prominent ribs. Callus of the sealed umbilicus is visible on the base.

Remarks: The shell is reminiscent of the *Megalotachea* species from the Karpatian Korneuburg Basin (compare BINDER 2002) and from Grund in Lower Austria (Badenian). The ribs are well preserved by the sediment. Specimens of *Megalotachea turonensis* (DESHAYES) can also develop ribs. These specimens have been erroneously described as *Helix asperula* DESHAYES (1831) (compare TRUC 1971b: 284, 286, pl. 15, fig. 2).

Genus: *Klikia* PILSBRY, 1895

***Klikia devexa robusta* nova subspecies**

(pl. 6, figs. 1, 2, 4)

Material: holotype (NHMW 1988/0134/0074) and 5 paratypes (NHMW 1988/0134/0058, 0059, 0075-0077) from Oberdorf.

Measurements: height: 7.7 mm; width: 12.7 mm

Derivatio nominis: based on the robust shell

Locus typicus: Open-cast working Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene

Diagnosis: A robust *Klikia* with very narrow umbilicus and large papillas.

Description: A depressed, globular shell with 4.5 regularly increasing whorls. A distinct depression appears close to the aperture; umbilicus of adult specimens is nearly completely covered by the reflected peristome. Surface is covered by fine ribs and papillas (see pl. 6, fig. 4).

Remarks: The evolution of the genus *Klikia* is reflected by several species (see WENZ 1912). Within the *devexa*-lineage, the newly established subspecies is more or less intermediate between *Klikia devexa devexa* (REUSS) from Tuhovce (see REUSS 1860; KLIKA 1891) and *Klikia orbiculata* BINDER from the Korneuburg Basin (Karpatian). The shape is similar to *Klikia devexa devexa* and not as flat discoidal as *Klikia orbiculata*. The papillas of *Klikia devexa robusta* are larger than *Klikia devexa devexa*, but not as large as those of *Klikia orbiculata* (compare BINDER 2002: 173, pl. 6, fig. 7b).

***Klikia giengensis* (KLEIN, 1846)**

(pl. 6, figs. 3 a, b)

1846 *Helix Giengensis* KRAUSS – KLEIN: 69, pl. 1, fig. 9.

Material: 2 specimen (NHMW 1988/0134/0011, 0022)

Measurements: height: approx. 4.6 mm; width: approx. 10 mm

Remarks: This species differs from *Klikia devexa robusta* by narrowly coiled shell and the wide umbilicus and agrees fully with the specimen of *Klikia giengensis* from Zwiefalten, stored in the collection of the NHMW. *Helix Giengensis* KRAUSS is not published. The valid author's name is KLEIN (compare WENZ 1923). A similar, but damaged specimen with an umbilicus is mentioned from the Karpatian (*Klikia* sp. see BINDER 2002).

Genus: *Tropidomphalus* PILSBRY, 1895

Tropidomphalus rotundus nova species

(pl. 7, figs. 1-4)

Material: holotype (NHMW 1988/0134/0005), paratypes (NHMW 1988/0134/0002-0004, 0006-0010, 0012-0014, 0016, 0019-0021, 0025-0033, 0035, 0037, 0038, 0040, 0056, 0060-0066); 1989/0054/0016-0023; 1992/2002/0022, 2003z0086/0013, 2003z0087/0004).

Measurements: height: 19-22.7 mm, width: 29.8 -31 mm

Derivatio nominis: The outline of the globated shell is rounded.

Locus typicus: Opencast mine Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene

Diagnosis: A globular *Tropidomphalus* with sealed umbilicus.

Description: Globular shell with a rather conical spire of 4 slightly convex whorls. The protoconch is sac-like, the teleoconch whorls are regularly increasing, and have growth-ridges. Near the aperture there is an extralabial depression. The peristome margin is thickened and reflected (see pl. 7, fig. 3). The umbilicus is fully covered and sealed by this lip. The surface of the protoconch has fine papillas (see pl. 7, fig. 2d) whereas the teleoconch displays larger, oval papillas, surrounded by little depressions (see pl. 7, fig. 4). In addition, the shell is covered by small, delicate elevations.

Remarks: The genus *Tropidomphalus* developed many different species (see TRUC 1971a; LUEGER 1981). *Tropidomphalus robustus* (REUSS) from Tuhořice (see REUSS 1849; KLIKA 1891) is similar but differs in its distinct umbilicus. The microsculpture of the newly described species is characteristic by the genus *Tropidomphalus* (compare TRUC 1971a: 287, pl. 18).

Superfamily: Camaenoidea

Family: Camaenidae

Genus: *Pleurodonte* FISCHER VON WALDHEIM, 1808

Pleurodonte norica nova species

(pl. 8, figs. 1a-i)

Material: 1 specimen: holotype (NHMW 1988/0134/0001).

Derivatio nominis: The location lies in the range of the Roman province Noricum.

Locus typicus: Opencast mine Oberdorf, near Köflach, Styria, Austria.

Stratum typicum: Ottnangian, Lower Miocene

Measurements: height: 18 mm; width: 38 mm

Diagnosis: A discoidal shell with ribs and without a keel.

Description: The shell is discoidal with convex and regularly increasing whorls without a keel. The large protoconch of 1.5 whorls has an apex like a sac and is strongly increasing afterwards. The surface of the protoconch bears delicate, irregularly curved and dichotomously fissured ribs (see pl. 8, fig. 1e). The microsculpture of the teleoconch is quite different. The ribs are coarse and vary in thickness. They are prominent on the last whorl. The upper part of the whorls flattens toward the periphery and separated by deep sutures. The last whorl turns downwards and a distinct depression is developed near the aperture. The peristome margin is thickened and reflected. Originally, the umbilicus was partly obscured by it, but due to fragmentation the umbilicus became exposed (pl. 8, fig. 1g). The part of the shell where the peristome margin was attached exhibits a well-preserved sculpture of little knobs arranged in rows (see pl. 8, fig. 1f).

Remarks: All Camaenidae have a protoconch with a sac-like apex and a strongly enlarged following part of the protoconch. Recent representatives of *Pleurodonte* sensu lato

FISCHER VON WALDHEIM 1808 (see GOTO & POPPE 1996) inhabit the Caribbean Sea (see PFEIFFER 1846, PILSBRY 1894, BAKER 1962; modern illustrations are in PARKINSON, HEMMEN & GROH 1987). A fossil record from the Caribbean region is published by JUNG (1971). PILSBRY (1939) has established the genus *Pleurodontites* containing a fossil species in America - *Pleurodontites haruspica* (DALL) - but this genus differs by its spiral lines (see ZILCH 1959). The description of *Pleurodonte norica* agrees with the genus-description of RICHARDSON (1985), but the species differs by the rounded whorls from most modern relatives, which have keeled whorls. Camaenidae occur also in other Neogene locations. Yet, ANDREAE (1902) mentioned the relationship between recent Camaenidae (*Pleurodonte*) and fossil species of Silesia (Sarmatian). SACCO (1897: 61, pl. 5, fig. 2) described *Helix (Galactochilus) exbrocchi* from the Upper Neogene and he also compared it with a tropical species. A similar species, *Helix (Galactochilus) brocchi*, was described by SANDBERGER (1874: 741, pl. 32, fig. 17). The newly described species from Oberdorf is distinctly flatter than the mentioned Upper Miocene relatives and has a characteristic microsculpture with ribs and little knobs, but no keel.

Conclusions

1. Biostratigraphy (see Table 1)

The terrestrial gastropod fauna of Oberdorf yields several stratigraphically significant taxa. Some species such as *Tropidomphalus rotundus* and *Triptychia ederae* are hitherto only known from the Ottnangian. Within the genus *Klikia*, the newly established subspecies *Klikia devexa robusta* documents the shift towards large papillas. Some elements of the fauna are similar to species of Tuhořice (see KLIKA 1891), which is older (Eggenburgian, mammal zone MN3). This relation is well documented by the pairs *Tropidomphalus rotundus* and *Tropidomphalus robustus* or *Klikia devexa devexa* and *Klikia devexa robusta*. Stratigraphically older faunas (SANDBERGER 1858; MOAYEDPOUR 1977) and also the assemblages from younger ages (e.g. Karpatian, BINDER 2002) differ considerably.

Tab. 1: The shift of species during the Miocene

Middle Miocene

Badenian: *Klikia coarctata* *Klikia giengensis*

Early Miocene

Karpatian: *Klikia orbiculata* *Klikia* sp. *Tropidomphalus extinctus*

Ottnangian: *Klikia devexa robusta* *Klikia giengensis* *Tropidomphalus rotundus*

Eggenburgian: *Klikia devexa devexa* *Tropidomphalus robustus*

2. Ecological interpretation (see Table 2 and 3)

A tentative paleoecological interpretation might be given based on the comparison with the requirements of recent relatives. Furthermore, the constructional morphology provides hints to reconstruct the former habitat (see BINDER 2002). Several habitats can be distinguished:

Wetland and riparian woods:

Most of the terrestrial gastropods of Oberdorf lived under wet conditions. Very abundant are *Tropidomphalus rotundus* and *Triptychia ederae*. This frequency in the fossil record is interpreted to reflect the closeness between habitat and place of deposition in the sediment.

Subtropical woods of the hinterland:

Miozonites sp., *Aegopinella denudata*, *Discus neumaieri*, *Napaeus* cf. *complanatus*, *Pleurodonte norica* and *Helicigona* sp. derive from the subtropical woodland. The recent relatives of these genera are dwellers of wood and therefore similar conditions for the fossil species might be expected. A high percentage of species may be regarded as forest dwellers, but the frequency of specimens in the fossil record is very low. This is probably caused by the rather wide distance between the former habitat and the place of deposition. The reconstruction of forests as the predominate habitats coincides with the data on mammals and plants (see DAXNER-HÖCK et al. 1998 and KOVAR-EDER & MELLER 2002).

Open landscape:

Only a single, damaged specimen of the genus *Megalotachea* reflects an habitat of open environments. Traits like smooth surface, ribs and callus indicate these conditions (see BINDER 2002: 162, 175). The habitat was clearly situated far away.

Limnic habitats:

The freshwater gastropods, with *Lymnaea dilatata* and *Planorbarius cornu*, indicate an eutrophic river with many plants.

Brachyhaline habitats?

Agapilia cf. *picta* indicates a brachyhaline environment and therefore quite different conditions than those preferred by the planorbids. If the hole is a trace of naticid-predation it would be a further argument for at least brachyhaline deposits. The preservation of the shell is very good, probably due to the robustness of *Agapilia* shells, which are resistant against corrosion. Allochthonous transposition from older deposits is therefore possible. Fluvial sediments, which might indicate dislocation, are described in the sedimentary analysis (see HAAS et al. 1998).

Tab. 2: The habitats of the Lower Miocene location Oberdorf, based on occurrence of gastropoda

river	riparian wood, wetland	subtropical forest	dry and open habitat
<i>Planorbarius</i> and <i>Lymnaea</i> fauna	<i>Tropidomphalus</i> <i>Triptychia</i> fauna	<i>Miozonites</i> <i>Klikia</i> fauna	<i>Megalotachea</i> fauna

Tab. 3: The malakofauna of Oberdorf and its habitats:

Ecological features: Wetland – H, wet woods – Wh, woods of the "hinterland" – Wm, open landscape – O, open woods – WO, limnic – L, brachyhaline – h

<i>Apapilia</i> (FÉRUSSAC)	h	
<i>Pomatias</i> sp.	Wm, WO, O	
<i>Lymnaea dilatata</i> (NOULET, 1858)	L	
<i>Galba</i> sp.	L	
<i>Planorbarius cornu</i> (BRONGNIART, 1810)	L	abundant
<i>Gyraulus dealbatus</i> (BRAUN, 1851)	L	
<i>Carychium nouleti</i> BOURGUIGNAT, 1857	H	
<i>Vertigo</i> sp.		
<i>Napaeus</i> cf. <i>complanatus</i>	Wm	
<i>Miozonites</i> sp.	Wm	
<i>Aegopinella denudata</i> (REUSS, 1849)	Wm	
<i>Discus neumaieri</i> SCHLICKUM, 1964	Wm	
<i>Limax</i> ? sp.		
<i>Deroceras</i> ? sp.		
<i>Milax</i> ? sp.		
<i>Triptychia ederae</i> nova species		abundant
<i>Serrulella hoeckae</i> nova species		
<i>Pseudidyla schultzi</i> nova species		
<i>Palaeoglandina dactylina</i> nova species		
<i>Helicigona</i> sp.	Wm	
<i>Megalotachea</i> cf. <i>turonensis</i> (DESHAYES, 1831)	O	
<i>Klikia devexa robusta</i> nova subspecies		
<i>Klikia giengensis</i> KLEIN, 1846		
<i>Tropidomphalus rotundus</i> nova species	Wh	abundant
Helicellinae indet. spec.		
<i>Pleurodonte norica</i> nova species	Wm	

3. Paleobiogeography

Species which are related to modern subtropical taxa (e.g. *Bulimus*, *Pleurodonte*) are the most striking feature of the fauna from Oberdorf. The occurrence of these species can be explained as remnants of an older, Paleogene biogeography. Several genera which live today in tropical, subtropical and Mediterranean environments already existed during the Palaeogene in Europe (OPPENHEIM 1890). Due to the later geological and climatic change, the range of these species was fragmented. This development in the terrestrial gastropod fauna is paralleled by the change in the distribution of the floras (compare SCHROEDER 1998).

4. The climatic conditions

Terrestrial gastropods yield information about the climate. Remarkable in the fauna of Oberdorf are the large-sized snails such as *Triptychia ederae*, *Tropidomphalus rotundus* and *Pleurodonte norica*. These large forms indicate warm conditions because they needed

a warm season to reach maturity. The papillas or other elevations on the shell surface of some genera indicate moist conditions. The terrestrial molluscs of Oberdorf exhibit an optimum in the climatic evolution of the Neogene (compare KOVAR-EDER & MELLER 2002: 100).

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Plate 1

Fig. 1-3: *Agapilia cf. picta* (FÉRUSSAC)

Fig. 1a, b: with trace of naticid predation – NHMW 2003z0086/0001

Fig. 2: pattern with tongue-like lines – NHMW 2003z0086/0002

Fig. 3: with "toothed wheel" pattern – NHMW 2003z0086/0003

Fig. 4a, b: *Pomatias sp.* operculum – NHMW 2003z0086/0005

Fig. 5: *Galba sp.* – NHMW 2003z0086/0008

Fig. 6: *Galba sp.* – NHMW 2003z0086/0009

Fig. 7: *Lymnaea dilatata* (NOULET) – NHMW 1988/0134/0067

scale bars = 1 mm

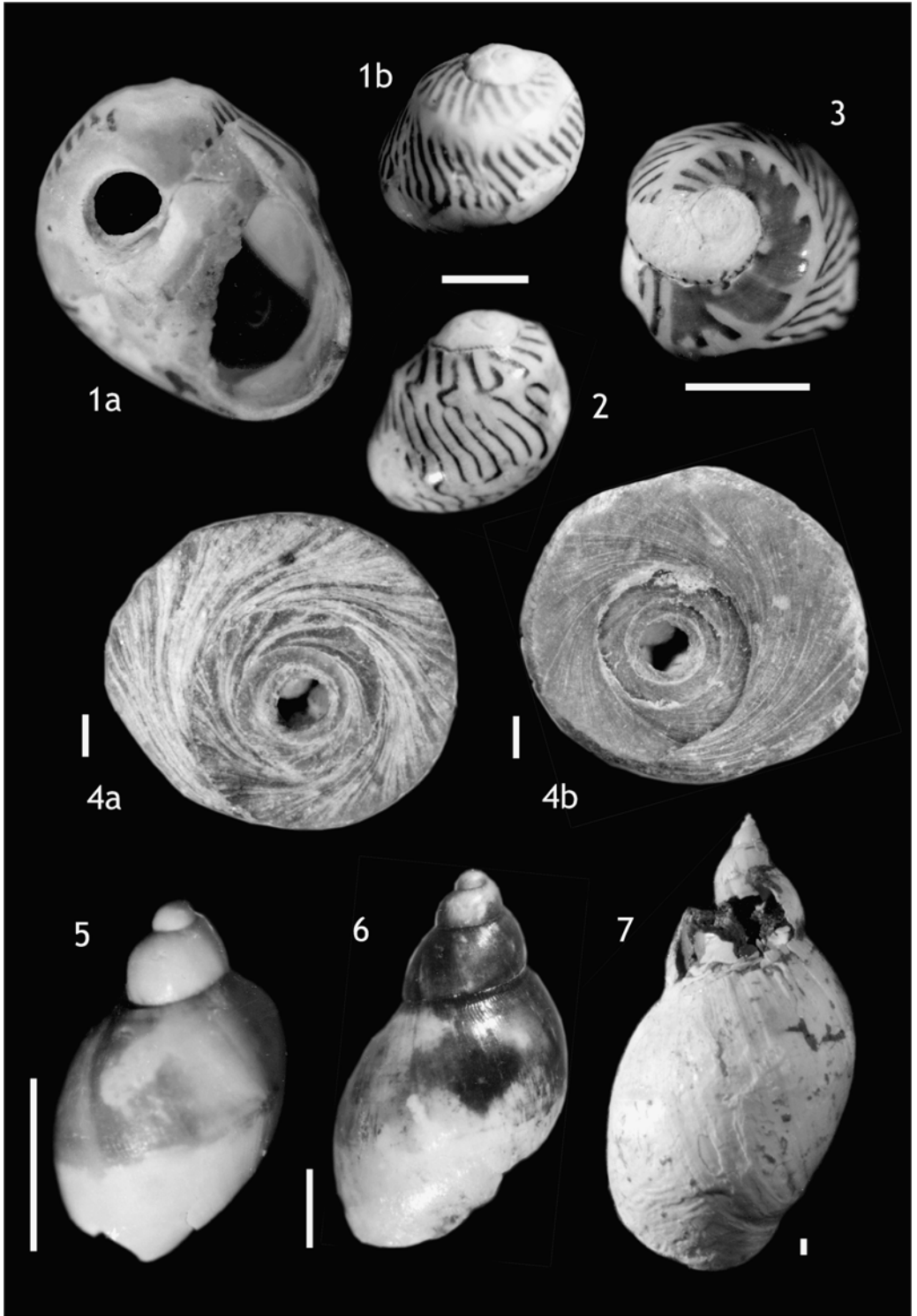


Plate 2

Fig. 1a, b, c: *Gyraulus dealbatus* (AL. BRAUN) – NHMW 1992/0002/0003

Fig. 2: *Planorbarius cornu* (BRONGNIART) – NHMW 1988/0134/0072

Fig. 3: *Planorbarius cornu* (BRONGNIART), microsculpture and protoconch –
NHMW 1988/0134/0073

scale bars = 1 mm

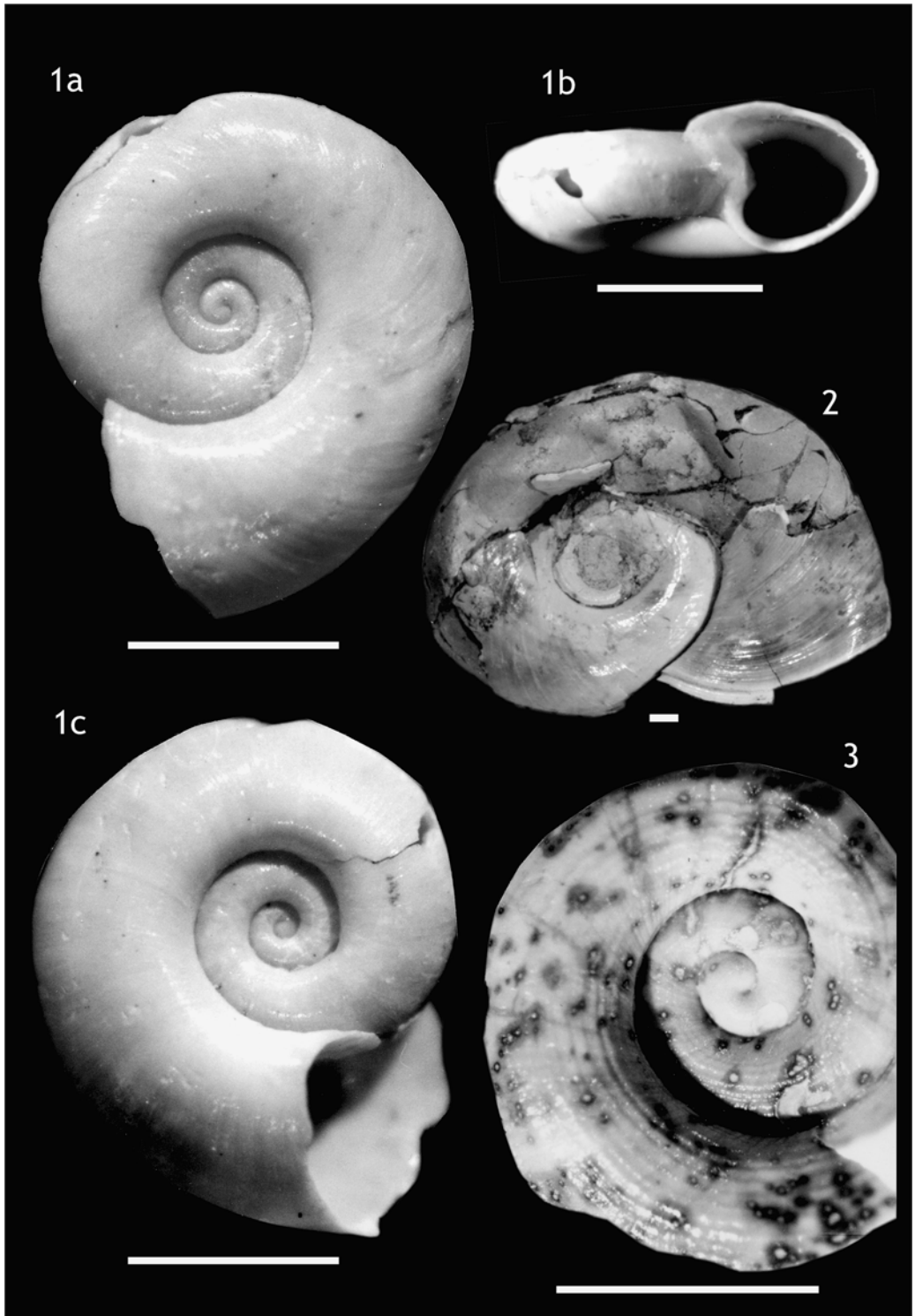


Plate 3

Fig. 1a, b: *Vertigo* sp. – NHMW 1992/0002/0006

Fig. 2: *Carychium nouleti* BOURGUIGNAT – NHMW 1992/0002/0005

Fig. 3a, b: *Discus neumaierei* SCHLICKUM – NHMW 1992/0002/0009

Fig. 4: *Aegopinella denudata* (REUSS) – NHMW 1988/0134/0039

Fig. 5a, b: *Miozonites* sp. – NHMW 1988/0134/0017

Fig. 6: *Miozonites* sp., juvenile whorl – NHMW 1992/0002/0008

Fig. 7: *Deroceras* ? sp. – NHMW 1992/0002/0014

Fig. 8: *Limax* ? sp. – NHMW 1992/0002/0011

Fig. 9: *Limax* ? sp. – NHMW 1992/0002/0013

scale bars = 1 mm

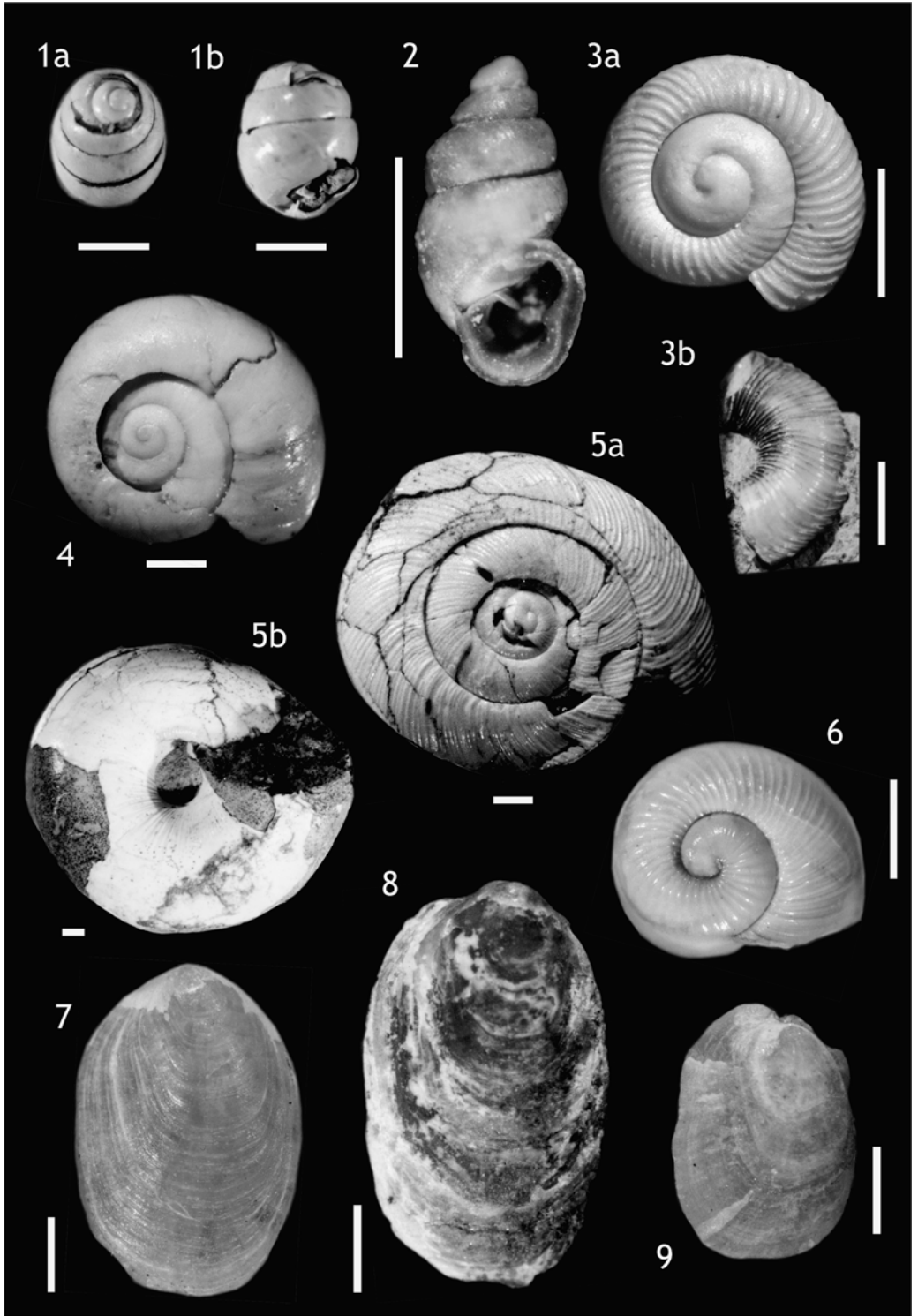


Plate 4

- Fig. 1: *Triptychia ederae* nova species – NHMW 1988/0134/0045
Fig. 2: *Triptychia ederae* nova species – NHMW 1988/0134/0041
Fig. 3a, b: *Pseudidyla schultzi* nova species – NHMW 1992/0002/0019
Fig. 4: *Serrulella hoeckae* nova species – NHMW 1992/0002/0017
Fig. 5: *Triptychia ederae* nova species – NHMW 1988/0134/0042
Fig. 6a, b: *Palaeglandina dactylina* nova species – NHMW 1988/0134/0070

scale bars = 1 mm

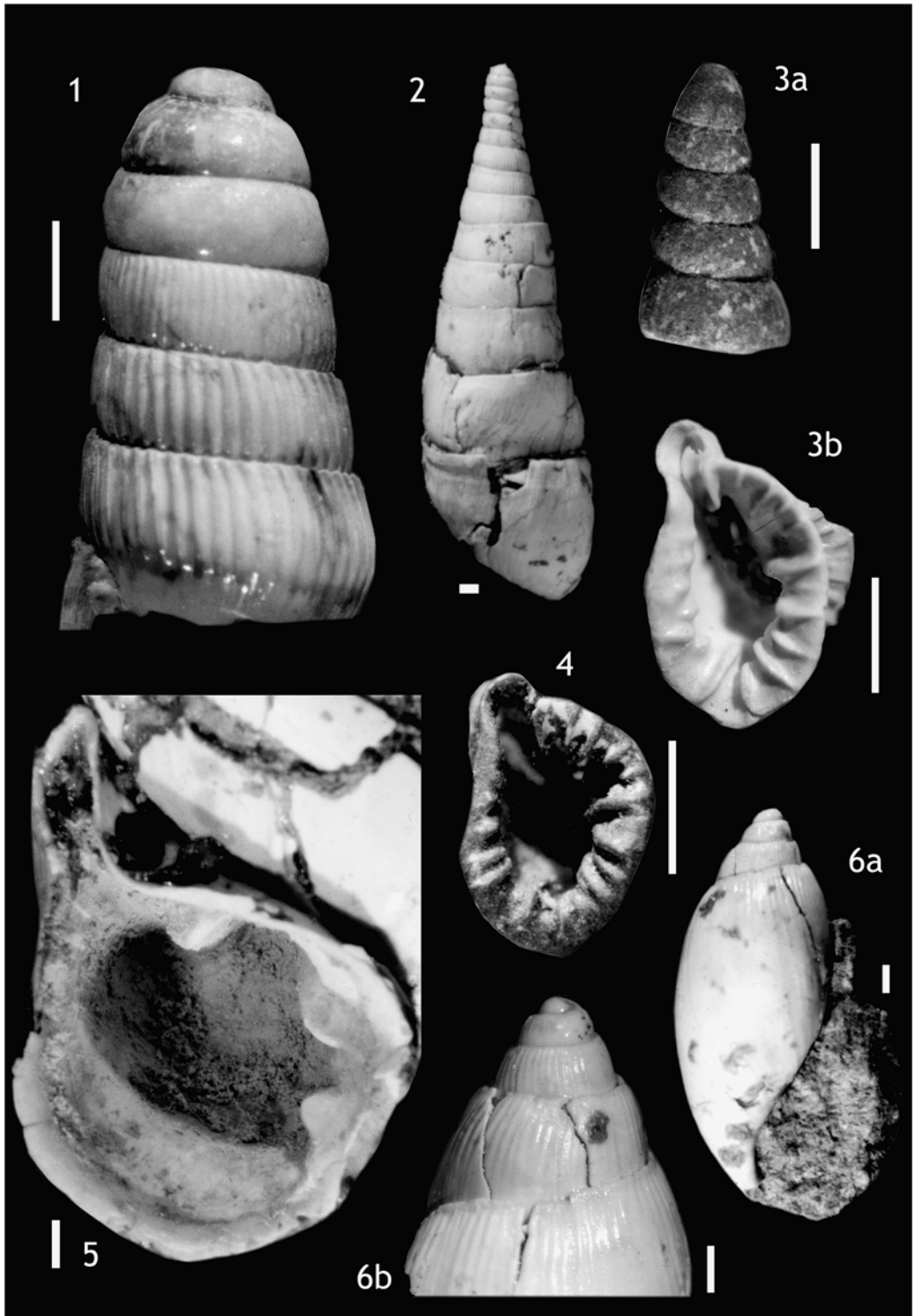


Plate 5

Fig. 1a: *Helicigona* sp., microsculpture of the upper surface – NHMW 2003z0087/0002

Fig. 1b, c: *Helicigona* sp. – NHMW 2003z0087/0002

Fig. 2a, b: *Napaeus* cf. *complanatus* (REUSS) – NHMW 1992/0002/0007

Fig. 3a: **Helicellinae indet. spec.** – NHMW 2003z0087/0001

Fig. 3b: **Helicellinae indet. spec.**, detail of the sculpture – NHMW 2003z0087/0001

Fig. 4: *Megalotachea* cf. *turonensis* (DESHAYES, 1831) – NHMW 1992/0002/0021

scale bars = 1 mm

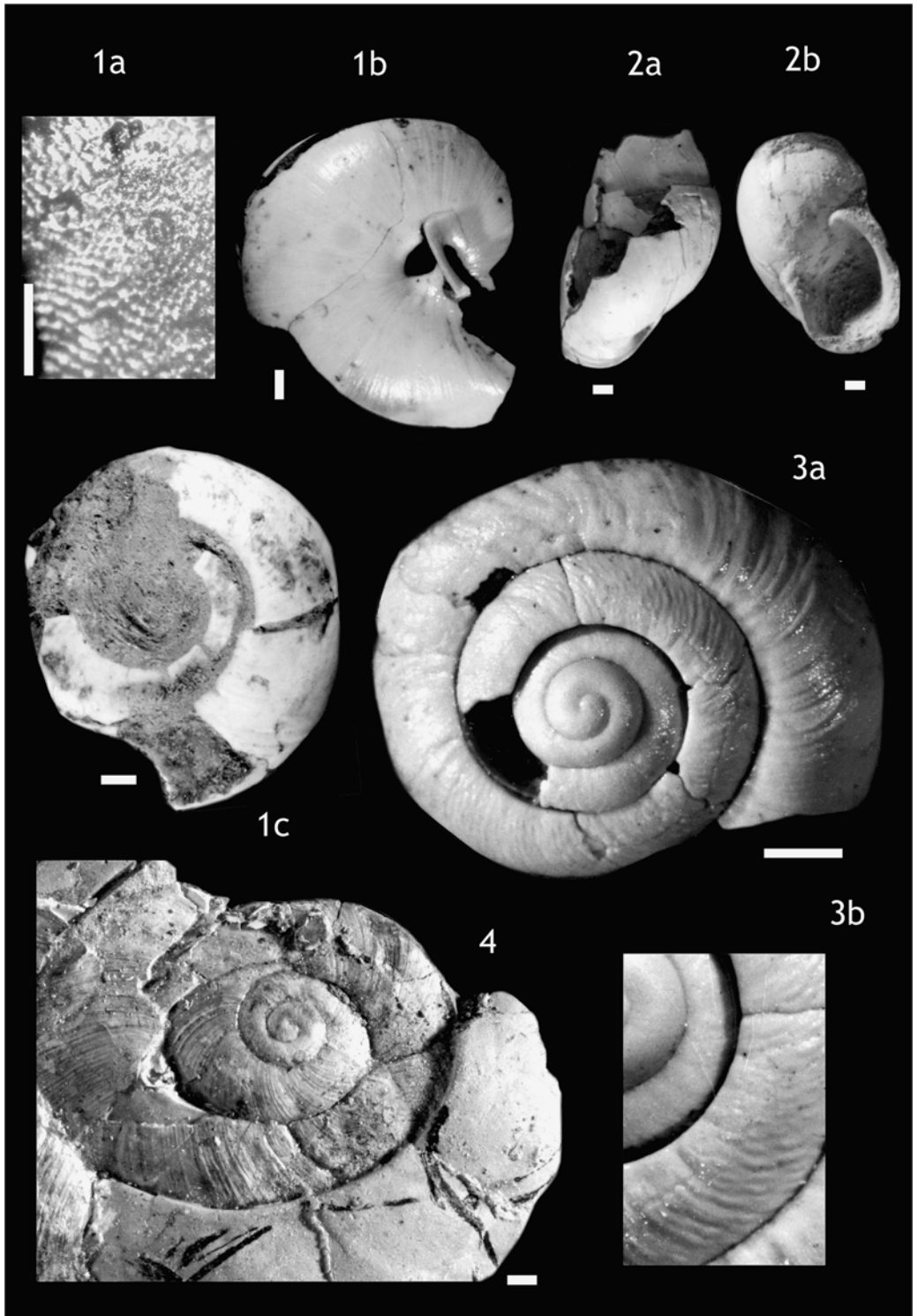


Plate 6

- Fig. 1, 2: ***Klikia devexa robusta nova subspecies***
Fig. 1a-c: holotype – NHMW 1988/0134/0074
Fig. 1d: holotype, detail of fig. 1
Fig. 1e: holotype, peristome, detail of fig. 1
Fig. 2: paratype – NHMW 1988/0134/0075
Fig. 3a, b: ***Klikia giengensis* (KLEIN)** – NHMW 1988/0134/0022
Fig. 4: ***Klikia devexa robusta nova subspecies*** paratype with papillas. –
NHMW 1988/0134/0076

scale bars = 1 mm

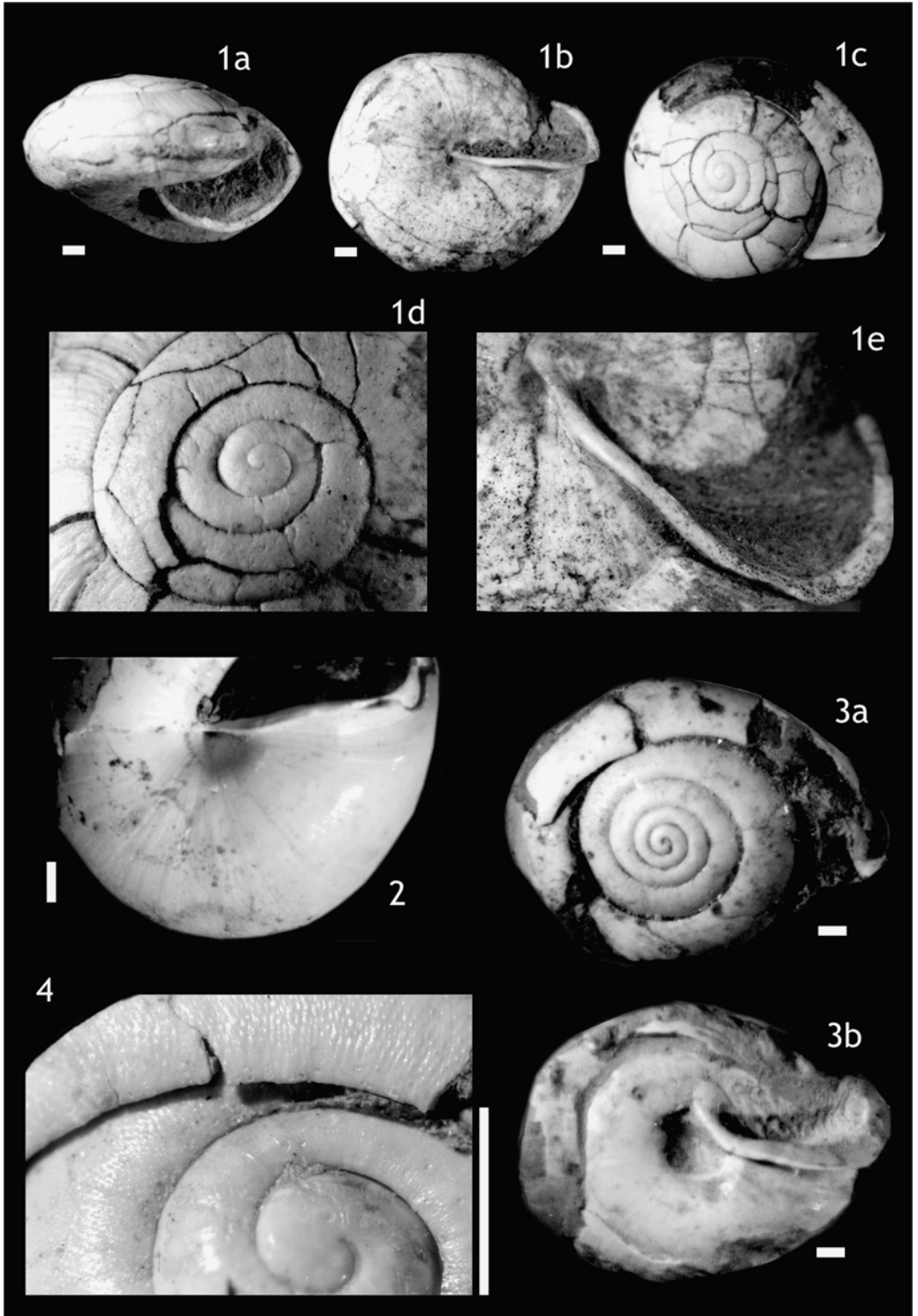


Plate 7

Fig. 1-4: ***Tropidomphalus rotundus nova species***

Fig. 1a: juvenile specimen, paratype – NHMW 1988/0134/0002

Fig. 2a-c: holotype – NHMW 1988/0134/0005

Fig. d: protoconch with papillas – NHMW 1988/0134/0004

Fig. e: pits as traces of papillas, holotype, detail of fig. 2. – NHMW 1988/0134/0005

Fig. 3: sealed umbilicus – NHMW 1988/0134/0006

Fig. 4: papillas of the teleoconch – NHMW 1988/0134/0007

scale bars = 1 mm

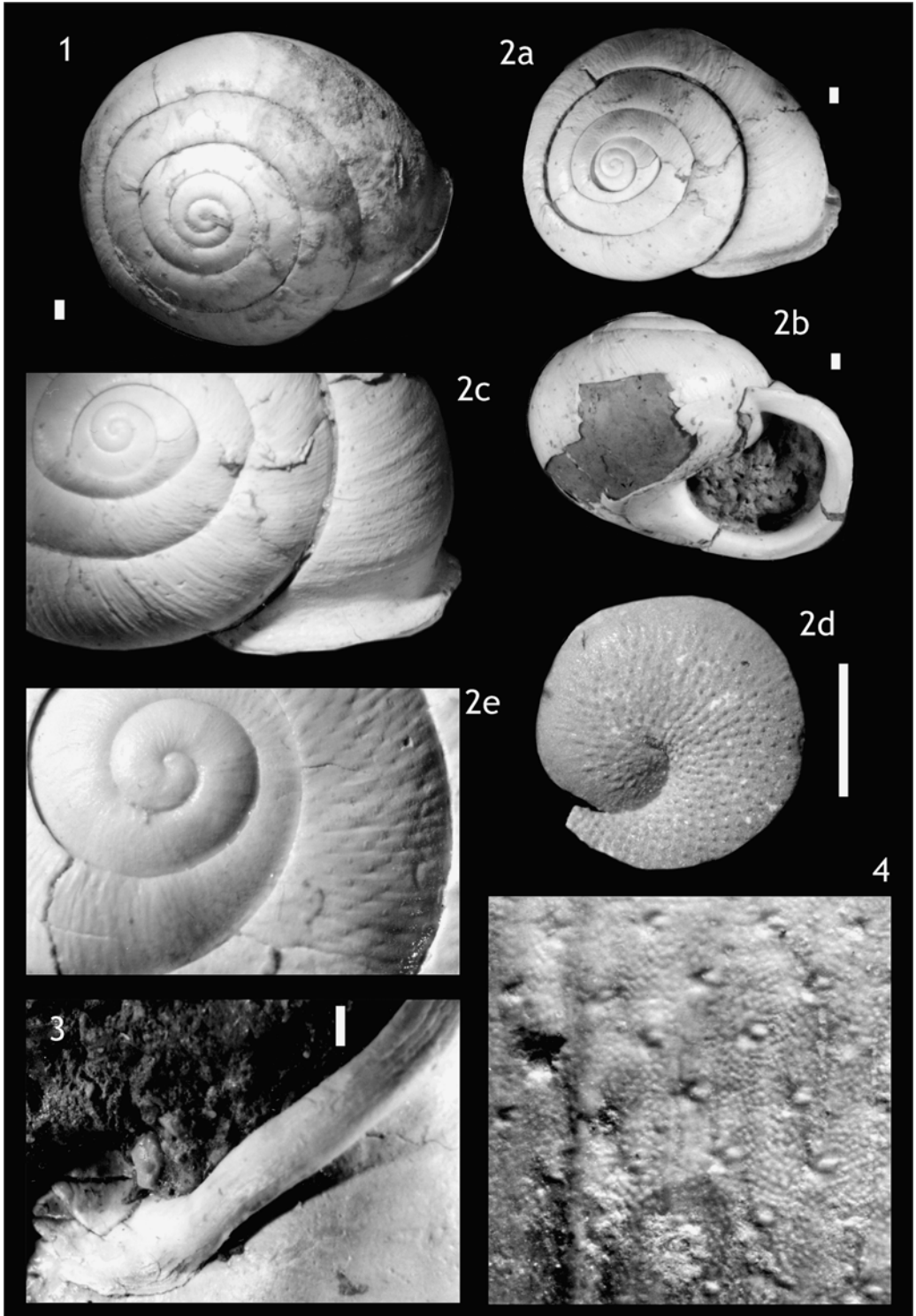


Plate 8

Fig. 1: *Pleurodonte norica nova species*, NHMW 1988/0134/0001

Fig. 1a-c: holotype

Fig. 1d: protoconch

Fig. 1e: microsculpture of the protoconch

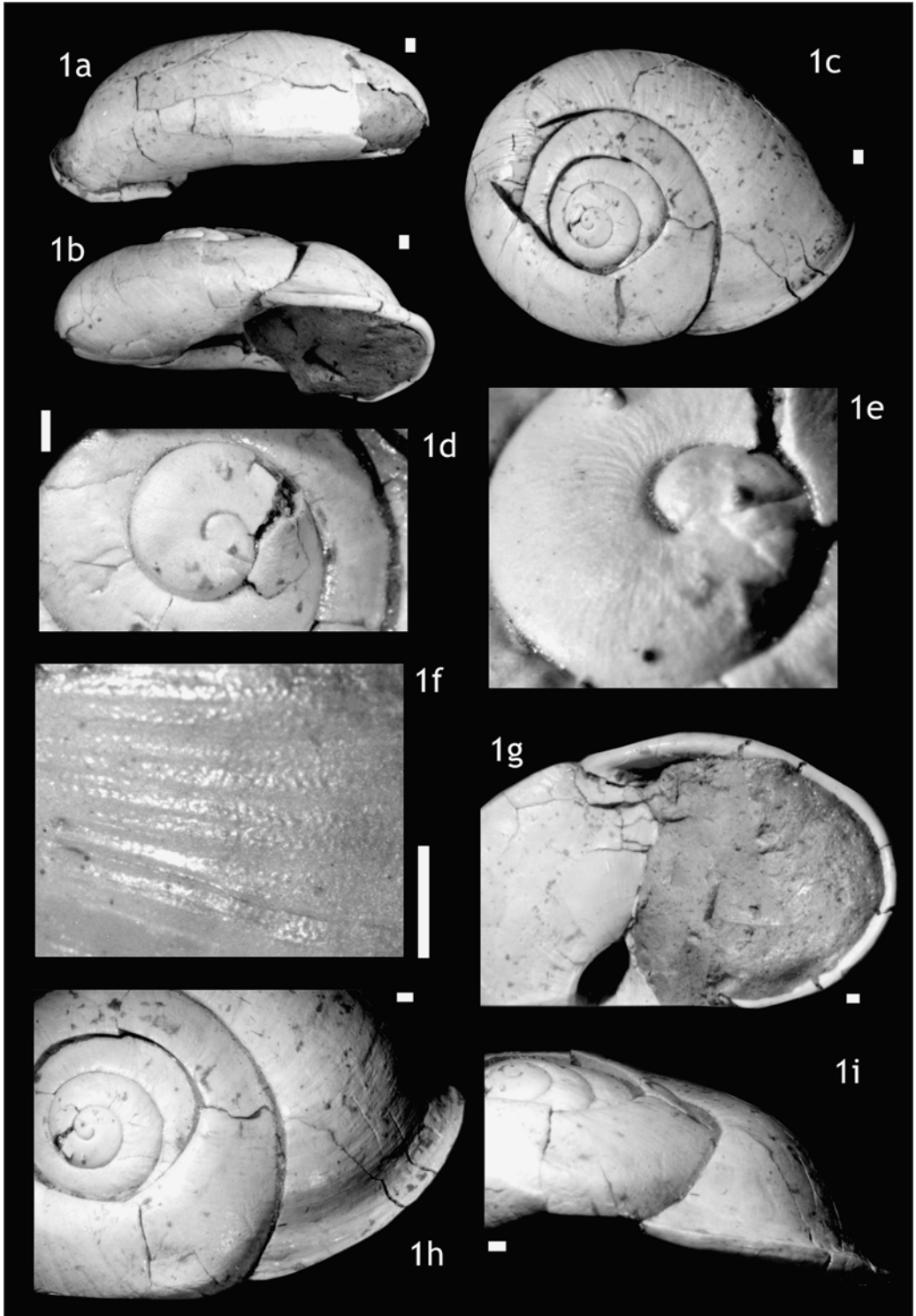
Fig. 1f: microsculpture of the base

Fig. 1g: umbilicus

Fig. 1h: peristome margin

Fig. 1i: peristome margin

scale bars = 1 mm



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