

# A late Burdigalian bathyal mollusc fauna from the Vienna Basin (Slovakia)

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**Abstract:** This is the first record of a bathyal mollusc fauna from the late Early Miocene of the Central Paratethys. The assemblage shows clear affinities to coeval faunas of the Turin Hills in the Mediterranean area and the Aquitaine Basin in France. The overall biostratigraphic value of the assemblage is hard to estimate due to the general very poor knowledge of Miocene bathyal faunas. Several species, however, are known from deep water deposits of the Middle Miocene Badenian stage as well. This implies Early Miocene roots of parts of the Middle Miocene deep water fauna and suggests a low turnover for bathyal mollusc communities at the Early-Middle Miocene boundary. The nassariid gastropod *Nassarius janschloegli* Harzhauser nov. sp. and the naticid gastropod *Polinices cerovaensis* Harzhauser nov. sp. are introduced as new species.

**Key words:** Early Miocene, Central Paratethys, Vienna Basin, bathyal, molluscs.

## Introduction

The molluscs were collected at Cerová-Lieskové in the Slovak Republic. The outcrop is situated at the western slope of the Malé Karpaty Mts which forms the eastern margin of the central Vienna Basin (Fig. 1A,B). The deposits of the former clay pit are massive, locally laminated calcareous clay and clayey silt with thin tempestites (up to 5 mm thick) with plant remains and several thin sandstone layers in the uppermost part of the section (Fig. 1C) belonging to the Lakšárska Nová Ves Formation (Špička & Zapletalová 1964). The grey sediments have a beige-whitish weathering colour and are characterized by a high amount of diatom skeletons. A detailed description of the geological setting and the sedimentology will be given elsewhere (Hyžný & Schlögl 2011). The age of the Cerová section is Late Karpatian according to the regional stratigraphic scheme, corresponding to the late Burdigalian.

## Bathyal faunas in the Central Paratethys

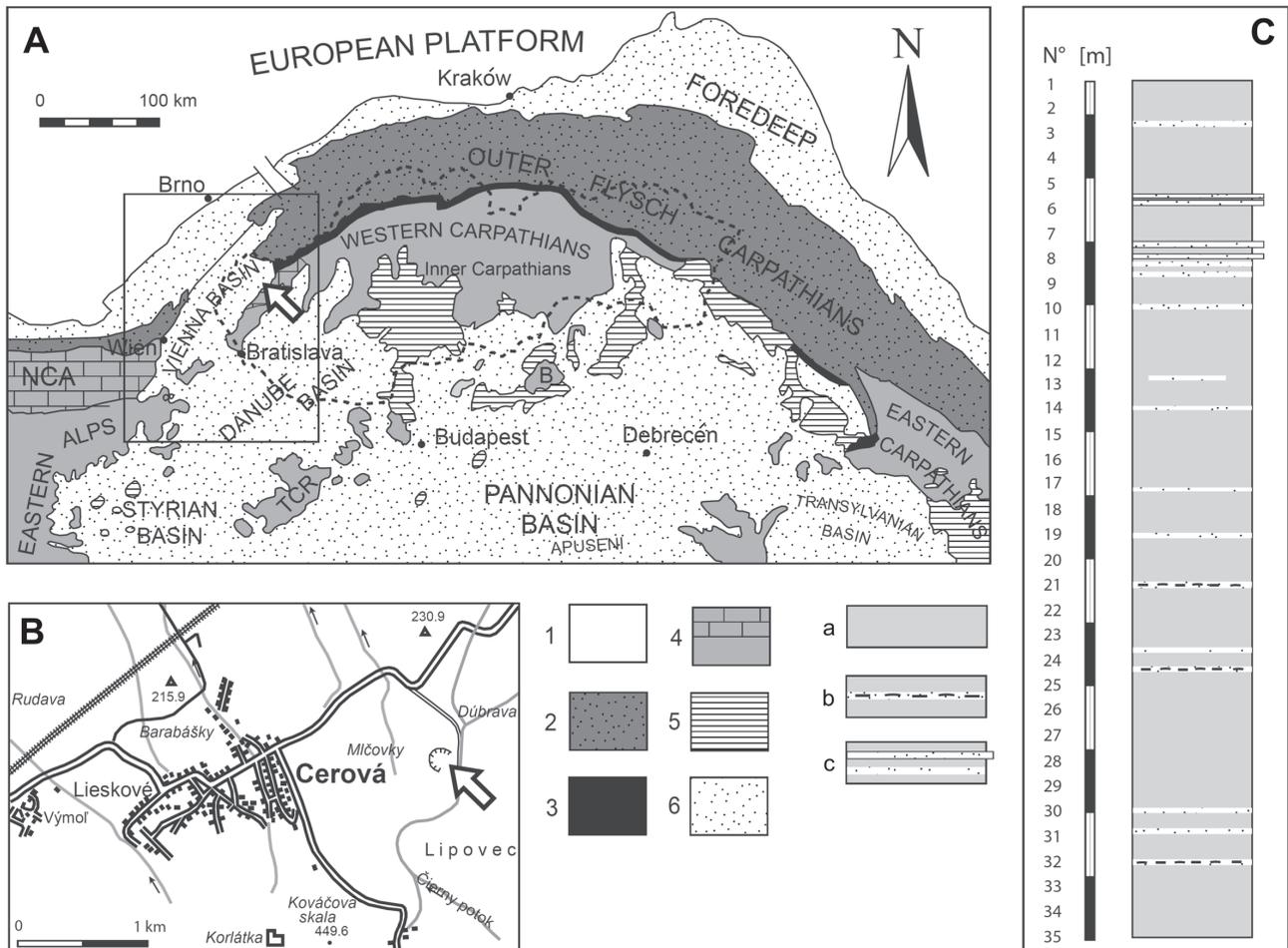
The deep water fauna of the Paratethys is poorly known. In the synthetic lists on Paratethyan Oligocene and Miocene gastropods in Harzhauser & Piller (2007) most taxa derive from shallow marine sections. Shallow bathyal communities from the Late Oligocene of Eger in Hungary were described as *Hinia-Cadulus* community by Báldi (1973). From Eggenburgian and Ottnangian deposits, no bathyal mollusc faunas are known so far. The so-called Ottnangian schlier fauna as described by Hoernes (1875) was sometimes considered to have lived in deeper marine settings but turned out to represent moderately deep sublittoral environments between 100–150 m water depth (Grunert pers. comm.). Information on the Karpatian mollusc fauna is based largely on littoral to shallow sublittoral

assemblages from mud-flats, sandy shores, lagoons and mangroves (Harzhauser 2002, 2003). Nevertheless, deeper water settings were widespread during Karpatian times. Spezzaferri & Coric (2001) and Spezzaferri et al. (2004) discuss water depths of ca. 400–500 m in the Styrian Basin and of ca. 200 m in the North Alpine Foreland Basin. One of their key-sections is the middle Karpatian section Laa in Lower Austria which is only ca. 80 km west of the coeval Cerová-Lieskové section. The mollusc faunas of the Austrian sections are very poor consisting mainly of scattered shells of the cephalopod *Aturia* and the pteropod *Vaginella*. The absence of a benthic mollusc fauna may be related to the dysoxic conditions on the sea floor (Spezzaferri et al. 2004).

During the Middle Miocene, deeper marine faunas are only known from the Badenian basinal clays. The water depth in the Vienna Basin, where most of the classical Early to Middle Badenian faunas derive from, ranged around 300 meters (Hohenegger et al. 2008). Similar conditions might have been established in the Transylvanian Basin where deeper marine mollusc assemblages are known from Lapugiu de Sus and Kostež. Bathyal associations, however, are undescribed. A deep sublittoral mollusc assemblage from the Late Badenian of Devínska Nová Ves is the latest of its kind in the Central Paratethys (Tomašových 1998).

## Composition and biostratigraphy

The mollusc assemblage consists of 14 bivalves, 15 benthic and 1 pelagic gastropods and 3 scaphopods. More than 85 % of the benthic gastropods are carnivores, scavengers or parasites. In total numbers, the carnivorous tonnoideans, naticids and conaceans predominate along with nassariids which are scavengers and/or predators. Herbivores such as *Calliotropis?*



**Fig. 1.** A–B — Geographic position of the Cerová section on the eastern border of the Vienna Basin; **1** — European platform, **2** — Carpathian-Alpine externides, **3** — Pieniny Klippen Belt, **4** — Alpine-Carpathian-Dinaride and Pannonian internides, **5** — Neogene volcanites, **6** — Neogene basins. **B** — Bükk, **CEA** — Central Eastern Alps, **CWC** — Central Western Carpathians, **M** — Mecsek, **MA** — Magura Group, **NCA** — Northern Calcareous Alps, **RF** — Rhenodanubian Flysch Zone, **TCR** — Transdanubian Central Range, **W** — Waschberg Unit, **ZD** — Ždánice Unit. **C** — lithology of the section; numbers indicate the position of the samples as mentioned in the text; **a** — massive calcareous clay, **b** — thin tempestite layers with plant remains, **c** — thin siltstone/sandstone layers or silt lenses.

sp. are extremely rare. Among the bivalves, two carnivorous (*Parvamussium* and *Cardiomya*), four chemosymbiotic (*Lucinoidea* and *Solemya*), four detritus (*Nuculoidea* and *Tellinidae*) and four suspension feeding (others) bivalves are represented. Such composition indicates a deposition in the aphytal zone and a low contribution by transported taxa from shallower settings. The endemism is seemingly high, with 3 species (18 %) among the gastropods and 4 species (29 %) among the bivalves, but should be considered with care in respect to our poor knowledge on Miocene deep water faunas. Within the scaphopods, no endemism is observed as all taxa are also known from the Mediterranean area.

The biostratigraphic value of the assemblage is hard to evaluate due to the scarceness of ecologically equivalent faunas. Only the pteropod *Balantium collina* (Janssen & Zorn 2001) is known so far only from the Burdigalian of Italy. *Calliotropis?* sp., *Polinices cerovaensis* nov. sp. and *Nassarius janschloegli* nov. sp. are only known from Cerová and may represent Karpatian marker species. *Amalda glandiformis* (Lamarck, 1810), *Galeodea echinophora* (Linnaeus, 1758),

*Conolithus antdiluvianus* (Bruguière, 1792), *Ringicula minor* (Gratoloup, 1838) and *Fissidentalium badense* (Parsch in Hörnes, 1856) appear already during the Early Miocene and persist throughout the Miocene. Others, such as *Stellaria testigera* (Bronn, 1831), *Mitrella hilberii* (Cossmann, 1901), *Genota valeriae* (Hoernes & Auinger, 1891), *Cylichna* cf. *salbriaensis* (Peyrot, 1932), *Sabatia callifera* Boettger, 1906, *Gadila gracilina* Sacco, 1897 and *Gadilina taurogracilis* Sacco, 1897 have not been known so far from the Early Miocene but are documented from the Langhian. This indicates that the Langhian deep water fauna is largely rooted in Burdigalian species. Moreover, the herein described Burdigalian assemblage displays several — probably closely related — counterparts in the Late Oligocene bathyal faunas of Hungary. These counterparts are *Nassarius schlotheimi* (Beyrich, 1854), *Cylichna burdigalensis* (sensu Báldi 1973), *Ringicula paulucciae* (sensu Báldi 1973), *Gadila gracilina* (sensu Báldi 1973), *Gadilina taurogracilis* (sensu Báldi 1973). Thus, no big turnover seems to have taken place as far as this can be judged from the fragmentary data.

This pattern is also reflected by the bivalve assemblage. All bivalve species from Cerová pass the Early-Middle Miocene boundary and are present also in the Badenian deep water deposits. Five species are restricted to the Early and Middle Miocene: *Leionucula ehrlichii* (Hoernes, 1875), *Limaria labani* (Meznerics, 1936), *Lucina callipteryx* Tournouer, 1874, *Laternula fuchsi* (Hoernes, 1875), and *Cardiomya elegantissima* (Hoernes, 1875). All other species except for *Nucula mayeri* (Hörnes, 1865) persist even into the Pliocene. The latter, together with *Yoldia nitida* (Brocchi, 1814), *Solemya doederleini* Mayer, 1861, *Atrina pectinata* (Linnaeus, 1767), *Macoma elliptica* (Brocchi, 1814), and *Thyasira flexuosa* (Montagu, 1803), already occurs during the Oligocene.

### Bathymetry

An ecologically highly significant taxon is the scaphopod *Gadilina taurogracilis*. Its descendent *Gadilina triquetra* (Brocchi, 1814) is widespread in Pliocene deposits of Italy. According to Ceregato et al. (2007) it is strictly bathyal and indicative for unstable deep marine environments with high sedimentation rates. Such *Gadilina*-dominated assemblages are part of the widespread Early Pliocene *Korobkovia oblonga*-*Jupiteria concava* paleocommunity of Ceregato et al. (2007) which contains also *Stellaria testigera* and *Galeodea echinophora*. As mentioned above, the Hungarian *Hinia-Cadulus* paleocommunity of Báldi (1973) is an Oligocene counterpart in the Paratethys (= *Nassarius-Gadila* paleocommunity according to modern systematics).

### Material

The material is stored in the collection of the Natural History Museum Bratislava, Department of Geology and Paleontology, Faculty of Natural Sciences, Comenius University in

Bratislava and in the Natural History Museum Vienna (only type material).

Class: **Gastropoda** Cuvier, 1797

Subclass: **Orthogastropoda** Ponder & Lindberg, 1996

Superorder: **Vetigastropoda** Salvini-Plawen & Haszprunar, 1987

Superfamily: **Seguenzioidea** Verrill, 1884

Family: **Chilodontidae** Wenz, 1938

?Genus: *Calliotropis* Seguenza, 1903

*Calliotropis?* sp.

**Material:** 1 shell fragment (sample number: 20-21); diameter: 5.3 mm.

**Remarks:** A very poorly preserved specimen, which does not allow a clear identification. The base bears 4-5 blunt spiral ribs which are crossed by sharp, wide-spaced axial ribs. Small nodes appear at the intersections and a slightly more prominent spiral rib forms a peripheral keel. The umbilicus is wide and open. No comparable vetigastropod is described from Paratethyan and Mediterranean Miocene deposits.

Suborder: **Hypsogastropoda** Ponder & Lindberg, 1997

Infraorder: **Littorinimorpha** Golikov & Starobogatov, 1975

Superfamily: **Naticoidea** Guilding, 1834

Family: **Naticidae** Guilding, 1834

Subfamily: **Polinicinae** Gray, 1847

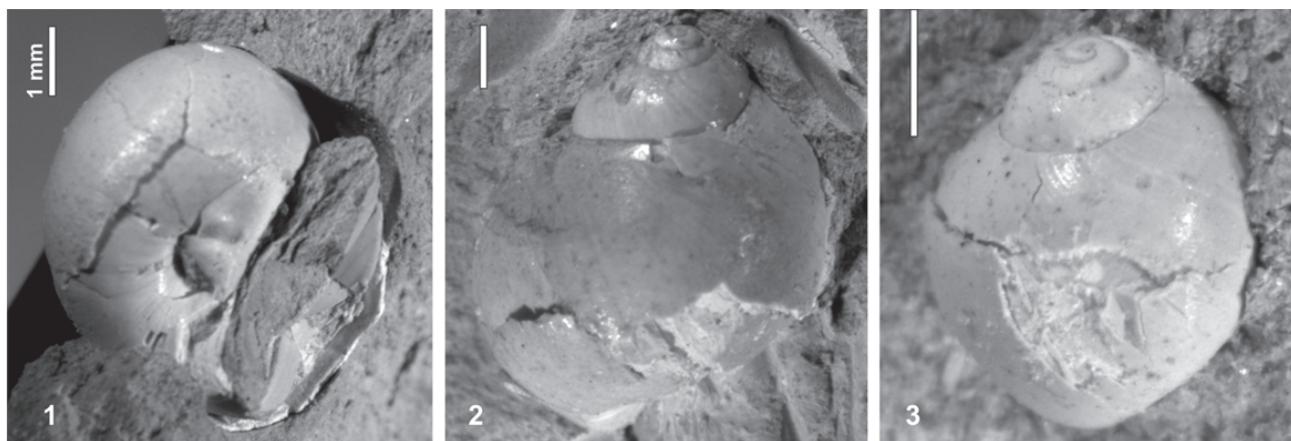
Genus: *Polinices* Montfort, 1810

*Polinices cerovaensis* Harzhauser nov. sp.

Fig. 2.1-3

**Material:** 12 shells (sample numbers: 5-6, 6, 7, 7-8, 13-14, 14, 15, 15-16, 16-17, 19, 20, 21).

**Holotype:** NHMW 2010/0080/0001; height: 6.9 mm, diameter: 6.5 mm (Fig. 2.1).



**Fig. 2.** 1-3 — *Polinices cerovaensis* Harzhauser nov. sp. 1 — holotype NHMW 2010/0080/0001, 2 — paratype NHMW 2010/0080/0002, 3 — a third, not fully grown specimen.

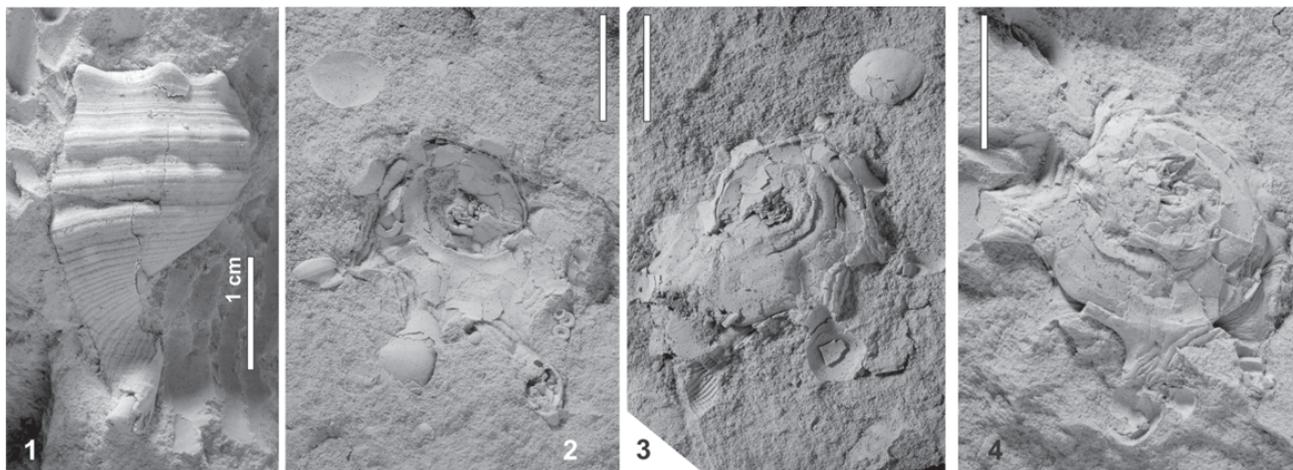


Fig. 3. 1 — *Galeodea echinophora* (Linnaeus, 1758), 2–4 — *Stellaria testigera* (Bronn, 1831).

**Paratype:** NHMW 2010/0080/0002; height: 9.1 mm, diameter: 7 mm (Fig. 2.2).

**Stratum typicum:** Grey calcareous silt of the Lakšárska Nová Ves Formation.

**Type locality:** Cerová-Lieskové, Slovak Republic.

**Age:** Early Miocene, late Burdigalian; Karpatian.

**Name:** Referring to the type locality.

**Diagnosis:** A small *Polinices* with globose to broad drop-shaped outline. The small, moderately thickened parietal callus bears a shallow sulcus.

**Description:** A small naticid which ranges between 5–10 mm in height. Small, depressed turbiniform protoconch of 1.7 convex whorls. Globose to slender globose shell consisting of 3–4 convex whorls. The spire height is quite variable and ranges from moderately elevated to low. The last whorl is nearly straight sided close to the upper suture or may even form a very shallow and indistinct concavity, causing a broad drop-shaped outline. Shell surface smooth except for prosocline growth lines. These may be more prominent in the adapical third of the whorls. In one specimen these growth lines are quite strongly developed on the penultimate whorl. The parietal callus is small, moderately thick, well demarcated from the base and develops a shallow sulcus in its middle. This callus covers large parts of the umbilicus which is deep but narrow and sickle shaped.

**Remarks:** A common species at Cerová. Its small size and the sulcus on the parietal callus separate this species distinctly from *Polinices pseudoredemptus* (Friedberg, 1923) which occurs in coastal marine and brackish environments during the Karpatian and Badenian (Harzhauser 2002). *Polinices proredemptus* (Sacco, 1891) from the Early Miocene of Italy and France, lacks the sulcus, has a depressed spherical shape and develops a wide lobe of the parietal callus and a second lobe on the base (Cossmann & Peyrot 1919). The sulcus also separates the new species from the French Early Miocene *Polinices benoisti* (Cossmann & Peyrot, 1919) which has a similar shape but develops a wider and deeper umbilicus (Cossmann & Peyrot 1919; Lozouet et al. 2001). *Polinices turbinooides* (Grateloup, 1828), from the Early Miocene of

France, develops a more slender shape with high penultimate whorl (Cossmann & Peyrot 1919).

Family: **Xenophoridae** Troschel, 1852

Genus: *Stellaria* Schmidt in Möller, 1832

***Stellaria testigera* (Bronn, 1831)**

Fig. 3.2–4

1831 *Phos testigerus* Bronn, p. 61

2004 *Stellaria testigera testigera* (Bronn, 1831) — Landau et al., p. 85, pl. 19, figs. 3–4 (cum syn.)

**Material:** 2 shells (sample numbers: 15, 20); diameter: 27–30 mm.

**Remarks:** A rare species at Cerová. The identification is based on the characteristic rugose sculpture that undulates along the lower sutures and especially close to the long digitations. The attached objects are small molluscs such as nassariids and bivalve fragments. This is the first Early Miocene record of *Stellaria testigera* which is otherwise documented only from the Middle Miocene to Pliocene of the Paratethys and the Mediterranean Sea (see Landau et al. 2004 for details). In the Vienna Basin it is restricted to deeper marine clays of the Badenian stage.

Superfamily: **Tonnoidea** Suter, 1913

Family: **Tonnidae** Suter 1913

Family: **Cassidae** Latreille, 1825

Genus: *Galeodea* Link, 1807

***Galeodea echinophora* (Linnaeus, 1758)**

Fig. 3.1

1758 *Buccinum echinophorum* Linnaeus, p. 735

2009 *Galeodea echinophora* (Linnaeus, 1758) — Landau, p. 66, pl. 3, figs. 1–2 (cum syn.)

**Material:** 17 shells (sample numbers: 5–6, 15, 16–17, 17–18, 18–19, 20–21, P2–5); mostly fragments; the size seems to have ranged between 40–50 mm.

**Remarks:** One of the most abundant gastropods at Cerová. A strongly sculptured morphotype predominates with three spiral rows of strong nodes on the last whorl and a fourth row of spiny nodes along the shoulder. The shells are usually strongly fragmented and have been destroyed before deposition. Obviously, it was the favourite prey for crushing predators such as decapods or molluscivore fish. The species appears during the Early Miocene and is still present in the Mediterranean Sea and along the coast of western Africa (Ardovini & Cossignani 2004). In the Paratethys it is known from the Eggenburgian to the Badenian (see Landau et al. 2009 for details).

Infraorder: **Neogastropoda** Wenz, 1938  
 Superfamily: **Buccinoidea** Rafinesque, 1815  
 Family: **Columbellidae** Swainson, 1840  
 Genus: *Mitrella* Risso, 1826

***Mitrella hilberi* (Cossmann, 1901) nov. comb.**  
 Fig. 4.2

1879 *Columbella carinata* Hilber, p. 6, pl. 1, fig. 3 (non *Columbella carinata* Hinds, 1844)

1880 *Columbella carinata* Hilber — Hoernes & Auinger, p. 97, pl. 12, figs. 9–11

1901 *Atilia (Macrurella) hilberi* Cossmann, p. 245

1966 *Columbella (Atilia) hilberi* Cossmann — Strausz, p. 293, pl. 12, fig. 12

**Material:** 1 cast and silicone mould (sample number: 17); height: 15.4 mm, diameter: 4.3 mm.

**Remarks:** The specimen differs from the type of *Mitrella hilberi* from the Early Badenian of the Styrian Basin in its less angulated transition towards the base. Specimens from the Early Badenian of Kosteĵ in Romania, illustrated by Hoernes & Auinger (1880), are also characterized by a less prominent angulation and correspond fully to the shell from Cerová. The specimen from the Badenian of Sámsonháza in Hungary, il-

lustrated in Strausz (1966), also belongs to this morphotype. The separation from *Mitrella petersi* (Hilber, 1879) would need further confirmation but seems to be justified based on the nearly straight sided whorls and the more slender outline of the type of *M. petersi*. *Mitrella aquitanica* (Peyrot, 1925) from the Aquitanian of France is stout and has a shorter last whorl.

*Mitrella hilberi* was known so far only from marl and clay of the Badenian stage.

Family: **Nassariidae** Iredale, 1916

Genus: *Nassarius* Duméril, 1806

***Nassarius janschloegli* Harzhauser nov. sp.**

Fig. 5.1–4

**Material:** 22 shells (sample numbers: 5–6, 7, 7–8, 8–9, 12, 13–14, 14, 15, 16–17, 17, 17–18, 18–19, 19–20, 21, 21–22, P2–5).

**Holotype:** NHMW 2010/0079/0001; height: 6.1 mm, diameter: 4.1 mm (Fig. 5.1).

**Paratype 1:** NHMW 2010/0079/0002; height: 6.9 mm, diameter: 4.3 mm (Fig. 5.2).

**Paratype 2:** NHMW 2010/0079/0003; diameter: 3.3 mm (Fig. 5.4).

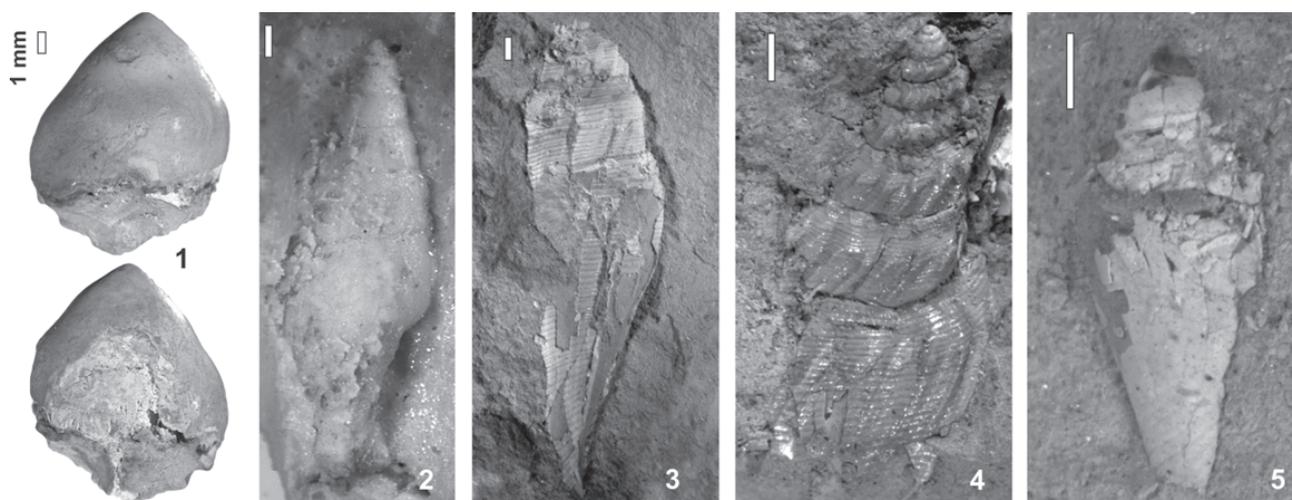
**Stratum typicum:** Grey calcareous silt of the Lakšárska Nová Ves Formation.

**Type locality:** Cerová-Lieskové, Slovak Republic.

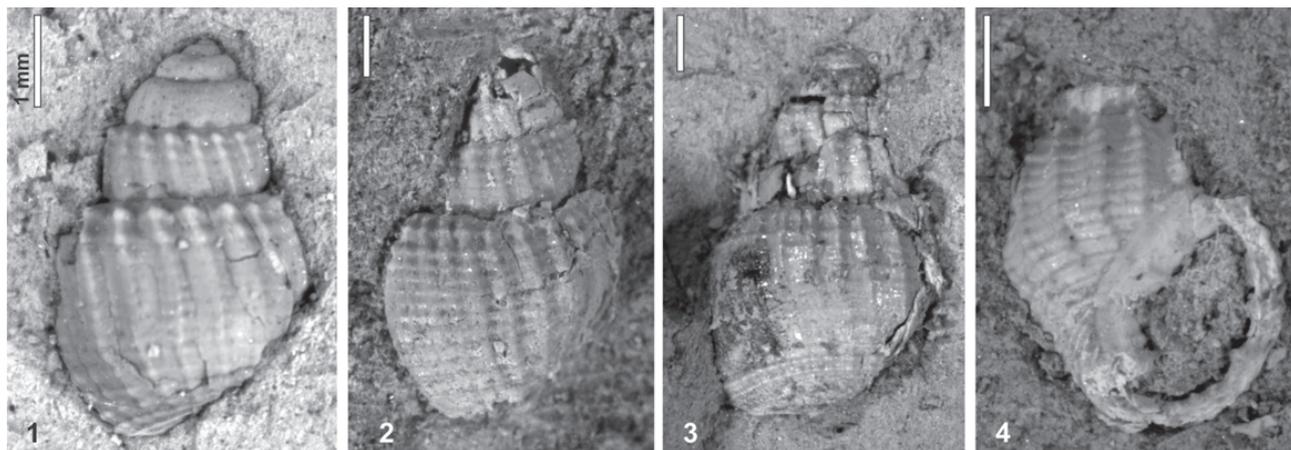
**Age:** Early Miocene, late Burdigalian, Karpatian.

**Name:** In honor of Jan Schlögl, paleontologist at the Comenius University, Bratislava.

**Diagnosis:** Small shell with elevated spire of 2.5 weakly convex spire whorls and a broader, convex last whorl. Sculpture consisting of prosocline to slightly sigmoidal axial ribs which cross weaker, broad spiral ribs. Nodes appear at the intersections. A conspicuous row of nodes at the upper suture causes a stepped outline.



**Fig. 4.** 1 — *Amalda glandiformis* (Lamarck, 1810), 2 — *Mitrella hilberi* (Cossmann, 1901), 3–4 — *Genota valeriae* (Hoernes & Auinger, 1891), 5 — *Conolithus antdiluvianus* (Bruguière, 1792).



**Fig. 5.** 1–4 — *Nassarius janschloegli* Harzhauser nov. sp., 1 — holotype NHMW 2010/0079/0001, 2 — paratype NHMW 2010/00879/0002, 4 — paratype NHMW 2010/00879/0003.

**Description:** The species has a 1-mm-broad, low dome-shaped protoconch consisting of 3.5 convex whorls. The second protoconch whorl bears 2–3 faint spiral threads in the upper third; additional wrinkled spirals seem to appear close to the lower suture on the last protoconch whorl (this feature is obscured by the poor preservation). The teleoconch develops a moderately high and stepped spire of three weakly convex whorls and a broader, convex last whorl. The sculpture of the early whorls consists of narrow prosocline to weakly sigmoidal axial ribs and less prominent, broader spiral ribs separated by shallow interspaces. The intersections tend to form small pointed nodes. The spiral ribs become stronger towards the last whorl but the axial ribs remain the dominating sculpture. The uppermost row of nodes along the upper suture is distinctly stronger, slightly separated from the next row and causes the stepped profile. In some specimens, the second row below the upper suture is also somewhat more prominent and forms a pair of nodes on the adapical termination of the axial ribs. The spiral sculpture becomes weak on the last whorl below the point of maximum convexity but reappears as 2–3 sharp beaded spiral threads on the base. The aperture is ovoid; columella strongly concave, adapically nearly straight with two broad denticles. Two further denticles occur close to the wide and deep siphonal canal. Columellar callus moderately thickened, clearly delimited. Outer lip terminating in a smooth bevelled edge; five strong and elongate denticles occur at some distance from the termination.

**Remarks:** A highly reminiscent species is *Nassarius schlotheimi* (Beyrich, 1854) as described from the Late Oligocene of Hungary (Báldi 1973). It displays a similar variability in sculpture, agrees in the development of the adsutural row of nodes and has a similar large protoconch but lacks the prominent denticles in the outer lip and has more convex whorls. Interestingly, *Nassarius schlotheimi* was described by Báldi (1973) as member of the bathyal communities. Both species belong to a morphological group which is represented during the Early Miocene by species such as *Nassarius pauli* (Hoernes, 1875), *Nassarius illovensis* (Hoernes & Auinger 1882), *Nassarius perpulchra* (Bellardi, 1882) and *Nassarius incerta* (Bellardi, 1882).

*Nassarius pauli*, from the Ottnangian stage of Upper Austria, might be a close relative. Parallels are the large bulbous protoconch and the row of small nodes along the shoulder (Harzhauser & Kowalke 2004). Differences are the much larger size of *N. pauli*, which attains about double the height, and the much shorter spire. Moreover, *N. pauli* develops broader axial ribs which bear broader rounded nodes. *Nassarius illovensis*, which occurs in Middle Miocene offshore marls in the Paratethys, is much larger and stout (Harzhauser & Kowalke 2004). Its spire whorls are more convex; the sculpture differs in its dense and regular pattern of nodes. *Nassarius incerta*, from the Burdigalian of the Italian Turin Hills, is strongly reminiscent of the species from Cerová but lacks the stepped outline, the adsutural row of nodes and is much larger (Ferrero Mortara et al. 1981). *Nassarius perpulchra*, from the Burdigalian of the Italian Turin Hills, develops a very similar sculpture but has a broader spire and develops a conspicuous bulgy convexity in the lower third of the last whorl (Ferrero Mortara et al. 1981). *Nassarius janschloegli* was a small nassariid which was probably adapted to deeper marine environments.

Superfamily: **Olivoidea** Latreille, 1825

Family: **Olividae** Latreille, 1825

Genus: *Amalda* Adams & Adams, 1852

***Amalda glandiformis* (Lamarck, 1810)**

Fig. 4.1

1810 *Ancillaria glandiformis* Lamarck, p. 305

1997 *Ancilla (Baryspira) glandiformis* (Lamarck) — Batuk, p. 24, pl. 6, figs. 1–11

2002 *Amalda (Baryspira) glandiformis* (Lamarck) — Harzhauser, p. 109, pl. 8, fig. 19 (cum syn.)

**Material:** 1 spire fragment (found in scree material); diameter: 9 mm.

**Remarks:** The wide apical angle and thick callus agree fully with *Amalda glandiformis* and can be easily separated from *Amalda obsoleta* (Brocchi, 1814), which is typical for deeper marine deposits. Typically, the slender elongate *A. obsoleta* predominates in the Badenian clay of the Vienna Basin

and the Korytnica clay in Poland, whilst small-sized *A. glandiformis* are rare. This polymorphic species (or species flock) appears during the Oligocene, flourishes during the Miocene in all European seas and persists in the Mediterranean Sea and the Eastern Atlantic up the Pliocene (Landau & Marques da Silva 2006). During the Karpatian it is a frequent species in shallow marine settings of the Korneuburg Basin in Austria (Harzhauser 2002).

Superfamily: **Conoidea** Fleming, 1822

Family: **Conolithidae** Tucker and Tenorio, 2009

Genus: *Conolithus* Swainson, 1840

***Conolithus antediluvianus* (Bruguière, 1792)**

Fig. 4.5

1792 *Conus antediluvianus* Bruguière, p. 637, pl. 347, fig. 6

1964 *Conus antediluvianus* Bruguière — Hall, p. 17, pl. 2, fig. 7

1966 *Conus (Conolithus) antediluvianus* Bruguière — Strausz, p. 451, pl. 66, fig. 10, pl. 67, fig. 1

1998 *Conus (Conolithus) antediluvianus* Bruguière — Schultz, p. 72, pl. 29, fig. 9

**Material:** 1 shell (found in scree material); height: 8 mm, diameter: 3.5 mm.

**Remarks:** The small slender shell is characterized by a stepped spire with small, triangular nodes at the shoulder, pointing in apical direction. The base bears a sculpture of delicate spiral furrows in the lower third. These features are typical for *Conolithus antediluvianus*, which is a common species in Miocene offshore clays. In the Paratethys, it is recorded from Ottnangian “Schlier” facies in the North Alpine Foreland Basin (Hoernes 1875), from the Karpatian of the Vienna Basin (Harzhauser 2003) and from the Badenian of the Vienna Basin and the Pannonian Basin complex (Strausz 1966). In the Mediterranean and the Eastern Atlantic it appears during the Early Miocene (e.g. late Burdigalian deep sublittoral environments of the Mut Basin in Turkey; Mandic et al. 2004), reaches the North Sea during the Middle Mio-

cene (Janssen 1984) and persists in the Mediterranean Sea up to the Pliocene (Chirli 1997).

Hall (1964) pointed out that *antediluvianus*, which is commonly used in the literature, is a spelling error for the correct *antidiluvianus*.

Family: **Conorbinae** de Gregorio, 1890

Genus: *Genota* Adams & Adams, 1853

***Genota valeriae* (Hoernes & Auinger, 1891)**

Fig. 4.3–4

1891 *Pleurotoma (Genota) valeriae* Hoernes & Auinger, p. 311, pl. 34, fig. 15

1966 *Genota ramosa valeriae* Hoernes & Auinger — Strausz, p. 448, fig. 198

2003 *Genota (Genota) valeriae* (Hoernes & Auinger, 1891) — Bałuk, p. 55, pl. 18, figs. 4–6

**Material:** 2 shells (sample numbers: 15, 17); height: ca. 30 mm, diameter: ca. 9 mm.

**Remarks:** The fragments agree well with the type material from Lapugiu de Sus in Romania in the collections of the Natural History Museum Vienna. Its protoconch corresponds largely to that of *Genota ramosa* (Basterot, 1825) as illustrated by Janssen (1984) supporting a close relationship between the two species. Whilst *G. ramosa* is widespread in shallow marine environments during the Early Miocene in the Mediterranean, the Eastern Atlantic and the North Sea, its relative *Genota valeriae* is known so far only from deeper marine Badenian marls of Romania, Hungary, Poland and Austria. The occurrence at Cerová is thus the oldest record of the species.

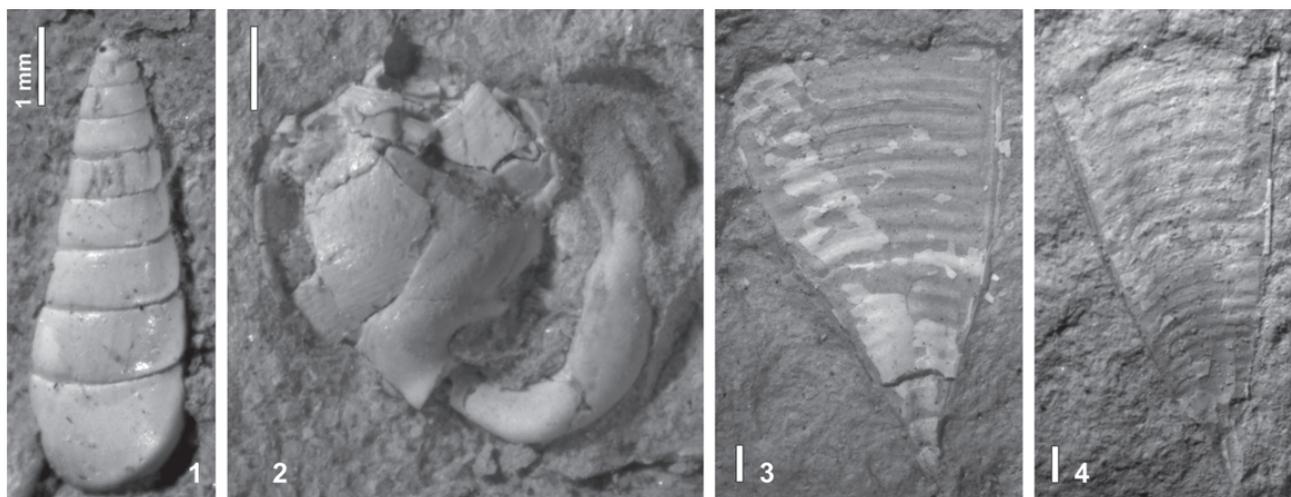
Superfamily: **Pyramidelloidea** Gray, 1840

Family: **Pyramidellidae** Gray, 1840

Genus: *Pyramidella* Lamarck, 1799

***Pyramidella cf. gratteloupi* d’Orbigny, 1852**

Fig. 6.1



**Fig. 6.** 1 — *Pyramidella cf. gratteloupi* d’Orbigny, 1852, 2 — *Ringicula minor* (Grateloup, 1838), 3–4 — *Balantium collina* (Janssen & Zorn, 2001).

cf. 1852 *Pyramidella gratteloupi* d'Orbigny, p. 34  
 cf. 2001 *Pyramidella gratteloupi* (d'Orbigny) — Lozouet et al., p. 74,  
 pl. 36, fig. 6

**Material:** 1 shell (sample number: 16); height: 6.8 mm,  
 diameter: 2.1 mm.

**Remarks:** The preservation does not allow a clear identification. Size and shape are reminiscent of the Early Miocene *Pyramidella gratteloupi* from France. Shells from the Middle Miocene of the Paratethys which are treated as *Pyramidella plicosa* (Bronn, 1838) in the literature and in the collection of the NHMW differ in their lower early spire whorls. The later teleoconch of these shells, however, is nearly indistinguishable from the shell from Cerová. (Note that the original spelling in d'Orbigny (1852) is *gratteloupi* instead of *grateloupi*.)

Order: **Opisthobranchia** Milne-Edwards, 1848

Suborder: **Cephalaspidea** Fischer, 1883

Superfamily: **Ringiculoidea** Philippi, 1853

Family: **Ringiculidae** Philippi, 1853

Genus: *Ringicula* Deshayes in Lamarck, 1838

***Ringicula minor* (Grateloup, 1838)**

Fig. 6.2

1838 *Auricula ringens* var. b. *minor* Grateloup, p. 286, pl. 6, fig. 8  
 1878 *Ringicula paulucciae* Morlet, p. 266, pl. 6, fig. 6, pl. 8, fig. 9  
 1878 *Ringicula* (*Ringiculella*) *tournoueri* Morlet, p. 287, pl. 6, fig. 10  
 1954 *Ringicula* (*Ringiculella*) *auriculata paulucciae* Morlet — Berger,  
 p. 7, figs. 3–18  
 1984 *Ringicula* (*Ringiculella*) *paulucciae* Morlet — Švagravský, p. 184,  
 pl. 2, fig. 6  
 1998 *Ringicula paulucciae* Morlet — Valdés & Héros, p. 700, fig. 2f  
 1998 *Ringicula tournoueri* Morlet — Valdés & Héros, p. 700, fig. 3g  
 2001 *Ringicula minor* (Grateloup) — Lozouet et al., p. 80, pl. 37, fig. 1

**Material:** 3 fragments (sample numbers: 13, 16, 19–20);  
 diameter: 5.1 mm.

**Remarks:** The ringiculids of the Paratethys have been studied by Berger (1954) who mainly referred to Morlet (1878) but failed to integrate other French literature (e.g. Peyrot 1932). Consequently, he assigned the Early and Middle Miocene Paratethyan ringiculid shells with elongate spire and spiral sculpture to *Ringicula paulucciae* Morlet, 1878 and its synonym *Ringicula tournoueri* Morlet, 1878 (illustrated in Valdez & Herós 1998). Later, Lozouet et al. (2001) showed that the types of these species are conspecific with *Ringicula minor* (Grateloup, 1838). *Ringicula minor*, though referred to as *Ringicula paulucciae* in Paratethys literature, is a widespread species during the Early and Middle Miocene in the Eastern Atlantic, the Mediterranean Sea and the Central Paratethys. Many Paratethyan shells, referred to as *Ringicula buccinea* (Brocchi, 1814), by Strausz (1966) and Atanacković (1985) represent *R. minor* as well.

Superfamily: **Philinoidea** Gray, 1850

Family: **Cylichnidae** Adams & Adams, 1854

Genus: *Cylichna* Lovén, 1846

***Cylichna* cf. *salbriacensis* (Peyrot, 1932)**

Fig. 7.2–4

1932 *Roxania helvetica* var. *salbriacensis* Peyrot, p. 198, pl. 13,  
 figs. 36, 40

**Material:** 8 shells (sample numbers: 5–6, 7–8, 9, 16–17,  
 17–18, 19–20, 20–21, P2–5); height: 9–16 mm, diameter:  
 4.5–7 mm.

**Remarks:** A large, subcylindrical shell with conspicuous spiral sculpture on the spire and the lower third of the last whorl. The prominent spirals on the base are duplex-rib pairs with a narrow thread-like furrow separating each pair. These are then separated from each other by deep spiral furrows. The sculpture is only reduced in the middle part of the whorl.

*Cylichna salbriacensis* (Peyrot, 1932), from the Langhian of the Aquitaine is highly reminiscent concerning shape, size and sculpture. This species was introduced by Peyrot (1932) as a subspecies of *Roxania helvetica* Peyrot, 1932 (non *Roxania helvetica* Berger, 1953) from Saubrigues in France. *Cylichna helvetica* differs from *Cylichna salbriacensis* in its much finer sculpture and the elongate barrel-shaped outline, whereas *C. salbriacensis* develops a slight convexity on the adapical third similar to the shells from Cerová.

The species is missing in the revision on Miocene opisthobranchs from the Vienna Basin by Berger (1953). This may be caused by the fact that Berger (1953) did not consider any species from the Miocene of France described by Peyrot (1932). Nevertheless, a shell in the collection of the NHMW from the Early Badenian of Kostej in Romania, which was mentioned by Hörnes (1856) as *Bulla brocchi* Michelotti, 1847, is conspecific with the specimens from Cerová. The Romanian shells were later treated as the much younger *Retusa brocchii* (Michelotti) by Berger (1953) or as *Retusa testiculina* (Bonelli) by Boettger (1906). The former name refers to a Late Miocene or Pliocene Mediterranean species with very weak to absent spiral sculpture and the latter name is a mere catalogue name and is invalid. Shells from the Early Badenian of Lower Austria, erroneously identified as *C. pliocrassa* by Berger (1953), may be conspecific with the species from Cerová. The Pliocene *Cylichnina pliocrassa* Sacco, 1897, however, differs from the Cerová species and that of Berger (1953) in its delicate sculpture and the sub-parallel flanks of the last whorl.

Genus: *Sabatia* Bellardi, 1877

***Sabatia callifera* Boettger, 1906**

Fig. 7.1

1856 *Bulla utriculus* Brocchi — Hörnes, p. 618 (partim), pl. 50, fig. 2  
 (non *Roxania utriculus* (Brocchi, 1814))  
 1906 *Sabatia callifera* n. sp. Boettger, p. 205  
 1934 *Sabatia callifera* Boettger — Zilch, p. 278, pl. 22, fig. 20  
 1953 *Roxania* (*Sabatia*) *callifera callifera* (Boettger) — Berger, p. 112,  
 pl. 18, fig. 78  
 1985 *Roxania* (*Roxania*) *callifera* (Boettger) — Atanacković, p. 188,  
 pl. 42, figs. 4–5

**Material:** 4 specimens (sample numbers: 13, 14, 16–17,  
 19); height: 5 mm, diameter: 3 mm.

**Remarks:** Only two fragments were found at Cerová. Most parts of the shells are covered by sediment and therefore the identification is difficult. Nevertheless, size, shape, spire

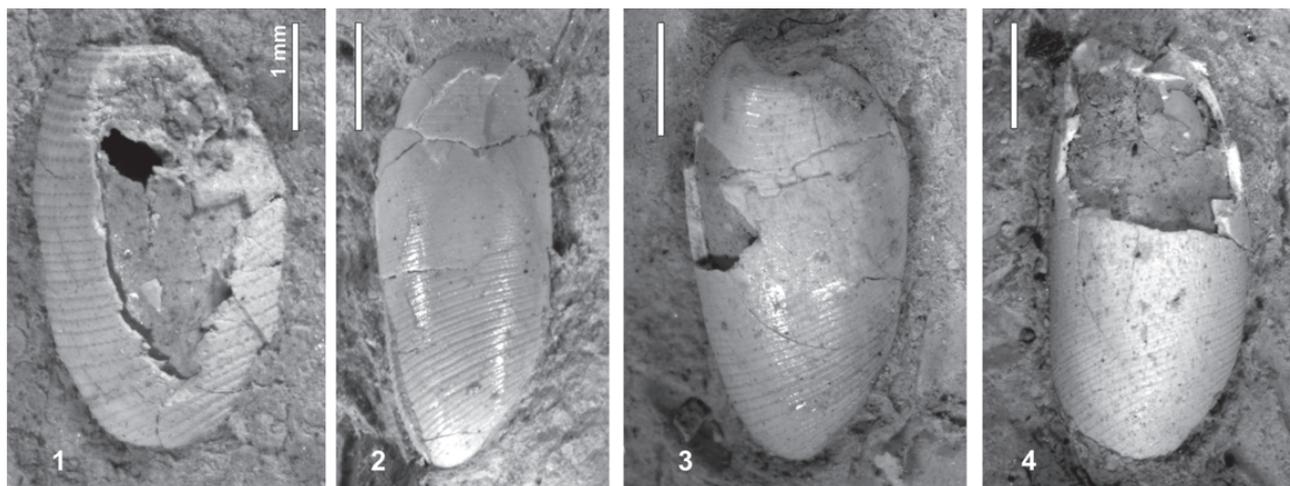


Fig. 7. 1 — *Sabatia callifera* Boettger, 1906, 2–4 — *Cylichna cf. salbriacensis* (Peyrot, 1932).

morphology and the conspicuous sculpture agree fully with Middle Miocene shells of *Sabatia callifera*. This rare species was described so far only from deeper marine clays of Early Badenian age from Lapugiu de Sus in Romania and from a few sections in the Vienna Basin (Berger 1953). Additionally, it is reported from the Badenian of Bulgaria and Bosnia (Atanacković 1985). This record is, thus, the oldest occurrence of the species.

Superorder: **Heterobranchia** Gray, 1840  
 Order: **Thecosomata** Blainville, 1823  
 Superfamily: **Cavoliniodea** Fischer, 1883  
 Family: **Cliidae** Jeffreys, 1869  
 Genus: *Balantium* Bellardi, 1872

***Balantium collina* (Janssen & Zorn, 2001)**

Fig. 6.3–4

2001 *Clio* (*Balantium*) *collina* spec. nov. Janssen & Zorn, p. 47, fig. 1

**Material:** 12 shells, (sample numbers: 5–6, 6–7, 8–9, 10–11, 12, 13–14, 14–15, 16–17, 17–18, 19, 19–20, 21); length: 16 mm, diameter: 8 mm.

**Remarks:** A common species at Cerová; the shells appear as isolated specimens without forming distinct layers. The species was originally described by Janssen & Zorn (2001) from the Burdigalian Termô-Fôrà Formation of the Turin Hills. It is thus a good biostratigraphic marker for the Burdigalian age of the Lakšárska Nová Ves Formation and documents the open marine connection between the Karpatian Paratethys and the Burdigalian Mediterranean Sea.

Class: **Scaphopoda** Bronn, 1862  
 Order: **Dentaliida** da Cosat, 1776  
 Family: **Dentaliidae** Children, 1834  
 Genus: *Fissidentalium* Fischer, 1885

***Fissidentalium badense* (Partsch in Hörnes, 1856)**

Fig. 8.6–7

1856 *Dentalium Badense* Hörnes, p. 652, pl. 50, fig. 30  
 1991 *Fissidentalium badense* (Partsch in Hörnes, 1856) — Pavia, p. 146, pl. 5, fig. 4, pl. 6, fig. 6 (cum syn.)

**Material:** 5 shells, (sample numbers: 5–6, 6–7, 17, 18, 21); length: 41 mm, diameter: 5 mm.

**Remarks:** This species appears during the Burdigalian in the Mediterranean where it is found in the Turin Hills (Sacco 1897) and in deep water deposits of the Mut Basin in Turkey (Mandic et al. 2004). The specimens from Cerová are the first Early Miocene record of this species from the Paratethys. During the Langhian it is widespread from the Eastern Atlantic (Cossmann & Peyrot 1917), the Mediterranean and the Paratethys Sea and persists in the Mediterranean Sea up the Late Miocene (Pavia 1991).

Family: **Gadiliniidae** Chistikov, 1975

Genus: *Gadilina* Foresti, 1895

***Gadilina taurogracilis* Sacco, 1897**

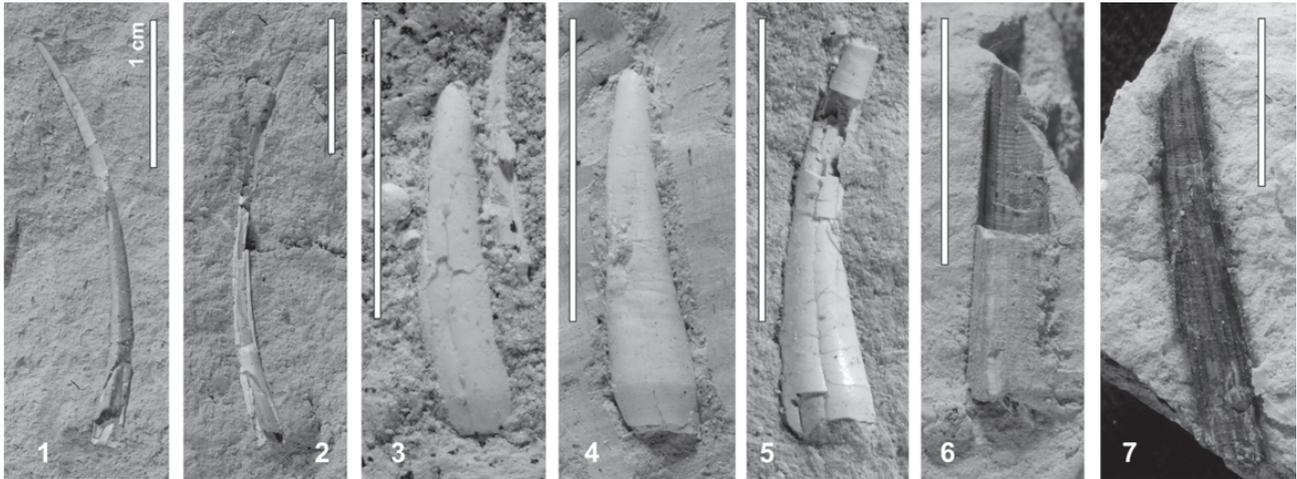
Fig. 8.1–2

1897 *Gadilina triquetra* var. *taurogracilis* Sacco, p. 114, pl. 10, figs. 44–46

1991 *Gadilina triquetra taurogracilis* Sacco — Pavia, p. 130, pl. 7, fig. 3a–b

**Material:** 8 shells, (sample number: 8–9, 10–11, 14, 16–17, 18–19, 19–20, P2–5 and scree material); length: 29 mm, diameter: 3 mm.

**Remarks:** The slender, smooth and glossy shells are weakly triangular in cross-section with rounded edges. This species was introduced by Sacco (1897) from the Langhian of the Monte dei Cappuccini in the Turin Hills. He considered it a subspecies of the Late Miocene to Pliocene deep water scaphopod *Gadilina triquetra* (Brocchi, 1814). Pavia (1991) designated a lectotype, re-illustrated the specimen and emphasized the less angular edges and the more slender outline of the Middle Miocene taxon. An even earlier record of this species is presented



**Fig. 8.** 1-2 — *Gadilina taurogracilis* Sacco, 1897, 3-5 — *Gadila gracilina* Sacco, 1897, 6-7 — *Fissidentalium badense* (Partsch in Hörnes, 1856).

by Cosmann & Peyrot (1917) from the Chattian of Aquitaine in France and by Báldi (1973) from the Chattian of Hungary. The small, less curved and ovoid instead of trigonal Oligocene specimens, however, seem to represent another species.

Order: **Gadilida** Starobogatov, 1974  
 Suborder: **Gadilimorpha** Steiner, 1992  
 Family: **Gadilidae** Stoliczka, 1868  
 Genus: *Gadila* Gray, 1847

***Gadila gracilina* Sacco, 1897**  
 Fig. 8.3-5

1897 *Gadila gadus* var. *gracilina* Sacco, p. 117, pl. 10, figs. 86-87  
 1991 *Gadila gracilina* Sacco — Pavia, p. 144, pl. 8, figs. 1-4

**Material:** 8 shells, (sample numbers: 5-6, 6-7, 13-14, 15-16, 16-17, 17-18, 19-20, P2-5); length: 13-19 mm, diameter: 3.5 mm.

**Remarks:** The most common scaphopod at Cerová. The maximum diameter of the smooth and glossy shell is developed close to the rapidly contracting anterior aperture. This feature distinguishes *Gadila gracilina* from the shorter *Gadila ventricosa* (Bronn, 1827) which has a much longer part between aperture and maximum diameter. The latter species appears in the Badenian of the Paratethys (Pavia 1991) whereas *Gadila gracilina* was unknown so far from this sea. It was originally described by Sacco (1897) from the Langhian of the Monte Cappuccini in the Turin Hills and from the Late Miocene of Sant'Agata. One syntype was re-illustrated by Ferrero-Mortara et al. (1984) and Pavia (1991) provided a re-description. Another Langhian occurrence is mentioned by Cosmann & Peyrot (1917) from the Aquitaine. Chattian occurrences in Hungary (Báldi 1973) and France (Cosmann & Peyrot 1917) need confirmation.

Class: **Bivalvia** Linnaeus, 1758  
 Subclass: **Protobranchia** Pelseneer, 1889  
 Order: **Nuculida** Dall, 1889

Superfamily: **Nuculoidea** Gray, 1824  
 Family: **Nuculidae** Gray, 1824  
 Genus: *Nucula* Lamarck, 1799

***Nucula mayeri* Hörnes, 1865**  
 Fig. 9.1

1865 *Nucula Mayeri* Hörn. — Hörnes, p. 296-297, pl. 38, fig. 1  
 1875 *Nucula Mayeri* M. Hoern. — Hoernes, p. 377, pl. 14, fig. 10  
 1912 *Nucula Mayeri* Hoernes — Cossmann & Peyrot, p. 219-221, pl. 5, figs. 21-24  
 2001 *Nucula* (*Nucula*) *mayeri* Hörnes, 1865 — Schultz, p. 2, pl. 1, figs. 3-4

**Material:** 1 single left shell fragment embedded in sediment with interior side down (sample 18). Length (interpolated) 7.2 mm, height (interpolated) 6.4 mm.

**Remarks:** Shell small, strongly convex, ovoid in outline, elongated anteriorly, smooth with very fine concentric lamellae on the proximal shell exterior and very fine radial striae of which proximally every fifth is a little more prominent. Determination is based on microscope comparison with type material stored in the NHMW collection. Except for the about 2.5× smaller size the specimen coincides very well with the type specimens.

The species occurs throughout the Late Oligocene and Miocene in the Central Paratethys, the Mediterranean Sea and the Eastern Atlantic (Tejkal et al. 1967; Báldi 1973; Steininger 1973; Schultz 2001).

Genus: *Leionucula* Quenstedt, 1930

***Leionucula ehrlichi* (Hoernes, 1875) nov. comb.**  
 Fig. 9.2

1875 *Nucula Ehrlichi* nov. sp. — Hoernes, p. 378-379, pl. 14, figs. 11-13  
 1954 *Nucula ehrlichi* R. Hoernes — Csepregy-Meznerics, p. 62, 121, pl. 13, fig. 14  
 2001 *Nucula* (?*Nucula*) *ehrlichi* Hoernes, 1875 — Schultz, p. 1-2, pl. 1, figs. 1-2

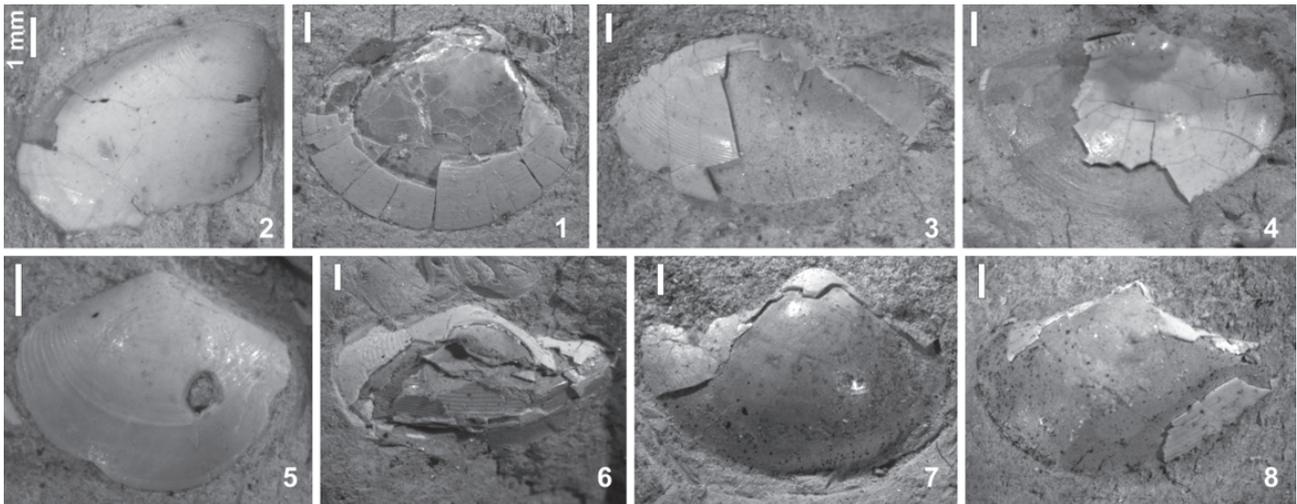


Fig. 9. 1 — *Nucula mayeri* (Hörnnes, 1865), 2 — *Leonucula ehrlichi* (Hoernes, 1875), 3–8 — *Yoldia nitida* (Brocchi, 1814).

**Material:** 1 articulated shell embedded in sediment with left valve exterior up, 1 right valve with peeled off exterior layer (samples: 13–15, 17 and 18); length: 8.5 mm, height: 6.5 mm.

**Remarks:** Shell small, low convex, longer than high with ellipsoid outline, umbo slightly pointed and shifted posteriorly, shell wall thin, outer layer dull, inner layer shiny, shell exterior ornamented by very fine growth lamellae, interior margin not crenulated.

Except for the about two times smaller size, the specimen corresponds fully to the type specimens from Ottnang in their oval outline, thin shell wall and low-convex valve. The absence of a crenulation of the interior shell margin was not mentioned by Hoernes (1875) but can be seen in the original illustrations and the reproductions by Schultz (2001) and in all specimens from the type locality housed in the NHMW collection. In consequence of the latter feature, the species name is now combined with *Leonucula*. The difference to *L. laevigata* (Sowerby, 1818) is the more symmetrical outline resulting from the less posteriorly shifted umbo. The latter Neogene species and its Paleogene predecessor (or synonym) *L. peregrina* (Deshayes, 1858) have a reduced posterior shell portion and develops a stronger postero-anterior shell elongation. Based on its outline, the shells described as *N. laevigata* by Tejkal et al. (1967) represent also *Leonucula ehrlichi*.

The species is restricted to the Ottnangian to Badenian of the Central Paratethys, found between the Alpine Foredeep and the North-Hungarian Basin (Tejkal et al. 1967; Steininger 1973; Schultz 2001).

Order: **Nuculanoida** Adams & Adams, 1858  
 Superfamily: **Nuculanoidea** Adams & Adams, 1858  
 Family: **Yoldiidae** Habe, 1977  
 Genus: *Yoldia* Möller, 1842

***Yoldia nitida* (Brocchi, 1814)**

Fig. 9.3–8

1814 *Arca nitida*: nob. — Brocchi, p. 482–483, pl. 11, fig. 3  
 1865 *Leda nitida* Brocc. — Hörnnes, p. 308–309, pl. 38, fig. 9

1898 *Yoldia nitida* (BR.) — Sacco, p. 57–58, pl. 12, figs. 14–17

1989 *Yoldia (Yoldia) nitida* (Brocchi, 1814) — Andres, p. 328–329, pl. 1, fig. 12

2001 *Yoldia (Yoldia) nitida* (Brocchi, 1814) — Schultz, p. 26, pl. 2, figs. 3–4 (cum syn.)

**Material:** 2 articulated specimens, 8 left and 10 right valves (samples: 5–6, 12, 16–17, 17, 17–18, 18–19, 19, 19–20, 20, 21–22 and scree material); LV — length: 11.8 mm, height: 6.8 mm, convexity: 1.8 mm.

**Remarks:** Shell small, thin walled, moderately convex, dorsally inflated. Dorsal margin trigonal with pointed umbo projecting over the hinge; ventral margin broadly convex, posterior margin narrowly convex pointed; anterior margin with broad rostrum. Shell exterior smooth with dorsally and anteriorly developed fine, projecting, concentric lirae. Interior margin smooth, hinge taxodont with numerous fine teeth. Some specimens tend to broaden the anterior margin similar to *Y. longa* (Bellardi, 1875) from the Lower Miocene of Ottnang in Lower Austria. The latter species is less convex and smooth, missing the previously described concentric sculpture.

This species, originally described from the Upper Pliocene of Northern Italy, is represented throughout the Miocene, Pliocene and Pleistocene of the Paratethys, Mediterranean and E Atlantic. In the Paratethys the oldest well documented record is from the Ottnangian of the North Alpine Foreland Basin (Schultz 2001).

Order: **Solemyoidea** Dall, 1889  
 Suborder: **Solemyina** Dall, 1889  
 Superfamily: **Solemyoidea** Adams & Adams, 1857  
 Family: **Solemyidae** Gray, 1840  
 Genus: *Solemya* Lamarck, 1818

***Solemya doderleini* Mayer, 1861**

Fig. 10.1–2

1861 *Solenomya Doderleini* Mayer — Mayer, p. 364  
 1865 *Solenomya Doderleini* Mayer — Hörnnes, p. 257, pl. 34, fig. 10

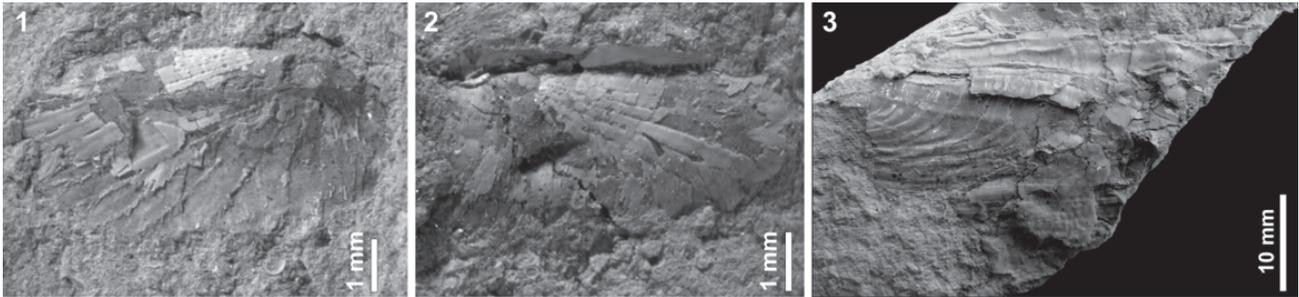


Fig. 10. 1–2 — *Solemya doderleini* Mayer, 1861, 3 — *Atrina pectinata* (Linnaeus, 1767).

1875 *Solenomya Doderleini* Mayer — Hoernes, p. 376, pl. 13, figs. 9–12  
 1901 *Solenomya Doderleini* (May.) — Sacco, p. 128–129, pl. 27, figs. 1–4  
 2001 *Solemya doderleini* (Mayer, 1861) — Schultz, p. 29–31, pl. 2, fig. 8 (cum syn.)

**Material:** 4 poorly preserved articulated specimens (sample: 16–17); length: 6 mm, height: 2.5 mm.

**Remarks:** Small, fragile, dorso-ventrally elongated shells with ellipsoid outline. Low shell convexity and ornamentation by flattened radial folds and grooves on the exterior surface which are posteriorly more prominent and anteriorly suppressed. The specimens are extremely small and may represent juveniles. They show identical orientations and are embedded within one single rock slab.

The species is present throughout the Oligocene to Miocene in deep marine water deposits of the Mediterranean Sea and from the Kiscellian to Badenian in the Paratethys Sea (Löffler 1999; Schultz 2001).

Subclass: **Autobranchiata** Grobben, 1894  
 Superorder: **Pteriomorphia** Beurlen, 1944  
 Order: **Pteriida** Newell, 1965  
 Suborder: **Pinnina** Waller, 1978  
 Superfamily: **Pinoidea** Leach, 1819  
 Family: **Pinnidae** Leach, 1819  
 Genus: *Atrina* Gray, 1842

***Atrina pectinata* (Linnaeus, 1767)**

Fig. 10.3

1767 *Pinna pectinata* Linnaeus, p. 1160, nr. 264  
 1867 *Pinna Brocchi* d'Orb. — Hörnes, p. 372–373, pl. 50, fig. 2  
 1914 *Atrina Basteroti* no sp. — Cossmann & Peyrot, p. 67–69, pl. 11, figs. 31–32  
 2001 *Atrina pectinata brocchii* (d'Orbigny, 1852) vel nov. ssp. — Schultz, p. 133–136, pl. 10, figs. 5–6, pl. 11, fig. 1 (cum syn.)

**Material:** 1 left valve fragment and 2 shell fragments (sample 17 At.B). Length/height of left valve fragment 31.0 mm/50.7 mm.

**Remarks:** Shell only fragmentarily preserved, with dull surface layer mostly flaking off remaining shiny, nacreous inner shell layer. It is flattened, elongated posteroanteriorly and thin walled, bearing at its proximal exterior surface fine radial ribblets. Its central and distal exterior bear coarse ribs dorsally and coarse irregular comarginal rugae ventrally.

There is ongoing discussion of the subspecies level taxonomy of *A. pectinata* (Pfister & Wegmüller 1994; Schultz 2001). We consider “*Pinna Brocchi* d'Orb.” in any case for a morphotype of *A. pectinata* and follow the taxonomic concept of Studencka et al. (1998). The taxonomic revision by Marquet (1995) distinguishing between *P. pectinata* and *P. fragilis* (Pennant, 1777) and proposing the renewed introduction of distinguishing fossil subspecies names is not followed by subsequent authors. This common species in Eggenburgian to Badenian deposits of the Paratethys still lives in world oceans and seas. It occurs from the tide level up to bathyal depths.

Order: **Pectinoidea** Adams & Adams, 1858  
 Superfamily: **Pectinoidea** Rafinesque, 1815  
 Family: **Propeamussiidae** Abbott, 1954  
 Genus: *Parvamussium* Sacco, 1897

***Parvamussium felsineum* (Foresti, 1893)**

Fig. 11.1–4

1893 *Amussium felsineum* Foresti — Foresti, p. 381–382  
 1897 *Variamussium felsineum* (For.) — Sacco, p. 49, pl. 14, figs. 7–22  
 1928 *Amussium felsineum* Foresti — Depéret & Roman, p. 182–183, text-fig. 5, pl. 27, figs. 7–12  
 1977 *Propeamussium (Parvamussium) felsineum* (Foresti, 1895) — Jakubowski & Musiał, p. 91–92, pl. 5, figs. 11–13, pl. 6, figs. 1–2  
 2001 *Propeamussium (Parvamussium) felsineum* (Foresti, 1893) — Schultz, p. 162, pl. 15, figs. 10–11

**Material:** 7 articulated shells, 6 single left valves and 7 single right valves (samples: 2×L+2×A, 7: 1×A, 10: 1×A, 13–14: 1×R, 16–17: 1×A, 17: 1×R+1×L, 17–18: 1×A+2×R+1×L, 18: 1×R, 19: 1×A+2×L+1×R, 21: 1×R; other samples — 7–8, 8–9, 15–16, 19–20, 20–21 and scree material). Dimensions: LV — height: 10.5 mm, length: 10.2 mm, convexity: 0.6 mm.

**Remarks:** Shell as high as long, low convex, circular in outline, inclined anteriorly, dorsal margin straightened with posterior ear small and anterior ear large and pointed. Right valve exterior with regular, fine, slightly projecting comarginal lirae, left valve exterior with numerous (about 30 at central disc portion) fine ribblets intersected by fine projecting lirae; the number of ribblets increases distally by intercalation; scaly nodes present at lirae/ribblet intersections. Interior with about 12 interior ribs restricted to proximal four fifths of height, the very distal fifth with thinned shell wall.

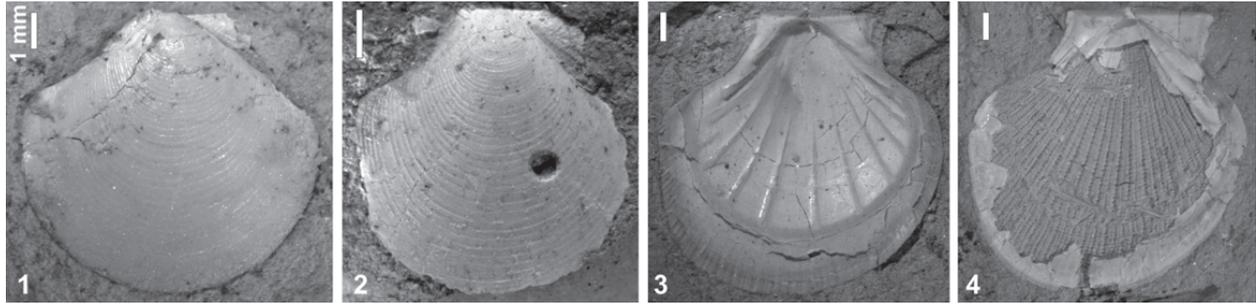


Fig. 11. 1-4 — *Parvamussium felsineum* (Foresti, 1893).

The presence of radial ribblets on the left valve exterior surface allows a differentiation of this species from *P. duodecimlamellatum*. In contrast to NW Bulgaria (Kojumdgieva & Strachimirov 1960), no smooth left valves were recorded from the Styrian and Vienna Basins and the identifications of *P. duodecimlamellatum* in those basins is questionable (Depéret & Roman 1928; Mikuž 1998; Schultz 2001). Because of the prominent left valve sculpture, our specimens correspond to *P. felsineum* morph. *styriaca* (Meznerics 1936).

*P. felsineum* is frequent in the Early Badenian of the Styrian Basin and the northern Slovenia (Meznerics 1936; Mikuž 1998) and in the Early/Middle Badenian of the Vienna Basin in Austria (Depéret & Roman 1928; Schultz 2001) and NW Bulgaria, the Late Badenian of the Carpathian Foredeep in SE Poland (Jakubowski & Musiał 1977) and the Pannonian Basin in NE Hungary (Csepregy-Meznerics 1960, 1966). Further, the species is present from the Middle Miocene to Pliocene in the Mediterranean Sea and the NE Atlantic. The type locality of Ponticello in the Val de Savena near Bologna in Italy is of Pliocene age.

Order: **Limida** Waller, 1978  
 Superfamily: **Limoidea** Rafinesque, 1815  
 Family: **Limidae** Rafinesque, 1815  
 Genus: *Limea* Bronn, 1831

***Limea strigilata* (Brocchi, 1814)**

Fig. 12.1-4

- 1814 *Ostrea strigilata* — Brocchi, p. 571, pl. 14, fig. 15  
 1867 *Lima strigilata* Brocc. — Hörnes, p. 392, pl. 54, fig. 7  
 1898 *Limea strigilata* (Br.) — Sacco, p. 21-22, pl. 6, figs. 4-7  
 1907 *Limea strigilata* Br. sp. — Cerulli-Irelli, p. 89, pl. 4, fig. 45  
 1914 *Limea strigillata* mut. *subhelvetica* nov. mut. — Cossmann & Peyrot, p. 160-161, pl. 20, figs. 37-38  
 1984 *Limea* (*Limea*) aff. *strigilata* (Brocchi, 1814) — Janssen, p. 57, pl. 26, fig. 4

**Material:** 1 articulated specimen, 5 left and 2 right valves (samples: 5-6, 7, 13, 16-17, 17-18, and scree material). Dimensions: LV — height: 6.8 mm, length: 5.7 mm, convexity: 1.8 mm.

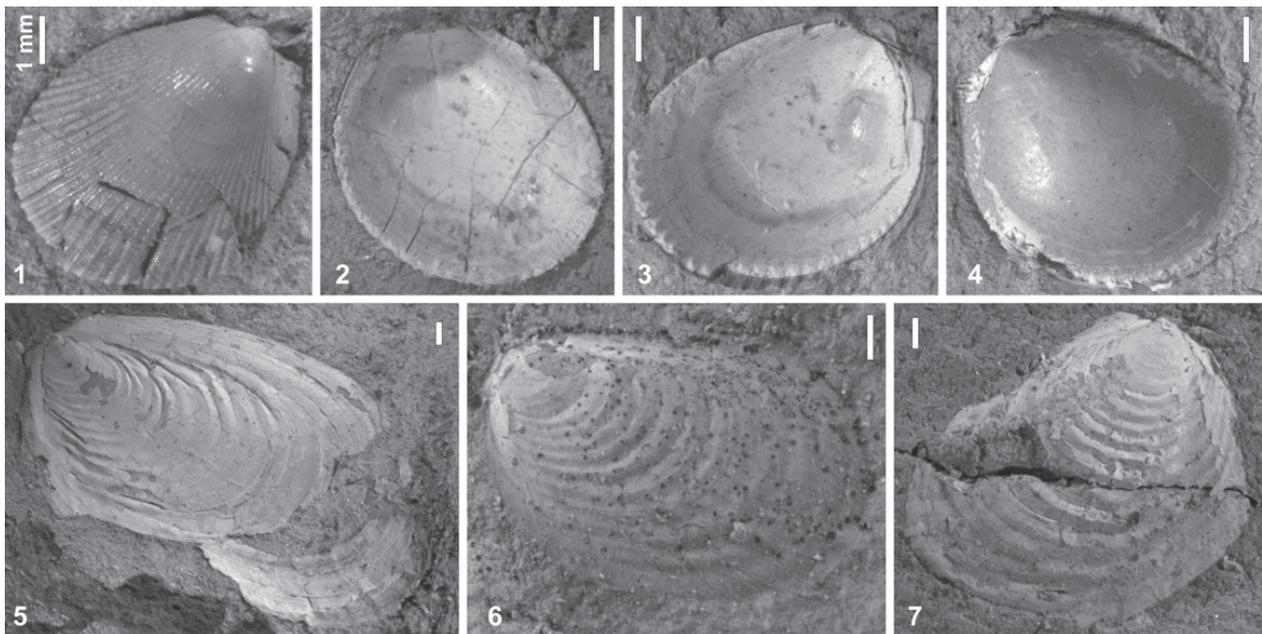


Fig. 12. 1-4 — *Limea strigilata* (Brocchi, 1814), 5-7 — *Limaria labani* (Meznerics, 1936).

**Remarks:** Shell very small, highly inflated, anteroventrally elongated with straightened hinge margin and umbo projecting over it. Very proximal and dorsal lateral shell portion except for comarginal lirae smooth. The rest of exterior surface bears numerous fine, flat topped, smooth radial ribblets intercalated at the distal margin by single scaly ribblets. The whole exterior surface bears weak comarginal lirae, better visible in the rib interspaces and lateral dorsal margins. Interior shell margin is crenated.

This species differs from *Limaria tuberculata* by the much smaller, not gaping shell, showing a crenulated interior margin. The Middle Miocene *L. subhelvetica* from the Aquitaine Basin represents a somewhat stronger elongated, less convex morphotype of *L. strigilata*. In the Paratethys, *Limea strigilata* has been previously described only from Badenian strata. Therefore, the specimens from Cerová represent the stratigraphically oldest occurrence of this Miocene to Pliocene species.

Genus: *Limaria* Link, 1807

***Limaria labani* (Meznerics, 1936)**

Fig. 12.5-7

1936 *Lima* (*Mantellina*) *labani* nov. spec. — Meznerics, p. 127, 133, pl. 4, figs. 9-14

1967 *Lima* (*Mantellum*) *labani* Meznerics, 1935 — Tejkal et al., p. 162, pl. 1B, fig. 22

2001 *Limaria* (*Mantellina*) *labani* (Meznerics, 1936) — Schultz, p. 301

**Material:** 2 left and 2 right single valves (samples: 18 and 21, and scree material); length: 8.5 mm, height: 6 mm.

**Remarks:** Shell up to 17 mm long, thin walled, fragile, ellipsoid in outline, strongly elongated postero-ventrally, low convex. Hinge line short, slightly overwhelmed by umbo, which is slightly inflated and pointed dorsally. Exterior sculpture comprises coarse, regular comarginal folds and very fine radial ribblets absent only at dorsal marginal area which is smooth except for fine growth lines.

*Limaria labani* is restricted to Karpatian and Badenian of the Paratethys, occurring in the Slovenian part of the Styrian Basin (Lower Badenian), the northern margin of the Pannonian Basin in N Hungary (Karpatian-Badenian; Csepregy-Meznerics 1954) and E Slovakia (Karpatian) and in the Vienna Basin in N Slovakia (Karpatian).

Subclass: **Heterodonta** Neumayr, 1884

Order: **Venerida** Adams & Adams, 1856

Superfamily: **Tellinoidea** Blainville, 1814

Family: **Tellinidae** Blainville, 1814

Subfamily: **Macominae** Olsson, 1961

Genus: *Macoma* Leach, 1819

***Macoma elliptica* (Brocchi, 1814)**

Fig. 13.1-2

1814 *Tellina elliptica*, p. nob. — Brocchi, p. 513, pl. 12, fig. 7

1875 *Tellina ottnangensis* nov. sp. — Hoernes, p. 370-371, pl. 13, figs. 1-4

1879 *Tellina Floriana*. — Hilber, p. 418, 450, 451, pl. 6, figs. 1-2

1900 *Tellina Floriana* Hilber — Bauer, p. 38, 42-43, pl. 2, fig. 13

1900 *Tellina Floriana* var. *plicata* Bauer — Bauer, p. 43, pl. 2, fig. 14

1901 *Macomopsis elliptica* (Br.) — Sacco, p. 107-108, pl. 22, figs. 36-40

1910 *Macoma elliptica* (Brocchi) — Cossmann & Peyrot, p. 281-282, pl. 9, figs. 33-35

1998 *Macoma elliptica* (Brocchi, 1814) — Duckheim & Strauch, p. 203-219, 224-225, pl. 1, figs. 1-8, pl. 2, figs. 1-8

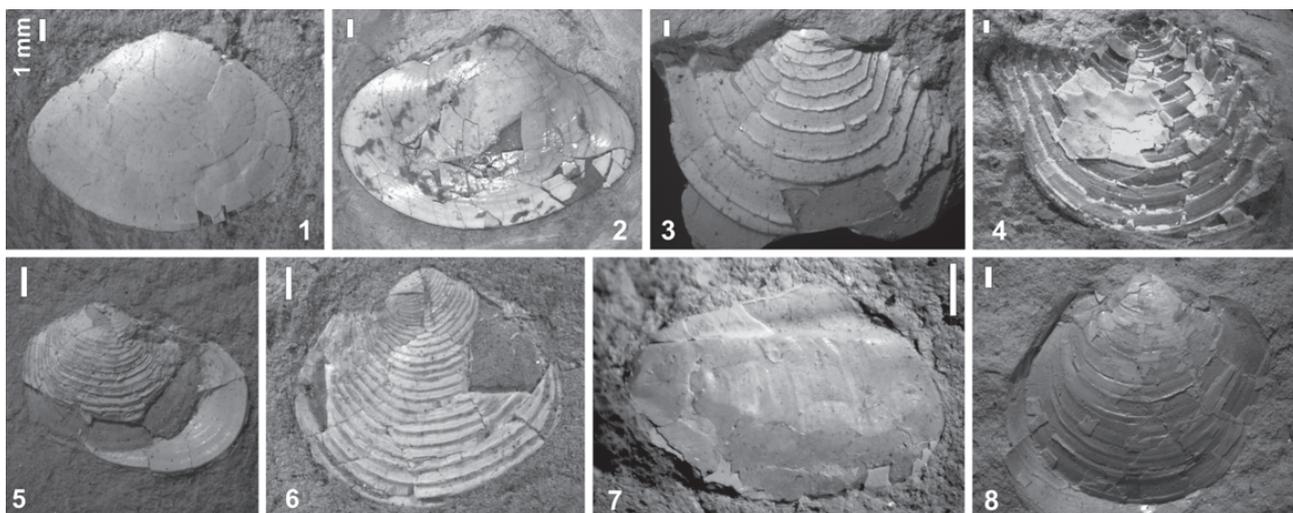
2001 *Macoma* (*Psammacoma*) *elliptica* (Brocchi, 1814) — Harzhauser & Mandic, p. 748-749, pl. 9, fig. 8

2005 *Macoma* (*Psammacoma*) *elliptica* (Brocchi, 1814) s.l. (excl. *M. (P.) elliptica ottnangensis* (Hoernes, 1875)) — Schultz, p. 721, pl. 99, fig. 6 (cum syn.)

2005 *Macoma* (*Psammacoma*) *elliptica ottnangensis* (Hoernes, 1875) — Schultz, p. 722-724, pl. 99, figs. 7-9

2005 *Macoma* (*Psammacoma*) *elliptica floriana* (Hilber, 1879) — Schultz, p. 724-725, pl. 99, figs. 10-13

2005 *Macoma* (*Psammacoma*) *elliptica plicata* (Bauer, 1900) — Schultz, p. 725, text-fig. 14



**Fig. 13.** 1-2 — *Macoma elliptica* (Brocchi, 1814), 3-4 — *Lucina callipteryx* Tournouer, 1874, 5-6 — *Gonimyrtea submichelottii* (Sacco, 1901), 7 — *Thyasira flexuosa* (Montagu, 1803), 8 — *Laternula fuchsi* (Hoernes, 1875).

**Material:** 2 articulated specimens, 3 left and 5 right valves (sample: 12, 13, 16, 16–17, 17–18, 19, 21+); LV — length: 15.2 mm, height: 10.6 mm, convexity: 2.1 mm.

**Remarks:** Shell small, thin walled, with shiny surface, moderately convex, beak slightly pointed, shifted more or less posteriorly, dorsal margin trigonal, ventral margin broadly convex, anterior margin narrowly convex, posterior margin pointed, shell exterior smooth with minute, weak irregular growth lamellae getting little more prominent only at posterior margin, interior shell with smooth margin, deep sinus and minute radial threads.

As pointed out already by Hoernes (1875) and Hilber (1879) this is a highly variable species especially in outline and convexity. For different morphotypes numerous species and subspecies names are available in the literature. In the present study, we follow the revision by Duckheim & Strauch (1998) and consider those names as synonyms of *M. elliptica*. Our specimens, with more centrally placed umbonal region and reduced postero-ventral elongation, resembles particularly *Tellina floriana* Hilber, 1879. *Gastrana fragilis*, in contrast, may develop a similar outline but has a more prominent concentric sculpture showing well projecting concentric lirae.

The species is present from the Late Oligocene to Pliocene in the Paratethys Sea, the Mediterranean Sea and the Eastern Atlantic (Schultz 2005).

Superfamily: **Lucinoidea** Fleming, 1828

Family: **Lucinidae** Fleming, 1828

Subfamily: **Lucininae** Fleming, 1828

Genus: *Lucina* Bruguière, 1797

***Lucina callipteryx* Tournouer, 1874**

Fig. 13.3–4

1874 *Lucina callipteryx* — Tournouer, p. 306, pl. 10, fig. 4

1911 *Miltha (Eomiltha) callipteryx* (Tournouer) — Cossmann & Peyrot, p. 285–287, pl. 27, figs. 18–21

**Material:** 4 articulated specimens, 4 single left and 2 single right valves (samples: 5–6, 7, 8, 13–15, 16, 16–17, 19, 19–20, 21). Dimensions: RV — length: 22.8 mm, height: 17.4 mm, convexity: 1.0 mm.

**Remarks:** Shell small in size, low convex with postero-dorsal depression; outline subquadrangular with subtrigonal dorsal portion and rounded ventral portion; anterior margin pointed, posterior margin rounded. Exterior surface with projecting comarginal lirae (0.5 mm distance in proximal part and 2.3 mm in distal part). Numerous fine growth lines are visible between the lirae. Interior margin smooth.

The type specimen differs only in its about two times larger size. Our specimens differ from *Lucinoma borealis* (Linnaeus, 1767) not only by more regular and more widely spaced concentric lamellae but mainly by the subquadrangular, anteriorly pointed outline. The specimen from the Karpatian schlier of the North Hungarian Basin, illustrated by Csepregy-Meznerics (1954) as *Miltha ottngangensis* (Hoernes, 1875), has a fragmented anterior outline but the rest of the outline together with shell exterior sculpture suggests an affinity to *L. callipteryx*.

This extraordinarily rare species, originally defined from the Burdigalian of the Aquitanian Basin, was previously recorded in the Central Paratethys only from the Lower Badenian of Romania (Studencka et al. 1998). The present study provides the first illustrations of a specimen ever found in the Paratethys Sea area.

Subfamily: **Myrteinae** Chavan, 1969

Genus: *Gonimyrtea* Marwick, 1929

***Gonimyrtea submichelottii* (Sacco, 1901) nov. comb.**

Fig. 13.5–6

1901 *Dentilucina Meneghini* de Stef. var. *submichelottii* — Sacco, p. 85, pl. 20, figs. 10–11

1934 *Phacoides submichelottii* Sacco — Friedberg, p. 107, pl. 19, figs. 4–5

**Material:** 10 articulated specimens and 1 right and 2 left valves (samples: 7, 8–9, 12, 15–16, 16, 16–17, 17–18, 19, 19–20, and scree material). Dimensions: LV — length: 7.0 mm, height: 6.8 mm, convexity: 0.8 mm.

**Remarks:** Shell is small, moderately convex with moderately thick wall; outline rounded, exterior surface with prominently projecting lamellae throughout ontogeny, somewhat narrower proximally than distally, interior shell margin smooth.

Studencka et al. (1998) place this species into *Parvilucina* which has — in contrast to *Gonimyrtea* — a crenated interior shell margin. *Phacoides sub-Michelottii* (Sacco, 1901) of Cossmann & Peyrot (1912, pl. 28, figs. 51–54) from the Aquitanian Basin has a much finer concentric sculpture and a stronger developed anterior muscle scar. Therefore, we consider this identification as questionable. The illustrated specimen might rather represent *Gonimyrtea meneghini* (De Stefani & Pantanelli, 1878) from the Italian Mio-Pliocene that occurs in the Badenian of the Paratethys (Schultz 2001) as well. The very similar *Lucina ottngangensis* (Hoernes, 1875) is up to 4 times larger. It has a variably prominent concentric sculpture and is actually treated as *Lucinoma borealis* (see Schultz 2003).

*Gonimyrtea submichelottii* is common in the Lower to Middle Miocene of the Turin Hills and in the Italian Pliocene. In the Paratethys it was previously found only in the Lower Badenian of southern Poland.

Family: **Thyasiridae** Dall, 1901

Genus: *Thyasira* Leach in Lamarck, 1818

***Thyasira flexuosa* (Montagu, 1803)**

Fig. 13.7

1803 *Tellina flexuosa* — Montagu, p. 72–73

1984 *Thyasira (Thyasira) flexuosa* (Montagu, 1803) — Janssen, p. 60–61, pl. 1, figs. 4–5

1986 *Thyasira (Thyasira) flexuosa* (Montagu, 1803) — Studencka, p. 56–57, pl. 7, fig. 10

2005 *Thyasira (Thyasira) flexuosa* (Montagu, 1803) — Marquet, p. 8–9, pl. 2, fig. 2

**Material:** 1 left valve (sample: 16–17); length: 6.0 mm, height: 4.4 mm.

**Remarks:** Minute shell, thin walled, moderately convex with strong dorsal anterior depression, beak prosogyr, outline subquadrangular rounded, exterior surface smooth with irregular, non-prominent concentric ribs.

The species is present from the Late Oligocene in the Paratethys, the Mediterranean and the NE Atlantic. In the Central Paratethys its previous record is restricted to the Badenian (Studencka et al. 1998), with one single specimen collected so far from the Lower Badenian of Poland (Studencka 1986).

Subclass: **Anomalodesmata** Dall, 1889  
 Order: **Pholadomyida** Newell, 1965  
 Suborder: **Pholadomyina** Newell, 1965  
 Superfamily: **Thracioidea** Stoliczka, 1870  
 Family: **Laternulidae** Hedley, 1918  
 Genus: *Laternula* Röding, 1798

***Laternula fuchsi* (Hoernes, 1875)**

Fig. 13.8

1875 *Anatina Fuchsi* nov. sp. — Hoernes, p. 366–367, 393, 397, pl. 13, figs. 13–16

1954 *Anatina fuchsi* R. Hoernes — Csepregy-Meznerics, p. 108, 126, pl. 13, fig. 15

1973 *Laternula fuchsi* (R. Hoernes, 1875) — Steininger, p. 542, pl. 30, fig. 1

1998 *Laternula (Laternula) fuchsi* (Hoernes) — Schultz, p. 112, pl. 50, fig. 5

2005 *Laternula (Laternula) fuchsi* (Hoernes, 1875) — Schultz, p. 1043–1044, pl. 151, figs. 2–4

**Material:** 7 articulated specimens, and 2 right valves (samples: 13, 13–14, 15, 15–16, 16, 16–17, 20–21). Dimensions: LV — height: 12.3 mm, height: 10.6 mm, convexity: 1.6 mm.

**Remarks:** The shell is small, thin walled, shiny and translucent, low convex with oblique posteroventral depression; outline oval to rounded, elongated anteroventrally, anteriorly rounded, posteriorly truncated, umbo posteriorly pointed. Shell exterior smooth, with fine irregularly projecting comarginal lirae and/or rugae.

As already remarked by Steininger (1973), the shells of this species are usually highly deformed and the outline is seemingly very variable. The only well preserved specimen (Fig. 13.8) displays a rather rounded outline whereas other specimens show a posteroventral elongation which is typical

for the type specimen from Ottnang in Upper Austria (NHMW collection). Therefore, the specimens differ from other *L. fuchsi* (Hoernes, 1875) morphs only by their about 2 to 3 times smaller size.

The previous fossil record of this species is restricted to the Ottnangian of Upper Austria and the Karpatian to Lower Badenian of the North Hungarian Basin (Csepregy-Meznerics 1954). Additionally, it has been reported from the Ottnangian of Bavaria (Steininger 1973), the Karpatian of Slovakia (Tejkal et al. 1967) and the Lower Badenian of Northern Slovenia (Meznerics 1936).

Suborder: **Cuspidariina** Dall, 1886  
 Superfamily: **Cuspidarioidea** Dall, 1886  
 Family: **Cuspidariidae** Dall, 1886  
 Genus: *Cardiomya* Adams, 1864

***Cardiomya elegantissima* (Hoernes, 1875)**

Fig. 14.1–3

1875 *Neaera elegantissima* M. Hoernes — Hoernes: p. 368, pl. 13, fig. 8

1967 *Cuspidaria (Cuspidaria) elegantissima* (R. Hoernes, 1875) — Tejkal et al., p. 189, pl. 8B, fig. 16

1973 *Cuspidaria (Cuspidaria) elegantissima* (Hoernes, 1853) — Steininger, p. 544, pl. 30, fig. 2

2003 *Cuspidaria (Cuspidaria) elegantissima* (Hoernes, 1875) — Schultz, p. 1056, pl. 152, fig. 3

**Material:** 5 articulated specimens, 2 left valves and 1 right valve (sample numbers: 5–6, 6–7, 7–8, 13–14, 16, 17–18, 19–20 and scree material). Dimensions: length: 10.5 mm, height: 6 mm.

**Remarks:** Shell small, about 10 mm in length, fragile, postero-ventrally elongated, and moderately convex. Anterior side slightly pointed, narrowly rounded, with shell surface bearing coarse irregular concentric ribs. Posterior side shortly rostrate, with posterior part of the exterior surface bearing three prominent radial triangular ribs, laterally adjoined by up to four additional tinny ribs; rest of exterior surface, at rostrum, smooth. This species is reminiscent of the extant *C. costellata* (Deshayes, 1833) from the Mediterranean Sea and the Atlantic, which is a carnivorous deep water bivalve (Poutiers & Bernard 1995). The latter differs from *C. elegantissima* by much weaker concentric ribs at the anterior shell surfaces.

This species is restricted to the Lower Ottnangian of the eastern North Alpine Foredeep and the Karpatian of the northern Vienna Basin.

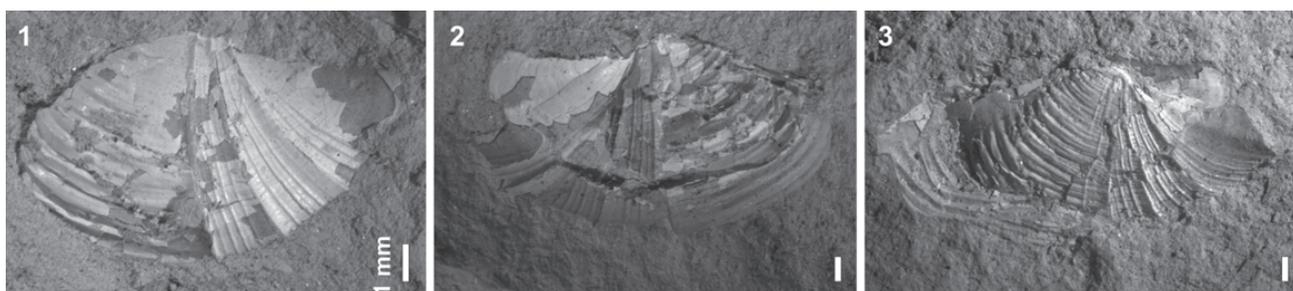


Fig. 14. 1–3 — *Cardiomya elegantissima* (Hoernes, 1875).

**Mollusc taxa from Cerová****Gastropoda**

- Calliotropis?* sp.  
*Polinices cerovaensis* nov. sp.  
*Stellaria testigera* (Bronn, 1831)  
*Galeodea echinophora* (Linnaeus, 1758)  
*Mitrella hilberi* (Cossmann, 1901)  
*Nassarius janschloegli* nov. sp.  
*Amalda glandiformis* (Lamarck, 1810)  
*Conolithus antidiluvianus* (Bruguière, 1792)  
*Genota valeriae* (Hoernes & Auinger, 1891)  
*Pyramidella* cf. *gratteloupi* d'Orbigny, 1852  
*Turbonilla* sp.  
*Triphora* sp.  
*Ringicula minor* (Grateloup, 1838)  
*Cylichna* cf. *salbriacensis* (Peyrot, 1932)  
*Sabatia callifera* Boettger, 1906  
*Balantium collina* (Janssen & Zorn, 2001)

**Scaphopoda**

- Fissidentalium badense* (Partsch in Hörnes, 1856)  
*Gadilina taurogracilis* Sacco, 1897  
*Gadila gracilina* Sacco, 1897

**Bivalvia**

- Nucula mayeri* Hörnes, 1865  
*Leionucula ehrlichi* (Hoernes, 1875)  
*Yoldia nitida* (Brocchi, 1814)  
*Solemya doderleini* Mayer, 1861  
*Atrina pectinata* (Linnaeus, 1767)  
*Parvamussium felsineum* (Foresti, 1893)  
*Limea strigilata* (Brocchi, 1814)  
*Limaria labani* (Meznerics, 1936)  
*Macoma elliptica* (Brocchi, 1814)  
*Lucina callipteryx* Tournouer, 1874  
*Gonimyrtea submichelottii* (Sacco, 1901)  
*Thyasira flexuosa* (Montagu, 1803)  
*Laternula fuchsi* (Hoernes, 1875)  
*Cardiomya elegantissima* (Hoernes, 1875)

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