



Peelipilina, a new tergomyan mollusc from the Middle Ordovician of Bohemia (Czech Republic)

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ABSTRACT. The Middle Ordovician *Peelipilina* gen. n. is established as the first known tergomyan mollusc with a low coniform shell and a blunt subcentral apex within a tryblidiiform muscle scar pattern. The two anterior paired scars are connected with narrow divergent ridges interpreted as the radular muscle scars. The four pairs of pedal attachments consist of elongate scars approximately normal to the apertural margin. The shell is small (up to 10 mm long), thin-walled, with ovoid aperture. The only species, *P. latiuscula* (Barrande in Perner, 1903) occurs in the Middle Ordovician (Darriwilian) Šárka Formation, Bohemia. *Peelipilina* represents a model of tergomyans showing both tryblidiid and cyrtoneid features; it is, therefore, classified in a separate family Peelipilinidae fam. n.

■ Mollusca, Tergomya, Tryblidiida, Peelipilinidae fam. n., *Peelipilina* gen. n., muscle scars, Ordovician.

INTRODUCTION

The new genus *Peelipilina* gen. n. is based on a small, coniform tergomyan from the Middle Ordovician Šárka Formation, originally distinguished by Barrande (MS) and described and published by Perner (1903) as *Palaeacmaea latiuscula* Barrande in Perner, 1903. In his revision of the Lower Palaeozoic Monoplacophora etc. of 1963, Horný listed it as a *nomen dubium*. In 2002, he tentatively assigned it to the genus *Pygmaeoconus* Horný, 1961 [*Pygmaeoconus? latiusculus* (Barrande in Perner, 1903)]. In 2006, Horný studied *Pygmaeoconus porrectus* (Barrande in Perner, 1903) in detail and concluded that *P.? latiusculus* is synonymous with *Palaeacmaea kettneri* Říha, 1938 and represents another, unrelated genus.

As the holotypes of *Palaeacmaea latiuscula* (Fig. 3) and *Palaeacmaea kettneri* (Fig. 4) are poorly preserved and show no muscle scars, additional specimens were gathered and prepared in connection with the study of *Pygmaeoconus porrectus*. Muscle scars have been recognized in about ten specimens.

Peelipilina gen. n. is the first known Ordovician genus with a tryblidiiform muscle scar pattern in shell with a central apex and a slightly ovoid aperture, pointed anteriorly. A new family Peelipilinidae is established to accommodate tergomyans with this unique and extraordinary morphology. The only Czech Ordovician tryblidiid genus of the family Tryblidiidae is *Pentalina* Horný, 1961, in which the apex slightly overhangs the anterior shell margin. *Pentalina* and *Peelipilina* are the smallest known fossil representatives conclusively assigned to the superfamily Tryblidioidea.

Peelipilina gen. n. occurs in the Middle Ordovician Šárka Formation (Darriwilian) at localities Rokycany, Osek, Díly, Praha-Šárka, and perhaps also in the overlying

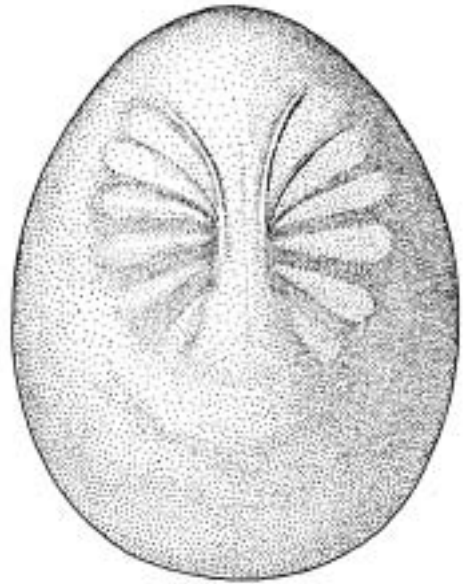


Fig. 1. Specimen MBHR 12398, internal mould with most completely preserved muscle scars. **A** – dorsal, **B** – anteroapical, **C** – left lateral views; **D** – slightly schematised drawing. The shell is slightly deformed by lateral pressure. Note the prominent divergent anterior ridges, interpreted as a part of the radular scars. Length of the specimen 5.0 mm. Šárka Formation, Osek near Rokycany, $\times 13$.

Dobrotivá Formation (Dobrotivian) (Praha-Šárka). All studied specimens are deposited in the Museum of Dr. B. Horák at Rokycany (abbreviation MBHR) and in the National Museum, Praha (abbreviation NM L). Specimens at the Rokycany Museum were mostly collected by Jaroslav and Petr Kraft; the majority of those deposited in the Prague National Museum come from the collections of Joachim Barrande, František Hanuš, and Celda Klouček.

P. latiuscula is definitely more common than suggested from specimens available in collections. The amateur collectors preferred (and still prefer) trilobites to small, morphologically unattractive and even nameless fossils.

MATERIAL AND METHODS

The majority of collected specimens are preserved in hard dark grey siliceous (probably originally carbonatic) concretions, derived from clayey shales and weathered during the late Cenozoic. A few specimens come from grey silty concretions. Concretions mostly include taphocoenoses of abundant and often fragmentary benthic fauna, above all trilobites, brachiopods, ostracods, echinoderms, gastropods, tergomyans, and bivalves. Fragments of fossils are usually covered with limonite. Specimens of *P. latiuscula* usually occur individually but two samples contain two and three specimens in close proximity, all oriented with the apex up. As the shell wall is very thin, the shells are often laterally compressed (Figs 4, 8). The lateral compression is greatest near the apertural margin. Specimens from the locality Praha-Šárka often show radial cracks at the apertural margin, originated by vertical pressure during diagenetic processes and filled probably with ankerite (Fig. 8). As the size of shells is rather small (length often about 5–7 mm), the muscle scars are weak and hardly visible. The external surface is observable in counterparts, but these are rare since they were usually neglected by the older collectors or are imperfectly preserved.

The thin space after the shell wall is either empty or more or less filled with dusty limonite; altered shell was not observed. The limonitic residua were removed by ultrasound and external moulds showing outer shell sculpture were studied on Revultex impressions. Photographs of specimens whitened with ammonium chloride sublimate were taken by an Olympus Digital Camera DP 70.

SYSTEMATIC PART

Class Tergomya Horný, 1965

Order Tryblidiida Lemche, 1957

Family Peelipilinidae fam. n.

DIAGNOSIS: Shell slightly ovoid, coniform, with blunt subcentral apex inside the muscle scars zone, slightly offset toward anterior shell margin; aperture oval, planar; outer shell sculpture consists of unequal, concentric growth lines; six pairs of elongate, radial muscle scars, arranged around the apex. The two anterior pairs consist of larger scars, on proximal lateral sides bordered with narrow long divergent ridges.

DISCUSSION: *Peelipilina* has an almost tryblidiid muscle scar pattern in a shell with a blunt subcentral apex. Another Ordovician genus *Archaeophiala* Perner, 1903, located in the subfamily Archaeophialinae Knight et Yochelson, 1958, also has a subcentral apex, as do two genera whose systematic position is unclear (the Ordovician *Micropileus* Wilson, 1951, without preserved muscle scars, and the Devonian *Calloconus* Perner, 1903, also without plausible muscle scars, perhaps a gastropod; see Knight & Yochelson 1960, Horný 1963). The genus *Archaeophiala* strongly differs from *Peelipilina* in having a less central apex, a heavy thick sugarloaf-shaped shell, and six pairs of short muscle scars



Fig. 2. Specimen MBHR 12563, internal mould with divergent anterior ridges, anteroapical view. This structure usually remains as the only part of the muscle scar pattern. Length of the specimen 6.3 mm. Šárka Formation, Rokycany 2, $\times 12$.



Fig. 3. The holotype of *Palaeacmaea latiuscula* Barrande in Perner, 1903, NM L 8386. Internal mould with no muscle scars preserved, dorsal view. Length of the specimen 5.7 mm. Šárka Formation, Osek near Rokycany, $\times 11$.

located nearer to the apertural margin. (The specimen PMO 20508, figured by Yochelson 1977 on Fig. 1 B, C, deposited in the Palaeontological Museum, Oslo, has an almost central apex.) The family Protoconchioididae Geyer, 1994 is based on the Middle Cambrian *Protoconchioides* Shaw, 1962. It has a low coniform shell, but the apex is narrow and projects like a nipple. Its muscle area is described as a ring-shaped, continuous band, parallel to the apertural margin.

INCLUDED GENUS: *Peelipilina* gen. n.

DISTRIBUTION: Middle Ordovician, Barrandian Area, Czech Republic.

***Peelipilina* gen. n.**

TYPE SPECIES: *Palaeacmaea latiuscula* Barrande in Perner, 1903. Middle Ordovician, Darriwilian, Šárka Formation; Barrandian Area, Bohemia.

ETYMOLOGY: Named in honour of Prof. John Stuart Peel in acknowledgement of his contribution to our knowledge of the Lower Palaeozoic univalved molluscs. Feminine.

DIAGNOSIS: As for the family Peelipilinidae fam. n.

DISCUSSION: *Peelipilina* is a small, low, slightly ovoid, coniform mollusc with central to subcentral apex, at the maximum 10 mm long and about 5 mm high. This type of shell commonly occurs throughout the Cambrian and Ordovician. Some of the Upper Cambrian and Ordovician genera are representatives of the class Tergomya – both Cyrtoneillida and Tryblidiida. Various Middle Cambrian coniform shells were described by Stinchcomb



Fig. 4. The holotype of *Palaeoacmaea kettneri* Říha, 1938, NM L 30070. Internal mould with no muscle scars preserved, A – dorsal, B – right lateral views. Note the almost central position of the apex with a distinct protoconch. The specimen is strongly laterally compressed, 7.5 mm long. Šárka Formation, Osek near Rokycany, $\times 6$.

(1986) and Stinchcomb and Angeli (2002) (e.g. kirengellids), none of them with preserved muscle scars. Geyer (1994) described Middle Cambrian shells with central to subcentral apex and a ring-shaped muscle scar. Webers, Pojeta, Jr. and Yochelson (1992) reported several genera from the Upper Cambrian of Antarctica, some of them with a subcentral apex, unfortunately without muscle scars. Yochelson (1958) described Lower Ordovician tryblidians from Missouri. A series of papers of Russian authors (Rozov 1968, 1970, 1975, Dogužaeva 1972, 1981, Belyj 1973) reported several new genera of small Lower Ordovician coniform shells with a subcentral apex, some of them with muscle scars, which, however, show no tryblidian pattern (for discussion see Peel 1988, 1991).

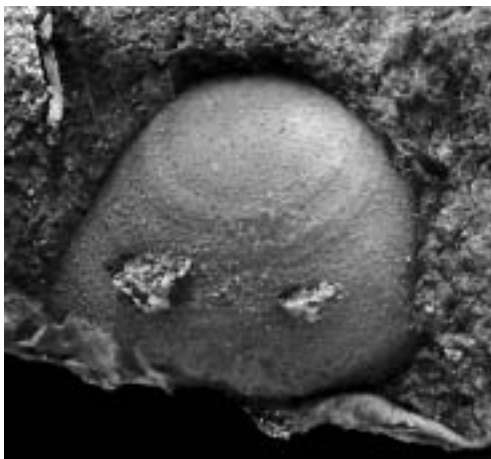


Fig. 5. Revultex impression of specimen MBHR 13103, showing external surface of the protoconch and early stages of teleconch; oblique anterior view. Diameter of protoconch is 2 mm. Šárka Formation, Praha-Šárka, $\times 15$.

The discovery of a tryblidian muscle scar pattern in *Peelipilina* in a low coniform shell with central to subcentral apex inside the muscle scar zone suggests closer relationship of the groups Tergomya and Cyclomya (Horný 1965a, b) or, as reinterpreted by Peel (1991), the orders Tryblidiida and Cyrtoneilliida within the class Tergomya. This fact, however, does not bring evidence that the Middle Ordovician *Peelipilina* manifested itself during the tergomyan phylogeny. Undoubted tryblidiids of the family Tryblidiidae are known from the Upper Cambrian (*Pilina* described by Yu & Yochelson from Liaoning, China, in 1999) and similarly the cyclomyan cyrtoneilliids (e.g. *Telamocornu* described by Berg-Madsen and Peel from Wales in 1994).

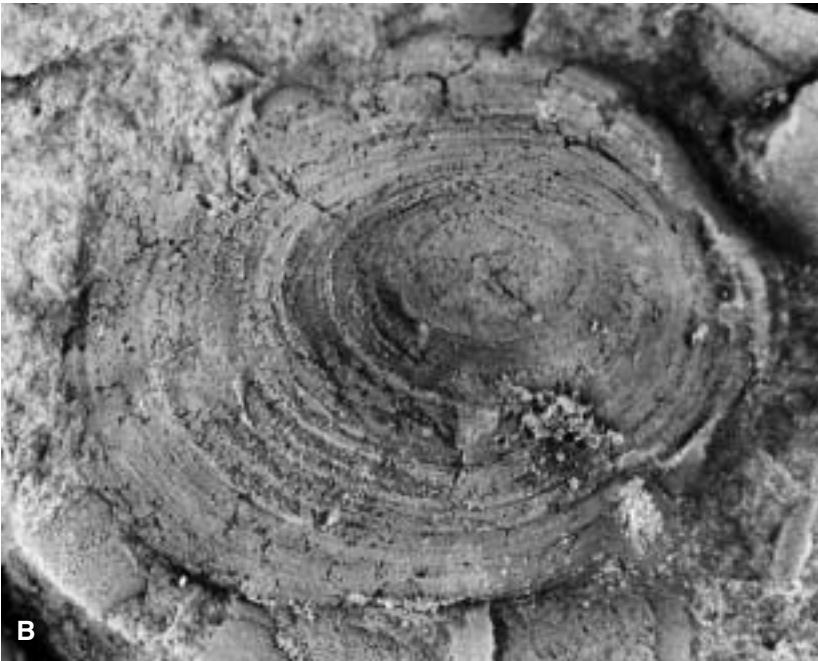


Fig. 6. Revultex impression of specimen MBHR 87924, showing external surface of the shell with irregular comarginal rugosities and fine increments. Deformed by pressure. A – oblique left lateral, B – oblique right apicolateral views. Length of the specimen is 7.5 mm. Šárka Formation, Osek near Rokycany, $\times 13$.



Fig. 7. A sample of a concretion (“Rokycany ball”) MBHR 2363 with fragments of various fauna and two internal moulds of *P. latiuscula*. The older and bigger specimen (upper right), 5.2 mm long, has weak but visible muscle scars. Šárka Formation, Osek near Rokycany, × 11.

Peelipilina appears in the same stratigraphic level as the typical tryblidiid *Pentalina* Horný, 1961 and the advanced cyrtoneid cyrtolitid *Cyrtodiscus* Perner, 1903. Also the somewhat problematic Lower Ordovician tergomyan *Solandangella* from the Montagne Noire described by Horný in 1995 has a tryblidiiform muscle scar pattern but its subapical scar gave rise to certain doubts about its affinity. Nevertheless, the presence of subapical scars has been demonstrated also in *Drahomira* Barrande in Perner, 1903 (Horný 2005b).

The discovery of a tryblidiid muscle scar pattern in a coniform shell with a central to subcentral apex indicates that the principal characters of the musculature may persist in different lineages, although adapted to equivalent life conditions. In this connection we can mention various taxa with low coniform shells, e.g. *Protoconchioides* Geyer, 1994, *Kirengella* Rozov, 1968, *Pygmaeoconus* Horný, 1961, *Floripatella* Yochelson, 1988, and *Peelipilina* gen. n. This situation, of course, brings serious difficulties for taxonomy and determination of fossils imperfectly or incompletely preserved in various types of rocks. Study of muscle scars must be often connected with special and careful preparation methods and patience, usually not accessible and pleasurable for geologists and stratigraphers. INCLUDED SPECIES: *Peelipilina latiuscula* (Barrande in Perner, 1903). Middle Ordovician, Darriwilian, Šárka Formation, Barrandian Area, Bohemia.

***Peelipilina latiuscula* (Barrande in Perner, 1903)**

1903 *Palaeacmaea latiuscula* Barrande in Perner, 1903; J. Perner, Pl. 5, figs 18, 19.

1938 *Palaeacmaea kettneri* Říha; A. Říha, Pl. 1, figs 2 a, b.

1963 *Pygmaeoconus?* *kettneri* (Říha, 1938); R. Horný, Pl. 9, fig. 11.



Fig. 8. A sample of a concretion (“Šárka ball”) with fragments of various fauna and three internal moulds of *P. latiuscula* (A – NM L 38722, B – NM L 38723, C – NM L 38724). Specimens A and B show fine muscle scars. Note the cracks near the margins originated by vertical pressure. Specimen B is deformed also by lateral pressure. Length of specimen A is 7.2 mm. Šárka Formation, Praha – Šárka, $\times 7$.

1963 *species dubia*; R. Horný, Pl. 18, fig. 6.

2002 *Pygmaeoconus kettneri* (Říha, 1938); R. Horný, Pl. 3, fig. 12.

2002 *Pygmaeoconus? latiusculus* (Barrande in Perner, 1903); R. Horný, Pl. 4, fig. 7.

HOLOTYPE: Specimen NM L 08386, figured here on Fig. 1.

STRATUM: Middle Ordovician, Darriwilian, Šárka Formation.

TYPE LOCALITY: Osek near Rokycany.

MATERIAL: 25 specimens (13 specimens in the National Museum, Prague, 12 specimens in the Museum of Dr. B. Horák, Rokycany).

DESCRIPTION: Shell morphology. The low coniform shell is widely ovoid with almost central to subcentral, anteriorly shifted apex. The average length:width ratio is 1.4, length:height ratio varies between 1.2 – 1.5. The smallest, juvenile specimen MBHR 20964 is 3.4 mm long, 2.4 mm wide, and 1.3 mm high, the biggest NM L 38717 is 10.0 long, 7.0 wide, and 4.2 mm high. The apex is blunt, wide, rounded, located either near the



Fig. 9. Revultex impression of specimen NM L 38721, right side, showing typical external surface of shell with variably thick increments and a small, local, repaired injury. Length of the specimen is 7.5 mm, Šárka Formation, Praha – Šárka, $\times 10$.



Fig. 10. Detail of the specimen NM L 38721. $\times 25$.

centre or more or less shifted towards the anterior apertural margin. The protoconch (Fig. 5) is a fairly large, smooth, flatly hemispherical with an aperture which is oval in shape, measuring 2.0–2.3 mm. The adapical ends of the muscle scars lie below the protoconch. Both the anterior and posterior margins are rounded. The anterior side is steeper and more convex than the posterior, which is shallowly convex between the apex and posterior margin in mature specimens. The lateral sides are often *post mortem* laterally compressed and deformed in many specimens, which reflects the thin shell (Figs 4, 8). The apertural margin is planar, sharp, without a brim. The shell wall is very thin, max. 0.3 mm in the apical area and 0.1 mm or less at the aperture. Its composition and structure are unknown, being weathered and substituted by limonite. External sculpture consists of simple, somewhat irregular and unequal growth lines (10 to 15 per mm); some specimens bear variably strong, irregular comarginal depressions and elevations (Figs 6, 9).

MUSCLE SCARS. As the shells are small and shell wall is thin, the muscle insertions are rather small and hardly observable (Figs 1, 7, 8). Furthermore, the weathered structure of the surface of internal moulds is not smooth enough to reflect fine details. The muscle scars are slightly raised, with weakly defined margins. The muscle scar pattern consists of two pairs of anterior (cephalic) muscle scars and four pairs of pedal muscle scars. The scars are arranged around the shell apex, with a median gap between the cephalic scars. The scars are elongate, variably widened distally and their axes are approximately perpendicular to the apertural margin. The two proximal pairs consist of wider flat scars proximally bordered with narrow, proximally diverging ridges. The ridges of the first pair are longest and strongest, originating laterally to the apex, joining the weaker ridges of the second pair and bordering the median gap. This is usually the only muscular structure that remains on weathered surface of internal moulds (Fig. 2). The posterior pairs of pedal muscle scars are usually weaker and the last pair is often not observable. The weak medio-dorsal groove is preserved in the specimen MBHR 12563 (Fig. 2). It resembles similar but stronger structures in *Cambridium* Horný, 1957, *Carcassonnella* Peel et Horný, 1996, *Sinuitopsis* Perner, 1903, or *Yochelsonellis* Horný, 1966.

The pallial line and associated structures have not been ascertained.

DISCUSSION: The small dimensions of the shell probably precluded preservation of additional structures known in larger, typical, tryblidians like e.g. *Pilina* Koken et Perner, 1925 (*P. liaoningensis* Yu et Yochelson, 1999, *P. cheyennica* Peel, 1977, *P. unguis* (Lindström, 1880). The paired divergent ridges, however, may represent attachments of the radular scars, which are usually dominant in the cephalic muscular structures (Lemche & Wingstrand 1959, Peel 1977, Wingstrand 1985, Yu & Yochelson 1999, Horný 2005a,b). The muscle scar pattern differs fundamentally from that of *Pygmaeoconus porrectus* (Barrande in Perner, 1903), which consists of rounded attachments located near the aperture migrating by saltation at least three times through the ontogeny (Horný 2006). The muscle attachments of *Peelipilina* increased continuously; they are elongate, located radially around the shell centre and arranged normal to margin of the aperture.

MODE OF LIFE

Peelipilina latiuscula has been collected in the Šárka Formation in two areas, Rokycany and Praha-Šárka, in similar assemblages of predominantly benthic fauna. According to Havlíček & Vaněk (1990) and especially to Havlíček et al. (1994), the localities were situated in areas that surrounded the median graben-like depression of the Pragian basin. The fauna belongs to the *Euorthisina-Placoparia* Community in about B A 3–4 life positions in Boucot's classification (1975). All specimens of *P. latiuscula* originate from concretions containing taphocoenoses of abundant and often fragmentary benthic fauna: trilobites, ostracods, brachiopods, hyolithids, gastropods, cyclomyans, bivalves, carpoids, graptolites and others. Brachiopods and bivalves are often found with both valves in situ and complete trilobite exoskeletons are not an exception. *P. latiuscula* usually occurs as single specimens, but one sample exists with two and one with three specimens of different sizes in close association, with the apex in the same position (probably directed upwards). *P. latiuscula* was probably a slow inhabitant of the sea floor, living on various fragments of dead invertebrates and grazing on bacterial or algal films.

One specimen (NM L 38721) shows a small repaired injury in the left shell margin (Fig. 9). It may have been caused by a small predator, either a juvenile cephalopod or arthropod, present in the assemblage.

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