A review of Bellardiella Tapparone-Canefri, 1883, with descriptions of a new subgenus and two new species (Gastropoda: Cyclophoroidea: Pupinidae)

András Varga¹ and Barna Páll-Gergely²,³*

Abstract. This paper reviews the genus Bellardiella Tapparone-Canefri, 1883. Two new species are described, Bellardiella kovaci new species, from West Papua, and Bellardiella (Szekeresia) saparuana new species, from Maluku. Bellardiella kovaci is most similar to B. fabula Benthem-Jutting, 1963, and B. martensiana Tapparone-Canefri, 1883, but differs from them in the shell shape, and the formation of the aperture and the peristomal lip. Bellardiella (Szekeresia) saparuana new species differs from B. (S.) ceramicus von Martens 1864 by the thicker peristome, the shorter angular tube, and the oblique plane of the aperture to the shell axis, and the elevated lamina on the outer surface of the operculum. A neotype of B. crassilabris Möllendorff, 1899 is designated. A new subgenus (Szekeresia n. subgen.) characterised by the presence of an angular tube in the upper (parieto-palatal) edge of the aperture is also proposed here, and comprises the following species: Rhaphaulus ceramicus von Martens, 1864 (type species), Bellardiella (Szekeresia) saparuana new species, and Bellardiella lissocilia Benthem-Jutting, 1963.

Key words. Caenogastropoda, Szekeresia, breathing tube, taxonomy, systematics, new taxa, New Guinea, neotype

INTRODUCTION

The family Pupinidae (Caenogastropoda: Cyclophoroidea) is a group of terrestrial operculate species that mostly possess ovoid shells. Most recognised genera possess apertural devices ranging from simply by-pass channels formed by internal plicae to snorkel-like tubes, which allow gas exchange when the operculum seals the aperture (Kobelt, 1902; Rees, 1964; Páll-Gergely et al., 2015, 2016, 2017). Due to the limited available anatomical and molecular phylogenetic information, the systematics of this family is largely based on the morphology of the apertural passages.

The pupinid genus Bellardiella Tapparone-Canefri, 1883 is so far endemic to New Guinea and its satellite islands, and includes the following species: B. martensiana Tapparone-Canefri, 1883; B. crassilabris Möllendorff, 1899; B. minor Hedley, 1891; B. lissocilia Benthem-Jutting, 1963; B. fabula Benthem-Jutting, 1963. All Bellardiella species have an elongate-ovoid or ovoid shell with a rather matt surface, and possess a peristomal tube which is situated at the lower angle of the peristome [=umbilical tube]. Here we review the genus Bellardiella. The examination of all Bellardiella species and most members of Pupinella Baird, 1850 resulted in the proposal of a new subgenus for Bellardiella von Martens, 1864, and descriptions of two new species. A neotype of B. crassilabris Möllendorff, 1899 is designated.

MATERIAL AND METHODS

The counting of the shell whors follows Kerney & Cameron (1979: 13). We received photos of the type specimens of Bellardiella species from museum curators. The mentioned species of Pupinella have been examined in the collection of the NHM. The mostly widely used terms were used in the descriptions, with the exception of the following: “angular tube” refers to the tube that is produced against the penultimate whorl at the top corner of the peristome; umbilical tube refers to the tube that is situated behind the columellar side of the aperture.

Abbreviations.
AM: Australian Museum (Sydney, Australia)
MK: collection Michael Kesl (Prague, Czech Republic)
MMGY: Mátra Museum of the Hungarian Natural History Museum (Gyöngyös, Hungary)
MSNG: Museo Civico di Storia Naturale di Genova (Genova, Italy)
NHM: The Natural History Museum (London, UK)
NHMB: Naturhistorisches Museum, Basel (Basel, Switzerland)
NHMUK: When citing NHM registered specimens
SMF: Senckenberg Forschungsinstitut und Naturmuseum (Frankfurt am Main, Germany)
AH: aperture height
AW: aperture width
D: shell diameter (width)
H: shell height

TAXONOMY AND SYSTEMATICS

Family Pupinidae

Genus Bellardiella Tapparone-Canefri, 1883

Bellardiella Tapparone-Canefri, 1883: 265.

Type species. Bellardiella martensiana Tapparone-Canefri, 1883 by monotypy.

Diagnosis. The genus Bellardiella is characterised by an umbilical tube, which is a passage without a suture on the side of the peristome.

Remarks. Porocallia Möllendorff, 1893 (and Sulapina Maassen & Kittel, 1996, which is probably a synonym of Porocallia; see Egorov, 2013) also possesses an umbilical tube, but the shell is small, polished, glossy, resembling those of Pupina Vignon, 1829.

Pupinella is similar in shell shape and the formation of the aperture, but it has an umbilical passage, which possess a suture (furrow) on the side of the peristome. The umbilical passage of the lower apertural angle of Pupinella is very variable. In Pupinella macgregori E. A. Smith, 1889, and Pupinella minor E. A. Smith, 1889, the canal rolls up in the direction of the umbilicus and forms a structure which is practically a tube open only at both ends. However, the slit-like suture along the canal is always visible from the direction of the peristome and an umbilical tube, which is attached to the body whorl.

Type locality. “Angeblich von Borneo aber wohl sicher von Neuguinea” (allegedly from Borneo, but quite certainly from New Guinea).

Remarks. Operculum unknown. This species was described based on a single shell from Bruno Strubell’s collection. No illustrations of Bellardiella crassilabris have ever been published. The whereabouts of the holotype is unknown, and it is certainly not in the SMF where most of Möllendorff’s types are housed (R. Janssen pers. comm., May 2016). We found a single shell labelled as Bellardiella crassilabris in the NHM (reg. no.: NHMUK 1910.12.30.97). No information on the origin of this specimen was written on the label, only “New Guinea”. Interestingly, the measurements of that specimen (D: 7 mm, H: 11.8 mm) largely match the sizes given by Möllendorff (D: 7.5 mm, H: 12 mm). According to the museum catalogue, the NHM purchased that specimens from Sowerby and Fulton sometime before 1910 together with, for example, the type sample of Amphidromus buelowi Fruhstorfer, 1905 (reg. no.: NHMUK 191012.30.98). It is likely that the purchased specimens were part of Carl Bülow’s private collection, where the collection of Strubell has ended up (Dance 1986: 157). All this information suggests that the single Bellardiella specimen is possibly the holotype of B. crassilabris, although the evidence is not strong enough for clear statement. Since the original measurements and the description match the shell we found, we designate it the neotype of Bellardiella crassilabris Möllendorff, 1899. See also under Discussion.
Bellardiella (Bellardiella) fabula Benthem-Jutting, 1963

Bellardiella fabula Benthem-Jutting, 1963: 693, Plate 28, Fig. 15.

Diagnosis. A small (H: 10–11 mm, D: 6.1–6.8 mm) Bellardiella species with ovoid, nearly smooth shell, open umbilicus, rectangular aperture, well-developed sinusulus, a strong parietal callus, and a moderately thickened peristome.

Type locality. “Near Manokwari, along the Uriami River” (ca. 0°47′S, 133°58′E).

Remarks. Operculum unknown.

Bellardiella (Bellardiella) kovacsi new species

(Fig. 2F–L)

Type material. Holotype (MMGY 74592, probably flotsam shell; H = 17.85 mm, D = 9.5 mm, Fig. 2G–L), Indonesia, West Papua, Batanta Island, dry valley of the Kaliselatan River, 0°54.513′S, 130°35.883′E, coll. T. Kovács, R. Horváth & R. Sauyai, 14 February 2016; Paratype (MMGY 74593; flotsam, weathered shell), Indonesia, West Papua, Batanta Island, valley of “Wilson” stream, 0°49.385′S, 130°48.364′E, coll. T. Kovács, R. Horváth & P. Juhász, 19 February 2017; Paratype (MMGY 74594, Fig. 2F), Indonesia, West Papua, Batanta Island, valley of Warmon stream, between the lower and upper waterfall (0°50.076′S, 130°42.900′E, and 0°50.388′S, 130°42.586′E), coll. T. Kovács, R. Horváth & P. Juhász, 20 February 2017, collected among leaf litter at the base of a large tree).

Diagnosis. A large (H: 17.1–17.9 mm, D: 8.9–9.5 mm) Bellardiella species with relatively slender ovoid, nearly smooth shell, open, deep umbilicus, rounded aperture, well-developed sinusulus, a strong parietal callus, a strongly thickened peristome, and an umbilical tube, which is attached to the peristome.

Description. Shell ecru-cream coloured (maybe due to weathering) or brownish, matt, elongate ovoid with pointed apex; the increase of the whorls is rather regular, slow at the beginning, and increasing in the last approx. 2.5 whorls; there are 6.3 whors out of which the protoconch consists of approx. 2.3 whorls, although the boundary between the protoconch and the teleoconch is hardly discernible; protoconch smooth; teleoconch with very fine growth lines; growth lines overall slightly oblique to shell axis, but near the suture they are slightly bent, becoming nearly perpendicular to the suture; sculpture of body whorl slightly stronger than that of preceding whorls; the very slightly bulging whorls are separated by a shallow suture; the last approx. quarter whorl has a slight subsutural furrow (Fig. 2I); aperture rounded with a small, narrow sinusulus, resulting in a pear-shaped outline; sinusulus continues as a short, shallow groove inside the aperture; aperture nearly parallel with shell axis, only slightly oblique from lateral view (basal part situated slightly more anteriorly than parietal part); peristome continuous with strong parietal callus and inner and outer peristome; outer peristome strongly thickened, slightly expanded and reflected only on the basal area; lower part of peristome approx. twice as thick as the upper part (observed from lateral view, Fig. 2H); outer peristome follows arc of sinusulus, rounded at parietal and basal part, and slightly angled at parietal-columellar transition; inner peristome slightly protruding in anterior direction, blunt; its margin with very slight notch just before tube, indicating that the tube might have been in contact with inner margin in an earlier stage of the development; umbilicus rather wide, deep, shows the last whorl only; umbilical tube slightly S-shaped, follows columellar part of peristome, and points backwards (away from the peristome); its inner end not visible, its outer ending slightly compressed, circular. Operculum and anatomy unknown.

Measurements. H = 17.1–17.9 mm, D = 8.9–9.5 mm, AH = 7.6–7.8 mm, AW = 6.4–6.6 mm (n = 3).

Differential diagnosis. Bellardiella kovacsi new species has the most slender shell among all of its congeners, therefore can be distinguished from them at first sight. Bellardiella martensiana has a more ovoid shell with slightly more bulging whors, much stronger parietal callus and the peristomal lip is rounded from lateral view (angled in B. kovacsi new species). Based on the formation of the aperture Bellardiella kovacsi new species is most similar to B. fabula because of the thick peristome, the strong callus and the narrow sinusulus, but differs from the new species in the much larger, slender shell, and the comparatively smaller, rounded peristome (rather rectangular in B. fabula). Bellardiella crassilabris is also similar to the new species in terms of the formation of the aperture, but that species is smaller and more corpulent than the new species, and its thick, reflected peristome almost closes the umbilicus. Bellardiella minor has a closed umbilicus, therefore differs from all other Bellardiella species.

Type locality. Indonesia, West Papua, Batanta Island, dry valley of the Kaliselatan River, 0°54.513′S, 130°35.883′E.

Distribution. The new species is known from three localities in Batanta Island (Raja Ampat Islands in West Papua province, Indonesia).

Etymology. This new species is dedicated to and named after Tibor Kovács, a prominent entomologist and friend of the authors, who collected the specimens.

Bellardiella (Bellardiella) martensiana Tapparone-Canefri, 1883

(Fig. 1D–G)

Bellardiella Martensiana Tapparone-Canefri, 1883: 266, Plate 10, Figs. 20–21.

Bellardiella Martensiana, — E. A. Smith, 1897: 287.

Bellardiella martensiana, — Benthem-Jutting, 1963: 691.

Bellardiella martensiana, — Egorov, 2013:10, Fig. 15A.

Diagnosis. A small to large (H: 11.5–16.9 mm, D: 6.6–9.6 mm) Bellardiella species with ovoid, nearly smooth shell,
Fig. 2. Shells of *Bellardiella* species. A–E, neotype of *B. crassilabris* Möllendorff, 1899 (NHMUK 1910.12.30.97); F–L, *Bellardiella* (*Bellardiella*) *kovaci* new species. F, paratype (MMGY 74594); G–L, holotype (MMGY 74592). Scale represents 5 mm. Photos: B. Páll-Gergely (A–E) and A. Varga (F–L).

open umbilicus, rounded aperture, relatively weak sinulus, a weak parietal callus, a moderately thickened peristome, and an umbilical tube, which is attached to the peristome.

**Type locality.** “Port Dorey, Nuova Guinea” (0°52′S, 134°4′E).

**Remarks.** Operculum unknown. Benthem-Jutting (1963) reports the species from the following localities: “Teminabuan” (1°26′S, 132°4′E), “limestone hills at headwater of Beraur River” (S Birdhead Peninsula, ca. 1°17′S, 131°38.5′E), and Salawati Island: Waileh district; W. side of Waijar Bay (we could not locate this point). We have not examined these specimens.

**Bellardiella (Bellardiella) minor** Hedley, 1891
(Fig. 1H–S)

*Bellardiella minor* Hedley, 1891: 102, Plate 12, Fig. 35.
*Bellardiella minor*, — Benthem Jutting, 1933: 83, Fig. 12.
*Bellardiella (Litabella) minor*, — Iredale, 1941: 62.

**Diagnosis.** A small (H: 11.7–12.3 mm, D: 7.4–7.6 mm) *Bellardiella* species with conical-ovoid, finely striated shell, closed umbilicus, slightly rectangular aperture with pointed parieto-palatal incision, a weak parietal callus, a moderately thickened peristome, and an umbilical tube, which is attached to the peristome.
Type locality. “Mission Hill, near the village of Ngauauni, upon the upper waters of the St. Joseph; I found several dead specimens in a banana garden”.

Remarks. Operculum unknown. Photos of a lectotype (AM, C.111435, specimen “b”) and two paralectotypes (C.545028, specimens “a” & “c”) were examined.

Iredale (1941) classified B. minor into its own subgenus (Litabella Iredale, 1941) based on the more pointed spire, more swollen body whorl, more circular aperture and the absence of an umbilicus. This classification was not followed by subsequent authors (Benthem-Jutting, 1963; Egorov, 2013). We also regard it as a synonym of Bellardiella, because none of the characters mentioned are sufficient for subgeneric differentiation. The umbilicus of B. crassilabris is nearly closed by the reflected peristome; therefore this character seemingly shows clinal variability across Bellardiella species.

The umbilical tube of a juvenile specimen of B. minor (Fig. 1N–S) is not closed entirely by the peristome. This indicates that the umbilical tube is initially formed as a canal similar to that of Pupinella (Fig. 1A–C), and later transformed to a tube by the peristome.

Benthem-Jutting (1963) reports the species from the following localities: “Batavia bivak, on the Mamberamo River” (Batavia falls = formerly Dabra, Mamberamo, Foja Mountains, ca. 2°48’S, 138°19’E), and “Mt. Grobar near Murara, between rivers Waim and Apauer” (which we could not find on the map).

Subgenus Szekeresia new subgenus

Type species. Rhaphaulus ceramicus von Martens, 1864.

Diagnosis. Lower end of aperture with umbilical tube, upper edge (palatal-parietal transition) with an angular tube.

Differential diagnosis. This new subgenus differs from the nominotypical subgenus by the presence of a well-developed, short angular tube of the upper edge of the peristome.


Etymology. This new subgenus is dedicated to our friend, the clausiliid specialist Miklós Szekeres.

Distribution. This subgenus is known from Salawati, Ceram and Saparua Islands so far (Maluku Island and West Papua).

Bellardiella (Szekeresia) ceramicica (von Martens, 1864)

(Fig. 3F–K)

Rhaphaulus ceramicus von Martens, 1864: 118.
Pupinella ceramicica, — von Martens, 1867: 155, Plate 4, Fig. 9.

Material examined. 17 shells (MK), 3 shells (PGB), 1 figured shell (Fig. 3F–I) + figured operculum (Fig. 3J, K) (NHMUK 20170142), Indonesia, Maluku, Island, Seram, Saleman, limestone rocks in forest, coll. M. Kesl, 31 January 2012; 1 shell (NHMUK, without inventory number), Ceram Island, probably ex coll. Martens, collection Cuming.

Diagnosis. A small (H: 8.8–10.9 mm, D: 4.3–4.8 mm) Bellardiella (Szekeresia) species with slender ovoid, very finely striated shell, wide umbilicus, rounded aperture, which is straight to the shell axis in lateral view, a strong parietal callus, a moderately thickened peristome, an umbilical tube, which is attached to the peristome, and a long angular tube, projecting well beyond peristome. Outer side of operculum multispiral with a slightly elevated lamina (Fig 3K).

Type locality. “Insel Ceram (Molukken)”.

Bellardiella (Szekeresia) lissochila Benthem-Jutting, 1963

(Fig. 3A–E)

Bellardiella lissochila Benthem-Jutting, 1963: 692, Plate 28, Fig. 14.

Diagnosis. A small (H: 8.4–9.7 mm, D: 5–5.3 mm) Bellardiella (Szekeresia) species with an ovoid, nearly smooth shell (although all available shells are weathered), wide umbilicus, slightly suborbicular aperture, which is strongly oblique to the shell axis in lateral view, a strong parietal callus, a rather thin peristome, an umbilical tube, which is attached to the peristome, and a short angular tube.

Type locality. “Island of Salawati, Waileh district”.

Remarks. Operculum unknown. The thickening behind the peristome might be characteristic of the species, or might be due to teratological shell growth.

Bellardiella (Szekeresia) saparuana new species

(Fig. 3L–P)

Type material. Holotype (NHMUK 1910.12.30.70, H = 10.6 mm, D = 5.1 mm), Saparua Ids; Paratype (NHMUK 1910.12.30.71), Saparua Ids.; Paratype (NHMUK 20170015), Saparua Ids, coll. E.R. Sykes 1954, Acc. 1825.

Diagnosis. A small (H: 9.1–10.6 mm, D: 4.8–5.2 mm) Bellardiella (Szekeresia) species with an elongate ovoid, very finely striated shell, open, but relatively narrow umbilicus, rounded aperture, which is slightly oblique to the shell axis in lateral view, a strong parietal callus, a strongly thickened peristome, an umbilical tube, which is attached to the peristome, and a short angular tube. Outer side of operculum multispiral without elevated lamina (Fig. 3L).

Description. Shell reddish brown, moderately glossy, elongate ovoid with pointed apex; the increase of the whorls is rather regular, slow at the beginning, and increasing in the last approx. 2 whorls; there are 5.5–6 whorls out of which the protoconch consists of approx. 1.5–1.75 whorls; first
whorl of protoconch smooth, later with some fine radial lines; teleoconch also with fine radial ribs; sculpture of comparable strength on entire teleoconch; upper whorls moderately bulging, last two whorls less bulging; last approx. quarter whorl has a slight subsutural furrow (Fig. 3O); aperture rounded, sinusulus absent; plane of the aperture oblique to shell axis in lateral view, with the base of the aperture protruding (Fig. 3N); peristome continuous with strong parietal callus; peristome strongly thickened and reflected; inner peristome is reflected; boundary between inner and outer peristomes visible in lateral and dorsal views; umbilical tube short, does not extend beyond peristome, its route visible as a keel around umbilicus, and its inner end visible by oblique view through the aperture; angular tube short, hardly projecting beyond peristome, its inner end visible by oblique view through the aperture; umbilicus open, rather narrow, deep, shows the last whorl only.

Operculum. Outer side of operculum could be observed, it is horny, glossy, multispiral, without elevated lamina.

Measurements. H = 9.1–10.6 mm, D = 4.8–5.2 mm, AH = 3.5–3.8 mm, AW = 3.9–4.3 mm.

Differential diagnosis. Bellardiella (Szekeresia) saparuana new species is most similar in shape to B. (S.) ceramicia, which is more slender than the new species, has a thinner peristome, a longer angular tube, the plane of the aperture parallel to the shell axis, and elevated lamina on the outer surface of the operculum.

Type locality. Saparua Isds.

Etymology. This new species is named after the island (Saparua) where it occurs.

DISCUSSION

We diagnose the genus Bellardiella Tapparone-Canefri, 1883 on the basis of the umbilical tube, which lacks a surface suture or furrow on the side of the peristome (present in Pupinella species). Examination of all Bellardiella and most Pupinella species showed that two species (B. lissochila and P. ceramicia) possess an angular tube in the parieto-palatal angle of the aperture in addition to the umbilical tube, and the new subgenus Szekeresia is proposed based on this character. Bellardiella (Bellardiella) kovacsi new species is described here as Bellardiella (Szekeresia) saparuana new species.

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LITERATURE CITED


Benthem Jutting WSS van (1933) Non marine Mollusca from Dutch North New Guinea, including an annotated list of the species of Papuina. Nova Guinea (Zoology), 17: 71–150.


