
Short Notes

**Systematic Relocation of *Chrystella kajiyamai* Habe, 1961
to the Eulimid Genus *Bacula* (Gastropoda: Vanikoroidea)**Tsuyoshi Takano^{1*}, Shouji Tsuzuki² and Yasunori Kano³¹Meguro Parasitological Museum, 4-1-1 Shimomeguro, Meguro, Tokyo 153-0064, Japan; *ttakano@kiseichu.org²53-17 Oyumi, Chiba, Chiba 260-0813, Japan³Atmosphere and Ocean Research Institute, The University of Tokyo,
5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8564, Japan

The genus *Chrystella* Laseron, 1956 is a group of little-known gastropods in the family Pickworthiidae (superfamily Cerithioidea; see Takano & Kano, 2014; Bouchet *et al.*, 2017). These gastropods have been reported only as empty shells from intertidal to bathyal waters in tropical and subtropical regions worldwide (Le Renard & Bouchet, 2003; Santos & França, 2008; Moolenbeek & Mussai, 2010). The type species of the genus, *C. islandica* Laseron, 1956, was described from an incomplete shell from Christmas Island of Australia (Laseron, 1956).

Eight extant species are currently placed in *Chrystella* according to MolluscaBase (2020a). Their shells are characterized by 1) a small size, with a height of *ca.* 2 mm, 2) a high conical shape, 3) lack of coloration, 4) strong spiral ribs on teleoconch whorls, 5) a developed keel at the periphery, and 6) a more or less circular aperture with a thickened lip (*e.g.*, Laseron, 1956; Bouchet & Le Renard, 1998; Santos & França, 2008). The protoconch of the type species, *C. islandica*, has never been reported, while *C. finckhi* (Hedley, 1899) with a similar teleoconch bears a distinctly sculptured protoconch with convex whorls (Hedley, 1899; Bouchet & Le Renard, 1998). These teleoconch and protoconch characters combined justify the current assignment of the genus to Pickworthiidae (Bouchet & Le Renard, 1998; Le Renard & Bouchet, 2003). Pickworthiid snails are known to inhabit submarine caves, crevices and similar cryptic voids in shallow subtidal waters (Kase & Hayami, 1992; Kase, 1998; Takano & Kano, 2014).

Some species of *Chrystella* also resemble *Pyramidelloides miranda* (A. Adams, 1861), the type species of *Pyramidelloides* Nevill, 1884 in the

family Eulimidae (superfamily Vanikoroidea), in sharing a small, colorless high-conical teleoconch with strong spiral ribs (Warén, 1983; see *e.g.*, Hedley, 1899: fig. 72; Laseron, 1956: fig. 111). Eulimids are exclusive parasites of echinoderms, with *Pyramidelloides* specializing in brittle stars (Warén, 1983, 1984; Takano & Kano, 2014). Their similar teleoconch morphologies led Warén (1983) to suggest a close relationship between *Chrystella* and *Pyramidelloides* and Ponder (1985) to regard the former as a subgenus of the latter in the family Eulimidae. The protoconch morphology, however, dismisses such a generic or familial assignment. Protoconchs in the Eulimidae, including those of *Pyramidelloides*, are smooth conical or pupiform without having a strong surface sculpture or deep sutures (*e.g.*, Warén, 1983: figs 66–68).

“*Crystella*” *kajiyamai* Habe, 1961 (= *Chrystella kajiyamai* Habe, 1961; see Nomenclature below) is a species for which information on the protoconch has been lacking to date. Its holotype, from Kakeroma Island in southwestern Japan, is an empty shell of 2.2 mm height with a broken apex (Habe, 1961: text-fig. 3; Higo *et al.*, 2001: fig. G1948). The original assignment of the species to *Chrystella* was thus made on the basis of teleoconch characteristics including strong spiral ribs (Habe, 1961: text-fig. 3). This generic position has been maintained by subsequent authors (*e.g.*, Warén, 1983; Higo & Goto, 1993; MolluscaBase, 2020a), whereas Le Renard & Bouchet (2003) did not include the species in their checklist of pickworthiid taxa with no comment. Japanese authors have placed the species (and the genus *Chrystella*) either in Eulimidae (Higo *et al.*, 1999, 2001; Hori, 2000) or

in Pickworthiidae (Hasegawa, 2017), apparently by following Ponder (1985) or Bouchet & Le Renard (1998), respectively. We herein propose placing *C. kajiyamai* in the eulimid genus *Bacula* H. Adams & A. Adams, 1863 based on a newly collected shell with an intact protoconch. We also conduct a brief taxonomic review of the species of *Bacula* and provide circumstantial evidence that they are ectoparasites on ophiuroid echinoderms.

Systematics

Superfamily **Vanikoroidea** Gray, 1840

Family **Eulimidae** Philippi, 1853

Genus *Bacula* H. Adams & A. Adams, 1863

Bacula H. Adams & A. Adams, 1863: 18. Type species: *Bacula striolata* H. Adams & A. Adams, 1863: 18, 19, by monotypy.

Subeulima Soubervie, 1875: 296. Type species: *Subeulima lamberti* Soubervie, 1875: 296 (subjective junior synonym of *Bacula striolata*), by monotypy.

Remarks: This genus comprises three described species: *B. striolata* (= *Subeulima lamberti* Soubervie, 1875), *B. kajiyamai* (Habe, 1961) and *B. morisyuichiroi* (Habe, 1968). See below for details.

Bacula kajiyamai (Habe, 1961) n. comb.

(Fig. 1)

Crystella kajiyamai [sic; = *Chrystella*]: Habe, 1961: 271, 273, text-fig. 3; Ekawa, 1985: 8, pl. 2, fig. 23; Ekawa, 1993: 96, fig. 91; Higo & Goto, 1993: 86; Héros *et al.*, 2007: 219.

Chrystella kajiyamai — Warén, 1983: 293; Hori, 2000: 363, pl. 180, fig. 81; Hasegawa, 2017: 800, pl. 67, fig. 7; Kitagawa, 2017: fig. 047-06.

Pyramidelloides (Chrystella) kajiyamai — Higo *et al.*, 1999: 184.

Pyramidelloides kajiyamai — Higo *et al.*, 2001: 56, fig. G1948.

Nomenclature: The generic name “*Crystella*” in Habe (1961) is, given his reference to the type species of *Chrystella* (as “*Crystella islandica* Laseron”), most certainly a *lapsus calami* and an “incorrect subsequent spelling” (see International

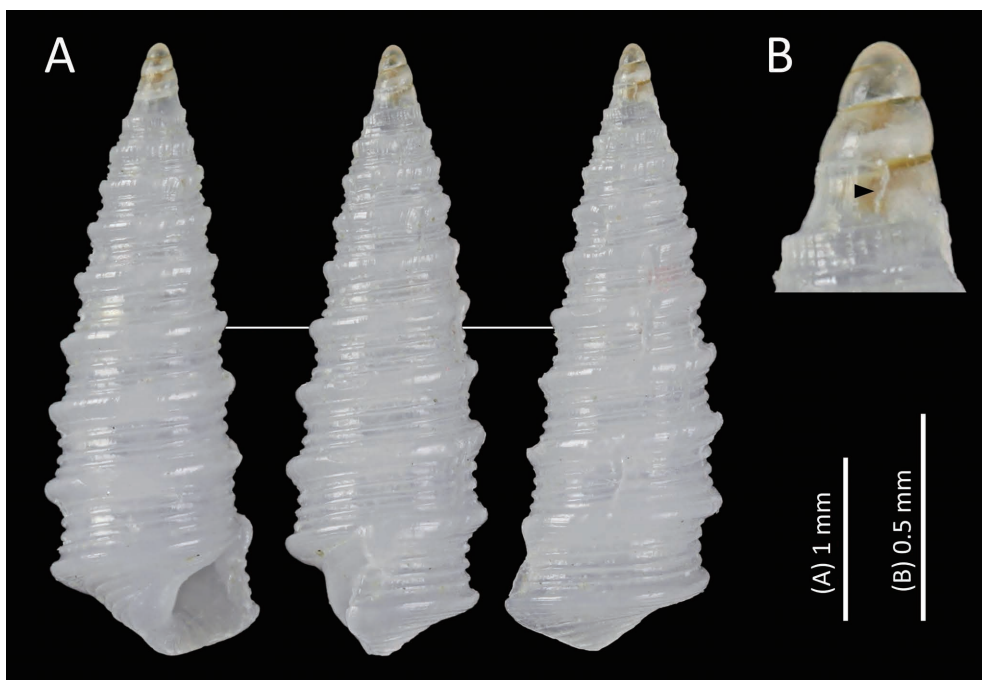


Fig. 1. *Bacula kajiyamai* (Habe, 1961) n. comb. from Zamami, Okinawa Islands, Japan, NSMT-Mo 79123. **A.** Apertural, lateral and abapertural views of shell. **B.** Protoconch. Arrowhead indicates protoconch–teleoconch boundary.

Code of Zoological Nomenclature, ICZN, Article 33.3). The species name *kajiyamai* is deemed to have been proposed in combination with the correct spelling of the generic name *Chrystella* (ICZN, Article 11.9.3.2).

Type specimen: Holotype NSMT-Mo 39838 in the National Museum of Nature and Science, Tokyo (see Habe, 1961: text-fig. 3; Higo *et al.*, 2001: 56, fig. G1948) from Kakeroma Island, Amami Islands, Kagoshima Prefecture, Japan.

Material examined: NSMT-Mo 79123, an empty shell sorted by one of the authors (ST) from shallow subtidal sediment off Zamami Island, Kerama, Okinawa Prefecture, Japan, 26°15'N, 127°18'E, at a depth of 3 m, July 1, 2016.

Distribution: Japan: Wakayama, Honshu Island (Higo *et al.*, 1999); islands of Amami and Okinawa (see above). New Caledonia, Southwest Pacific: Grand Récif de Koumac, Expedition MONTROUZIER, Stn. 1316, 20°40'S, 164°11'E, 12–55 m deep, October 1993 (SMNH-50835 in Swedish Museum of Natural History, photograph courtesy of A. Warén; Héros *et al.*, 2007).

Redescription: Shell slender, straight, conical, 3.8 mm high and 1.3 mm wide, solid (Fig. 1A). Teleoconch colorless with 9.2 whorls. Each whorl bears up to six spiral ribs, which are more numerous on later whorls; uppermost rib strongest, knobby on third to sixth whorls and smooth on later whorls, largely overlapping peripheral keel of preceding whorl. First two whorls also with fine axial and spiral threads, forming grid pattern. Incremental lines or growth pause scars distinct, irregularly spaced, situated at 0.8, 1.4, 2.2, 2.7, 3.4, 4.1, 5.0, 6.0, 6.9 and 8.0 whorls. Body whorl occupies 30% of shell height; periphery forms strong rib-like keel with four fine spiral cords on undersurface; base slightly convex with six spiral ribs. Aperture small, oblong-ovate; peristome interrupted by posterior notch; outer lip curved in lateral view with its most protruding part at position of peripheral keel; columellar callus very thick. Umbilicus closed. Protoconch with *ca.* 3 slightly convex whorls, pupiform, smooth, glassy, translucent with brown tinge, slightly tilted from coiling axis of teleoconch; exposed part 420 µm high and 280 µm wide; apertural outer lip or demarcation line with teleoconch distinct, opisthocline (Fig. 1B).

Remarks: The present species has a smooth, pupiform protoconch with a brown tinge (see Fig. 1B; the same is seen in the photograph of SMNH-50835 from New Caledonia). Very similar protoconchs have been reported for such

eulimid genera as *Bacula*, *Eulima* Risso, 1826, *Hemiliostraca* Pilsbry, 1917 and *Pyramidelloides* (e.g., Habe, 1968; Warén, 1980, 1983). These contrast with the markedly sculptured protoconch of the pickworthiid genus *Chrystella* (see Bouchet & Le Renard, 1998: fig. 15.101I; Santos & França, 2008: fig. 2; Moolenbeek & Mussai, 2010: fig. 3). The presence of the incremental lines on the teleoconch further corroborates the affinity of *C. kajiyamai* to Eulimidae (see below).

We herein transfer *C. kajiyamai* to the eulimid genus *Bacula* H. Adams & A. Adams, 1863, based on its conchological resemblance to the type species *B. striolata* H. Adams & A. Adams, 1863. Somewhat confusingly, however, *B. kajiyamai* does not look very similar to the “holotype” (= probable syntype) of *B. striolata* from “China Sea” (NHMUK 1878.1.28.68 in the Natural History Museum, London). This “holotype” is a 7.7-mm high shell with many spirals but without a carinated periphery (Warén, 1984: fig. 48). It represents, however, an immature condition of a large species, as exemplified by the holotype of *Subeulima lamberti* Soubervie, 1875 from New Caledonia, southwest Pacific. The holotype shell of the latter nominal taxon has a height of 23 mm and a strongly carinated periphery, whereas its upper whorls are nearly identical to the “holotype” of *B. striolata* (Warén, 1984: 74, figs 203, 204). The genus *Subeulima* and *S. lamberti* as its type species were therefore synonymized under *Bacula* and *B. striolata*, respectively, in the seminal generic revision of the family Eulimidae by Warén (1984: 32).

Bacula kajiyamai shows an even stronger resemblance to *B. morisyuichiroi* (Habe, 1968), the only other known species of the genus. The latter species was originally described from Amami-Oshima Island, southwestern Japan and later reported from elsewhere in the western Pacific (e.g., Savazzi & Sasaki, 2004: fig. 1E as *B. striolata*; Sasaki, 2008: fig. 10H; Tröndlé & Boutet, 2009; Hori & Matsuda, 2017: pl. 106, fig. 11). Although *B. morisyuichiroi* at maturity develops the peripheral keel into a much stronger, wing-like structure and the depression of the columellar base into a deep umbilicus (Habe, 1968: text-fig. 1), the two species look very similar in the comparison of the first seven or eight teleoconch whorls. The smooth, pupiform protoconch with a brown tinge also exists in *B. morisyuichiroi* (TT, personal observation). An alternative position of *B. morisyuichiroi* in the heterobranch family Pyramidellidae has been

suggested based on the examination of the holotype (Warén, 1984: 32), but the holotype (NSMT-Mo 49863) bears the incremental lines on the teleoconch whorls that confirm the eulimid affinity of the species (Habe, 1968: 58; see also Higo *et al.*, 2001: 59, fig. G2083).

A marked difference between the present species and the other two congeners is a straight (*B. kajiyamai*) or a right-curved (*B. striolata* and *B. morisyuichiroi*) spire of the teleoconch. The shells of the latter two species have incremental scars that are perfectly periodical and synchronized between whorls, *ca.* 1.1 whorls from each other, aligned in a single oblique line on the spire (Warén, 1984: fig. 204; Savazzi & Sasaki, 2004: fig. 1E; Sasaki, 2008: fig. 10H). These incremental scars are associated with a growth hiatus, subsequent thickening of the aperture and slight changes to the axis of coiling, hence the right-curved spire (see Savazzi & Sasaki, 2004: 89; Webster & Vermeij, 2017: 739). On the other hand, incremental scars appear irregularly in *B. kajiyamai*, with intervals of 0.5–1.1 whorls, resulting in the straight spire of the species. Some authors had considered the presence or absence of the curvature an important enough criterion for the generic separation of Eulimidae (see Souza & Pimenta, 2019 for review). However, the spacing of the incremental lines and shape of the spire may vary among closely related species (*e.g.*, Hori & Matsuda, 2017: pls. 98, 99 for *Melanella* spp.) and even among intraspecific specimens (Warén, 1984: 18), potentially reflecting their adaptive responses to varying selective pressures in a short evolutionary timescale (see Savazzi & Sasaki, 2004; Webster & Vermeij, 2017).

There is no information available to date on the parasitic ecology or echinoderm host for the genus *Bacula*. Previous studies have shown, however, that eulimid species in a single genus and closely related genera exploit hosts of the same echinoderm class (Warén 1984; Takano & Kano, 2014; Takano *et al.*, 2018). It is noteworthy that the species of *Bacula* share the same protoconch characters (pupiform, smooth and brownish) with such ophiuroid-parasite groups as *Eulima*, *Hemiliostraca* and *Pyramidelloides* (see above). The shells of *Bacula* particularly resemble those of *Pyramidelloides* in sharing a strongly sculptured teleoconch, which is rather rare in the entire Eulimidae (Warén, 1984; Savazzi & Sasaki, 2004). The uppermost spiral rib of *B. kajiyamai* is knobby in the early teleoconch whorls (Fig. 1A) and this might even

be homologous with the also knobby uppermost spiral of *Pyramidelloides miranda*, the type of the genus (Warén, 1983: figs 57–59). These lines of circumstantial evidence suggest an ectoparasitic mode of life on brittle stars for all species of *Bacula*.

As a side note, the genus *Teretianax* Iredale, 1918 includes eulimid species with two strong spiral keels on the teleoconch and thus approaches *Pyramidelloides* and *Bacula* in appearance (see Warén, 1984: fig. 205; Ponder, 1985: fig. 150C, D; Faber, 1990: figs 10–12). Some consider *Teretianax* a subgenus or a junior synonym of *Pyramidelloides* apparently with this resemblance in mind (Ponder, 1985; Faber, 1990; MolluscaBase, 2020b). However, the type [*T. suteri* (W. R. B. Oliver, 1915)] and other species of *Teretianax* bear a colorless protoconch with only two whorls (*e.g.*, Warén, 1983: figs 78, 79; Ponder, 1985: fig. 150E; Hori & Matsuda, 2017: pl. 107, fig. 2), potentially suggesting a distant relationship to *Pyramidelloides* or *Bacula*. *Teretianax* and *Pyramidelloides* seem to differ also in the presence or absence of the radula. A probable lack of a radula and a snout has been noted for *T. pagoda* Powell, 1926 (Warén, 1983; Ponder, 1985), a species conchologically similar to the type *T. suteri* (see Ponder, 1967: pl. 11, fig. 1). On the other hand, a ptenoglossate radula is present in all species of *Pyramidelloides*, *Eulima* and *Hemiliostraca* examined so far (Warén, 1983, 1984; no information available for *Bacula*). Given that the radula might have been lost only once in the evolutionary history of the Eulimidae (Takano & Kano, 2014), it seems safe to regard *Teretianax* as a valid, independent genus with an unknown host preference.

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クリンツボの所属変更 (ハナゴウナ科: オドリオネジニナ属)

高野剛史・都築章二・狩野泰則

要 約

クリンツボは、鹿児島県加計呂麻島の打上げ死殻をタイプ標本とする微小な巻貝で、後成殻の螺肋および周縁角の特徴から *Chrystella* 属の新種 *C. kajiyamai* Habe, 1961 (リソツボ科) として記載された。同属は現在ソビエツボ科 (オニソツガイ上科) に含まれ、世界で8種が知られるが、いずれも生貝の報告がなく内部形態の情報を欠く。クリンツボも破損した死殻として報じられるのみであった。

今回、沖縄県座間味島の潮下帯から本種の新鮮な死殻を採集し、その原殻が細長い蛹型、約3階、殻表平滑で薄い褐色を帯びていることを初めて明らかにした。これらの特徴は *Chrystella* の諸種を含むソビエツボ科貝類のものと明らかに異なり、*Bacula* オドリオネジニナ属、*Pyramidelloides* レイシツボ属、*Hemiliostraca* クテンハナゴウナ属、*Eulima* ハナゴウナ属の諸種を含む一部のハナゴウナ科貝類に近似する。本種の後成殻にみられる外唇縁痕もハナゴウナ科に広く共有される特徴であり、螺肋および周縁角の形状とあわせて、本種をオドリオネジニナ属に所属変更した。なお、「オドリオネジニナ属」は元来 *Subeulima* Soubervie, 1875 に対する和名であるが、*Bacula* H. Adams & A. Adams, 1863 がその古参シノニムとされている。

オドリオネジニナ属は、タイプ種 *B. striolata* (= *Subeulima lamberti*) オドリオネジニナ、*B. morisyuichiroi* クリンオドリオネジニナ、*Bacula kajiyamai* クリンツボの3種からなる。前2種では外唇縁痕が約1.1巻き毎に刻まれ、螺塔は強く右に曲がるが、クリンツボの外唇縁痕は不規則に生じ螺塔はまっすぐである (なお、これらの特徴はハナゴウナ科の属内で比較的变化しやすい)。いずれの種についても寄生生態に関する知見はないが、原殻・後成殻の類似から、上記レイシツボ属、クテンハナゴウナ属、ハナゴウナ属の諸種と同様、クモヒトデ類を宿主とする外部寄生者である可能性が高い。