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Three new records of Korean cyclostomatous bryozoans

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Three cyclostomatous bryozoans from Korea belonging to the genera *Bicrisia* and *Nevianipora* are described here for the first time. The specimens collected from six localities of the South Sea and Jejudo Island during the period from 1981 to 2020 were observed. The three cyclostomatous bryozoans are *Nevianipora pulcherrimoidea* (Liu in Liu, Yin & Ma, 2001), *N. rugatata* (Liu in Liu, Yin & Ma, 2001), and *Bicrisia edwardsiana* (d'Orbigny, 1841). *Nevianipora pulcherrimoidea* and *N. rugatata* were previously found only from the South China Sea, whereas *Bicrisia edwardsiana* is widespread. As a result of this study, the Korean cyclostomatous bryozoans have increased to 20 species, 10 genera, and five families. Redescriptions and illustrations by scanning electron microscopy of the three species new to the Korean fauna are provided herein.

Keywords: *Bicrisia edwardsiana*, cyclostomatous bryozoans, Korea, *Nevianipora pulcherrimoidea*, *Nevianipora rugatata*

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Introduction

The order Cyclostomatida established by Busk (1852) composes a small part of marine Bryozoa, as approximately 540 of an estimated total of 6,000 marine bryozoan species belongs to this order (Bock and Gordon, 2013; Cook *et al*., 2018). Similarly, while previously only five species (*Tubulipora pulchra*, *Crisia eburneodenticulata*, *Disporella novaehollandiae*, *Patinella radiata*, and *Hornera jeongsangi*) were reported in the Korean fauna (Seo, 2005; Zágoršek *et al*., 2017), it has increased to 17 species due to continuous taxonomic studies with scanning electron microscopy. They are as follows: *Tubulipora similis*, *T. perforata*, *T. pulchra*, *Exidmonea intercalata*, *Qingdaoella conaria*, *Nevianipora pulcherrima*, *Bicrisia erecta*, *Crisia cuneata*, *C. elongata*, *C. jejuensis*, *C. spissus*, *Filicrisia cygnus*, *Hornera jeongsangi*, *Disporella novaehollandiae*, *D. pristis*, *D. wanganuiensis*, and *Patinella radiata*.

For years, Korean researchers have conducted taxonomic studies mainly on the families such as Crisiidae, Tubuliporidae, and Lichenoporidae (genus *Disporella*). This study aims to increase the diversity of Korean cyclostomatous bryozoans, and focused especially on the colonies with erect forms.

Materials and Methods

All cyclostomatous bryozoans showing the erect colonial form were found in the collection (MBRBK) of Woosuk University in Jincheon. The specimens were collected from six localities of the South Sea and Jejudo Island, during the period from 1981 to 2020 (Fig. 1) and have been preserved in 95% ethanol.

For identification, the external features of zooid were observed under stereomicroscope (SZX16; Olympus, Japan) and parts of specimens were bleached with hot aqueous sodium hypochlorite, washed, and gold coated (MCM-100; SEC, Korea), prior to examination using a scanning electron microscope (SNE-3200M Mini-SEM; SEC, Korea) at 15 kV accelerating voltage. Measurements were made on SEM images of zooids using Image J.

Results and Discussion

Phylum Bryozoa Ehrenberg, 1831
Class Stenolaemata Borg, 1926
Order Cyclostomatida Busk, 1852
Family Diaperoeciidae Canu, 1918
Genus *Nevianipora* Borg, 1944

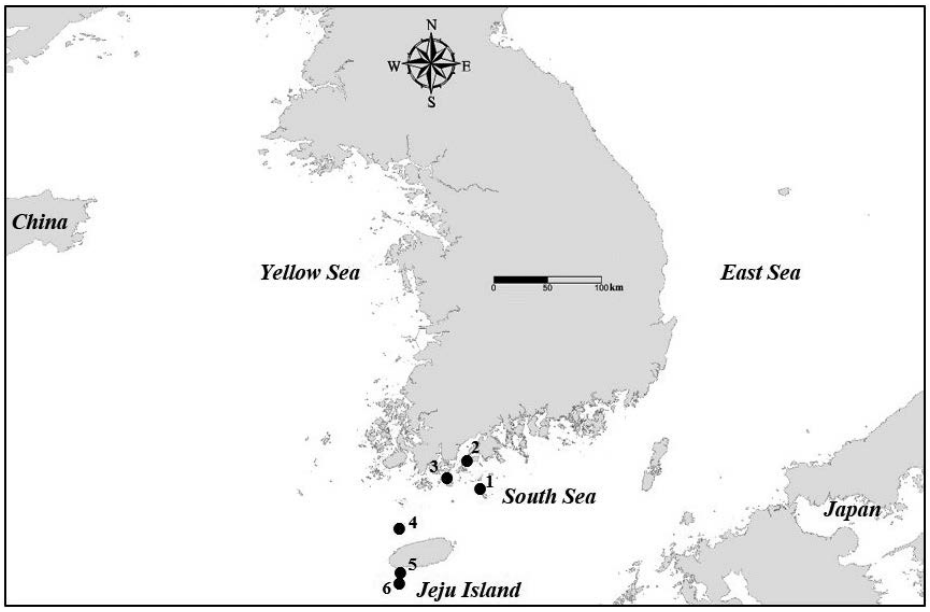

Fig. 1. A map of the collection localities in this study. 1, Geomundo Island; 2, Gyedo Island; 3, Chenogsando Island; 4, Sangchujado Island; 5, Gapado Island; 6, Marado Island.

1. *Nevianipora pulcherrimoidea* (Liu in Liu, Yin & Ma, 2001) (Fig. 2)

Tubulipora pulcherrimoidea Liu in Liu, Yin & Ma, 2001: 790.

Nevianopora pulcherrimoidea: Liu, Liu & Zágoršek, 2019: 490.

Material examined. Korea: Jeollanam-do: Goheung-gun, Gyedo Island, 24 June 2008.

Substratum. Stone.

Description. Colony erect, branching (Fig. 2A). Branch dichotomous, 664–773 μm wide, up to 1,745–2,069 μm wide at bifurcation. Cross bars consisted of numerous kenozooids connecting between branches, 279–334 μm wide, sometimes present (Fig. 2A). Autozooids tubular with external circular wrinkles, elevated, arranged in indistinct rows, directed slightly outwards and upwards, 179–339 μm long × 110–130 μm wide. Aperture circular, approximately 91–103 μm in diameter (Fig. 2A, B). Gonozooid extended, elongate oblong, flattened or convex (Fig. 2A, C). Ooeciostome oval, elongate and large, transverse slit-like, frontally directed or curved distally or proximally, edges extended, isolate, never adnate to autozooid (Fig. 2A, C, D). Dorsal surface with pseudopores and constriction lines (Fig. 2E). Frontal surface of both autozooids and gonozooids covered by pseudopores. All pseudopores small, irregular shaped, sunken (Fig. 2F).

Remarks. Liu in Liu *et al*. (2001) described *N. pulcherrimoidea*'s ooestomes as situated at the distal end of the gonozooid, but the Korean specimen has ooestomes located at any position on the gonozooid as well as at the distal end. Excluding this, the present material accords well with Liu in Liu *et al*.'s (2001) species from the South China Sea. Furthermore, Liu *et al*. (2019), in which *Tubulipora pulcherrimoidea* was transferred into the genus *Nevianopora*, described only the shape without mentioning the location of the ooeciostomes. Considering that *N. pulcherrimoidea* was found only in the South China Sea and the South Sea, this species seems to prefer warm waters.

Distribution. Korea (South Sea) and South China Sea.

2. *Nevianipora rugatata* (Liu in Liu, Yin & Ma, 2001) (Fig. 3)

Tubulipora rugatata Liu in Liu, Yin & Ma, 2001: 790.

Nevianipora rugatata: Liu, Liu & Zágoršek, 2019: 488.

Material examined. Korea: Jeju-do: Seogwipo-si, Marado Island, 4 July 2015, depth 15–30 m.

Substratum. Unknown.

Description. Colony erect, branching. Branches dichotomous or trichotomous, 985–1,094 μm wide, up to 1,778–2,090 μm wide at bifurcation. Cross bar consisted of numerous kenozooids connecting between branches, sometimes present (Fig. 3A). Autozooids tubular, elevated, arranged in indistinct of 5–8, concentric striated, 138–445 μm long × 86–113 μm wide, directed slightly outwards and upwards, two or three autozooids in a row at both lateral sides of branch (Fig. 3A, B). Apertures circular or oval, approximately 70–130 μm in diameter (Fig. 3C). Gonozooid extended, flattened or slightly convex. Ooe-

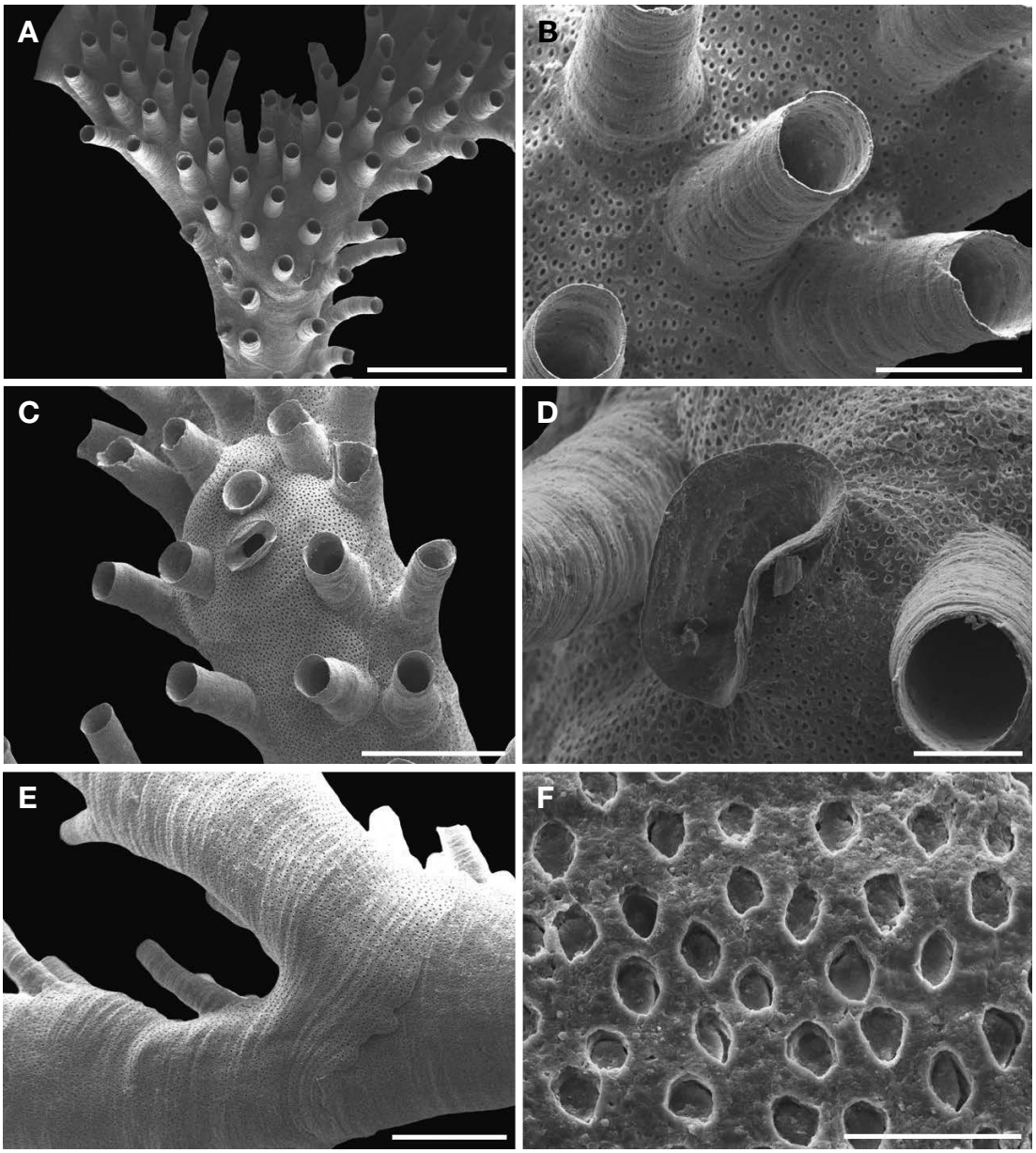

Fig. 2. *Nevianipora pulcherrimoidea* Liu in Liu, Yin & Ma, 2001. A, General view showing the arrangement of autozooids; B, Detailed autozooids; C, Detailed ooeciostome on gonozooid; D, Detailed ooeciostome; E, Dorsal surface; F, Detailed pseudopores. Scale bars: A = 1 mm; B = 200 μm; C, E = 500 μm; D = 100 μm; F = 30 μm.

ciostome circular, urceolate, located close to autozooid, but separated, usually frontally directed (Fig. 3B–D). Frontal surface covered by pseudopores (Fig. 3C, D).

Remarks. Korean specimens accord well with Chinese ones in terms of the arrangement and size of autozooids, position and shape of ooeciostome, and shape of gonozooid (Liu in Liu *et al*., 2001; Liu *et al*., 2019).

Two species, *N. pulcherrimoidea* and *N. rugatata* found in this study show the obvious difference in the shape of the ooeciostome. The former has oval, elongate and transverse slit-like ooeciostome, while the latter has rounded and urceolate one. In terms of occurrence of *N. rugatata*, this species seems to inhabit subtropical to tropical waters.

With the addition of two species in this study, three species of 15 species belonging to the genus *Nevianipora* worldwide are found from Korean waters. All of three *Nevianipora* species from Korean waters are only distributed in the South China Sea (http://www.bryozoan.net/cyclostomata/diaperoeciidae/nevianipora.html - 22 July 2023).

Distribution. Korea (Jejudo Island) and South China Sea.

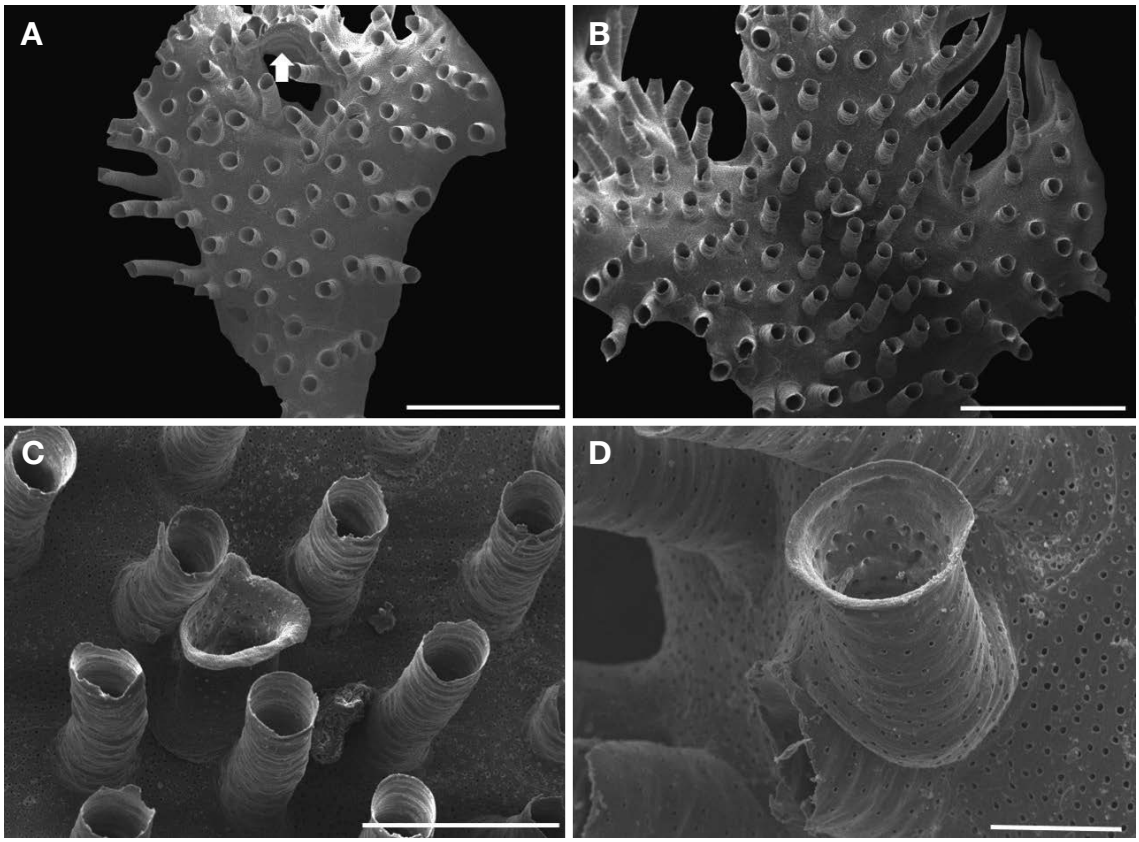

Fig. 3. *Nevianipora rugatata* Liu in Liu, Yin & Ma, 2001. A, B, General view showing arrangement of autozooids and cross bar between branches (arrow); C, Ooeciostome, autozooids and pores in B; D, Detailed ooeciostome. Scale bars: A, B = 1 mm; C = 300 μm; D = 100 μm.

Family Crisiidae Johnston, 1838
Genus *Bicrisia* d'Orbigny, 1853

3. *Bicrisia edwardsiana* (d'Orbigny, 1841) (Fig. 4)

Crisidia edwardsiana d'Orbigny, 1841: 8.
Bicrisia edwardsiana: Borg, 1926: 351; Osburn, 1953: 676; Gordon, 2016: 605; Branch and Hayward, 2007: 5.

Material examined. Korea: Jeollanam-do: Wando-gun, Chenogsando Island, 25 July 1981, depth 15 m; Jeju-do: Seogwipo-si, Gapado Island, 16 June 1985; Sangchujado Island, 22 July 1990; Jeollanam-do: Yeosu-si, Geomundo Island, 16 June 2020, depth 20 m.
Substratum. Other bryozoan and seaweed.
Description. Colony erect, articulated branching, small, delicate, slender, curved forward (Fig. 4A, D). Branch ramified at first zooid. Internodes narrowing proximally, beginning with one zooid, two to four zooids, only one internode of six; sterile internodes short, 443–743 (588 ± 11) μm long, alternately situated two to four zooids; fertile internode comprising three zooids, 493–564 (528 ± 49) μm long (Fig. 4A, B). Zooids forward, 76–186 (117 ± 4) μm long × 67–76 (70 ± 4) μm wide, slender, elongate peristome, slit-shaped pseudopores, with numerous jointed spines arising at base side of peristome (Fig. 4B, C). Aperture circular, 38–61 (48 ± 8) μm diameter. Gonozooid placed at second zooid, erect, oval, slit-shaped pseudopores, longer than wide, 336–365 (351 ± 20) μm long × 199–248 (223 ± 33) μm wide (Fig. 4A, C). Ooeciostome oval, short, bent, located at near distal end on dorsal, facing forward (Fig. 4C). Dorsal surface with slit-shaped pseudopores and transverse lines, constricted, curved inward (Fig. 4D).
Remarks. Korean *B. edwardsiana* is characterized by the gonozooid situated in the second zooid, always ramified from the first zooid, the forward bent ooeciostome near the distal end on the dorsal side of the gonozooid, and the jointed spines arising at base of peristome. The locations of the gonozooid and ooeciostome are important characteristics in identifying the species of the genus. In Osburn' description, a characteristic feature of *B. edwardsiana* is "the position of the ooeciostome on the dorsal side near the distal end" (Osburn, 1953), which agrees well with our materials.

All of six species of *Bicrisia* have been recognized: *B. abyssicola* Kluge, 1962; *B. biciliata* (MacGillivray, 1869);

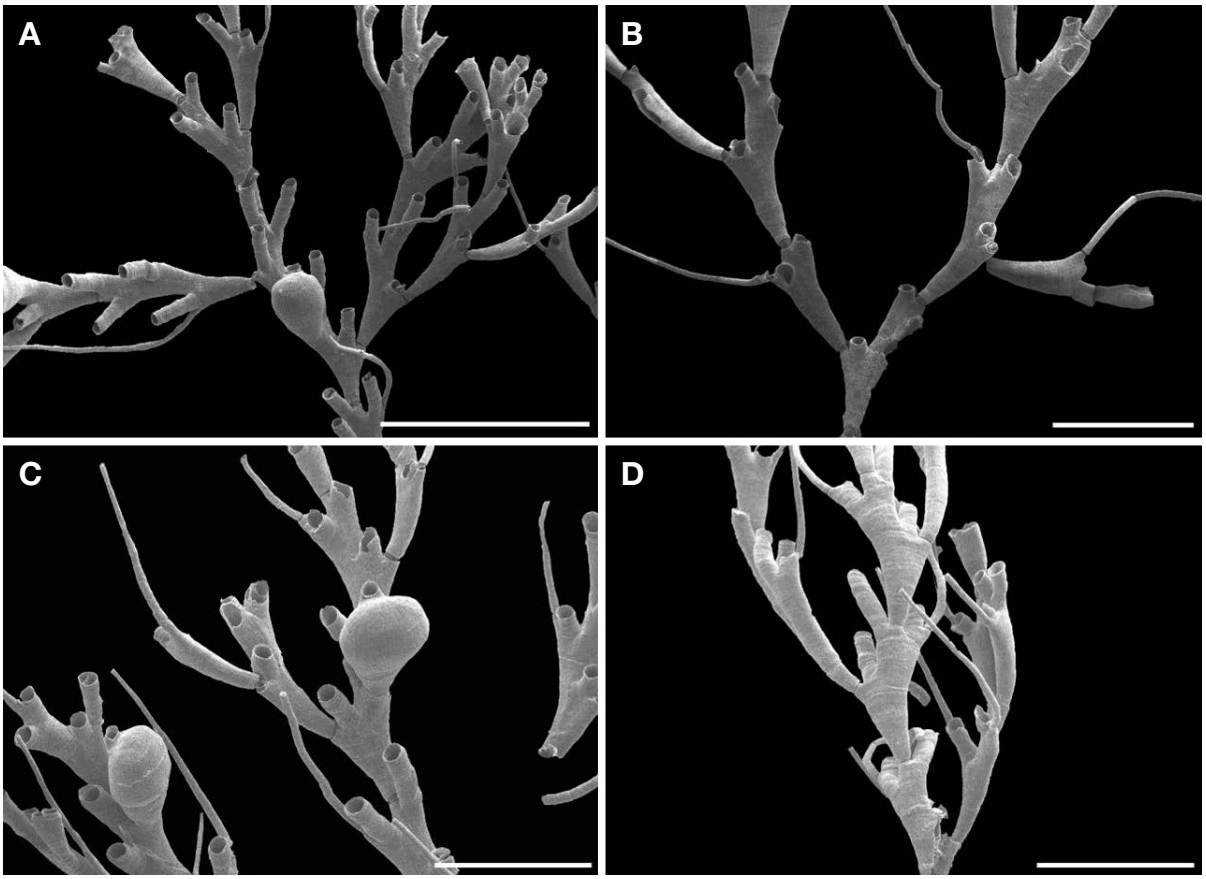

Fig. 4. *Bicrisia edwardsiana* (d'Orbigny, 1841). A, Colony showing autozooidal arrangement with gonozooid; B, Internodes and jointed spines; C, Gonozooids and ooeciostomes; D, Dorsal surface. Scale bars: A = 1 mm; B–D = 500 μm.

B. edwardsiana (d'Orbigny, 1841); *B. erecta* Mawatari & Mawatari, 1973; *B. gibraltarensis* Harmelin, 1990; and *B. robertsonae* Soule, Soule & Chaney, 1995 (Chae *et al*., 2018; www.bryozoan.net/cyclostomata/crisiidae/bicrisia.html - 21 July 2023). *Bicrisia edwardsiana* is close to *B. erecta* from Japan in the shape and location of the gonozooid is distinguished from *B. erecta* by the forward facing ooeciostome on gonozooid and by fertile internodes comprised of three zooids. Furthermore, *B. edwardsiana* has characteristics in common with *B. biciliata* from Australia in the shape of the gonozooid and the location and shape of the ooeciostome. The colony of both species always branches from the first zooid. *B. biciliata* differs in the location of the gonozooid, which replaces the third zooid.

The materials of Chenogsando Island and Sangchujado Island lacks gonozooids, but the shape of colonies and autozoid, the number of autozooid per internode, and the position of spine us to consider it *B. edwardsiana*.

Distribution. Korea (South Sea and Jujudo Island) and widespread.

Acknowledgements

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