

Taxonomic study of freshwater bryozoans from Jeju Island, Korea

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This study aims to investigate the freshwater bryozoans of Jeju Island off the Korean Peninsula for the first time. To date, twelve species has been reported from the mainland of Korea. However, no study of freshwater bryozoans has ever been conducted on Korean islands including Jeju Island, which is the largest island in Korea. Five species in three genera *Fredericella*, *Plumatella* and *Stephanella*, from Jeju Island are described. Of which, three species, *Fredericella indica*, *Plumatella mukaii* and *P. rugosa*, are new records of Korean bryozoan fauna. As a result of this study, the number of identified Korean freshwater bryozoans is now 15 species, including 12 phylactolaemates and three gymnolaemates.

Keywords: freshwater bryozoans, *Fredericella*, Jeju Island, *Plumatella*, *Stephanella*

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INTRODUCTION

The phylum Bryozoa consists of three classes, the Phylactolaemata, members of which are found in freshwater, and the Stenolaemata and Gymnolaemata, which are found mostly in marine habitat. Bryozoans comprise more than 8,000 species worldwide, only approximately 90 of which are found in freshwater. The first taxonomic study of Korean freshwater bryozoans was of ten species by Toriumi (1941b), and followed by a study of an alien species, *Pectinatella magnifica* (Leidy, 1851), by Seo (1998). Since then, Jung *et al.* (2017) reported two species, *Hislopiopsis prolifica* Hirose and Mawatari, 2011 and *Victorella pavidula* Saville Kent, 1870, in the class Gymnolaemata from the Han River, Geum River and leptic water bodies in Gangwon Province in mainland Korea. Twelve species, including three gymnolaemate bryozoans have been reported from fresh-brackish water in mainland Korea to date. However, no freshwater bryozoan has ever been reported on any Korean island, including Jeju Island. Jeju Island, which formed about 1.2 million years ago, is the largest volcanic Island in Korea. The aim of this study was to investigate freshwater bryozoans of Jeju Island.

MATERIALS AND METHODS

The materials examined in this study were collected

from nine natural and artificial reservoirs and ponds on Jeju Island from 2015 to 2016 (Fig. 1). Colonies were collected from the substrata, such as water caltrop and wood. Floatoblasts were collected by examining floating debris that had accumulated downwind or downstream at each collecting locality. Colonies and statoblasts were preserved in 95% ethanol and transported to the laboratory for microscopical study. For identification, the external features of zooids were observed under a stereomicroscope and statoblasts were coated with gold in an ion sputter coater, prior to examination with a SNE-3200M Mini-SEM at 15 kV accelerating voltage.

SYSTEMATIC ACCOUNTS

Single asterisks (*) indicate species that were added to the Korean freshwater bryozoan fauna record.

Class Phylactolaemata Allman, 1856
Order Plumatellida Allman, 1856
Family Fredericelliade Allman, 1856
Genus *Fredericella* Gervais, 1839

*1. *Fredericella indica* Annandale, 1909 (Fig. 2)

인도등근총담이끼벌레 (신칭)

Fredericella indica Annandale, 1909: 373-374; Wood and Okamura, 2005: 45, 76, fig. 13b; Hirose and



Fig. 1. A map showing the localities in Jeju Island where the materials were collected. 1. Susan reservoir. 2. Geumoreum. 3. Yongsu reservoir. 4. Wonmul pond. 5. Bungurut pond. 6. Suwori pond. 7. Sasaengi pond. 8. Nammunji pond. 9. Ojori pond.

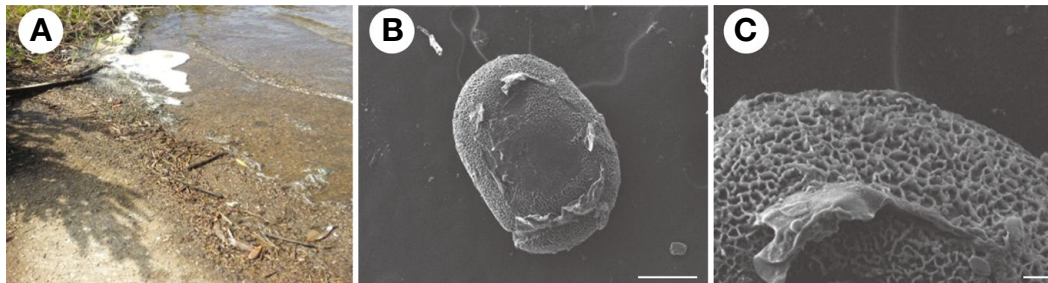


Fig. 2. *Fredericella indica* Annandale, 1909. A. habitat. B. piptoblast. C. surface of piptoblast. Scale bars: B = 100 μ m. C = 10 μ m.

Mawatari, 2011b: 5-8, figs. 2, 3A.

Material examined. Susan reservoir, 5 Jun. 2015.

Substratum. Wood.

Description. Piptoblast broadly oval, long sides nearly straight and parallel with rounded ends, 204.50 μ m long by 144.49 μ m wide, length/width ratio of about 1.4 (Fig. 2B). Surface extensively covered with prominent reticulation (Fig. 2C).

Remarks. This species is reported from Korea for the first time. Colony was not found. We collected only one piptoblast in heaps at the edge of the reservoir (Fig. 2A), which had an irregular, strong reticulum covering the surface. The surface of the piptoblast in the specimen seemed to be taken off when it was obtained in the substratum (Fig. 2C). *Fredericella indica* is distinguished

from *F. sultana* in having strongly reticulated piptoblast.
Distribution. Cosmopolitan, including Korea and Japan.

Family Plumatellidae Allman, 1856
Genus *Plumatella* Lamarck, 1816

2. *Plumatella emarginata* Allman, 1844

톱니깃털이끼벌레 (Fig. 3)

Plumatella emarginata Allman, 1844: 330; Seo, 1998: 372-373, fig. 1; 2005: 268-269, pl. 4; 2011: 15-16, fig. 3; Wood and Okamura, 2005: 51, 80, figs. 21, 47, 48; Hirose and Mawatari, 2011a: 4-5, fig. 2C.

Material examined. Susan reservoir, 30 Jun. 2015; Suwori pond, 4 Jul. 2015; Sasaengi pond, 28 May 2016;

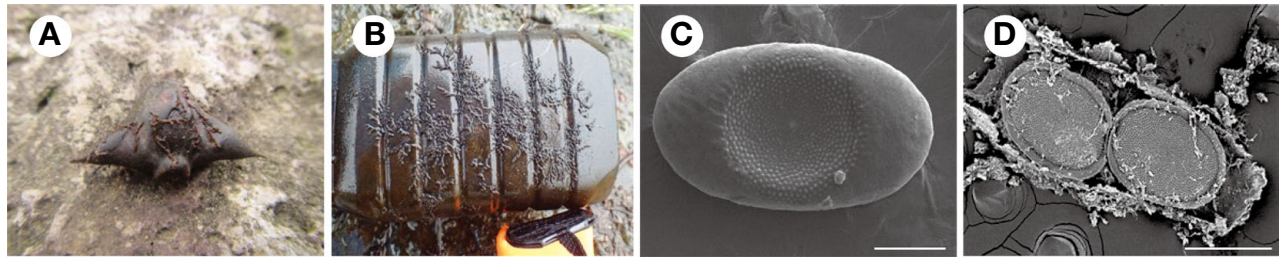


Fig. 3. *Plumatella emarginata* Allman, 1844. A, B. habitat, water caltrop and plastic bottle. C. floatoblast, ventral view. D. sessoblasts. Scale bars: C = 100 μ m. D = 300 μ m.

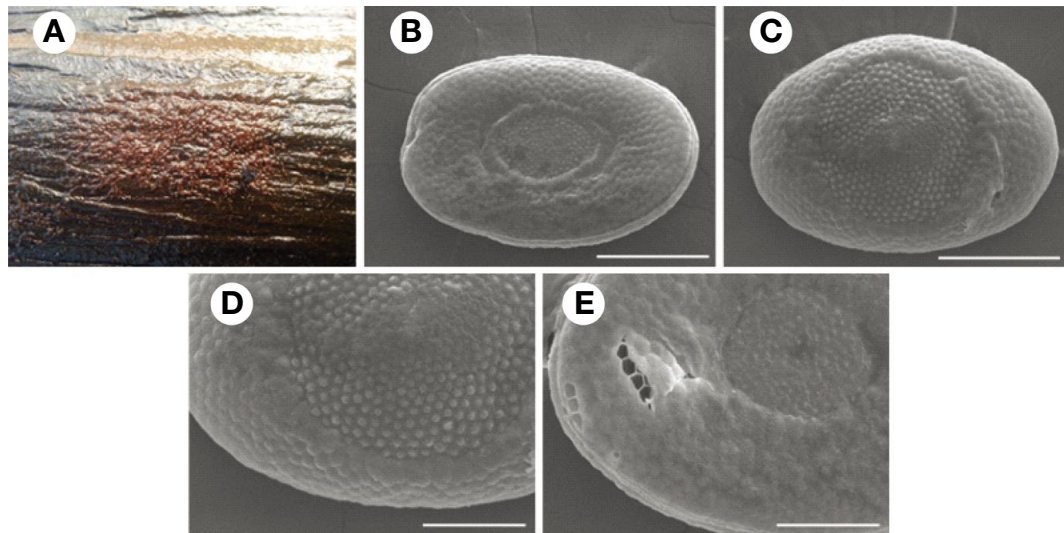


Fig. 4. *Plumatella mukaii* Wood, 2001. A. habitat, wood. B. floatoblast, dorsal view. C. floatoblast, ventral view. D. floatoblast, ventral view, detail. E. internal structure and surface of annulus. Scale bars: B, C = 100 μ m. D, E = 50 μ m.

Geumoreum, 29 May 2016.

Substratum. Water caltrop, plastic bag and plastic bottle.

Description. Colony variable, light brown to dark brown in color (Fig. 3A, B). Zooid long and tubular, loosely free branching and V-shaped emargination mark. Tentacles 30-45. Floatoblasts elliptical, elongate, asymmetrical, 384.05 (369.8-398.3) μ m long by 211.3 (208.5-214.1) μ m wide, length/width ratio of about 1.8; fenestra of ventral circular, 127.72 μ m (Fig. 3C): both covered with tubercles, fenestra of ventral more than four times of dorsal. Sessoblasts (Fig. 3D) oval, flat, annulus narrow and smooth, fenestra 104.26 (105.35-103.17) μ m long by 75.98 (74.01-77.96) μ m wide, length/width ratio of about 1.3, annulus 7.36 (6.47-7.45) μ m, completely covered with uniform tubercles, stick to substratum firmly in linear form.

Remarks. The floatoblasts had only been collected from Paldang, Daecheong and Andong reservoirs in Korea until now (Seo, 1998; 2005). In this study, we were for-

tunate to collect the colony and sessoblast as well as floatoblasts, which attached to the water caltrop, plastic bag and plastic bottle.

Distribution. Korea, Japan, Europe, North America, and New Zealand.

*3. *Plumatella mukaii* Wood, 2001

무카이깃털이끼벌레 (Fig. 4) (신칭)

Plumatella mukaii Wood, 2001: 51, figs. 1, 3-6; Hirose and Mawatari, 2011a: 6-7, fig. 2D.

Material examined. NIBRIV0000760229, Ojori pond, 8 Nov. 2015; Ojori pond, 15 Dec. 2015.

Substratum. Wood and plastic bag.

Description. Colony irregular branched, adhering to substratum, light brown to dark brown in color (Fig. 4A). Zooid tubular and well chitinized. Floatoblasts oval, light brown to dark brown, asymmetrical, ventral strongly convex and dorsal almost flat, 236.89 (230.51-243.28) μ m long by 161.63 (150.88-172.39) μ m wide,

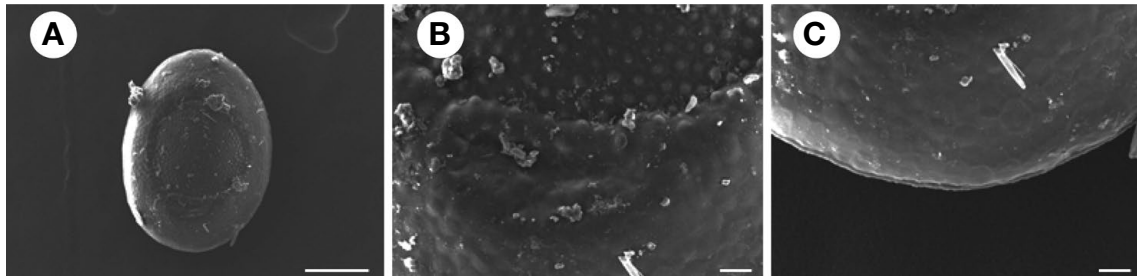


Fig. 5. *Plumatella rugosa* Wood, Wood, Geimer and Massard, 1998. A. floatoblast, dorsal view. B. floatoblast, annulus and fenestra view, detail. C. the outer annulus with concave cells between raised reticulations. Scale bars: A = 100 μ m. B, C = 10 μ m.

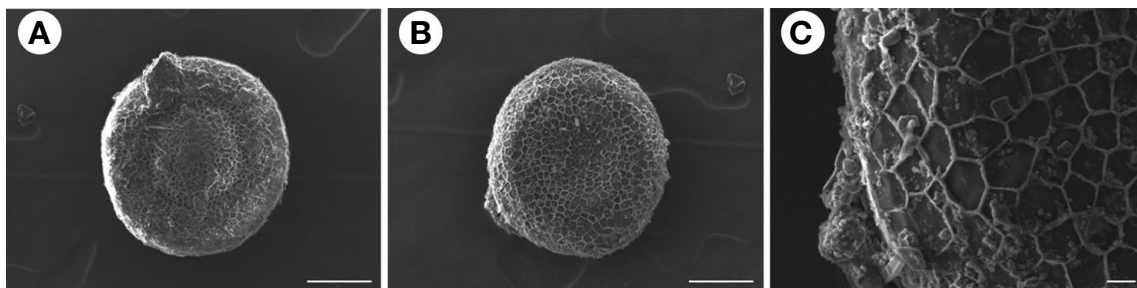


Fig. 6. *Stephanella hina* Oka, 1908. A. dorsal view. B. ventral view. C. reticulations view. Scale bars: A, B = 100 μ m. C = 10 μ m.

length/width ratio of about 1.5. Dorsal fenestra small, oval, 80.50 μ m long by 52.35 μ m wide, length/width ratio of about 1.5, less than half as long as ventral fenestra. (Fig. 4B). Ventral fenestra almost circular, 127.93 (125.79-130.07) μ m (Fig. 4C). Fenestra of both dorsal and ventral covered with tubercles and wrinkled (Fig. 4D). Annulus not smooth, covered with minute tubercles (Fig. 4E).

Remarks. *Plumatella mukaii* Wood, 2001 is similar to *Plumatella emarginata* Allmann, 1844 in the colonial form and shape of floatoblast, but differs by having the minutely wrinkled surface of floatoblast. In addition, the floatoblasts in this study were significantly shorter than those of previous studies (Wood, 2001; Hirose and Mawatari, 2011a). This species is reported from Korea for the first time.

Distribution. Korea, Japan, India, Thailand, Chile, and North America.

***4. *Plumatella rugosa* Wood, Wood, Geimer and Massard, 1998**

주름깃털이끼벌레 (Fig. 4) (신칭)

Plumatella rugosa Wood *et al.*, 1998: 642-643; Taticchi *et al.*, 2005: 176-177, figs. 2-13; Wood and Okamura, 2005: 61, 90, fig. 32; Hirose, 2012: 21, fig. 3.

Material examined. NIBRIV0000760225, Susan reservoir, 5 Jun. 2015; Wonmul pond, 4 Jun. 2015; Bungurut

pond, 4 Jul. 2015.

Substratum. Plastic bottle and styrofoam.

Description. Floatoblast oval, 316.5 (304.7-328.3) μ m long by 229.15 (219.5-238.8) μ m wide, with length/width ratio of about 1.4 (Fig. 5A). Dorsal fenestra nearly round, tubercles on reticulation, 117.65 (90.9-144.4) μ m long by 133.15 (119.5-146.8) μ m (Fig. 5B). Annulus reticulation, lacking tubercles, cells concave (Fig. 5C).

Remarks. This species is reported from Korea for the first time. Colony was not found. Floatoblast is similar to that of *Plumatella repens* (Linnaeus, 1758) in the shape and tubercles of fenestra, but differs in that it has reticulation without tubercles on annulus surface. *Plumatella rugosa* is common in North America and has also been reported from New Zealand (Wood and Okamura, 2005), Italy (Taticchi and Pieroni, 2005), and Japan. Furthermore, the floatoblast of our specimen had a length/width ratio of about 1.4, whereas the reported ratio was approximately 1.5 in Japan and 1.37 ± 0.01 in Italy.

Distribution. Korea, Japan, North America, New Zealand, and Italy.

Genus *Stephanella* Oka, 1908

5. *Stephanella hina* Oka, 1908 (Fig. 6)

왕관이끼벌레

Stephanella hina Oka, 1908: 277, pl. 10, figs. 1-5; To-

riumi, 1941a: 207, fig. 10; 1941b: 422, text-fig. 11; Smith, 1988: 253-258; Seo, 2005: 270-271; Hirose and Mawatari, 2011b: 17, figs. 5I, J, 6D.

Material examined. Susan reservoir, 5 Jun. 2015; Yong-su reservoir, 4 Jul. 2015.

Description. Floatoblast small, flat, circular, 309 $\mu\text{m} \pm 16$, length/width about 1.0. Fenestra nearly circular (Fig. 6A). Surface of dorsal and ventral side including annulus and fenestra covered with reticulation (Fig. 6A-C).

Remarks. Colony was not found. The colony of this species is known to be difficult to find.

Distribution. Korea, Japan, and North America.

CONCLUSIONS AND DISCUSSION

The morphological features of statoblasts are the most important diagnostic characteristics for the identification of phylactolaemate species (Hirose and Mawatari, 2007). Therefore, the five species in this study were primarily identified on the basis of statoblast morphology. Five species, *Fredericella indica*, *Plumatella emarginata*, *P. mukaii*, *P. rugosa*, and *Stephanella hina*, were found from nine localities on Jeju Island. Of which, *F. indica*, *P. mukaii* and *P. rugosa* added to the Korean freshwater bryozoan fauna record.

Remarkably, no colonies or statoblasts of *Pectinatella magnifica* were found on Jeju Island. *Pectinatella magnifica* is an alien species introduced from Japan (Seo, 1998) and it is the most common species on the mainland of Korea at the present time. This implies that *Pectinatella magnifica* has not yet been introduced to Jeju Island.

Wood (2001) synonymized *Plumatella emarginata* with *P. mukaii* by Toriumi (1952), Mukai *et al.* (1990), Mukai and Kobayashi (1988), Mukai (1999) and Orellana-Liebbe (1999), and thus assumed that this species was distributed in Korea. While the floatoblast of *P. mukaii* in this study was slightly smaller in size than previous reports of this species, it had the same length/width ratio of about 1.5 as previous reports of *P. mukaii* and had a similarly minutely wrinkled surface. Therefore, *Plumatella mukaii* was added to the Korean freshwater bryozoan fauna record in this study.

A total of 26 species, including five Korean species in the present study, have been recorded from Japan to date. Therefore, more freshwater bryozoans are expected to be found in Korea during future taxonomic studies.

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