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Four unrecorded moss species from the Korean flora

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한반도 미기록 선류식물 I

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ABSTRACT: Four unrecorded species (*Barbella flagellifera*, *Isothecium hakkodense*, *Mnium orientale* and *Fissidens gardneri)* and with one unrecorded genus, *Barbella,* are reported new to the Korean moss flora. *B. flagellifera* (Meteoriaceae) was found on a tree at alt. 300-350 m of parasitic Seogeomun-oreum Volcano on Jeju Island. The species are mainly distributed in subtropic regions. *I. hakkodense* (Lembophyllaceae) was found around the top of Seongin-bong on Ulleung Island. This species is similar to *I. subdiversiforme*, however, it can be distinguished by the morphologies of branch leaves and alar cells. *M. orientale* (Mniaceae) was collected from Mt. Jiri. This is similar to *M. heterophyllum*, however, it can be distinguished by plant size, number of teeth in leaf margin and cell size on leaf. *F. gardneri* (Fissidentaceae) was found along the valley of Mt. Palyeong, Jeollanam Province. This species is similar to *F. obscurirete*, but distinguished by the size of the plants and their leaves as well as the costal lengths of the leaves.

Keywords: Unrecorded moss species, *Barbella flagellifera*, *Fissidens gardneri, Isothecium hakkodense*, *M. orientale*

적 요: 우리나라 미기록 선류식물 4종을 발견하였다. 미기록속인 Meteoriaceae (누운끈이끼과)의 오름끈이끼(*Barbella flagellifera* (Card.) Nog.)는 주로 아열대 지방에 분포하는 것으로 알려졌으나, 제주도 서검은오름의 나무 등에 착생하여 생육하고 있었다. 미기록종인 Lembophyllaceae (호랑꼬리이끼과)의 울릉잎맥호랑꼬리이끼(*Isothecium hakkodense* Besch.)는 *I. subdiversiforme*와 유사하지만 가지 잎의 모양과 익부세포의 분화정도에 따라 구분이 가능하고, 울릉도 성인봉 부근의 바위에서 수백개체가 생육하고 있었다. Mniaceae (초롱이끼과)의 백무초롱이끼(*Mnium orientale* R. E. Wyatt, Odrzykoski & T. J. Kop.)는 *M. heterophyllum*와 유사하지만 식물체의 크기, 겹톱니의 유무, 세포의 크기면에서 구분이 가능하며, 경상남도 함양군 지리산 백무동계곡에서 채집되었다. Fissidentaceae (봉황이끼과)의 바위봉황이끼(*Fissidens gardneri* Mitt.)는 *F. obscurirete*와 유사하지만 식물체의 크기, 잎의 모양, 잎맥의 길이 등으로 구분이 가능하며, 전라남도 고흥군 팔령산 계곡의 바위 착생하여 생육하고 있었다.

주요어: 미기록종, *Barbella flagellifera*, *Fissidens gardneri, Isothecium hakkodense*, *Mnium orientale*

The first collector of mosses in Korean peninsula was Urban Faurie and his collections were studied by Cardot (1904). He listed a total of 97 species which included many new species. Until later in 1950's, Korean bryophytes were mainly studied by Japanese botanists, Okamura, Horikawa, Sasaoka, Kasimura, Nogichi and Osada at various localities in Korean peninsula (Song & Yamada, 2001, 2003). Hong & Ando (1959) was the first Korean botanist who studied Korean moss and he continued to study Korean bryophytes until now. Afterward, Korean botanists began to study moss flora of Korea (Hong, 1960a, 1960b; Hong & Ando, 1961; Choe, 1977; Choe & Choi, 1980). However, much of the materials

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of these studies including voucher specimens in the herbarium could not be found and this causes main difficulties in understanding moss flora of Korea.

The first collector of moss in Korean peninsula was Urban Faurie. Their collections were studied by Cardot. Later in 1940's, Japanese scholar Okamura, Horikawa, Sasaoka, Kasimura, Nogichi, Osada studied bryophyte in Korea (Song & Yamada, 2001, 2003). Afterward, the study of domestic scholars was accomplished (The flora of bryophyte on Mt. Kwanak, with some new additions to the korean flora, The flora of mosses on Mt. Chi I some new additions to the korean flora, The bryophyte on Mt. Soyo, with some new addition to the korean flora, A list of bryophytes in Korea, Studies on Illustration of the Korean Bryophyte) (Hong, 1960a; Hong, 1960b; Hong & Ando, 1961; Choe, 1977; Choe & Choi, 1980). But the specimens of study and specimens in the herbarium could not found, it is difficult to understand moss flora of area.

Mosses contain approximately 10,000 species in nearly 700 genera (Schofield, 1985). China has about 2,500 species (Gao et al., 1999) and Japan has about 1,200 species (Hallingbäck & Hodgetts, 2000). Korea has about 450-650 species (Choe, 1980; Park, 2007), which corresponds to about 6.5% of all the mosses currently recognized in the world. The mosses are by far the most species and diverse among the three major groups (moss, liverwort and hornwort) of nonvascular land plant and inhabit a number of ecological niches (Simpson, 2007). Most mosses grow in wet soil, rocks or tree epidemics. Usually, operculum falls off the capsule apex, has a pore and columella without elaters. mosses are readily distinguishable from hepaticae by capsule and seta maintained long (Choe, 1980; Simpson, 2007). And mosses show a wide range of distribution and it was reported that mosses are existing in extreme environments where other plants will not be able to survive (Bold et al., 1987). In this paper, on the basis of collected specimens from several localities in Korea, four unrecorded moss species, *Barbella flagellifera, Isothecium hakkodense, Mnium orientale* and *Fissidens gardneri* are reported.

Descriptions

Barbella M. Fleisch. ex Broth. Nat. Pflanzenfam. 1(3): 823. 1906.

Korean name: Ggeun-i-kki-suk (끈이끼속)

Plants slender to fairly robust, long-filiform, pale-green or brown. Secondary stems usually long, pendent, irregularly to subpinnately branched. Leaves appressed or slightly spreading both dry and moist, ovate- or oblong-lanceolate, gradually acuminate; margin serrulate or entire; costa single, slender, ending above the mid-leaf, or short to absent. Laminal cells linear to oblong-rhomboidal, with one or more papillae, rarely smooth. [Dioicous. Perichaetia on branches or secondary stems. Setae short, almost as long as the capsules, often curved, smooth or scabrous. Capsules erect, oblong to oblong-cylindric, smooth; stomata absent. Annulus none. Exostome teeth usually linear-lanceolate, fairly elongate, usually papillose throughout, sometimes the papillae arranged in diverse rows in the lower portion; basal membrane of endostome moderately high, the segments almost as long as the exostome teeth or a little shorter, linear to linear-lanceolate, usually perforate along the keel, minutely papillose. Spore minutely papillose. Operculum rostrate. Calyptra mitriform and lobate at base or cucullate, smooth or hairy. Perigonia on branches; inner perigonial leaves broadly ovate, shortly acuminate, cymbiform (Noguchi, 1989).]

1. ***Barbella flagellifera*** (Card.) Nog., J. Jap. Bot. 14: 28. 1938.

Meteorium flagelliferum Card., Beih. Bot. Centralbl., Abt. 2. 19(2): 120. 18. 1905.

Barbella asperifolia Card., Bull. Soc. Bot. Genève 3: 276. 1911.

Korean name: O-reum-ggeun-i-kki (오름끈이끼)

Plants very slender, yellow-green, pale-green or brownish, not glossy. Stems flexuose, creeping or pendent; primary stems longer than 30 cm; secondary stems complanately and widely leaved, filiform apices; branches to 20 mm long, acute to shortly attenuate. Primary stem leaves appressed or slightly spreading when dry, to 1.5 × 0.35 mm long, triangular-oblong, slenderly acuminate and gradually tapering to a pilferous apex, broadest above the base, concave; margins remotely and indistinct serrulate throughout; costa single, reaching mid-leaf. Median laminal cells linear to linear-rhomboidal, 45–63 × 5.0–5.5 μm, usually unipapillose, rarely smooth; alar cells quadrate or subquadrate in small group of several rows. [Setae 2.5–3.0 mm long, smooth. Capsules usually oblong-cylindric, 1.7–2.2 × 0.6–0.9 mm, becoming blackish with age. Exostome teeth whitish when dry, linear, ca. 0.7 mm long, minutely and densely papillose throughout; endostome segments linear, perforate along the keel. Spores 14–17 μm. Perigonia on branches, ca. 1 mm long (Noguchi, 1989).]

Habitats: The plant is slender on tree branches in the Seogeomeum-oreum (parasitic cone) in Jeju-do, Korea

Distribution: Korea, Borneo, Burma, China, India, Japan (Honshu, Shikoku, Kyushu, Ryukyu), Java, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam (Noguchi, 1989).

Specimens examined: Seogeomeum-oreum (parasitic cone),

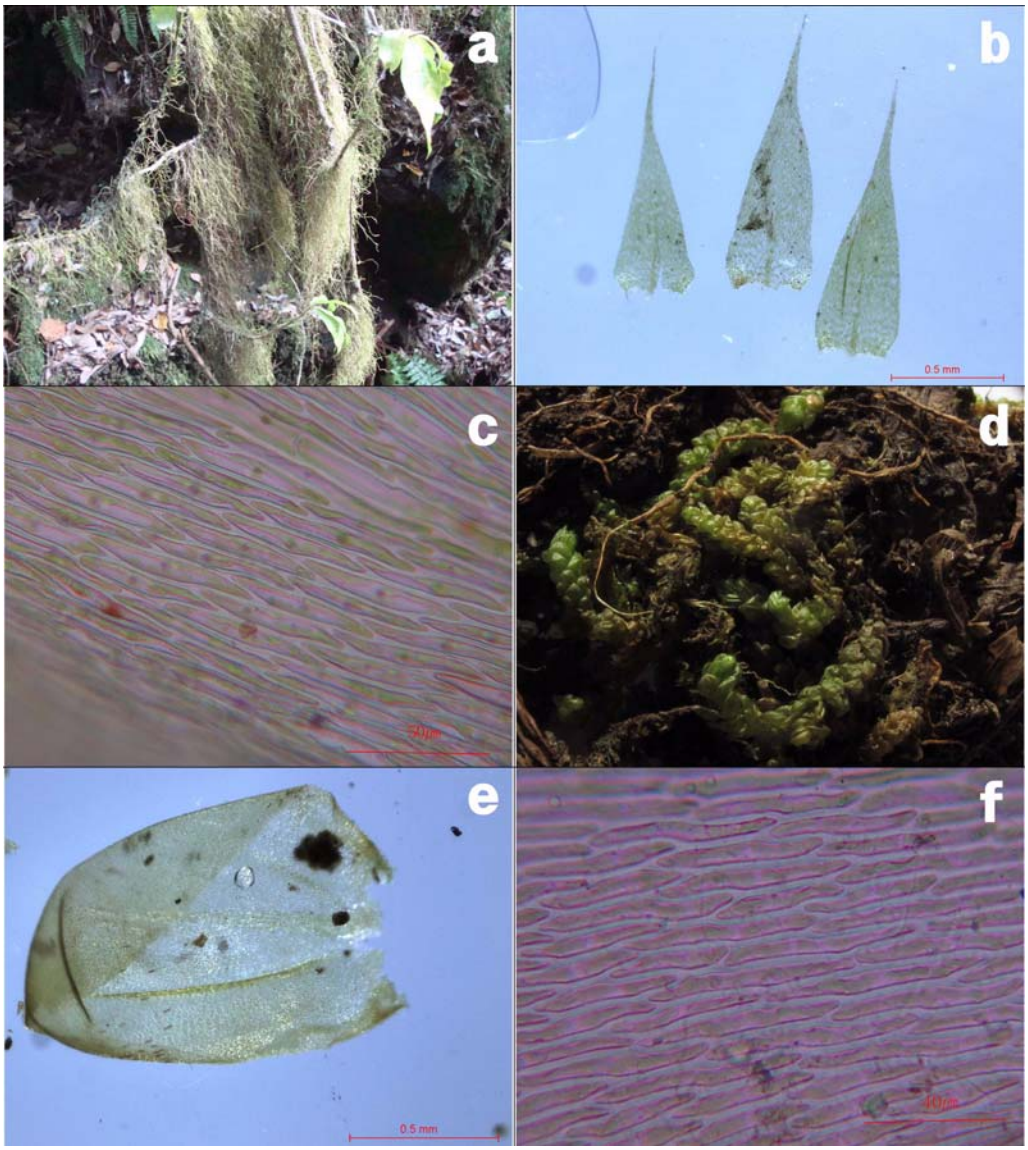

Fig. 1. *Barbella flagellifera* (a. Habit; b. Stem leaf; c. Median cells of leaf) and *Isothecium hakkodense* (d. Habit; e. Stem leaf; f. Median cells of leaf).

Bukjeju-gun, Jeju-do, Korea. 18 Nov. 2007, *Yoon Y. J. 00031* (JNU, NIBR)

In the family Meteoriaceae, only one genus, *Meteorium* (Brid.) Doz. et Molk has been reported until now (Choi, 1980). However, one more genus, *Barbella* was reported here as unrecorded genus to the moss flora of Korea. *B. flagellifera* is most similar to *B. pendula* (Sull.) Fleisch. in Japan by plants slender including costa reaching mid-leaf and papillose and alar cells differentiated. However, the two species are readily distinguishable by the unipapillose of laminal cells (Noguchi, 1989).

2. ***Isothecium hakkodense*** Besch., Ann. Sci. Nat. Bot., sér. 7, 17: 371. 1893.

Isothecium robustulum Broth. ex Ihs., Cat. Mosses Japan 166. 1929.

Korean name: Ull-eung-ip-maek-ho-rang-ggo-li-i-kki (울릉잎맥호랑꼬리이끼)

Plants robust, stout, yellow-green or green. Secondary stems to 15–25 mm long. Secondary stem leaves imbricate when dry, oblong, broadly obtuse or rounded-obtuse, to 1.2–2.0 × 0.7–1.3 mm long; margins crenulate at apex; costa single or sometimes fork, reaching mid-leaf or ending below the leaf apex. Median laminal cells sublinear or elongate-rhomboidal, to 25–45 × 2.5–5.0 μm long; upper cells elliptic or oblong, to 7.5–13 × 5.0–7.5 μm long; alar cells indistinctly differentiated, quadrate or subquadrate. [Inner

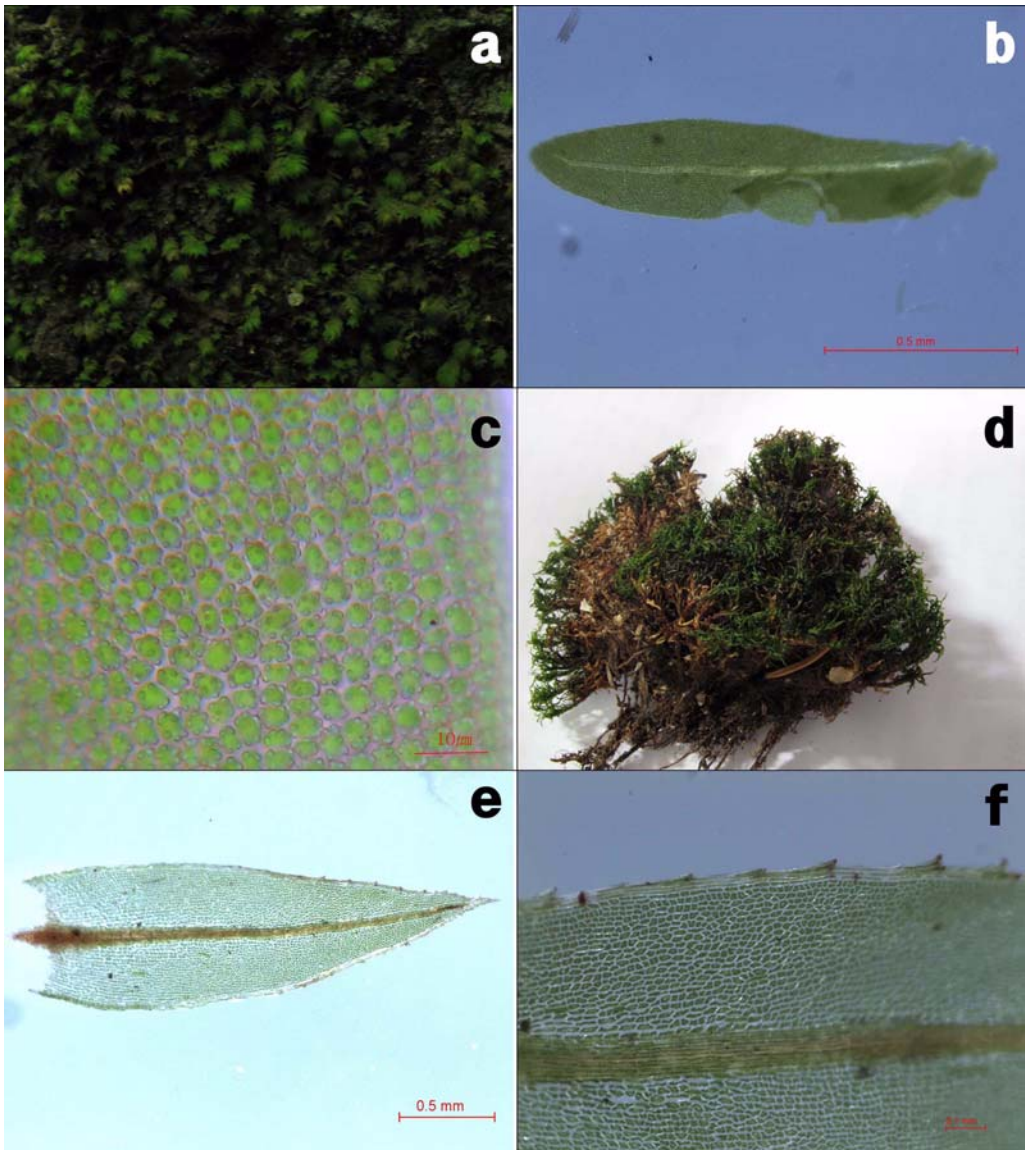

Fig. 2. *Fissidens gardneri* (a. Habait; b. Lower leaf of stem; c. Median cells of leaf) and *Mnium orientale* (d. Habit; e. Stem leaf; f. Median cells of leaf).

perichaetial leaves to 2 mm long, serrulate above. Setae 8–12 mm long, curved or ± flexuose. Capsules oblong, ca. 1.3 × 0.8 mm, without apophysis. Exostome teeth ca. 0.6 mm long; basal membrane of endostome ca. 0.17 mm long, cilia 1–2 short. Spore 12–15 μm, almost smooth. Calyptra ca. 2.2 mm long, extending to middle of capsule (Noguchi, 1991).]

Habitats: It was distributed on the rocks and humus rocks around the peak of Seongin-bong in Ulleung-do, Gyeongsangbuk-do, Korea.

Distribution: Korea and Japan (Noguchi, 1991).

Specimens examined: Seongin-bong, Ulleung-do, Gyeongsangbuk-do, Korea, 22 Aug. 2008, *Yoon Y. J & S. S. Choi, 00001* (JNU, NIBR)

I. hakkodense of Lembophyllaceae was collected from peak of the Seungin-bong in Ulleung-do. *I. subdiversiforme* Broth. in Korea is distinguished from *I. hakkodense* by leaf shape, imbricate secondary stem leaves when dry and indistinctly differentiated alar cells.

Key to the species of *Isothecium*

1. Branch leaves lanceolate, acute. Alar cells differentiated ..... *I. subdiversiforme*
1. Branch leaves ovate-oblong, obtuse. Alar cells indistinctly

differentiated ····· *I. hakkodense*

3. ***Mnium orientale*** R. E. Wyatt, Odrzykoski & T.J. Kop., Bryologist. 100: 231. f. 4. 1997.

Korean name : Baek-mu-cho-long-i-kki (백무초롱이끼)

Plants large, dark green, paler at younger parts. Stems erect, to 40 mm long, simple, rarely branched. Leaves curled and twisted when dry, lower small, upper larger, crowed, narrowly ovate or oblong-ovate, the upper leaves 4.5–6.0 × 0.7–1.0 mm, slightly decurrent at base; borders distinct throughout, double teeth from middle; costa red-brown, extending to the leaf apex, sometimes ending below the leaf apex, with large teeth on the back above. Median laminal cells rectangular, subrectangular or irregular, 12–35 × 10–20 μm long, basal cells rectangular. [Dioicous. Outer perichaetial leaves linear, narrower at middle, the innermost leaf triangular-linear, mostly ca. 2 mm long. Setae to 40 mm long, 0.25 mm thick, flexuose. Capsules horizontal to slightly pendent, 3.5–4.5 × 1.5–1.7 mm, brown. Operculum rounded-conic, ca. 0.8 mm long. Exostome teeth yellowish; basal membrane of endostome extending to 1/2 the length of exostome teeth, the cilia 3, as long as the segment. Spores 15–30 μm, variable in size, yellowish, minutely papillose. Male plants similar to the female, with a discoid perigonium. Outer perigonal leaves acute, reflexed, ca. 4.0 × 1.5 mm, the inner leaves ovate, broadly acute, ca. 2 mm long (Noguchi, 1989).]

Habitats: It was found on the soil along the trail of Mt. Jiri (alt. 1100 m) in Hamyang-gun, Gyeongsangnam-do, Korea.

Distribution: Korea, Europe, Japan(Hokkaido, Honshu, Shikoku, Kyushu) and N. America (Noguchi, 1989).

Specimens examined: Mt. Jiri, Hamyang-gun, Gyeongsangnam-do, Korea, 22 Oct. 2009, *Yoon Y. J. 4751* (JNU, NIBR)

M. orientale is distinguished from allied species by its large size, and the reddish costa bearing several large teeth at the back above (Noguchi, 1989). It may also be confused with *Atrichum undulatum* or *A. crispum.* The former has more longly tapering undulate leaves and costa with lamellae on the adaxial side, the latter has ovate to ovate-oblong leaves, a greenish border, larger cells lamellae, on the adaxial surface of the costa (Smith, 2004).

Key to the species of two Korean *Minum*

1. Plants small, stems to 10 mm long. Border of leaves with single teeth. ····· *M. heterophyllum*

1. Plants large, stems to 50 mm long. Border of leaves with paired teeth throughout ····· *M. orientale*

4. ***Fissidens gardneri*** Mitt., J. Linn. Soc., Bot. 12: 593. 1869.

Fissidens brevinervis Broth., Akad. Wiss. Wien Sitzungsber., Math.-Naturwiss. Kl., Abt. 1, 133: 559. 1924.

Fissidens elegans Brid., Muscol. Recent. Suppl. 1: 167. 1806.

Fissidens microcladus Thwait. & Mitt. J. Linn. Soc., Bot. 13: 324. 1873.

Korean name: Ba-wi-bong-hwang-i-kki (바위봉황이끼)

Plants small, green. Shoots to 1.2–4.2 × 0.8–1.3 mm long, usually simple, rarely branched; central strand lacking. Leaves 5–11 pairs, lower leaves very small, upper leaves much larger, oblong-lanceolate to lanceolate, to 0.7–1.2 × 0.20–0.25 mm long, acute at apex; costa ending below the apex, sometimes distally forked with a very short branch; vaginant laminal extending to mid-leaf, thin-walled, cells of vaginant lamina similar to those of dorsal laminal. Median laminal cells quadrate to hexagonal, 2.0–5.0 μm long; minutely pluri-papillose. [Rhizautoicous. Perichaetium terminal. Seta 1.5–2.5 mm long, ca. 0.08 mm thick. Capsule erect, cylindric, 0.45–0.55 × 0.25–0.35 mm, with indistinct apophysis. Operculum rostrate. Peristome teeth ca. 0.15 mm long, spirally thickened above. Spores 9–13 μm. Calyptra campanulate. Perigonium small, adhering to the base of the female plant (Noguchi, 1987).]

Habitats: It was distributed on the rocks along the valley of Mt. Palryung (alt. 290 m) in Goheung-gun, Jeollanam-do, Korea.

Distribution: Korea, China, Japan, Nepal, India, Sri Lanka, Thailand, Laos, Philippines, Africa and America (Li et al., 2001).

Specimens examined: Mt. Palryung, Goheung-gun, Jeollanam-do, Korea, 23 Jun. 2009, *Yoon Y. J. 3506* (JNU, NIBR)

The Fissidentaceae, one of the largest families of mosses, consists of a monogeneric taxon *Fissidens*, with about 900 species worldwide (Ishihara & Iwatsuki, 1992; Iwatsuki et al., 1999; Imura & Iwatsuki, 1988). Korea has about 16 species in Fissidentaceae (Park, 2007). *F. gardneri* is most similar to *F. obscurirete,* however, the two species are readily distinguishable by plants size including costa length and leaf shape.

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