



First record of *Crepidomanes schmidtianum* (Zenker ex Tasch.) K. Iwats. (Hymenophyllaceae) from Korea

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(Received 5 February 2014; Accepted 24 February 2014)

한반도 미기록 식물: 두메괴불이끼(처녀이끼과)

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ABSTRACT: The newly recorded species, *Crepidomanes schmidtianum* (Zenker ex Tasch.) K. Iwats. (Hymenophyllaceae) was collected from forests in Mt. Jirisan, Baegmu-dong, Macheon-myeon, Hamyang-gun, Gyeong-sangnam-do. *C. schmidtianum* (vernacular name: 'Du-me-goe-bul-i-kki') was distinguished from other Korean congeners of the genus *Crepidomanes* by having pseudo-vein, almost wingless in stipe, and involucre cup shaped with dilated. A new Korean name, 'Du-me-goe-bul-i-kki', was given based on its habitat. Descriptions and illustrations of this taxon and its photograph in the habitat are provided along with a key to the species of *Crepidomanes* from Korea.

Keywords: *Crepidomanes schmidtianum*, Hymenophyllaceae, first report

적 요: 처녀이끼과 미기록 분류군 두메괴불이끼(*Crepidomanes schmidtianum*)가 지리산(경상남도 함양군 마천면 백무동)에서 발견되었다. 두메괴불이끼는 괴불이끼속의 다른 분류군들에 비해서 위맥이 있고, 잎자루에 날개가 거의 없으며, 위가 갈라지고 컵모양인 포막을 갖는 점이 뚜렷이 구별된다. 새로운 국명은 높은 산에서 자란다는 의미로 두메괴불이끼로 하였고, 주요형질에 대한 중기제 및 해부도와 서식지 식물사진 및 한국산 괴불이끼속 식물에 대한 검색표를 제시하였다.

주요어: 두메괴불이끼, 처녀이끼과, 미기록

The Hymenophyllaceae family, known as filmy ferns, contains about 600 species that are distributed mostly in tropical and subtropical regions, in addition to some temperate regions (Iwatsuki, 1990). This family is characterized as rather simple, mostly single cell thick, laminae like mosses, and the monophyly of the family has not been questioned (Ebihara et al., 2006). On the other hand, the intrafamilial classification of

this family is highly controversial. Copeland (1938) split this family into 34 genera, and his scheme has been adopted by many Asian scholars (Ching, 1959; Nakaike, 1975; Parris, 1992). The other system was divided by Morton (1968) into only two genera, *Hymenophyllum* with bivalved involucre and *Trichomanes* with tubular involucre, consisting of nine subgenera containing 35 sections. Another system of 47 genera was proposed by Pichi Sermolli (1977). Iwatsuki (1984) created a new system consisting of eight genera based on morphological studies on Asiatic filmy ferns. However, these classifications have been limited to only regional concepts. Some molecular phylogenetic studies have provided new insights into the

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systematic relationships within Hymenophyllaceae (Dubuisson, 1997; Pryer et al., 2001; Dubuisson et al., 2003; Hennequin et al., 2003; Ebihara et al., 2004, 2006, 2007). Recent molecular systematic studies support two traditional genera showing two distinct monophyletic clades (Pryer et al., 2001; Ebihara et al., 2006, 2007). Finally, Ebihara et al. (2006) proposed a new classification of Hymenophyllaceae, consisting of nine genera (*Hymenophyllum*, *Didymoglossum*, *Crepidomanes*, *Polyphlebium*, *Vandenboschia*, *Abrodictyum*, *Trichomanes*, *Cephalomanes* and *Callistopteris*) based on morphology, chromosome data, and molecular phylogeny. The family Hymenophyllaceae in Korea contains three genera, *Hymenophyllum*, *Crepidomanes*, and *Vandenboschia*, according to the system of Ebihara et al. (2006).

The genus *Crepidomanes* C. Presl contains about 30 species that are mostly distributed in the old world tropics up to northern temperate regions and from Asia to Africa (Ebihara et al., 2006). This genus is characterized by wiry rhizomes, short or long creeping, with dense to sparse dark short hairs, rachis winged throughout or wingless near base, lamina pinnately decomposed or rarely digitate to fan-shaped by reduction, entire, glabrous, false veinlet or lacking, sori axillary or apical on segments; involucre conical to campanulate or funnel-shaped, rounded to acuminate at apex, with bilabiate or truncate mouth, receptacles projecting (Liu et al., 2013). This genus was circumscribed by Ebihara et al. (2006) and was reported as a distinct monophyletic group corresponding to the traditional genus *Trichomanes* L., s. l. as arranged by Morton (1968).

Some studies have attempted the delimitation of species and sections within this genus (Morton, 1968; Iwatsuki, 1984, 1995; Ebihara et al., 2006, 2007). According to Ebihara et al. (2006), the genus can be divided into two subgenera, *Crepidomanes* with three sections (*Crepidomanes*, *Gonocormus*, and *Crepidum*) and *Nesopteris*, based on morphology, cytology, and molecular phylogeny. The base chromosome number of *Crepidomanes* is $n = 36$ (Mitui, 1967; Yoroï and Iwatsuki, 1977; Ebihara et al., 2006).

The filmy fern *Crepidomanes minutum* from Western Africa to the Pacific Islands, including Hawaii, is highly morphologically variable with a distribution of it (Yoroï and Iwatsuki, 1977). A complex of *Crepidomanes minutum* was studied based on morphology, nuclear (*gapCp*) and chloroplast (*rbcL*) DNA sequences, cytology, field observation, and spore counts, and samples of their populations revealed a complex reticulate evolution (Nitta et al., 2011). Recently, a new variety, *C. minutum* var. *mascarenensis* Pynee & Dubuisson, was described from the Mascarene Islands in the Indian Ocean (Pynee et al., 2012).

The genus *Crepidomanes* in Korea has been reported to

contain two species, *C. minutum* (Blume) Iwatsuki, and *C. latealatum* (Bosch) Copeland, as a simple species description (Park, 1975; Lee, 1980; Korean Fern Society, 2005; Lee, 2006; Korea National Arboretum, 2008). The former corresponds to the section *Gonocormus* and the latter to the section *Crepidomanes* as *sensu* Ebihara et al. (2006). Except for simple taxonomic descriptions like this, no study on the taxa of *Crepidomanes* or even Hymenophyllaceae from Korea has been carried out.

Except for the above taxa, we found an additional species, *C. schmidtianum* (Zenker ex Tasch.) K. Iwats., with about 40 individuals per 5 m². It is reported as a newly recorded taxon from Korea, and it was collected from a forest in Mt. Jirisan, Baegmudong, Macheon-myeon, Hamyang-gun, Gyeongsangnam-do. The local name was designated as 'Du-me-goe-bul-i-kki' based on its habitat. We compared and analyzed morphological characters between *C. schmidtianum* and similar taxa of *Crepidomanes* in order to elucidate their taxonomic relationship. Morphological characters and illustrations of *C. schmidtianum*, along with photographs of the habitat, are newly reported with a taxonomic key to the species of *Crepidomanes* from Korea.

Taxonomic Treatment

Crepidomanes schmidtianum (Zenker ex Tasch.) K. Iwats., J. Fac. Sci. Univ. Tokyo 13: 526 (1985).

Trichomanes schmidianum Zenker ex Tasch., Duab. Trichom. Sp.: 34 (1843).

Vandenboschia schmidtiana (Zenker ex Tasch.) Copel., Philipp. J. Sci. 67: 53 (1938).

Lacosteopsis titubuensis (H. Itô) Nakaïke, Enum. Pterid. Jap., Fil. 25 (1975).

Korean name: Du-me-goe-bul-i-kki (두메괴불이끼) (Figs. 1, 2)

Winter green herb, epiphytic, height 3-7 cm. Rhizomes long creeping, thin, 0.3-0.5 mm diameter, brownish hairy, hairs unicellular, 0.2-0.5 mm length. Stipes remote 1-2 cm apart, 0.5-1.8 cm length, 0.3-0.5 mm width, wingless or narrowly winged, commonly hairy at base; hairs light straw colored brown to dark. Laminae bipinnatifid, 4-8 lateral pinnae pairs, ovate-subteltoid to ovate-lanceolate, dark green, commonly lower pinnae largest, membranous, 2-5 cm length, 1.5-2.5 cm width, glabrous; lateral pinnae oblique ovate, narrowing continuously from base, 1-1.4 cm length, 3-4 mm width; large ones short-stalked about 0.1 mm length, ultimate segments oblong, apex acuminate, 1.5 mm width, often imbricate to the neighboring ones; rachis winged throughout, deep green, glabrous; veinlets

anadromous, present false veinlets. Sori terminal on short axially segments; involucre cup shaped, narrowly winged, 1.5 length, 1.2 mm diameter, entire, apex broadly rounded, lips usually dilated; receptacles long projection extruded. Spores trilete.

Habitat: In moist crevices of great stone in high mountain forests.

Distribution: Korea, Japan, China, Taiwan, Himalaya.

Specimens examined: Mt. Jirisan, Baegmu-dong, Macheon-myeon, Hamyang-gun, Gyeongsangnam-do, Korea, 22 June 2013 *G.H. Lee 1306100-4* (EWH), 19 Oct. 2013 *C.S. Lee & G.H. Lee 1310100-1*(NIBR).

Notes: The new reported taxon in Korea, *C. schmidtianum* (Zenker ex Tasch.) K. Iwats., has been classified as a taxon of *Vandenboschia* (Copeland, 1938), *Trichomanes* (Morton, 1968), *Lacosteopsis* (Nakaike, 1975), or *Crepidomanes* (Iwatsuki, 1985), which supports Iwatsuki (1985). However, this taxon belongs to the section *Crepidomanes*, subgenus *Crepidomanes*, which corresponds to Ebihara et al. (2006) based on only containing those species that have false veinlets as morphological characters (Table 1). The new local name ‘Dume-goe-bul-i-kki’ was given based on its habitat. It was found in Korea with *Crepidomanes latealatum*, *Hymenophyllum polyanthus*, *Magnolia sieboldii*, *Acer palmatum*, *Dryopteris crassirhizoma*, *Dryopteris austriaca*, *Acer triflorum*, and *Deutzia parviflora* in a forest in Mt. Jirisan, Baegmu-dong, Macheon-myeon, Hamyang-gun, Gyeongsangnam-do.

This taxon was distinguished from other Korean congeners of the genus by having pseudo-vein, broadly winged in rachis, almost wingless in stipe, cup shaped involucre, and prominently bent back involucre margin (Table 1, Figs. 1, 2).

Crepidomanes schmidtianum is distributed from the Himalayan region to Japan, and two infraspecific taxa, var. *schmidtianum* and var. *latifrons* of this species, are recognized by Iwatsuki (1985). The former is distributed in Japan. The latter is found in Taiwan and Bhutan of Himalaya, which has larger fronds that are more than 8 cm when fully mature and segments rather remote compared to the former (Iwatsuki, 1985). *C. schmidtianum* in Korea is typically similar to Japanese plants, and it is treated as *C. schmidtianum* var. *schmidtianum*.

Farrar (1967, 1971, 1992, 1998) has studied independent gametophytes in the Appalachian mountains of the eastern United States, which are maintained by gemmiferous gametophytes, producing sporophytes only as occasional sterile juveniles or not producing sporophytes at all (Moran, 2004; Ebihara et al., 2008). So far, he has described the occurrence of four species [*Grammitis nimbata* (Jenman) Proctor, *Vittaria appalachiana* Mickel and Farrar, *Hymenophyllum tayloriae* Farrar and Raine, and *Trichomanes intricatum* Farrar]. Among

them, *Trichomanes intricatum* is the most widespread, which resembles a tangle of multicellular filaments with spindle-shaped gemmae. The gametophyte form of *T. intricatum* is common to several species of *Trichomanes* s.l., including temperate species of *Vandenboschia*, which occurs as sporophytes in the eastern U.S. and Europe, and *Crepidomanes*, which occurs as sporophytes in eastern Asia (Ebihara et al., 2008). Ebihara et al. (2008) compared the chloroplast genomes between the sporophyte-less filmy fern *T. intricatum* in the eastern U.S. and *C. schmidtianum* in Japan in order to investigate their relationship. They asserted that the *rbcL*

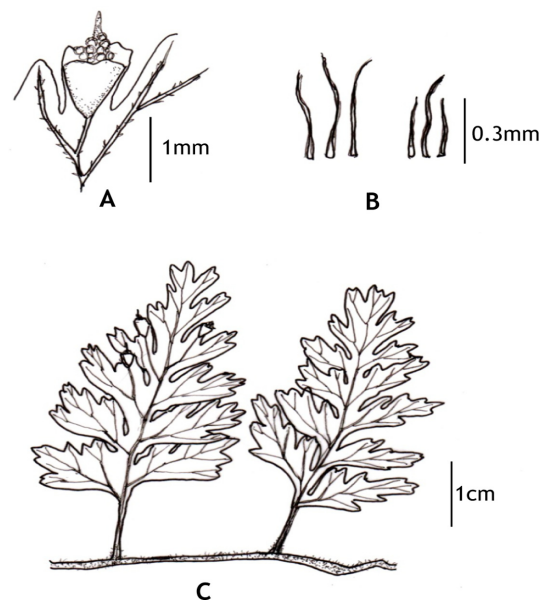


Fig. 1. Illustrations of *Crepidomanes schmidtianum* (Zenker ex Tasch.) K. Iwats., taken in Mt. Jirisan, Baegmu-dong, Macheon-myeon, Hamyang-gun, Gyeongsangnam-do, Korea, 22 June 2013. A. Sori and involucre; B. Hairs in rhizome and stipe; C. Habit.



Fig. 2. Photographs of *Crepidomanes schmidtianum* (Zenker ex Tasch.) K. Iwats., taken in Mt. Jirisan, Baegmu-dong, Macheon-myeon, Hamyang-gun, Gyeongsangnam-do, Korea, 22 June 2013. A. Pinna with involucre and sori; B. Habit.

Table 1. Comparative morphological characters between *C. schmidtianum* and related taxa distributed in Korea with one taxon in Japan of subgenus *Crepidomanes* of *Crepidomanes* (*Kurata and Nakaike, 1979; Iwatsuki, 1992, 1995).

Characters	Sect. <i>Gonocormus</i>	Sect. <i>Crepidomanes</i>		Sect. <i>Crepidium</i>
	<i>C. minutum</i>	<i>C. schmidtianum</i>	<i>C. latealatum</i>	* <i>C. humile</i>
Plant height (cm)	1.5-2	2.5-7	3-7	4
Stipes length (cm)	1	0.5-1.8	0.8-2.0	1
Stipes wing presence	no	no	very narrowly presence	presence in upper part
Laminae pinnation	simple to pinnate	2-3 pinnatifid	2-3 pinnate	2-pinnate
Laminae length	1	2-5	2-5	3
Laminae shape	fan-shaped to oblong	ovate-subdeltoid or ovate-lanceolate	ovate-oblong to oblong-subtriangular	narrow oblong
Pinnae shape	oblong	oblique ovate	oblong	linear oblong
Pinnae color	dark green	dark green	dark green	green
Segments diameter (mm)	0.8	1.5	1-1.2	0.8-1.2
Marginal cells elongate parallel to margin	no	no	no	presence
False veinlets presence	absence	presence	presence	absence
Involucres shape	tubular	cup-shaped with dilated	campanulate in lower, bilabiate in upper	tubular to campanulate
*Chromosomes	2n = 72	2n = 72, 108	2n = 72	2n = 72

sequence of the gametophytic *T. intricatum* from the eastern U. S. matched 100% to that of a sporophyte of *Crepidomanes schmidtianum* collected in Japan. The morphology of *T. intricatum* also matches that described for a species of *Crepidomanes* (Stokey, 1940; Yoroi, 1972), and *T. intricatum* and *C. schmidtianum* were produced by independent hybrid events. Therefore, he presumed that *T. intricatum* should be treated as a synonym of *C. schmidtianum* (Ebihara et al., 2008). This finding is very exciting to us in that it may be possible to identify independent gametophytes in Korea. Accordingly, we need to perform more detailed investigations.

Key to the known allied taxa of *C. schmidtianum* in Korea

1. Laminae simple, fan-shaped to pinnate, oblong; segments false veinlets absent; involucres tubular
..... *C. minutum* 부채피불이끼
1. Laminae 2-3 pinnate; segments false veinlets present; involucres cup shaped with dilated or campanulate in lower, bilabiate in upper.
 2. Stipes no winged; involucres cup shaped with dilated
..... *C. schmidtianum* 두메피불이끼
 2. Stipes very narrowly presence; involucres campanulate on lower part, lip shaped on upper part
..... *C. latealatum* 피불이끼

Acknowledgment

This search was supported by grants from “The Survey of new and unrecorded taxa in vascular plants (NIBR No. 2013-02-001)” founded by the Ministry of Environment of the Korean Government. Thanks to Hee Nyeon Kim for guiding at Mt. Jirisan.

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