



First record of *Diplazium mettenianum* (Miq.) C. Chr. var. *mettenianum* (Athuriaceae) from Korea

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한반도 미기록 식물: 깃주름고사리(개고사리과)

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ABSTRACT: The newly recorded species, *Diplazium mettenianum* (Miq.) C. Chr. var. *mettenianum* (Athuriaceae) was collected from a forest in Min-oreum, Jeju-do. *D. mettenianum* var. *mettenianum* (vernacular name: 'Kit-ju-reum-go-sa-ri') is distinguished from other Korean congeners of the genus *Diplazium* by having pinnae shallowly or halfway lobed, lower pinnae stalked, lanceolate, pinna segments serrate margin and obtuse apex. A new Korean name, 'Kit-ju-reum-go-sa-ri', was given based on the shape of pinna halfway lobed. Descriptions and illustrations of this taxon and its photograph in the habitat are provided along with a key to the species of *Diplazium* from Korea.

Keywords: *Diplazium mettenianum* var. *mettenianum*, Athuriaceae, first report

적 요: 개고사리과 미기록 분류군 깃주름고사리(*Diplazium mettenianum* var. *mettenianum*)가 제주도 민오름에서 발견되었다. 깃주름고사리는 주름고사리속의 다른 분류군들에 비해서 우편이 얇게 갈라지고 맨 아래 우편은 자루가 있으며 피침형이고, 우편의 열편은 가장자리가 찢어졌고, 끝이 뭉뚝한 점이 다른 종과 뚜렷이 구별된다. 새로운 국명은 우편이 갈라진다는 의미로 깃주름고사리로 하였고, 주요형질에 대한 증거 및 해부도와 서식지 식물사진 및 한국산 주름고사리속 식물에 대한 검색표를 제시하였다.

주요어: 깃주름고사리, 개고사리과, 미기록

The Athuriaceae family, known as the lady fern family, consists of 600 species distributed in mostly tropical and subtropical regions, in addition to a few species found in temperate regions (Kato, 1977; Wang et al., 2004; Tryon and Tryon, 1982; Wu and Ching, 1991). Athuriaceae includes the majority of genera placed in Woodsiaceae (Lellinger, 1985; Iwatsuki, 1992; Iwatsuki et al., 1995; Lee, 2006; Smith et

al., 2006). As Woodsiaceae is paraphyletic, molecular phylogenetic studies provided new insights into the systematic relationships within Athuriaceae (Lehtonen, 2011; Christenhusz et al., 2011). Athuriaceae is defined by five genera (*Anisocampium*, *Athyrium*, *Cornopteris*, *Deparia*, *Diplazium*) based on Kato (1977), Wang et al. (2004), and Lehtonen (2011). The family Athuriaceae in Korea consists of four genera without *Anisocampium*.

The genus *Diplazium* Sw., s.l., known as a twinsorus fern includes about 400 species that are mostly distributed in the old world tropics up to subtropical regions (Kramer and Kato, 1990). This genus is characterized by rhizomes creeping to

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erect, and scaly, stipes green, deeply grooved adaxially, either scaly or glabrous, lamina either singular or in sets of two and entirely pinnate, mostly broadly ovate, oblong, or oblong-lanceolate to deltoid, and herbaceous to papery, basal sori linear, single or double paired back-to-back on the same vein, indusia linear, persistent, chromosome number, $x = 41$ (Kramer and Kato, 1990; Kato, 1995). This genus is split into several genera or sections (*Allantodia*, *Callipteris*, *Diplaziopsis*, *Momolangium*, and *Diplazium*, s. s.) and this scheme has been adopted by some Asian scholars (Ching, 1964; Kato, 1977; Chu and He, 1999). Most taxa of the genus *Diplazium* were moved to *Allantodia* R. Br. by Ching (1964) based on discontinuous groove of rachis and costa, and sori linear and spread from midrib to margin. However this genus *Diplazium* in its broadest sense is followed by Sano et al. (2000), Wang et al. (2003), and Ebihara (2011) based on molecular phylogenetic studies. It was reported as a distinct monophyletic group corresponding to the traditional genus *Allantodia* R. Br., *Callipteris* Bory, and *Monomelangium* Hayata which were arranged by Ching (1964) and Chu and He (1999). *Diplaziopsis* was recently segregated as the Diplaziopsidaceae family (Lehtonen, 2011; Maarten et al, 2011). Recently Wei et al. (2013) suggested that the genus *Diplazium* can be proposed as a single genus and divided into four subgenera (*Pseudallantodia*, *Diplazium*, *Sibirica*, and *Callipteris*) based on morphology and molecular phylogeny.

Among these taxa, *Diplazium subsinuatum* has been changed to other genera, *Athyrium*, *Neotriblemma*, and *Triblemma*. Recently, Sano et al. (2000) proposed it should be moved from *Diplazium* to *Deparia* according to molecular, morphological and cytological studies.

The genus *Diplazium* in Korea has been reported to contain five to ten species as a simple species description (Park, 1975; Lee, 1980; Lee, 2006; Korea National Arboretum, 2008). Lee (2005) performed cladistic analysis to determine the interspecific relationships of nine taxa with *D. subsiniatum*, which it was treated as *Deparia lacera* by Sano et al. (2000) as Korean *Diplazium* (Woodsiaceae) based on 17 morphological characters. *Diplazium nipponicum*, was recently reported from Jeju Island, and is most closely related to *D. chinense* by having acuminate apex of pinnule segment and fascicled fronds (Lee, 2005).

Among these taxa, Park (1961, 1975) recorded *Diplazium taquetii* distributed in Jeju Island, but it has not been observed in Korea since it was a misidentification of *D. nipponicum*. *Diplazium okudairae* was recorded in Korea by Park (1975) and Lee (2006), but it also has not still observed in Korea according to misidentification of other taxon or undiscovered thing.

We found an additional species, *Diplazium mettenianum* (Miq.) C. Chr. var. *mettenianum*, with about 10 individuals per 5 m². It is reported as a newly recorded taxon from Korea, and it was collected from a forest in Min-oreum, Ora-dong, Jeju-si, Jeju-do. The local name was designated as 'Kkit-ju-reum-go-sa-ri' based on its habitat. We compared and analyzed morphological characters between *D. mettenianum* var. *mettenianum* and similar infraspecific taxa of *Diplazium* in order to elucidate their taxonomic relationship. Morphological characters and illustrations of *D. mettenianum* var. *mettenianum*, along with photographs of the habitat, are newly reported with a taxonomic key to the species of *Diplazium* from Korea.

Taxonomic Treatment

Diplazium mettenianum (Miq.) C. Chr. var. *mettenianum*, Index Filic. 236 (1905). (Figs. 1, 2)

Asplenium mettenianum Miq., Ann. Mus. Bot. Lugd.-Bat. 3: 174 (1867).

Allantodia metteniana (Miq.) Ching, Acta Phytotax. Sin. 9 (1): 51 (1964).

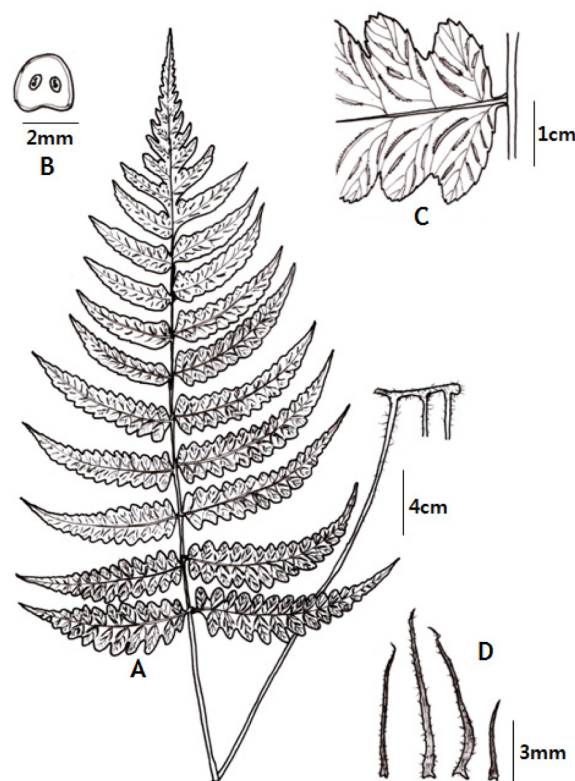


Fig. 1. Illustrations of *Diplazium mettenianum* (Miq.) C. Chr. var. *mettenianum*. A. Habit; B. Stels in stipe; C. Pinna with sori and involucre; D. Hairs in rhizome and stipe.



Fig. 2. Photographs of *Diplazium mettenianum* (Miq.) C. Chr. var. *mettenianum*, taken in a forest at Min-oreum, Jeju-do, Korea, 7 Sept. 2012. A. Pinna with involucre and sori; B. Habit.

Korean name: Kit-ju-reum-go-sa-ri 깃주름고사리

Winter green herb, terrestrial, height 50-75 cm. Rhizomes long creeping, about 4 mm diameter, scaly, leaves remote. Scales linear lanceolate, some toothed margin, 5-6 mm length, ca. 1 mm width, dark brown, margin with projection. Stipes 25-45 cm length, greenish brown or stramineous, rarely scaled at base. Laminae 1 pinnate deeply, lanceolate-triangular or ovate lanceolate, gradually narrowing toward long acute apex, hard herbaceous, 30-40 cm length, about 30 cm width, groovy on upper side of rachis. Pinnae 10-13 pairs, alternately or somewhat opposite, linear lanceolate, upper parts somewhat curved to upward, 8-16 cm length, 1.5-3 cm width, basal pinnae with short stalked or no. Segments apex round or obtuse, margins serrated; leaf veins free, simple. Sori long linear toward midveins of segments on lateral veins to near margin. Indusia almost entire or somewhat serrated to margin.

Habitat: In lowland of mountain forests.

Distribution: Korea, Japan, South of China, Taiwan, Philippines, Vietnam.

Specimens examined: Min-oreum, Ora-dong, Jeju-si, Korea, 7 Sept. 2012 C.S. Lee & K. Lee 121001-3 (EWH); 4 Mar. 2013 C.S. Lee & K. Lee 1303100-3 (KB)

Notes: The new reported taxon in Korea, *Diplazium mettenianum* var. *mettenianum*, has been classified as a taxon of *Asplenium* (Miquell, 1867) and *Allantodia* (Ching, 1964). However, this taxon belongs to the subgenus *Callipteris*,

corresponding to Wie et al. (2013) based on the margin of rhizome and stipe toothed, color of scales concolorous, sori flattened, and dissection of leaf imparipinnate as morphological characters.

The new local name 'Kit-ju-reum-go-sa-ri' was given based on the shape of pinna halfway lobed. It was found in Korea with *Hedera rhombea*, *Camellia japonica*, *Machilus japonica*, *Sasa borealis*, *Fatsia japonica*, *Thelypteris japonica*, *Achyranthes japonica*, *Pinus densiflora*, *Quercus myrsinaefolia*, and *Prunus yedoensis*, in a forest in Min-oreum, Jeju-do.

This taxon was distinguished from other Korean congeners of the genus *Diplazium* by having pinnae shallowly or halfway lobed, lower pinnae stalked, lanceolate, pinna segments serrate margin and obtuse apex (Figs. 1, 2).

Diplazium mettenianum var. *mettenianum* is distributed in Japan, Taiwan, South China, Vietnam, and Thailand. Due to its polymorphic characters, this species has been described from infraspecific taxa, var. *mettenianum*, var. *fauriei* (H. Christ) Tagawa, var. *isobasis* (H. Christ) Tagawa, and var. *teniufolium* Sa Kurata. Some pteridologists have identified two to four varieties (Nakaike, 1992; Iwatsuki et al., 1995). Ohta and Takamiya (1999) re-examined about four varieties of *D. mettenianum* complex in Japan based on morphology, cytology and taxonomy. According to a previous study, *D. mettenianum* in Korea is more typically similar to *D. mettenianum* var. *mettenianum* than other varieties based on having laminae margins crenulate, midveins crenate to serrate and unclear to distinct basal acroscopic vienlets (Table 1).

Key to the known allied taxa of *Diplazium mettenianum* var. *mettenianum* in Korea

1. Laminae 1 pinnate
 2. Pinnae margins serrated, distinctly auriculed in base; sori attached toward the midrib of pinna
..... *D. wichurae* 주름고사리
 2. Pinnae margins deeply torn to a little or the middle, no auriculed; sori attached toward the midrib of segments
.... *D. mettenianum* var. *mettenianum* 깃주름고사리
1. Lamina 2 pinnatifid or 3-4 pinnated
 3. Sori usually broad oblong or ovate or short cylindrical; indusia arch-liked, easily fallen
..... *D. virescens* 검정비늘고사리
 3. Sori short or long linear; indusia flat, opened to upward after mature, permanent
 4. Pinnules oblong, apex blunt or slightly pointed
 5. Stipes length more than 30 cm, rate of the rate of width/length less than 1/3, pinnules mostly no

Table 1. Comparative morphological characters between *Diplazium mettenianum* (Miq.) C. Chr. var. *mettenianum*, and related infraspecific taxa distributed in Japan of *Diplazium* [Tagawa, 1959; Iwatsuki, 1992; Kato, 1995; mainly referred Ohta and Takamiya (1999)].

Characters	<i>Diplazium mettenianum</i>			<i>D. griffithii</i>
	var. <i>mettenianum</i>	var. <i>faurieri</i>	var. <i>teniufollum</i>	
Habit	evergreen	evergreen	summer-green	evergreen
Rhizomes	long creeping	long creeping	short creeping	short creeping
Scales margin	weekly toothed	weekly toothed	entire	subentire to weekly toothed
Laminae length	19-42 cm	13-34 cm	20-38 cm	30-50 cm
Laminae texture	herbaceous, papyraceous	herbaceous, papyraceous	soft-herbaceous	papyraceous, coriaceous
Pinnae lobed	less than 1/3 to more than 2/3 lobed	1/3 lobed	more than 2/3 lobed	pinnate
Pinnae length (cm)	8.5-16	3-6	6.5-14.5	10.5-21
Maximum width lowest pinnae (cm)	2.1-5.5	0.8-1.8	3.5-6.3	3.5-6.0
Segments margin	crenulate, crenate to serrate	entire to crenulate	serrate	serrate
Lateral veins	simple to 1 forked	simple	1-3 forked	1-3 forked
Midveins	unclear to distinct basal 3/4 of whole lobes	no differentiation	distinct from basal 2/3 to almost whole lobe	clear differentiation
Sori type	double (unequal or split)	double (unequal)	double (equal, unequal or split)	single
Chromosome	4x = 164	4x = 164, 6x = 246	6x = 246	4x = 164

- overlapped *D. squamigerum* 내장고사리
5. Stipes length less than 30 cm, rate of the rate of width/length from 1/3 to 1/2, pinnules mostly overlapped
6. Hairs glandular hairs present on rachis of pinnae or pinnules
..... *D. sibiricum* var. *sibiricum* 두메고사리
6. Hairs glandular hairs absent on rachis of pinnae or pinnules
..... *D. sibiricum* var. *glabrum* 민두메고사리
4. Pinnules usually lanceolate, acute apex
7. Sori and indusia attached alternately face to face to midrib *D. mesosorum* 큰개고사리
7. Sori and indusia attached parallel to middle or nearby of segment margin and midrib
8. Scales and indusial margins serrated
..... *D. nipponicum* 큰섬잔고사리
8. Scales and indusial margin almost entire
9. Laminae 2 pinnatifid, scales brown; segment margins round; sori short linear
..... *D. hachizoense* 섬잔고사리
9. Laminae 3-4 pinnate, scales dark brown; segments deeply torn; sori linear *D. chinense* 암고사리

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