Sparganium glomeratum (Typhaceae): A new record from South Korea

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ABSTRACT: In this study, we report a new record of the clustered bur-reed *Sparganium glomeratum* (Laest. ex Beurl.) Beurl., from Yongneup Moor of Daeamsan Mt. in Gangwon-do, Korea. This species is distributed in the cool temperate and circumboreal regions of the Northern Hemisphere. As we recorded this species in a high-altitude wetland, we named it “Du-me-heuk-sam-neung” after the Korean word that translates to “*Sparganium* found in deep mountains.” We provide descriptions of the morphological characteristics, photographs, and detailed illustrations of *S. glomeratum*, as well as a key to allied taxa in Korea.

Keywords: clustered bur-reed, *Sparganium*, Typhaceae, Yongneup, Daeamsan Mt., unrecorded species

Since the mid-1800s, when the exploration of floristic diversity of the Korean Peninsula started, a total of 3,777 native vascular plant taxa were documented in this region (Chang et al., 2015; Korea National Arboretum, 2017). Although most taxa are well recognized and revised via several approaches (i.e., Asteraceae, Ranunculaceae, Cyperaceae, etc.) (Lee, 2018), some plant groups still need to be explored to catalogue the plant biodiversity of the Korean Peninsula.

One of such uninvestigated plant groups is the genus *Sparganium* (Typhaceae), which includes approximately 14–19 species occurring mainly in the Northern Hemisphere, though some species' ranges extend to some parts of Oceania (Cook and Nicholls, 1986, 1987; Sun and Simpson, 2010). Because this genus comprises a small number of species that are continuously widely distributed in the Northern Hemisphere, there are no local or regional endemic species, with a few controversial exceptions in China. Monographic studies for *Sparganium* were first conducted by Cook and Nicholl (1986, 1987) who divided this genus into two subgenera (i.e., *Xanthosparganium* and *Sparganium*) based on some morphological characteristics of the perianth. Recently, however, a phylogenetic study of *Sparganium* was conducted and the

classification of this genus was rearranged (Sulman et al., 2013).

Until recently, three *Sparganium* species (*S. erectum* L., *S. japonicum* Rothert, and *S. hyperboreum* Laest. ex Beurl.) were reported to inhabit the Korean Peninsula (Lee, 1980, 1996a, 1996b; Kim and Choi, 2007). In the last decade, as more taxonomic studies and field surveys were conducted, three more species, *S. fallax* (Kim et al., 2010), *S. subglobosum* (Lim et al., 2017), and *S. coreanum* (Ha et al., 2019), were documented in this area. However, there is still a possibility of more unrecorded species inhabiting the Korean Peninsula. Furthermore, Cook and Nicholls (1986) suggested that *S. glomeratum* (Laest. ex Beurl.) Beurl. and *S. emersum* Rehmann also occur in Korea, but more surveys are needed to confirm this.

In 2017, during the project of the Illustrated flora of Korea (Juncaceae, Eriocaulaceae, and Typhaceae), we conducted a field expedition to Yongneup Moor of Daeamsan Mt. (Yanggu city), located in the middle part of the Korean Peninsula, and found an unidentified and unrecorded population of *Sparganium*. For the exact identification of this species, we visited this location several times in order to examine flowers and fruits, which are important characteristics for the identification of *Sparganium* species. However, we were unable

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to find any flowers or fruits for two years and this seems due partly to a thick peat layer of Yongneup Moor, which made a harsh environment for *Sparganium* species. We collected a few individuals of this species as living collections and grew them in the greenhouse of the Korea National Arboretum. In June 2019, we were able to examine the reproductive morphological characteristics of this species and identified it as *S. glomeratum*. In addition, we conducted phylogenetic analyses of *Sparganium* species using nrDNA internal transcribed spacer, and the analyses included the population from this study, other *Sparganium* species in Korea, and data of Sulman et al. (2013). The results showed that Yongneup population was embedded in the *S. glomeratum* clade (maximum likelihood bootstrap

[ML BS] = 99%, Bayesian inference posterior probability [BI PP] = 1) and this clade was sister to the clade of *S. emersum* with moderate supporting value (ML BS = 63%, BI PP = 0.93) (Gil et al., 2018). In this study, we recorded *S. glomeratum* in the South Korea for the first time and we presented the description of its morphological characteristics, illustrations, and photographs of this species, along with a key to this and allied taxa in Korea.

Taxonomic Treatment

Sparganium glomeratum (Laest. ex Beurl.) Beurl., Arsberätt. Bot. Arbeten Upptäckter 1851: 221, 1855 (Figs. 1, 2).

Fig. 1. Photographs of *Sparganium glomeratum*. A. Habitat. B. Habit. C. Inflorescence stem. D. Male heads. E. Female head. F. Fruit. G. Endocarp.

Fig. 2. Illustrations of *Sparganium glomeratum*. **A.** Habit. **B.** Flowering inflorescence stem. **C.** Fruiting inflorescence stem. **D.** Cross sections of distal, middle, and proximal part of leaf. **E.** Male head. **F.** Male flower. **G.** Female head. **H.** Female flower, pistil, and perianth. **I.** Fruit with perianth, fruit, and perianth. **J.** Endocarp and its longitudinal (middle) and transversal (right) section.

Sparganium erectum var. *glomeratum* Laest. ex Beurl.,
Arsberätt. Bot. Arbeten Upptäckter 1850 (Bih. 1): 2, 1853.

Sparganium glehnii Meinsh., Bull. Acad. Imp. Sci. Saint-
Pci. Saint- 36: 34, 1895.

Sparganium glomeratum var. *angustifolium* Graebn.,
Pflanzenr. IV, 10: 20, 1900.

Sparganium manshuricum D. Yu, Bull. Bot. Res., Harbin
12: 255, 1992.

Description: Plants 50–70 cm tall, robust, erect, emergent, floating or submerged in deep water. Rhizomes creeping. Leaves linear, erect or floating, emergent or submerged, 29–55 cm long, 5–11 mm wide, abaxially carinate, triangular toward the base, sheathed at the base with membranous margin. Inflorescence axis erect, 11–23 cm long, non-branched; 1–2 male heads compacted on the upper part, 5–7 female heads on the lower part. Male head ca. 14 mm in diameter at anthesis,

Table 1. Morphological characteristics of *Sparganium* species in Korea.

Taxa	Ridges on endocarps	Pedunculate endocarp	No. of inflorescence branches	Sex composition of the lowermost inflorescence branch	Distance between female and male heads	Supra-axillary female heads	Width of leaves (mm)
<i>S. erectum</i>	○	○	3–5	♀+♂	Separate	×	10–20
<i>S. coreanum</i>	○	○	3–5	♀	Separate	×	5–23
<i>S. subglobosum</i>	×	×	0–1	♀+♂	Separate	×	2–4
<i>S. japonicum</i>	×	×	0	-	Separate	×	5–10
<i>S. fallax</i>	×	×	0	-	Separate	○	4–10
<i>S. glomeratum</i>	×	×	0	-	Adjacent	○	4–9
<i>S. hyperboreum</i>	×	×	0	-	Adjacent	○	1–3

Source: Cook and Nicholls (1986), Kim et al. (2010), Lim et al. (2017), Ha et al. (2019).

female heads adjacent to male heads, sessile, but the lowermost 1–2 female heads pedunculate, ca. 11 mm in diameter at anthesis. Male flowers with 3 perianths, spatulate, ca. 2 mm long. Stamens 3 or more, anthers 0.7–0.9 mm long, filaments 5–6 mm long. Female flowers with 3–6 perianths, oblong to spatulate, transparent, 2–3 mm long; carpels 1; ovaries lanceolate or narrow fusiform; stigmas 0.6–0.8 mm long. Fruits fusiform, 3.5–5 mm long, 1–2 mm diameter; exocarp fleshy, endocarp hard, smooth surface with longitudinal lines, pedunculate. Seeds ovate, ca. 2 mm long.

Phenology: Flowering Jun–Jul and fruiting Aug–Oct.

Distribution: Korea, Japan, China, Tibet, Russia, Norway, Sweden, Finland, Canada

Vernacular name: 두메흑삼릉(Du-me-heuk-sam-neung, Korean), clustered bur-reed (English).

Voucher specimens: KOREA. Gangwon-do: Inje-gun, Seohwa-myeon, Seoheung-ri, Daeamsan Mt., Yongneup, cultivated at KNA, 11 Jul 2019, *Hee-Young Gil GIL 2990* (KH); 1 Aug 2019, *Hee-Young Gil GIL2995* (KH).

Taxonomic notes: *Sparganium glomeratum* is distributed in the cool temperate and circumboreal regions of the Northern Hemisphere. Although the species is mainly distributed in Northern Europe and Eastern Asia, it also sporadically occurs in Russia, Tibet, and Canada (Cook and Nicholls, 1986; Grebenjuk, 2018). The known habitat of this species are small ponds and streams, and the species was rarely recorded on marginal parts of big lakes (Cook and Nicholls, 1986; Sun and Simpson, 2010). The presence of *S. glomeratum* in North Korea was suggested by Cook and Nicholl (1986), but this has not been confirmed to date as this species has never been documented in the Korean flora. During the field survey of Yongneup Moor located at the top of Daeamsan Mt., we found a population of *S. glomeratum*. Yongneup Moor (1,280 m a.s.l.) is well known as the first

Korean wetland registered in the Ramsar List of Wetlands of International Importance in 1997. It is a rare and valuable ecosystem because of its unique environmental conditions, including barren soil, cold temperature, and high humidity. A total of 227–294 vascular plant species were documented on this high altitude moor based on recent floristic surveys (Lee et al., 2007; Oh et al., 2013; Cho, 2016). This *Sparganium* population, however, has been identified as different species depending on the survey team [e.g., *S. stoloniferum* (= *S. erectum*) (Lee et al., 2003, 2007), *S. hyperboreum* (Cho, 2016), *S. stenophyllum* (= *S. subglobosum*) (Lee, 1969)]. *S. glomeratum* can be well distinguished from other *Sparganium* species in Korea by several morphological characteristics (Table 1). The species that is morphologically most similar to *S. glomeratum* could be *S. japonicum* or *S. fallax* because of certain common characteristics shared among these three species, such as non-branched inflorescence axis, length of the lowermost bract, leaves width. However, *S. glomeratum* differs from *S. japonicum* or *S. fallax* by the number of males heads and absence of gap between male and female heads. As *S. glomeratum* was found at a high altitude, we designated it with the Korean vernacular name Du-me-heuk-sam-neung (두메흑삼릉), meaning *Sparganium* found in deep mountains.

A key to *Sparganium glomeratum* and related taxa in Korea

1. Inflorescence axis 3–5 branched; stigmas and ovary locules 1–2; stigmas longer than ovary; endocarps with longitudinal ridges and without stalks 2
2. The lowermost inflorescence branch with male and female heads; stigmas 3–4 mm long; fruits 3–4.5 mm wide *S. erectum* (흑삼릉)

2. The lowermost inflorescence branch with single female head; stigmas 6–9 mm long; fruits 6–10 mm wide *S. coreanum* (조선흑삼릉)
1. Inflorescence axis never branched or rarely 1-branched (*S. subglobosum*); stigmas and ovary locules 1; stigmas shorter than ovary; endocarps without longitudinal ridges and with stalks 3
3. The lowermost inflorescence bract shorter than or equal to inflorescence axis; female heads never pedunculated *S. subglobosum* (가는흑삼릉)
3. The lowermost inflorescence bract longer than inflorescence axis; the lowermost 1–2 female heads pedunculated 4
4. Plants usually floating and submerged; leaves non-carinate (flat); width of leaves 1–3 mm
..... *S. hyperboreum* (좁은잎흑삼릉)
4. Plants usually erect and emergent; leaves carinate; width of leaves 3–11 mm 5
5. Female heads adjacent to male heads; number of male heads 1–3
..... *S. glomeratum* (두메흑삼릉)
5. Female heads separated from male heads; number of male head 6–10 6
6. Female heads axillary; inflorescence bracts ascending or spreading
..... *S. japonicum* (긴흑삼릉)
6. Female heads supra-axillary; inflorescence bracts erect *S. fallax* (남흑삼릉)

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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