New record of an alien plant, *Petrorhagia nanteuilii* (Caryophyllaceae) in Korea

Jeong-Ki HONG, Sang Deog SHIM¹, Hyun Sik KIM², Sunhee SIM³,
Chang Woo HYUN³ and Jung-Hyun KIM^{3*}

Animal and Plant Research Department, Nakdonggang National Institute of Biological Resources, Sangju 37242, Korea

¹Woori Botanical Garden, Gwangju 61431, Korea

²Korea Gas Corporation (Citizen Researcher), Daegu 41062, Korea

³Plant Resources Division, National Institute of Biological Resources, Incheon 22689, Korea

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ABSTRACT: *Petrorhagia nanteuilii* (Burnat) P. W. Ball & Heywood (Caryophyllaceae), native to western Europe and western North Africa and an introduced or alien plant in South America, Australia, and Japan, was newly found in Gyeongsangnam-do, Korea. *Petrorhagia* is clearly distinguished from other genera by a bract at the base of calyx, which differs from *Gypsophila* L., and commissures at the sepals, which is different from *Dianthus* L. *Petrorhagia nanteuilii* grows on slopes and roadsides, suggesting that it is likely to have been introduced through the installation of green sites and road construction. A precise description, illustration, photographs, and a key to related genera and species is provided.

Keywords: alien plant, Caryophyllaceae, new record, *Petrorhagia nanteuilii*

Caryophyllaceae Juss., include approximately 3,000 species in about 100 genera (Hernández-Ledesma et al., 2015). The family has a primarily North Temperate distribution and a diversity center in the eastern Mediterranean and Irano-Turanian regions. Its presence in the tropics and the southern hemisphere is limited and mostly confined to higher elevations (Bittrich, 1993; Rabeler and Hartman, 2005; Greenberg and Donoghue, 2011). Approximately 86 species of Caryophyllaceae, distributed among 17 genera (Hong and Choi, 2018), are in Korea. Kang et al. (2020) have reported 619 alien plants in Korea, including 21 taxa in the Caryophyllaceae.

Petrorhagia (Ser.) Link is a genus of 33 species distributed in the Mediterranean region, Europe and Western Asia (Ball and Heywood, 1964; Rabeler, 1985). In the past, it was considered to be part of such genera as *Dianthus* L., *Gypsophila* L., *Kohlrauschia* Kunth, and *Tunica* Scop. (Trigas et al., 2018). Evidence from both traditional and phylogenetic systematics supports its recognition as a distinct genus which is sister to a clade including *Dianthus* and *Velezia* L. (Ball and Heywood,

1964; Rabeler and Hartman, 2005; Greenberg and Donoghue, 2011; Trigas et al., 2018).

We here report the first occurrence of *Petrorhagia*, represented by *P. nanteuilii* in Korea (Figs. 1, 2). The Korean name for the genus is given as ‘Pae-raeng-i-a-jae-bi-sok’.

During a field survey of plant diversity in Gyeongsangnam-do, we found the unrecorded alien plant, *Petrorhagia nanteuilii*, in abandoned fields and roadsides in Goseong-gun, Korea. We here provide a description, illustrations, a taxonomic key to related taxa as well as habitat details.

Taxonomic Treatment

Description of the genus

Petrorhagia (Ser.) Link, Handbuch 2: 235, 1831; *Gypsophila* sect. *Petrorhagia* Ser. in DC., Prodr. 1: 354, 1824.

Type species: *Petrorhagia saxifraga* (L.) Link, Handbuch 2: 235, 1831.—TYPE: not cited.

*Author for correspondence: kimjh4065@korea.kr

Fig. 1. Photographs of *Petrorhagia nanteuilii* (Burnat) P. W. Ball & Heywood. **A.** Habit. **B.** Stem with leaf and sheath. **C.** Flowers (apical view). **D.** Capsule. **E.** Seeds.

Korean name: Pae-raeng-i-a-jac-bi-sok (패랭이아재비속).

Herbs, annual or perennial, hermaphroditic, dioecious or gynodioecious. Stems erect or ascending, simple or branched, sometimes proximally woody. Leaves opposite, simple, sessile; blade linear to narrowly oblanceolate, apex acute, margins entire, both surfaces glabrous or scabrous, 1- or 3-veined. Inflorescences terminal, dense capitula or lax cymes or flowers

solitary; bracts paired, often enclosing inflorescence; involucre bracteoles of 1–4 pairs or rarely absent. Flowers bisexual or unisexual; sepals basally connate, forming a tube, cylindrical, 15-veined, green or reddish and white or brown, scarious; lobes green, reddish, or brown, 3-veined, oblong, shorter than tube, margins white or brown, scarious, apex rounded; petals 5, pink, purplish or white, clawed, auricles absent, coronal appendages absent, apex entire, obtuse or 2-fid; stamens 10; filaments

Fig. 2. Illustrations of *Petrorhagia nanteuilii* (Burnat) P. W. Ball & Heywood. **A.** Habit. **B.** Stem with leaf and sheath. **C.** Flower (apical view). **D.** Involucre bract. **E.** Capsule. **F.** Seeds (a, ventral view; b, dorsal view).

distinct; staminodes absent; ovary 1-locular; styles 2; filiform; stigmas 2, linear, along adaxial surface of styles, papillate. Fruit capsules, 4-lobed, oblong, shorter than sepals. Seeds 8–15, blackish brown, shield- or helmet-shaped, dorsiventrally compressed, reticulate or papillate, marginal wing absent, embryo central, straight.

Key to *Petrorhagia* and related taxa in Korea

1. Bracts absent at base of calyx ... *Gypsophila* 대나물속
1. Bracts present at base of calyx.
 2. Commissures between adjacent sepals present; veins per sepal 1–3 *Petrorhagia* 패랭이아재비속
 2. Commissures between adjacent sepals absent; veins per sepal 5 or more *Dianthus* 패랭이꽃속

Description of the species

Petrorhagia nanteuilii (Burnat) P. W. Ball & Heywood, Bull. Brit. Mus. (Nat. Hist.), Bot. 3: 164, 1964; *Dianthus nanteuilii* Burnat, Fl. Alpes Marit. 1: 221, 1892 (Figs. 1, 2).—TYPE: not cited.

Korean name: Pae-raeng-i-a-jae-bi (패랭이아재비).

Herbs, annual, 20–50 cm tall, glabrous, or partly tomentose. Stems erect, simple or branched; internodes glabrous or mid stem and proximal ones minutely stipitate glandular. Leaves opposite, simple, sessile; blade linear, 1–3 cm long, apex acute, margins scabrous, 3-veined; sheath 1–2(–3) mm long, 1.5–2 times longer than wide. Inflorescences terminal, capitate; inflorescence bracts and involucre bracteoles enclosing flowers, broadly ovate, brown scarious, apex of outer bracts mucronate, inner bracts obtuse or mucronate; pedicels 0.1–2 mm long. Flowers: calyx 5–10 mm long, calyx-lobes obtuse, membranous; petals pink or purplish, 5–10 mm long, primary veins 3, central vein darkly colored near base of blade, apex obcordate or 2-fid; stamens 10, slightly exserted; styles 2, exserted. Capsules ellipsoid-ovoid, ca. 6 mm long. Seeds brownish black, shield shaped, 1–1.5 mm long, tuberculate.

Flowering: May to June.

Fruiting: June to July.

Distribution: Korea, Asia, Australia, South America, western Europe, western North Africa

Specimens examined: KOREA. Gyeongsangnam-do: Goseong-gun, Goseong-eup, Su-nam-ri, 13 Jun 2020, *Hyun Sik Kim* KIMJH20155, KIMJH20156, KIMJH20157, KIMJH20158 (KB); same locality, 17 Jun 2021, *Jung-Hyun Kim & Seog*

Table 1. Classification of invasive alien plants in Korea.

Grades of spread	Classification	No. of places
V (WS)	Widespread	>100
IV (SS)	Serious spread	75–100
III (CS)	Concerned spread	50–74
II (MS)	Minor spread	25–49
I (PS)	Potential spread	<25

woo Kwon KIMJH21089, KIMJH21090, KIMJH21091, KIMJH21092, KIMJH21093, KIMJH21094 (KB); same locality, 20 Jun 2021, *Sang Deog Shim & Hyun Sik Kim* KIMJH21095, KIMJH21096, KIMJH21097 (KB).

Notes: *Petrorhagia nanteuilii* is native in western Europe and western North Africa, whereas it is an alien in South America, Australia, and Japan (Osada, 1972, 1989; Auld et al., 2003; Shimizu, 2003; Rabeler and Hartman, 2005). It may be an allopolyploid derived through hybridization between *P. prolifera* and *P. dubia* in Europe (Thomas and Murray, 1983). We first found *P. nanteuilii* on roadsides in Goseong-gun, Gyeongsangnam-do, in Korea in 2019 and confirmed its presence during the flowering seasons of 2020 and 2021. The population was composed of 2,000 individuals within an area of 50 × 20 m². The canopy vegetation included *Ulmus pumila* L.; the herbaceous vegetation was made up of *Stellaria alsine* var. *undulata* (Thunb.) Ohwi, *Lespedeza cuneata* (Dum. Cours.) G. Don., *Medicago lupulina* L., *Vicia sativa* subsp. *nigra* (L.) Ehrh., *Oenothera biennis* L., *Erodium cicutarium* Willd., *Torilis japonica* (Houtt.) DC., *Metaplexis japonica* (Thunb.) Makino, *Amethystea caerulea* L., *Veronica persica* Poir., *Bidens pilosa* L., *Coreopsis lanceolata* L., *Erigeron annuus* (L.) Pers., *Bromus japonicus* Thunb., *Eragrostis curvula* (Schrud.) Nees, and *Setaria viridis* (L.) P. Beauv.

Thousands of individuals of *Petrorhagia nanteuilii* now grow at high density in the site where it was found. Additional populations will probably be discovered. According to the invasive grades (Table 1) categorized by Jung et al. (2016), *P. nanteuilii* is classified as a potential invasive species, since no additional sites have been found. Nevertheless, considering its population size and rate of seed set, a grade adjustment may be necessary in the future due to its spread.

ORCID: Jeong-Ki HONG <https://orcid.org/0000-0002-5450-8331>; Sang Deog SHIM <https://orcid.org/0000-0002-7437-3972>; Sunhee SIM <https://orcid.org/0000-0001-9788-7653>; Chang Woo HYUN <https://orcid.org/0000-0001-9677-5270>; Jung-Hyun KIM <https://orcid.org/0000-0003-2699-5635>

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Conflicts of Interest

The authors declare that there are no conflicts of interest.

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