

A New Record for Invasive Alien Plant: *Melilotus dentatus* (Waldst. & Kit.) Desf. (Fabaceae) in Korea

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Abstract - *Melilotus dentatus* (Waldst. & Kit.) Desf. is an invasive plant native to Europe, Russia, Uzbekistan, Mongolia and China. It was introduced to North America to create grazing areas for livestock; its growth has since become uncontrollable. *Melilotus dentatus* is now found in Namyang-eup, Hwaseong-si, Gyeonggi-do, South Korea as an alien plant. This species is morphologically similar to *Melilotus suaveolens* Ledeb. and *Melilotus officinalis* (L.) Lam. *M. dentatus* differs from other species based on its oblong leaflets, distinct teeth, two ovules, surface of the legume that is minutely reticulate-nerved or smooth, and seeds that are dark green to greenish brown. Here, we have provided a detailed description and photographs of the alien species *M. dentatus* as well as an updated key to five *Melilotus* taxa studied, which will help prepare a continuous monitoring and management plan.

Key words – Banat sweet clover, Fabaceae, Invasive alien plant, *Melilotus dentatus*

Introduction

Fabaceae Lindl. is the third largest family of flowering plants, containing 730 genera and more than 19,400 species distributed worldwide (Ahmad *et al.*, 2016; Pedrol *et al.*, 2018). Several species are economically important; for instance, legumes are used as a food source, and they fix atmospheric nitrogen via a symbiotic relationship with bacteria (Aboel-Atta, 2009; Conn *et al.*, 2008; POWO, 2019; Seo *et al.*, 2022; Yan *et al.*, 2017). However, Fabaceae is also a family that has many species spread around the world because they coexist with bacteria and are highly adaptable even in barren areas (Fort *et al.*, 2015; Zhao *et al.*, 2021).

Melilotus (L.) Mill. (Fabaceae: Trifolieae) comprises 20 taxa, which are distributed in central and eastern Europe, Mediterranean countries, Asia, and North America (Bobrov, 1945; Isely, 1954; Langran *et al.*, 2010). Many species are considered weeds in arable land, and they primarily grow in disturbed areas (Lee *et al.*, 2022); in few areas, they are treated as invasive alien plants that cannot be controlled owing to their extensive spread (Conn *et al.*, 2008; Conn and Seefeldt,

2009; GBIF Secretariat, 2021).

Morphologically, *Melilotus* is clearly distinguished from related genera based on characteristics such as the leaflet margin, stipules attached to the petiole base, long raceme, and legume character (Choi, 2018; Isely, 1954). In Korea, a total of four species of alien plants have been reported, including *Melilotus suaveolens*, *Melilotus albus*, *Melilotus indicus*, and *Melilotus officinalis*, which are native to Europe and Asia (Kim *et al.*, 2019; Korea National Arboretum, 2021).

In this study, the identity and surrounding growth environment of *Melilotus* population found in Namyang-eup, Hwaseong-si, Gyeonggi-do were examined (Fig. 1). Based on the results, we provided the detailed species descriptions, photograph of *Melilotus dentatus*, and an identification key for all species of *Melilotus* that are found in Korea.

Materials and Methods

We examined the external morphological characteristics of live, immersed, and dried specimens collected between August 2021 and August 2022 from Namyang-eup, Hwaseong-si, Gyeonggi-do. An electronic Vernier caliper (Mitutoyo 500-196-30 absolute digimatic Vernier caliper; Mitutoyo, Kanagawa,

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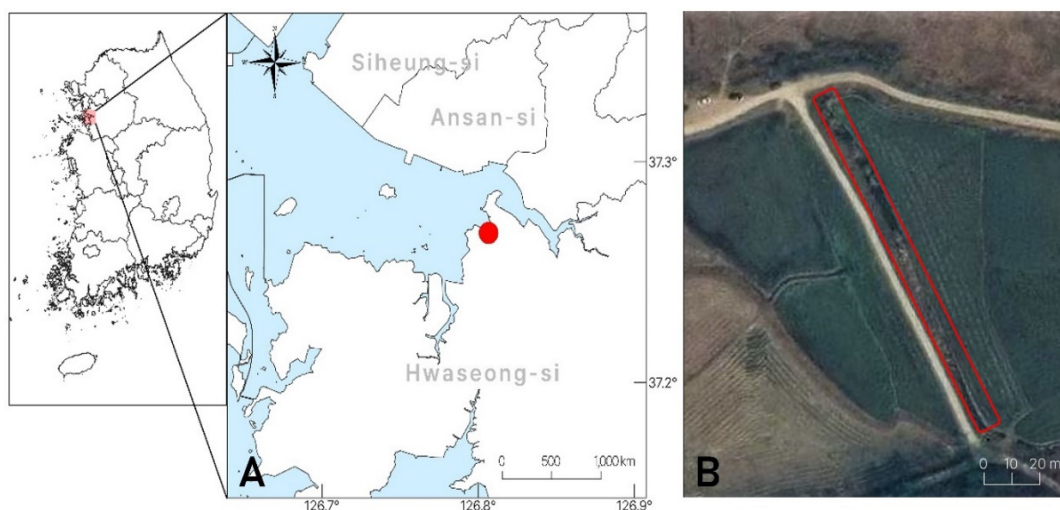


Fig. 1. Location of the first record of *Melilotus dentatus* (Waldst. & Kit.) Desf. A. Map of the collection site (Red circle, site), B. Satellite photograph of collection site (Red rectangle, population range and research area).

Japan) was used to measure the plant characters, and the growth site and morphological features of plants were recorded using a digital camera (Nikon D810, Nikon 105 mm AF Micro-Nikkor; Nikon, Tokyo, Japan) and a stereo microscope (Leica MZ7.5, CLS 150X Microscope Cold Light Source; Leica, Wetzlar, Germany) to prepare photographs. We reviewed related literature for the identification of the species (Choi, 2018; Kim *et al.*, 2019; Langran *et al.*, 2010; Ohwi, 1965) and generated the species description and key to taxa based on our observations. The voucher specimens were stored in the Korea National Arboretum (KH).

Results

Taxonomic Description

Melilotus dentatus (Waldst. & Kit.) Desf., Tabl. École Bot. 188, 1804 (Fig. 2, 3).

Trifolium dentatum Waldst. & Kit., Descr. Icon. Pl. Hung. 1:41, 1801; *Sertula dentata* (Waldst. & Kit.) Kuntze, Revis. Gen. Pl. 1:205, 1891; *Medicago dentata* (Waldst. & Kit.) E.H.L.Krause, J.Sturm, Deutschl. Fl. Abbild., ed. 2. 9: 124, 1901; *Trigonella dentata* (Waldst. & Kit.) Coulot & Rabaute, Mesogene Biocosm 31: 149, 2014.

Herb biennial. **Stems** erect, branched, terete, longitudinally ridged, 50–140 cm tall, red or green. **Leaves** alternate, 3-folio-

late; stipules lanceolate, 1–2 pairs on petiole base, 6–8.4 mm long, green, sometimes red at apex; petioles 6.2–10.8 mm long, hair; leaflets oblong to oblanceolate, 2–3 × 0.4–0.5 cm, green, margin needle-shaped teeth, 9–12 pairs on a side, longest apex teeth. **Inflorescence** raceme, 2.4–5 cm long, 28–43 flowers; peduncle and pedicel hair. **Flowers** calyx 1.8–2.2 mm long, hair, lobes 5, lanceolate; petals 3.4–4.3 mm long, standard slightly longer than wings and keel, yellow; stamen 10, diadelphous; pistil 1; ovary elliptic, ovule 2. **Fruits** legume, ovate to globular, 3.3–3.5 × 2–2.4 mm, green or partially pale red, surface minute reticulate nerved or smooth. **Seeds** 1–2, broadly elliptic to rounded, 1.8–2.4 × 1.6–1.8 mm, dark green or greenish brown.

Korean name: Seo-yang-jeon-dong-ssa-ri (서양전동싸리)

English name: Banat sweet clover

Flowering and fruiting season: August to October

Distribution: Europe, Central Asia, China / North America, Japan, Korea (introduced)

Distribution in Korea: Gyeonggi-do (Hwaseong)

Specimens examined: South Korea. Gyeonggi-do: Hwaseong-si, Namyang-eup, munho-ri, 18. Aug. 2021, J. S. Kim *KJS938* (3 sheets, KH); same locality, 26 Aug. 2021, K. H. Lee and B. K. Park *munhori 210826* (2 sheets, KH); same locality, 16 Aug. 2022, E. S. Kang and S. R. Lee *munhori 220816* (8 sheets, KH).

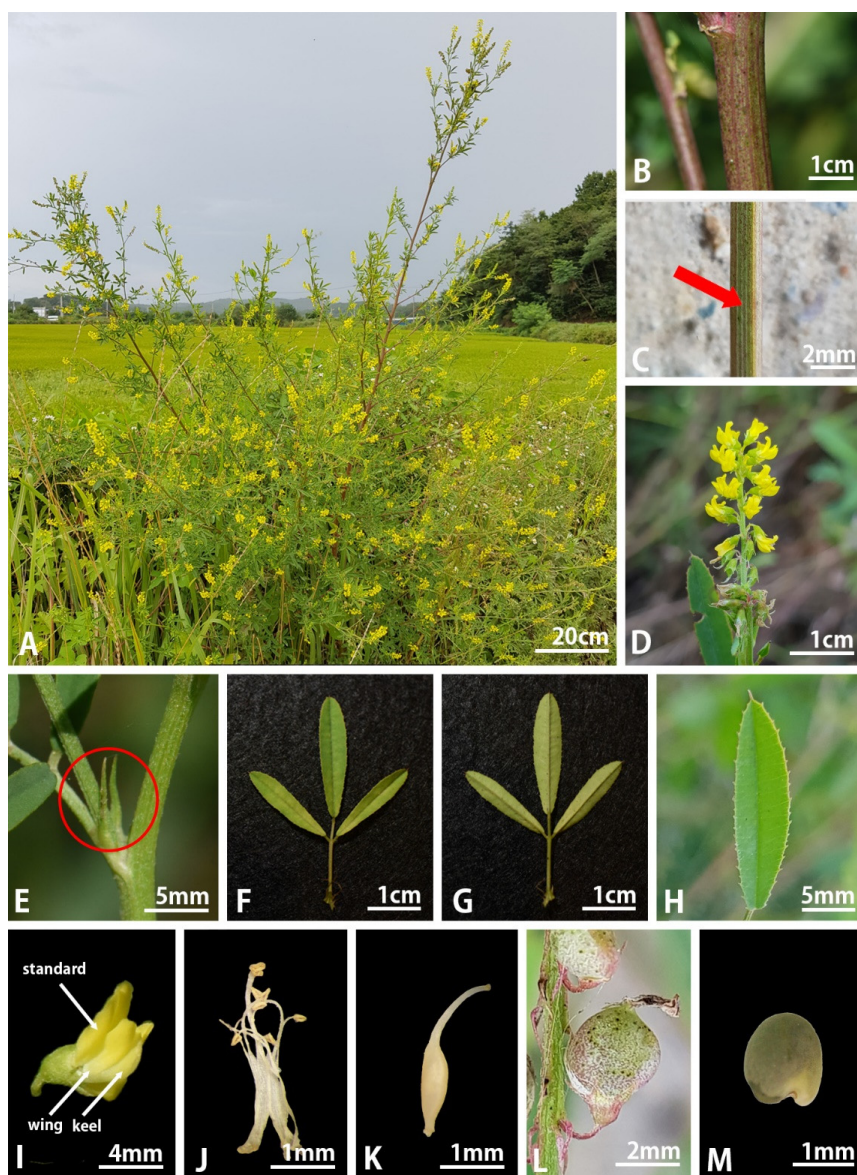


Fig. 2. Photographs of *Melilotus dentatus* (Waldst. & Kit.) Desf. A. Habitat, B. Stem, C. Branched stem (the red arrow indicates longitudinally ridges in the stem), D. Inflorescence, E. Stipule (the red circle indicates a stipule at the base of the petiole), F. Adaxial leaf, G. Abaxial leaf, H. Leaflet, I. Flower (standard slightly longer than wings and keel), J. Diadelphous stamens, K. Pistil, L. Fruit, M. Seed.

Habitat and Ecology

Melilotus dentatus mainly inhabits areas affected by frequent disturbances, such as grasslands, farmlands, parks, and industrial facilities (Tabaka *et al.*, 1988). In Korea, *M. dentatus* was found on the roadside between paddy fields in moist soil and sunny environments (Fig. 1, 2A). Regarding surrounding plants, *Rubus parvifolius* L., *Morus bombycis* Koidz., *Morus alba* L., *Rosa multiflora* Thunb., and *Robinia pseudoacacia* L. form a

shrub layer. In the herbaceous layer, *Conyza canadensis* (L.) Cronquist, *Artemisia indica* Willd., *Artemisia codonocephala* Diels, *Oenothera biennis* L., *Pennisetum alopecuroides* (L.) Spreng., *Sonchus brachyotus* DC., *Eleusine indica* (L.) Gaertn., *Rubia cordifolia* L., *Symphytichum pilosum* (Willd.) G.L.Nesom, *Cirsium japonicum* Fisch. ex DC. var. *maackii* (Maxim.) Matsum., *Leonurus japonicus* Houtt., *Lythrum salicaria* L., *Calystegia dahurica* (Herb.) Choisy, *Metaplexis japonica* (Thunb.)



Fig. 3. Voucher specimen of *Melilotus dentatus* (Waldst. & Kit.) Desf. (KH).

Makino, *Commelina communis* L., *Aegilops cylindrica* Host, and *Rumex crispus* L. grow together.

Key for identification of the genus *Melilotus* in Korea

- 1. Flowers white *M. albus* Medik. 흰전동싸리
- 1. Flowers yellow.
 - 2. Plants 20-50 cm tall; flowers 2-3 mm long
..... *M. indicus* (L.) All. 좁전동싸리
 - 2. Plants 50-150 cm tall; flowers 3.4-7 mm long.
 - 3. Stipules lanceolate; leaflets needle-shaped teeth; fruits ovate to rounded; seeds dark green or greenish brown *M. dentatus* (Waldst. & Kit.) Desf. 서양전동싸리
 - 3. Stipules linear; leaflets serrate; fruits ovate-elliptic; seeds yellowish brown.
 - 4. Leaflets oblanceolate to obovate; flowers 3.5-5 mm long; calyx lobes shorter than calyx tubes; fruits reticulated nerved surface
..... *M. suaveolens* Ledeb. 전동싸리

- 4. Leaflets elliptic to oblong; flowers 5-7 mm long; calyx lobes same as calyx tube; fruits transverse nerved surface *M. officinalis* (L.) Lam. 주름전동싸리

Discussion

Most *Melilotus* species are native to Europe, Central Asia, and China. Currently, *M. albus*, *M. officinalis*, and *M. dentatus* have been introduced into North America in the United States and into Canada (GBIF Secretariat, 2021; Tabaka *et al.*, 1988; Turkington *et al.*, 1978). *Melilotus* species are mainly found in artificial environments, such as cultivated fields, parks, and gardens (POWO, 2019).

Common characteristics among Korean *Melilotus* taxa include 3-foliolate leaves, stipules on petiole base, long racemes, and elliptic to globular legumes. *M. dentatus* plants are 50-140 cm tall, display yellow flowers, and the leaves and flowers are less than 1 cm long when viewed with the naked eye. *M. suaveolens* cannot be easily distinguished from *M. officinalis*. However, the oblong leaflets of *M. dentatus* can be distinguished from the leaflets of *M. suaveolens* (Fig. 2H). Furthermore, *M. dentatus* has a calyx length of 1.8-2.2 mm and reticulated or smooth fruit surface, whereas *M. officinalis* has a calyx length of 2.5-3 mm and a transverse nerved fruit surface. *M. dentatus* has lanceolate stipules (Fig. 2E), needle-shaped leaflet margin, and dark green or greenish brown seeds (Fig. 2M) which can be distinguished from features of other species of *Melilotus* (Bobrov, 1945; Ohwi, 1965; Choi, 2018; Kim *et al.*, 2019).

In comparison with other legumes, *M. dentatus* has high resistance to drought, cold damage, and pests, and it has a low coumarin content, which makes it suitable for fodder production. *M. dentatus* is particularly useful for re-cultivation and soil restoration in salty soils (Muntyan *et al.*, 2012). However, few studies have raised concerns regarding the environmental impacts of *Melilotus*. *M. albus* and *M. officinalis* have been reported to adversely affect native species in the Rocky Mountains of Colorado, USA, leading to a decrease in biodiversity (Wolf *et al.*, 2003). Additionally, seeds can germinate in soil without dormancy for at least 20 years, even in low-temperature regions like Alaska. The seeds spread rapidly along the water system to form a new population, and controlling

their spread is difficult (Conn *et al.*, 2008; Conn and Seefeldt, 2009).

Although there are no domestic ecological risk studies on *M. dentatus*, it is presumed that *M. dentatus* was first introduced unintentionally together with crop seeds from arable land, considering the cases of overseas spread and the surrounding environment. It is highly likely to spread across arable land. Since there is a concern that *M. dentatus* may have a direct impact on the production of crops in arable land in the future, additional research on the spread and inflow is necessary, and the preparation of a continuous monitoring and management plan is urgently required.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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