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***Erodium amanum*, a new record for the flora of Iran**

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The genus *Erodium* comprising nearly 74 species is almost a cosmopolitan taxon, however, the Mediterranean basin harboring about 80% of all species is considered the species diversity center of this genus. *Erodium amanum* reported here as a new record for the flora of Iran, is a dwarf dioecious perennial plant growing in a few restricted habitats at alpine steppes of NW of Iran. The genus is currently represented by 12 annual and four perennial species in Iran, of which only one is endemic. Its description, geographical distribution map, photos, and morphological comparison with its close species are provided.

Keywords: Alpine flora, *Erodium*, *Geraniaceae*, rare species, subendemic species***Erodium amanum* گزارشی جدید برای فلور ایران***

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خلاصه

جنس *Erodium* یا نوک لک‌لکی با حدود ۷۴ گونه، یک آرایه جهان‌وطن به شمار می‌رود. با این وجود، حوزه دریای مدیترانه که تقریباً ۸۰ درصد گونه‌ها را در بر می‌گیرد، به عنوان کانون تنوع گونه‌ای این جنس شناخته می‌شود. در بررسی حاضر، *Erodium amanum* به عنوان گزارشی جدید برای فلور ایران معرفی می‌شود. با احتساب این گونه، جنس نوک لک‌لکی با ۱۲ گونه یک‌ساله و چهار گونه چندساله در ایران حضور دارد که از میان آن‌ها تنها یک گونه انحصاری است. گونه مذکور گیاهی کوتاه قد، دوپایه و چندساله است که در رویشگاه‌های محدودی در استپ‌های مرتفع شمال‌غرب ایران می‌روید. شرح گیاه‌شناسی، نقشه پراکنش، تصاویر و جدول مقایسه ریخت‌شناسی آن با گونه‌های مشابه آرایه شده است (شکل‌های ۱ و ۲).

واژه‌های کلیدی: تیره شمعدانی، فلور آلپی، گونه نادر، گونه نیمه‌انحصاری، نوک لک‌لکی

Introduction

Erodium L'Hér. ex Aiton by around 74 species after *Geranium* Tourn. ex L. (with nearly 430 spp.) and *Pelargonium* L'Hér. ex Aiton (with nearly 200 spp.) is the third-largest genus of the *Geraniaceae* (the cranesbill family). Despite its intercontinental distributional range (including Europe, Asia, Africa, N and S America, and Australia), the Mediterranean basin where harbors with more than 80% of all species is considered the diversity center of *Erodium* (Alarcón *et al.* 2011, Aldasoro *et al.* 2000, Fiz *et al.* 2006). The main diversification of the species-richest clade of *Geraniaceae* containing *Geranium* and *Erodium*, probably has been occurred in late Miocene and Pliocene in the Mediterranean basin and Eurasia (Fiz *et al.* 2008).

Members of *Erodium* (stork's-bills) as both morphologically similar and evolutionary close relatives to the genus *Geranium* (cranesbills), are still distinguished by characteristics of their androecium (five fertile stamens and five staminodes vs. 10 stamens all-fertile) and leaf venation (subpinnate to pinnate vs. palmate) (Fiz *et al.* 2006, 2008). The genus *Erodium* is the most diverse group within the family from the points of view of lifespan and breeding systems (Alarcón *et al.* 2011). Flowers of some *Erodium* species are equipped with functionally specialized shining spherical trichomes mimicking nectar droplets. Furthermore, their petals are veined with darkly patterned marks called flower guides. These colored signs accompanied by glistening hairs and spectacular petals via increasing the attractiveness efficiency address pollinator insects toward the nectar presence sites (Aldasoro *et al.* 2000).

The wide-ranging geographical and ecological distributions and especially close evolutionary relationships among *Erodium* species on different continents are reflections of their high capability in long distance dispersal and colonization (Fiz *et al.* 2006, 2010). Although, the genus is not relatively much used in ethnomedicine, the anti-inflammatory and antimicrobial properties of some *Erodium* species have been studied

and several species are traditionally used in the treatment of some health problems (Munekata *et al.* 2019).

In the Flora Iranica account for the genus *Erodium*, 13 species have been reported for the flora of Iran (Schönbeck-Temesy 1970). *Erodium litwinowii* Woronow (Faghihnia & Naseh 2002) and *E. absinthoides* subsp. *armenum* (Trautv.) P.H. Davis (Assadi 1984) were later recorded and altogether 15 species were included in the Flora of Iran (Janighorban 2005). Excluding *E. dimorphum* Wendelbo which is a narrow endemic to N Iran, all other members are widely spread species in the world, e.g., *E. moschatum* (L.) L'Hér. and *E. cicutarium* (L.) L'Hér. (Fiz *et al.* 2010, Alarcón *et al.* 2011) have the widest latitudinal ranges within the genus and are distributed all over the world except the Antarctica. In addition, the genus is represented in Iran by three perennial and 12 annual habits.

First described from Turkey and later recorded from Armenia (Davis 1967), *E. amanum* has been known as a subendemic species of Turkish Flora. The present study reports *E. amanum* Boiss. & Kotschy for the first time for the flora of Iran, which is a rare perennial species constricted to alpine snow-bed habitats in NW of Iran. Morphological description, habit and habitat photos, as well as its distribution map are also represented.

Materials and Methods

During floristic studies in NW Iran (e.g., Bahadori *et al.* 2016, 2021, 2022, Mahmoodi *et al.* 2015, 2016, 2017, 2022), an unrevealed alpine species was collected in 2021. The material was compared with all specimens of *Erodium* in TARI and images of related species in K, E, B, W, WU, and G herbaria (acronyms according to Thiers 2017), and finally using related literature (Boissier 1867, Davis 1967, Schönbeck-Temesy 1970) could be identified as *Erodium amanum*, which was not before reported for the flora of Iran. The voucher specimen was preserved at the herbarium of research Institute of forests and rangelands (TARI-108907). The species was described and compared with its close species in the area.

Both the literature and herbarium specimens were investigated to describe the diagnostic characteristics of the species included in the morphological comparison (Table 1). The general characteristics of its pollen

grains were also studied using Olympus BX51 light microscope. Finally, the geographical distribution map of the recorded species was provided using QGIS v. 3.22.3 software based on both inferred and projected sites.

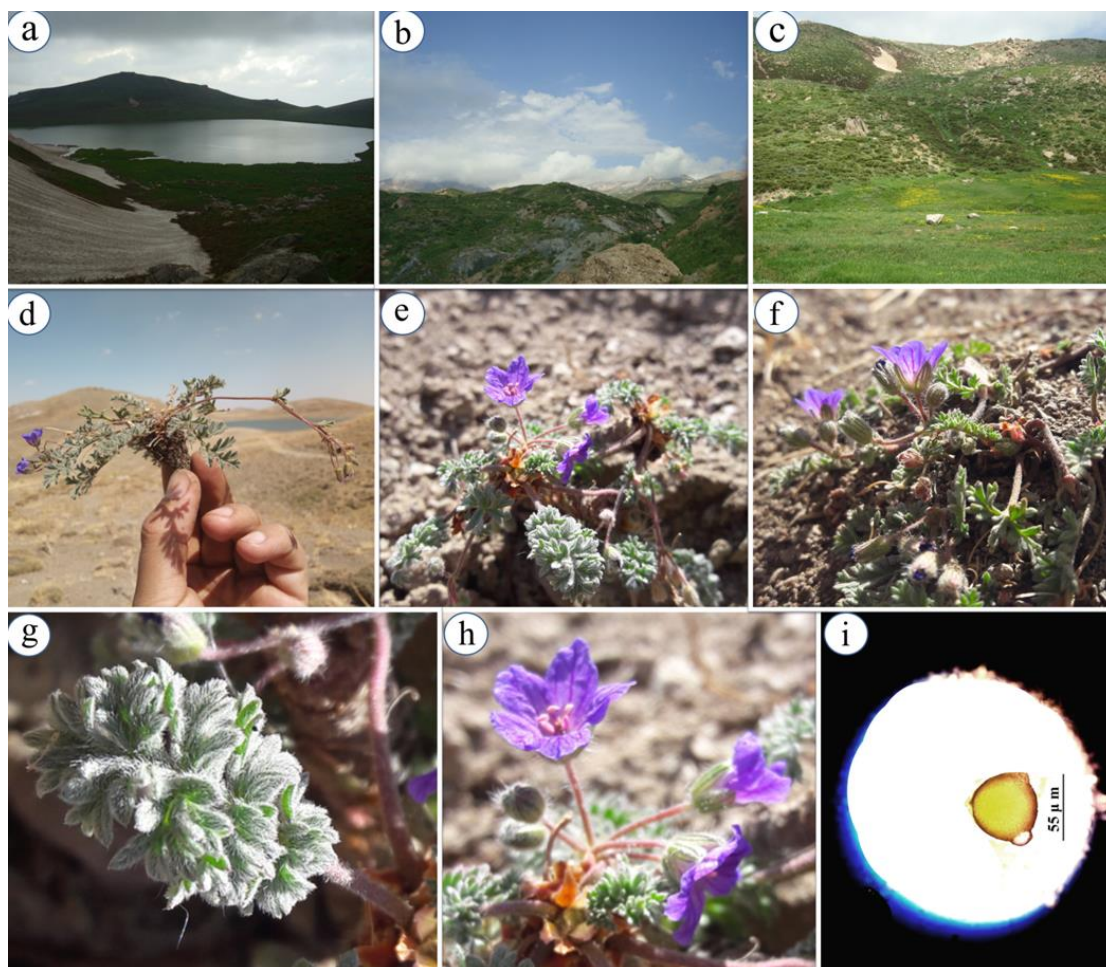


Fig. 1. *Erodium amanum*: a-c. Habitat (Dalamber dağı, Urmia, W. Azerbaijan), d-f. Habit, g. Close view of leaf, h. Male flower, i. Tricolpate pollen grain in polar view (Photos: a-c, A.H. Sohi, d-i, E. Jarchi).

Results and Discussion

Erodium amanum Boiss. & Kotschy, *In*: Boiss., *Fl. Or.* 1: 887 (1867) (Fig. 1)

Type: alpine rocky highlands of Akmadagh, Hatay, Turkey

Caespitose, dioecious perennial herb with branched rhizomes. Stems 5–8 cm long, decumbent to ascending, retrorsely hirsute to glandular-pubescent. Basal leaves densely 2–3-pinnatisect, blade ovate 1–4.5 × 0.5–1.7 cm, rachis winged, densely and patently pubescent, sparsely glandular, segments shortly oblong, apex obtuse; petiole 1.5–5 cm long, furrowed, patently pubescent and rarely glandular; cauline leaves sessile or shortly petiolate (to 0.5 cm), densely 1–3-

pinnatisect, blade ovate 0.5–1.5 × 0.4–0.7 cm, densely and patently pubescent, sparsely glandular; stipules triangular, 5–11 mm long, membranous, light to dark brown, ciliate. Peduncle 2–4 cm long, retrorsely hirsute with glandular hairs.

Inflorescence a bracteate 3–5-flowered umbel-like cyme; bracts 2–4, triangular, 0.5–1 × 0.2–0.5 mm; pedicels 2–4 cm, sparsely glandular-villous; flowers unisexual; nectaries present; sepals linear-lanceolate, apex acuminate with 0.2–0.4 mm long awns, membranous with 3–5 greenish veins, 4–4.5 × 1–1.5 mm, glandular-pubescent, sparsely simple haired (0.5–1.2 mm); petals imbricate, purple (dark violet when dried), 3–5-darkly

veined, $6-7 \times 2.5-3$ mm, hairy at base, claw 0.4 mm, densely hairy (0.5–0.7 mm); androecium with five fertile stamens in an inner and five staminodes in an outer whorl, filaments 2–3 mm long, subulate, rarely hairy, anthers 1–1.2 mm, longitudinally dehiscent, dorsifixed. Pistillode (in male flowers) 2–2.5 mm. Ovary 5-carpeled, 5-loculed, 10-ovuled, style accrescent with five stigmas, fruit schizocarpic, about 1/3 as long as the beak, villose, mericarps indehiscent, separating by a 3–4 cm longed persistent and stout beak, seeds oblanceolate, 5×1.6 mm, surface reticulated. Pollen grains monad, isopolar, spheroidal, radially symmetrical, tricolporate.

Specimens examined: IRAN: W. Azerbaijan, Urmia, Zeyveh, Dalamper mountain, rocky slopes, around the lake of Dalamper, $37^{\circ}10'58''$ N, $44^{\circ}48'31''$ E, 2720 m, 07.8.2021, Bahadori & Jarchi (TARI-108907). *Erodium absinthoides* subsp. *armenum*: E. Azerbaijan prov., 20 km from Ahar to Tabriz, $38^{\circ}24'33''$ N, $46^{\circ}53'01''$ E, 1800 m, Assadi & Wendelbo (TARI-27925); W. Azerbaijan prov., Maku to Khoy, South Western slopes of Kilisa Kandi mountain, $38^{\circ}41'35''$ N, $44^{\circ}22'34''$ E, 2650 m, Assadi & Mozaffarian (TARI-30323); 50 km from Khoy to Siahcheshmeh, $38^{\circ}48'10''$ N, $44^{\circ}33'26''$ E, 1880 m, Assadi (TARI-52228). *Erodium absinthoides* subsp. *absinthoides*: TURKEY: Bitlis, Van, 10 km SE of Felli, $38^{\circ}09'20''$ N, $43^{\circ}05'43''$ E,

2515 m, Davis & Polunin (D-22563). *Erodium dimorphum*: Semnan prov., N of Semnan, Nazva mountain, $35^{\circ}56'35''$ N, $53^{\circ}17'54''$ E, 3500 m, Assadi & Ranjbar (TARI-82086); IRAN: Tehran prov., ca. 31 km from Firoozkuh to Semnan, Basm pass, $35^{\circ}43'33''$ N, $53^{\circ}02'17''$ E, 2600 m, Assadi & Mozaffarian (TARI-40333).

Habitat and ecology: *E. amanum* in NW of Iran (Dalamper Dağı) inhabits rocky highland steppes at an estimative altitudinal range of about 2700–2850 m a.s.l.

The species in the area is usually associated with shrubby, geophyte or herbaceous plants such as *Ononbrchysis cornata* (L.) Desv., *Crocus specioes* M. Beib., *Thymus pubescens* Boiss. & Kotschy ex. Čelak., *Astragalus leiophyllus* Freyn & Bormm. (sect. *Adiaspastus*), *A. hirticalyx* Boiss & Kotschy. (sect. *Hymenostegis*), *Jurinella moschus* subsp. *pinnatisecta* (Boiss) Danin & Davis., *Cirsium lappaceum* (M. Bieb.) Fisch., and *Oxyria digyna* (L.) Hill. At the same altitudinal zone in the area, *C. hygrophilum* Boiss, *Primula auriculata* Lam., *Gentiana verna* L., and *Bistorta major* Gray. are well-established in more humid habitats.

Phenology: The species in W. Azerbaijan blooms about early July to late August.

General distribution: Turkey, Armenia, and NW of Iran (Fig. 2).



Fig. 2. Geographical distribution of *Erodium amanum*, *E. absinthoides* subsp. *armenum*, and *E. dimorphum* in Iran.

Note: Based on studies, many perennial species of *Erodium* have medium to high pollen/ovule (P/O) ratios and are dichogamous mixed-mating species endemic to the mountain ranges of the Mediterranean. In contrast, the annual species of this genus, often adapted to disturbed sites, are adichogamous selfers with low P/O ratios and extended distribution areas (Alarcón *et al.* 2011). Accordingly, *E. amanum* is an obligate out-crosser perennial species and exhibits a narrow distributional range adapted to mountainous habitats. In addition, the only endemic species of the genus i.e., *E. dimorphum* is a very rare alpine perennial, whereas all the annual members of *Erodium* of Iran have extensive distributions in both Iran and the world (Davis 1967, Janighorban 2005, Schönbeck-Temesy 1970).

Taking into account the new record, 16 species of the genus are currently known in Iran. *E. amanum* could be readily distinguished by its characteristics leaves (ovate with short petioles, patently pubescent indumentum, and obtusely apexed, shortly oblong crowded laciniae), nevertheless a comparison among this species and its much similar species are provided (Table 1). The general characteristics of pollen grains of *E. amanum* mentioned above (Fig. 1), are in accordance with evidence available about pollen micromorphology of this species previously studied (İlçim *et al.* 2019).

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Table 1. Diagnostic traits compared among *Erodium amanum* and its close taxa

Taxa	<i>E. amanum</i>	<i>E. dimorphum</i>	<i>E. absinthoides</i> subsp. <i>armenum</i>	<i>E. absinthoides</i> subsp. <i>absinthoides</i>
Stem length and branching	Up to 8 cm, unbranched	Up to 3 cm, unbranched	Up to 30 cm, branched	Up to 12 cm, usually unbranched
Stipule length	5–11 mm	10–13 mm	6–11 mm	4–8 mm
Basal leaf length	Up to 5 cm	Up to 6.5 cm	Up to 10 cm	Up to 13 cm
Leaf shape	Ovate	Oblong, ovate-cuneate	Oblong, ovate-cuneate	Ovate to narrowly oblong
Leaf indumentum	Patently pubescent	Velutinous	Villous	Adpressed-pilose, canescent or subsericeous
Leaf segments' shape	Obtusely-apexed shortly oblong	Acute to subacutely-apexed ovate-cuneate	Acute to-subacutely apexed linear to linear-lanceolate	Obtusely-apexed oblong
Leaf segments' density on the blade	Densely arranged	Openly arranged	Openly arranged	Openly arranged
Petiole length in basal leaves	1.5–5 cm	3–13 cm	6–10 cm	2–13 cm
Petiole length in cauline leaves	Sessile to 0.5 cm	sessile to 1cm	1–4 cm	0.5–3 cm
Peduncle length	2–4 cm	5–6 cm	2–10 cm	2–10 cm
Sepal awn length	Up to 0.4 mm	Up to 1 mm	Up to 2.8 mm	Up to 2.8 mm

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