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ANDROSACE ARMENIACA SUBSP. *VULCANICA* SEFALI & EROĞLU: A NEW TAXON FROM EASTERN ANATOLIA, TÜRKIYE

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Abstract

A new taxa, *Androsace armeniaca* subsp. *vulcanica* Sefalı & Eroğlu nov. (Primulaceae) is described and illustrated from Ağrı Province, Türkiye. It is morphologically assigned to *Androsace* sect. *Andrapsis* based on its long scape and small flower habit and the presence of glandular hairs covering the calyx and scape. This new taxon closely resembles *A. armeniaca* subsp. *armeniaca* var. *armeniaca* and *A. armeniaca* subsp. *armeniaca* var. *macrantha*, but is easily distinguished by its overall habitus, smaller flowers, distinct corolla and calyx characteristics (including the color and lobe shape), pedicel length and habitat (volcanic areas).

Introduction

The genus *Androsace* Linnaeus (1753: 141) comprises approximately 158 species distributed across the northern hemisphere, primarily on extratropical mountain ranges (Schönswetter *et al*. 2015, Jacquemoud and Jordan 2020, Sefalı 2021, Sefalı and Yapar 2022). The genus typically inhabits cold environments, particularly during periods of rapid climatic change (Anderberg and Kelso 1996, Boucher *et al*. 2012, Roquet *et al*. 2013, Schönswetter *et al*. 2015). The genus *Androsace* is classified into six distinct sections (*Chamaejasme* Koch, *Andraspis* (Duby) Koch, *Pseudoprimula* Pax., *Aretia* (L.) Duby, *Aizoidium* Hand.-Mazz. and *Douglasia* (Gray) Wendelbo). The section *Andrapsis* primarily comprises annual and biennial species, with occasional short-lived perennials. It includes approximately 23 species and is distributed across the entire Holarctic region, including the Mediterranean, Iran, Asia (Anatolia), Afghanistan, Eurasia, and North America (Smith and Lowe 1997, Stevanovıć *et al*. 2005, Sefalı 2021, Sefalı and Yapar 2022). The *Andrapsis* consists of two distinct species groups: *Androsace septentrionalis* and *A. albana* (Smith and Lowe 1997). The *A. albana* group, which includes seven species, is primarily distributed over the Caucasus and Türkiye (Smith and Lowe 1997, Sefalı 2021, Sefalı and Yapar 2022).

Türkiye is home to nine *Androsace* species, along with ten taxa at the subspecific rank (Davis 1980, Davis *et al*. 1988, Sefalı 2021, Sefalı and Yapar 2022). Among these species are six members of the *A. albana* group: *A. azizsancarii* Sefalı, *A. albana* Steven, *A. armeniaca* Duby, *A. artvinensis* Sefalı & Yapar, *A. intermedia* Ledeb., and *A. multiscapa* Duby.

This plant, found in a volcanic area (Fig. 1), has been observed to have floristic characteristics similar to *A. armeniaca* in the Flora of Turkey, but it does not match existing varieties. Therefore, the presence of subspecies-level differences in the plant specimens led to the consideration of a new *A. armeniaca* species.

The ultimate aim of this study was to identify and formally describe a new subspecies of *A. armeniaca*.

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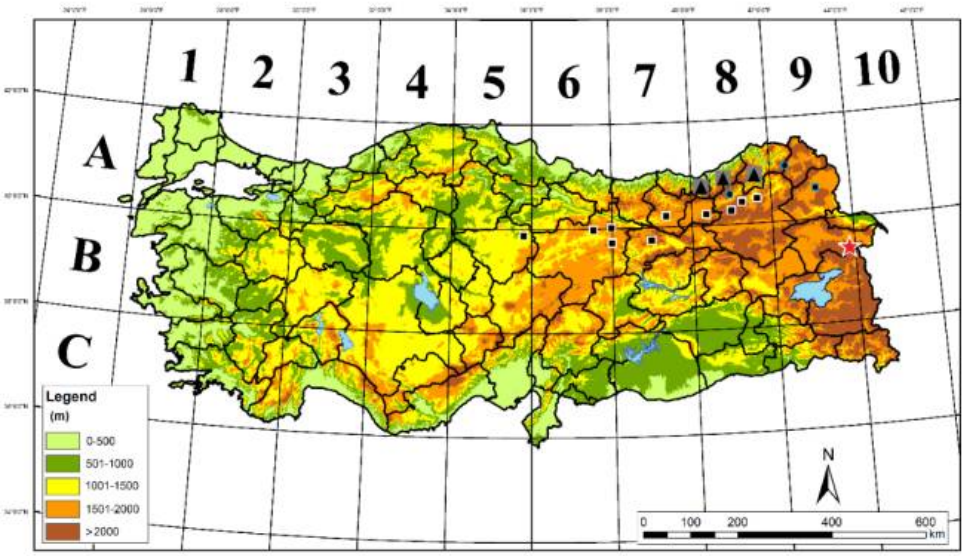

Fig. 1. Distribution map of *Androsace armeniaca* subsp. *vulcanica* (★), *A. armeniaca* subsp. *armeniaca* var. *armeniaca* (●), *A. armeniaca* subsp. *armeniaca* var. *macrantha* (■), and *A. intermedia* (▲).

Materials and Methods

Specimens of *Androsace armeniaca* subsp. *vulcanica* were compared with herbarium specimens at VANF, EGE, ISTE, Bingöl University Biology Department (BIN), Selçuk University (KNYA), ANK, Çukurova University (CUEF), Nigde Ömer Halisdemir University, and Bolu Abant İzzet Baysal University (AIBU). Moreover, some digital herbarium materials were also examined herbaria E, K, and G (acronyms according to Thiers 2022), and the relevant literature (Lamond 1978, Smith and Lowe 1997, Schönswetter and Schneeweiss 2009, Boucher *et al*. 2012, Xu *et al.* 2016, Dentant *et al*. 2018, Jacquemoud and Jordan 2020, Sefalı 2021, Sefalı and Yapar 2022, Ulcay *et al*. 2024) was reviewed. Extensive morphological measurements were conducted on the new taxon material using a stereo-binocular microscope equipped with millimetric rulers. These measurements were then compared with those of closely related species, namely *A. armeniaca* subsp. *armeniaca* var. *armeniaca* and *A. armeniaca* subsp. *armeniaca* var. *macrantha*.

Pollen slides were then prepared using the Wodehouse (1935) method. Pollen grains from each species were first washed with 70% ethanol to remove any dirt, and then permanently mounted on microscope slides using gelatin-glycerin and safranin. The slides were subsequently studied under a light microscope (a Leica ICC50HD camera attached to a Leica DM500 microscope; Leica Microsystems, Wetzlar, Germany). To examine the pollen grains under the electron microscope, the pollen was mounted on conductive double-sided tape, which was then affixed to aluminum stubs. The pollen grains were then coated with a gold-palladium layer and imaged using a Zeiss Leo 440 scanning electron microscope (SEM) (Carl Zeiss AG, Oberkochen, Baden-Württemberg, Germany). Pollen grains were described based on the relevant literature (Punt *et al.* 2007). To examine the seed surface morphology, the seeds were prepared using the same procedure as that for pollen and imaged with the same SEM. The seed surface morphology of the specimens was then analyzed by consulting the pertinent literature (Stearn 1983, Bojňanskı and Fargašová 2007).

Results and Discussion

Androsace armeniaca subsp. *vulcanica* Sefalı & Eroğlu nov. (Figs 2 and 3, Table 1)

Androsace armeniaca subsp. *vulcanica* is related to *A. armeniaca* subsp. *armeniaca* var. *armeniaca*, *A. armeniaca* subsp. *armeniaca* var. *macrantha* and *A. intermedia*. It differs from *A. armeniaca* subsp. *armeniaca* var. *armeniaca* by its corolla diameter, (4–)5–6 mm (vs. 6–7 mm), and corolla lobes, 2–3 × 1.25–1.5 mm (vs. 3–8 × 1.5 mm), oblong to narrowly obovate, apex emarginate, (obovate, apex emarginate, or three-lobed), generally longer scape (8)10–12(15) cm (vs. scape 1.5–10 cm). It differs from *A. armeniaca* subsp. *armeniaca* var. *macrantha* by its smaller corolla diameter, (4–) 5–6 mm (vs. up to 10–14 diam), purple to pinkish flowers (vs. white); cylindrical to campanulate calyx shape (vs. campanulate calyx shape). It differs from *A. intermedia* by its distinctly branched and sometimes a few dendroid hairs on the scape (vs. scape glabrous).

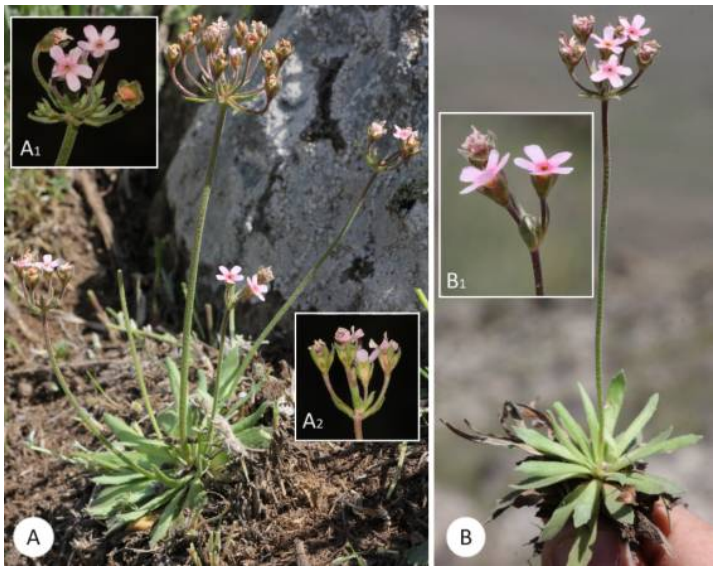

Fig. 2. Characteristics of *Androsace armeniaca* subsp. *vulcanica*: A: Habitus of a multi-scape, single-scape (B), A_1-B_1: Flowers and A_2: Calyx and inflorescence.

Type: TURKEY. Ağrı: Mount Tendürek (Lesser Tendürek), northern slopes near the summit, stony places, 3290 m, 07 July 2024, *A. sefalı* 1090 (type: VANF; isotypes: herbarium of Bingöl University).

Etymology: *Androsace armeniaca* subsp. *vulcanica* was named based on its habitat. This "vulcanica" epithet (in Turkish, Volkan), refers to in Latin Volcanus, Vulcanus. The Turkish name for this species was chosen as "volkanik arınca" (Menemen *et al.* 2016).

Description: Biennial (8)10–12(15) cm, single rosette forming 2–4 cm in diameter. Leaves in flat basal rosettes, narrowly lanceolate to linear, (10–)12–18 × 2–4 (–5) mm, margin entire to ± deeply and bluntly toothed in upper one-third; surface mixed short-hairy, especially toward the apex, with simple, furcate and branched hairy. Scapes 1–6, c. 15 cm long, covered with densely branched hairs; median scape, sometimes distinct. Bracts (1–)2–6 mm, linear lanceolate, margin entire; scattered short simple and furcate hairy and not glandular, shorter than pedicels. Inflorescence with (3–) c. 15 flowered. Pedicel 5–14 mm, clearly longer than bracts. Calyx 4 × 3.5 mm, forked, short simple hairs especially toward the apex or margin. Calyx base densely branched

and glandular-hairy, calyx teeth triangular 1.5 × 1.5 mm. Corolla cylindrical to campanulate, purple, (4–)5–6 mm in diameter, with a yellowish or pink center; tube ± equaling calyx; lobes oblong to narrowly obovate 2–3 × 1.25–1.5 mm, apex emarginate. Capsule 2.5–4 mm, elliptical. Seeds black, elliptical, 0.75–1 × 0.5 mm, surface reticulate (Fig. 2).

Fig. 3. Morphologically related species interm flowers, bracts, pedicel length, and calyx shape: A: *Androsace armeniaca* subsp. *vulcanica*, B: *A. armeniaca* subsp. *armeniaca* var. *armeniaca*, and C: *A. armeniaca* subsp. *armeniaca* var. *macrantha*.

Table 1. Morphological comparison of *Androsace armeniaca* subsp. *vulcanica* with *A. armeniaca* subsp. *armeniaca* var. *armeniaca* and *A. armeniaca* subsp. *armeniaca* var. *macrantha*.

Characters	*A. armeniaca* subsp. *vulcanica*	*A. armeniaca* subsp. *armeniaca* var. *armeniaca*	*A. armeniaca* subsp. *armeniaca* var. *macrantha*
Plant height	(8)10–12(15) cm	1.5–10 cm	4-20 cm
Indumentum	Densely branched hairs (generally max. 5 branched), a few dendroid hairs, scattered short simple, and forked hairs, and calyx always glandular hairs.	Branched (generally max. 3 or 4 branched), and densely forked and simple hairs, generally not glandular; if present, very scattered.	Densely branched hairs (generally max. 4 branched), scattered short simple, and forked hairs, and densely glandular hairs.
Bract	(1–)2–6 mm, linear lanceolate, margin entire.	Ca. 10 mm, elliptic or angulate-obovate, occasionally toothed.	Ca. 10 mm, elliptic or angulate-obovate, occasionally toothed.
Calyx	4 × 3.5 mm, forked, short simple hairs, especially toward the apex or margin. Calyx base densely branched and glandular hairy.	3 × 2.5 mm, forked or short simple hairs, especially toward the apex or margin. Calyx base scattered branched hairy.	5–5.5 × 4–5 mm, densely short glandular-hairy. Calyx base densely branched and glandular hairy.
Calyx teeth	Triangular 1.5 × 1.5 mm.	Narrow triangular 1.5–2 × 1–1.5 mm.	Narrow triangular 2.5-3 × 1.5-2.5 mm.
Corolla	Purple, (4–)5–6 mm in diameter, with a yellowish or pink center.	White or rose, 6–7 mm in diameter, with a pink or yellowish center.	White, 6–10 mm in diameter, with a pink or yellowish center.
Corolla lobes	2–3 × 1.25–1.5 mm, flat, horizontal, oblong to narrowly obovate, apex emarginate.	3–8 × 1.5 mm, generally spreading or curved up, obovate, apex emarginate, or three-lobed.	4–8 × 2.5 mm, generally spreading or curved up, obovate, apex retuse.

Phenology: Flowering from July; fruiting in August.

Seed and pollen morphology (Fig. 4): The pollen grains of *Androsace armeniaca* subsp. *vulcanica* are in monads, isopolar, tricolporate, prolate (polar axis length: 13.37 (±0.71) µm, equatorial axis length: 9.60 (±0.66) µm, long axis length/short axis length: 1.39, exine thickness in polar equatorial area: 0.65 (±0.03) µm, intine thickness in polar equatorial area: 0.35 (±0.03) µm, colpus length: 11.42 (±0.45) µm colpus width 1.78 (±0.25) µm and pore width 1.99 (±0.21), ornamentation is microreticulate.

The seeds of *Androsace armeniaca* subsp. *vulcanica* are ovoid-triquetrous in shape and have a reticulate alveolate ornamentation type. Seed sizes are 2.42–4.6 × 1.32–2.41 mm, seed color is black. In *A. armeniaca* subsp. *vulcanica*, the anticlinal cell walls are sunken, while the periclinal cell walls are concave. Morphological and micromorphological examinations of the pollen and seeds of *A. armenica* subsp. *vulcanica*, *A. armenica* subsp. *armeniaca* var. *armeniaca*, and *A. armenica* subsp. *armeniaca* var. *macrantha* did not reveal any significant differences, except for minor dimensional variations.

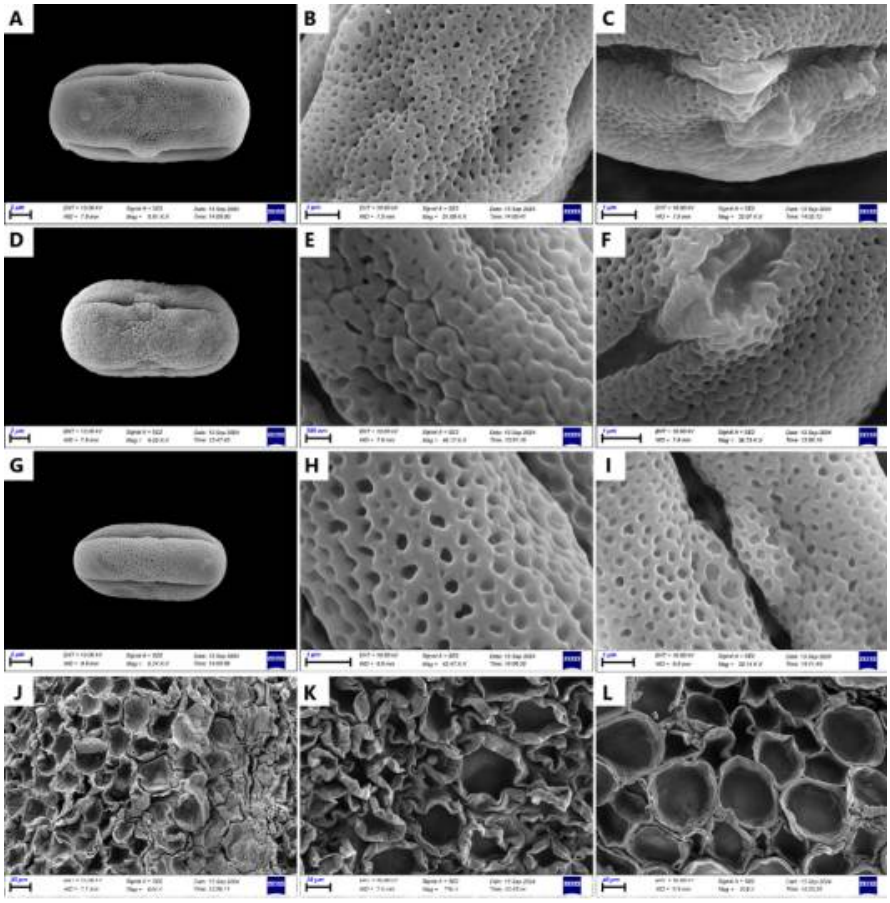

Fig. 4. SEM photographs of the pollen grains and seeds of the three closely related taxa: A-C and J: *A. armeniaca* subsp. *vulcanica*, E-F and K: *A. armeniaca* subsp. *armeniaca* var. *armeniaca*, and G-H and I: *A. armeniaca* subsp. *armeniaca* var. *macrantha* (A,D and G: general view of a pollen grain; B,E and H: close view of the surface of a pollen grain; C,F and I: close view of the colpus; J, K and L: epidermal cells of the seeds).

Distribution and ecology: The new taxa is a local endemic, restricted to Mount Tendürek in Ağrı Province, eastern Anatolia. It is believed to be an element that coincides with both the Irano-Turanian and Euro-Siberian phytogeographical regions. Species growing in the near vicinity include *Draba siliquosa* M.Bieb., *Peltariopsis grossheimii* N.Busch, *Primula algida* Adams, *Viola rupestris* F.W.Schmidt, *Oxytropis lazica* Boiss., *Carum caucasicum* (M.Bieb.) Boiss., *Saxifraga sibirica* L., *Asperula laxiflora* Boiss., *Astragalus saganlugensis* Trautv., *Potentilla argaea* Boiss. & Balansa, *Silene lucida* Chowdhuri, *Hedysarum hedysaroides* (L.) Schinz & Thell., *Sibbaldia parviflora* Willd.

Taxonomic relationships: In Türkiye, the type locality of *A. armeniaca* subsp. *armeniaca* var. *armeniaca* was identified in Erzurum Province (Lamond 1978). During the field studies, this taxa was collected in the higher elevations of Palandöken Mountain (altitude about 3000–3200 m) near the summit. It was observed that this plant is dwarf and branched (generally with a maximum of four branches) with scattered glandular hairs. It has white flowers (sometimes pinkish-white with white flowers on the same individual), that are medium-sized (7–9 mm). Additionally, it exhibits corolla lobes typically spread or curved upward, obovate, apex emarginate, sometimes three-lobed. The *A. armeniaca* subsp. *armeniaca* var. *armeniaca* specimens found in northeastern Türkiye (Kars and Ardahan provinces) exhibit a dwarf growth habit with branched, hairy stems (typically up to 4 branches), occasionally glandular structures, and have medium-sized flowers (8–9 mm) that are purplish pink in color. The plants predominantly have pink flowers, although distinct, white-flowered individuals are also observed. Occasionally, both white and pink flowers can be found on the same plant. The new taxon, *Androsace armeniaca* subsp. *vulcanica*, is restricted only to Mount Tendürek in Ağrı Province, close to the Van border. The taxon features elongating scapes, smaller ((4–)5–6 mm) purple and pinkish flowers, corolla lobes flat, horizontal, oblong to narrowly obovate, apex emarginate, and branched (typically up to 5 branches) with scattered to densely glandular hairs. *Androsace* species exhibit intriguing branching patterns, including fur-like, 3, 4, or 5 branches with hairy stems (Ulucay *et al*. 2024).

Another variety, *A. armeniaca* subsp. *armeniaca* var. *macrantha*, has distinct bigger flowers, longer scapes, and densely glandular hairs on the scape and calyx (Lamond 1978, Sefalı and Yapar 2022). This taxa is an endemic that is more widely distributed in northeastern Türkiye than *A. armeniaca* subsp. *armeniaca* var. *armeniaca*. While *A. armeniaca* subsp. *vulcanica*, is similar to *A. armeniaca* subsp. *armeniaca* var. *macrantha* in terms of its general habitus, it differs by having scattered glandular hairs and smaller, purplish flowers. Therefore, it does not resemble *A. armeniaca* subsp. *armeniaca* var. *macrantha*.

According to Lamond (1978), *A. armeniaca* subsp. *armeniaca* var. *armeniaca* prefers the highest altitudes. However, when found at lower elevations, it resembles *A. armeniaca* subsp. *armeniaca* var. *macrantha*. At high altitudes, the plant becomes dwarfed (*A. armeniaca* subsp. *armeniaca* var. *armeniaca*), whereas at low elevations, it grows taller (*A. armeniaca* subsp. *armeniaca* var. *macrantha*). Therefore, Lamond (1978) noted that intermediate forms can be found. The type locality of *A. armeniaca* subsp. *armeniaca* var. *armeniaca* is at an altitude of 3000–3200, where it exhibits a dwarf growth form. Although Mount Tendurek reaches an altitude of approximately 3290 m, *A. armeniaca* subsp. *vulcanica* does not exhibit a dwarf form. Additionally, no white-flowered individuals have been observed in its population, nor are there instances of both white and pink flowers occurring on the same plant.

The ongoing discovery of new *Androsace* taxa in the Eurasian mountains suggests that, despite recent taxonomic advancements, our understanding of plant diversity on mountain summits remains incomplete (Dentant 2018). Cold climatic factors have played a significant role in the diversification of *Androsace* species, particularly in alpine regions (Boucher *et al*. 2012, Roquet *et al*. 2013). *A. azizsancarii*, a recently discovered species, also thrives in an alpine

environment with a cold climate (Sefalı 2021). Mount Tendürek in Ağrı Province is influenced by cold climatic conditions and stands as the highest mountain near the Van border, after Mount Ağrı. Given its isolation and harsh climate, this mountain presents a promising location for the discovery of new *Androsace* taxon.

Examined specimens: *Androsace armeniaca* subsp. *armeniaca* var. *armeniaca* - TÜRKİYE Kars, Kısır Mountain, above of Kiziroglu Village, mountain steppe, 2600 m a.s.l., 10 June 2021, *A. Sefalı 690* (VANF 165225!). *Androsace armeniaca* subsp. *armeniaca* var. *macrantha* – TÜRKİYE Erzurum, Ilıca, Söğütlü Village, Kel Mountain, mountain summit, 2400 m a.s.l., 25 July 2021, *A. Sefalı* 751.

In conclusion, *Androsace armeniaca* subsp. *vulcanica* has been described as a new taxon based on geographic and floristic characteristics. With this new subspecies, there are now 11 taxa belonging to nine *Androsace* species in the Flora of Turkey.

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