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Research

Androsace azizsancarii sp. nov. (Primulaceae): a new species from northeastern Anatolia, Turkey

Abdurrahman Sefali

A. Sefali (https://orcid.org/0000-0002-0092-0857) ✉ (asef4petal@gmail.com), Dept of Primary Education, Faculty of Education, Bayburt Univ., Bayburt, Turkey.

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Androsace azizsancarii (Primulaceae) is described and illustrated as a new species from Bayburt Province in northeastern Anatolia, Turkey. Diagnostic morphological characteristics, a full description and a distribution map are provided. The new species is morphologically closest to *Androsace albana*, *A. multiscapa* and *A. villosa*, but it is easily distinguished from these species by indumentum, leaf, flower and seed characters.

Keywords: Bayburt, Flora of Turkey, new species, taxonomy

Introduction

Primulaceae is one of the 22 families in the order Ericales (APG IV 2016, Christenhusz and Byng 2016). The family Primulaceae consists of about 53 genera with approximately 2790 species in the broad sense, including the former families Myrsinaceae and Theophrastaceae, which are mainly distributed in the north temperate zone (APG IV 2016, Christenhusz and Byng 2016).

The genus *Androsace* L. (Primulaceae) comprises about 156 species (Mabberley 2008, Jacquemoud and Jordan 2020) that are mainly distributed in the extratropical mountain ranges of the northern hemisphere. They have experienced some periods of rapid diversification (Anderberg and Kelso 1996, Roquet et al. 2013, Schönswetter et al. 2015) as most *Androsace* species tend to occur in generally cold environments (Boucher et al. 2012, Roquet et al. 2013). Ancestors of the genus (short-lived) probably had to adapt to the conditions on the cold steppes, and although these ancestral species spread across the mountains, their insufficient dispersal ability prevented them from migrating back to their original habitats, and instead forced them to adapt to new habitats to survive (Boucher et al. 2012, Roquet et al. 2013). The cold climatic conditions influenced the enhanced diversification of *Androsace* species, especially in Alpine areas (Boucher et al. 2012, Roquet et al. 2013). There has been ongoing discovery of new *Androsace* taxa in the Eurasian mountains, which shows that despite some taxonomic novelties, we have little knowledge about plant diversity on the mountain summits (Dentant 2018). The genus *Androsace* has been divided into six quite distinct sections, comprising *Pseudoprimula* Pax., *Chamaejasme* Koch, *Aretia* (L.) Duby, *Andraspis* (Duby) Koch, *Douglasia* (Gray) Wendelbo and *Aizoidium* Hand.-Mazz. *Androsace* sect. *Andraspis* comprises approximately 20 species, mostly annuals and biennials, or short-lived perennials, distributed over the

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whole Holarctic, from the Arctic regions of Eurasia and North America, extending towards the warm and arid regions of the Mediterranean, Asia Minor, Iran and Afghanistan (Pax and Knuth 1905, Smith and Lowe 1997, Stevanović et al. 2005). The diversity center of *A.* sect. *Andraspis* is the Caucasus area, mainly Armenia (Shishkin and Bobrov 1952, Grossheim 1967, Stevanović et al. 2005). According to Smith and Lowe (1997), *A.* sect. *Andraspis* includes two distinct species groups: the *A. septentrionalis* and *A. albana* (*A. armeniaca*) groups. The *A. albana* group is distributed over the Caucasus and Turkey and includes five species (Smith and Lowe 1997). Overall, eight *Androsace* species (nine taxa) are distributed in Turkey, including four species of the *A. albana* group, i.e. *Androsace albana* Steven, *A. armeniaca* Duby, *A. intermedia* Ledeb. and *A. multiscapa* Duby (Lamond 1978).

During field studies in July 2020, an unusual *Androsace* population was discovered on the southern part of Anzer Mountain, which is a part of the Soğanlı Mountain chain, in the Bayburt Province of Turkey. This species had mostly simple hairs and a few small glandular hairs, but no forked or branched hairs. It resembled *A. albana* and other members of the *A. albana* group, especially *A. multiscapa*, as well as *A. villosa* L. The latter, is a caespitose perennial species, forming dense cushions or lax mats, and it is distributed in Europe and the Mediterranean region. A detailed morphological study of the specimens collected from Anzer Mountain revealed that they are distinct from all related species, and they belong to a new, undescribed species. This species is described here as *Androsace azizsancarii*.

Material and methods

Androsace azizsancarii specimens were collected from Bayburt Province (near the Rize border) in the northeastern Anatolia region, in 2020 (Fig. 1). The holotype specimen was deposited in the herbarium of İstanbul University (ISTE), and isotypes were deposited at Ege University (EGE), Ankara University (ANK) and the Biology Dept at Bingöl University. All morphological measurements were made on dried specimens using a millimetric ruler. A stereo-binocular microscope was used to examine the gross morphology of the new species. Plant species nomenclature follows The Plant List (2013) website. The *Androsace* specimens were compared with the relevant taxonomic literature (Pax and Knuth 1905, Grossheim 1967, Lamond 1978, Smith and Lowe 1997, Mabberley 2008, Schönswetter and Schneeweiss 2009, Boucher et al. 2012, Xu et al. 2016, Dentant et al. 2018, Jacquemoud and Jordan 2020) and material in the herbaria of ISTE, Selçuk University (KNYA), EGE, Biology Dept of Bingöl University, Nigde Ömer Halisdemir University, Çukurova University (CUEF), ANK and Bolu Abant İzzet Baysal University (AIBU), and some digital herbarium materials were examined from the the E, G and K herbaria. Detailed morphological measurements were performed on the new species and it was compared with the closely related species *Androsace albana* and *A. multiscapa*, using a stereo-binocular microscope.

A total of 20 specimens of the new species were examined. At least 50 pollen grains and 50 mature seeds were measured using a light microscope and a scanning electron microscope (SEM). The pollen terminology was adopted from Punt et al. (2007), and classifications using the P/E ratio and shape followed Erdtman (1969). During the field studies, photographs of the living material of the new species and its related taxa were taken using a digital camera. The general terminology used by Baytop (1998) was adopted.

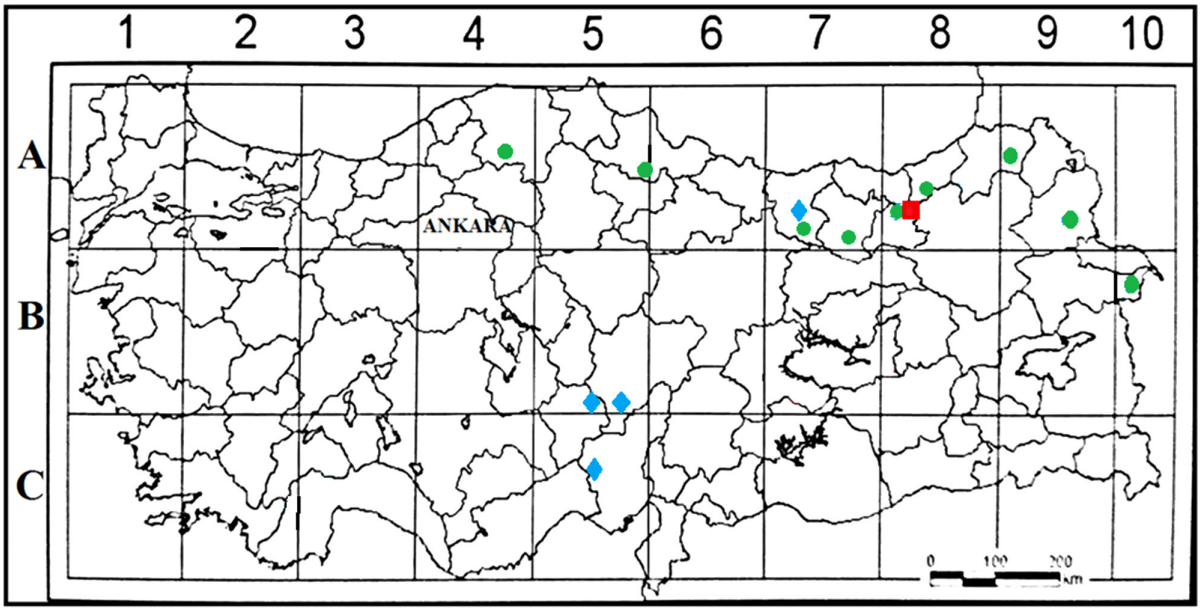


Figure 1. Distribution map for *A. azizsancarii* (■), *A. albana* (●), *A. multiscapa* (◆).

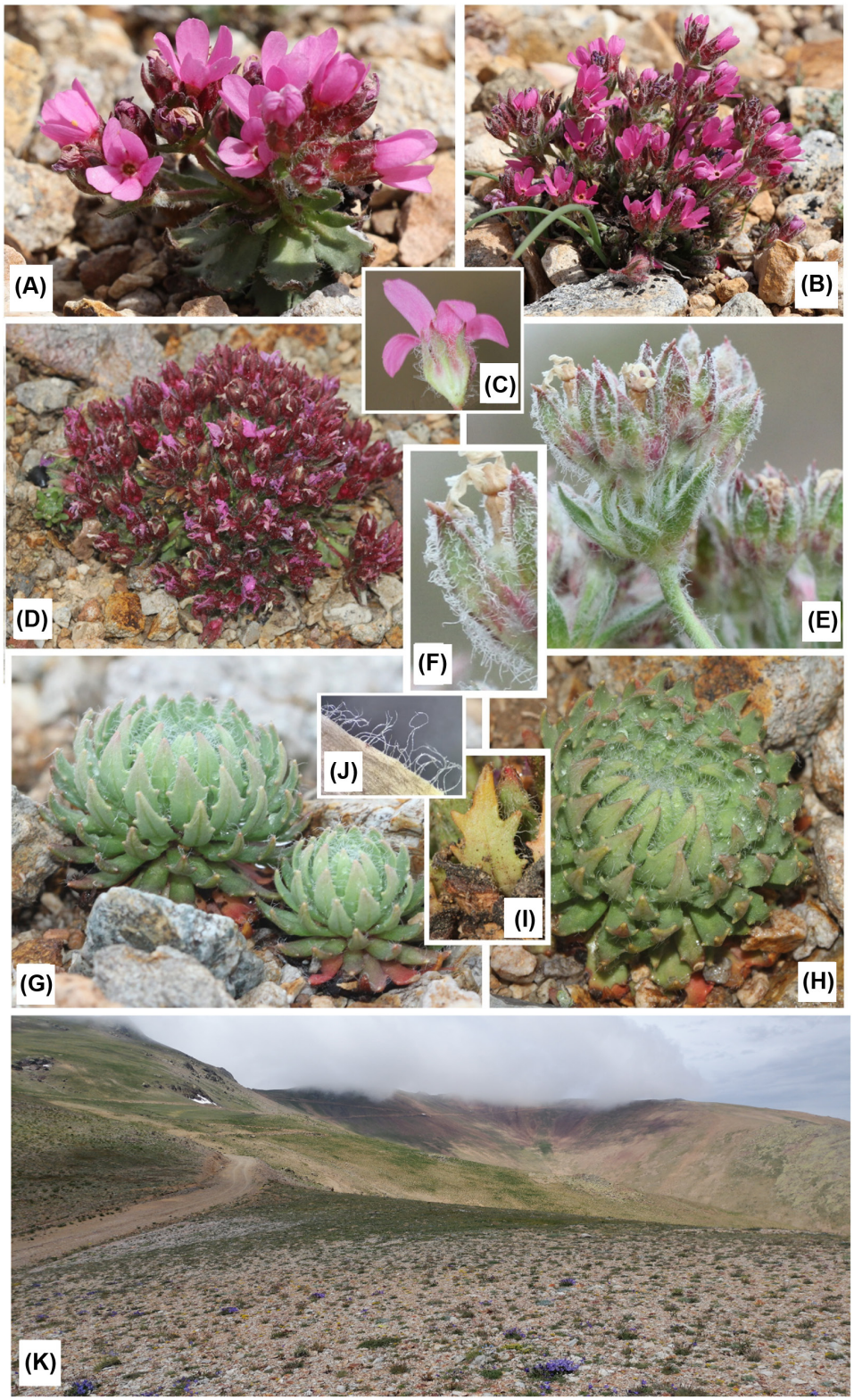


Figure 2. *Androsace azizsancarii* sp. nov. (A–D) habitus in flowering time, (E–F) indumentum of late period, (F) habitus in early fruiting time, (G–H) nonflowering rosettes, (I) basal leaves, (J) leaf indumentum, (K) habitat.

Results and discussion

Androsace azizsancarii Sefalı sp. nov. (Fig. 2–4)

A species related to *A. albana*, *A. multiscapa* and *A. villosa*. It differs from *A. albana* by its shorter scapes up to 4.5 cm long (versus up to 28 cm long), the silky, simple hairs (versus branched and simple hairs), pink corolla (versus white) and larger seeds 3.0–3.1 × 2.0 mm (versus 1.4 × 0.8–1.0 mm). It differs from *A. multiscapa* by its simple hairs (versus dendroid), leaf margin with 1(–2) pairs of teeth (versus 0–1) and the pink corolla (versus white). It also differs from *A. villosa* by its larger leaves (5–)6–18(–20) × 3–4 mm (versus 2–7(–9) × 1–2 mm), the pink, campanulate corolla (versus white, rotate) and the dark brown to black seeds 3.0–3.1 × 2.0 mm (versus pale brown to yellow, 1.7–2.2 × ca 1.2 mm).

Type: Turkey, Bayburt: Soganlı Mountains, south of Anzer Mountain, on moraines, 2831 m a.s.l., 40°30′N, 40°30′E, 1 July 2020, A.Sefalı 507 (holotype: ISTE 117267; isotypes: ANK 60610, BIN 9405, EGE 43195).

Etymology

Androsace azizsancarii was named in honor of Prof. Dr. Aziz Sancar, who is the Nobel Laureate in Chemistry 2015. The Turkish name of this species was chosen as 'Sancarınca' (Menemen et al. 2016).

Description

Perennial plant with simple hairs, 1.0–6.5 cm tall, usually forming a single rosette 1.4–4.0 cm in diameter. Leaves in hemispherical basal rosettes, somewhat fleshy, narrowly oblong to linear-lanceolate or linear, incurved, (5–)6–18 (–20) × 3–4 mm; adaxial surface often hairy, especially towards the apex, with long soft hairs 0.2–1.3 mm long towards the margins; margin with 1(–2) pairs of teeth towards the apex. Scapes (5–)10–30, 1–3 cm long during anthesis, elongated to 1.3–4.5 cm long when fruiting, covered with long, soft, simple, hairs; median scape usually present and stout. Bracts linear to narrowly lanceolate, generally equaling pedicel during anthesis and fruiting, 2.0–7.0 × 1.4 mm, densely villous. Inflorescence with (1–)2–5(–8) flowers. Pedicel 1–7 mm long at anthesis, elongated up to 12 mm when fruiting.

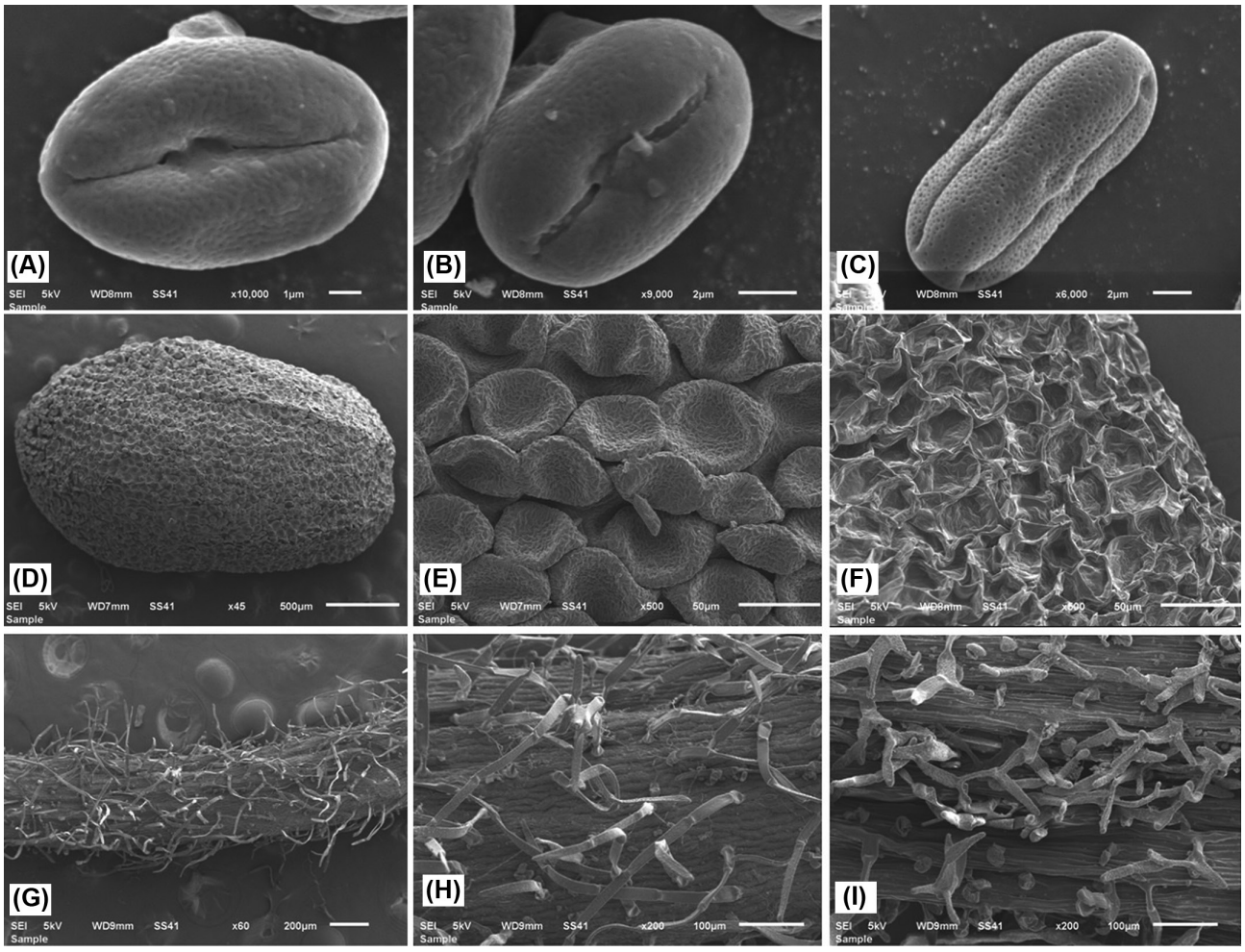


Figure 3. SEM photographs: *Androsace azizsancarii* sp. nov. (A–B) pollen grain and pollen surface, (D–E) seed and seed surface, (G–H) indumentum, *A. albana*: (C) pollen grain, (F) seed surface, (I) indumentum.

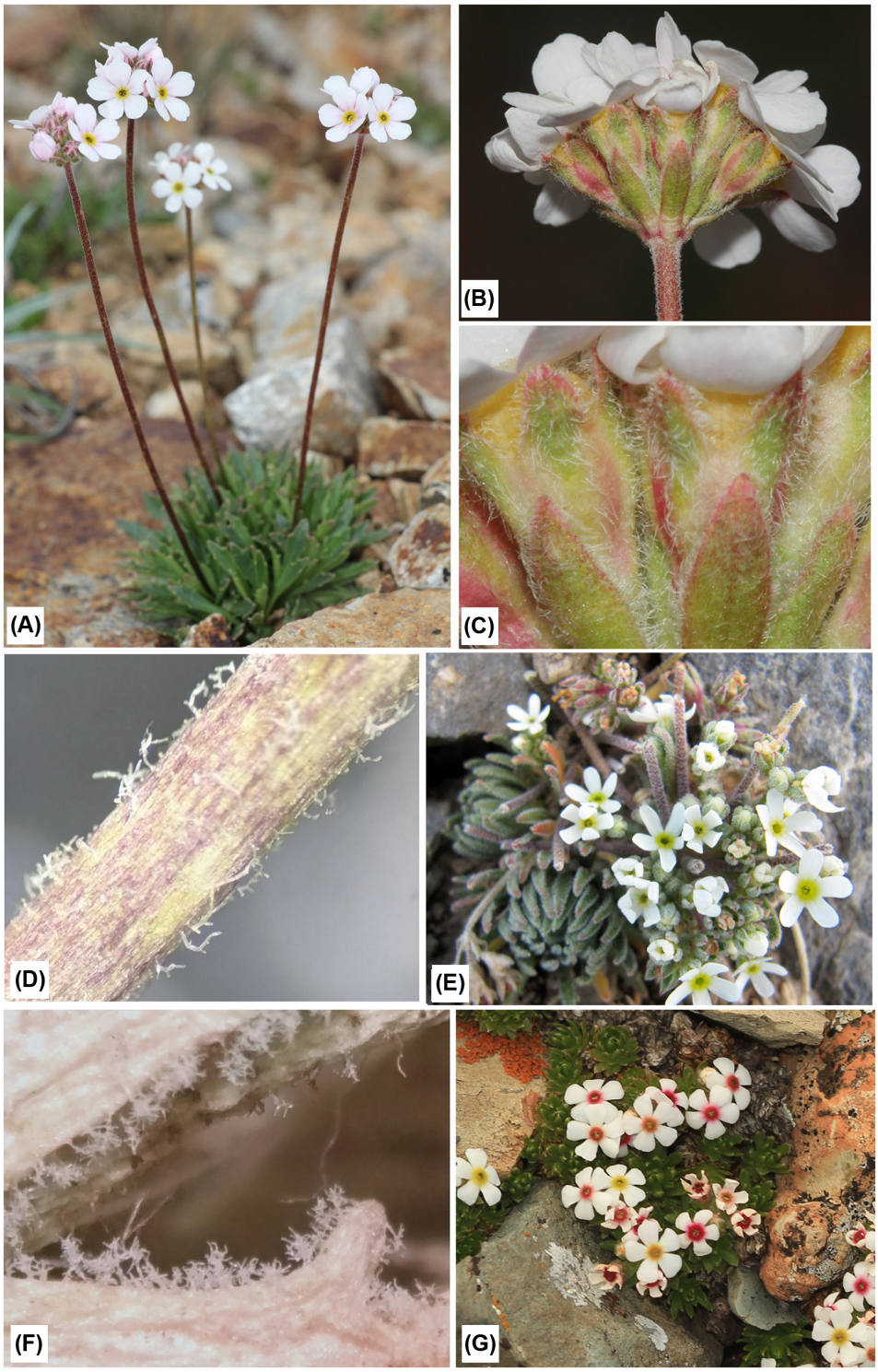


Figure 4. Morphological related species to *Androsace azizsancarii*: (A–D) *A. albana*, (D) branched hairs, (E–F) *A. multiscapa* (photos: Ahmet Savran), (F) dendroid hairs, (G) *A. villosa*.

Calyx 6.0–6.8(–8.2) mm, with long silky hairs and scattered short glandular hairs; calyx teeth ovate to triangular up to 3.2 mm long. Corolla campanulate, 8–10 mm in diameter, pink with yellow centre; tube ± equaling calyx; lobes oblong to obovoid; throat constricted and annulate. Capsule 5–6 × 3–4 mm, ovoid. Seeds dark brown to black, ovoid, 3.0–3.1 × 2.0 mm.

Phenology

Flowering from June to July; fruiting in August.

Table 1. Comparison of the pollen of *Androsace azizsancarii* with *A. albana*.

Characters	*A. azizsancarii*	*A. albana*
Polar axis (P) (µm)	14.07 ± 1.19	12.30 ± 1.53
Equatorial axis (E) (µm)	11.42 ± 1.63	9.04 ± 1.47
P/E and shape	1.35–prolate	1.36–prolate
Ornamentation	Microreticulate	Microreticulate
Aperture type	Tricolporate	Tricolporate
Colpus length (Clg) (µm)	11.44 ± 0.95	9.45 ± 0.94
Colpus width (Clt) (µm)	2.13 ± 0.19	1.95 ± 0.24
Por (µm)	3.07 ± 0.36	2.64 ± 0.42
Exine thickness (µm)	0.44 ± 0.32	0.42 ± 0.30
Intine thickness (µm)	0.24 ± 0.16	0.25 ± 0.27

Pollen morphology and seed surface

Pollen grains of *A. azizsancarii* are tricolporate and isopolar. The polar axis (P) is 14.07 ± 1.19 µm; equatorial axis (E) is 11.42 ± 1.63 µm; P/E ratio is 1.35 µm and pollen shape is prolate. The exine is 0.44 ± 0.32 µm, and the intine is 0.24 ± 0.16 µm. The exine ornamentation is microreticulate.

Pollen grains of *A. albana* are tricolporate and isopolar. The polar axis (P) is 12.30 ± 1.53 µm; equatorial axis (E) is 9.04 ± 1.47 µm; P/E ratio is 1.36 µm and pollen shape is prolate. The exine is 0.42 ± 0.30 µm, and the intine is 0.25 ± 0.27 µm. The exine ornamentation of pollen grains is microreticulate (Table 1, Fig. 2).

Distribution and ecology

Androsace azizsancarii is a local endemic species restricted to the southern slope of Anzer Mountain in Bayburt Province, northeastern Anatolia. It is an element belonging to the Hyrcano-Euxine (mt.) phytogeographical region. The new species colonizes moraines, between 2820 and 2835 m a.s.l. Species growing in the near vicinity include *Allium balansae* Boiss., *Androsace albana*, *Bupleurum falcatum* L. subsp. *persicum* (Boiss.) Koso-Pol., *Campanula aucheri* A.DC., *Helichrysum pallasii* (Spreng.) Ledeb., *Psephellus appendicigerus* (K.Koch) Wagenitz, *P. pulcherrimus* (Willd.) Wagenitz and *Oxytropis lazica* Boiss.

Taxonomic relationships

The sections of *Androsace* have been distinguished by life form, leaf shape, perianth and fruit characteristics. *Androsace azizsancarii* belongs to *A.* sect. *Andraspis* and to the informal *A. albana*-group. It includes characterized by annuals, biennials or somewhat short-lived perennials (especially the members of *A. albana*-group) (Smith and Lowe 1997). It has been noticed that indumentum features are especially important in the taxonomy within *A.* sect. *Andraspis* (Shishkin and Bobrov 1952, Grossheim 1967, Lamond 1978, Smith and Lowe 1997). *Androsace azizsancarii* stands out in terms of its long silky indumentum. This feature makes *A. azizsancarii* clearly different from all other members of *A.* sect. *Andraspis* and *A. albana*-group. When looking at the members of *A. albana*-group, this new species is closely similar to *A. albana* in terms of its indumentum. However, *A. albana* has only long simple hairs in the calyx region, not throughout the whole plant. Moreover, *A. albana* has branched hairs, mostly in the scape region.

Androsace bidentata K. Koch, is an imperfectly known species from Turkey. This species is similar to *A. albana* and has branched hairs, however, it was observed that it has larger flowers and fewer-flowered heads. Another closely related species is *A. multiscapa*, which has a completely different hair type, known as dendroid hairs (Fig. 4, Table 2). *Androsace*

Table 2. Morphological comparison of *A. azizsancarii* with *A. albana*, *A. multiscapa* and *A. villosa*.

Characters	*A. azizsancarii*	*A. albana*	*A. multiscapa*	*A. villosa*
Plant height	1.0–6.5 cm	3–22(–28) cm	1.5–5.0 cm	1–2 cm
Indumentum	long simple (silky) hairs and scattered short glandular hairs	long simple, long branched and scattered short glandular hairs	short, much branched, dendroid hairs	long simple (silky) hairs and scattered short glandular hairs
Leaf size	(5–)6–18(–20) × 3–4 mm	5.0–27.0(–40.0) × 1.5–8.0 mm	6–15 × 1–3 mm	2–7(–9) × 1–2 mm
Leaf shape	linear-lanceolate or linear to spatulate, incurved	oblanceolate, oblong-spathulate or obovate	narrowly elliptic to linear	linear to elliptic or narrowly ovate mostly obtuse
Leaf margin	with 1(–2) pair of teeth towards the apex	entire to ± deeply and bluntly toothed in upper 1/2	entire or with a pair of teeth near apex	entire
Leaf indumentum	silky hairy towards the apex and margin	with short simple hairs at margin and apex	short simple and dendroid hairy towards the apex and margin	silky hairy towards the apex and margin
Scape indumentum	only long simple (silky) hairs	with short, branched hairs and shorter glandular hairs	short, much branched, dendroid hairs	only long simple (silky) hairs
Calyx	6.0–6.8(–8.2) mm long, silky hairy with scattered short glandular hairs	4–5 mm long, with simple hairs, short glandular hairs also occasionally present	3–6 mm long, dendroid hairs with scattered short glandular hairs	4–5 mm long, pillose to silky hairy with scattered short glandular hairs
Corolla color	pink with yellow annulus	white to rose with yellow annulus	white with yellow annulus	white with yellow to rosy-pink
Seed	dark brown to black, ovoid, 3.0–3.1 × 2.0 mm	dark brown to black, ovoid-orbicular, 1.4 × 0.8–1.0 mm	unknown	pale brown to yellow, 1.7–2.2 × ca 1.2 mm

azizsancarii was also compared with other *A. albana*-group species, and it was then observed that *A. armeniaca* Duby has branched, dendroid or at least forked hairs, while *A. azizsancarii* does not have branched hairs. Another species, *A. intermedia* Ledeb. is biennial and typically has markedly unequal pedicels (*A. azizsancarii* is a short-lived perennial, without markedly unequal pedicels). When the new species was compared to other Turkish *Androsace* species (beyond *A.* sect. *Andraspis*), it was observed that it superficially resembles *A. villosa*, which has a silky indumentum, but its general habit is mat-forming, with a shorter scape and white flowers.

As a result, it was concluded that *A. azizsancarii* is a distinct new species, clearly different from all other members of *A. albana* group and easily distinguished from the widespread *A. villosa*.

Selected specimens examined

Androsace albana – Turkey, Kastamonu, Ilgaz Mountain, 12 Jun 1885, E. Wiedemann, (E 00024846!); Artvin: Yusufeli, Altıparmak Village, Kaçkar Mountains footage, moist places, 19 Jul 1989, Z. Aytaç 1991 (GAZI!); Bayburt; south side of Anzer Mountain, 2860 m a.s.l., 5 Jul 2020, A. Sefali 494 (ISTE 117268!); Rize: Çamlıhemşin, Ortayayla Village, Verçembek Mountain, above lake of Atmeydan, stony places, 3100 m a.s.l., 20 Aug 1982, A. Güner 4501 (HUB 09014!); İkizdere, Cimil, above of Cermaniman highland, alpinic steppe, 2300 m a.s.l., 23 Jul 1984, A. Güner 6000 (HUB 09012!); Kars: Posof, Centrum, Gümüşkonak, Riversides, 28 Jun 1986, Demirkuş 3645 (HUB 09013!), Posof, Ulgar Mountain, Çamyazı Place to Alköy Village, 1586–2730 m a.s.l., 16–20 Jun 1986, Demirkuş 3556 (HUB 09015!)

Androsace multiscapa – Lebanon, 1837, P. M. R. Aucher-Eloy 2607 (Syntype G 00139871!); 1835, P. M. R. Aucher-Eloy 320 (Syntype G 00139868!); Turkey, Konya, Ereğli, Aydos Mountain, Yazıgöl highland, alpinic steppe, 2700 m a.s.l., 16 Jul 1981, S. Erik 2319 (HUB 09044!); Niğde, Ulukışla, Çiftehan, Horoz Village, volcanic gravel, 1750–2900 m a.s.l., 31 Jun 1984, Ş. Yıldırımlı 7222 (HUB 09043!); Ulukışla, Maden Village, Bolkar Mountains, Kızıl Tepe, Bozkaya Tepe, 2700–2950 m a.s.l., 2 Jul 2015, K. Gurbanov & A. Savran 79 (Niğde University!)

Androsace villosa – Turkey, Bayburt, Kop Mountains, Bahtlı Mountain, stony places, 2800 m a.s.l., 20 Jun 2018, A. Sefalı 394 (BIN!); Erzurum, İspir, above Noryah, hills, stony places, 2200 m a.s.l., 27 Jun 1981, O. Beyazoğlu (SÜ 11635!); Erzurum, Şenkaya, Allahuekber Mountain, Köroğlu and Sarıgöl Plateau, meadows, 2850 m a.s.l., 16 Jun 1982, A. Tatlı 6546 (SÜ 11634!); Konya, Little Geyik Mountain, steppe, 2300 m a.s.l., 14 Jun 1967, R. Çetik & E. Yurdakul 43 (SÜ 11636!); Konya, Phrygia, Sultandagh, in jugis alpinis supra Tschai, 9 Jul 1899, Bornmüller & Nicolaus 5502 (E E00024849!)

Androsace azizsancarii (paratypes) – Bayburt; Soganlı Mountains, south of Anzer Mountain, on moraines, 2831 m a.s.l., 1 July 2020, A. Sefalı 507 (holotype: ISTE 117267!; isotypes: ANK 60610!, BIN 9405!, EGE 43195!).

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Data availability statement

Data are available from the Dryad Digital Repository: <http://dx.doi.org/10.5061/dryad.4f4qrfjc4> (Sefali 2021).

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