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VERBASCUM AKARKOEYENSE SP. NOV. (SCROPHULARIACEAE) A NEW SPECIES FROM CENTRAL ANATOLIA, TÜRKİYE

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Abstract

Verbascum akarkoeyense (Scrophulariaceae) is described as new species from Central Anatolia, Türkiye. The diagnostic and morphological characteristics of the new species and its closest relatives *V. orgyale* and *V. microsepalum* are discussed. Pollen characters, seed morphology, conservation status and geographical distribution of the new species are also provided. *V. akarkoeyense* appears to be sharply different from by closest related species by unbranched stem, oblong to oblanceolate basal leaves, racemose inflorescences, outside of corolla and fruit covered with sparsely stellate hairs.

Key words: Akarköy, New species, Taxonomy, Türkiye, *Verbascum*.

Introduction

The Scrophulariaceae is represented by 62 genera and 1830 taxa worldwide (Christenhusz & Byng, 2016). The genus *Verbascum* L. is represented by 256 taxa out of which 202 are endemic in Türkiye (Huber-Morath, 1971, 1978; Vural & Aydoğdu, 1993; Ekim, 2000; Sutory, 2001, 2004, 2017; Kaynak *et al*., 2006; Parolly & Tan, 2007; Karavelioğulları & Aytaç, 2008; Parolly & Eren, 2008; Yılmaz & Dane, 2008; Dane & Yılmaz, 2009; Aytaç & Duman, 2012; Karavelioğulları, 2008, 2009, 2012, 2015, 2016; Karavelioğulları *et al*., 2004, 2006, 2008, 2009, 2011, 2014a, 2014b, 2015; Fırat, 2017a, 2017b, 2022; Bani *et al*., 2010; Çeçen *et al*., 2015; Çıngay & Karavelioğulları, 2016; Çıngay *et al*., 2018; Duman *et al*., 2017, 2020, 2021; Uzunhisarcıklı & Koç, 2020; Ulukuş *et al*., 2020; Demir *et al*., 2021).

Verbascum genus is the center of origin in Türkiye and is generally distributed in Eastern, Southern and Central Anatolia. Iran-Turanian phytogeographic region is the general distribution area of the genus. In addition to the new species, 15 endemic *Verbascum* taxa are distributed in Karaman province (Huber-Morath, 1978; Ertuğrul & Tugay, 2018).

The author collected an interesting specimen of a *Verbascum* population occurring in the south part of Akarköy village, which belonged to Kazımkarabekir municipality of Karaman province, during a walk through the nature around this village in 2016. In the subsequent years, the same population was studied thoroughly by the collection of additional specimens, bearing all the characters of the plant were obtained. After a detailed examination of the collected specimens, they were described as *Verbascum akarkoeyense* Çeçen sp. nov. due to the presence of morphological characters not found in other taxa in the genus.

Material and Methods

The herbarium samples were studied under stereo microscope (Olympus SZ51) and compared with various *Verbascum* species accounts published previously (Huber-Morath, 1960, 1971, 1976, 1978, 1981; Feinbrun-Dothan, 1978a, 1978b; Meikle, 1985; Ekim, 2000), and relevant voucher specimens were compared in ANK, BASBG, G, GAZI, HUB and KNYA (Thiers, 2024).

The pollen and seed morphology of the unidentified specimens of *Verbascum* were studied using light microscope (LM) and scanning electron microscope (SEM). Wodehouse (1935), technique was employed to prepare the pollen samples for LM. Hereby, the pollen grains were mounted and stained with glycerin-jelly and safranin. Afterward, the pollen slides were studied and measurements for pollen grains were made under LM. At least 30 pollen grains per specimen for each morphological characteristic were investigated using an ocular micrometer. Pollen grains were dried and transferred onto stubs and then coated with gold for SEM *visualization*. The gold-coated pollen grains were studied and photographed using a ZEISS EVO LS10 SEM in ILTEK, Selçuk University, Konya, Türkiye. Relevant terminology was adopted from Faegri & Iversen (1992) and Punt *et al*., (2007). Based on theratio of polar axis to equatorial axis (P/E), the polen shape class was identified by using Erdtman's system (Erdtman, 1969).

The IUCN Red List category was evaluated on the extent of occurrence (EOO), area of occupancy (AOO), and number of mature individuals according to IUCN criteria (Anon., 2022).

Results and Discussion

Verbascum akarkoeyense Çeçen sp. nov. (Figs. 1-4; Tables 1-2).

Type: Türkiye C4 Karaman: Kazımkarabekir, from Akarköy to Masdat, 7th km south of Akarköy village, Hacıbaba Mountain, north of Masdatbeli, steppe, calcareous rocks, 1200– 1600 m a.s.l., 06 August 2021, *Ö. çeçen* 6514&*R. Çeçen* (Holotype: KNYA; Isotypes: ANK, HUB, GAZI and Karamanoğlu Mehmetbey University Biodiversity Application and Research Center).

Paratypes: Türkiye C4 Karaman: Kazımkarabekir, from Akarköy to Masdat, 7th km south of Akarköy village, Hacıbaba Mountain, nourth of Masdatbeli, steppe, calcareous rocks, 1200–1600 m a.s.l., 28 June 2016, *Ö. çeçen* 5247 & *M. Çeçen* (ANK, HUB, GAZI and KNYA, Karamanoğlu Mehmetbey University Biodiversity Application and Research Center).

Fig. 1. *Verbascum akarkoeyense:* (a) growth habit (b) habitus (c) basal and cauline leaves (d) flowers detail (e) fruits in clusters. Scale bars: 10 mm.

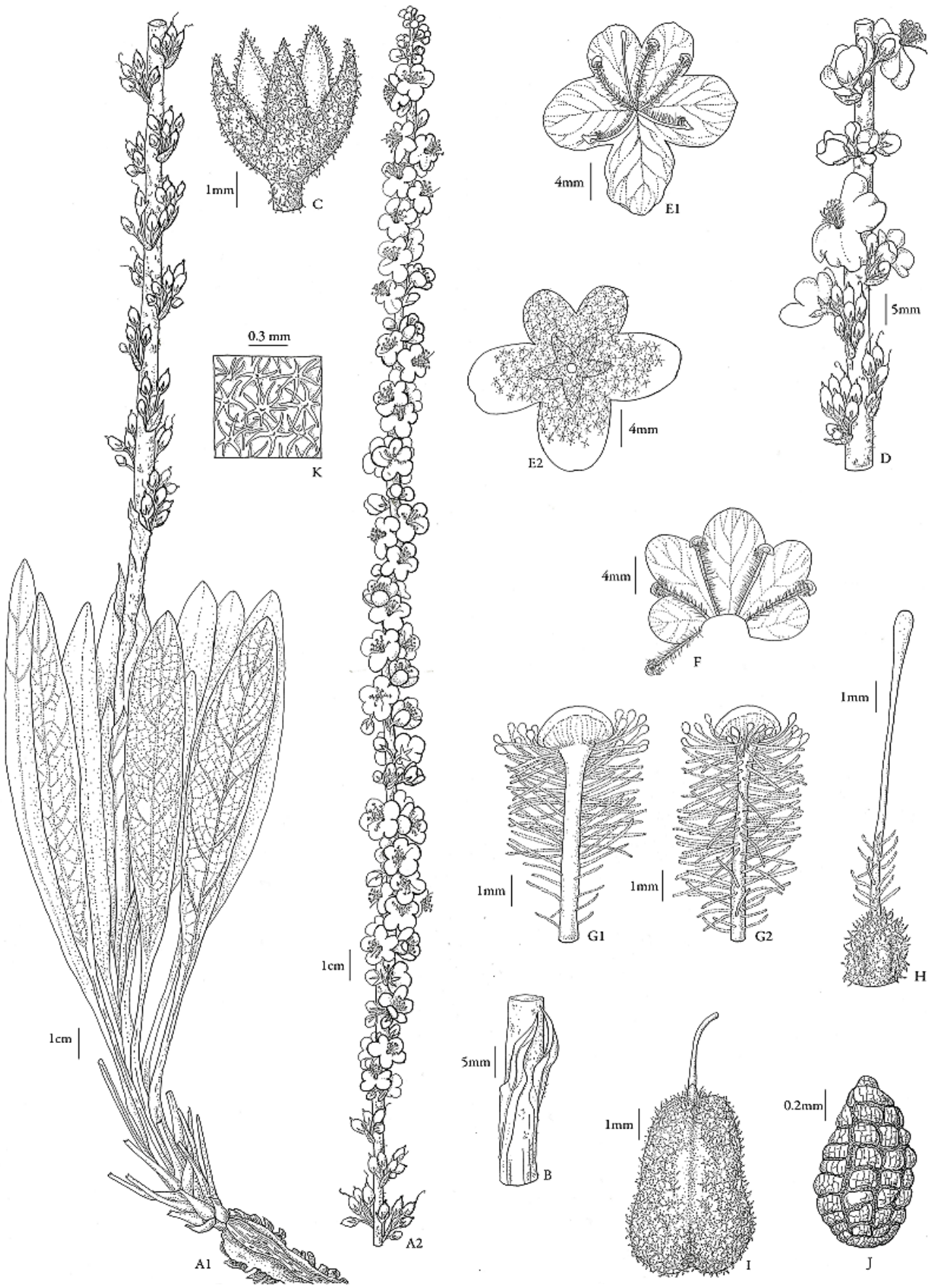

Fig. 2. Illustration of *V. akarkoeyense* (a1) stem and basal leaves (a2) stem and inflorescence (b) cauline leaves (c) calyx (d) flowers ve fruits in clusters (e1) outside surface of corolla (e2) abaxial side of Corolla (f) adnation of stamens to corolla (g1) glabrous up to outside surface of filament anterior in 2 stamens. (g2) hairy up to outside surface of filament anterior in other stamens (h) gynoecium (ı) capsule (j) seed (k) stellate hairs (drawings by Şebnem Akyıldız).

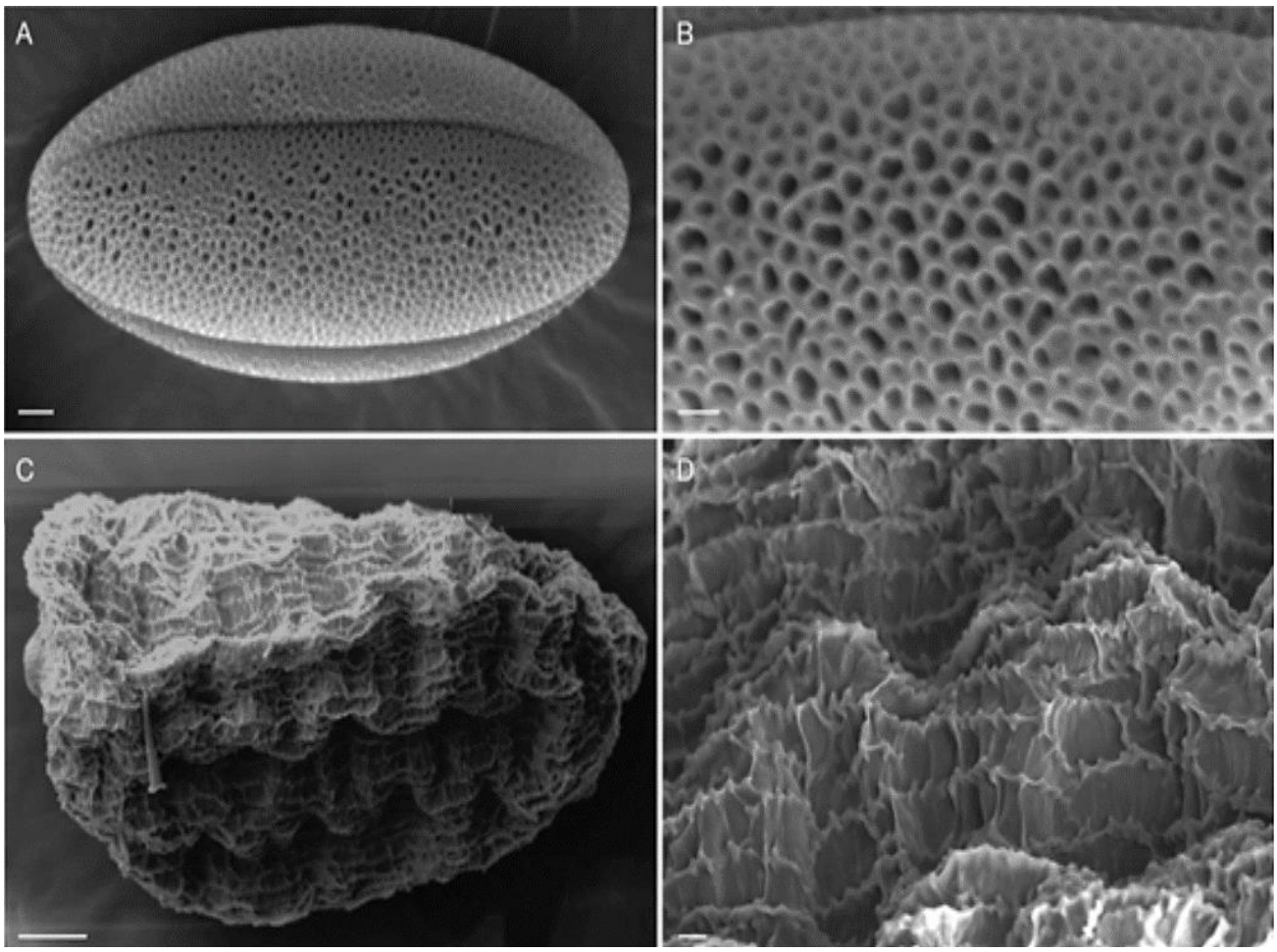

Fig. 3. SEM photos of *Verbascum akarkoeyense* pollen grain: (a) general view and (b) exine ornamentation. SEM photos of *V. akarkoeyense* seed coat*:* (c) general shape and (d) seed coat surface. Scale bars: A, 2µm; B, 1 µm; C, 100 µm; D, 10 µm.

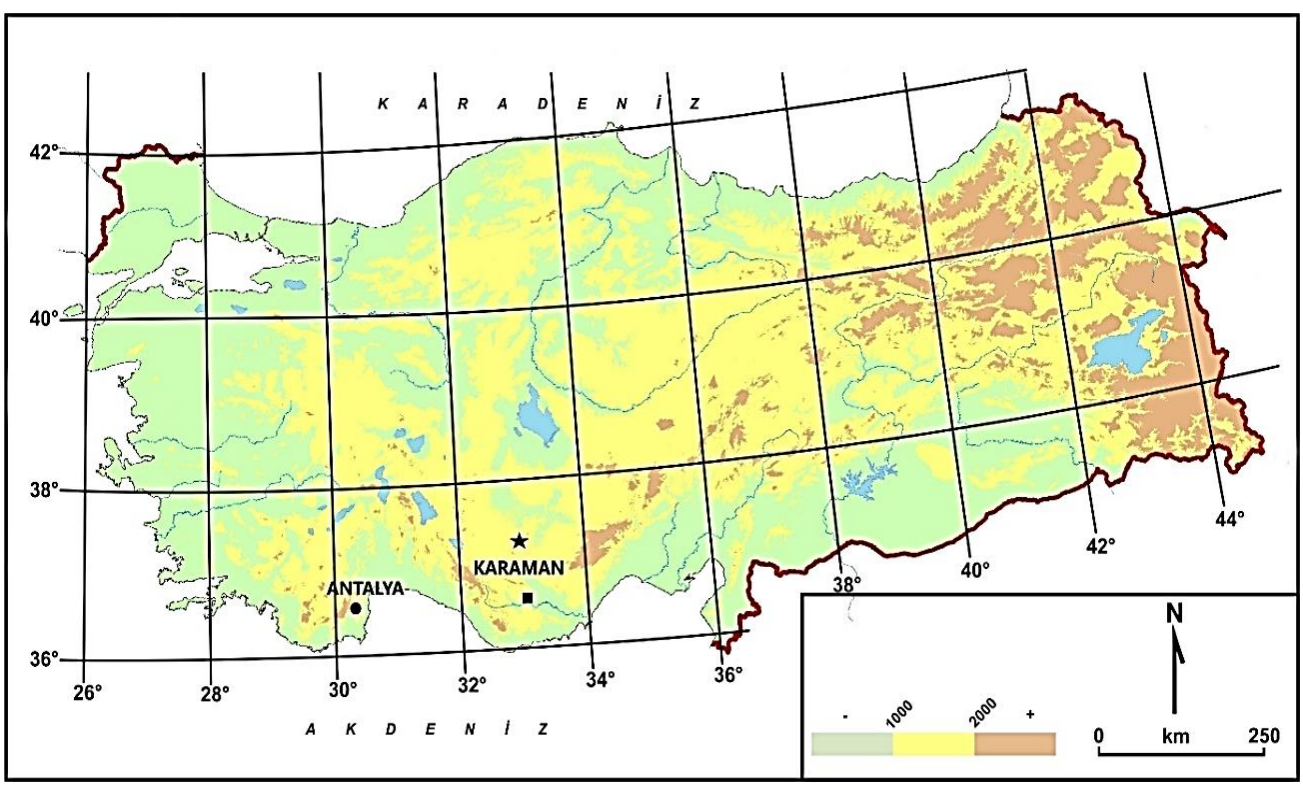

Fig. 4. Distribution of *Verbascum akarkoeyense* (star), *V. microsepalum* (square) and *V. orgyale* (circle) in Türkiye.

Table 1. Pollen morphological features of *V. akarkoeyense.*

Polar Axes (µm)	Min.	27.32
	Max.	32.41
	Mean ± SD	29.62 ± 1.76
Equatorial Axes (µm)	Min.	19.22
	Max.	25.35
	Mean ± SD	22.16 ± 1.07
P/E		1.27 ± 0.07
Pollen Shape		Prolate
Ornamentation		Microreticulate

Diagnosis: *Verbascum akarkoeyense* is a characteristic member of *Verbascum* genus growing in Türkiye. The species shows close similarities to two endemic *Verbascum* species: *V. orgyale* Boiss. & Heldr. and *V. microsepalum* Huber-Morath. *V. akarkoeyense* differs from *V. orgyale* by its stem 40–70 cm long, unbranched (not 70–200 cm long, angled above, branched); basal leaves narrowly oblong to oblanceolate (not lanceolate to linear-lanceolate); cauline leaves lanceolate, decurrent in the base (not broadly ovate orbicular, acuminate, auriculate at base); bracts linear to lanceolate, acuminate (not subulate); inflorescences simple, erect densely racemose (not numerous long slender rod-like branches); capsule oblong to elliptic (not elliptic to ovate). It is closed to *V. microsepalum* but differs by its stem 40–70 cm long, unbranched (not 50– 200 cm long, finely striate, with numerous rod-like branches); basal leaves narrowly oblong to oblanceolate (not lanceolate to obovate); inflorescences simple, erect densely racemose (not slender rod-like branches, forming oblong panicle); capsule oblong to elliptic (not cylindrical to cylindrical-oblong).

Description: Biennial, 40–70 cm long, adpressed with white stellate-tomentose, eglandular hairs. Stem robust, terete, unbranched. Basal leaves narrowly oblong to oblanceolate, 14–18 × 1.5–3 cm, obscurely crenulate to entire, acute, petiole 3–5 cm, winged, lower surface net-veined prominent. Cauline leaves lanceolate, sessile, acuminate, decurrent at the base. Inflorescence simple, erect densely racemose, with crowded clusters of 4–7 flowers. Bracts linear-lanceolate, upto 8mm long, acuminate, lower surface glabrous. Pedicels up to 10 mm long. Bracteoles setaceous, minute. Calyx 3–4 mm long, lobes lanceolate to linear, acute. Corolla yellow, 15– 20 mm in diam, without pellucid glands, sparsely stellate tomentose outside. Stamens 5; anthers reniform; filaments with whitish-yellow wool up to anthers. Capsule oblong to elliptic, 4–5 × 2–3 mm, obtuse, with sparsely stellate hairs. Seeds 0.6–0.8× 0.4–0.6mm, blackish brown, oblong to obovoid, coated by alveolate and bireticulate-rugose, irregular polygonal cells, with distinct and numerous vesicles (Figs. 1-3).

Pollen morphology: The pollen grains of *Verbascum akarkoeyense* are prolate, isopolar and radially symmetrical. The aperture type is trizonocolporate. Exine sculpturing micro reticulate at polar and equatorial regions. The pollen morphology characteristics of the new species are given in Table 1 (Fig. 3).

Etymology: The species epithet is derived from Akarköy, the place of its occurrence from where the type specimen was collected.

Proposed Turkish name for the new species: "Akarköy sığırkuyruğu" (Menemen *et al.*, 2016, 2021).

Phenology: Flowering from June to July and fruiting from July to August.

Additional specimens examined: *V. microsepalum* Huber-Mor.: C4 Karaman: Ermenek-Anamur, Brachfield 10 km to nach Ermenek 850 m a.s.l., 11 vi 1948, *Huber-Morath* 8774 & *Reese* (holo G! photo G00000242) (Fig. 5A). C4 Konya: 8 km S.E of Ermenek 1230 m a.s.l., *Huber-Morath* 14946!

Table 2. Morphological comparison of *Verbascum akarkoeyense* with its closely related species.

Characters	*Verbascum akarkoeyense*	*Verbascum orgyale**	*Verbascum microsepalum**
Habit and situation of hairy	40–70 cm long, adpressed white stellate tomentose eglandular	70–200 cmlong, finely adpressed greyish stellate tomentose, glabrescent above, eglandular	50–200 cm long, densely adpressed white-tomentose, glabrescent, eglandular
Stem	robust, terete, unbranched	robust, tereteor obtuse angled above, branched	robust, terete, finely striate, with numerous rod-like branches
Basal leaves	narrowly oblong to oblanceolate, 14–18 × 1.5–3 cm	lanceolate to linear-lanceolate, 10–30 × 1.5–10 cm	lanceolate to obovate, 10–20 ×3.5–7 cm
Cauline leaves	lanceolate, decurrent at base	upper broadly ovate to orbicular, acuminate, auriculate at base	middle and upper sessile, lanceolate to ovate, crenulated to entire, acuminate, auriculate and shortly (5–10 mm) decurrent at base
Inflorescences	simple, erect densely racemose, with clusters of 4–7 flowers	With numerous long slender rod-like branches, with loose clusters of 2–7 flowers	With slender rod-like branches, forming oblong panicle, with loose clusters of 2–7 flowers
Bracts	linear to lanceolate, acuminate	linear to lanceolate, subulate	cordate-triangular to ovate-lanceolate, acuminate
Calyx	3–4 mm long, lobes linear linear-lanceolate, acute	1.5–3 mm long, lobes linear-lanceolate, acute	1.5–3 mm long, lobes linear-lanceolate, ± blunt
Corolla	yellow, 15–20 mm diam., without pellucid glands, outside sparsely stellate hairs	yellow, 15–20 mm diam., without pellucid glands, stellate-tomentose outside	yellow, 15–20 mm diam, without pellucid glands, stellate-tomentose outside
Capsule	oblong to elliptic, 3–5×2–3 mm, obtuse, with sparsely stellate hairs	elliptic-cylindrical, obtuse or emarginate, 3.5–5×1.5–2mm, stellate-tomentose, glabrescent	elliptic-cylindrical, 5–6× 2–2.5 mm, obtuse tomentose, glabrescent
Habitat; elevation	steppe, calcareous rocks, 1200–1600 m	*Quercus* Scrub, limestone rocks, 0–1500 m	*Quercus* Scrub, fallow fields, 850–1230 m

*Data from Huber-Morath (1978)

Fig. 5. (a) *Verbascum microsepalum* (holo G! G000009255). (b) *V. orgyale* (holo G! G00009445).

***V. orgyale* Boiss. & Heldr.:** C3 Antalya: in rupestribus apricis faucimontis Climatics Lyciae (Yeni Dağ) supra Kourmalu (Koruma?) 305 m a.s.l., v. 1845 *Heldreich (*holo G! Photo GO00009255) (Fig. 5B), C3 Aydın Söke Kayas 860 ma.s.l., *Uslu* 1975 :3412! C2 Denizli: Boz Da. nr. Acıpayam 1500 m a.s.l., *D. 13395!* Muğla Sandras Da. Ağla 600 m a.s.l., *D. 1364!* C3 Antalya: Tahtalı Da. nr. Kuzdere Y. 1200 m a.s.l., *D. 15118.*

Distribution and habitat: The new species is endemic to Türkiye, and it is known only from the type locality. The distribution of the new species found to Hacıbaba Mountain in Karaman province in the Central Anatolian Region of Türkiye, at 1200–1600 m. in a steppe on calcareous rocks (Figs 1 & 4). *Verbascum akarkoeyense* survives together *Pinus nigra* J.F. Arnold. subsp. *pallasiana* (Lamb.) Holomboe., *Juniperus foetidissima* Willd., *J. drupacea* Labill., *Salvia heldreichiana* Boiss. ex Bentham (endemic), *Cyclotrichium origanifolium* (Labil) Manden & Schenk, *Ballota larendana* Boiss. et Heldr. (endemic), *Scutellaria salviifolia* Benth., *Lotus aegaeus* (Gris.) Boiss., *Linaria simplex* (Willd.) DC., *Ononis pusilla* L., *Salvia candidissima* Vahl. subsp. *occidentalis* Hedge, *Nepeta cilicia* Boiss. et Benth, *Aubrieta pinardii* Boiss. (endemic), *Minuartia pestalozzae* (Boiss.) Bornm., *Bunium microcarpum* (Boiss.) Freyn et Bornm. subsp. *microcarpum, Astragalus angustifolius* Lam. subsp. *angustifolius, Euphorbia anacampseros* Boiss. var. *anacampseros, Ferula parva* Feryn et Boiss. (endemic), *Marrubium astracanicum* Jacq. subsp. *astracanicum, Leontodon hispidus* L. subsp. *hispidus, Dianthus stramineus* Boiss. (endemic), *D. zonatus* Fenzl. var. *zonatus. Acantholimon venustum* Boiss. *venustum, Acanthus hirsutus* Boiss. var. *hirsutus, Chondrilla juncea* L. var. *juncea, Echinophora tournefortii* Jaub.et Spach., *Teucrium polium* L. subsp. *polium, Morina persica* L. var. *persica, Phlomis armeniaca* Willd.

Conservation status: *Verbascum akarkoeyense* is known from a single location; its extent of occurrence (EOO) and area of occupancy (AOO) is approximately 10 km^2 (criterion B1, B2); number of individuals less than 500 (D1); number of locations is only one (a), and estimated continuing decline (b) in area of occupancy (ii), quality of habitat (iii), number of mature individuals (v). Although the main threat is not preferred by animals, it is in danger due to the destruction caused by humans and animals due to the migration of plateau nomads to the region during the summer period. As a result, this new species is assessed as 'Critically Endangered: CR, B1ab (ii, iii, v) + B2ab (ii, iii, v)' (Anon., 2022) (Figs. 1, 4).

Taxonomic relationships: *Verbascum akarkoeyense* belongs to "Group M" due to flowers 2 or more in the axil of each bract; clusters umbellate, sessile, bracteoles present, longest pedicels 2 × calyx or longer. Fertile

stamens 5, anthers all reniform; connective of all anthers with adaxial surface densely papillose; filament wool whitish yellow (Huber-Morath, 1978; Davis *et al*., 1988). Therefore, the new species was compared with *V. orgyale* and *V. microsepalum* and the new species was first thought to be similar to *V. microsepalum* and *V. orgyale* belonging also to the "Group M": *V. microsepalum* is distinguished from ***V. akarkoeyense*** by its; longer and branched stem, lanceolate to obovate of basal leaves; inflorescence panicle, capsule cylindrical oblong. *V. orgyale* is distinguished from ***V. akarkoeyense*** by its.; longer and branched stem linear to lanceolate of basal leaves; cauline leaves broadly ovate orbicular, acuminate, auriculate at base, inflorescence numerous long slender rod-like branches, capsule elliptic to ovate (Table 2).

Although the seeds in the *Verbascum* genus are quite similar, they sometimes differ. It is seen that *V. cherianthifolium* Boiss. and *V. speciosum* Schrad. Which are evaluated in "Group M" with *V. akarkoeyense*, exhibit similar seed shapes and surface features (Attar *et al*., 2007; Kheiri *et al*., 2009). *V. akarkoeyense* seeds are oblong to obovoid, as in these two species. Our results regarding the shape and surface morphology of the seed of the new species showed similar results to former studies (Juan *et al*.,1997; Attar *et al*., 2007; Cabi *et al*., 2011; Başer, 2021).

Although pollen characters cannot be used alone to distinguish species, the use of this character in combination with other characters may help to differentiate some taxa. While the pollen shape of *V. cherianthifolium* and *V. speciosum* taxa is subprolate whereas in *V. akarkoeyense* it is prolate. The pollen shape and surface morphology of *V. akarkoeyense* have been compared with the species in the relevant literature and show similar characteristics. (Pehlivan *et al*., 2008; Al-Hadeethy *et al*., 2014; Öztürk *et al*., 2018; Tekin & Yılmaz, 2018; Başer, 2021).

Ecology: *V. akarkoeyense* usually grows on calcareous rocks in the steppe whereas *V. microsepalum* and *V. orgyale* are found in *Quercus* L. scrub and fallow fields. Together with the new species, in Türkiye, the taxon presence of "Group M" the number has increased to 13 and its total and endemic number has risen to 257 and 203 (Huber-Morath, 1978).

A dichotomous key to *Verbascum akarkoeyense* and close relative species is added (adapted by *Verbascum* "Group M" in Flora of Turkey (Huber-Morath, 1978);

1. Basal leaves incised-ovate or lobed or pinnatifid near base
2. Bracts ovate-cordate to lanceolate; capsule ellipsoid to subglobose, 3–4.5×2,5–3 mm ……...… *V. banaticum*
2. Bracts linear-lanceolate to linear; capsule oblong-cylindrical, 5–6×2–5 mm …… *V. stenocarpum*
1. Basal leaves entire
3. Capsule subacute, keeled towards apex …… *josgadense*
3. Capsule obtuse, not keeled.
4. Bracts linear-lanceolate, subulate …….. *V.* ***orgyale***
4. Cauline leaves shortly decurrent at base
5. Bracts linear-lanceolate, calyx lobes acute ……..... *V.* ***akarkoeyense***
6. Bracts ovate to lanceolate, calyx lobes subobtuse ….…… *V.* ***microsepalum***
4. Cauline leaves not decurrent ……... other Turkish species

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