



## A new natural hybrid of *Verbascum* L. (Scrophulariaceae) from Turkey

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### Highlights

- *Verbascum aytachii* is defined as a new hybrid species to science.
- *V. aytachii* and its parents are compared in terms of morphology and palynology.
- The stem length, indumentum, filaments and aperture type are the most discriminative characters.

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### Abstract

*Verbascum* × *aytachii* *nothosp. nov.* H. Duman & Uzunh. (sect. *Bothrospermae*) is described and illustrated as a new natural hybrid from the Orhaneli (Bursa Region) area in Western Anatolia, Turkey. This species is identified to have some intermediate morphological and palynological characteristics that place it between the parents which are *V. ekicii* and *V. basivelatum*. A comprehensive description, ecology, a distribution map and a detailed illustration are provided. Furthermore, pollen morphological properties of *V.* × *aytachii* and its parents are compared via light (LM) and scanning electron microscopes (SEM).

## 1. INTRODUCTION

The genus *Verbascum* L. (excl. *Celsia* L.) (Scrophulariaceae) consists of approximately 360 species in the world [1,2]. It is mainly distributed in Eurasia and N Africa with the highest diversity in Turkey where it is represented by 256 species, 131 hybrids and 6 imperfectly known or doubtful records which are divided into 13 partly artificial groups. Among them, 201 species are endemic to Turkey, this indicating an endemism ratio of about 80% [3-34].

Some similar samples of *Verbascum* were collected during the field investigations in Çeki village (Bursa, western Turkey) within the scope of Trans Anatolia Natural Gas Pipeline Project (TANAP). According to our experience and the literature data, the hybridization rate is very high among *Verbascum* species where the regions of distribution overlap in the natural area. During the field trips, we thought that some suspected specimens could be *V. basivelatum* Hub.-Mor. and *V. ekicii* H. Duman & Uzunh. [35]. After thorough examinations of relevant literature and comparisons with specimens from various herbaria of Turkey and in foreign countries and also some detailed morphological and palynological investigations were carried out, the unidentified specimens were defined to be a new hybrid species, which is here named as *Verbascum* × *aytachii* H. Duman & Uzunh. With this new hybrid species, the number of hybrid *Verbascum* species in Turkey increased to 132.

## 2. MATERIALS AND METHODS

### 2.1. Plant Materials

At first, some flowering and fruiting specimens of *Verbascum* were collected by the authors during a field trip to West Anatolia (B2 Bursa-Orhaneli) in 2013. These unknown species were cross-checked regarding the descriptions of *Verbascum* in Huber-Morath [3, 36], Feinbrun-Dothan [37, 38], Meikle [39], Ekim [9]. Then, field explorations were carried out again in 2017 and 2018 to investigate these unusual populations of *Verbascum*, which could not be matched with any of the known taxa in Turkey and also seemed to have intermediate characteristics of *V. ekicii* and *V. basivelatum*. Observations were made on living plants, dried specimens, and digital images from the herbaria GAZI, ANK, HUB, ISTE, BM, G, P, K, E, WU and W (herbarium acronyms follow Thiers [40]). Authors' abbreviations of plant names were checked from Brummitt and Powell [41] and the International Plant Names Index (IPNI) [42].

### 2.2. Pollen Morphological Analyses

Pollen morphology of the investigated *Verbascum* species was studied by light microscopy (LM) and scanning electron microscopy (SEM). Pollen samples were prepared according to Wodehouse [43] technique for LM. Pollen grains were stained with glycerine-jelly plus safranin. Prepared pollen slides were investigated and measured under the light microscope. Measurements were performed on at least 30 pollen grains per specimen for each morphological characteristics using an Olympus CX31 Light Microscope with an ocular micrometer. For SEM studies, dried pollen grains were transferred onto stubs and then coated with gold. They were investigated and photographed with a JEOL JSM 6060 Scanning Electron Microscope. Terminology was adopted from Faegri and Iversen [44] and Punt et al. [45]. The classification of pollen shape was identified following Erdtman's system [46] based partly on the P/E ratio.

## 3. RESULTS and DISCUSSION

### 3.1. Morphological Characteristics

*Verbascum* × *aytachii* H. Duman & Uzunh. *nothosp. nov.* (Figures 1–3)

(*Verbascum ekicii* H. Duman & Uzunh. × *Verbascum basivelatum* Hub.-Mor.)

**Type:** TURKEY. B2 Bursa: Orhaneli, SW of Çeki village, 800 m, 19.vii.2017, serpentine areas, *M.E. Uzunhisarcıklı 2720a* & *H. Duman* (holotype GAZI, isotypes ANK, HUB).

**Diagnosis:** *Verbascum* × *aytachii* is similar to *Verbascum ekicii* and *V. basivelatum*. It is distinguished from *Verbascum ekicii* by its stems of length up to 100 cm (not to 70 cm), with sparsely white lanate-tomentose below, very sparsely white lanate-tomentose to glabrous above (not densely white lanate-tomentose), pedicels filiform, glabrous to sparsely tomentose (not pedicels thick, densely tomentose), densely pellucid-punctate outside (not without pellucid glands), all filaments with densely purple-violet hairs, two anterior glabrous near apex (not two filaments with purple-violate hairs, others white-yellowish, two anterior glabrous near apex). It can be distinguished from *V. basivelatum* by its stems up to 100 cm (not to 150 cm), fertile stamens 5 (not fertile stamens 4, without or rarely with an antherless 5<sup>th</sup> staminode), all filaments with densely purple-violet, rarely white-purplish hairs, two anterior glabrous near apex (not all filaments white-yellowish hairs, two anterior glabrous near apex), (Table 1).

**Table 1.** Morphological comparison between *Verbascum x aytachii*, *V. ekicii* and *V. basivelatum*

Characters	<i>V. x aytachii</i>	<i>V. ekicii</i>	<i>V. basivelatum</i>
<b>Stem (cm)</b>	up to 100	up to 70	up to 150
<b>Situation of hairy</b>	with sparsely white lanate-tomentose below, very sparsely white lanate-tomentose to glabrous above	densely white lanate-tomentose	densely or very densely lanate, glabrous or sparsely glandular above
<b>Pedicel</b>	filiform, glabrous to sparsely tomentose	thick, densely tomentose	filiform, glabrous
<b>Corolla</b>	densely pellucid-punctate outside	without pellucid glands	densely pellucid-punctate outside
<b>Stamen (fertile)</b>	5; all filaments with densely purple-violet hairs, two anterior glabrous near apex	5; two filaments with purple-violet hairs, others white-yellowish, two anterior glabrous near apex	4; two anterior ones glabrous, 3 posterior ones very densely villous-velutinous and with long white papillae

**Description:** Biennial to perennial herb, with sparsely white lanate-tomentose below, very sparsely white lanate-tomentose to glabrous above. Stem terete, erect, 50–100 cm, branched above. Basal leaves with petiole 1.5–4 cm, lamina 3.5–7.5 × 1.5–2.5 cm, elliptic to oblanceolate, crenate-denticulate, obtuse to acute. Cauline leaves small, very few, sessile, 0.7–4 × 0.3–1.5 cm, oblong-elliptic, entire to crenulate, obtuse-acuminate. Inflorescence lax raceme, slender, flowers in distant clusters of 1–4; axis completely glabrous to very sparsely tomentose. Bracts minute, scale-like, lanceolate-linear. Bracteoles absent. Pedicels filiform, 3–6 mm, glabrous to sparsely tomentose. Calyx 1.8–2 mm, divided almost to base, lobes linear to oblanceolate, obtuse, sparsely branched tomentose. Corolla rotate, c. 12 mm diam., yellow, densely pellucid-punctate outside, papillose-villosulous at base of upper lobes within, glabrous outside. Stamens 5; anthers reniform; all filaments with densely purple-violet, rarely white-purplish hairs, two anterior glabrous near apex. Ovary subglobose; stylus 6–9 mm, filiform; stigma spatulate.

**Phenology:** Flowering time from June to July.

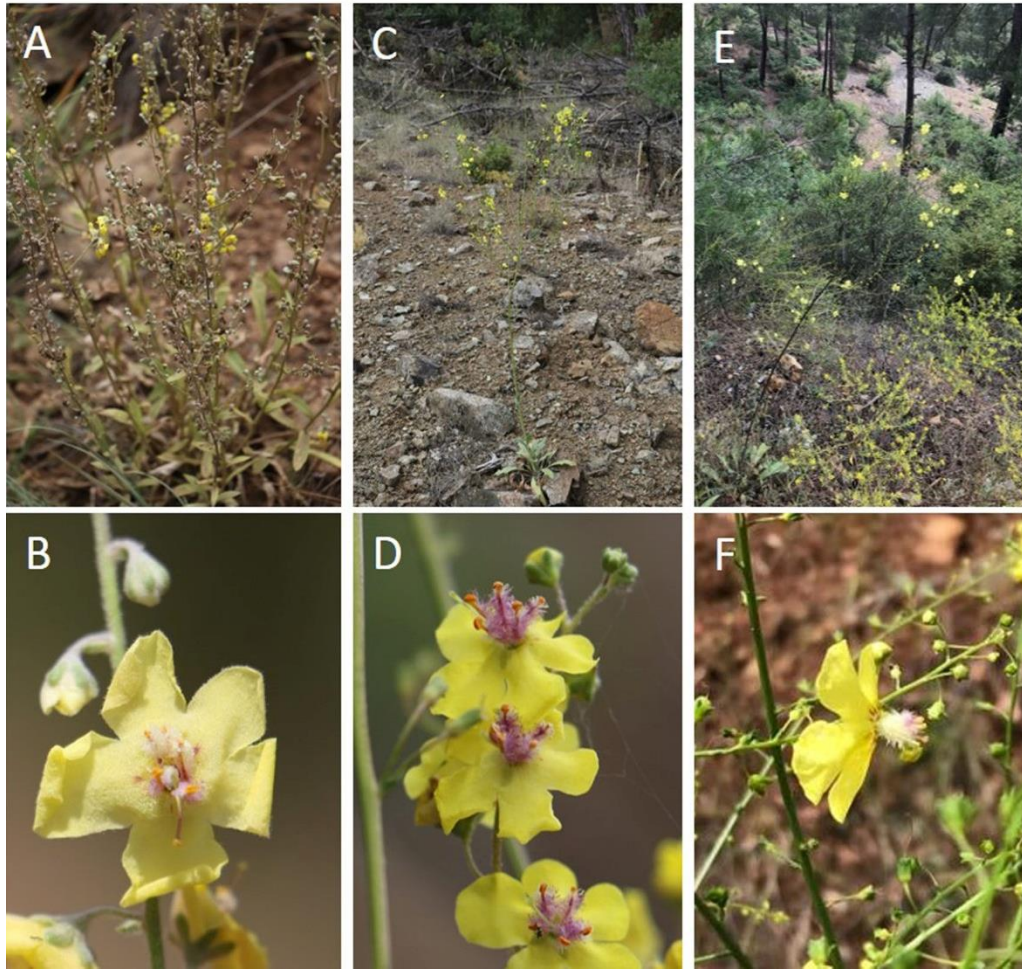
**Habitat and ecology of *V. × aytachii*:** The new hybrid species grows in serpentine areas under the *Pinus brutia* Ten. forest in company with *Phillyrea latifolia* L., *Juniperus oxycedrus* L., *Cistus creticus* L., *Quercus infectoria* G. Olivier, *Dianthus goekayi* Kaynak, Yılmaz & Taşkın, *Saponaria pamphylica* Boiss. & Heldr., *Dactylis glomerata* L., *Allium flavum* L. subsp. *tauricum* (Besser ex Reichb.) Stearn and *Alyssum dudleyi* N. Adiguzel & R.D. Reeves.

**Etymology:** The new hybrid species is named in honour of Prof. Dr. Zeki Aytaç.

### Specimens examined

***Verbascum ekicii*.** —TURKEY. **B2** Bursa: Orhaneli, SW of Çeki village, 800 m, 19 July 2017, serpentine areas, *M.E. Uzunhisarcıklı 2720 & H. Duman* (holotype GAZI!, isotypes ANK!, HUB!); *ibid.*, 19 May 2013, *M. Ekici 4473* (GAZI!).

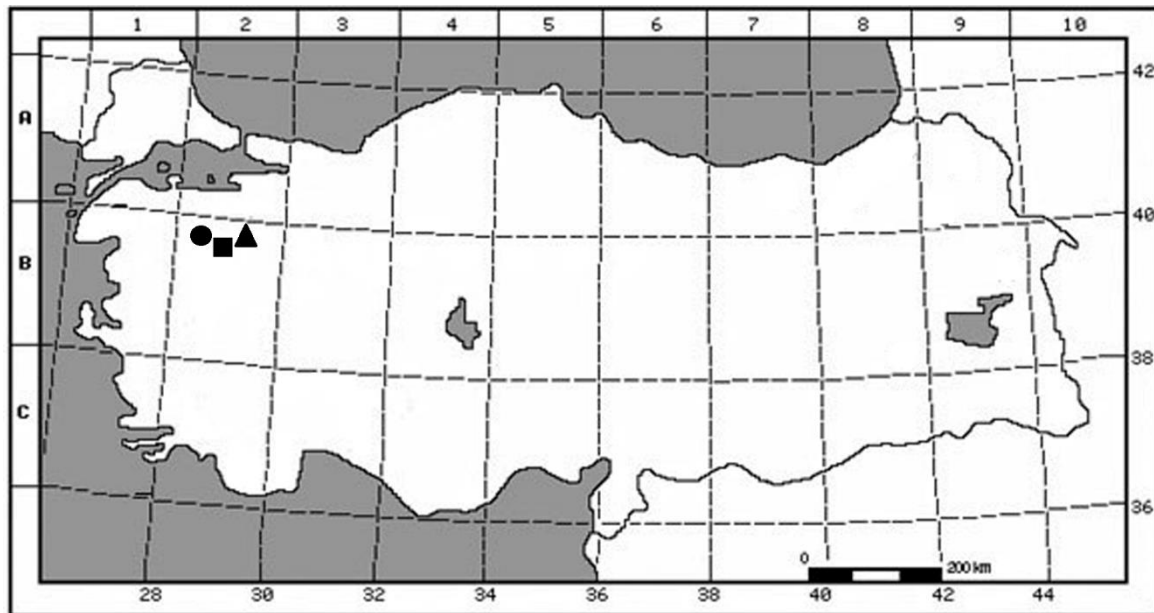
***Verbascum basivelatum*.** —TURKEY. **A2** Bursa: Bursa-Keles, 37 km W Keles, 510 m, 08 July 1982, *Max Nydegger 17028* (GAZI!). **A2** Bursa: 1 km from Soğukpınar to Uludağ, 1100 m, 05 July 1980, *Max Nydegger 15135* (GAZI!). **A2** Bursa: Harmancık-Orhaneli, 4 km N Harmancık, 770 m, 05 August 1983, *Max Nydegger 18639* (GAZI!). **B3** Eskişehir: Porsuk dam – Türkmen mountain, 930 m, rocky and disturbed forest, 23 July 1993, *Z. Aytaç 6208* (GAZI!). **B3** Eskişehir: around Porsuk dam, 992 m, serpentine, 18 July 2002, *FAK 3385* (GAZI!).



**Figure 1.** Habitus and flowers of *V. ekicii* (A, B), *V. × aytachii* (C, D) and *V. basivelatum* (E, F)



**Figure 2.** *V. x aytachii* H. Duman & Uzunh. A1) Stem and basal leaves, A2) Stem and inflorescence, B) Cluster of flowers, C1-C2) Stamens, D) Situation of hairy, E) Surface of petal



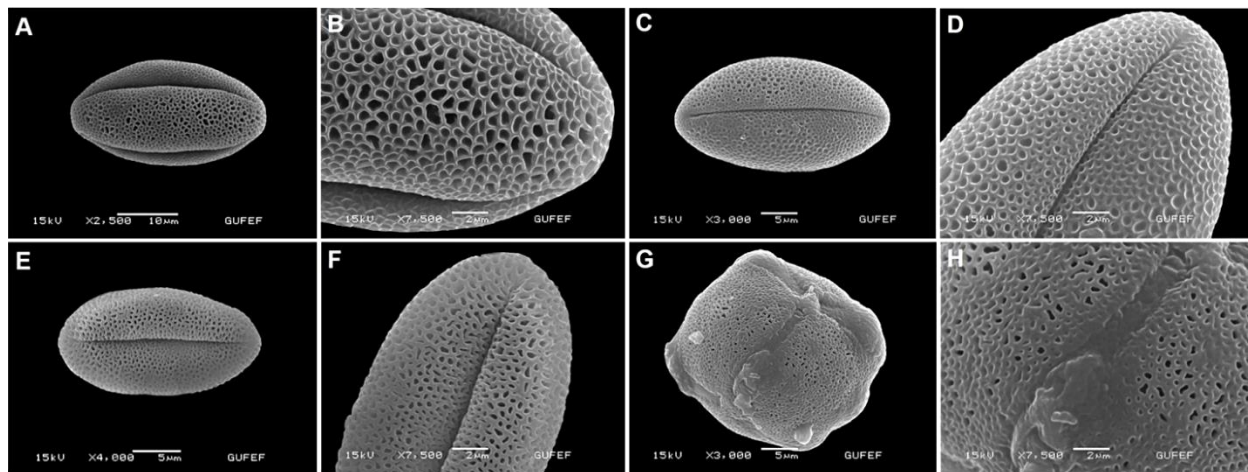
**Figure 3.** Distribution map of the *Verbascum ekicii* (●), *V. × aytachii* (▲) and *V. basivelatum* (■) in Turkey

### 3.2. Pollen Morphological Characteristics

The pollen grains of *V. × aytachii*, *V. ekicii* and *V. basivelatum* are isopolar and radially symmetrical. The aperture type is generally trizonocolporate in *V. ekicii* and *V. basivelatum*; but 5% tetracolporate, 3% trisyncolporate and 92% trizonocolporate pollen grains have been detected in *V. × aytachii*. The pollen shape is oblate-spheroidal in *V. × aytachii* (P/E:  $0.94 \pm 0.02$ ), *V. ekicii* (P/E:  $0.96 \pm 0.02$ ) and *V. basivelatum* (P/E:  $0.98 \pm 0.02$ ). The exine ornamentation is microreticulate at polar and equatorial regions in these investigated *Verbascum* species (Table 2, Figure 4).

**Table 2.** Pollen morphological features of *V. × aytachii* and its parents

Species	P (µm)			E (µm)			P/E	Aperture Type	Ornamentation
	Min.	Max.	Mean	Min.	Max.	Mean			
<i>V. × aytachii</i>	19	25	$21.53 \pm 1.38$	20	29	$22.93 \pm 1.93$	$0.94 \pm 0.02$	5% tetracolporate, 3% trisyncolporate, 92% trizonocolporate	Microreticulate
<i>V. ekicii</i>	21	23.5	$22.1 \pm 0.52$	20	24.75	$22.9 \pm 1.07$	$0.96 \pm 0.02$	Trizonocolporate	Microreticulate
<i>V. basivelatum</i>	18.5	22.5	$20.44 \pm 0.95$	19	22	$20.69 \pm 0.74$	$0.98 \pm 0.02$	Trizonocolporate	Microreticulate



**Figure 4.** SEM micrographs of pollen grains of investigated *Verbascum* species. A, B) *V. ekicii*, C, D) *V. basivelatum*, E-H) *V. × aytachii*, A, C, E) General aspect, G) Tetracolporate type, B, D, F, H) Exine ornamentation

*Verbascum × aytachii* is similar to its parents, *V. ekicii* and *V. basivelatum*. It is differentiated from *Verbascum ekicii* due to important characters such as densely pellucid-punctate outside, all filaments with densely purple-violet hairs and two anterior glabrous near apex. Also, it can be distinguished from *V. basivelatum* by some characteristics, such as fertile stamens 5, all filaments with densely purple-violet, rarely white-purplish hairs and two anterior glabrous near apex.

The pollen morphologies of *V. × aytachii* and its parents were compared and some differences were found in terms of these characteristics. Al-Hadeety et al. [47] observed the variations in pollen shape of 20 species of *Verbascum* from Iran. They divided the *Verbascum* species they investigated into four groups according to the pollen shape: prolate-spheroidal, prolate, subprolate and also oblate-spheroidal. Contrary to these researchers, we observed only oblate-spheroidal pollen shape in our studied *Verbascum* species. Öztürk et al. [48] determined that trisyncolpate and trizonocolpate aperture type as well as trizonocolporate in their studied *Verbascum* species distributed in Turkey. They reported that aperture type was a diagnostic character for taxonomic discrimination between and within the groups in the genus *Verbascum*. The aperture type of our studied species is generally trizonocolporate, whereas in *V. × aytachii* they are 5% tetracolporate, 3% trisyncolporate and 92% trizonocolporate. Therefore, the aperture type is an important character that can be used to distinguish these species from the other morphological features.

As a result of this study, the number of hybrid species belonging to the genus *Verbascum* in Turkey has increased to 132.

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#### CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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