Research Journal of Biology Sciences
E-ISSN: 1308-0262 14(2): 170-183, 2021
Research Article

INVESTIGATION OF THE SOME MORPHOLOGICAL AND ANATOMICAL FEATURES OF THE LOCAL ENDEMIC *Verbascum basivelatum* Hub.-Mor in CENTRAL ANATOLIA

Nilgün Demirezen[1,a], Atila Ocak[2,b,*], Sevim Küçük[3,c],Okan Sezer[2,d], Derviş Öztürk[4,e], Onur Koyuncu[2,f]

[1]*Eskişehir Osmangazi University Institute of Science and Technology, Eskişehir, Turkey*
[2]*Eskişehir Osmangazi University, Faculty of Arts and Sciences, Eskişehir, Turkey*
[3]*Anadolu University Faculty of Pharmacy Eskişehir, Turkey*
[4]*Eskişehir Osmangazi University Mahmudiye Horse Breeding Vocational School, Eskişehir, Turkey*

**Corresponding Author:*
E-mail: nilgundemirezen@hotmail.com

(Received 19th October 2021; accepted 22th November 2021)

a: ORCID 0000-0002-4895-8985, b: ORCID 0000-0003-1149-1194, c: ORCID 0000-0002-3594-0364
d: ORCID 0000-0001-7304-1346, e: ORCID 0000-0001-7189-7407, f: ORCID 0000-0002-0364-6638

ABSTRACT. In this study, the morphological features and anatomical structure of the endemic *Verbascum basivelatum* species were examined for the first time. As a result of the examinations, new morphological characters were determined. The morphology obtained from the *V. basivelatum* (in Tukish Kadifesığırkuyruğu) species was compared with its description in the Flora of Turkey and tabulated. The *V. basivelatum* species is distributed in the Iran-Turanian phytogeographic region and is an endemic species in the A group determination key. Its habitat is serpentine rocks. The species has 5 stamens, of which 4 are fertile and 1 is staminode, filaments are whitish-purple-violet hairy. Anatomical features of the *V. basivelatum* species were determined by transverse sections taken from root, stem, leaves and superficial sections taken from leaves. The leaf has multicellular candelabra hairs and glandular hairs. Thus, the endemic *V. basivelatum* species was examined in detail for the first time in terms of morphology and anatomy, and new findings were revealed. This study will contribute to the recognition and protection of Turkey's biodiversity.

Keywords: *Verbascum basivelatum, morphology, anatomy, endemic, biodiversity, Turkey*

INTRODUCTION

The genus *Verbascum*, which belongs to the Scrophulariacea family, is represented by approximately 360 taxa in the world. In Turkey, the genus *Verbascum* is represented by approximately 255 species under 13 groups, 130 of which are hybrids [1, 2]. It has an endemism rate of approximately 70% with 180 endemic species in Turkey. Species in the genus *Verbascum* are annual, biennial, perennial, and rarely shrubs. Plant taxa of this genus have adapted to the hot and dry conditions of summer and are plant groups with high temperature tolerance. *Verbascum* species are found in habitats such as limestone cliffs, serpentine rocks, roadsides, rocky slopes, sandy areas, meadows, mountain steppes, *Pinus* forests. The species belonging to the genus *Verbascum* have a great diversity of species due to their distribution in different geographical regions.

Important morphological studies have been carried out on the genus *Verbascum*, which has a rich species diversity [3, 4, 5, 6, 7]. Among the important morphological characters of the genus *Verbascum*; There are the number of stamens, the color of the filament hairs,

the length of the flower stalk, the number of flowers in the bract, the presence of the bracteole, the length of the brach, the capsule, the seed, the size of the corolla, and the trichome conditions. There are many anatomical studies on *Verbascum* species. In the anatomical studies, multicellular cover hairs, candlestick hairs and glandular hairs were found on the leaves [1, 8, 9, 10].

Verbascum species are medically used in respiratory disorders such as asthma, tuberculosis, dry cough, bronchitis, rheumatic pain, against hemorrhoids, eczema, diuretic, wound healing, migraine pain, sedative, expectorant and to treat fungal infection. In addition, its flowers, leaves and roots are antioxidant, antiviral, anti-inflammatory, anticancer, antispasmodic, antiseptic, antimalarial, antiulcerogenic, cytotoxic, sedative, bactericidal [11, 12].

Verbascum species in Turkey; It is distributed in Iran-Turanian, Mediterranean and Euro-Siberian phytogeographic regions. *Verbascum basivelatum* is a species found in the Irano-Turanian phytogeographic region and in the A group designation key (Figure 1). *Verbascum* group A species are easily distinguished from other *Verbascum* groups by their fertile 4 stamens [13, 14]. In addition, according to the species IUCN criteria; Taxa that are in danger of extinction are in the category of CD (Coservation Dependent) (Figure 2-4). *Verbascum basivelatum* was first described by Hub.-Mor. and published in the journal Bauhinia in 1979.

In this study, the morphological features of the endemic *V. basivelatum* species were examined and the determined features were compared with the data in Flora of Turkey [15, 16]. The morphological characters of the species were supported by drawings (Figure 5). In addition, the anatomical features of the species were examined for the first time in this study, with sections taken from the root, stem and leaves.

Fig. 1. *Distribution of the endemic V. basivelatum species in Turkey*

Verbascum basivelatum Type: Turkey B3 Eskişehir: Türkmen Da. Porsuk Barajı, auf Serpentinfelsen, zirka 900m, 16 iv1976, T Ekim ANK 2071.

Other Localities: 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!). B3 Eskişehir: Porsuk dam (39º 38′ 03″ K- 30º 17′ 04″ D, 931m) (OUFE: 21522).

Fig. 2. *General view of V. basivelatum*

Fig. 3. *Appearance of the flower of V. basivelatum*

Fig. 4. *Appearance of the basivelatum of V. basivelatum*

MATERIALS AND METHODS

Plant Materials

Plant material was collected from Eskişehir Porsuk dam (39º 38′ 03″ K- 30º 17′ 04″ D, 931m). Photographs of the collected specimen were taken for its habitat and general appearance (Figure 2). Herbarium sample was prepared from the dried samples of the plant and placed in Anadolu University Faculty of Pharmacy and Eskişehir Osmangazi University Biology Department Herbariums. In addition, alcohol material was prepared by placing the plant sample in 70% alcohol for anatomical studies.

Morphological Studies

Flora of Turkey was used in the identification of collected *V. basivelatum* species [15, 16]. The morphological features of the taxon were examined and compared with the characters in the Flora of Turkey. Measurements were made for the morphological parts of the plant. The general appearance of the species was drawn, and the basal leaves, stem leaves, bract, bracteole, calyx, corolla, pistil, stamen, fruit and seed were studied in order to determine its morphological features.

Anatomical Studies

The root, stem and leaves of the plant were used. Cross sections were taken from the root, stem and leaves, and sections were taken from the lower and upper surfaces of the leaf. The sections were fixed with glycerin-gelatin after staining with Sartur Reagent.

RESULTS AND DISCUSSION

Morphological Observations

Morphological features of the *V. basivelatum* species are given in Table 1. In this table, the morphological characters obtained as a result of the study were compared with the morphological characters given in the Flora of Turkey. In addition to the characters depicted in the Flora of Turkey in Table 1, new morphological characters that may be important in the systematics of *V. basivelatum* were determined. Drawings of morphological characters that are important in describing *V. basivelatum* are given in Figure 5.

***Verbascum basivelatum*:** Perennial, 100-165 cm. Stem brown, taproot. Stem single, strong, cylindrical, completely erect, obtus-angular, very densely woolly hairy at base, sparsely glandular above. Leaf shape is lanceolate, the number of leaves is very large, leaf length 11-20 cm (including petiole) x 2.5-3.5 cm, leaf surface lanatus (woolly) hairy, base leaf arrangement rosette, leaf margin crenate-denticulate, leaf tip acute. Leaf venation is reticulate. Leaf lamina lanceolate shaped, margin crenate. Leaf blades are cuneate shaped. Petiolate petiolate, 2-8 cm long, densely white woolly pubescent. The flowers are numerous, their outlets are leaf axils. Inflorescence racemus weak, loosely flowering, completely glabrous. Bract green, 2-3 mm in length, lanceolate shaped, hairless. The peduncle is pedicellate, 5-8 mm long, filamentous, glabrous. Calyx 2-3 mm, color green, calyx type gamosepal, rotat, 5-toothed, tooth shape lanceolate, pointed, glabrous. Corolla type gamopetal, rotate, yellow in color, 5-lobed, outer surface of corolla densely transparent-dotted, base of upper lobes papillary-thin long soft hairs few. Perianth type dichlamideic. Receptaculum ovoid, glabrous. It has 4 stamens, their length is 0.4-0.9 cm, the stamen arrangement is indinamus. Anthers are kidney-shaped, 0.5-1 mm in length, their attachment to the filaments is basic. Filament length is 0.4-0.5 cm, filaments are whitish-purple violet hairy up to the anthers. The theca arrangement is parallel. Stigma with small grooves, capitate. Stylus length 0.6-0.8 cm, terete. The ovarian state is hypogin. Flower sex status hermaphrodite. Capsule ovoid, 3-3.5 x 1-1.5 mm, glabrous. Seed length and width 0.2-0.3 x 0.3-0.4 mm, seed color brown, shape prismatic-oblong, surface reticulate-rugose.

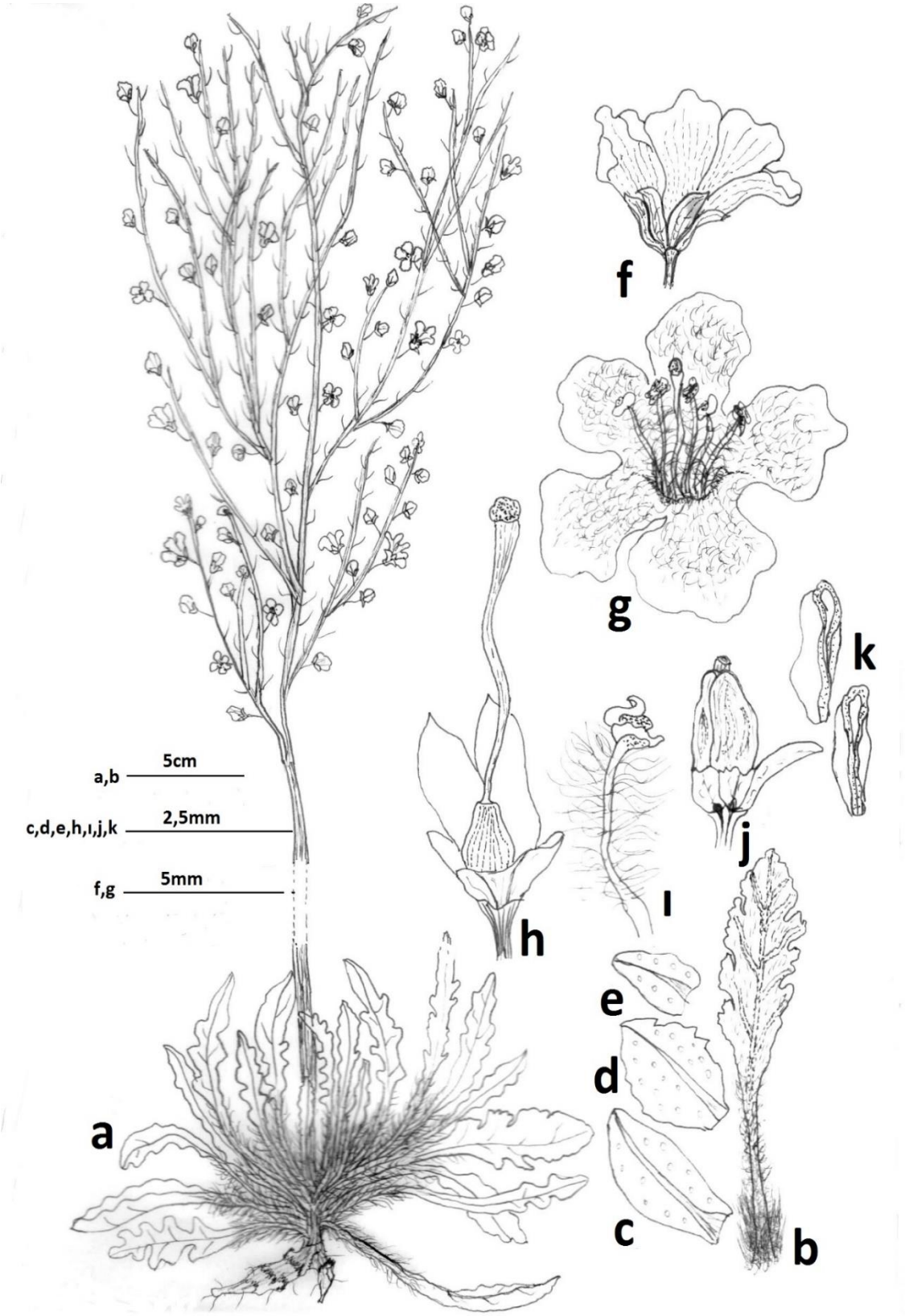

Fig. 5. *General appearance and morphological characters of V. basivelatum; a: general view of the plant, b: base leaves, c: stem leaf, d: bract, e: bracteole, f: calyx, g: corolla (top), h: pistil, i: stamen, j: fruit, k: seed (Drawing by Prof. Dr. Sevim Küçük)*

Table 1. *Comparison of Anatomical and Anatomical Characteristics of V. basivelatum with Records in Flora of Turkey*

Morphological and Anatomical Characters	**Flora of Turkey [15]**	**This Study**
Life form	Perennial	Perennial
Plant height	About 100-150cm	About 100-165cm
Root tip shape	---	Tap-root
Root color	---	Brown
Stem shape	Single, strong, cylindrical, fully erect, obtus-angular	Single, strong, cylindrical, fully erect, obtus-angular
Branching	Branched	Branched
Body feather condition	Very dense woolly hairs at the base, sparsely glandular upper parts	Very dense at the base woolly hairy, sparsely glandular upper parts
Number of leaves	Too much	Too much
Leaf shape	Lanseolat	Lanseolat
Leaf venation	---	Retikulat
Leaf lamina shape	---	Lanseolat
Leaf lamina edge	---	Crenat
Leaf blade shape	---	Cuneat
Leaf size	10-20 cm (including petiole) x 1.5-4 cm	11-20 cm (including petiole) x 2.5-3.5 cm
Leaf type	Acute	Acute
Leaf edge	Crenat-denticulat	Crenat-dentikulat
Leaf surface feather structure	---	Lanatus
Leaf arrangement at the base	---	Rozet
petiole	---	Petiolat
petiole feather condition	Dense white woolly hairy	Dense white woolly hairy
Petiole length	2-6 cm	2-8 cm
number of flowers	Multi-flowered	Multi-flowered
Origin of flowers	---	Leaf axillary
Flower status	Racemos weak, lax flowering	Racemos weak, lax flowering
Inflorescence feather structure	Completely hairless	Completely hairless
Bract	Ovat-Lanseolat	Lanseolat
Bract length	1-1.5 mm	2-3 mm
Bract feather condition	---	glabrous
Bract color	---	Green
Pedicel	---	Pedisellat
Pedicel shape	Fibrous	Fibrous
Pedicel hair condition	Glabrous	Glabrous
Pedicel length	4-6 mm	5-8 mm
Calyx color	---	Green
Calyx feather condition	Glabrous	Glabrous
Calyx length	2-2.5 mm	2-3 mm
Number of calyx teeth	---	5
Calyx shape	Linear-lanseolat, acute	Lanseolat, acute

Table 1. *Comparison of Anatomical and Anatomical Characteristics of V. basivelatum with Records in Flora of Turkey (Continued)*

Calyx type	---	Gamosepal, rotat
Corolla color	Yellow	Yellow
Number of corolla lobes	---	5
Corolla type	---	Gamopetal, rotat
Corolla feather condition	The outer side is densely transparent-dotted, the base of the upper lobes is papillary-thin long soft hairs few	The outer side is densely transparent-dotted, the base of the upper lobes is papillary-thin long soft hairs few
Perianth type	---	dichlamideic
Receptaculum shape	---	Ovoid
Receptaculum feather condition	---	Glabrous
Number of stamens	4	4
Stamen length	---	0.4-0.9 cm
Stamen pattern	---	Didinamus
Anther shape	Reniform	Reniform
How the anther is attached to the filament	---	Basifix
Anther length	---	0.5-1 mm
Arrangement of theca	---	Parallel
Filament length	---	0.4-0.5 cm
Filament fluff condition	One of the 2 filaments in the front is glabrous, one of the 3 filaments in the back is densely slender-long soft-hairy-velvet and white papillae	Filaments up to anthers with whitish-purple violet hairs
Stigma shape	---	Small groove, capitate
Stylus size	---	0.6-0.8 cm
Stylus shape	---	Terete
Ovarium status	---	Hypogin
Capsule shape	Ovoid	Ovoid
Feather condition of the capsule	Glabrous	Glabrous
Capsule length-width	---	3-3.5 x 1-1.5 mm
Lower sex status	---	Hermafrodit
Seed shape	---	Prismatic-oblong
Seed surface	---	Reticulat-rugos
Seed length-width	---	0.2-0.3 x 0.3-0.4 mm
Seed color	---	Dark brown

Anatomical Observations

The anatomical features of *Verbascum basivelatum* were determined from the transverse sections taken from the roots and stems and the superficial and transverse sections taken from the leaves and are shown in Figure 6-10.

Root

The root is composed of periderma, 4-7 rows of phloderma, and 5-8 rows of radially distorted fungal tissue in this species. The phloem consists of 4-9 rows of ring-shaped, irregularly arranged, oval-shaped cells under the periderma. The cambium is

indeterminate. The xylem is composed of small or large tracheal elements within a sclerenchymatic base tissue. The pith is sclerenchymatic (Fig. 6).

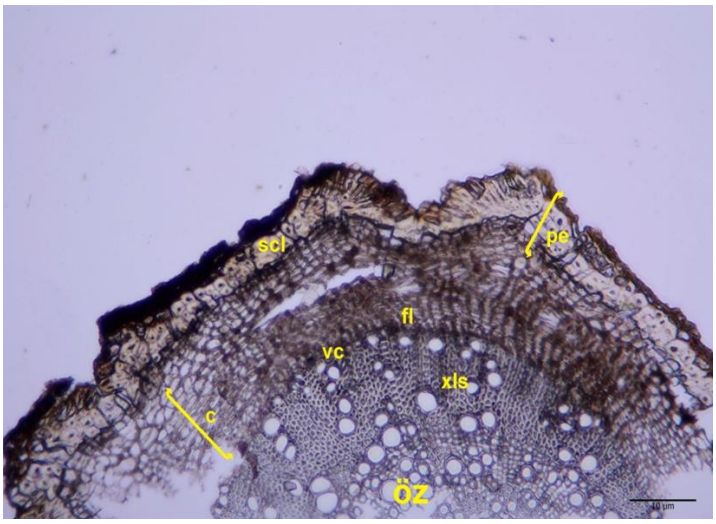

Fig. 6. *Cross section from the root of V. basivelatum; c: cortex, pe: periderma, scl: sclerenchyma fibers, vc: vascular cambium, fl: phloem, xls: xylem, (10X10)*

Stem

When the cross-sections taken from the stem of this plant are examined; The epidermis consists of thick-walled, single-row, oval or round cells. The epidermis is covered with a thin cuticle. There are 6-7 rows of cortical parenchyma under the epidermis. 4-6 rows of sclerenchyma bundles are found on the phloem. Phloem consists of 3-7 rows of oval or flattened amorphous cells. The xylem is located below the phloem. The pith is composed of round shaped parenchymatic cells with lignified walls (Figure 7).

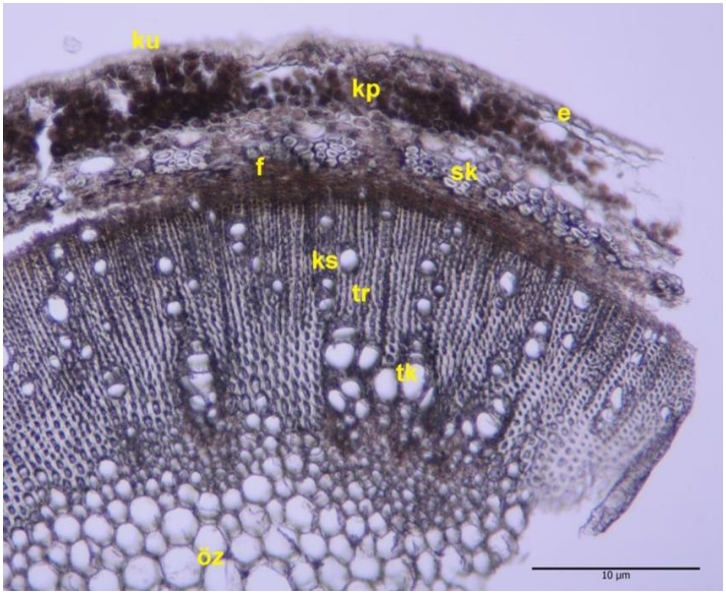

Fig. 7. *Cross section from the stem of V. basivelatum; ku: cuticle, e: epidermis, kp: cortex parenchyma, sc: sclerenchyma, f: phloem, ks: xylem, tr: trachea, tk: tracheid*

Leaf

The epidermis is composed of a single row of round, rectangular, or oval cells. The epidermis is covered with a thin layer of cuticle. Covering and glandular hairs were observed in both epidermis. The cover hairs are multicellular candelabra hairs. Glandular hairs are of 3 types with 1 cell on the stem 1, 1 cell on the 2 head, 2 cells on the stem 2 heads.

The mesophyll is composed of 2-3 rows of palisade parenchyma with abundant chloroplasts and 3-5 rows of sponge parenchyma (dorsiventral leaf, bifacial) located under the upper epidermis. Conduction bundles consist of xylem and phloem (Figure 8-11).

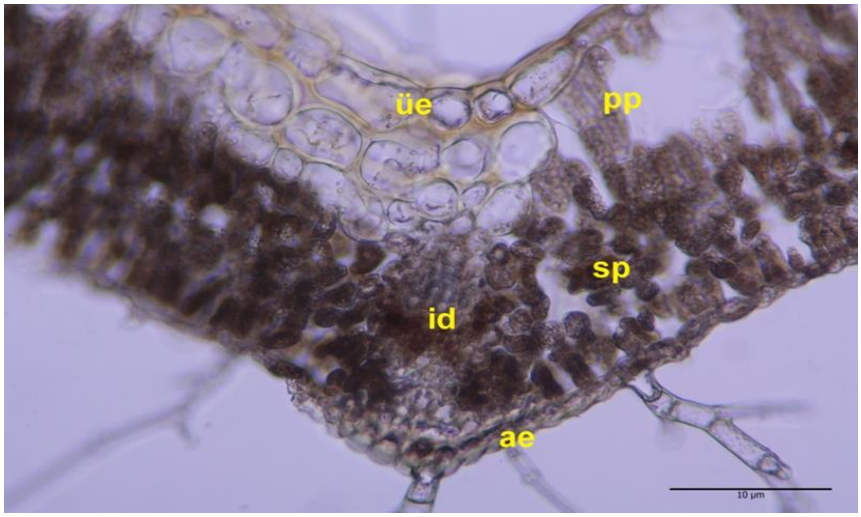

Fig. 8. *Cross-section of V. basivelatum leaf; üe: upper epidermis, pp: palisade parenchyma, sp: sponge parenchyma, id: vascular bundles, ae: lower epidermis*

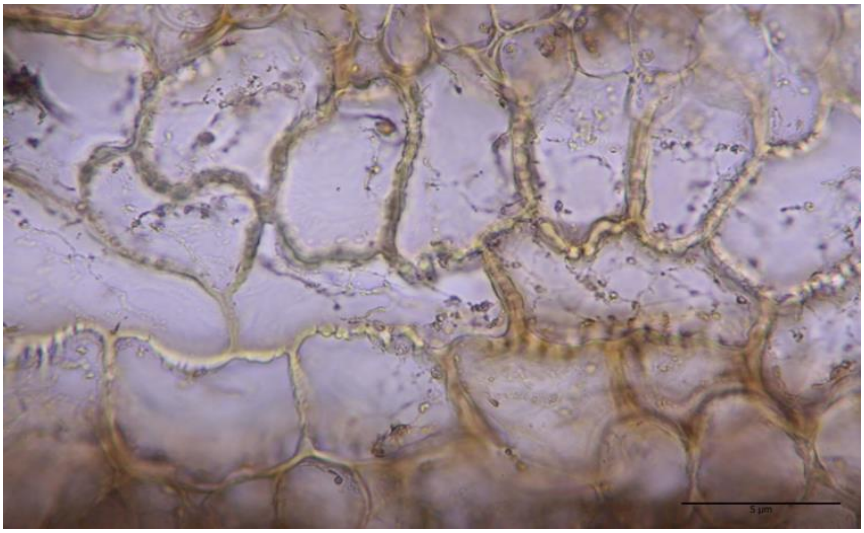

Fig. 9. *Epidermal cells in the superficial section taken from the leaf top of V. basivelatum, e; epidermis cell*

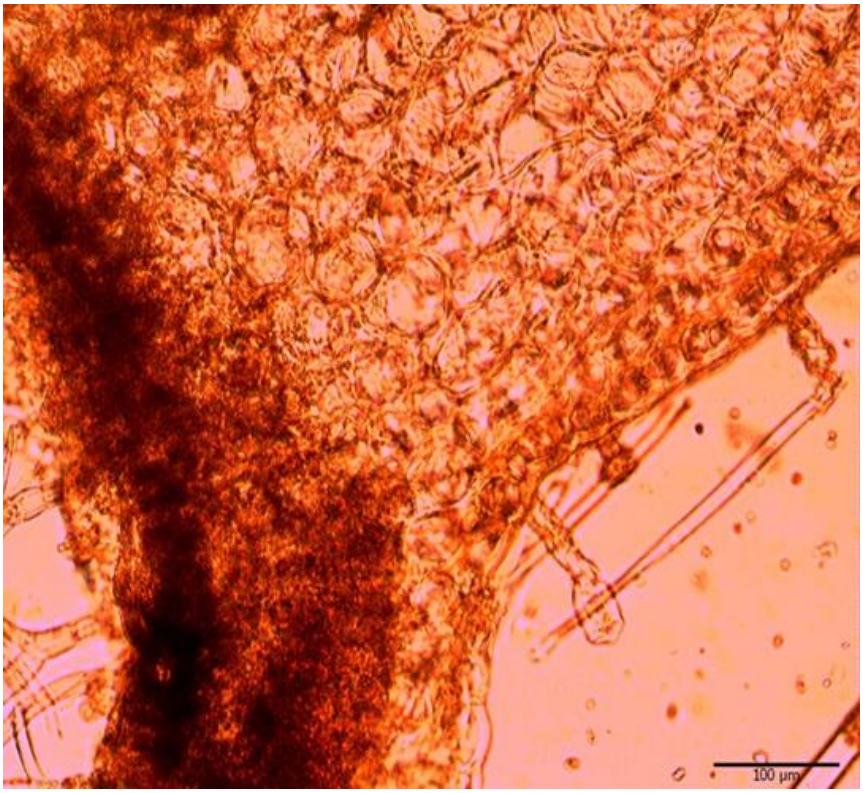

Fig. 10. *V. basivelatum leaf in cross section; st: glandular hair*

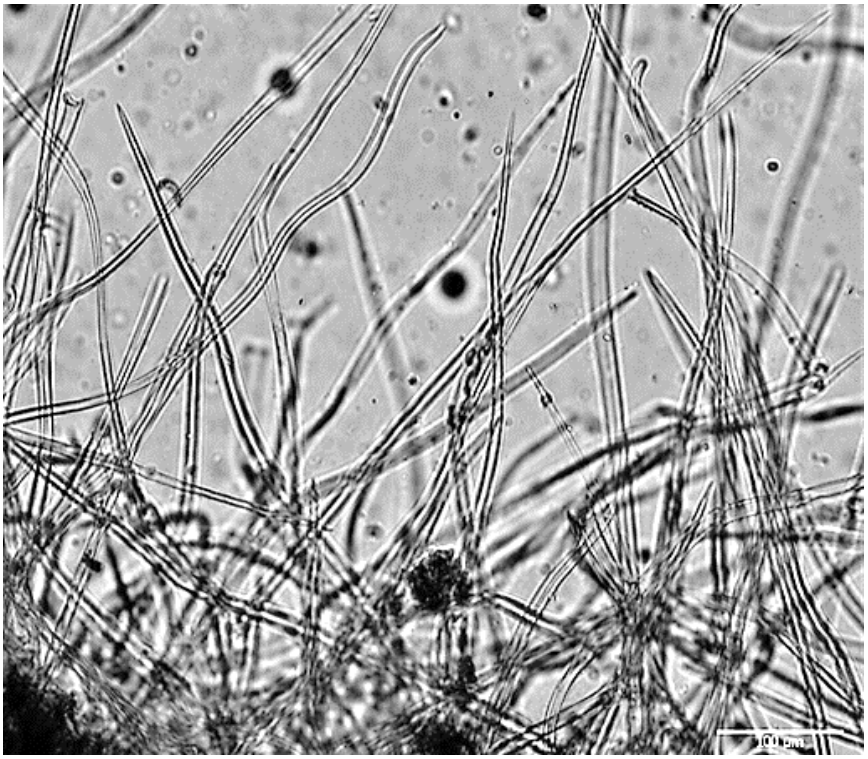

Fig. 11. *V. basivelatum leaf lower superficial section; eu: cover hairs*

Verbascum basivelatum is an endemic species and is an Iranian-Turanian floristic element. It is in group A in the Flora of Turkey. The number of stamens examined in the grouping of *Verbascum* species is 4 in *V. basivelatum* and it is in group A. In this study, the morphological and anatomical features of *V. basivelatum* were examined for the first time.

Some morphological measurements made in the *V. basivelatum* species were different from the measurements in Flora of Turkey. The length of the species is about 100-165 cm. Leaf length was measured as 11-20 cm (including petiole) x 2.5-3.5 cm. Petiole length is 2-8 cm. Bract length is 2-3 mm. Pedicel length was measured as 5-8 mm. The length of the calyx is 2-3 mm.

The stem of the plant is branched, single, strong, cylindrical, completely erect, obtus-angular. The plumage of the body is very dense woolly hairy at the base, and the upper parts are sparsely glandular. The number of leaves is very large, the edge is crenate-denticulate, the tip is acute. The petiole is densely white woolly hairy. The number of flowers is too many, the inflorescence racemus is weak, loose flowers. Pedicel filamentous, glabrous. Calyx lanceolate shaped, glabrous. Corolla yellow, outer side densely transparent-dotted, base of upper lobes papillary-thin long soft hairs few. The number of stamens is 4. Anther shape is reniform. The filaments are whitish-purple-violet hairy up to the anthers. Capsule ovoid shaped, glabrous (Figure 5. and Table 1.).

New morphological characters that we have identified as a result of our study, which are not described in the Flora of Turkey, have been found. Root tip shape is taproot, color is brown. Leaf venation is reticulate. The leaf lamina shape is lanceolate. Leaf lamina margin is crenate. Leaf blade shape is cuneate. The leaf surface hair structure is lanatus hairy. The leaf arrangement at the base is rosette. The petiole is petiolate. The exit points of the flowers are the leaf axils. The bract plumage is hairless. Bract color is green. The flower stalk is pedicellate. Calyx color is green. Number of calyx teeth 5. Calyx type is gamosepal, rotate. The number of corolla lobes is 5. corolla type is gamopetal, rotate. Perianth type is dichlamideic. The shape of the receptaculum is ovoid. The receptaculum feather state is hairless. Stamen length was measured as 0.4-0.9 cm. The stamen order is laborious. The way the anther is attached to the filament is basic. Anther length was measured as 0.5-1 mm. The theca arrangement is parallel. Filament length was measured as 0.4-0.5 cm. The shape of the stigma is capitate, with small grooves. The stylus length was measured as 0.6-0.8 cm. The stylus is terete. The ovarian state is hypogin. Capsule length-width was measured as 3-3.5 x 1-1.5 mm. The flower sex state is hermaphrodite. The seed shape is prismatic-oblong. The seed surface is reticulate-rugos. Seed color is dark brown. Seed length-width was measured as 0.2-0.3 x 0.3-0.4 mm (Table 1). These morphological characters were examined in order to contribute to the systematics of the species and the determination of taxonomic relations between species.

The anatomical structure of the root, stem and leaves of *V. basivelatum* was first elucidated in this study. The root is composed of outer protective tissue periderma, phloderma and fungal tissue. The phloem is composed of irregularly arranged cells under the periderma. The cambium is indeterminate. The xylem is composed of tracheal elements within a sclerenchymatic base tissue. The core is sclerenchymatic. The epidermis is composed of thick-walled, single-row, oval or round cells. Below the epidermis is the cortex parenchyma. Bundles of sclerenchyma are found on the phloem. The xylem is located below the phloem. The core is composed of round shaped

parenchymatic cells. The mesophyll layer in the leaf consists of 2-3 rows of palisade parenchyma with abundant chloroplasts and 3-5 rows of sponge parenchyma (dorsiventral leaf, bifacial) under the upper epidermis. Covering and glandular hair were observed in two epidermis. The cover hairs are multicellular candlestick hairs. Glandular hairs have 1 cell on the stem 1, 1 cell on the 2 stem, 2 cells on the 2 stem.

With this study, a morphological and anatomical study was conducted for the first time on *V. basivelatum* and we believe that it will contribute to other studies on the subject.

Acknowledgement. This article is derived from master's thesis of Nilgün Demirezen.

REFERENCES

[1] Aktas, K., Özdemir, C., Özdemir, B. (2020). Morphology, Anatomy, Palynology and Seed Micromorphology of Turkish Endemic Verbascum exuberans Hub.-Mor.(Scrophulariaceae). Planta Daninha, 38.

[2] Duman, H., Uzunhisarcıklı, M. E., Özbek, F. (2020). A new species of Verbascum (Scrophulariacae) from western Turkey. Botany Letters, 167(4), 409-416.

[3] Çıngay, B., Demir, O., Cabi, E. (2018). Verbascum faik-karaveliogullarii (Scrophulariaceae), a new species from southeastern Anatolia, Turkey. Phytotaxa, 372(4), 263-272.

[4] Khamar, H., Civeyrel, L., Pelissier, C., Badr, D., El-Oualidi, J., Touhami-Ouazzani, A. (2017). Verbascum ifranensis (Scrophulariaceae), a new endemic species from Morocco. Phytotaxa, 295(2), 132-140.

[5] Firat, M. (2017). Verbascum gimgimense (Scrophulariaceae), a new species from Muş province (Turkey). Phytotaxa, 291(3), 209-216.

[6] Zografidis, A. (2016). Two new infraspecific taxa of Verbascum delphicum (Scrophulariaceae, Scrophularieae) from mainland Greece and the island of Evvia. PhytoKeys, (74), 107.

[7] Çeçen, Ö., Karavelioğulları, F. A., Ünal, A. (2015). Verbascum misirdalianum (Scrophulariaceae), a new species from central Anatolia, Turkey. Phytotaxa, 217(1), 96-99.

[8] Küçük, S., Gökçe, M. B., Göktürk, R. S. (2018). Anatomic Studies on Verbascum pestalozzae Boiss. and Verbascum pycnostachyum Boiss. & Heldr. Turkish Journal of Pharmaceutical Sciences, 15(3), 347.

[9] Küçük, S. (2017). Anatomical characteristics of endemic Verbascum bellum Hub. and Mor.(Scrophulariaceae). Anadolu University Journal of Science and Technology C-Life Sciences and Biotechnology, 6(1), 22-30.

[10] Sevim, A., Gökman, A. B. (2008). Endemik Verbascum orgyale Boiss. & Heldr. türünün morfolojik, morfometrik ve anatomik özelliklerinin incelenmesi. Biyolojik Çeşitlilik ve Koruma, 8(1), 94-103.

[11] Kahraman, C., Akdemir, Z. S., Tatlı, İ. (2012). Promising cytotoxic activity profile, biological activities and phytochemical screening of Verbascum L. species. Medicinal and Aromatic Plant Science and Biotechnology, 6(2), 63-75.

[12] Tatli, I. I., Akdemir, Z. F. (2006). Traditional uses and biological activities of Verbascum species. FABAD Journal of Pharmaceutical Sciences, 31(2), 85.

[13] Karavelioğulları, F. A., Celik, S., Işık, G. (2016). The Altitudinal, Climatical and Phenological Classification of Verbascum L. Species From Different Phytogeographical Regions of Turkey.

[14] Duman, H., Uzunhisarcıklı, E., Özbek, F. (2021). A new natural hybrid of Verbascum L.(Scrophulariacae) from Turkey Gazi University Journal of Science, Vol.34, DOI: 10.35378/gujs.787401
[15] Davis, P. H. (Ed.), 1978, Flora of Turkey and The East Aegean Islands, Edinburgh at the Unıversity Press, Vol. 6, p. 458.
[16] Davis, P.H., Mill, R.R., Tan, K., 1988, Flora of Turkey and The East Aegean Islands (Supplement), Edinburgh at the University Press, Vol.10, p. 191.