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**Morphological and Autecological Study *Verbascum suworowianum* (C. Koch)  
O. Kuntze. var. *Suworowianum* and var. *Papillosum* (Murb.)  
Hub.-Mor. (Scrophulariaceae) in the Northeast Anatolia**

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**Abstract:** *Verbascum suworowianum* (C.Koch) O. Kuntze, var. *suworowianum* and *Verbascum suworowianum* var. *papillosum* (Murb.) Hub.-Mor. are included in the A group of genus of *Verbascum* L. in Flora of Turkey. A group is different from other groups by having 4 stamens. These two taxa have a local distribution in the Northwest of Anatolia and under the threatened factors. Both of them are local taxa. In this study, the detail morphological description which was not given as accurate previously in Flora of Turkey, the ecological peculiarities, pollen, seed structure and indumentum in SEM are given. The description of these two varieties are supported by palynologic and ecologic characteristics and some suggestions and studies are started for the conservation.

**Key words:** Conservation, ecology, palinology, seed structure, *Verbascum*

## INTRODUCTION

The genus *Verbascum* L. (*Scrophulariaceae*) includes about 360 species on Earth<sup>[1]</sup>. In Turkey, it has 232 species in 13 groups and 126 hybrids<sup>[1,2]</sup>. Partly artificial groups are used in the Flora of Turkey<sup>[3]</sup> account. All Turkish species of *Verbascum* and this new species belong to sect. *Bothrosperma* Murb.<sup>[4,5]</sup>.

*Verbascum* was previously revised by Huber-Morath for the Flora of Turkey. After that, six species and eight hybrids have been described from Turkey<sup>[3-8]</sup>.

In Flora of Europaea<sup>[9]</sup>, the genus *Verbascum* is represented by 99 species, in Flora of the USSR<sup>[10]</sup> by 51, in Flora Iranica<sup>[11]</sup> by 49, in Flora Palaestina<sup>[12,13]</sup> by 20, in Flora of Cyprus<sup>[14]</sup> by 6 and in Flora of Egypt<sup>[15]</sup> by 4 species.

In Turkey, 188 (80%) of the 235 species are endemic<sup>[3,6,7]</sup>. The plants are adapted especially to steppe, open places, roadside and stony slopes.

## MATERIALS AND METHODS

Soil and plants specimens which are used in this study were collected for *Verbascum suworowianum* var. *suworowianum* in Kars: Tuzluca-Kagizman, 15 km, 1000 m,

10.06.2001, stream pebble pace, N 40°06' 62", E 43°34' 96" FAK 3070 (GAZI), Kağızman-Erzurum, 14 km, 1300 m, 10.06.2001, pebble place, FAK 3075 (GAZI). Ibid. 16. km, 12.06.2002, FAK 3274 (GAZI). ibid. 12.07.2002, N 40°06' 01", E 42°58' 48", FAK 3362 (GAZI) and *Verbascum suworowianum* var. *papillosum* (Murb.) Hub.-Mor. collected in Agri: Dogubeyazit, Topcatan village (konikork), 09.06.2001, 1550 m, volcanic tuff, N 39°35' 35", E 44°10' 91", FAK 3058 (GAZI), ibid. 19.07.2001, FAK 3132 (GAZI), ibid. 12.07.2002, N 39°35' 10", E 44°10' 53", FAK 3368 (GAZI), ibid. 02.08.2002, FAK 3392 (GAZI). To determine the properties of the plant communities in the distribution area, herbarium samples were collected from the flora in the sample areas. Having been described according to Davis<sup>[3]</sup>. The abbreviations of the authors of plant names were checked from Brummitt and Powell<sup>[16]</sup>.

Herbarium specimens are preserved in the in the Herbarium of Biology Department at Gazi herbarium. The morphological observations and biometric measurements were made on fresh as well as herbarium specimens. In all of 20 measurements results were evaluated statistically. For palynological studies, pollen and seed samples were taken from the specimens at herbarium Gazi. Pollen preparations were made according to the Wodehouse method<sup>[17]</sup>. Pollens of each taxon were measured till a

Gauss curve occurred for long axis (A), short axis (B), A/B, Exine, Intine, length of the colpus (clg), width of the colpus (clt), amb (the outline of pollen grain seen in polar view), t (the distance between the apices of the two colpi of a zonocolpate pollen grain) and the mathematical average were calculated according to (M) SPSS 8.0 program. Pollen measurements were done by Prior light microscope<sup>[18]</sup>. X 100 immersion objective were used for measurement. Lengths and widths of 10 seeds of each taxon were measured with Euromex trademark micrometer by using stereomicroscope and average values of seeds were defined. Dry seeds were coated by Polaron SC 502 trademark gold coater and investigated with Jeol JSM-840 A trademark scanning electron microscope<sup>[19-22]</sup>.

Soil profiles (0-10, 10-20, 20-30 cm) were studied at each site and soil samples deep were collected. The analysis of soil samples were done according to the followings methods; Bouyoucos<sup>[23]</sup> Hydrometer method for texture, glass and calomel/combined electrode method for soil reaction, Scheibler type calsimeter for total calcium carbonate, digestion method for amount of organic substance Wakley-Black<sup>[24]</sup>, semi-micro kjeldal method for nitrogen, ammonium-acetate method for potassium, Olsen<sup>[25]</sup> method for phosphorus (P<sub>2</sub>O<sub>5</sub>).

The measurements for Iron, Copper, Zinc and Mangan are done by method of Wakley-Black. The measurements are repeated three times by Perkin-Elmer 3030 B atomic specktophotometer as 0.01 ppm. The results are evaluated according to Schröder<sup>[26]</sup>.

## RESULTS AND DISCUSSION

**Morphological characteristics:** A series of 6 foundation parameters obtained for both var. *suworowianum* and var. *papillosum* are shown in Table 1. Half of the traits are reproductive.

**Pollen grains and seed structure:** The pollen type in *V. suworowianum* var. *suworowianum* is tricolpate. Detailed features of pollen are as follows: polar axis (A) 20,69 µm, equatorial axis (B) 20,86 µm, A/B 0,99. Pollen shape, oblate, aperture features; colpus narrow and long with distinct margin, exine; 0.91 µm intine: 0.50 µm;

Table 1: The morphological characters between *Verbascum suworowianum* (C.Koch) O. Kuntze. var. *suworowianum* and var. *papillosum* which separate that taxa

Characters	var. <i>papillosum</i>	var. <i>suworowianum</i>
Height of plants	25-35 cm	30-70 cm
Basal leaves	undivided, dentate	dentate-lobed to pinnatisect
Stem	glandular below, densely covered with obtuse papillae, glandular hairs above	glandular hairs
Lower bracts	ovate	ovate-lanceolate
Corolla	glabrous outside sometimes sparsely glandular	sparsely glandular
Capsule	5-5.5 x 4.5-5.5 mm	5.5-6 x 4-5 mm

structure; tectate, sculpture; reticulate (Fig. 1A and B). The seed structure in *V. suworowianum* var. *suworowianum*; colour; black, shape; ovate, surface; reticulate with faveolate surface and size; 0.5 x 0.3 mm (Fig. 2A and B; Table 2). The pollen type in *V. suworowianum* var. *papillosum* is tricolpate. Detailed features of pollen are as follows: polar axis (A) 21,35 µm, equatorial axis (B) 19,29 µm, A/B 1,11. Pollen shape; prolate, aperture features; colpus narrow and long with distinct margin, exine; 0.86 µm intine: 0,43 µm; structure; tectate, sculpture; reticulate (Fig. 3A and B; Table 3). The seed structure in *V. suworowianum* var. *papillosum*; colour; black, shape; ovate, surface; reticulate with faveolate surface and size; 0.5 x 0.3 mm (Fig. 4A and B). The glandular hairs are present in both variety of *V. suworowianum* (Fig. 5A and B).

**Ecology and conservation:** *Verbascum suworowianum* var. *suworowianum* is found in local area between Kağızman and Erzurum highway, near Aras valley. Var. *papillosum* was collected from Topçatan village, around Doğubeyazıt, Ağrı province. The population is not in majority and it is under threatened effects. According to our field observations between 2001 and 2003, the most negative factor for the threatness is the widening of roads. In addition, the distribution of populations is very close to streamside. For the var. *papillosum*, the most negative factor is the cattle dialing in area. Due of the interesting and sensitive morphological characteristics of these two varieties, both of were in the

Table 2: Seed feature of the *V. suworowianum* var. *suworowianum* and var. *papillosum*

Seed feature	Shape	Seed surface	Seed colour	Size (mm)
var. <i>suworowianum</i>	ovate	alveolate-reticulate	black	0.5x0.3
var. <i>papillosum</i>	ovate	alveolate-reticulate	black	0.5x0.3

Table 3: Conclulate of pollen feature of the *V. suworowianum* var. *suworowianum* and var. *papillosum*

Species	A (µm)	B (µm)	A/B	exine	intine	clg	clt	t	shape	Amb	Sculpturetype
var. <i>suworowianum</i>	20.69	20.86	0.99	0.91	0.50	18.17	4.37	2.69	oblate	19.73	reticulate
var. <i>papillosum</i>	21.35	19.29	1.11	0.86	0.43	17.16	3.70	2.67	prolate	19.09	reticulate

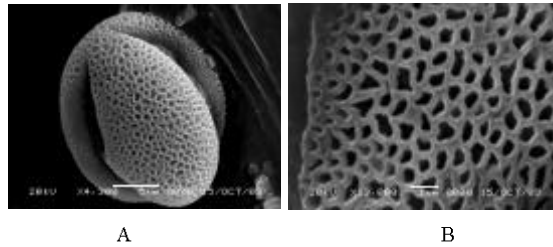


Fig. 1: A: *V. suworowianum* var. *suworowianum* SEM microphotography (Pollen), B: Ornemantation (FAK 3362). Magnification: A x 4300, B x 13000

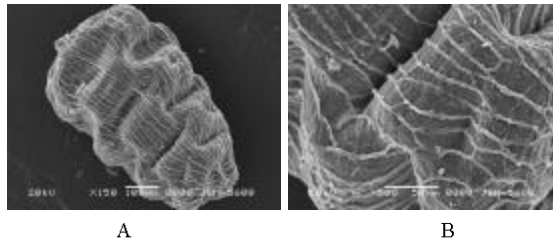


Fig. 2: A: *V. suworowianum* var. *suworowianum* SEM microphotography (Seed), B: Surface(FAK 3362). Magnification: A x 150, B x 500

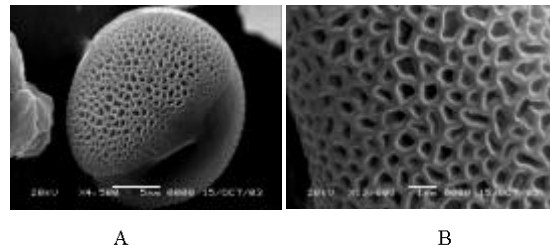


Fig. 3: A: *V. suworowianum* var. *papillosum* SEM microphotography (Polen), B: Ornemantation (FAK 3392). Magnification: A x 4500, B x 13000

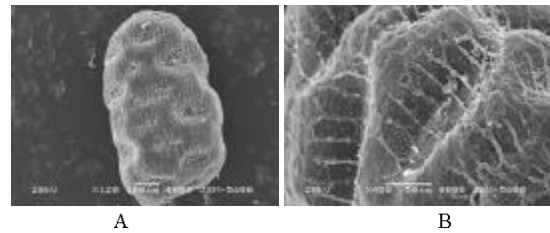


Fig. 4: A: *V. suworowianum* var. *papillosum* SEM microphotography (Seed), B: Surface (FAK 3392). Magnification: A x 120, B x 450

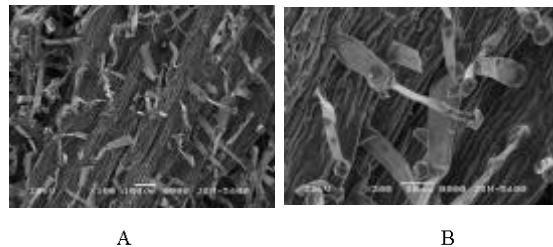


Fig.5: A: The general view of glandular hairs on the leaves B: The doser view of glandular hairs (FAK 3392). Magnification: A x 100, B x 300

Table 4: Soil Chemical Analysis of *V. suworowianum* var. *suworowianum* and var. *papillosum*

Species	Soil Deepth (cm)	pH 1/2.5	Total			NaCl		Ca <sup>++</sup> ppm	Mg <sup>++</sup> ppm	Na <sup>+</sup> ppm	K <sup>+</sup> ppm
			CaCO <sub>3</sub> (%)	Organic matter	P <sub>2</sub> O <sub>5</sub>	EC 10 <sup>3</sup> , 25°C ms/cm	N (%)				
var. <i>suworowianum</i>	0-10	8.20	1.49	0.97	26	0.50	0.01	2525	127	21	103
	10-20	8.20	1.49	0.67	21	0.52	0.02	2646	123	26	15
	20-30	8.30	2.92	0.47	9	0.33	0.02	4985	505	20	15
var. <i>papillosum</i>	0-10	8.10	5.92	2.21	26	0.83	0.01	2371	133	20	153
	10-20	8.20	4.46	1.35	35	0.50	0.03	2263	119	20	205
	20-30	8.20	5.18	0.86	26	0.50	0.02	1504	253	20	153

category of VU (vulnerable) according to Turkish Red Data Book<sup>[27]</sup>.

*Verbascum suworowianum* var. *papillosum* is found with *Helichrysum plicatum* DC., *Salvia hydrangea* DC., *Tanacetum abrotanifolium* (L.) Druce, *Centaurea glastifolia* L., *Stachys atherocalyx* C. Koch., *Tanacetum balsamita* L. subsp. *balsamitoides* (Schultz Bip) Griens. *Amberboa moschata* (L.) DC., *Centaurea solstitialis* L. subsp. *solstitialis*, *Centaurea iberica* Trev. ex Sprengel.

*Verbascum suworowianum* var. *suworowianum* is found with *Astragalus latifolius* Lam., *Astragalus aduncus* Wild., *Centaurea leptophylla* (C. Koch) Tchihat., *Ribes orientale* Desf., *Onosma nigricaulis* H. Riedl., *Scrophularia orientalis* L., *Valeriana officinalis* L., *Silene dianthoides* Pers., *Nepeta ramosa* Lam. and *Viburnum lantana* L. According to our observations, allelopathy is not found between these two taxa.

Var. *suworowianum* and var. *papillosum*; by taking the soil samples, (0-10, 10-20, 20-30 cm), var. *suworowianum* is found as a poor by organic matters, is normal by % of N, is medium by values pH (basic), the lime is very poor by % of total CaCO<sub>3</sub> (Table 4) and is very poor with P<sub>2</sub>O<sub>5</sub>%, Ca<sup>++</sup>, Mg<sup>++</sup>, K<sup>+</sup> and Na<sup>+</sup>. On the other hand, for var. *papillosum*, organic matters is found as middle, % of N is normal, soil reaction is middle of PH (basic), total % of CaCO<sub>3</sub> is poor and P<sub>2</sub>O<sub>5</sub>%, Ca<sup>++</sup>, Mg<sup>++</sup>, K<sup>+</sup> and Na<sup>+</sup> is poor<sup>[26,28]</sup>.

In this study, it is found that there are some differences between these two varieties:

Height of plant for var. *papillosum* is 25-35 cm, for var. *suworowianum* is 30-70 cm; basal leaves of var. *papillosum* undivided, dentate, var. *suworowianum* dentate-lobed to pinnatisect; stem for var. *papillosum* glandular below, densely covered with obtuse papillae, glandular hairs above; lower bracts of var. *papillosum* is ovate, for var. *suworowianum* is ovate-lanceolate; corolla for var. *papillosum* is glabrous outside, sometimes sparsely glandular, for var. *suworowianum* is sparsely glandular; capsule for var. *papillosum* 5-5.5 x 4.5-5.5 mm, for var. *suworowianum* 5.5-6 x 4-5 mm. For these two varieties, any differences are not found for seed characteristics. In both variety, the surface of seed is hollow-reticulate, ovate and black. As a result of analysing the pollen morphology of two varieties, it was

determined that they can be divided two group regarding the ratio (A/B) of polar axis to equatorial axis. The pollen type is prolate for var. *papillosum* whereas it is oblate for var. *suworowianum*

The size of population of plants is mainly depend of morphological variations, the differences of seeds, genetical variations, the presence of predator in habitat and ecological factors<sup>[29-33]</sup>.

As a result of analysing of soil structure by taking the samples of soil particles, it was determined that var. *suworowianum* has more content of Ca<sup>++</sup> than that of var. *papillosum*. However, var. *suworowianum* is much poor regarding organic materials and CaCO<sub>3</sub> % than that of var. *papillosum*. Other characters of soil content and habitat are mainly similar.

One of the other important factor that can effect the vigour of species is the flow of gene among these three population. In some of previous studies that carried out in different plant species, it was found among the plant species which are pollinated by insects, the isolation can be seen from 15 m to several km.

In future, by detailed studies, the effect of ant, insects and wind on the dispersion of seeds will be examined with the long period of observation within the long part of time.

This species can be the indicator of limestone and tufa when the habitat is take into consideration.

In order to complete the *in situ* activities regarding the conservation of these two rare varieties, the seeds of both var. *suworowianum* and var. *papillosum* are collected carefully and in less amount and kept in seed bank of Çanakkale 18 Mart University, Biology Department and seed bank of Izmir Menemen. The collection of seeds will be continued in long period without damage. On the other hand, we are studying on the germination of seeds, the gaining of plant to cultivation and production of plant.

By improving the new technics on the production of plant, the wild population under threatened will be preserved and excess demand of plant will be provided.

Var. *suworowianum* and var. *papillosum* taxa have narrow distribution and that's why the population of both of them are under the extinction.

The threatened category of species was previously given as VU (vulnerable) but as it is mentioned above, due to of the ecological reasons and long field observations, the CR (Critically Endangered) category can be suggested<sup>[34]</sup>.

In this region, the endemic plants are in majority and the farmers can be trained or guided to other meadows that has richness of grass, especially to the areas that have productivity on the south and east directions. Of course, it is not possible to preserve all the plant species in this way but at least it can be done for the *Centaurea odyssei* that is known only from one locality.

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