

# The Taxonomical Position of *Arabis Graellsiformis* Hedge (Brassicaceae) that It's Known as an Endemic Species of Turkey

## Türkiye için Endemik Bir Tür Olduğu Bilinen *Arabis Graellsiformis* Hedge (Brassicaceae)' in Taksonomik Durumu

Research Article

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### ABSTRACT

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A new combination and status, *Arabis mollis* Steven subsp. *graellsiformis* (Hedge) Mutlu *comb. & stat. nov.*, is proposed for *Arabis graellsiformis* Hedge, formally known as Turkish endemic. Further morphological and palynological characters of related taxa are discussed.

### Key Words

*Arabis*, Brassicaceae, Endemic, Synonym, Pollen, Turkey.

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### ÖZET

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Türkiye'den endemik olarak bilinen *Arabis graellsiformis* Hedge için yeni bir taksonomik kombinasyon ve statü *Arabis mollis* Steven subsp. *graellsiformis* (Hedge) Mutlu *comb. & stat. nov.* olarak önerilmiştir. Ayrıca yakın türler ve taksonların ayrımı için morfolojik ve palinolojik özellikleri tartışılmıştır.

### Anahtar Kelimeler

*Arabis*, Brassicaceae, Endemik, Sinonim, Polen, Türkiye

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## INTRODUCTION

The genus *Arabis* has been represented with in Turkey 23 species (excluding *Turritis*) [1,2]. A recent study on Genus of *Arabis*, however, proposed that *Arabis turrita* L. was a different genus and it was named as *Pseudoturritis* Al-Shehbaz [3]. Before our study, the total number of *Arabis* species recorded for Turkey was 22, nine of them being endemic.

*Arabis graellsiformis*, published by Hedge in 1957, belongs to the section *Alliariopsis* N.Busch, so named because of the similarity of its members to *Alliaria petiolata* (Bieb.) Cavara & Grande (i.e. long petioled radical leaves, clasping stem leaves and long narrow siliques). *Arabis graellsiformis* was named as "graellsiform" because of similar habit of genus *Graellsia* Boiss. [4]. Taxon number of section *Alliariopsis* increased to two with addition of this species which was described as *A. graellsiformis*.

Some morphological characteristics on the diagnosis that have been used to separate with species of *A. graellsiformis* and *A. mollis* have suffered ambiguity. Overlapping characters and some descriptional errors have caused the researchers to consider *A. mollis* as a morphological variable species that includes *A. graellsiformis*.

This study briefly discusses morphological and palinological characters useful in separating and making new combination of these two taxa.

## MATERIAL AND METHODS

This study is based on collected and herbaria (INU, E, VANF, HUB, ANK, WU, W, B, G and G-Boiss). These specimens were identified basically using the Flora of Turkey [5-7] and other Floras [8-14]. For each taxon at least one sample are deposited at INU herbarium. Authorities for all cited plant names are given according to *Authors of Plant Names* [15].

The plant morphological examinations and pollen studies were carried out with stereo and light (LM: Olympus light microscope model Vanox) microscope. The pollen grains were mounted in glycerine jelly after acetolysis [16] and prior to LM observation. The polar, equatorial, AMB and

apocolpium axes, colpus length and colpus width, exine, sexine and nexine thickness were measured with the same LM. About 30-100 pollen grains were used for each measurement.

Discriminant analysis was utilized to determine suitability of specific variables for predictive classification used with palinological characters as given in Table. The discriminant subprogram of the SPSS [17] was used for the canonical discriminant analysis.

## RESULTS AND DISCUSSION

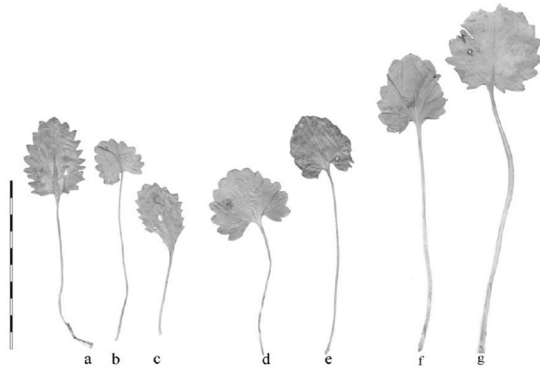
Some morphological characteristics that have been used to separate *A. graellsiformis* and *A. mollis* species was wrongly described in the type specimens. Overlapping characters and some description errors have caused the researchers to consider *A. mollis* as a morphological variable species that includes *A. graellsiformis*.

Habitus of *Arabis mollis*, *A. graellsiformis* and *A. brachycarpa* are very similar in respect at the long petioled, cuneate-cordate and rounded-acute lobes of their basal leaves (Figure 1). The seed wings are reported as a taxonomically informative character of *A. mollis* [4] (Figure 2). This distinct character is differentiated *A. mollis* from *A. graellsiformis*. Given the immature fruit of type specimens (specimen number; D 22574) the seed wing on type specimens of *A. graellsiformis* was proved to be difficult in respective study (Figure 3). Our study, however, showed that the seed wing is presented in the type specimen of *A. graellsiformis* and most important morphologically distinct characters between *A. mollis* and *A. graellsiformis* were determined as indumentums of upper leaves, teeth shape and number of basal leaves and seed shape (Table 1).

*Arabis mollis* Steven subsp. *mollis* in Mem. Soc. Nat. Moscow III (1812) 270 non (Scop.) A. Kerner.

Type: Dagestan, source of the Yukharibash River, (LE and Helsingfors).

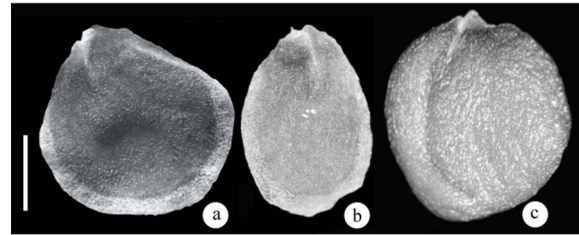
Synonym: *Arabis nepetifolia* Boiss. in Fl. Orient., 1: p. 177, (1867) [Apr-Jun 1867] (G-Boiss., B!); *Arabis mollis* Steven var. *nepetifolia* Bunge apud Boiss. in Fl. Orient., 1: p. 178 (1867); *Arabis christiani* N.Busch,



**Figure 1.** Radical leaf shapes of *Arabis mollis* Steven subsp. *mollis* (a, b, c) (AAD 10800) and *A. mollis* subsp. *graellsiformis* (Hedge) Mutlu (d, e) (D 22574) and *A. brachycarpa* Rupr. (f, g) (Mutlu 5415); scale bar: 10 cm.

in *Monit. Jard. Bot. Tiflis*, vi. 7 (1906): N. Busch in *Flora Cauc. crit.* III, 4 (1909) 498.

Detailed description of this taxon was given by Mutlu and Dönmez [1].



**Figure 2.** Seeds of *Arabis mollis* Steven subsp. *mollis* (AAD 11101) (a), *A. mollis* subsp. *graellsiformis* (Hedge) Mutlu (D 22574) (b) and *A. brachycarpa* Rupr. (Mutlu 5415) (c); scale bar: 1 mm.

**Distribution:** Turkey. B9 Van: Başkale, Güzeldere Pasture, rocky places near the stream, 38° 09' 144" N, 43° 58' 587" E, 30 vi 2002, 2393 m, A.A. Dönmez 10800-B. Mutlu (HUB!) (in flower); 30 vi 2002, A.A. Dönmez 11101 (INU!) (in fruit); between Güzelsu and Başkale, Güzeldere Pasture, stony place, 2400 m, 02 vi 2002, M. Armağan 2362 (VANF!). Persia: in jugo Mishu Dagh probe stationem viae ferrae Yam, 2200-2400 m, in alpis montis Elburus Persia borealis inter Asterabad et Schahrub, Bunge sn. (G-Boiss., B!). Dagistan: source of the Yukharibash River (LE and Helsingfors).

*Arabis mollis* Steven subsp. *graellsiformis* (Hedge) Mutlu *comb. et stat. nov.*

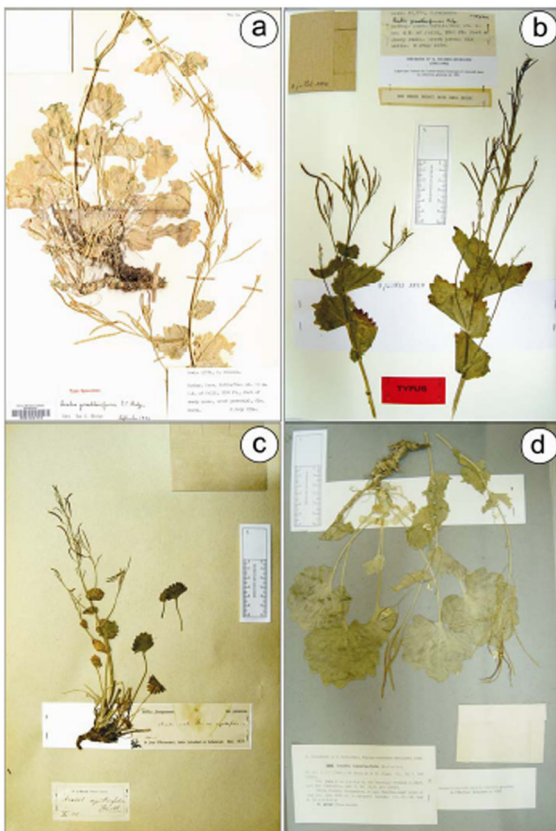
**Holotype:** Turkey/B9 Bitlis-Van; mt. 10 km. S.E. of Pelli, foot of shady rocks, erect, perennial, fls. white, 2890 m., 8 July 1954, Davis & O. Polinin D.22574, (holotype E!, iso. K, BM, G!, ANK!). **Iconography:** Original herbarium specimen photography of this species was given in *Notes R.B.G.*[4] (Figure 3).

**Basionym:** *Arabis graellsiformis* Hedge *Notes* from the Royal Botanic Garden, 23-25. 1957.

**Synonym:** *Arabis nepetifolia* Boiss. var. *elata* Grossheim, in *Beih. Bot. Cent.*, 45, p. 215 (1928), type not indicated in the protologue of this taxon [18].

Detailed description of this taxon was given by Hedge [4].

**Distribution:** Turkey. B9 Bitlis/Van: 10 km SE of Pelli Mountain, foot of shady rocks, 2890 m, 8 July 1954, Davis & O. Polinin D.22574!. C9 HAKKARI:



**Figure 3.** Type specimens of *Arabis graellsiformis* Hedge (a, b), *A. nepetifolia* Boiss (c) and *A. nepetifolia* Boiss. var. *elata* Grossheim (Specimen of Grossheim in G Herbarium) (d). Holotype in E (a), G-Boiss. (c) and isotype in G-Boiss. (b).

Cilo D., W. of Cilo Tepe, 4000 m, *Davis* 24178. Cilo Tepe, 3100 m, 8/8/1954, *Davis & O.Polunin* 24084. C10 HAKKARI: Sad Dağı, between Varagöz and Sad Gölü, 2400-2650 m, shady igneous rock crevices, 26/6/1966, *Davis* 45613. Sad Dağı, NW of Sad Gölü 2900-3000 m, shady igneous rocky, 28/6/1966, *Davis* 45696. Sad Dağı, between Varagöz and Sad Gölü, 2900-3000 m, shady rocks 26/6/1966, *Davis* 45592. Cilo Tepe, shady ledges on cliffs, 3200 m, 8 August 1954, *Davis & O.Polunin* D. 24122.

These two taxa grow on different altitudes. While *Arabis mollis* grows mostly between 2300-2400 m, *A. graellsiformis* grows between 2890-4000 m. The indumentums at the surface of upper leaves of the former were dense, while the latter showed glabrous or subglabrous of leaves surface. Furthermore, flowering time of *A. mollis* and *A. graellsiformis* is different. *Arabis mollis* is flowered from May to June but for this period of *A. graellsiformis* is from July to August.

*Arabis mollis* are growing from Dagestan to Southeast Anatolia but *A. graellsiformis* is growing Southeast Anatolia and Northwest of Iran (Figure 4).

European record of this species in the first edition of *Flora Europae* [11] was corrected in the second edition that this species was wrongly recorded in Bulgaria in the first edition [14]. *Arabis mollis* species is growing to the north side according to the *A. graellsiformis*. This is an allopatric distribution if these species accepted as a same species.

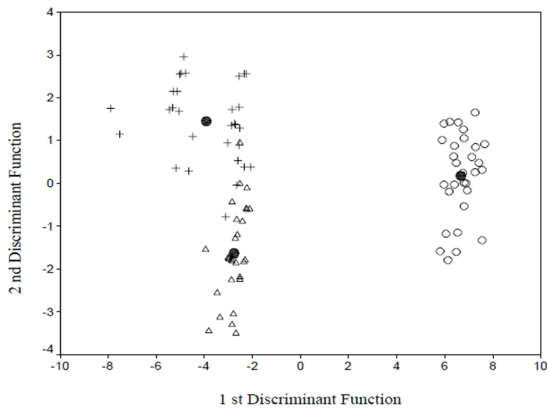
Discriminant analysis showed that *A. mollis* and *A. graellsiformis* were distinctly separated in respect of their palinological characteristics (Figure 5). *A. mollis* has a subprolate (Polar axes:  $27.58 \pm 3.56$ ; Equatorial axes:  $23.9 \pm 1.53$ ) pollen shape, while the pollen shape of *A. graellsiformis* is prolatespheroidal (Polar axes:  $20.20 \pm 2.42$ ; Equatorial axes:  $19.27 \pm 2.13$ ).

One of the interesting results of discriminant analysis is that *A. mollis* and *A. brachycarpa* have been found to be closely related, while *A. mollis* and *A. graellsiformis* were not.

All these might be a result of differences in geographical conditions and flowering periods. Some researches indicated that ecological or

**Table 1.** Characters used to distinguish between taxon of Sec. Allariopsis (*A. mollis* Steven subsp. *graellsiformis* (Hedge) Mutlu, *A. mollis* Steven subsp. *mollis*, and *A. brachycarpa* Rupr.).

Characters	<i>Arabis mollis</i> subsp. <i>graellsiformis</i>	<i>Arabis mollis</i> subsp. <i>mollis</i>	<i>Arabis brachycarpa</i>
Basal leaves shape	rounded lobes	rounded or acute lobes	rounded or acute lobes
Upper leaves surface	glabrous or subglabrous	dense indumentum	glabrous
Sepal length (mm)	4 - 5.5 x 1 - 2	5 - 6 x 1.2 - 4	4 - 5.25 x 2 - 3
Petal length (mm)	10 - 13 x 3 - 6	10 - 16 x 4 - 7	5 - 11 x 2.5 - 5
Pedicel length in fruit (mm)	6 - 13	5 - 15	8 - 16
Fruit surface	glabrous	hairy on 1/3 of length to the base	glabrous
Seed shape	oblong-ovate	circular - obovate	oblong - ovate
Seed length (mm)	2 - 2.5 x 1 - 1.5	2 - 2.5 x 1.5 - 2.5	2.6 - 3.4 x 1.3 - 2.0
Seed wing	+	+	-
Pollen shape	prolatae - spheroidal	subprolatae	prolatae - spheroidal
Polar axes ( $\mu\text{m}$ )	$20.20 \pm 2.42$	$27.58 \pm 3.56$	$21.65 \pm 2.03$
Equatorial axes ( $\mu\text{m}$ )	$19.27 \pm 2.13$	$23.91 \pm 1.53$	$20.75 \pm 1.60$
AMB axes ( $\mu\text{m}$ )	$19.27 \pm 2.27$	$23.65 \pm 1.53$	$21.26 \pm 1.29$
Colpus length ( $\mu\text{m}$ )	$16.28 \pm 2.41$	$26.60 \pm 3.56$	$17.58 \pm 2.09$
Colpus width ( $\mu\text{m}$ )	$4.52 \pm 1.59$	$4.81 \pm 1.57$	$5.05 \pm 1.35$
Exine thickness ( $\mu\text{m}$ )	$2.20 \pm 0.24$	$2.24 \pm 0.33$	$2.78 \pm 0.25$
Sexine thickness ( $\mu\text{m}$ )	$1.38 \pm 0.20$	$1.42 \pm 0.28$	$1.81 \pm 0.25$
Nexine thickness ( $\mu\text{m}$ )	$0.82 \pm 0.17$	$0.81 \pm 0.11$	$0.97 \pm 0.04$
Apocolpium ( $\mu\text{m}$ )	$4.31 \pm 1.22$	$6.01 \pm 1.17$	$5.58 \pm 1.06$
Flowering time	July - August	May - June	June - July
Altitude (m)	2890 - 4000	2300 - 2400	1580 - 3130



**Figure 5.** Discriminant scores for pollen shape of *Arabis mollis* subsp. *mollis* (○) (AAD 10800), *Arabis mollis* subsp. *graellsiiiformis* (△) (D 22574) and *Arabis brachycarpa* (+) (ND 3549). The solid dots (●) are the unstandardized canonical discriminant functions evaluated from group means.

environmental condition is not correlated in respect to pollen morphology [19].

*A. mollis* and *A. graellsiiiformis* (accepted as *A. mollis* subsp. *graellsiiiformis* in this research), however, were differentiated with their polar,

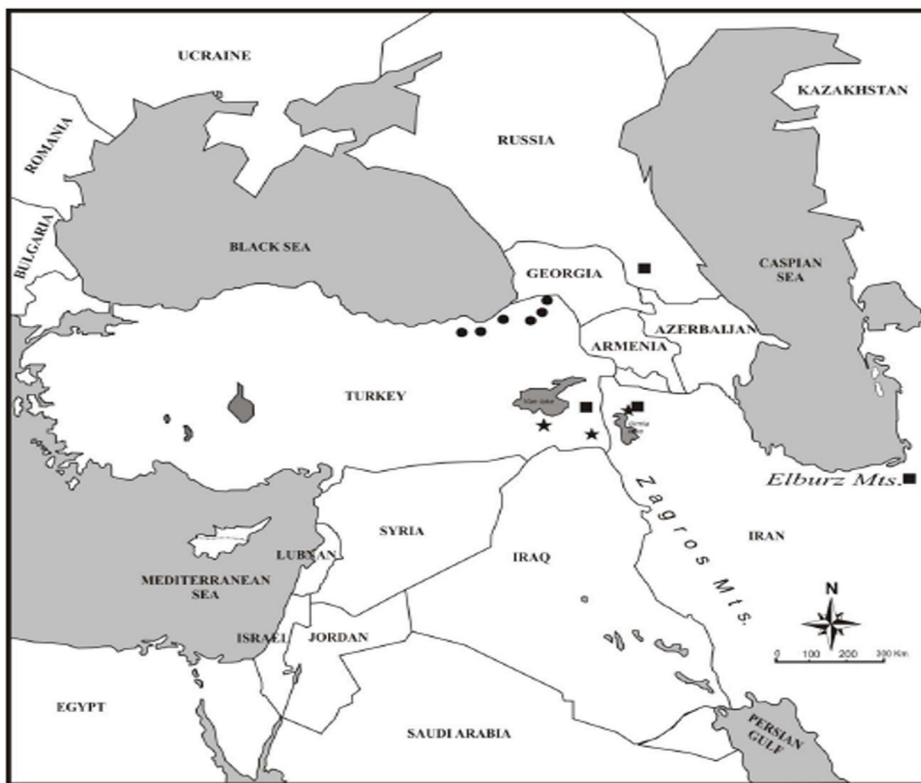
equatorial and AMB axes and colpus length (Table 1).

Because of their morphological similarity, allopatric distribution and palynological differences, an intraspecific ranking would be more appropriate of these species (Figure 4). The transfer of *A. graellsiiiformis* in to brings the total number of *Arabis* species in Turkey from 22 to 21 and increases the number of taxa from 22 to 23. The following key is provided to distinguish the subspecies of *Arabis mollis*.

1. Base of basal leaves cordate, 8-14 rounded lobes, upper leaf surfaces glabrous or subglabrous; seeds oblong subsp. *graellsiiiformis*

1. Base of basal leaves cordate to cuneate, 12-20 acute serration or rounded lobes, upper leaf surfaces with dense indumentum; seeds rounded subsp. *mollis*.

*Representative specimen examined: Arabis brachycarpa* -Turkey. A7 GÜMÜŞHANE: Karagöl D., 3000 m, *Sint.* 1894: 7311. A8 BAYBURT: Karakaya



**Figure 4.** Distribution map of *Arabis mollis* subsp. *mollis* (■), *A. mollis* subsp. *graellsiiiformis* (★) and *A. brachycarpa* (●).

Dağı, 3000 m, 24/7/1934, *Balls-Gourlay* 1812. RİZE: İkizdere, Basköy (Cimil) Cermaniman Yaylası üstü, 3130 m, hareketli kayalıklar, 23/6/1984, A.Güner 6012!. Cimil, *Bal* sn.; Çamlıhemşin, Yukarıkavrun Yaylası, Derebaşı çevresi, 2850 m, sulak kaya aralıkları, 5/8/1985, A.Güner-M.Vural 6697!; Çamlıhemşin Yukarıkavrun yaylası, 2850 m, 14/8/1999, Mutlu 5415 & F.Mutlu (INU!). A9 KARS: Ardahan, Hoçvan, Kısırdağı' nın güney eteğinden Köroğlu Tepesi' ne doğru, 17/7/1982, N.Demirkuş 1146!; Posof, Ulugardağı-Çomyazı Köyü arası, 1580-2730 m, 18/6/1986, N.Demirkuş 3549!; Kağızman, Aschick-dade (Aşağı D.), Radde sn.

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