

Vascular anatomy of *Alyssum alyssoides* and *A. desertorum* (*Brassicaceae*) from Eastern Anatolia, Turkey

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Received: December 10, 2016 ► Accepted: January 19, 2017

Abstract. In this study, the morphological and anatomical features of *Alyssum alyssoides* (L.) L. and *Alyssum desertorum* var. *desertorum* Stapf. were studied. Both species are annual, with the surface of leaves covered intensely with stellate hairs. In anatomical studies, the cross sections of root, stem and leaf were taken and photographed, then evaluated. Both taxa were studied for vascular bundles located unifacially as a continuous ring on stem and leaves.

Key words: *Alyssum*, anatomy, Eastern Anatolia, morphology

Introduction

Genus *Alyssum* L. belongs to *Brassicaceae* (*Cruciferae*) family. This family is characterized by cruciform corolla, tetradidynam stamen and silicula type (Warwick & al. 2008). Al-Shehbaz & al. (2007) have stated that Turkey is one of the species-richest countries of the *Brassicaceae* family. While across America 653 species have been reported belonging to 61 genera of that family, Turkey has 583 species belonging to 92 genera, according to recent studies (Davis 1965; Güner & al. 2000; Özhatay & Kültür 2006). Genus *Alyssum* L. is represented by 99 species, of which 56 are endemic to Turkey (Güner & al. 2012). There are some studies on pollen morphology of the *Brassicaceae* family (Aytug 1971; Doğa & Inceoğlu 1990).

There has been no detailed morphological and anatomical studies on *Alyssum*, except for the recent studies into *Alyssum pateri* Nyar., *A. praecox* Boiss. & Bal., *A. blepharocarpum* Dudley & Hub-Mor., *A. murale* Waldst. & Kit, *A. obtusifolium* Steven ex DC, *A. sibiricum* Willd., and *A. umbellatum* Desv. (Vural & Ince 1994; Inceoğlu & Karamustafa 1977; Orcan & Binzet 2003).

In this study, *A. alyssoides* (in sect. *Psilonema* (Meyer) Hook.) and *A. desertorum* var. *desertorum* (in sect. *Alyssum*) taxa were investigated in terms of their anatomical and morphological characters. Since, according to literature, there was no study on the morphological and anatomical characteristics of *A. alyssoides* and *A. desertorum* var. *desertorum*, the authors aim was to elucidate the morphological and anatomical features of these taxa.

Material and methods

The investigated plants were collected from natural locations in Turkey (Table 1). Some of these specimens were used for anatomical and morphological studies, while others were prepared as herbarium material. Description of species followed Davis (1965) in *Flora of Turkey*, vol. 1.

Herbarium materials were stored in the Herbarium of the Manisa Celal Bayar University. The samples for anatomical studies were soaked in 70 % alcohol prior to preparation of the sections. The anatomical

characteristics of root, stem and leaf were investigated in cross-sections. The paraffin method was used for preparing a cross-section of stem, leaves and root (Algan 1981). Transverse sections of 15–20 µm were made by sliding microtome (Leica DM3000 motorize microscope) and stained with safranin-fast green.

Table 1. Origin of the analysed plant samples and plant material of *A. alyssoides* and *A. desertorum* var. *desertorum*.

<i>Taxon name</i>	<i>Localities</i>	<i>Herbarium number</i>
<i>A. alyssoides</i>	B10 Ağrı, Doğubeyazıt district, around the İshakpaşa Palace, 22.04.2012.	BBOZDAG055
<i>A. desertorum</i> var. <i>desertorum</i>	B10 Iğdır, Aralık district Serdarbulak highland road, 1650–1700 m, 20.04.2012	BBOZDAG056

Results

Species morphology

***A. alyssoides*:** An annual plant, up to 35 cm high. Stem erect. Indumentum consists of adpressed few-ray stellate hairs. Leaves linear-oblongate. Petals obovate, up to 4 mm long, usually glabrous. Fruits orbicular, emarginate or truncate, 2.5–3.5 mm, inflated, with small adpressed stellate hairs. Styles 0.5 mm, glabrous. Flowering in March–August, grows at altitudes up to 2000 m (Figs. 1,2 A).

***A. desertorum* var. *desertorum*:** An annual plant, up to 20 cm high. Stem decumbent. Indumentum consists of sublepidote stellate hairs with many short rays. Racemes elongate and cylindrical. Pedicels with strigose indumentum. Petals 1.5–3 × 0.5–1 mm, emarginate, pale-yellow. Leaves linear-lanceolate. Fruits orbicular, emarginate, glabrous, 2.2 mm in diameter. Seeds narrowly winged. Flowering in April–July. Distributed from sea level up to 2000 m a.s.l. (Fig. 1,2 B).

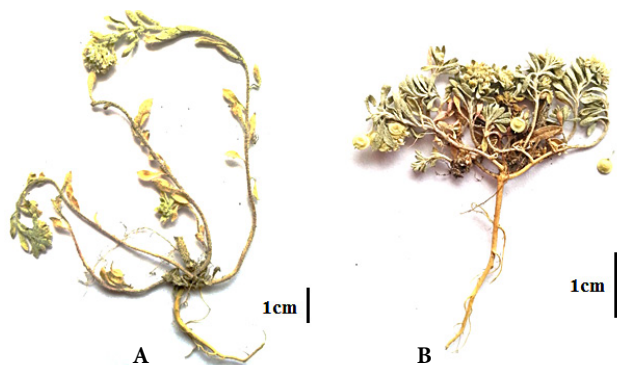


Fig. 1. Habitats of the studied species: A. *A. alyssoides*, B. *A. desertorum* var. *desertorum*.

Vascular anatomy

***A. alyssoides*:** A single-layer epidermis consisting of irregularly shaped cells lined the outermost part of the transverse section of the root (за това ли става дума?). Cortex parenchyma formed of 1–3 layer cells occupies a small area. The cells are thin-walled and wide. Pith region occupies a large area in the middle. The phloem occupies a small area, whereas the xylem covers most of the center of the cross-section (Fig. 3 A, Table 2). A thin cuticle covers the outermost transverse section of the stem. Just under it lies the single-layer epidermis. Cortex cells with 5–8 layers are wider than long and located under the epidermis. Centerwise, the cell size increases and then decreases again towards the pith. The xylem occupies a wider area than the phloem. The thick-walled cells of the xylem are roundish, whereas the thin-walled cells of the phloem are rectangular in shape. There are sclerenchyma groups on the phloem cells. The pith of the plant stem is formed of parenchymatous cells, whose size increases moving inward (Fig. 4 A, Table 2). In the leaves, the outer surface of the adaxial and abaxial epidermis is covered by cuticle. Width of the adaxial epidermis cells are larger than that of the abaxial epidermis cells. These cells are square. Stomata cells and trichomes are located on both sides of the leaves. A mesophyll layer constitutes the round or armed parenchymatous cells. No differentiation into palisade and spongy parenchyma has been observed in the mesophyll tissue (unifacial leaf). Mesophyll tissue is 10–15 layered. There are 10–12 vascular bundles observed in the leaf cross-section (Fig. 5 A, Table 2).

***A. desertorum* var. *desertorum*:** The root cross-section is round in shape. Single-layer epidermis covers the outer side of the section. The epidermis cells are oval, squarish or nearly rectangular in the cross-section. Parenchymatous cortex cells cover a narrow area between the epidermis and vascular bundles. Vascular bundles cover very large area in the root. The phloem cells cover a small area, whereas the xylem cells cover most of

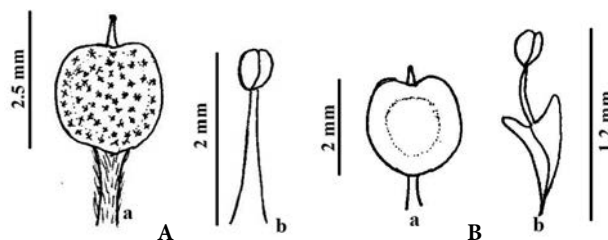


Fig. 2. A. *A. alyssoides*, B. *A. desertorum* var. *desertorum*. a) fruit, b) stamen.

the center of the cross section (Fig. 3 B, Table 2). In the upper part of the stem cross-section, there is a thin cuticle layer followed by a single layer of epidermis below the epidermis layer cortex tissue, which has 3–8 layers. Regularly arranged endodermis cells are observed above the vascular bundles. In the vascular bundles, the xylem cells occupy a large area and create a continuous, uninterrupted and undulating bundle above the pith region. There is a sclerenchymatic cells group above the phloem cells. Pith region cells have a stellar arrangement (shape with the cells). They are round, big in diameter and with thin walls (Fig. 4 B, Table 2). A cuticle covers the adaxial and abaxial epidermis cells of the leaf. The shape of epidermal cells is rectangular. There are stomata cells and trichomes between the epidermis cells. Palisade and spongy parenchyma is not fully distinguishable at the mesophyll (unifacial leaf). The cells are equal or longer in shape. Mesophyll cells surround the vascular bundles. Some 10–15 vascular bundles are located in the leaf cross-section (Fig. 5 B, Table 2).

Table 2. Anatomical measurements of the investigated taxa.

		<i>A. alyssoides</i>			<i>A. desertorum</i> var. <i>desertorum</i>		
		Min-max. (μm)	Medium \pm SD		Min-max. (μm)	Medium \pm SD	
ROOT							
Epidermis	Width	7.50 – 30.25	20.1 \pm 6.61		7.5 – 25.5	14.06 \pm 5.03	
	Length	5.10 – 20.15	13.1 \pm 4.09		5.2 – 12.5	8.71 \pm 2.14	
Cortex	Diam.	12.4 – 75.50	36.5 \pm 20.30		10.2 – 37.5	23.44 \pm 9.70	
Trachea	Diam.	17.5 – 45.20	28.8 \pm 9.79		7.5 – 25.2	15.42 \pm 5.43	
Tracheids	Diam.	3.75 – 10.1	5.76 \pm 1.72		3.75 – 10.2	7.44 \pm 1.80	
STEM							
Cuticle	Diam.	2.15 – 5.2	3.04 \pm 0.95		1.5 – 3.75	2.51 \pm 0.63	
Epidermis	Width	17.5 – 47.5	30.77 \pm 10.43		7.5 – 22.5	14.85 \pm 4.50	
Cortex	Length	17.5 – 32.5	22.69 \pm 4.62		5.2 – 20.3	11.04 \pm 4.97	
	Width	12.5 – 50.3	27.50 \pm 9.74		5.2 – 30.2	16.37 \pm 8.20	
Pith region	Length	10.1 – 37.5	22.31 \pm 7.74		5.2 – 17.5	10.60 \pm 3.77	
	Diam.	10.0 – 50.0	26.11 \pm 11.75		7.5 – 40.5	24.90 \pm 10.76	
Xylem	Diam	6.25 – 12.5	8.96 \pm 2.15		3.75 – 12.5	8.37 \pm 2.80	
LEAF							
Abaxial cuticle		2.25 – 4.5	3.23 \pm 0.79		2.50 – 5.2	3.67 \pm 0.78	
Adaxial epidermis	Width	12.5 – 32.5	20.44 \pm 6.64		12.5 – 37.5	25.16 \pm 8.55	
	Length	15.2 – 31.2	21.98 \pm 5.58		5.2 – 15.2	9.62 \pm 3.40	
Mesophyll cell	Width	10.5 – 22.5	15.70 \pm 4.11		12.5 – 25.2	18.23 \pm 4.36	
	Length	8.75 – 25.2	16.38 \pm 4.49		12.5 – 30.3	17.62 \pm 4.34	
Xylem	Diam.	2.50 – 6.2	4.20 \pm 1.22		2.2 – 5.2	3.44 \pm 0.78	
Abaxial epidermis	Width	12.5 – 32.5	23.83 \pm 5.76		12.5 – 27.5	20.56 \pm 4.35	
	Length	17.5 – 25.3	20.43 \pm 2.10		7.50 – 15.2	10.53 \pm 2.12	
Abaxial cuticle		1.25 – 3.3	2.08 \pm 0.59		2.50 – 5.0	3.48 \pm 0.73	

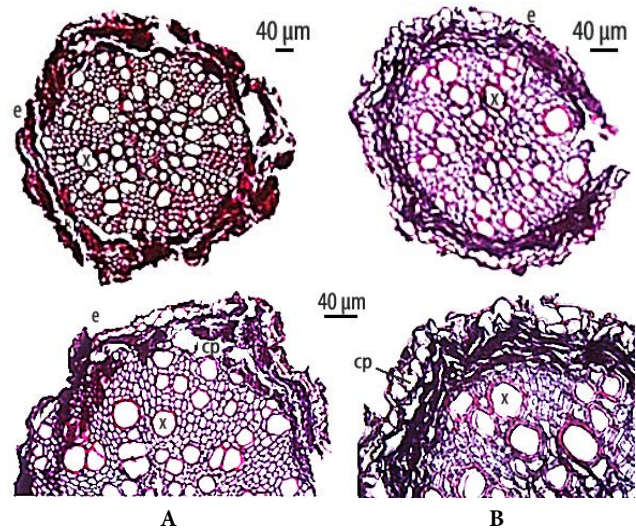


Fig. 3. Anatomical features of the root. **A.** *A. alyssoides*; **B.** *A. desertorum* var. *desertorum* (e. epidermis; cp. cortex parenchyma; x. xylem).

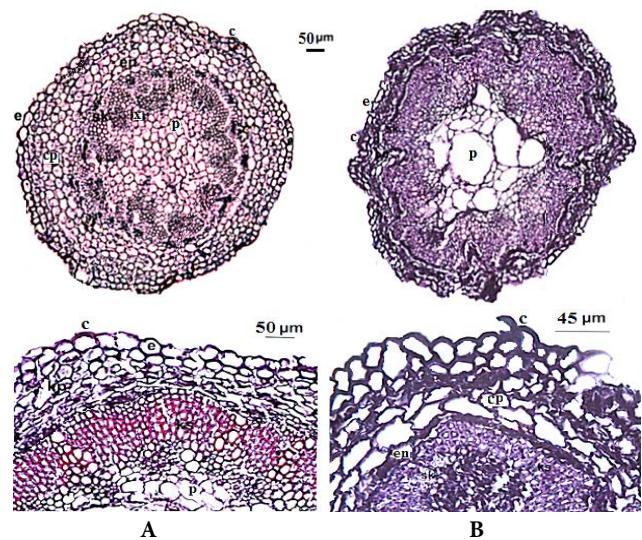


Fig. 4. Anatomical features of the stem. **A.** *A. alyssoides*; **B.** *A. desertorum* var. *desertorum* (c. Cuticle; e. Epidermis; cp. cortex parenchyma; en. Endodermis; x. xylem; p. pith).

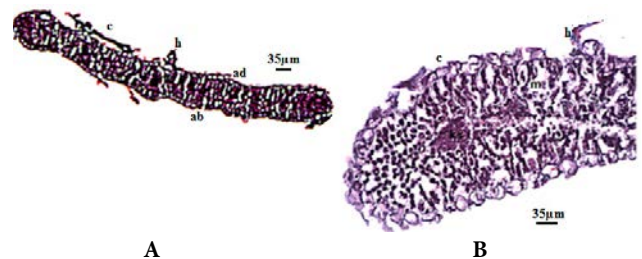


Fig. 5. Anatomical features of the leaf. **A.** *A. alyssoides*; **B.** *A. desertorum* var. *desertorum* (c. Cuticle; m. Mesophyll; ad. adaxial epidermis; ab. abaxial epidermis; h. hair).

Discussion

In this study, we have determined the anatomical and morphological features of *A. alyssoides* and *A. desertorum* var. *desertorum*. Morphologically, both *A. alyssoides* and *A. desertorum* var. *desertorum* are annual plants. The stem of *A. alyssoides* is erect, while of the other species is decumbent. *A. desertorum* has glabrous fruits and bilaterally winged filaments, while *A. alyssoides* has stellate hairy fruit and wingless filaments (Fig.2). They have similar and different anatomical features. The results of anatomical measurement of the root and stem of *A. alyssoides* are higher than of *A. desertorum* var. *desertorum*. Occasionally, these differences could be twice greater.

In *A. alyssoides*, the length of adaxial and abaxial epidermis cells of the leaves amount to 21.98–20.43 µm, while in *A. desertorum* var. *desertorum* it is 9.62–10.53 µm. The xylem measurement of leaves of both species are identical (Table 2).

According to a study in Iran, *A. alyssoides* has sclerenchymatic cells above the phloem layer in the vascular bundle (Pakravan & al. 2011). Similar results have been observed in this study.

Researchers have determined that *Alyssum obtusifolium* Steven ex DC. has secondary thickening of the root and stem and unifacial and stellate trichomes of the leaves (Orcan & Binzet 2003). However, no secondary thickening was observed in our study because these taxa are annual. Both taxa have unifacial leaves and trichomes.

According to Metcalfe & Chalk (1950), the stem of *A. spinosum* L. has a concentric ring formed of cambium cells. Such ring was not observed in this study because both taxa represent an annual life form.

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