

MORPHOLOGICAL AND ANATOMICAL INVESTIGATIONS ON THREE *ALLIUM* L. (LILIACEAE) SPECIES OF EAST ANATOLIA, TURKEY

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Abstract

Three East Anatolia species of *Allium* namely, *A. karsianum* Fomin, *A. kunthianum* Vved., *A. rupestre* Steven are compared morphologically and anatomically. The results showed that all the species investigated can be distinguished by their morphological and anatomical characters.

Introduction

The genus *Allium* L. consists of more than 600 species distributed across the northern hemisphere (Van Raamsdonk and De Vries 1992). The first knowledge about *Allium* species of Turkey was given by Boissier (1884). In Turkey, there are 146 species of *Allium* (Seçmen *et al.* 1998) and 35% of these species are endemic (Özhatay 1986). These species have been described in *Flora of Turkey* and East Aegean Islands (Kollmann 1984, Davis 1988). The three species (*A. karsianum* Fomin, *A. kunthianum* Vved., *A. rupestre* Steven) occur naturally in East Anatolia, have economic importance (Davis 1988) and thus, the present investigation was undertaken.

Materials and Methods

Allium karsianum Fomin, *A. kunthianum* Vved. and *A. rupestre* Steven were collected from natural populations of East Anatolia, Turkey. Some of these specimens were used for morphological and anatomical studies, while some were deposited in the herbarium of Celal Bayar University Turkey. Samples were fixed in 70% alcohol for anatomical studies. In addition some of the materials were preserved in glycerol and 70% alcohol (1:1), and were used for preparing a cross section of root, scape and leaves. The sections were stained with Sartur solution and camera lucida drawings of the sections were made. Details of the collected specimens are given in Table 1.

Table 1. Locality, collector and collection no. of three *Allium* species.

Species	Locality and collector	Collection number
<i>A. karsianum</i>	A8 Erzurum, Senkaya, Gülveren Village, Open Field, 14.08.1997, Yasin Altan	6722
<i>A. kunthianum</i>	A9 Artvin, Savsat, Sahara Mountain, Alpine meadow, 2500m, 23.08.1996, Yasin Altan	6681
<i>A. rupestre</i>	A8 Erzurum, Oltu, Camlıbel Village, Steppe, 1400m, 01.08.1996, Yasin Altan	6646

Results and Discussion

Morphological properties: *A. karsianum* Fomin: Bulbs, ovoid-globose, 1-2 cm in diameter and 1-2 cm long with outer tunics papyraceous, grayish-white. Stems 18-35 cm high, erect, covered by leaf sheaths up to $\frac{1}{3}$ - $\frac{2}{3}$ of its length. Leaves 2-4, narrowly linear, 2.0-2.5 mm breadth upper leaf longer than inflorescence. Inflorescence many flowered. Pedicels unequal, 2-5 mm x as long as perianth. Perianth narrowly cylindrical, pale pink to white with a purple midvein, 4-5 mm

long and 1.5-2.0 mm wide. Stamens 6 and included. Capsules 4-6 mm long and 2.5-4.0 mm wide (Figs 1a, 2).

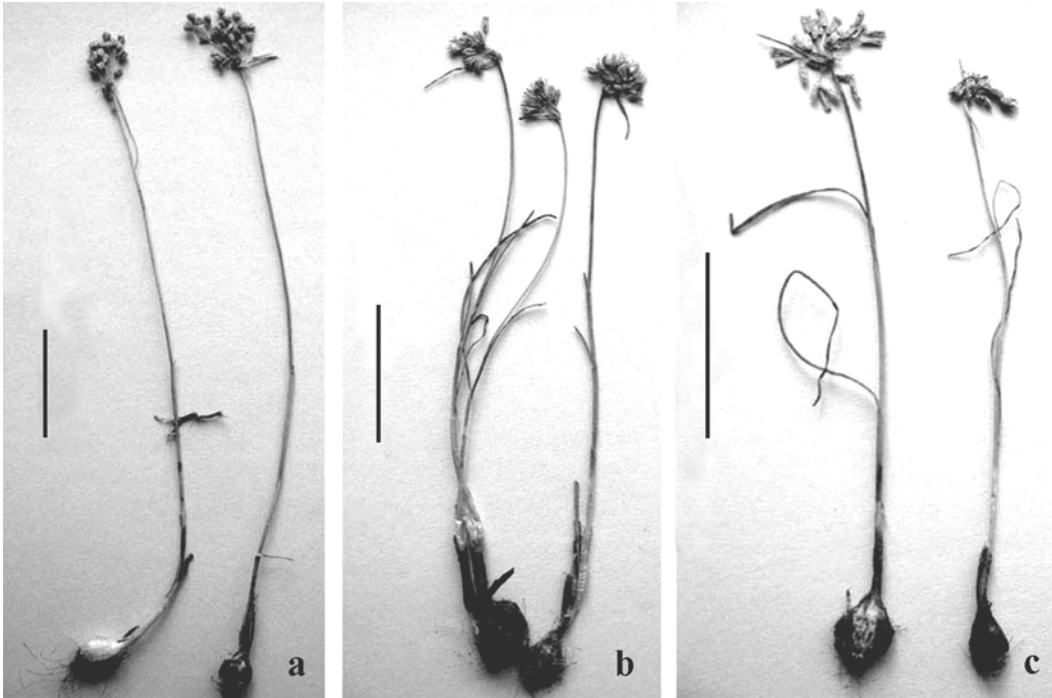


Fig. 1. General appearance of *Allium* species; a. *A. karsianum*, b. *A. kunthianum*, c. *A. rupestre*. Bar = 5 cm.

A. kunthianum Vved: Bulbs, ovoid, 0.5 - 1.5 cm long, 0.8 - 1.3 cm diameter, with outer tunics brownish, papyraceous. Stems 8 - 25 cm high, covered by leaf sheaths for $\frac{1}{3}$ - $\frac{2}{3}$ of its length. Leaves 2 - 4, semicylindrical, 1mm breadth. Spathes longer than inflorescence. Inflorescence is few flowered, fastigate-hemispherical. Pedicels are subequal, usually shorter than perianth. Perianth narrowly campanulate, deep rose with a deep purple midvein, linear-oblong, 5 - 8 mm long and 0.8 - 1.5 mm wide. Stamens 6 and included. Capsules 1.5 - 2.5 mm long and 1 - 2 mm width (Figs 1b, 2).

A. rupestre Steven: Bulbs ovoid, 1.0 - 1.5 cm long, 8 - 20 mm in diameter. The outer bulb tunics yellow-white, membranous. Stem 17 - 35 cm high, erect, covered by leaf sheaths for $\frac{1}{3}$ - $\frac{2}{3}$ of its length. Leaves 2 - 3, filiform, 0.4 - 1.0 mm broad, sheathing lower half of the stem. Spathe longer than inflorescence or subequal with unequal valves. Valves of spathe linear at base, narrowed above into a long, slender appendage, many times longer than umbel. Inflorescence 5 - 20 flowered. Pedicels 5 - 15 mm long. Perianth segments pale, pink-pinkish white to pinkish, brownish-purple at margin, midvein purple, 4-6 mm long and 1.0 - 2.5 mm wide. Stamens 6 and included. Capsules 3 - 4 mm long and 1.5 - 2.0 mm wide (Figs 1c, 2).

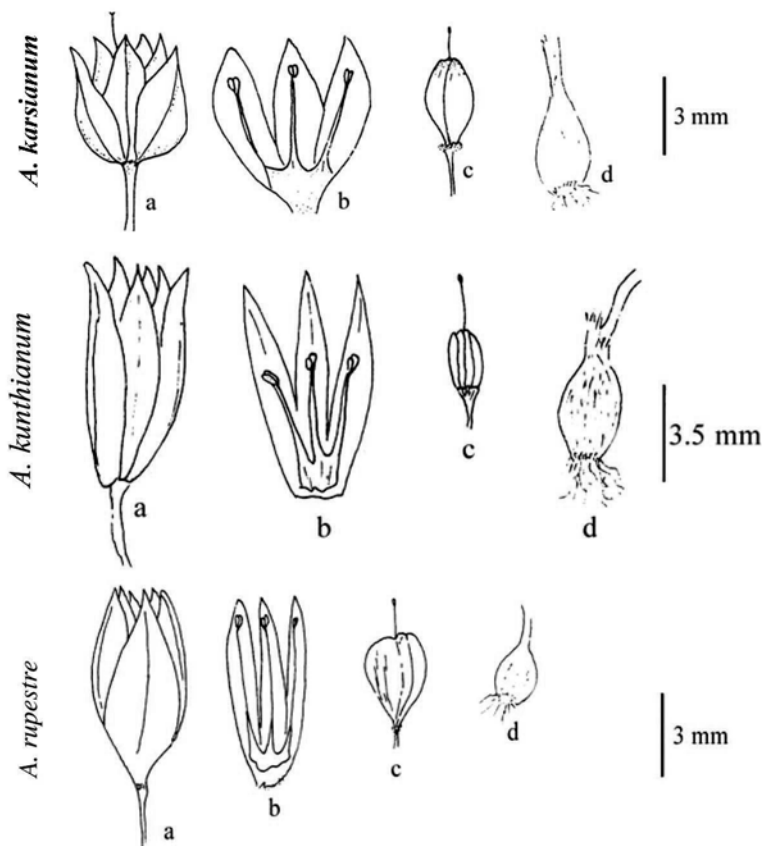


Fig. 2. Parts of *Allium* species; a. Flower, b. L.S. of perianth with stamens, c. Ovary and style, d. Bulb.

Anatomical properties

A. karsianum Fomin

Root: Epidermis single layered, cortex 4 - 6 layered consisting of ovoidal cells. The wall thickening of the endodermis three-sided. Pericycle cells very small and distinguishable. Phloem region is very small. Single metaxylem is present on the median part of vascular cylinder. 3 - 4 xylem strands are present on the periphery of the vascular cylinder and these strands reach the pericycle (Fig. 3a).

Scape: Epidermis is single layered, consists of prismatical thick-walled cells with thick cuticle. Parenchymatic cortex cells are orbicular, 7 - 12 layered. Outer cortical cells are small and with thickened wall. Vascular bundles are arranged in two rings. Vascular bundles which are located in the centre of the scape are big and 4 in number. There are very wide pith spaces in the centre of scape (Fig. 4i a, b).

Leaf: Epidermis is composed of cubical cells and covered by well developed cuticle. Palisade tissue 1 - 2 layered, many vascular bundle in the mesophyl tissue. Spongy parenchyma tissue compact, with bigger cells in the centre (Fig. 5i a, b).

***A. kunthianum* Vved.**

Root: Epidermis two layered, cells prismatical and thin-walled. Cortex 4-5 layered, cortex cells bigger the inner ones. The wall thickenings of endodermis cells three-sided. Pericycle cells under endodermis, 1-2 metaxylem; and present in the centre vascular cylinder. Xylem strands 3-4 in number and reach the pericycle (Fig. 3b).

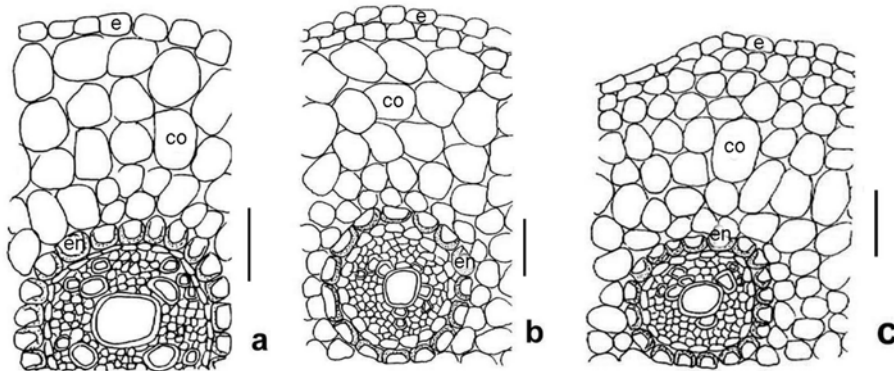


Fig. 3. Cross-section of roots of *Allium karsianum* (a), *A. kunthianum* (b) and *A. rupestre* (c). e. epidermis, co. cortex, en. endodermis. Bars = a, 40 μ m; b, 20 μ m; c, 30 μ m.

Scape: Epidermis tissue single layered, cells walls slightly thickened with thick cuticle. Cortex cells 7-9 layered and orbicular smaller on the outer part of cortex. The cells have thickened wall, some cells of cortex with big diameter have starch grain. Vascular bundles are arranged in two rings. This bundles have the same as in size. The bundles in inner part of cortex are 4 in number (Fig. 4ii a, b).

Leaf: Epidermal cells cubical, palisade tissue one layered. Many vascular bundles in the mesophyll tissue (Fig. 5ii a, b).

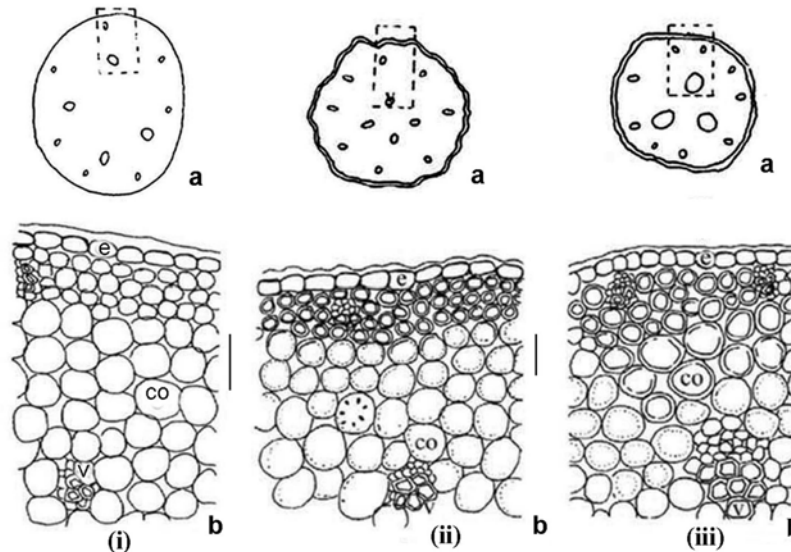


Fig. 4. Cross-sections of scapes of *Allium karsianum* (i), *A. kunthianum* (ii), *A. rupestre* (iii). a. Cross-section of a scape showing gross morphology, b. A part enlarged (e. epidermis, co. cortex, v. vascular bundle). Bars = 70 μ m.

***A. rupestre* Steven**

Root: Single layered epidermis, cells thin walled and prismatic in shape. Cortex 5-6 layered, cells are ovoidal and have intercellular spaces. The wall thickenings of endodermis single layered are clear in cross-section of root. This thickenings are three-sided. A single metaxylem in the center and 3-4 xylem strands on the periphery of metaxylem, some of xylem strands do not reach the pericycle (Fig. 3c).

Scape: Single layered epidermis with thick cuticle. Wall of epidermis cells are slightly thickened. Cortex consists of orbicular cells, outer ones are smaller than the cells located at the inner scape. Some of the cortex cells are thick-walled. Vascular bundles are arranged in two ring, the outer ring are smaller than inner ring, Large vascular bundles are 3-5 in number. There is pith centre of scape (Fig. 4iii a, b).

Leaf: Cross sections of semicylindrical with many ribs. Epidermis is covered by a well developed cuticle. Palisade tissue is 2-3 layered. The leaf is fistulous in the centre and spongy tissue is limited to a narrow peripheral belt. There are many vascular bundles (Fig. 5iii a, b).

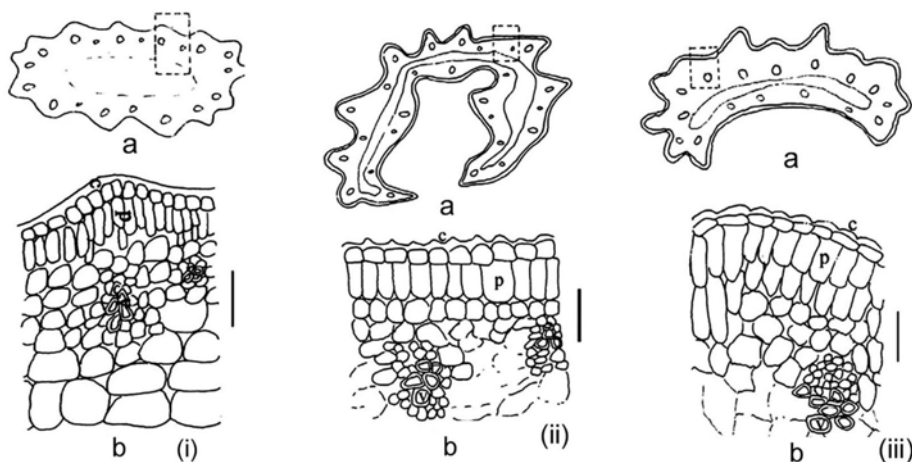


Fig. 5. Cross-section of leaves of *Allium karsianum* (i), *A. kunthianum* (ii), *A. rupestre* (iii). a. Cross-section of leaves, b. A part of enlarged. c, cuticle; p, palisade parenchyma; v, vascular bundle.

Dimensions of anatomical structures of the three species are within the range of each other (Table 2).

Table 2. Dimensions (in μm) anatomical structures of three *Allium* species

		<i>A. karsianum</i>		<i>A. kunthianum</i>		<i>A. rupestre</i>	
		Breadth	Length	Breadth	Length	Breadth	Length
Root	Epidermis	7 - 19	5 - 12	10 - 26	7 - 20	9 - 28	7 - 19
	Endodermis	8 - 14	7 - 10	7 - 10	2 - 5	9 - 21	4 - 11
	Pericycle	5 - 7	2 - 5	7 - 10	5 - 7	4 - 9	2 - 7
	Diameter of cortex	17 - 45		10 - 36		11 - 42	
	Diameter of metaxylem	24 - 40		14 - 19		17 - 29	
Scape	Thickening of cuticle	5 - 7		2 - 5		5 - 10	
	Epidermis	7 - 14	11 - 12	12 - 21	7 - 11	12 - 14	5 - 10
	Diameter of cortex	7 - 83		7 - 71		10 - 33	
Leaf	Thickening of cuticle	5 - 12		1 - 4		5 - 10	
	Epidermis	7 - 12	6 - 17	10 - 17		7 - 19	5 - 7

The three *Allium* species investigated have usually ovoid, ovoid-oblong bulbs, one or both spathe valves longer than umbel. These features are characteristics for Codonoprasum section of *Allium*. The stamens of *A. rupestre* have slightly exerted from the perigon. This feature distinguishes them from the other two species. The feature has been observed on the stamens of *Allium karacae* M. Koyuncu which belong to section Scorodon (Ünal and Duman 2002) and *Allium altynolicum* Friesen which belong to Schoenoprasum (Friesen 1996).

Anatomical structures of roots of the three species are typical monocotyledonous. Three-sided thickenings are very clear on the walls of the endodermal cells of roots of all the species. The same features have been observed in roots of some species belonging to Liliaceae and Iridaceae, while a thickening to pericycle has been observed on some other species of Liliaceae and Iridaceae (Özyurt 1978). Two of the investigated species have single metaxylem in the centre of roots, but *A. kunthianum* has 1 - 2 metaxylem.

The number of protoxylem groups are 3-4 in number, the feature observed in the roots of *Merendera trigyna* (Adam) Stapf and *M. attica* (Spruner.) Boiss & Spruner (Liliaceae) and *Crocus pulchellus* Herbert, *C. fleischeri* Gay and *C. danforiae* Maw (Iridaceae) (Özyurt 1978, Özdemir *et al.* 2004). Vascular bundles are arranged in two rings on the scape of investigated species. The same features has been observed in *Crocus aerius* Herb and *C. pulchellus* (Özyurt 1978, Özdemir and Akyol 2004). Kutbay *et al.* (2001) and Özdemir (2003) have emphasized that there were more than two rings consisting of vascular bundles on the scape of *Romulea columnae* Seb. & Mauri subsp. *columnae* and *Lilium ciliatum* P.H. Davis (Kutbay *et al.* 2001, Özdemir 2003).

The leaf epidermis of investigated species has a well developed cuticle with prominent ridges at vascular bundles. Spongy parenchyma tissue is limited to a peripheral belt except in *A. karisanum*, where the tissue is rather compact with bigger cells in the central part. The same feature has been observed in leaf cross-section of *Allium pilosum* Sibth. & Sm. belonging to Codonoprasum section (Brullo *et al.* 2001).

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