

Morphological and anatomical investigations of *Romulea bulbocodium* var. *bulbocodium* and *Romulea bulbocodium* var. *leichtliniana* (Iridaceae)

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Abstract: In this study, the morphological and anatomical features
of *Romulea bulbocodium* var. *bulbocodium* L. and *Romulea
bulbocodium* (L.) Seb. & Mauri var. *leichtliniana* (Heldr. ex Hal.) Bég
were studied. In the morphological part of the study, features of
various organs of the plants such as corm, scape, leaf and flower
were determined and illustrated. In anatomical studies, cross-
section of the plants root, scape and leaf parts were examined and
demonstrated. The anatomical properties of the two varieties were
determined to be similar to each other and also to other species of
the genus *Romulea*. The aim of this study is to demonstrate the
characteristics of the two taxa evaluating the results obtained from
morphological and anatomical investigations.

Keywords: Iridaceae, anatomy, morphology, *Romulea bulbocodium*.

Introduction

Romulea Maratti is a member of the subfamily Crocoideae (syn. Ixiodeae) in
the family Iridaceae. Ixiodeae, with over 800 species and about 30 genera, is the
largest subfamily of Iridaceae (KUTBAY et al. 2001; IŞIK & DÖNMEZ 2007).
Ixiodeae is a coherent subfamily in terms of both morphological and anatomical

characters (RUDALL & GOLDBLATT 1991). The genus *Romulea* that is included in Ixioideae comprises approximately 90 species, most of which are found in southern Africa (MANNING & GOLDBLATT 2001). Some 12 to 15 species, occur in the Mediterranean Basin, Canary Islands, the Azores, and Southern Europe. The remaining species are found in sub-Saharan Africa including the Arabian Peninsula and Socotra. *Romulea* genus is represented by 5 species in Turkey. One of the most prominent properties of this genus is the frequent occurrence of gynodioecism and sexuality may be linked with flower size and intensity of colour (MARAIS 1984). *R. bulbocodium* variants have been cultivated for their showy flowers in Europe (DAHLGREN et al. 1985), but have never been cultivated in Turkey.

There is a few studies on the morphology and anatomy of this genus (RUDALL & GOLDBLATT 1991; KUTBAY et al. 2001; ÖZDEMİR et al. 2007). Morphologically, these two taxa are separated by perianth tube colors according to Davis (DAVIS 1984). There are no morphological and anatomical studies on these two taxa. In this research, detailed morphological and anatomical features of *R. bulbocodium* var. *bulbocodium* and *R. bulbocodium* var. *leichtliniana* were studied.

Material and methods

Plants samples were collected from two populations during flowering period. The samples were collected from the following locations:

- *Romulea bulbocodium* var. *bulbocodium* : B1, Manisa, Maldan Village, open forest places, 24 February 2008-2009, Şen 023.
- *Romulea bulbocodium* var. *leichtliniana* : B1, İzmir, Urla district, Gülbahçe Village, 11 June 2007-2008, Akyol 093.

Some of collected plant samples were dried for herbarium. Some of dried and fresh plant samples were used for morphological measurements. The results of these measurements were compared with the Davis (DAVIS 1984) and plant samples were described. For anatomical studies plant specimens were fixed in 70 % alcohol. The paraffin method was used for preparing a cross-section of scape, leaves and root (ALGAN 1981). Transverse sections 15-20 μ were made using a sliding microtome and stained with safranin-Fast Green. Hand-cut sections were also made and stained with sartur reagent (ÇELEBIOĞLU & BAYTOP 1949).

Results

Morphological properties

As a result of measurements, we determined that the number of leaves of both taxa are up to 7 and some of this leaves (especially var. *leichtliniana* leaves) are recurved to soil, some of leaves are erect. Leaves of var. *bulbocodium* are 5-12 cm in length and 0.6-2 mm in width. Leaves of var. *leichtliniana* are 4.5-16.5 cm in length and 0.8-2 mm in width. Perianth segments

of var. *bulbocodium* are lilac or violet while perianth segments of var. *leichtliniana* are white color. Perianth segments of var. *bulbocodium* are 1–2.5 cm long and perianth tube is 3–8 mm. The perianth segments of var. *leichtliniana* are in length 2–3 cm and perianth tube is 3–8.2 mm. Both species have hairy perianth tube. (Fig.1, Fig. 2, Fig. 3)



Fig. 1. General appearance of *R. bulbocodium* var. *bulbocodium*

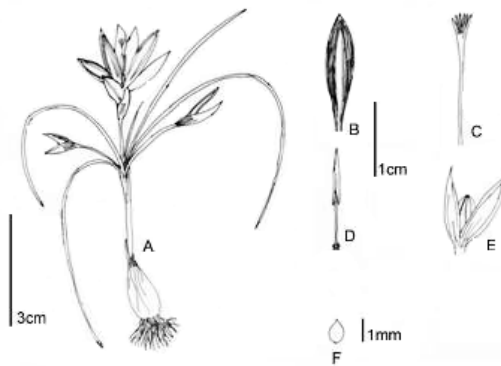


Fig.2. General appearance and details of floral organs of *R. bulbocodium* var. *leichtliniana*

A. whole plant, B. tepal, C. style, D. stamen, E. fruit, F. seed



Fig. 3. General appearance of *R. bulbocodium* var. *leichtliniana*

Anatomical properties

Root

A single layered epidermis was present in the root cross-section of var. *bulbocodium* while roots of var. *leichtliniana* usually had two layered epidermis. Both of taxa had 5-10 layered cortex. Cortex was consist of ovoidal, parenchymatic cells of var. *bulbocodium* while cortex of var. *leichtliniana* had roundish, thin walled, parenchymatic cells. We were determined that cortex cells diameter of var. *leichtliniana* (25–65 μm) larger than var. *bulbocodium* (13.6-34 μm). Both of species had single layered endodermis and pericycle. These cells were thickened 3 side. Var. *leichtliniana* had bigger endodermis cells than var. *bulbocodium*. Both of taxa had single metaxylem which was present at the median part of the vascular cylinder. Var. *bulbocodium* had 4 -5 xylem strands which reach the pericycle while var. *leichtliniana* had 4-8 xylem strands which reach the pericycle. (Fig. 4, Fig. 7, Tab. 1).

Scape

Cross section of scape, both of taxa had a thick cuticle on the outer part of scape and single layered epidermis which cells had isodiametric shape. Var. *bulbocodium* had 8-11 layered, ovoidal and thin walled cortex cells. Cortex of var. *leichtliniana* was consist of 3-5 layered and parenchymatic cells. Cortex cells diameter of var. *leichtliniana* was larger than var. *bulbocodium*. The vascular bundles cells were different sized and irregularly arranged from centre to periphery. Close to the flower scape of var. *leichtliniana* , cortex is 4-11 layered as to form double ring (Fig. 5 Fig.8, Fig. 9, Tab. 1).

Leaf

Both of species had a thin cuticle layer on abaxial and adaxial surface of leaf. The cuticle on adaxial surface was thicker than the abaxial surface investigated species. Both of species have one layered epidermis which had isodimetric shape. Var. *leichtliniana* had larger adaxial and abaxial epidermis cells than var. *bulbocodium*. Amaryllis type stoma cells were present on both of epidermis of two taxa. Vascular bundles var. *bulbocodium* had different size are elongated across the leaf axis. Big vascular bundles are surrounded by sclerenchymatic cells. Spongy parenchymatic region is very large. Cross section of leaf of var. *leichtliniana*, The big vascular bundle was surrounded sclerenchyma cells. Vascular bundle at center of the cross-section were surrounded by parenchymatic cells. The center of leaf was filled with large parenchymatic cells that lack chloroplasts and were broken down so as to form an air space. The mesophyll consisted of roundish cells with chloroplasts mostly in the abaxial part of the leaf (Fig. 6, Fig. 10, Tab. 1).

Tab. 1. Anatomical measurements of investigated species

	<i>R. bulbocodium</i> var. <i>bulbocodium</i>				<i>R. bulbocodium</i> var. <i>leichtliniana</i>			
	Width (µm)		Length (µm)		Width (µm)		Length (µm)	
	Min-Max	Mean±S.D	Min-Max	Mean±S.D	Min-Max	Mean±S.D	Min-Max	Mean±S.D
Root								
Epidermis cell	6.8-13.6	10.4±2.3	13.6-17.0	15.3±1.1	12.0-30.0	6.0±18.0	6.0-18.0	27.8±8.7
Cortex (diameter)	13.6-34.0	24.5±6.8			25.0-65.0	48.4±20.5		
Endodermis	5.1-13.6	9.1±2.8	3.4-4.0	3.7±0.2	8.5-11.9	9.7±1.0	17.0-18.7	18.0±0.6
Metaxylem (diameter)	17.0-34.0	26.6±6.5			20.0-35.0	43.4± 21.9	3.4-4.0	3.7±0.2
Scape								
Cuticle	5.0-10.0	7.5±1.7			5.0-10.0	7.5±1.7		
Epidermis cell	6.8-10.2	8.3±1.2	13.6-34.0	23.4±6.9	10.0-25.0	16.5±5.5	10.0-20.0	15.4±3.2
Cortex (diameter)	20.4-53.4	34.9±10.9			10.0-55.0	51.9±27.3		
Vessel	6.8-30.4	18.6±9.2			9.2-23.5	20.7±8.6		
Leaf								
Adaxial cuticle	2.6-8.5	4.9±2.2			8.1-11.1	5.9±2.7		
Abaxial cuticle	1.7-7.7	4.0±2.0			5.0-10.6	4.5±3.7		
Adaxial epidermis cell	5.1-13.6	8.2±2.7	3.4-13.6	8.1±3.4	8.5-30.8	42.9±16.7	10.7-25.4	29.0±9.9
Abaxial epidermis cell	10.4-17.0	13.5±2.4	3.4-6.8	5.3±1.1	10.9-25.5	33.2±21.7	15.6-30.1	22.3±9.2
Mesophyle cell	8.5-17.0	12.7±3.0	20.0-42.5	31.8±7.6				

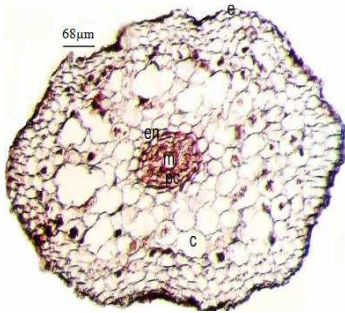


Fig. 4. Cross sections of root of *R. bulbocodium* var. *bulbocodium*, c: cortex, en: endodermis, e: epidermis, m: metaxylem, pc: protoxylem

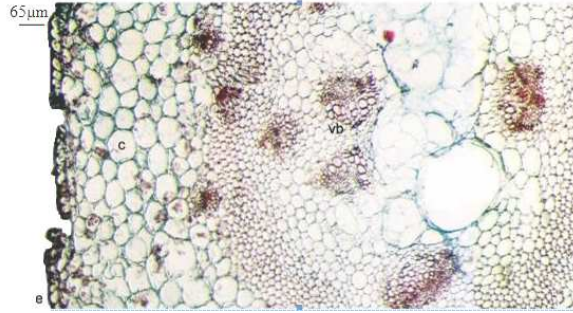


Fig. 5. Cross sections of scape of *R. bulbocodium* var. *bulbocodium* c: cortex, cu: cuticle, e: epidermis, vb: vascular bundle

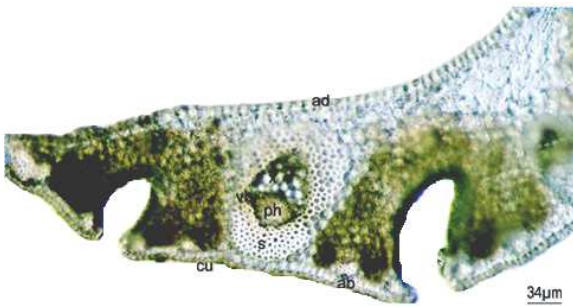


Fig. 6. Cross sections of leaf of *R. bulbocodium* var. *bulbocodium* ad: adaxial epidermis, ab: abaxial epidermis, cu: cuticle, ph: phloem, s: sclerenchyma, vb:vascular bundle, x: xylem

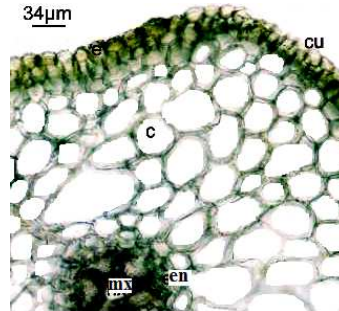


Fig. 7. Cross sections of root of *R. bulbocodium* var. *leichtliniana* e: epidermis, c: cortex, en: endodermis, mx: metaxylem, cu: cuticle

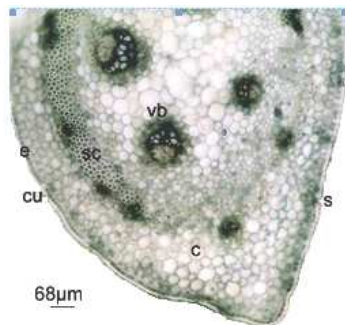


Fig. 8. Cross sections of scape (the part of close to the flower) of *R. bulbocodium* var. *leichtliniana* e: epidermis, c: cortex, vb: vascular bundle, cu: cuticle, sc: sclerenchyma, s: stoma



Fig. 9. Cross sections of scape (the part of close to the corm) of *R. bulbocodium* var. *leichtliniana*
e: epidermis, c: cortex, vb: vascular bundle, cu: cuticle, scr: sclerenchymatic ring

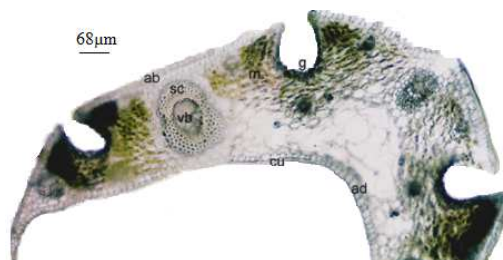


Fig. 10. Cross sections of leaf of *R. bulbocodium* var. *leichtliniana*
ab: abaxial epidermis, ad: adaxial epidermis, cu: cuticle, sc: sclerenchyma, g: groove, vb: vascular bundle, m: mesophyll

Discussion

In this study, we examined the morphological and anatomical characters of two varieties. The anatomical characters *Romulea bulbocodium* var. *bulbocodium* and var. *leichtliniana* are reported at first time in the present paper.

In anatomical studies it has been determined that there were 4-5, 4-8 xylem strands in the root of var. *bulbocodium*, var. *leichtliniana*. The same properties has been observed on the root *Romulea columnae* Seb. & Mauri subsp. *columnae*, *Gladiolus atrovioleaceus* Boiss. (Iridaceae) (KUTBAY et al. 2001; ÖZYURT 1978). RUDALL & GOLDBALTT (1991) have also pointed out that such leaf characters are either unique to Ixiodeae amongst Iridaceae, or occur rarely elsewhere. Regular prominent ridges at major vascular bundles were observed in transverse sections such as other members of Iridaceae family (RUDALL & GOLDBALTT 1991).

Differences have been noted after comparing the results obtained from these taxa. The results obtained from the morphological studies were compared with the description of these taxon in "Flora of Turkey" (DAVIS 1984). Our morphological findings of var. *bulbocodium* and var. *leichtliniana* were generally consistent with the morphological description of the taxon, given in the Flora of Turkey (DAVIS 1984), with some exceptions of the numerical data. DAVIS (1984) reported for var. *bulbocodium* the leaf length as 5-12 cm, the leaf width as 0.8-2 mm, the perianth segment as (1-)2-3.5(-5.5) cm, the perianth tube as 3.5- 8 mm while we were determined them respectively as 5-12 cm, 0.6-2 mm, 1-2.5 cm, 3- 8 mm. DAVIS (1984) reported for var. *leichtliniana* the leaf length as 5-12 cm, the leaf width as 0.8-2 mm, the perianth segment as (1-)2-3.5(-5.5), the perianth tube as 3.5- 8 mm while we have determined them respectively as 4.5-16.5 cm, 0.8-2 mm, 2-3 cm, 3- 8.2 mm. These findings showed that the intervals between the upper and the lower limits of the plant parts mentioned above enlarged. The difference in the number of the collected plant samples in "Flora of Turkey" and

also the changes in the climatical conditions for years may be responsible for some differences in our numerical data.

Consequently, anatomical structure of investigated taxon is similar each other and much similar to the other Iridaceae members especially it has typical Ixioid features in leaves (RUDALL & GOLDBALTT 1991; ÖZDEMİR & AKYOL 2004). The anatomical and morphological characters help to distinguish the variety of *Romulea bulbocodium* from each other. However, the anatomical structure of both variety are much similar to each other. In addition to these features of morphological, the differences in anatomical characters are ancillary observations that can serve to distinguish the variety from each other.

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