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Morphological, Anatomical and Ecological properties and Conservation Strategies on the Endemic *Crocus gargaricus* Herb ssp. g*argaricus* and *Muscari bourgaei* Baker growing in Kazdağ (Turkey)

İsmet UYSAL [*1], Mine TUNALI[2], Bahar KÖKÇÜ[1], Onur ESEN [1]

[1] Çanakkale Onsekiz Mart University, Faculty of Science and Arts, Dept. of Biology, Çanakkale,Turkey
[2] Directorate of Çanakkale National Education, Biology Teacher of Çanakkale High School, Çanakkale, Turkey

Abstract

In this study, the morphological, anatomical and ecological characteristics and conservation strategies of two endemic plant taxa *Crocus gargaricus* Herb. ssp. *gargaricus* and *Muscari bourgaei* Baker distributed in pseudo-alpinic area of Mount Ida were carried out. The characteristic features of *C. gargaricus* ssp. g*argaricus* were found out that its root cortex comprises of very large cells and gets smaller towards central cylinder, epidermal layer deeply dents in pieces in bulb anatomy and a parenchymatic structure including plentiful starch exists under epidermis, the cortex covers a large area in scape anatomy with angular structure. The characteristic features of *M. bourgaei* were revealed that its root cortex comprises of the cells with different sizes and they gets smaller towards central cylinder, parenchymatic structure existing under the epidermis includes plenty of druse crystal in bulb anatomy. Furthermore, in ecological examinations, the habitat features of the plants to grow and both the physical and chemical properties of the soil were determined. As the regions where the plants grew in Mount Ida are open to pasturage and especially to tourism, first of all, in-situ conservation strategy is obligatory for them. For this aim, in nature, conservation zones should be established.

Key words: endemic, *Crocus*, *Muscari*, morpholgy, anatomy, ecology, Turkey

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Kazdağı'nda yetişen *Crocus gargaricus* Herb. ssp. g*argaricus* (Kaz Çiğdemi) ve *Muscari bourgaei* Baker (Top Müşkürüm) endemiklerinin morfolojik, anatomik, ekolojik özellikleri ve koruma stratejileri

Özet

Bu çalışmada, Kaz Dağı'nın pseudo-alpinik alanında dağılan *Crocus gargaricus* Herb. ssp. *gargaricus* ve *Muscari bourgaei* Baker (Top Müşkürüm) iki bitki taksonunun morfolojik, anatomik, ekolojik karakterlerini ve koruma stratejilerini gerçekleştirilmiştir. *C. gargaricus* ssp. g*argaricus*'un (Kaz Çiğdemi) karakteristik özelliklerinin; kök korteksinin merkezi silindire doğru gittikçe küçülen oldukça büyük hücrelerden oluştuğu, soğan anatomisinde parçalarında epidermal derin oyuklar ve epidermis altında da bol nişasta içeren parankimatik bir yapısının olduğu, korteks açılı yapısıyla toprak üstü sürgün anatomisinde geniş bir alan kapladığı belirlenmiştir. *M. bourgaei'nin* karakteristik özelliklerinin; kök korteksinin merkezi silindire doğru gittikçe küçülen farklı boyuttaki hücrelerden oluştuğu, parankimatitik yapı soğan anatomisinde bol miktarda druz kristalini içeren epidermis altında yer almaktadır. Ayrıca ekolojik incelemelerde, bitkinin yetişmesi için habitat özellikleri ve toprağının hem fiziksel hemde kimyasal özellikleri saptanmıştır. Bu bitkilerin yetiştiği bölge olarak Kaz Dağı, özellikle turizme ve otlatmaya açıktır. Öncelikli olarak, bu türler için in-situ koruma çalışmaları zorunludur ve bu amaçla yetişme ortamlarında koruma alanları kurulmalıdır.

Anahtar kelimeler: endemik, *Crocus*, *Muscari*, morfoloji, anatomi, ekoloji, Türkiye

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +902862180018; Fax.: +902862180533; E-mail: ismetuysal@gmail.com
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1. Introduction

Liliaceae and Iridaceae families included to this research are among the families rich in endemism. *Crocus gargaricus* Herb. is a member of Iridaceae family. Species of *Liliaceae* contained within *The Plant List* belong to 18 plant genera (The plantlist.org, 2015). The family includes 70 genus and almost 1800 taxa available in the world (Secmen et al., 1995). In our country, its 5 genus and 193 taxa exist and 83 of the taxa is endemic (Mathew, 1984; Ekim et al., 2000; Bizimbitkiler.org, 2015a). The endemism rate is 53%. *Crocus gargaricus* ssp. g*argaricus*' is one of the endemic taxa, as well. *Muscari bourgaei* Baker species is a member of Asparagaceae family. Species of Asparagaceae contained within The Plant List belong to 128 plant genera and includes 2929 species (The plantlist.org, 2015). The family includes 19 genus and 183 taxa exist and 81 of the taxa is endemic for our country (Mathew, 1984; Ekim et al., 2000; Bizimbitkiler.org, 2015b). The *Muscari* Mill. genus belonging to this family is represented with 31 taxa in Turkey. 19 of these taxa is endemic and endemism ratio is 61.2 % for Turkey (Davis and Stuart, 1984, Ekim et al., 2000; Sezer et al., 2008). Endemism rate of the plant is 63%. *Muscari bourgaei* Baker is also one of the endemic taxa.

Kazdağı forms a natural border between the Marmara and Aegean regions of Turkey, which are phytogeographically located at the transition area of the Euro-Siberian, Mediterranean and Iran-Turan flora regions. The summit of Kazdagi is 1774 m high and its highest peaks are Karatas Hill, Baba Mountain, Tavşan Oynağı and Sarikiz Peak. Kazdagi is situated in northwestern Anatolia and is an important natural area, lying between 39° 42' N and 26° 51' E. It is situated in the vicinity of the Gulf of Edremit, forming a natural border between the provinces of Canakkale and Balikesir on the southeast part of the Biga Peninsula in northwestern Turkey (Uysal, 2010). While large geologic schist is widespread at the mountain, crystallized limestone is found at its summit. Such factors as climatic conditions of Çanakkale province and the research area, the area's geological structure and distinctive topography and lastly, the diversity in vegetation resulted in the formation of different types of soils (Koç, 2004). It experiences an average annual temperature of 14.8 ºC in Çanakkale Meteorological Office changes according to the altitude grade and the geographical properties of a place. In the Mount Ida, it decreases to 6 °C (Koc, 2001). The average annual rainfall is approximately 655.2 mm, and the average number of rainy days is 67.7. The precipitation regime is typical Mediterranean type with rainy winters. The aridity period is between June and September (Koc, 2001). Many researchers conducted studies on the morphological, anatomical and ecologic features of the endemic taxa. (Gönüz, 1987; Pirdal et al., 1988; Özdemir et al., 1988; Uysal et al, 1991; Uysal and Öztürk, 1991; Uysal, 1992; 1993; 1994; 1997a,b; 1999; 2002; Celik et al, 2005). The aim of this original investigation is put forth morphological, anatomical and ecological features of these taxa for the first time, but at the same time given detailed account of the morphological characteristics of Kazdagi endemics like *Crocus gargaricus* ssp. *gargaricus* and *Muscari bourgaei*.

2. Materials and methods

2.1. Plant materials

In this study, *Crocus gargaricus* ssp. g*argaricus* ve *Muscari bourgaei* taxa were collected from pseudoalpinic localities of the Mount Ida between the dates of 2004 and 2007. All specimens were dried according to standard herbarium techniques, identified according to *Flora of Turkey* and *The East Aegean Islands* (Mathew 1984, Davis et al., 1988), and are kept in the Biology Department of Çanakkale Onsekiz Mart University. A part of material was fixed in 70 percent alcohol for anatomical studies of the plant parts. Herbarium samples were used for morphological features and biometric studies. The biometric measurements and morphological drawings of the plant organs were carried out for morphological observations and the findings obtained were statistically evaluated.

2.2. Anatomical studies

In the present study of the anatomy of root, bulb, shoot, stem, leaf and ovary, the wax embedding procedure was followed. Plant parts were first fixed by using formalin/acetic alcohol (FAA) (Cutler, 1978; Celik et al., 2005). The samples were passed through an alcohol and histoclear series for dehydration. Paraplast was added to the histoclear and the samples placed in an oven. Cross sections of root, bulb, shoot, stem, leaf and ovary were taken with a rotary microtome to 7 μm thickness, and stained with safranin and crystal violet. Investigations were carried out under a light microscope (LM) and photographs taken with a microphotography apparatus (JENA). Soil samples collected from the localities were brought to the laboratory in the polyethylene bags, air dried and sieved by using 2 mm sieve and they were analyzed.

2.3. Ecological studies

Furthermore, the soil samples (0-20 cm) were taken from the locality where the plant samples grow and then, they were analyzed. Lastly, such physical analysis of the samples as texture, organic matter, total rate of water-soluble

salt, pH and CaCO3 and also their chemical analyses such as phosphorus (P), potassium (K) and organic matter were determined in the laboratory of Çanakkale Provincial Directorate of Agriculture..

3. Results

Morphology and Ecology of Crocus gargaricus ssp. gargaricus
3.1. External Morphology

Crocus gargaricus ssp. *gargaricus* is a perennial bulbous herbaceous plant. It is an Euxine element (Mathew 1984). Morphological features of its corm, root, and ground surface vegetative and generative parts are outlined below.

The morphological characteristics of *Crocus gargaricus* Herb. ssp. *gargaricus*

Initially, the corm generally doesn't produce stolons and the tunics have a thin and filamentous-reticulated structure. Also, bulb is 0.95±0.23 cm in diameter, and 1.33±0.23 cm long (Figure 2 A, Table 1). The roots are hairy and were measured to be 1,86±1.33 cm long (Figure 2 A, Table 1). Scapose is 0.22±0.07 cm in diameter and 2.57±1.49 cm long. Numbers of leaves are 3-4 and leaves appear with flowers simultaneously. A leaf is 0.15±0.03 cm wide and 4.52±1.38 cm long (Figure 2 F, Table 1). Perianth tube is yellow and hairless while its segments are dark yellow or orange, apex acute or rounded shape. The bracteas don't exist or they are ovate-lanceolate. According to the measurements, the corolla is 0,97±0,23 cm wide and 2,93±0,49 cm long (Figure 2 B, E, Table 1). Filament is pubescent hairy and anthers are in yellow color. The measurements revealed that filaments are 0,09±0,04 cm wide and 0,79±0,23 cm long while the anthers are 0,13±0,02 cm wide and 0,45±0,08 cm long (Figure 2 B,D; Table 1). Ovaries are 0,25±0,05 cm wide and 0,82±0,25 cm long (Figure 2 C, Table 1). Stilus has a shape divied into 3 thin, filamentous and branches is orange. Additionally, it was measured as 0,31±0,06 cm long (Figure2 G, Table 1). The fruit of the species is 1,27±0,17 cm wide and ,15±0,26 m long (Table 1). The general appearance in the natural environment of *Crocus gargaricus* ssp. *gargaricus* is given in Figure 1.

Table 1. Biometric measurements of *Crocus gargaricus* ssp. *gargaricus*

Plant part			Number of measurements	Width (cm)			Length (cm)		
				Min	Max	Mean.±S.E.	Min.	Max.	Mean.±S.E.
Leaf			30	0,25	1,52	0,59±0,27	8,27	20,02	12,29±2,95
Flower	-		-	-	-	-	-	-	-
	Corolla		30	0,34	1,27	0,97±0,23	2,04	3,69	2,93±0,49
	Stamen	Filament	30	0,04	0,17	0,09±0,04	0,48	1,31	0,79±0,23
		Anther	30	0,07	0,15	0,13±0,02	0,29	0,62	0,45±0,08
	Pistil	Style	30	-	-	-	0,21	0,46	0,31±0,06
		Ovary	30	0,14	0,37	0,25±0,05	0,18	1,63	0,82±0,25
Root			30	-	-	-	1,46	5,01	2,42±0,93
Scapose			30	0,15	0,32	0,20±0,05	16,21	34,62	24,51±3,74
Bulb			30	0,83	1,38	1,10±0,13	1,32	1,84	1,55±0,14
Fruit			30	1,06	1,55	1,27±0,17	2,52	1,63	2,15±0,26

Figure 1. General appearance in the natural environment of *Crocus gargaricus* ssp. *gargaricus*

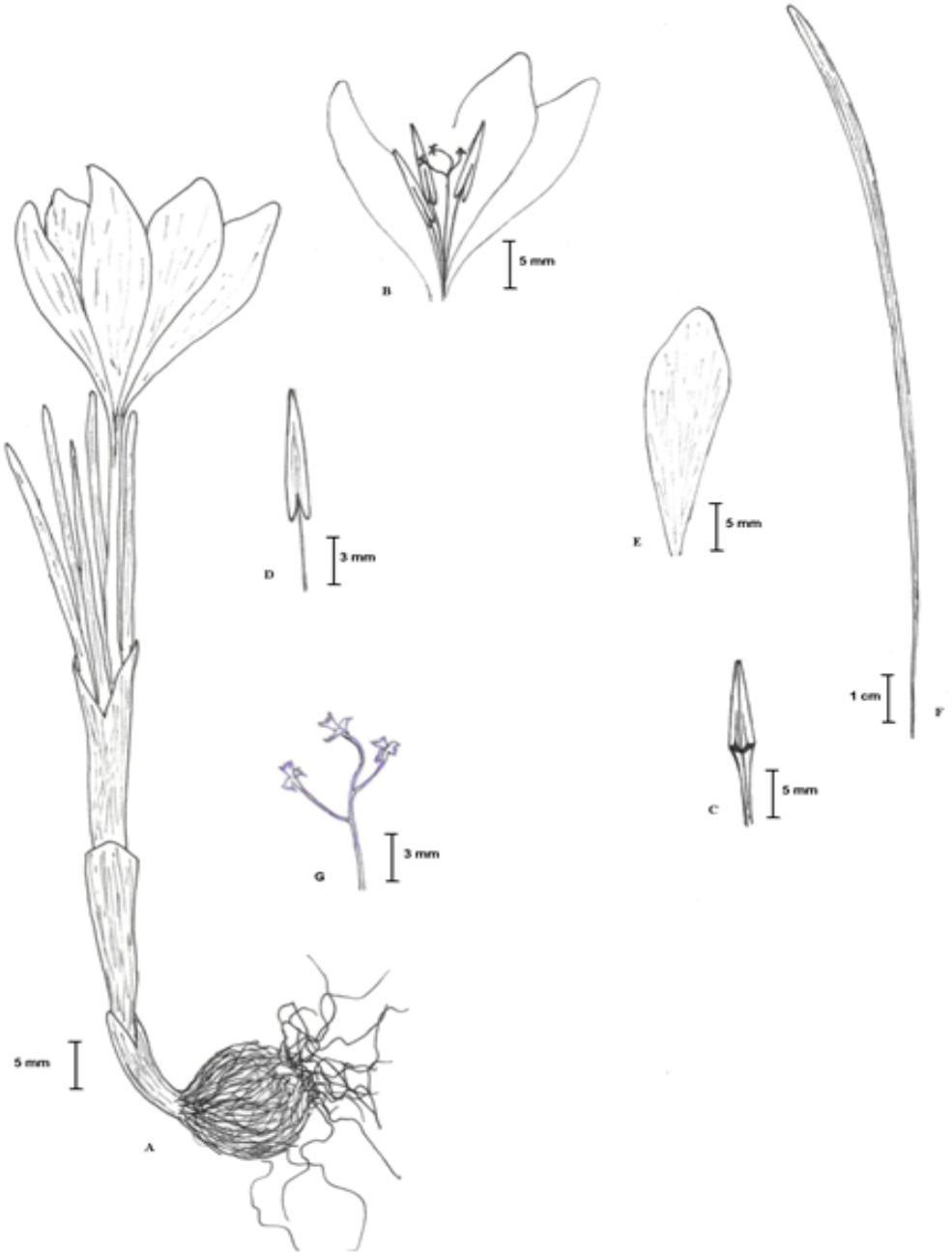

Figure 2. *Crocus gargaricus* ssp. *gargaricus* A: General view, B: Flower, C: Ovary, D: Stamen, E: Corolla, F: Leaf, G: style

3.2. Internal Morphology of the Crocus gargaricus Herb. ssp. gargaricus

The anatomical characteristics of root, scape, leaf, bulb and ovary are given below.

3.2.1. Anatomy of root

On the outermost side there is a single layer of epidermal cells followed by a sigle layer exodermis. Under the epidermis layer, the formation of exodermis which acts as a protector is observed. Following the exodermis layer, 2-3 line cortex layer can be seen. It is composed of large parenchymatic cells and becomes smaller as it approaches endodermis. Cortex covers a wide arcade up to endodermis (Figure 3) being parenchymatous. After the cortex, a typical endodermis-pericycle differentiation is observed. Endodermis, pericycle and circularly arranged vacular bundles follow the cortex. Endodermis is composed of the large cells with thick membranes while the pericycle comprises of single-layer thick cells. Central part has vascular bundles differentiable xylem and phloem. Metaxylene is located in the center (Figure 4).

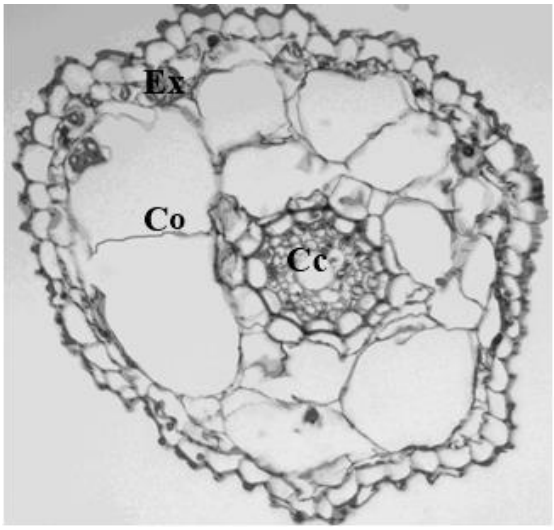

Figure 3. Root section of *Crocus gargaricus* ssp. *gargaricus* (40 X 10x) (Original) E: Epidermis, Ex: Exodermis, Co: Cortex, Cc: Central cylinder

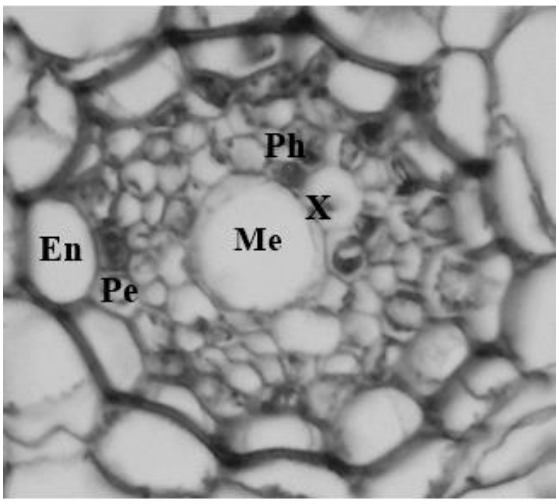

Figure 4. Magnified central part of root cross-section *Crocus gargaricus* ssp. *gargaricus* (40 X 10x) (Original) En: Endodermis, Pe: Pericycle, Me: Metaxylem, X: Xylem, Ph: Phloem

3.2.2. Anatomy of Bulb

On outerside lies a thin cuticle with a single layer of epidermal cells below it and is filled in by storage parenchymatic cells including starch. Epidermal cell layer is indented in patches. Vascular bundles spread within a parenchymatic tissue (Figure 5).

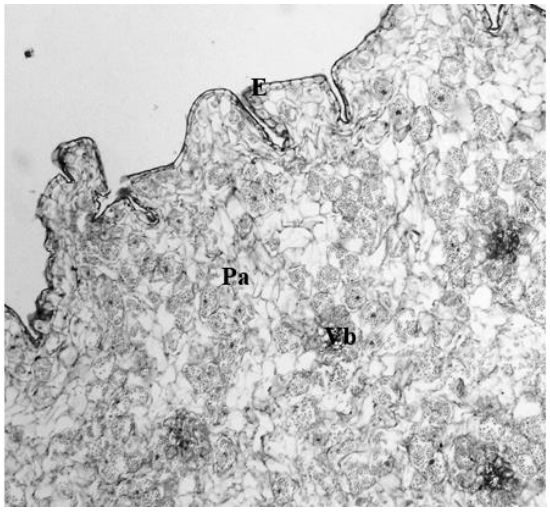

Figure 5. Cross-section of *Crocus gargaricus* ssp. *gargaricus* bulb (10 X 10x) (Original) E: Epidermis, Pa: Parenchyma, Vb: Vascular bundle

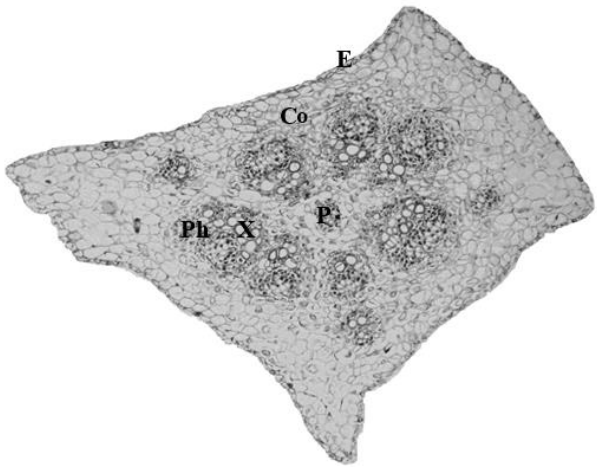

Figure 6. Cross-section of shoot in *Crocus gargaricus* ssp. *gargaricus* (10 X 10x) (Original) E: Epidermis, Co: Cortex, P: Pith, Vb: Vascular bundle, X: Xylem, Ph: Phloem.

3.2.3. Anatomy of Scape

Scape has a regular structure with its typical square shape and large epidermis cells ranged along the outer side of its cross-section. The surface of the epidermis is covered with a thin cuticle layer. Epidermis is followed with the flat and round shaped cortex composed of parenchymatic cells. Phloem lies on the outerside of bundles and xylem on the inner side. Pith is formed of parenchymatic cells (Figure 6).

3.2.4. Anatomy of Leaf

Leaves have a thick cuticle on the outside with a single layered epidermis below and the upper and the lower epidermis comprise of a layered of large cells. Palisade and sponge parenchyma are fully distinguishable in leaf

mesophyll. The leaf is bifacial (Figure 7). Leaves are not hairy and the lower epidermis has a large number of mesophytic stomata. So the leaf is hypostomatic (Figure 8).

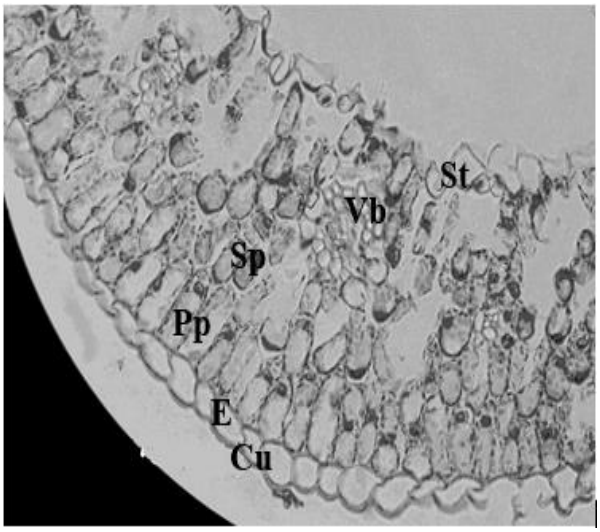

Figure 7. Cross-section of leaf in *Crocus gargaricus* ssp. *gargaricus* (40 X 10x) (Original) E: Epidermis, Cu: Cuticle, St: Stomata, Pp: Palisade parenchyma, Sp: Spongy parenchyma, Vb: Vascular bundle

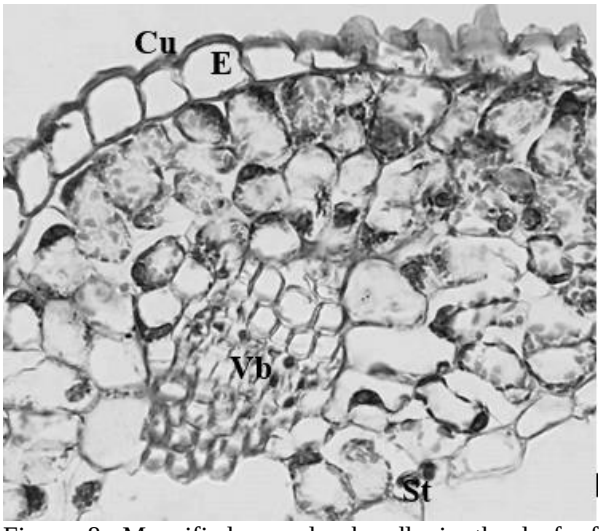

Figure 8. Magnified vascular bundle in the leaf of *Crocus gargaricus* ssp. *gargaricus* (40 X 10x) (Original) E: Epidermis, Cu: Cuticle, Vb: Vascular bundle, St: Stomata

3.2.5. Anatomy of Ovary

On the cross-section of the ovary, it is seen to have 3 loculus and carpels. A single ovary is observed in each loculus. The placentation is free central. The ovary is covered with a layer of epidermis from its outer side and under the epidermis, pericarp composed of parenchymatic cells exist. The vascular bundles are available inside the pericarp and the phloem are directed towards the outside while the xylem is directed towards the inside part (Figure 9).

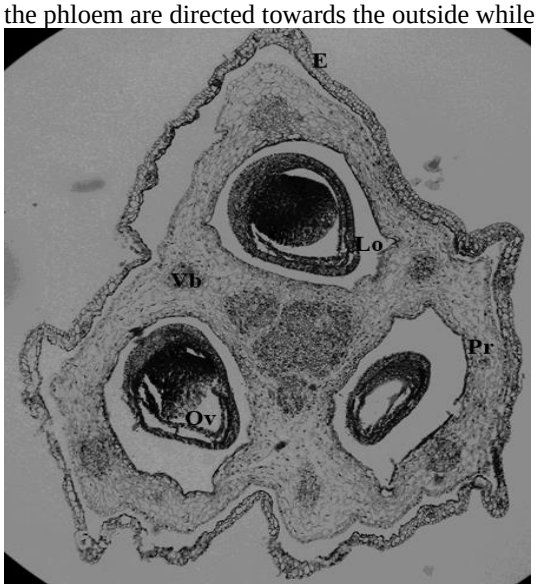

Figure 9. Cross-section of ovary of *Crocus gargaricus* ssp. *gargaricus* (10 X 10x) (Original) E: Epidermis, Pr: Pericarp, Vb: Vascular bundle, Lo: Loculus, Ov: Ovule

3.3. Ecology
3.3.1. Distribution

Crocus gargaricus ssp. *gargaricus* is an endemic taxon. Except from Mount Ida, it distributes in the provinces of Bursa A2 (A) and Muğla C2 in Turkey. It grows at a height of 1300–2200 metres in humid meadows and sparse pinewoods. Flowering time of the plant is between 4thand 5th (-6) months (Mathew, 1984). *C. gargaricus* ssp. *gargaricus* samples were recorded from an area at 1730 m altitude situated from silica-stoned northward slopes of Mount Ida's Babadağ location towards Susuz Hill on the 4th and 5th months of the years 2004-2007.

3.3.2. Soil Characteristics

Crocus gargaricus ssp. *gargaricus* prefers soils with a pH of 5.40 (medium degree acid), 0.43 (non-saline), Ca CO_3 % <1 (little amount of lime). Lastly, soil texture was found to be loamy.

Chemical analysis of the soils show that these are rich in organic matter (7.07 %), but medium phosphorus (kg/da) 6.08. The soils show enough of potassium (kg/da) 59.27.

Morphology and Ecology of Muscari bourgaei Baker

3.4. External Morphology

Muscari bourgaei is a perennial bulbous herbaceous plant. It is a Mediterranean element (Davis, 1988). Morphological features of its corm, root, and ground surface vegetative and generative parts are outlined below.

3.4.1. The morphological characteristics of Muscari bourgaei

Bulb is ovoid rectangular and its tunics are dirty-white. The bulb was measured to be 1,1±0,16 cm in diameter and 1,75±0,21 cm long. The plant has a hairy root which is 5,38±1,93 cm long. Scape is 0,12±0,03 cm in diameter and 11,69±2,19 cm long (Figure 11 A, Table 2). The leaves (2-) 3–6 (-8) are positioned patent or erect and they are slotted, linear-sublanceolate. Its apex are obtuse while its surface is greeny blue and the color of its narrow median band is pale-colored (Figure 11 F). The leaf was measured as 0,23±0,08 cm wide and 12,36±4,40 cm long (Figure 11 A,F; Table 2). Scape is seen to be raceme while the flower is fairly loose, large and avoid-oblong, this shape changes at the fruit.

The flower number of the raceme changes between 15–40 and the flowers are often imbricate or not. The pedicels of the fertile flowers are curled backward and they elongate horizontally at the flower while they elongate by 5 mm at the fruit. The pedicles of the sterile flowers are ascendant and 0,5–1 mm. The pedicles are 0,27±0,07 cm long. Fertile flowers are in a rather changed shape from obovate to oblong-urseolata. The diameter of the plant's orifice is up to approximately half the width of the orifice part diameter. The tube can be bright or in the colors of violet-blue, white or pale bluish (Figure 11 B, Table 2). The shape of sterile flowers change from oblong-urceolate to attenuate and they are at the same color with the fertile ones or pale color. Corolla was measured as 0,25±0,05 cm wide and 0,48±0,05 cm long (Figure 11 E, Table 2). Stamens are almost in single line and connected to the middle part of the tube. Anthers were measured to be 0,06 ±0,01 cm wide and 0,11±0,02 cm long (Figure 11 E, Table 2). Ovaries are 0,08±0,02 cm wide and 0,14±0,02 cm long. Stilus was measured to be 0,13±0,03 cm long (Figure 11 C, Table 2). The fruit is loculicidal capsule which is ovoid- orbicular and emarginate. Also, it is 0,43±0,09 cm wide and 0,42 ±0,08 cm long (Figure 11 G, Table 2). According to the measurements, the seeds are 0,12±0,01 cm wide and 0,14±0,01 cm long (Table 2). The general appearance in the natural environment of *Muscari bourgaei* is given in Figure 10.

Table 2. Biometric measurements of *Muscari bourgaei*

Plant part			**Number of measurements**	**Width (cm)**			**Length (cm)**		
				Min	Max	Mean.±S.E	Min.	Max.	Mean.±S.E.
Leaf			30	0,1	0,42	0,23±0,08	6,08	21,5	12,36±4,40
Flower	**Pedicel**		30	-	-	-	0,16	0,47	0,27±0,07
	Corolla		30	0,16	0,36	0,25±0,05	0,35	0,58	0,48±0,05
	Stamen	**Filament**	30	-	-	-	-	-	-
		Anther	30	0,05	0,07	0,06±0,01	0,09	0,18	0,11±0,02
	Pistil	**Style**	30	-	-	-	0,06	0,18	0,13±0,03
		Ovary	30	0,03	0,14	0,08±0,02	0,11	0,2	0,14±0,02
Root			30	-	-	-	3,12	9,82	5,38±1,93
Scapose			30	0,08	0,19	0,12±0,03	8,39	17,12	11,69±2,19
Bulb			30	0,86	1,47	1,1±0,16	1,41	2,28	1,75±0,21
Fruit			30	0,31	0,66	0,43±0,09	0,23	0,58	0,42±0,08
Seed			30	0,1	0,15	0,12±0,01	0,11	0,17	0,14±0,01

3.5. Internal Morphology of the Muscari bourgaei Baker

The anatomical characteristics of root, scape, leaf, bulb and ovary are given below.

3.5.1. Anatomy of root

On the cross-section of the root, a series of round shaped epidermis exists. Following the epidermis, cortex appears. It is composed of parenchymatic cells comprising large cells getting narrower towards the center (Figure 12). Under the cortex, endodermis and pericycle are available. The pith is full of xylem elements. The xylem and floem take place in radiant form at the central cylinder (Figure 13).

Figure 10. General appearance in the natural environment of *Muscari bourgaei*

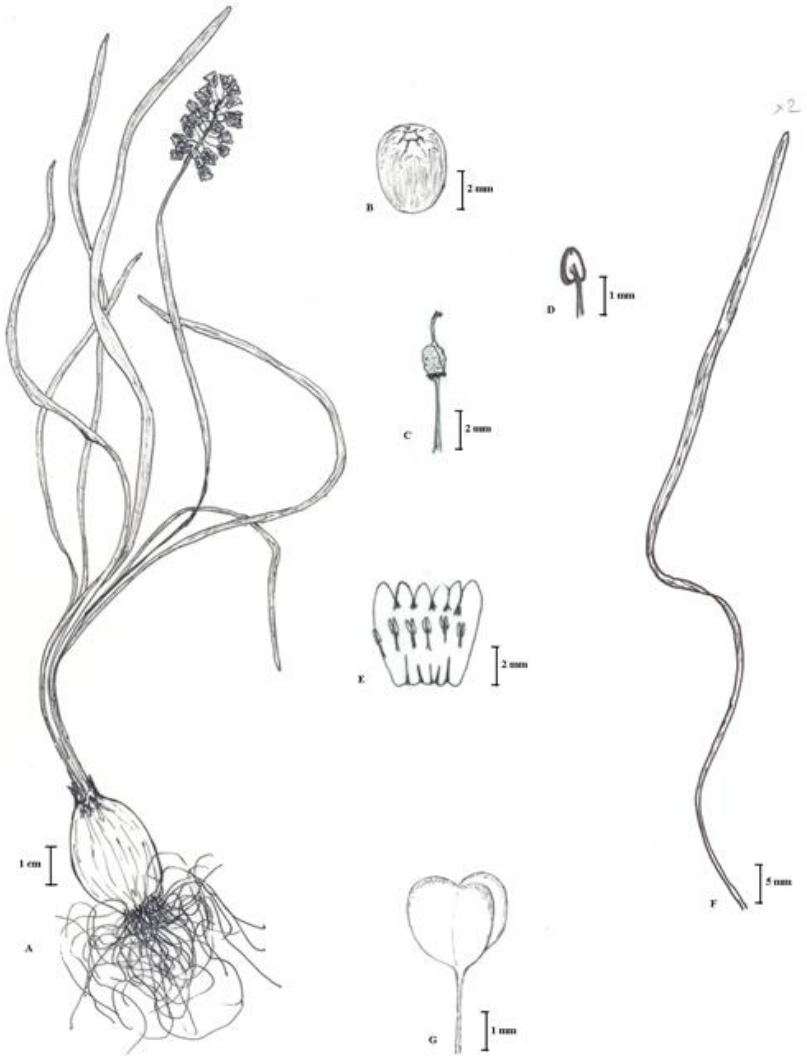

Figure 11. *Muscari bourgaei* A: General view, B: Flower, C: Ovary, D: Stamen, E: Corolla and stamen, F: Leaf, G: Fruit

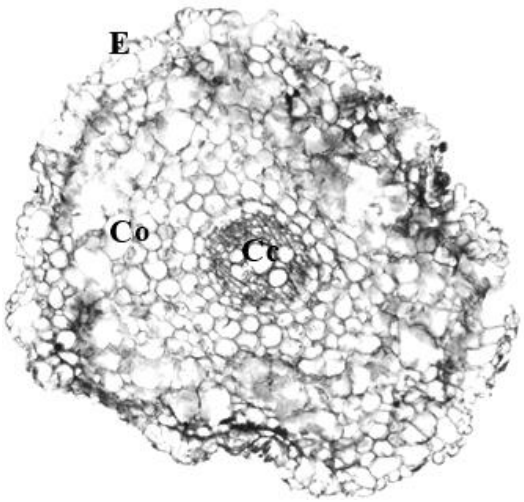

Figure 12. Root section of *Muscari bourgaei* (10 X 10x) (Original) E: Epidermis, Co: Cortex, Cc: Central cylinder

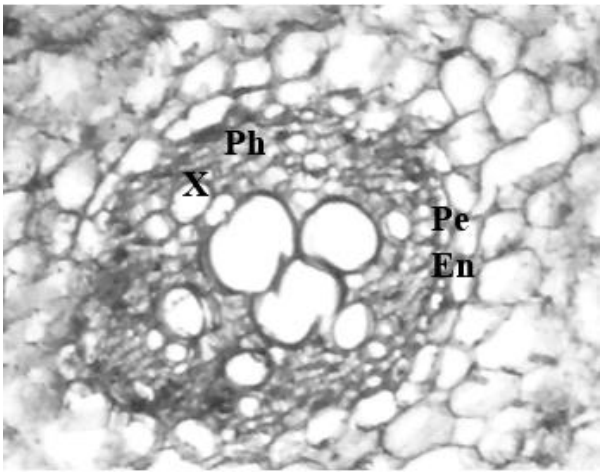

Figure 13. Magnified central cylinder of root cross-section *Muscari bourgaei* (40 X 10x) (Original) En: Endodermis, Pe: Pericycle, X: Xylem, Ph: Phloem

3.5.2. Anatomy of bulb

At the outer side of the bulb's cross-section, single-layered epidermis exists and its surface is covered with a thin cuticle. The shapes of the epidermis cells are seen to be flat and oval. The space between the upper and lower epidermis is full of oval or round shaped parametric cells having thin membranes (Figure 14). Plenty druse crystal formation is observed among the parenchymatic cells. Vascular bundles lie inside the parenchymatic tissue (Figure 15).

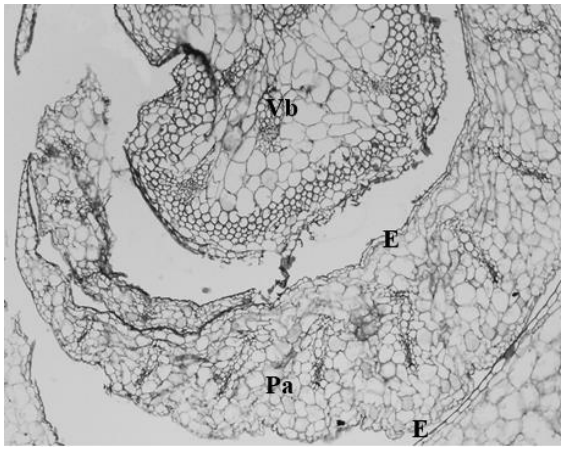

Figure 14. Cross-section of *Muscari bourgaei* bulb (10 X 10x) (Original) E: Epidermis, Pa: Parenchyma, Vb: Vascular bundle

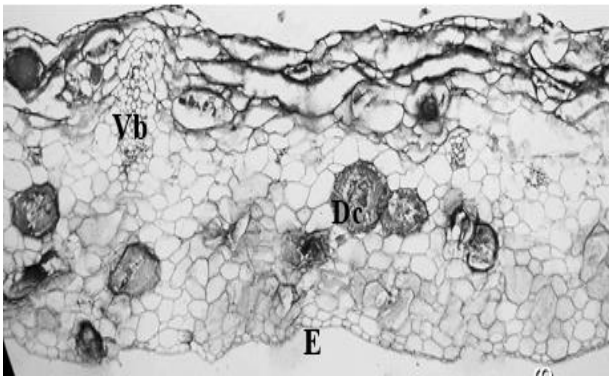

Figure 15. Druse crystal in the bulb of *Muscari bourgaei* (10 X 10) (Original) E: Epidermis, Dc: Druse crystal, Vb: Vascular bundle

3.5.3. Anatomy of Scape

On the ouhter side there is single layer of rectangular shaped epidermis exist and the surface of the epidermis is covered with a thin cuticle layer. Mesophitic type stomatas take place in epidermis and under it, singe layered hypodermis is found in a varriety of shapes. Vascular bundles under the the chloronchymatic zone are arranged in two circles, those in outer ring being smaller than inner ones. Phloem lies on the outerside of bundles and xylem on the inner side (Figure 16). Pith is formed of parenchymatic cells (Figure 17).

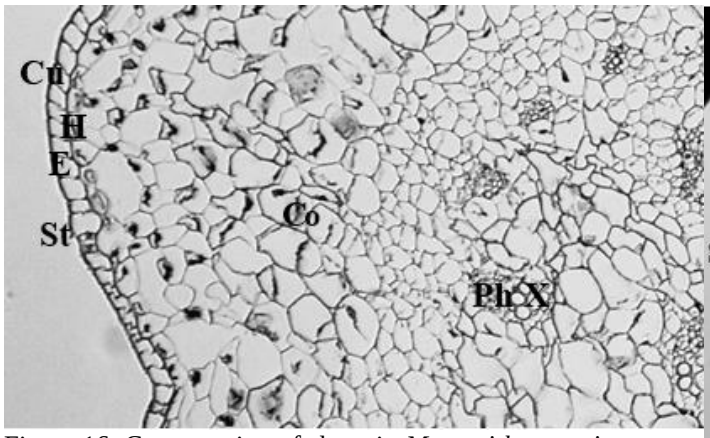

Figure 16. Cross-section of shoot in *Muscari bourgaei* (40 X 10) (Original) E: Epidermis, Cu: Cuticle, H: Hypodermis, Co: Cortex, St: Stomata, Ph: Phloem, X: Xylem

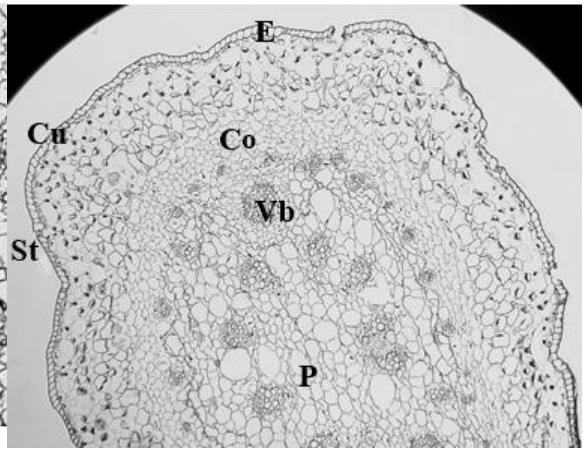

Figure 17. Cross-section of shoot in *Muscari bourgaei* (10 X 10x) (Original) E: Epidermis, Cu: Cuticle, Co: Cortex, Vb: Vascular bundle, P: Pith, St: Stomata

3.5.4. Anatomy of leaf

On the cross section of the leaf, a single layered epidermis consisted of oval or round shaped cells and covered with a thick cuticle is observed and than it is followed with palisade parenchyma which is seen on the both surfaces of the leaf, is equal to two sides of the leaf. The leaf is equifacial. Spongy parenchyma has completely filled the middle part of the leaf. Vascular bundles take place inside the spongy parenchyma and are composed of xylem and phloem (Figure 18). On the both surfaces of the leaf, mesophytic type stomatas are found (Figure 19).

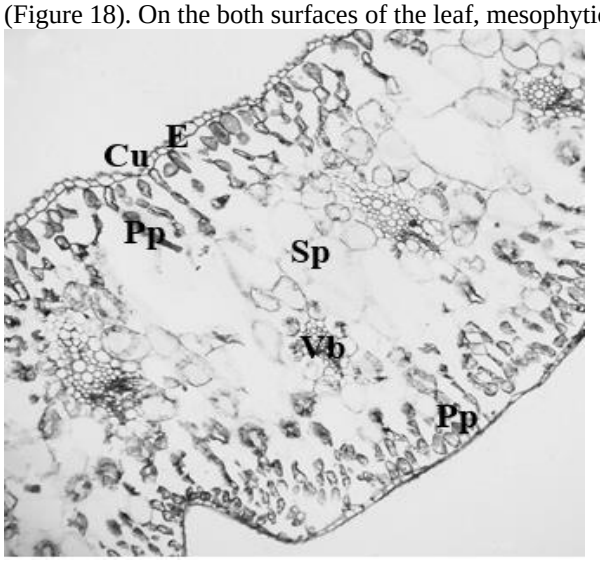

Figure 18. Cross-section of leaf in *Muscari bourgaei* (10 X 5x) (Original) E: Epidermis, Cu: Cuticle, Pp: Palisade parenchyma, Sp: Spongy parenchyma, Vb: Vascular bundle

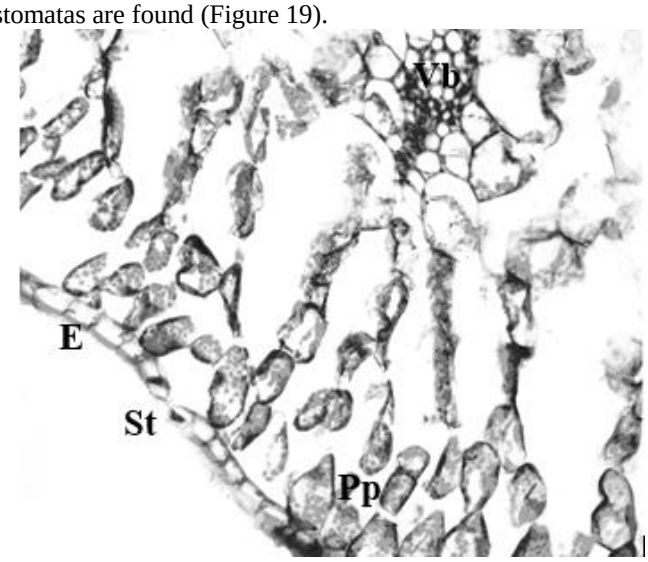

Figure 19. Magnified stomata in the leaf of *Muscari bourgaei* (10 X 10x) (Original) E: Epidermis, St: Stomata, Pp: Palisade parenchyma, Vb: Vascular bundle

3.5.5. Anatomy of ovary

On the cross-section of the ovary, it is seen to have 3 loculus and carpels, but the loculuses cannot be differentiated because of the tissue fractionation. It is clear that each loculus has 2 ovules and the plasentation is axial. The ovary is covered with a layer of flat shaped epidermis. pericarp composed of parenchymatic cells exist. The vascular bundles are available inside the pericarp and the phloem are directed towards the outside while the xylem is directed towards the inside part (Figure 20).

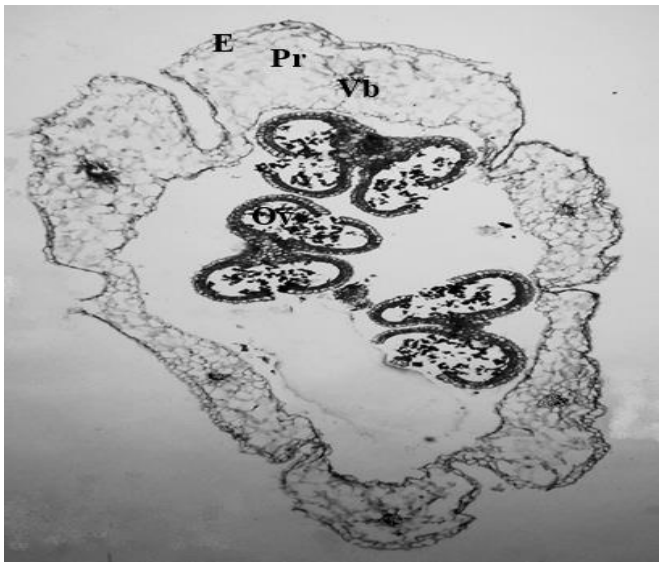

Figure 20. Cross-section of ovary of *Muscari bourgaei* (10 X 10x) (Original) E: Epidermis, Pr: Pericarp, Vb: Vascular bundle, Ov: Ovule

3.6. Ecology
3.6.1. Distribution

Muscari bourgaei is an endemic taxon. Except from Çanakkale, it distributes in the provinces of A2 (A) Bursa, A4 Çankırı, A5 Samsun, B2 Kütahya, C2 Aydın, C3 Antalya C5 Niğde in Turkey. It grows at a height of 1500–3000 metres in the meadows, stony hillsides, calcareous and lime stony grounds. Flowering time of the plant is between $5^{th}$and 7^{th} months (Mathew, 1984). *M bourgaei* samples were recorded from an area at 1730 m altitude situated from silica-stoned northward slopes of Mount Ida's Babadağ location on the 5^{th} and 6^{th} months of the years 2004-2007.

3.6.2. Soil characteristics

M. bourgaei prefers soils with a pH of 6.37 (lightly acidic), 1,05 (salt-free), Ca CO_3 2.37% (little amount of lime). Lastly, soil texture was found to be loamy.

Chemical analysis of the soils show that these are rich in organic matter (7.45 %), but rich in phosphorus (19.85 per kg/da). The soils show enough of potassium (kg/da) 157.72.

3.7. The conservation strategies of the endemic bulbous plants

Endemic plants having a significant place in Turkey are under various pressures and they are in danger of extinction. In addition to such pressures as urbanization, industrialization, the process of extending the agricultural lands, tourism and over-grazing, the plants face they are also under the risk of extinction because of such reasons as exportation, picking from the nature for domestic use, pollution, afforestation, fires, construction of the channels and the roads and erosion (Ekim et al., 2000).*Crocus gargaricus* ssp. *gargaricus* is also NT (near threatened). Although its risk of danger is low, it seems obligatory to get it under in-situ conservation as this taxon is found only in two provinces (Bursa and Muğla) except from the Mount Ida in Turkey and the area where the plant grows is open to tourism and grazing. *Muscari bourgaei* Baker is LC (least concern). Although it is not in the category of danger and grows in the provinces of Bursa, Çankırı, Samsun, Kütahya, Aydın, Antalya and Niğde except from the Mount Ida in Turkey, the taxon still should be under in-situ conservation as it is an endemic plant and the where it grows is open to the tourism and grazing.As both taxa are endemic, the population of the plants should be concerved through the conservation zones to be created at the areas where they distrubited. If necessary, in-situ conservation gardens should be established in nature. However, in case of a rise in danger, the plants should be transplanted to their natural habitats after they are produced in ex-situ conditions.

4. Conclusions and discussion

A rich flora of Turkey abounds in endemics with a percentage lying around 34 (Ekim et al., 2000). The current study examined morphological, anatomical and ecological properties and conservation strategies of the *C. gargaricus* Herb. ssp. *gargaricus* and *Muscari bourgaei* Baker endemic taxa naturally distributing in pseudo-alpinic area of the Mount Ida.

Although the extinction grade of *C. gargaricus* ssp. *gargaricus taxon* is low, it is obligatory for this plant taxon to be taken under in-situ protection due to the reasons that it grows in mount Ida and its natural habitat is open to grazing (pasturage). Also, although *M. bourgaei* taxon grows in other areas in addition to Mount Ida, it should be conserved against environmental pressures as it is among the endemic plants. It is observed that sheep and goats are grazing in the habitats of the plants and close areas. Especially, the reasons that the grazing events are observed in flowering time and *C. gargaricus* ssp. *gargaricus* grows only in Mount Ida endanger the plants. In conclusion, the pressure of grazing reduces the population of the two taxon.

C. gargaricus ssp. g*argaricus* has a hairy root. The corms of the *C. gargaricus* ssp. *gargaricus* taxon do not produce stolans contrary to the *C. gargaricus* ssp. *herberti* taxon. The tunics of *C. gargaricus* ssp. *gargaricus* is thin reticulated-filamentous; however, these structures are parallel to the bottom in *C. gargaricus* ssp. *herberti* (Erol et al., 2008). The onion average 0.95 cm diameter, 1.33 cm in length was measured. The scapose in *C. gargaricus* ssp. *gargaricus* was measured as 0,22 cm in diameter and 2,57 cm long. 3-4 leaves, flowers and leaves are also seen. The leaf is 0,15 cm wide in average and it is 4,52 cm long. However, Mathew (1984) stated the width of the leaf as 2 mm. This situation stems from the insufficiency of the habitat.

Perianth tube is yellow, hairless while its segments are dark yellow or orange and perianth ends truncated or rounded shape. The bracts are not or ovat lanseolat. Corolla is approximately 0,97 cm wide and 2,93 cm long. The filaments have pubescent hairs and they were measured as 0,09 cm wide 0,79 cm long. However, Mathew (1984) measured the filaments as 3–7 mm. This small difference stems from the plant's habitat. Anthers are in yellow color and approximately 0,13 cm wide and 0,45 cm long. Contrarily, in the study of Mathew (1984) the anther's length was given as 0,6–1,1 cm. In average, the ovaries are 0,25 cm wide and 0,82 cm long while the stillus has a shape divided into 3 thread-like orange branches and they are 0,31 cm long. The fruit is 1,27 cm wide and 2,15 cm long.

Anatomical findings of *Crocus gargaricus* ssp. g*argaricus* are compared *C. flavus* Weston subsp. *flavus* and *C. fleischeri* J.Gay (Table 3). While scapose anatomy of *Muscari bourgaei* has thin cuticle layer, others don't have this layer. Scapose the anatomy of species located in the pith, the cells are filled with parenchymatic cells; This feature did not mention other taxons. Furthermore, while leaf of *Crocus gargaricus* is equifacial, leaf of *Crocus flavus* is unifacial and leaf of *Crocus fleischeri* is bifacial. The fruit of M. bourgaei is loculucidal capsule, ovoid-orbicular, emarginated and it is 0,43 cm wide and 0,42 cm long in average. The seeds are approximately 0,12 cm wide and 0,14 cm long. Similar to the findings related to Muscari latifolium J.Kirk obtained by (Uysal, 1992). The placentation is axial. The ovary is covered with a series of flat-shaped epidermis outside and under the epidermis, pericarp composed of parenchymatic cells exists. Vascular bundles are found inside the pericarp and in the bundles the floem is directed outside while xylem is directed inside. *M. bourgaei* was collected from 1730 m. high, silex-stony hillsides located northward of Babadağı locality of the Mount Ida.

Table 3. Comparison of anatomical characters of *Crocus gargaricus* ssp. g*argaricus, C. flavus* Weston ssp. *flavus* and *C. fleischeri* J.Gay

Parts	**Characters**	**C. gargaricus**	**C. flavus subsp. flavus** (Ozdemir et al., 2006)	**C. fleischeri** (Ozdemir et al., 2004)
Root	**Epidermis**	Single layer	Single layer	2 layer
	Exodermis	Single layer	-	-
	Cortex	Composed of parenchymatic cells	Parenchymatic with intercellular spaces	Parenchymatic with intercellular spaces
	Endodermis	+	+	+
	Pericycle	+	+	+
	Pith	Metaxylem	Single metaxylem	Metaxylem
Scapose	**Cuticle**	Thin cuticle	-	-
	Epidermis	Single layer	Single layer	Single layer
	Cortex	Parenchymatic cells	+, no intercellular cells	+, no intercellular cells
	Vascular bundles	Phloem outerside xylem inner side	Periphery and centre of stem	Periphery and centre of stem
	Pith	Parenchymatic cells	-	-
Leaf	**Cuticule**	Thick cuticle	Thick cuticule	+
	Epidermis	Single layer	Single layer	Single layer
	Palisade parenchyma	Both surfaces of the leaf	±,Mesophyll cells are uniform, Unifacial leaf	One surface of the leaf, upper surface
	Spongy parenchyma	Middle part of the leaf		One surface of the leaf, lower surface
	Phloem	Upper side	Upper side, sheath consists of sclerenchymatic cells	Upper side
	Xylem	Inner side	Inner side	Inner side
	Intercellular Space	+	+	+

Anatomical findings of *Muscari bourgaei* are compared *M. sivrihisardaghlarensis* and *M. latifolium* (Table 4). Bulb of *Muscari bourgaei* has plenty of druse crystals. Druse crystals in the bulbs of *Muscari bourgaei* typical of a systematic feature. Furthermore, scapose anatomy of this taxon has hypodermis layer which located under the epidermis layer. While scapose anatomy of *Muscari bourgaei* has a single hypodermis layer, others don't have this layer.

Table 4. Comparison of anatomical characters of *Muscari bourgaei, M. sivrihisardaghlarensis* and *M. latifolium*

Parts	Characters	*M. bourgaei*	*M. sivrihisardaghlarensis* (Sezer et al., 2008)	*M. latifolium* (Uysal, 1992)
Root	Cuticle	-	±	-
	Epidermis	Single layer	Single layer	Single layer
	Exodermis	-	Single layer	-
	Cortex	Composed of parenchymatic cells	Very large area	Composed of parenchymatic cells
	Endodermis	+	+	+
	Pericycle	+	+	+
	Pith	Full of xylem elements	Radially arranged vascular bundle	Full of xylem elements
	Vascular cylinder	Radiant form	Radiant form	Radiant form
	Crystals	-	-	Raphide crystals
Scapose	Cuticle	Thin cuticle	Thick cuticle	Thick cuticle
	Epidermis	Single layer of rectangular shaped	Cells square-rectangular shaped	Single layer
	Hypodermis	Single layer	-	-
	Cortex	Chloronchymatic zone	Parenchymatic cells	Chloronchymatic zone
	Sclerenchymatic cells	-	+	-
	Vascular bundles	Phloem outerside xylem inner side	Closed collateral vascular bundles	Phloem outerside xylem inner side
	Pith	Parenchymatic cells	Parenchymatic cells	Parenchymatic cells
Leaf	Cuticle	Thick cuticule	Thick cuticule	Thick cuticule
	Epidermis	Single layer	Single layer	Single layer
	Palisade parenchyma	Both surfaces of the leaf	Both surfaces of the leaf	Palisade parenchyma surround spongy parenchyma
	Spongy parenchyma	Middle part of the leaf	Middle part of the leaf	Middle part of the leaf
	Phloem	Upper side	Upper side	Upper side
	Xylem	Inner side	Inner side	Inner side
	Intercellular space	+	+	-
	Crystals	-	Raphide crystals	-

C. gargaricus ssp. *gargaricus* ve *Muscari bourgaei* were seen to be soil texture class clayey in the soil samples taken from the areas where our plants grow. According to the examinations of the soils in terms of soil pH value, *C. gargaricus* ssp. *gargaricus* grows in medium acidic areas while *Muscari bourgaei* grows in slightly acidic areas. The examinations of the soils according to the salt density revealed that both plant taxa grow in non-saline soils. Regarding the examinations of the soils according to their lime rate, the soil supporting *C. gargaricus* ssp. *gargaricus and Muscari bourgaei* are rich in lime; which is consistent with its pH value. The examinations of the soils according to their organic matter contents revealed that the *C. gargaricus* ssp. *gargaricus* and *Muscari bourgaei* taxa are rich in organic substances. According to the examinations of the soils in terms of the phosphorus, *C. gargaricus* ssp. *gargaricus* has a medium value of phosphor while the *Muscari bourgaei* grows in the soils rich in phosphor. Lastly, according to the examinations of the soils in terms of their potassium value revealed that *C. gargaricus* ssp. *gargaricus* ve *Muscari bourgaei* taxa were found to be sufficient in potassium.

C. gargaricus ssp. *gargaricus* is in the threatened category NT (near threatened). Although its threat class is low, the taxon should be under in-situ conservation as it grows only in the provinces of Muğla and Bursa except from Mount Ida and the area where it grows is open to grazing and tourism. *M. bourgaei* Baker taxon should be preserved in LC (least concern) threatened category only as it is an endemic taxon. During the field studies, cattle's grazing was observed in the habitats in which the plants grow and in close areas. As the grazing occurs in blooming time of the flowers, the flowers will encounter the danger of extinction. Resultantly, the grazing pressure can diminish the populations of the two taxa.

In addition, to ensure the continuity of generations of plants should go also to the ex-situ conservation strategies. For this purpose, plants yielding seed in the ground in the nature of ex-situ conditions should be transplanted.

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References

Bizimbitkiler.org, 2015a. Bizim Bitkiler, http://www.bizimbitkiler.org.tr/v2/hiyerarsi.phpf=Liliaceae.

Bizimbitkiler.org, 2015b. Bizim Bitkiler, http://www.bizimbitkiler.org.tr/v2/hiyerarsi.phpf=Asparagaceae.

Celik S, Uysal, İ., Menemen, Y., 2005. *Centaurea* species in Turkey (A): *Centaurea odyssei* Wagenitz (Asteraceae) in Kazdagi (Mt. Ida) National Park. International Journal of Biodiversity Science and Management 1: 113–120.

Cutler D., 1978. Anatomia Vegetal Aplicada. London: Longman.

Davis P. H., Mill RR, Tan K., 1988. Flora of Turkey and the East aegean Islands, 10: 228 (Suppl. 1). Edinburgh: Edinburgh University Press.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N., 2000. Türkiye Bitkileri Kırmızı Kitabı. Türkiye Tabiatını Koruma Derneği ve Van Yüzüncü Yıl Üniv., Ankara.

Erol O, Küçüker O, Üzen E (2008) Corm tunic morphology of Turkish Crocodiaceae (Iridaceae) and their systematic significance. Nordic Journal of Botany 26, 66-73.

Gönüz, A., 1987. Bazı Alpinik Bitki Türlerin Adaptasyonları Üzerine Morfolojik, Anatomik ve Fenolojik Gözlemler. IX. Ulusal Biyoloji Kongresi Botanik ve Uygulamalı Biyoloji Bildiri Metinleri Cilt I, 119–137, İzmir.

IPNI, 2015. The Inernational Plant Name Index, http://www.ipni.org/.

Koc, T., 2001. Climate and Environment in Northwest Anatolia from the Synoptic, Statistical and Application Perspective. Cantay Press. Istanbul, Turkey (in Turkish).

Koç, T., 2003. Çanakkale Yerleşkesi 2003 Durum Raporu, Çanakkale Municipality, Çanakkale.

Koç, T., 2004. Canakkale Campus 2003 Status Report, Çanakkale Municipality, Çanakkale.

Mathew, B. 1984. *Crocus*. In: (Ed.): Davis, P,H. Flora of Turkey and the East Aegean Islands. (8th Ed) Edinburg University Press, London, pp. 413-438.

Ozdemir, C., Akyol, Y. and Alcitepe, E. 2004. Morphological and anatomical studies on two endemic Crocus species of Turkey area. Pakistan Journal of Botany 36.1:103-114.

Özdemir, C., Baran, P., Akyol, Y. 2006. The morphology and anatomy of *Crocus flavus* Weston subsp. *flavus* (Iridaceae). Turkish Journal of Botany, 30(3), 175-180.

Özdemir, F., Pirdal, M., Öztürk, M., 1988. Batı Anadolu'da Yayılış gösteren Bazı Endemiklerin Morfolojik, Anatomik ve Ekolojik Özellikleri Üzerinde Araştırmalar. X. Ulusal Biyo. Kong., Sivas.

Pirdal, M., Özdemir, F., Öztürk, M., 1988. *Astragalus tmoleus* ve *Marrubium rotundifolium'* un Morfolojisi, Anatomisi ve Ekolojisi Üzerine Araştırmalar. Türk Doğa Botanik Dergisi.

Seçmen, Ö., Gemici, Y., Görk, G., Bekat, L., Leblebici, E., 1995. Tohumlu Bitkiler Sistematiği. Ege Üniversitesi Fen Fakültesi Kitaplar Serisi, no, 116, İzmir.

Sezer, O., Özgişi, K., Yaylacı, Ö. K., Koyuncu, O., 2008. Some morpho-anatomical studies on rare endemic *Muscari sivrihisardaghlarensis*. Biological Diversity and Conservation, 6 (2): 26-33.

Stuart., D.C. 1984. Muscari Miller. In: (Ed.): Davis P.H., ed. Flora of Turkey and the East Aegean Islands. Edinburgh: Edinburgh University Press, 8: 227-263.

Uysal, İ. 2010. An overview of plant diversity of Kazdagi (Mt.Ida) Forest National Park, Turkey. Journal of Environmental Biology, 31: 141-147.

Uysal, İ., 1992. Kazdağı (B1 Balıkesir) Endemik Bitkileri Üzerinde Araştırmalar I "*Allium flavum* L. subsp. *flavum* var. *minus* Boiss. ve *Muscari latifolium* Kirk.", Doğa-Tr. J. of Botany,16: 299–310, Ankara.

Uysal, İ., 1993. *Papaver virchowi* Aschers & Sint. Endemik Türünün Morfolojisi, Anatomisi ve Ekolojisi. Selçuk Üniv. Fen-Ed. Fak. Fen Bil. Derg. 11: 105-115, Konya.

Uysal, İ., 1994. Türkiye'de Endemizm ve Çanakkale Yöresinin Endemikleri. Çanakkale Onsekiz Mart Üniversitesi Derg. 1: 26-30, Çanakkale

Uysal, İ., 1997a. *Astragalus trojanus* Stev. Endemik Türünün Morfolojisi, Anatomisi ve Ekolojisi Üzerinde Gözlemler. Erciyes Üniv. Fen Bil. Enst. Fen Bilimleri Dergisi 13 (1-2): 54-66, Kayseri.

Uysal, İ., 1997b. *Ballota nigra L.* subsp. *anatolica* Davis. Endemik Taksonunun Morfolojisi, Anatomisi ve Ekolojisi Üzerinde Araştırmalar. Erciyes Üniv. Fen Bil. Enst. Fen Bilimleri Dergisi 13 (1-2): 67-77, Kayseri.

Uysal, İ**.,** 1999. Morphological, Anatomical and Ecological Studies on the two Turkish Endemic Species Collected From Kazdağı (B1 Balıkesir) "*Allium sibthorpianum* Schultes & Schultes fil. and *Allium reuterianum* Boiss., Doğa-Tr. J. of Botany, 23: (2) 137-149, Ankara.

Uysal, İ., 2002. *Stachys cretica L.* subsp. *smyrneaea* Rech. fil. Endemik Taksonunun Morfolojisi, Anatomisi ve Ekolojisi Üzerinde Araştırmalar. Ekoloji Çevre Dergisi 11: (42) 16-20, İzmir.

Uysal, İ., Öztürk, M., 1991. *Digitalis trojana* Ivan Endemik türünün Morfolojisi, Anatomisi ve Ekolojisi. Anadolu Üniv. Fen-Ed. Fak. Derg. cilt, 3 (1): 53-61, Eskişehir.

Uysal, İ., Öztürk, M., Pirdal, M., 1991. *Sideritis trojana* Bornm., Endemik Türünün Morfolojisi, anatomisi ve Ekolojisi. Doğa-Tr. Jr. of Botany, 15: 371–379, Ankara.

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