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Comparative anatomical studies on twelve *Ornithogalum* (Asparagaceae) species (eleven nonendemic, one endemic) belonging to subgen. *Ornithogalum* and subgen. *Beryllis*, growing naturally in Eskişehir (Central Anatolia-Turkey)

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In this study, some anatomical features of 12 *Ornithogalum* species (eleven nonendemic, one endemic) which included by two subgenera (subgen. *Ornithogalum* and subgen. *Beryllis*) have been investigated for the first time. Also investigated anatomical features of every *Ornithogalum* species, they are naturally distributed in Eskişehir (Central Anatolia-Turkey) and its environs, were compared with each other on the purpose of assign taxonomic value of these features and so make contributions to the taxonomic identification of these taxa. For this reason, 11 anatomical chracters (7 for leaf and 4 for stem) of these *Ornithogalum* species were investigated. In addition to, photos of superficial section of upper and lower epidermis, cross section of the leaves and scapes given. According to the comparison of these features some useful anatomical chracters have been found in subgenus level. For example, stomatal index of lower epidermis in subgen. Subgen. *Ornithogalum* was 15-60 number mm^2 and subgen. *Beryllis was* 25 number mm^2. Vascular bundle numbers in subgen. *Ornithogalum* and subgen. *Beryllis* was 10-32 and 20-30, respectively. Stem diameter of subgen. *Ornithogalum* is 3,040-5,336 mm and subgen. *Beryllis* is 4.608-4.852 mm. These features are pratically useable for distinguish subgen. *Ornithogalum* and subgen. *Beryllis*.

Key words: *Ornithogalum*, anatomy, morphology, taxonomy, nomenclature, biodiversity.

INTRODUCTION

According to the recent phylogenetic studies, the genus *Ornithogalum* belonging to Asparagaceae family distributes almost all around the world (APG III, 2009). Especially, it distributes widely in Europe, around the Mediterranean and Balkan Peninsula, Asia (reaching Afghanistan to the East), Africa (except the Northern Tropic) and Madagascar (Martínez-Azorín et al.2010a, b, 2011; Meriç et al. 2011; Uysal 2005; Zahariadi 1980).

The number of species included in *Ornithogalum*, and hence its circumscription and taxonomy, still has been a matter of controversy (Martínez-Azorín et al. 2009, 2010a, b, 2011). *Ornithogalum* comprises about 120-130 species (Landstrom 1989) or even 200 according to Obermeyer (1978). However, Müller-Doblies & Müller-Doblies (1996) recognized only 123 species from southern Africa, forty of which were described as new taxa. Therefore, the total number of species in the world could be higher than 200-300 (Martínez-Azorín et al. 2007, 2010a, b). On the basis of floral and reproductive characters, 17 subgenera have been recognized in *Ornithogalum* genus (Zahariadi 1980; Obermeyer 1978; Martínez-Azorín et al. 2007; Baker 1872).

It was reported in the revision conducted by Cullen (1984) for the Flora of Turkey that *Ornithogalum* was represented by 23 taxa in Turkey. However, a few new taxa were added afterwards (Uysal et al. 2005; Cullen 1984; Bağcı et al 2009, 2011; Doğru-Koca 2010; Düşen and Deniz 2005; Mutlu and Karakuş 2012; Özhatay and Kültür 2006; Özhatay 2000; Varol 2008). Today, *Ornithogalum* is represented by about 60 taxa in four

subgenera (subgen. *Ornithogalum*, subgen. *Beryllis*, subgen. *Myogalum* and subgen. *Carulia*) in the flora of Turkey, 30 of these species are endemic and endemism ratio is *ca*. 50 % (Cullen 1984; Güner et al. 2012; IUCN 2001). Anatolia has the position of an important diversification center of *Ornithogalum* genus with about 60 taxa (Meriç et al. 2011; Cullen 1984; Davis et al 1988; Öztürk 2007).

Eskişehir province is situated in the Irano-Turanian phytogeographic region (Central Anatolia), where generally, steppe vegetation is dominant type. Due to the climatic, geographic, topographical and geological features of Eskişehir, it has high floristic diversity. Till today, about 1,500 taxa have been identified from Eskişehir and approximately 300 of these are endemic to Turkey. In the last decade, about 50 endemic taxa have been identified from Eskişehir and 13 of these are only endemic to Eskişehir.

This genus is represented in Eskişehir by 14 taxa in two subgenera (subgen. *Ornithogalum* and subgen. *Beryllis*) (Ocak et al. 2010). Some studies have been conducted on anatomical, morphological, palynological, karyological, taxonomical, systematical, pharmacological, ethnobotanical, antioxidant activity, chorological and conservational status in *Ornithogalum* genus (Martínez-Azorín et al. 2007, 2009, 2010a, b; Meriç et al. 2011; Uysal 2005; Cullen 1984; Bağcı et al. 2011; Düşen and Deniz 2005; Mutlu and Karakuş 2012; Özhatay 2000; Varol 2008; Davis et al. 1988; Öztürk 2007; Bednorz and Czarna 2008; Speta 2000).

Ornithogalum is a taxonomically difficult genus, while its morphology is poorly correlated with the variation in chromosome number and karyotype (Meriç et al. 2011; Dalgıç and Özhatay 1997). Anatomical characters are quite important in systematics of *Ornithogalum.* Although identification of *Ornithogalum* seems easy, the fact that the genus varies quite a lot makes identification harder (Martínez-Azorín et al. 2011; Meriç et al. 2011; Popova and Anastasov 1997).

Some studies on the anatomy of *Ornithogalum* genus are performed in Turkey (Meriç et al. 2011). Dalgıç (1990) and Dalgıç and Özhatay (1997) has examined the chorology, morphology and karyology of *Ornithogalum* in European Turkey. Also seed morphologies of some *Ornithogalum* species have been investigated by Bednorz & Czarna (2008), karyological and palinological properties of *O. boucheanum* were investigated by Dalgıç et al. (2009). Recently, morphological and anatomical contributions to the taxonomic identification properties of *O. nutans* and *O. boucheanum* were investigated by Meriç et al. (2011). Seed anatomy and numerical taxonomy of some *Ornithogalum* species were investigated by Çoşkunçelebi et al. (2000, 2001)

The aim of this study is to determine anatomical features in addition to morphological characters to distinguish these species (eleven nonendemic, one endemic) as taxonomically. Also additional taxonomic characters were tried to find by examining the scape and leaf of these twelve species represented by two subgen. (*Ornithogalum* and *Beryllis*) which distributes naturally in Eskişehir, (Central Anatolia-Turkey) (Figure1).

MATERIAL AND METHODS

Plant materials

The samples of *Ornithogalum* were collected from 12 different localities of Eskişehir province (Central Anatolia-Turkey) and its close environs, for the present study in 2006-2007 (Figure 1). Detalied information about localities and number of the collected specimens for each locaties are given. Identification of the plants was made according to Cullen (1984), Zahariadi (1980) and Davis et al. (1988). In order to ensure a systematic study of the material obtained, herbarium samples were prepared and protected at the Eskişehir Osmangazi University Herbarium (OUFE).

Totally, 20 fresh and fixed plant samples which in same developmental stage (the basal third of leaves and stem) were used for anatomical investigations of every species in springtime.

All measurements and counts have been performed on preparates made from 20 samples of same plant species and statistical analysis of obtained data were performed by IBM SPSS Statistics 21.0.

All results were expressed as mean ± Standart Deviation. The Shapiro Wilk's tests were used to detect the normality distribution of the data. Comparisons of numerical data were made using parametric ANOVA tests (one way ANOVA) for between group comparisons. The level of statistical significance was set at $p \leq 0.05$ in all analysis.

Localities and numbers of collected plant samples (origin of the examined taxa)

1- *O. alpigenum* Stapf: Turkey, B3 Eskişehir; Hekimdağ village, 39º52'84,2'' N- 030º34'75,5'' E, 1,273 m, 12 v 2006, OUFE: 16581, (36 plant samples).
2- *O. armeniacum* Baker: Turkey, A3 Eskişehir; Mihalıççık-Bey köy road, 40º04'99,4'' N- 030º45'98,0'' E, 240 m., 15 iv 2006, OUFE: 16582, (29 plant samples).
3- *O. comosum* L.: Turkey, B3 Eskişehir; Bozan reforestation site, 39º47'55,4'' N-031º07'13,7'' E, 878 m., 17.vi.2006, OUFE: 16587, (23 plant samples).
4- *O. fimbriatum* Willd.: Turkey, A3 Eskişehir; iter Mihallıççık-Tekkeköy, 40º05'44,3'' N- 031º12'55,5'' E, 1021 m., 05 v 2006, OUFE: 16580, (31 plant samples).
5- *O. lanceolatum* Labill.: Turkey, B3 Eskişehir; Mihalıççık-Gürleyik road 39º59'14,9'' N- 031º07'13,7'' E, 659m., 01.v.2007, OUFE: 16589, (37 plant samples).
6- *O. montanum* Cirillo: Turkey, A3 Eskişehir;

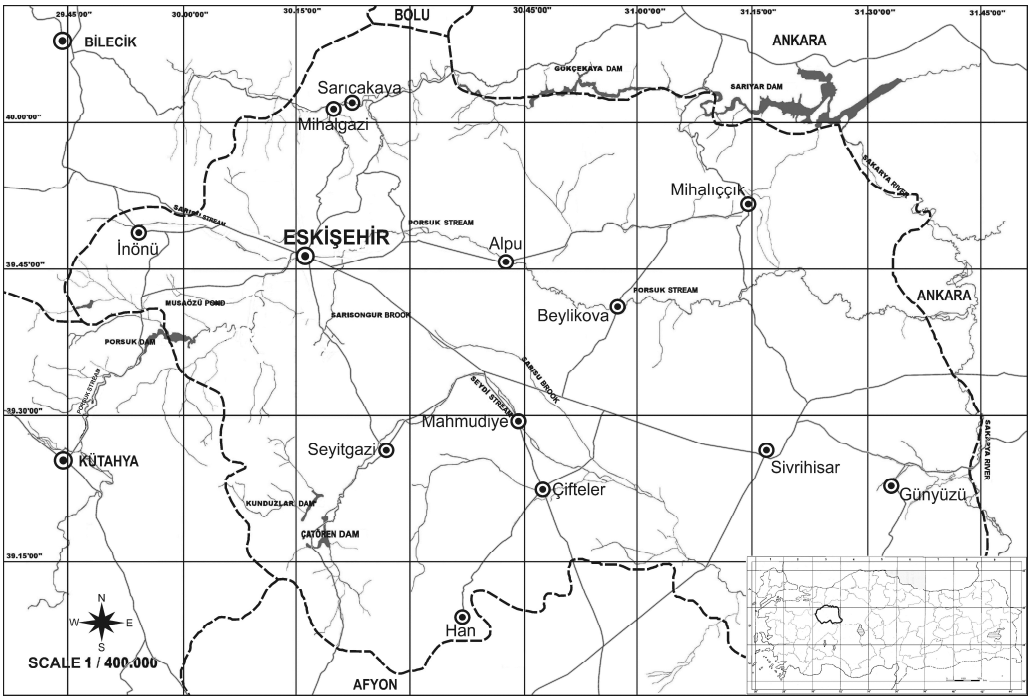

Figure 1. The area map from where plant samples were collected.

Emresultan-Sazak road, 40º04'07,0'' N- 031º23'43,5'' E, 399 m., 05 v 2006, OUFE: 16583, (27 plant samples).
7- *O. oligophyllum* E.D.Clarke: Turkey, B3 Eskişehir; Türkmen Mountain, 39º31'46,8'' N- 030º19'48,7'' E, 1598 m., 22 iv 2007, OUFE: 16590, (30 plant samples).
8- *O. orthophyllum* Kerner: Turkey, B3 Eskişehir; Alpu-Gökçekaya road, 39º52' 49,8'' N- 030º58' 39,8'' E, 927 m., 04 iix 2006, OUFE: 16579, (42 plant samples).
9- *O. umbellatum* L.: Turkey, A3 Eskişehir; Mihalgazi-Karacaoğlan road, 40º01'45,8'' N- 030º30'38,1'' E, 278 m., 14.iv.2007, OUFE: 16586, (21 plant samples).
10- *O. sigmoideum* Freyn & Sint.: Turkey, B3 Eskişehir; Tandır village, 39º55'27,6'' N- 030º41'33,3'' E, 1273 m., 23 iv 2006., OUFE: 16584, (24 plant samples).
11- *O. sphaerocarpum* A.Kern.: Turkey, A3 Eskişehir; Sarıyar village, 40º03'27,0'' N- 031º27'35,7'' E, 396 m., 12 v 2006, OUFE: 16588, (29 plant samples).
12- *O. pyrenaicum* L.: Turkey, A3 Eskişehir; Laçin-Mayıslar road, 40º01'3,4'' N- 030º43'35,1'' E, 234 m., 05 v 2006, OUFE: 16585, (22 plant samples).

Anatomical studies

The anatomical studies were conducted by conventional methods (Metcalfe and Chalk, 1950). For anatomical studies; the scape and leaves were fixed in 70% ethyl alcohol and then kept in the same solution until the acquisition of cross and superficial sections. For sectioning, samples were taken from the alcohol by hand and scalpel. The stained and unstained sections were mounted in glycerine-gelatine to make permanent preparations (Jensen 1962). The sections were photographed by the Kameram™ digital camera and Nikon 80i type microscope. A variety of foundation anatomical books and conducted studies were used as sources for identification of the plants (Meriç 2011; Metcalfe and Chalk 1950; Esau 1967; Fahn 1967; Ganesh 2013; Özörgücü 1991; Vardar 1987; Yentür 1995).

RESULT AND DISCUSSION

Leaf anatomy

Superficial section of upper and lower epidermis

Generally, superficial sections of upper and lower epidermis are almost similar to all investigated taxa and cells of leaf epidermis are long and have undulated cell walls. The undulated structure in the cell wall is known to make strong relation between the cells Yentür (1995). The leaf is amphistomatic and amaryllis type. The stomata type is anomocytic and the stomata cells are located on the same level of the other epidermal cells. Superficial sections of upper side of the examined taxa were observed and the stomata index was calculated between 15 and 60 (Table 1). Between investigated taxa, although *O. montanum*'s superficial section of upper side

Table 1. The anatomical features of investigated *Ornithogalum* L. taxa.

			subgen. *Ornithogalum*										subgen. *Beryllis*	
			O. alpigenum	*O. armeniacum*	*O. comosum*	*O. fimbriatum*	*O. lanceolatum*	*O. montanum*	*O. oligophyllum*	*O. orthophyllum*	*O. umbellatum*	*O. sigmoideum*	*O. sphaerocarpum*	*O. pyrenaicum*
Leaf	Stomata Index (number/mm^2)	upper epidermis*	30	35	15	35	25	60	30	15	15	50	15	25
		lower epidermis*	25	40	15	15	15	20	60	15	15	30	25	25
	Mesophyll	upper palisade parenchyma	+	+	+	+	+	+	+	+	+	+	+	+
		lower palisade parenchyma	-	+	-	-	-	+	-	+	+	+	-	-
		spongy parenchyma	+	+	+	+	+	+	+	+	+	+	+	+
		thickness (µm)*	400	578	600	665	860	400	286	650	560	396	400	445
		lacunae	large	small	large	large	large	small	large	small	small	small	large	large
Stem	Cortex layer number (min.-max.)		3-4	5-6	6-7	5-6	4-5	7-8	4-5	3-4	5-6	4-5	5-6	7-8
	Sclerenchyma layer number (min.-max.)		2-3	3-4	4-5	2-3	3-4	5-6	2-3	2-3	3-4	2-3	5-6	7-8
	Vascular bundle number (min.-max.)		10-14	18-22	16-20	22-26	18-22	28-32	16-18	12-16	18-22	18-22	26-30	20-24
	Diameter (mm)*		3.560	3.428	3.920	4.000	3.812	3.040	3.328	3.380	5.336	3.396	4.608	4.852

(+) exist, (-) lack, (*) average

has the largest stomatal index (60), *O. comosum, O. orthophyllum, O. umbellatum* and *O. sphaerocarpum* have the smallest stomatal index (15). Other stomatal index of investigated taxa are *O. sigmoideum* (50); *O. armenicum* and *O. fimbriatum* (35); *O. oligophyllum* and *O. alpigenum* (30); *O. lanceolatum* and *O. pyrenaicum* (25). According to the superficial section of lower side *O. oligophyllum* shows largest stomatal index (60) and *O. comosum, O. fimbriatum, O. lanceolatum, O. orthophyllum* and *O. umbellatum* have the smallest stomatal index (15). Other stomatal indices observed from superficial sections of lower side are *O. armenicum* (40), *O. sigmoideum* (30), *O. alpigenum, O. sphaerocarpum* and *O. pyrenaicum* (25) and *O. montanum* (20). While the significant differences were observed between upper and lower surface stomatal index of subgen. *Ornithogalum* (15-60), subgen. *Beryllis* didn't have significant differences (15-25). On the other hand, stomatal index of upper epidermis of subgen. *Ornithogalum* is between 15-60 and subgen. *Beryllis* is between 15-25. Stomatal index of lower epidermis of subgen. *Ornithogalum* is between 15-60 and subgen. *Beryllis* is 25.

According to the statistical data obtained from stomata index of upper leaf surface of *Ornithogalum alpigenum,* there are significant differences between the other species ($p<0.05$, Sig:,000). But between *O. alpigenum* and *O. oligophyllum* there is not any difference according to the lower stomata index (Sig: 1.00). Also statistical test shows that *O. armeniacum* differs from the other species ($p\leq 0.05$). Between the *O. armeniacum* and *O. fimbriatum,* the mean

difference is only significant at the p≤ 0.05. Because the consequence of the test is greater than 0.05 (Sig: 1.00), we can't say that these species have significant differences. But *O. comosum* is different from the other species. However the data sets show that mean of *O. comosum, O. ortophyllum, O. umbellatum* and *O. sphaerocarpum* is not significant (Sig: 1.00). Although 12 *Ornithogalum* species which we studied has significant mean according to the lower stomata index, in some species the mean doesn't look different. It means that only stomata index of upper leaf surface is not enough to get data to classify these species (Table 1).

Other information from the stomata index of lower leaf surface shows that the differences of mean are significant at almost all groups (p< 0.05, Sig: 1,000). Although *O. sphaerocarpum* and *O. pyrenaicum* which belong to different subgenus (subgen. *Beryllis*) have significant mean from other species which are from the subgen. *Ornithogalum,* the mean between these two species (*O. sphaerocarpum* and *O. pyrenaicum*) is not significant. So *O. sphaerocarpum* and *O. pyrenaicum* can be separeted from other species (Sig: 1.00) by using stomata index of lower leaf surface (Table 1).

These results are important to distinguish taxa only at the level of subgenus. It is not useful for level of species. On the other hand, these results are in conformity with Popova and Anastova (1997), Peruzzi et al. (2007) and Meriç et al. (2011). Guard cells are paralel to the neighbour cells and paracytic in all superficial sections (Figure 2, 3, a-l) (Table 1).

Transverse section of the leaf

Generally, transverse sections of the leaf are almost similar in all investigated taxa, and there is a strongly plicate cuticle on both upper and lower surfaces. Either upper or lower surface of the leaf in all investigated taxa has a single layered epidermis. The leaf blade is epistomatic.

The normal epidermal cells are elongate, thin-walled, narrowed at both ends. Epidermal cells are slightly elongated axially in the cross section. The leaf is amphistomatic. Stoma type is anomocytic. The thickness of mesophyll of the examined taxa vary between 286-860 µm; [*O. lanceolatum* (860 µm), *O. fimbriatum* (665 µm), *O. orthophyllum* (650 µm), *O. comosum*, (600 µm), *O. armeniacum* (578 µm), *O. umbellatum* (560 µm), *O. pyrenaicum* (445 µm), *O. alpigenum*, *O. montanum*, and *O. sphaerocarpum* (400 µm), *O. sigmoideum* (396 µm) and *O. oligophyllum* (286 µm)] (Table 1).

Mesophyll is equifacial and differentiated as palisade and spongy parenchyma in all taxa. Uniseriate layer of palisade parenchyma is present on both of upper and lower sides of some taxa (*i.e. O. armeniacum*, *O. montanum*, *O. orthophyllum*, *O. umbellatum* and *O. sigmoideum*). In some taxa, it is only present on the upper side (*i.e. O. alpigenum*, *O. comosum*, *O. fimbriatum*, *O. lanceolatum*, *O. oligophyllum*, *O. sphaerocarpum* and *O. pyrenaicum*). According to these observations, although subgen. *Beryllis* has palisade parenchyma on its upper side, there is no palisade parenchyma on the lower side. Taxa belong to subgen. *Ornithogalum* do not show any regularity in the presence or absence of a palisade parenchyma. Spongy cells are oval shaped and often broken down in the middle of the leaf. There are very large lacunae in some taxa (*i.e. O. alpigenum*, *O. comosum*, *O. fimbriatum*, *O. lanceolatum*, *O. oligophyllum*, *O. sphaerocarpum* and *O. pyrenaicum*), and some small lacunae (*i.e O. montanum*, *O. armeniacum*, *O. orthophyllum*, *O. umbellatum*, *O. sigmoideum*). Examinations of taxa show that although all taxa of subgen. *Beryllis* have large lacunae, some taxa of subgen. *Ornithogalum* have small, some have large. Lacunae are found among vascular bundles in all taxa.

Vascular bundles are surrounded by 1-2 layered parenchyma cells which close colleteral type, arrange in two rows and larger bundles alternate with smaller ones in the lower row. Sclerenchyma fibers are absent in vascular tissue. Epidermis of all investigated taxa do not have trichomes (Figure 4, a-l) (Table 1). According to studies based on cross section of leaf, it can be assumed that there is a difference between subgenus level but it is hard to distinguish the difference at the level of species.

Scape anatomy

Generally, scape cross sections are almost similar in all investigated taxa; they show common features in scape of monocotyledons. They contain epidermis with cuticle, cortex, stele with vascular bundles and parenchymatic pith. There is a thin cuticular layer. Epidermis is single layered, oval or squarish-shaped in the cross-section. Outer periclinal walls of epidermal cells are thick, while their inner periclinal walls and anticlinal walls are thin.

Cortex is 3-8 layered in investigated taxa. *O. montanum* and *O. pyrenaicum* have thick cortex layer in cross section of scape (7-8 layered); *O. alpigenum* and *O. orthophyllum* have thin cortex (3-4 layered). *O. lanceolatum, O. oligophyllum* and *O. sigmoideum* (4-5 layered); *O. armeniacum*, *O. fimbriatum*, *O. umbellatum* and *O. sphaerocarpum* (5-6 layered); *O. comosum* has 6-7 layered cortex in cross section of scape. It comprises of spherical parenchymatous cells.

The sclerenchyma tissue which is about 2-8 layers is present on the inner side of the cortex in all taxa: *O. alpigenum*, *O. fimbriatum*, *O. oligophyllum*, *O. orthophyllum* and *O. sigmoideum* (2-3 layered); *O. armeniacum*, *O. lanceolatum* and *O. umbellatum* (3-4 layered); *O. comosum* (4-5 layered); *O. montanum* and *O. sphaerocarpum* (5-6 layered); *O. pyrenaicum* has 7-8 layered sclerenchyma cells in cross section of scape. Scapes of all taxa contain about 10-32 layered vascular

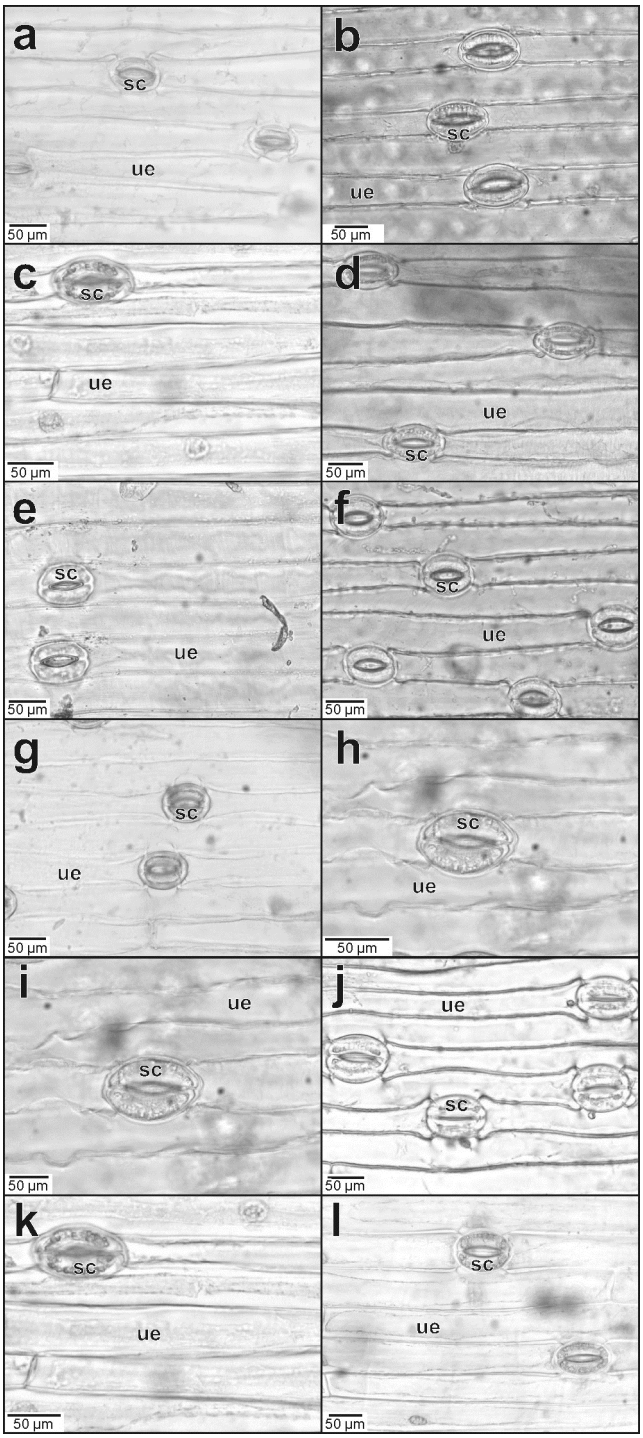

Figure 2. Superficial section of upper epidermis of the examined taxa (a-l): a- *O. alpigenum*, b- *O. armeniacum*, c- *O. comosum*, d- *O. fimbriatum*, e- *O. lanceolatum*, f- *O. montanum*, g- *O. oligophyllum*, h- *O. orthophyllum*, i- *O. umbellatum*, j- *O. sigmoideum*, k- *O. sphaerocarpum*, l- *O. pyrenaicum*, c: stomota cell, ue: upper epidermis.

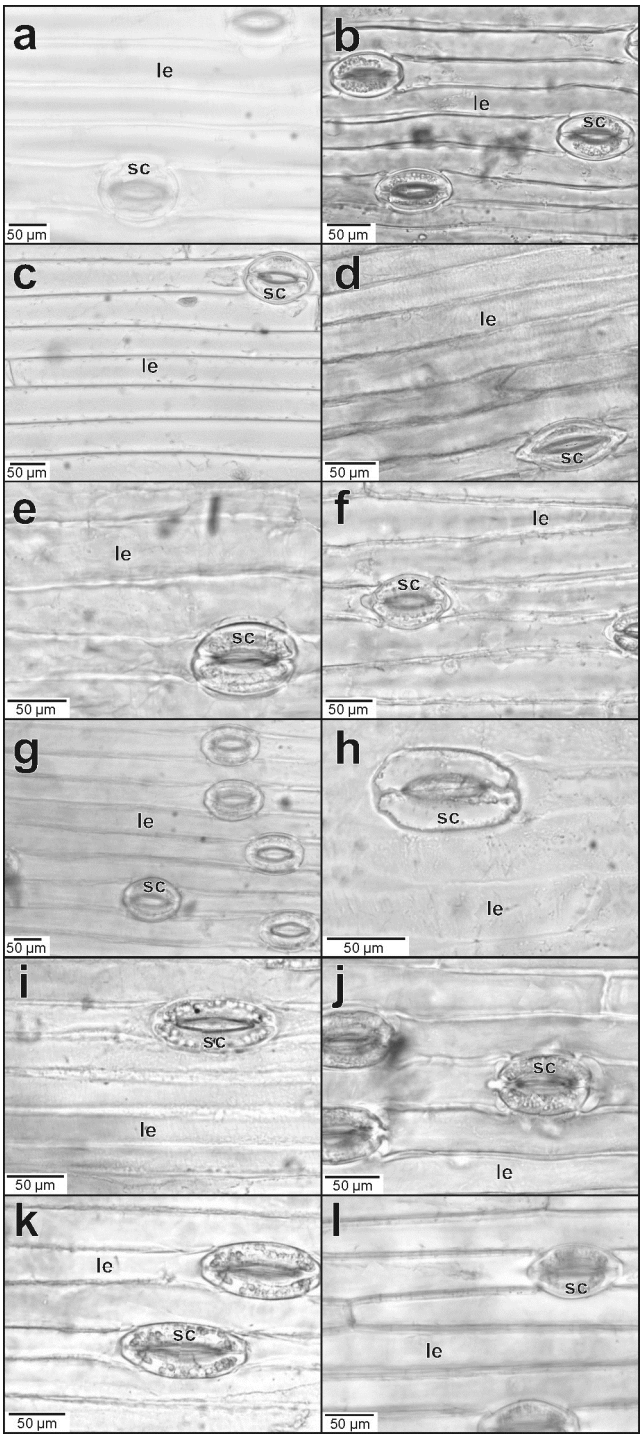

Figure 3. Lower epidermal peelings of the examined taxa (a-l): a- *O. alpigenum*, b- *O. armeniacum*, c- *O. comosum*, d- *O. fimbriatum*, e- *O. lanceolatum*, f- *O. montanum*, g- *O. oligophyllum*, h- *O. orthophyllum*, i- *O. umbellatum*, j- *O. sigmoideum*, k- *O. sphaerocarpum*, l- *O. pyrenaicum*, sc: stomota cell, le: layer epidermis.

bundles in vascular cylinder, *O. alpigenum* (10-14 layered), *O. orthophyllum* (12-16 layered), *O. oligophyllum* (16-18 layered), *O. comosum* (16-20 layered), *O. armeniacum*, *O. lanceolatum*, *O. umbellatum*

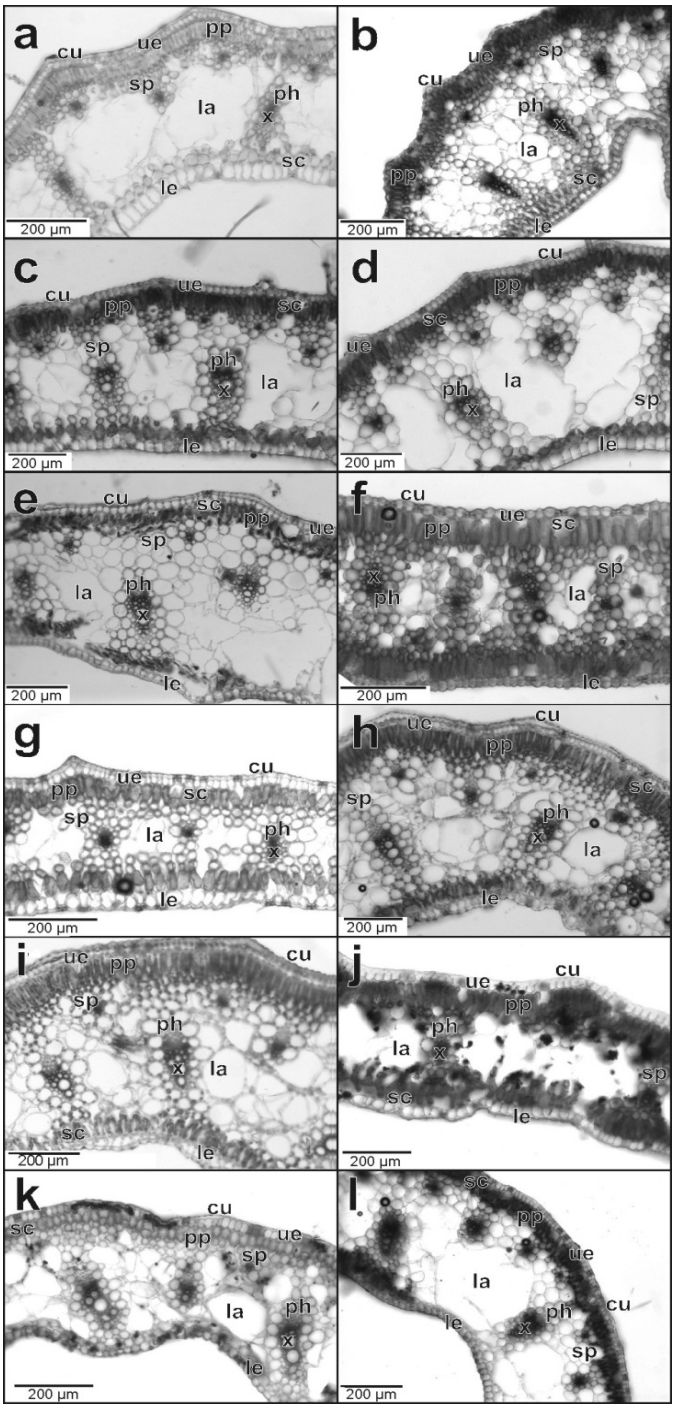

Figure 4. The cross section of the leaf examined (a-l); a- *O. alpigenum*, b- *O. armeniacum*, c- *O. comosum*, d- *O. fimbriatum*, e- *O. lanceolatum*, f- *O. montanum*, g- *O. oligophyllum*, h- *O. orthophyllum*, i- *O. umbellatum*, j- *O. sigmoideum*, k- *O. sphaerocarpum*, l- *O. pyrenaicum*; cu: cuticle, c: cortex, ue: upper epidermis, le: lower epidermis, sp: spongy parenchyma, ph: phloem, x: xylem, sc: stomata cell, la: lacunae.

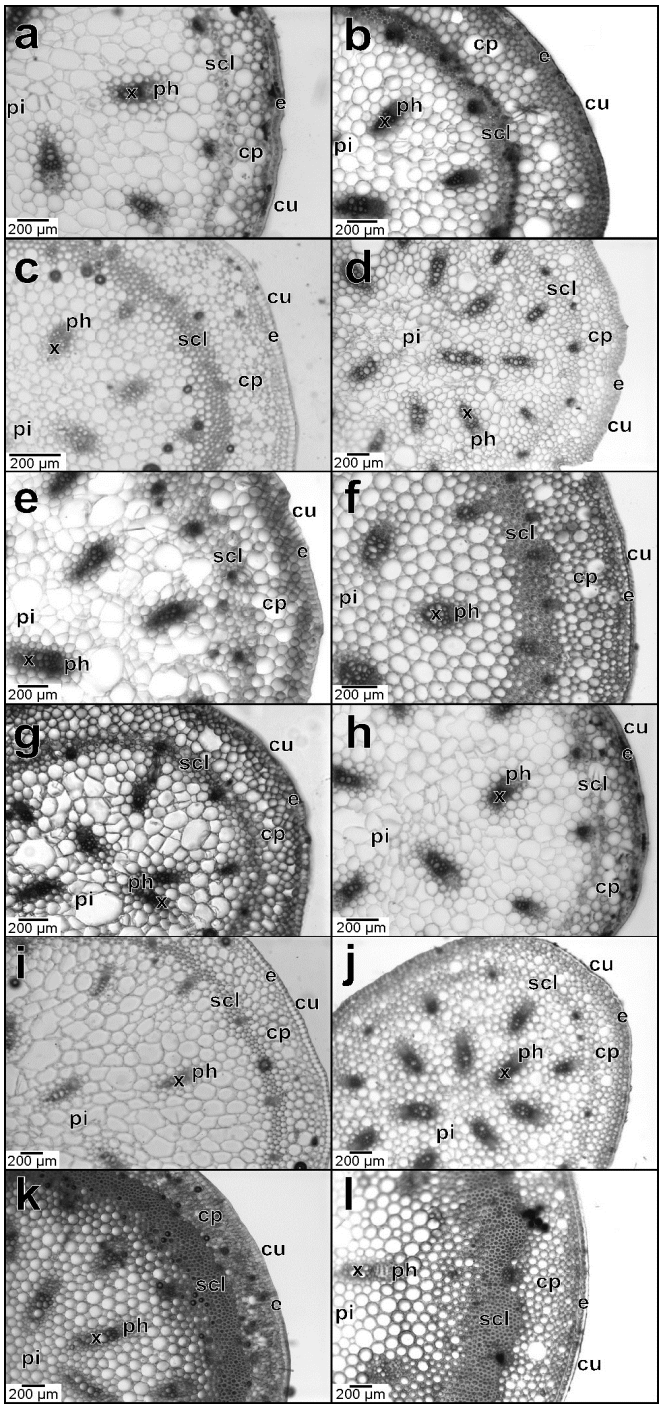

Figure 5. The scape cross sections of the examined taxa (a-l); a- *O. alpigenum*, b- *O. armeniacum*, c- *O. comosum*, d- *O. fimbriatum*, e- *O. lanceolatum*, f- *O. montanum*, g- *O. oligophyllum*, h- *O. orthophyllum*, i- *O. umbellatum*, j- *O. sigmoideum*, k- *O. sphaerocarpum*, l- *O. pyrenaicum*, cu: cuticle, c: cortex, e: epidermis, cp: cortex, parenchymatous, ph: phloem, x: xylem, pi: parenchymatous pith, scl: sclerenchyma.

and *O. sigmoideum* (18-22 layered), *O. pyrenaicum* (20-24 layered), *O. fimbriatum* (22-26 layered), *O. sphaerocarpum* (26-30 layered) and *O. montanum* (28-32 layered). Vascular bundles comprise of xylem and

phloem which show collateral bundles.

In xylem, thickness of spirals and annular rings are observed. Phloem tissue contains sieve and companion cells. The pith consists of parenchymatous cells. Thickness is variable that investigated taxa have scape which is between 3.040 to 5.336 mm in diameter. Measurements of stem diameter show that mean of *O. armeniacum*, *O. sigmoideum* and *O. ortophyllum* have not significant mean (Sig: 0.904, Sig: 1.00, p>0.05) (Table 1). *O. montanum* (3.040 mm), *O. oligophyllum* (3.328 mm), *O. orthophyllum* (3.380 mm), *O. sigmoideum* (3.396 mm), *O. armeniacum* (3.428 mm), *O. alpigenum* (3.560 mm), *O. lanceolatum* (3.812 mm), *O. comosum* (3.920 mm), *O. fimbriatum* (4.000 mm), *O. sphaerocarpum* (4.608 mm), *O. pyrenaicum* (4.852 mm) and *O. umbellatum* (5.336 mm) (Figure 5, a-l, Table 1). Measurements of scape diameter show that taxa of subgen. *Beryllis* have largest scape as compared to members of subgen. *Ornithogalum*. According to these observations, vascular bundle, sclerenchyma layer and cortex layer of subgen. *Beryllis* are larger than taxa of subgen. *Ornithogalum*.

In this study, anatomical properties of 12 *Ornithogalum* species that are distributed in Eskişehir (Central Anatolia) and its environs (10 taxa subgen. *Ornithogalum* and 2 taxa subgen. *Beryllis*) were determined for the first time. While stomatal index of subgen. *Ornithogalum* is 15 to 60 number/mm^2, subgen *Beryllis* is 15 to 25 number/mm^2. Although some members of subgen. *Ornithogalum* have lower palisade parenchyma, all members of subgen *Beryllis* have lower palisade parenchyma. While mesophyll thickness of subgen. *Ornithogalum* ranges from 286 µm to 860 µm, in subgen. Beryllis is 400 µm-445 µm.

Although all taxa of subgen. *Beryllis* have large lacunae, some taxa of subgen. *Ornithogalum* have small lacunae, some have large lacunae. Cortex layer number of subgen. *Ornithogalum* is 3 to 8, in subgen. *Beryllis* is 5-8. Sclerenchyma layer number in subgen. *Ornithogalum* is 2 to 8, in subgen. *Beryllis* is 5 to 8. Vascular bundle number of subgen. *Ornithogalum* is 10 to 32, in subgen *Beryllis* is 20 to 30. Scape diameter of subgen. *Ornithogalum* is between 3.040 mm-5.336 mm, in subgen. *Beryllis* 4.608mm to 4.852mm.

According to observations there are not significant anatomical differences between species as taxonomically. Although there are some differences between the subgenera, these differences are not significant individually.

Together all the characters contribute to classify at subgenus level. All results observed from these studies have accordance with related literature (Martínez-Azorín et al. 2009, 2010a, b, 2011; Meriç et al. 2005; Cullen 1984; Çoskunçelebi et al. 2000, 2002; Manning et al. 2009; Popova and Anastasov 1997; Peruzzi et al. 2007). This study will make contributions to the taxonomy of *Ornithogalum* genus.

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