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ARAŞTIRMA MAKALESİ

A Phytosociological Investigation on Endemic *Quercus vulcanica* Boiss. & Heldr. ex Kotschy at Sultan Mountains (Afyonkarahisar-Turkey)

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Abstract

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Quercus vulcanica Boiss. & Heldr. ex Kotschy communities, which are located at the intersection of Inner Anatolia, Aegean and Mediterranean regions and are spread on Sultan Mountains, have been analyzed syntaxonically. At this research, a new association, called *Lactuca variabilis-Quercetum vulcanicae*, which are localized at northern slope of Seydi Hill, Kapaali Hill and Kalebelen Hill in Sultan Mountains, has been described.

Sultan Dağları'ndaki Endemik *Quercus vulcanica* Boiss. & Heldr. ex Kotschy Üzerine Bir Fitososyolojik Araştırma (Afyonkarahisar-Türkiye)

Anahtar kelimeler **Özet**

Endemik;
Fitososyoloji;
Quercus vulcanica

İç Anadolu, Ege ve Akdeniz Bölgeleri sınırlarında yer alan Sultan Dağları'ndaki *Quercus vulcanica* Boiss. & Heldr. ex Kotschy toplulukları sintaksonomik olarak analiz edilmiştir. Bu araştırmada *Lactuca variabilis-Quercetum vulcanicae* olarak isimlendirilen ve Sultan Dağları'ndaki Seydi Tepe, Kapaali Tepe ve Kalebelen Tepenin kuzey yamaçlarında lokalize olmuş yeni bir bitki birliği tanımlanmıştır.

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1. Introduction

There are 18 oak (*Quercus*) species in Turkey, and *Quercus vulcanica*, called kasnakmeşesi in Turkish, is an endemic for Turkey. *Quercus vulcanica* is present in NT group according to the risk categories of IUCN Ekim et al. (2000). It can reach up to 27 m in height and 137 cm in diameter. Its top is broad Davis (1982). It is one of the economic plants of Turkey Akman (1995). This importance is due to its usage at the wood origin industry because of its high quality properties (covering, floor parquet, board of belt pulley, furniture, building material, tool handle, charcoal) and from the cultural, economic, social advantages of the forests, formed by *Q. vulcanica*, to the people living in Lakes district for decades Gezer et al. (2001).

Several studies have focused on various ecological traits of *Q. vulcanica* (Ünal and Ocakverdi 1991; Kurt et al. 1996; Kargioğlu 2001; Kenar and Ketenoğlu 2016). A number of floral and ecological studies reported the expansion of *Q. vulcanica* in Turkey Ekim (1978); Gökşin (1979); Çetik (1982); Hedge and Yaltırık (1982); Çırpıcı (1985); Avcı (1996); Kargioğlu (2003); Köse and Ocak (2004); (Aydınöz 2004). This species is not present commonly, but forms communities on Kovada-Gökbelenköy (Isparta) (37° 29' 30" N-31° 00' 04" E), Sultan Mountains (Afyonkarahisar) (38° 29' 58" N-31° 16' 02" E), Karadağ (Karaman) (36° 56' 50" N-33° 01' 39" E), Küre Mountains (Kastamonu) (N-41° 53' 46", E-33° 46' 37" and Melendiz Mountains (Niğde) (N-38° 06' 59", E-34° 24' 57") (Figure 1).

They can be rarely seen in Türkmendağı (Kütahya), Murat Dağı (Uşak-Kütahya), Ahırdağı, Kumalar Mountain, Emirdağ (Afyonkarahisar), Ilgaz Mountains (Çankırı), Erciyes Mountain (Kayseri), Şaphane Mountain (Kütahya), Amanos Mountains (Osmaniye), Hasan Mountain (Aksaray) ve Davras Mountain (Isparta). The total area of *Q. vulcanica* is 10-12 thousands hectar in Turkey Avcı (1996). *Q. vulcanica* communities can be found in the mountain layer of Mediterranean at 1300-1800 m. It stands as a mix of *Quercuscerris* L., *Q.*

pubescens Willd., *Q. trojana* Webb, *Acer hyrcanum* Fisch. & C.A. Meyer subsp. *sphaerocoryum* Yalt., *A. platanoides* L., *A. tataricum* L., *A. campestre* L., *Sorbustorminalis* (L.) Crantz var. *torminalis*, *Viburnum lantana* L., *Corylus avellana* L., *Sambucus nigra* L., *Pinus nigra* J.F. Arnold subsp. *pallasiana* (Lamb.) Holmboe var. *pallasiana* and *Cedrus libani* A. Rich. This research aims the investigation on phytosociological structure of *Q. vulcanica*, which naturally spreads on Sultan Mountains.

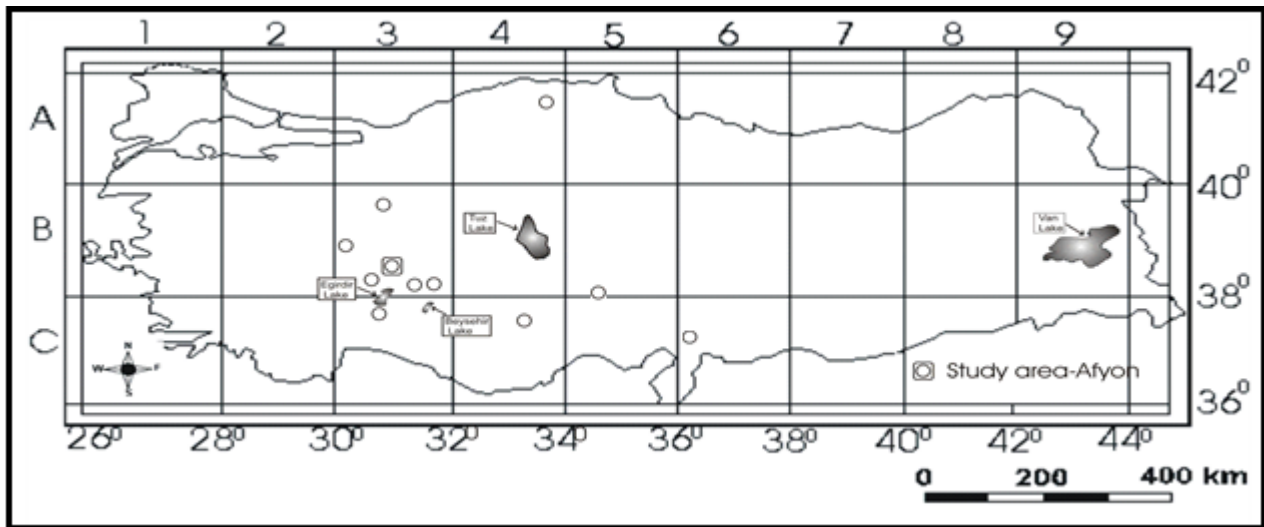


Figure 1. Distribution of *Quercus vulcanica* Boiss. & Heldr. ex Kotschy in Turkey and study area.

2. Materials and Methods

2.1. Distribution of *Quercus vulcanica* in Turkey

Extent of occurrence of *Q. vulcanica* is among Ilgaz Dağı (Kastamonu) 1350–1600 m, Erciyes Dağı (Kayseri) 1300–1850, Türkmendağı (Kütahya) 1300–1800 and Amanos Mountains (Osmaniye) 1300–1700 m in Turkey. The largest populations of *Q. vulcanica* occur mostly in the Kovada-Gökbelenköy (Isparta) 1350–1550 m, Sultan Mountains (Afyonkarahisar) 1500–1800, and Karadağ (Karaman) 1750–2000 m of Turkey (Çetik 1982; Hedge and Yaltirik 1982; Yaltirik 1984; Çırpıcı 1985) (Figure 1).

Usually, *Q. vulcanica* presents between 1200–1800 m altitudes but it can be seen at 2000 m altitudes in Karadağ (Karaman) at 2000 m. Although this species is located on limestone, it can be found on

volcanic bedrocks in Karadağ (Karaman), Erciyes Mountain (Kayseri-Hacılar), Hasandağı (Aksaray), and Kumalar Mountain (Afyonkarahisar) (Çetik 1982; Ocakverdi and Ünal 1991; Avcı 1996; Kargioğlu 2001).

2.2. A brief description of the area

The study area is within the boundary of Afyonkarahisar province in the Sultandağı Town. The research area falls within B₃ square of the grid system adopted by Davis (1965-1985) and Davis et al. (1988). Sultan Mountains is located at the boundary of Inner Anatolia, Aegean and Mediterranean as three geographical regions. Sultan Mountains seems like a part of Toros mountains, that extends through SE-NW direction. Sultan Mountains produces a continuous chain with its 100 km length and 14-20 km width. Its average height is 1900-2000 m and its highest point is

Gelincikana hill with 2610 m. There are Akşehir and Eber Lakes at the north and northeast of Sultan Mountains.

The study area consist of three hills: Seydi hill (1950 m), Kapaali hill (1500 m) and Kalebelen hill (1820 m) (Figure 2).

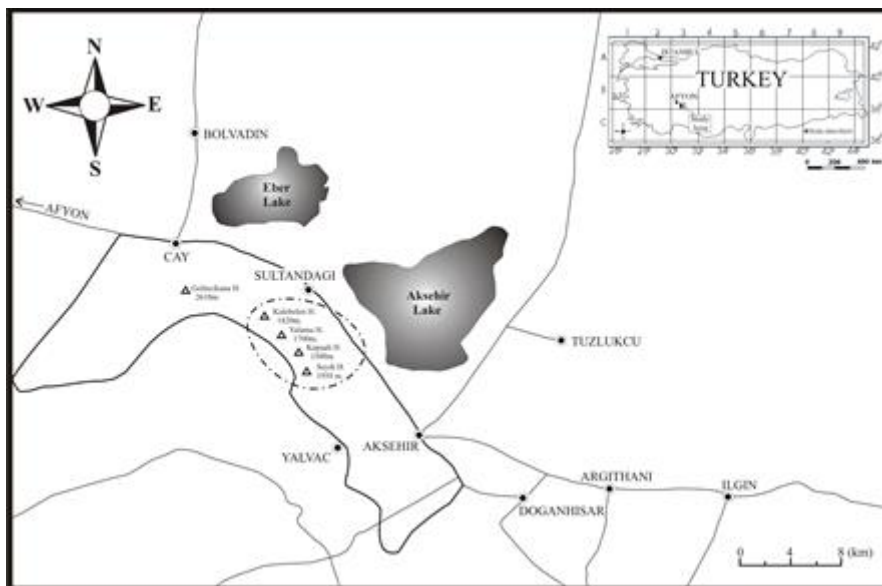


Figure 2. The location map of the research area.

Vegetation type was described in the field, and an association table was constructed using the traditional methods of Braun-Blanquet (1964). The size of the quadrants were estimated by means of a “minimal area” that was 400 m² in all quadrants.

The ecological data was placed at the top of each quadrant forming phytosociological table. Plant association was named according to phytosociological nomenclature Weber et al. (2000). The flora of Turkey Davis (1965-1985); Davis et al. (1988); Güner et al. (2000) was used in the identification of the specimens. Author abbreviations follow Brummit & Powell (1992). The climatic data for the area were obtained from the Akşehir meteorological station State Meteorological Institute (2000). A Mediterranean

climate is present in the study area and its precipitation regime is of the East Mediterranean Type 1 WSAS (winter, spring, autumn, summer) Akman (1982). In the research area, the annual mean temperature is 11.9 °C. The maximum mean temperature (M) is 40.5 °C in August. The minimum mean temperature (m) is -26.7 °C in December. The climatic data are given in Tables 1a, 1b. Soil specimens were taken from representative areas where the plant community was best represented. The Soil and Fertilizer Research Institute analyzed these soil samples using the methods of Bouyoucos (1962), Olsen Black et al. (1965) and Smith and Weldon (1941). The soil analysis results of this plant association are given in detail in Table 2.

Table 1a. The average and extreme climatic values belonging to Akşehir 1947 to 2000.

Meteorological elements	Obs. Per. (years)	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Mean Temp. (°C)	44	1.2	2.5	5.9	11.2	15.8	19.6	22.5	22.4	18.4	12.7	7.9	3.2	11.9
Max. mean temp. (°C)	45	18.0	19.2	26.2	30.0	34.0	35.0	39.0	40.5	34.9	31.1	25.6	20.6	40.5
Min. mean temp. (°C)	45	-24.4	-19.0	-16.1	-7.5	-0.2	2.6	6.0	5.6	0.6	-4.7	-18.6	-26.7	-26.7
Mean rainfall (mm)	53	82.5	70.4	74.8	68.2	62.2	48.1	16.9	11.5	22.0	47.2	56.5	77.4	637.7

Obs.: Observation, Per.: Period, Temp.: Temperature, Max.: Maximum, Min.: Minimum

Table 1b. Seasonal distribution of rainfall.

Station	Observation period	Spring total (mm)	Summer total (mm)	Autumn total (mm)	Winter total (mm)	Yearly (mm)
Akşehir	53	205.2	76.5	125.7	230.3	637.7

Table 2. Results of the physical and chemical analysis of the soils from the associations' plots.

Quadrat No	Soil Depth cm	Satur. %	PH	Total Salt %	CaCO ₃ %	Organic Matter %	P ₂ O ₅	K ₂ O kg	Sand %	Silt %	Clay %	Text.
1	0-30	59	5,56	0,010	0,88	1,68	1,83	50,13	45,69	23,66	30,65	SCL
	30-50	55	5,62	0,010	1,03	2,24	1,37	29,81	51,95	19,53	28,52	SCL
7	0-30	59	7,33	0,020	0,90	1,71	1,15	88,72	49,68	21,66	28,66	SCL
	30-60	68	7,48	0,020	1,05	0,09	1,15	40,65	41,30	21,75	36,96	CL
11	0-30	55	5,30	0,010	1,03	0,41	1,37	70,46	55,89	23,64	20,47	SCL
	30-60	59	5,53	0,010	0,88	1,80	0,46	84,01	49,75	25,69	24,55	SCL
12	0-30	72	5,24	0,020	0,74	5,14	1,15	81,30	50,76	24,16	25,07	SCL
	30-60	68	5,99	0,069	1,33	1,83	1,15	56,91	48,04	16,06	35,90	SC

C: Clayey, L: Loamy, S: Sandy, Satur.: Saturation, Text.: Texture

3. Results

Q. vulcanica has a spread between 1200-1800 m at the northeast slopes, looking to Akşehir lake. It stands as a mix of *Quercus cerris* L., *Q. pubescens* Willd., *Q. trojana* Webb, *A. platanoides* L., *A. tataricum* L., *Viburnum lantana* L., *Corylus avellana* L., *Pinus nigra* J.F. Arnold subsp. *pallasiana* (Lamb.) Holmboe var. *pallasiana* at 1200-1400 m of Yalama hill. ***Q. vulcanica***, which becomes dominant higher points, forms pure and large communities at height 1500-1800 m of Kalebelen hill, Seydi hill and Kapaali hill. Their heights become up to 15 m at dense places, sub-branches are less developed and stems are thinner. After 1880 m *Juniperus communis* L. var. *saxatilis* Pall., *Astracanthamicrocephala* (Willd.) Podlech and *Acantholimon puberulum* Boiss. & Balansa steppe communities are located.

Cicerbitovariabil-

Quercetum vulcanicae ass. *nova* (Table 3)

Holotype

Table 3, quadrat No 6.

This community which does not display a tremendous distribution in Turkey, is common in the subject area at 1500-1800 m of elevation, on slopes with 15-40 % inclination. *Q. vulcanica* community spreads on calcareous bedrocks and brown forest soils in the study area. Physical and chemical properties of the soil samples are presented in table 2. The soils of the association are sandy-clayey and loamy (SCL), clayey and loamy (CL), sandy and clayey in texture (SC) and have a mid-level asidic character. Organic matter is lower-level. The association is characterized by *Quercus vulcanica*, *Galium album* Mill. subsp. *pycnotrichum* (Heinr. Braun) Krendl and *Lactucavariabilis* Bornm. species. This plant community has been described in twelve sample quadrats.

This plant association comes from three layers of tree shrub and herb layer. *Quercus vulcanica* is dominant in the tree layer and at the same time

characteristic of this association. The general coverage of the tree layer is 80-100%, and their height varies between 10-15 m. The shrub layer consists of the following plant species: *Cytisushirsutus* L., *Juniperus communis* var. *saxatilis*, *J. oxycedrus*, *Viburnum lantana*, *Euonymus latifolius* (L.) Mill., *Lonicera caucasica* Pall. *J. communis* var. *saxatilis*. These species are dominant species of shrubs. The overall coverage of the shrub layer ranges from 10 to 30% and the height ranges from 30 to 50 cm.

The general cover of the herb layer is between 10-60 %, and between 20-35 cm in height. The order

QUERCO-CARPINETALIA ORIENTALIS are represented by *Cytisushirsutus* L. and *Laser trilobum* (L.) Borkh. In the association, there exist many species belonging to the order QUERCO-CEDRETALIA LIBANI and class QUERCETEA-PUBESCENTIS and upper class QUERCO-FAGEA. Therefore, this association is included in the order QUERCO-CEDRETALIA LIBANI of class QUERCETEA-PUBESCENTIS and upper class QUERCO-FAGEA. However, this association is not represented at the alliance. So, we are not put in any alliance.

Table 3. *Lactuca variabilis*-*Quercetum vulcanicae* ass. nov.

Quadrat No	1	2	3	4	5	6	7	8	9	10	11	12	PRESENCE	
Area (m ²)	400	400	400	400	400	400	400	400	400	400	400	400		
Altitude (m)	1750	1760	1740	1750	1800	1780	1760	1750	1500	1750	1640	1620		
Inclination (%)	25	20	30	20	15	15	15	25	40	25	30	30		
Exposition	NW	W	W	W	NW	S	E	E	N	N	NE	N		
Cover of the trees (%)	90	80	90	90	90	100	100	100	90	90	100	100		
Cover of the shrubs (%)	15	10	15	10	30	30	15	15	15	20	-	-		
Cover of the herbs (%)	60	60	40	30	30	20	20	20	20	30	10	20		
Bedrock	Calc	Calc	Calc	Calc	Calc	Calc	Calc	Calc	Calc	Calc	Calc	Calc		
Characteristics species of association														
<i>Quercus vulcanica</i>	4/4	3/3	4/4	4/4	5/5	5/5	5/5	5/5	4/4	4/4	5/5	5/5	V	
<i>Galium album</i> subsp. <i>pycnotrichum</i>	.	+1	+1	+1	+1	+1	+1	+1	+1	+1	.	+1	V	
<i>Lactuca variabilis</i>	.	.	+1	.	.	+1	+1	+1	.	.	.	+1	III	
<i>Bupleurum falcatum</i> subsp. <i>polyphyllum</i>	.	.	+1	.	+1	+1	.	.	.	.	.	.	II
Characteristics species of Quercus-Carpinetalia orientalis order														
<i>Cytisushirsutus</i>	+1	+1	.	+1	.	+1	.	.	.	+1	+1	.	III	
<i>Laser trilobum</i>	.	.	.	.	.	.	.	.	.	.	+1	+1	I
Characteristics species of Quercus-Cedretalia libani order														
<i>Vicia cracca</i> subsp. <i>stenophylla</i>	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	.	V	
<i>Quercus cerris</i>	.	.	+1	+1	.	+1	.	.	+1	+1	.	.	III	
<i>Juniperus excelsa</i>	.	.	+1	.	.	+1	+1	.	.	.	+1	+1	III	
<i>Cerastium fragillimum</i>	.	+1	.	.	.	+1	.	.	+1	.	.	.	II	
<i>Trifolium caudatum</i>	.	+1	.	.	.	.	+1	.	.	.	.	.	I
<i>Piptatherum holciforme</i>	.	.	.	.	.	.	+1	.	.	.	.	.	I
<i>Paeonia mascula</i>	.	.	.	.	.	.	.	.	+1	.	.	.	I
Characteristics species of Quercetea pubescentis and Quercus-Fagea														
<i>Frageria vesca</i>	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	V	
<i>Primula vulgaris</i>	+1	+1	+1	+1	+1	.	+1	+1	+1	+1	+1	+1	V	

<i>Lathyrus laxiflorus</i>	+1	+1	+1	+1	+1	+1	+1	+1	.	+1	.	+1	V
<i>Juniperus communis</i>	+2	+2	+2	+2	1/2	½	+2	1/2	+2	+2	.	.	V

Table continues on the next page

Table continuing from the previous page

<i>Clinopodium vulgare</i>	+1	.	+1	+1	.	+1	+1	.	+1	.	+1	+1	IV
<i>Anthriscus nemorosa</i>	+1	+1	.	.	.	.	+1	+1	+1	+1	+1	+1	IV
<i>Astrantia maxima</i> subsp. <i>haradjiani</i>	+1	.	+1	.	.	.	.	+1	.	.	+1	+1	III
<i>Trifolium medium</i>	.	+1	.	.	+1	+1	+1	.	+1	.	.	.	III
<i>Doronicum orientale</i>	+1	+1	+1	.	.	.	.	.	.	+1	.	.	II
<i>Veronica chamaedrys</i>	.	+1	.	+1	+1	.	+1	.	.	.	.	.	II
<i>Geum urbanum</i>	+1	+1	+1	.	.	.	.	+1	.	.	.	.	II
<i>Juniperus oxycedrus</i> subsp. <i>oxycedrus</i>	.	.	.	.	+1	.	+2	.	+1	+2	.	.	II
<i>Silene italica</i>	+1	+1	.	.	+1	.	.	.	.	.	+1	.	II
<i>Epipactis helleborine</i>	.	+1	.	.	.	.	.	.	.	+1	.	.	I
<i>Poa nemoralis</i>	.	.	.	.	.	.	.	.	.	.	+2	+2	I
<i>Digitalis ferruginea</i>	.	.	.	.	.	.	.	.	+1	.	+1	.	I
<i>Viola sieheana</i>	.	.	+1	.	.	.	.	.	.	.	.	+1	I
<i>Solidago virgaurea</i>	.	.	.	.	.	.	.	+1	+1	.	.	.	I
<i>Myosotis alpestris</i>	.	.	.	.	+1	+1	.	.	.	.	.	.	I
<i>Viburnum lantana</i>	.	.	.	.	.	.	.	.	.	+1	+1	.	I
<i>Sorbus torminalis</i>	.	.	.	.	.	.	.	.	.	.	.	+1	I
<i>Euonymus latifolius</i>	.	.	+1	.	.	.	.	.	.	.	.	.	I
<i>Coronilla varia</i>	.	.	.	.	.	.	.	.	.	.	+1	.	I
<i>Petrorhagia alpinas</i> subsp. <i>olympica</i>	.	.	.	.	.	.	+1	.	.	.	.	.	I
<i>Tanacetum parthenium</i>	.	.	.	.	.	.	.	.	.	.	.	+1	I
<i>Hypericum perforatum</i>	.	.	.	.	+1	.	.	.	.	.	.	.	I
<i>Brizamedia</i>	.	.	.	+1	.	.	.	.	.	.	.	.	I
Companions													
<i>Thymus longicaulis</i> subsp. <i>chaubardii</i>	+2	+2	+2	+2	+2	+2	.	.	+2	+2	+2	.	IV
<i>Dactylis glomerata</i>	+1	+1	.	+1	+1	+1	+1	+1	+1	.	+1	.	IV
<i>Ranunculus brutius</i>	.	+1	+1	+1	.	+1	.	.	+1	.	+1	+1	III
<i>Galium aparine</i>	.	+1	+1	.	.	.	+1	.	+1	+1	+1	+1	III
<i>Arrhenatherum palaestinum</i>	.	+1	.	+1	+1	.	+1	+1	.	+1	.	.	III
<i>Silene vulgaris</i>	.	.	.	.	.	+1	+1	.	.	.	+1	+1	II
<i>Trifolium ochroleucon</i>	+1	+1	.	+1	+1	.	.	.	.	.	.	.	II
<i>Rumex nepalensis</i>	.	.	.	.	.	.	.	+1	.	.	+1	+1	II
<i>Polygonatum orientale</i>	.	.	.	.	.	.	.	.	.	.	+1	+1	I
<i>Hypericum orientale</i>	.	.	.	.	+1	+1	.	.	.	.	.	.	I
<i>Physospermum cornubiense</i>	.	.	.	.	.	.	.	.	.	.	+1	+1	I
<i>Lonicera caucasica</i>	.	.	.	.	.	.	.	.	+1	.	.	.	I
<i>Arabis sagittata</i>	.	.	.	.	+1	.	.	.	.	.	.	.	I
<i>Trifolium arvense</i>	.	.	.	+1	.	.	.	.	.	.	.	.	I
<i>Sedum album</i> caule	.	.	.	.	.	+1	.	.	.	.	.	.	I
<i>Asyneum amichauxioides</i>	.	.	.	.	.	.	.	.	+1	.	.	.	I

4. Discussion and Conclusion

Quercus vulcanica communities have been spread at Sultan Mountains Mediterranean mountain layer. Research area is located at the transition zone of Mediterranean and Irano-Turanian flora regions due to phytogeography. Yet, in the community many plants belonging to Euro-Siberian flora have been developed. The reason can be explained in such a way: Sultan Mountains avoids, extending in SE-NW direction with an average height of 1900-2000 m, the forwarding of the weather masses from N and NE. Besides Akşehir and Eber lakes, staying in north and northeast, produce local climate conditions. For this reason, the north slopes of Sultan Mountains have more moist, cooler conditions and more precipitation. As a result, on northern slopes many species, belonging to Euro-Siberian phytogeographic area, have been spread. Some of these species; *Galium album* subsp. *pycnotrichum*, *Primula vulgaris* Huds., *Veronica chamaedrys* L., *Geum urbanum* L., *Digitalis ferruginea* L., *Viburnum lantana*, *Euonymus latifolius*, *Polygonatum orientale* Desf., *Sorbus torminalis* (L.) Crantz var. *torminalis* and *Bupleurum falcatum* L. subsp. *polyphyllum* (Ledeb.) Wolff. An association (***Dianthocibrarii-Quercetum vulcanicae***) similar to the association viewed above, was sampled by Kurt et al. (1996) at Gökbelenköy-Isparta. Then, it was situated in the order QUERCO-CEDRETALIA LIBANI, class QUERCETEA PUBESCENTIS. Another *Quercus vulcanica* association (***Quercetum vulcanicae*** ass. nova) is described in the Melendiz Mountains. This union was included by researchers to the QUERCETEA PUBESCENTIS (Oberd 1948) Doing Kraft 1955 class, QUERCO CERRIDIS-CARPINETALIA ORIENTALIS Quézel, Barbéro et Akman 1980 order and QUERCION ANATOLICAE Akman, Barbéro et Quézel 1979 alliance (Kenar and Ketenöglü 2016). *Quercus vulcanica* have spread on northern slopes and calcareous main rock of not only Sultan Mountains but also other places like (Karadağ-Konya, Gökbelenköy-Isparta, Kumalardıği-Afyonkarahisar, Türkmen dağı-Kütahya). Forming community of this species in such sites and the including of many species belonging to Euro-

Siberian phytogeographic area shows that ***Q. vulcanica*** prefers moist and cool places.

Usually class of QUERCETEA PUBESCENTIS have been spread around Mediterranean. Yet, they have been spread at North Anatolia and black sea region which has Euro-Siberian phytogeographic origin. This class is divided into two orders in terms of geographic conditions. QUERCO-CARPINETALIA ORIENTALIS and QUERCO-CEDRETALIA LIBANI. The order of QUERCO-CARPINETALIA ORIENTALIS includes forest communities, which throw out their leaves and which belong to Turkey's upper Mediterranean layer Akman et al. (1978). This order is represented by the species of *Cytisus hirsutus* and *Laser trilobum* within the association of *Quercus vulcanica*. Outside of the QUERCO-CARPINETALIA ORIENTALIS, the order of QUERCO-CEDRETALIA LIBANI includes community of forest which was situated up Mediterranean layer and Mediterranean mountain layer. In the association defined too, there exist many species belonging to order QUERCO-CEDRETALIA LIBANI, class QUERCETEA PUBESCENTIS. Geographical distribution, characteristic and dominant species being considered, this association has been classified into the upper divisions mentioned above.

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