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Phytosociological investigations of steppe and steppe forest vegetation in the south-east part of Central Anatolia of Turkey

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Abstract: To gain a better understanding of the ecological systems, it is necessary to study the development, composition, and classification of the steppe and steppe forest communities, which are the primary components of phytocoenoses in semi-arid environments. Therefore, this study was aimed to contribute to a syntaxonomic classification of the Central Anatolian steppe and *steppe* forest vegetation. The Braun–Blanquet approach was used to analyze the vegetation of the study area in Göllüdağ (2172 m a.s.l.) located in the north of Niğde province. The vegetation data were analyzed using cluster analysis and detrended components analysis. The relationships between the communities and certain environmental factors were examined by principal components analysis. Two new steppe and steppe forest communities in Central Anatolia were classified in this study. The steppe communities were included in *Agropyro tauri-Stachydion lavandulifoliae* and *Astragalo-Brometalia*, whereas the steppe forest communities were classified as *Quercion anatolicae* and *Querco cerridis-Carpinetalia orientalis.*

Key words: Göllüdağ, steppe, oak scrubs, phytosociology, syntaxonomy

İç Anadolu'nun Güneydoğu kesiminde step ve step bitki örtüsü ile ilgili fitososyolojik araştırmalar

Özet: Ekolojik sistemlerin daha iyi anlaşılması için yarı kurak ortamlardaki fitosenözlerin temel bileşenlerinden olan step ve step ormanı komünitelerinin gelişimi, yapısı ve sınıflandırılmasının araştırılması gerekmektedir. Bu nedenle çalışmada, İç Anadolu step ve step ormanı vejetasyonunun sintaksonomik olarak sınıflandırılmasına katkı sağlaması amaçlanmıştır. Niğde ilinin kuzeyinde bulunan Göllüdağ'da bulunan araştırma alanının vejetasyonu Braun-Blaunquet metoduna göre analiz edilmiştir. Vejetasyon verilerinin analizi, kümeleme ve Eğilimsiz Uyum Analizi ile gerçekleştirilmiştir. Komüniteler ile bazı çevresel faktörler arasındaki ilişki Temel Bileşen Analizi yardımıyla incelenmiştir. Çalışmada İç Anadolu'da iki yeni step ve step ormanı komünitesi tespit edilmiştir. Step komünitesi *Agropyro tauri-Stachydion lavandulifoliae* alyansına ve *Astragalo-Brometalia* ordosuna dâhil edilirken, step ormanı komünitesi *Quercion anatolicae* alyansına ve *Querco cerridis-Carpinetalia orientalis* ordosu içerisinde sınıflandırılmıştır.

Anahtar Kelimeler: Göllüdağ, step, meşe çalılığı, fitososyoloji, sintaksonomi.

1. INTRODUCTION

The vegetation of Central Anatolia is characterized by steppe and *Quercus*-dominated forests. The fluctuation in climate in time allowed woodlands and forests expanded and also displaced occasionally steppe which was formerly present in Central Anatolia (Aytuğ and Görecelioğlu, 1996; Cordova, 2005). The alteration of vegetation was mostly caused by climate change until the end of Late Glacial (10,000 BP), however; the human impact has been the most important factor on alteration of vegetation recently (Bottema, 1993). The destruction of these forests by human activity progressively caused the settlement of the pre-steppe formations in Central Anatolia and the *Quercus*-dominated forests transformed into small shrubs (Akman, 1974). Therefore, *Quercus*-dominated scrub-woodlands are

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blended with steppe vegetation in Central Anatolia at present. The pollen records indicate that although the vegetation of Central Anatolia was composed of the woodlands of *Quercus* L. sp., *Pistacia terebinthus* L., and *Juniperus* L. sp., the woodland vegetation was replaced by predominantly open grasslands due to human settlement over the last two millennia (Asouti, 2009; Baş, 1968; England et al., 2008). On the other hand some studies are indicated that the communities of wild orchards and conifers might be present before oak woodland vegetation in the region (Aytuğ, 1970; Hopf, 1992; Woldring and Bottema, 2003).

The steppe of Central Anatolia has rich floristic composition and is composed of different plant communities depending on different physical and chemical structure of the bedrock and elevation (Kurt et al., 2015). The Central Anatolian steppe can be physionomically grouped as *Gramineae* steppes, malacophyll steppes, tragaganthic, and salty steppes. *Gramineae* species such as *Bromus tomentellus* Boiss., *Festuca valesiaca* Schleich ex. Gaudin, *Stipa lessingiana* Trin. & Rupr., *Koeleria cristata* L. (Bertol.) are dominant in *Gramineae* steppes that are very scarce today. Malacophyll steppes are dominated by the broad-leaved plants in consequence of alteration of *Gramineae* steppes due to grazing. Tragaganthic steppes have the dominant species such as *Astragalus* L. sp. and *Acantholimon* L. sp. which are pulvinate chamaephytes having cushion forms and spines. Salty steppes spread on salty soils and marshes and include the halophytic species in the floristic composition (Kurt et al. 2006). The drainage of these salty areas (Salt Lake, Seyfe Lake, Sultansazlığı) which are under the influence of semi-arid or arid, very cold Mediterranean climate are damaged in the region. The salt concentration in soil and the limits of species against salt tolerance are the most important factors forming the zones of salty areas (Aksoy and Hamzaoğlu, 2006).

The steppe vegetation in Anatolia is included in the class *Astragalo-Brometea* Quézel 1985. The lowland steppe vegetation (800-1200 m a.s.l.) is classified in the orders *Onobrychido armenae–Thymetalia leucostomi* Akman, Ketenoğlu & Quézel 1985 and *Hyperico linarioidis–Thymetalia scorpilii* Akman, Quézel, Yurdakulol, Ketenoğlu & Demirörs 1987; the high mountain steppe vegetation (above 1200m a.s.l.) is classified in *Astragalo–Brometalia* Quézel 1973 and *Drabo–Androsacetalia* Quézel 1973 in Anatolia.

Quercus pubescens Willd. is the most common woody species in the region. It occurs as a shrub form in destructed areas. The more humid climatic conditions support the co-existence of *Q. robur* L., *Q. cerris* L. and, *Q. trojana* Webb. locally (Kirwan et al., 2010). *Quercus*-dominated forest communities in Central Anatolia is included in the alliance *Quercion anatolicae* Akman, Barbéro & Quézel 1979 and in the order *Querco cerridis-Carpinetalia orientalis* Quézel, Barbéro & Akman 1980 of the class *Quercetea pubescentis* (Oberd. 1948, Doing- Kraft 1955) Scamoni & Passarge 1959.

The steppe is one of the most important ecosystems including unique plant and animal species in Turkey as well as in the world. The composition of steppe has changed dramatically due to overgrazing, deforestation, and intensive agricultural activities for last thirty years in Central Anatolia (Akman et al., 2014). Therefore, the Central Anatolian steppe is under risk today and must be one of the primary conservation areas. The first step of the conservation studies is composed of the determination of the structure and process of the steppe ecosystem. Thus, syntaxonomic units of the Central Anatolian steppe and steppe forest vegetation are needed to find out. Some phytosociological studies have been done especially in steppe and steppe forest vegetation of Central Anatolia until today. (Adıgüzel and Vural, 1995; Kılınç, 1985; Ocakverdi and Ünal, 1991; Şanda and Küçüködük, 2000; Vural et al., 1995). Within the scope of this paper, it is aimed to determine of phytosociology of the particular area comprising steppe and steppe forest vegetation in the south-east part of Central Anatolia.

1.1 A brief description of the area

Göllüdağ (2172 m a.s.l.) is an inactive volcano near the village of Kömürcü in the north of Niğde province (Figure / Şekil 1). A crater lake is located at the summit of the mountain. The major soils occurring in the study area are regosols and brown soils without non-calcareous (Dizdar, 2003). The study area has a lower semi-arid very cold Mediterranean climate that mostly characterizes Central Anatolian climate. The steppe vegetation corresponds to the climatic conditions of the region which are cold winters with frost periods and dry hot summers. The seasonal precipitation regime is spring, winter, autumn, and summer. The average annual rainfall in the region varies between 336.4 and 345.7 mm and the average annual temperature about 11.1 and 12.1°C (Table / Tablo 1 and 2). Considering that ombrothermic diagram of Aksaray meteorological station, it is seen that there is a dry period from the begining of June to the mid-October (Figure / Şekil 2).

Figure 1. The study area including points of relevé locations
Şekil 1. Releve konumlarını içeren araştırma alanı

Table 1. The average and extreme climatic values of Aksaray in the period from 1950 to 2015
Tablo 1. 1950- 2015 yılları arasında Aksaray ilinin ortalama ve ekstrem iklimsel değerleri

	Months												
Meteorological parameters	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Mean**
Mean temperature (C°)	0.5	2	6.5	11.5	16.2	20.4	23.8	23.2	18.6	13	6.9	2.5	12.1
Max. mean temp. (C°)	5.4	7.2	12.4	17.9	22.8	27	30.5	30.4	26.5	20.6	13.5	7.6	18.5
Min. mean temp. (C°)	-3.6	-2.4	1.2	5.5	9.5	12.9	16	15.6	11.1	6.6	1.7	-1.6	6.04
Mean rainfall (mm)	38.6	34	40.2	46.9	40.8	25.2	6.1	3.8	8.4	26.1	32.2	43.4	345.7

Table 2. The average and extreme climatic values of Niğde in the period from 1950 to 2015
Tablo 2. 1950- 2015 yılları arasında Niğde ilinin ortalama ve ekstrem iklimsel değerleri

	Months												
Meteorological parameters	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Mean**
Mean temperature (C°)	-0.3	1	5.1	10.6	15.1	19.3	22.6	22.3	17.9	12.1	6.1	1.7	11.1
Max. mean temp. (C°)	4.9	6.3	11	16.7	21.3	25.6	29.3	29.4	25.6	19.5	12.8	7.1	17.5
Min. mean temp. (C°)	-4.5	-3.6	-0.1	4.5	8.3	11.8	14.8	14.4	10.3	5.9	1.1	-2.6	5.02
Mean rainfall (mm)	31.8	33.3	36	43.2	49	28.2	4.8	4.4	8.7	26.7	30.9	39.4	336.4

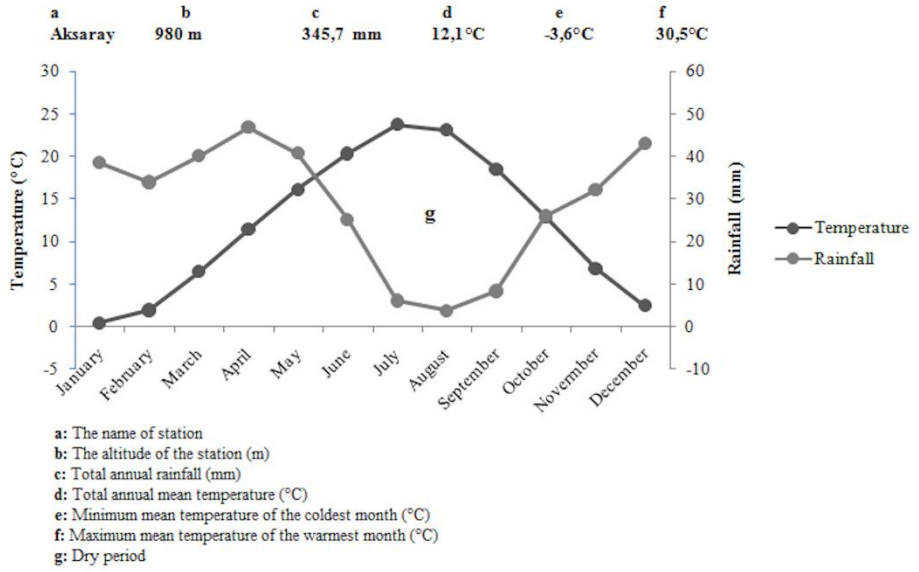

Figure 2. The ombrothermic diagram of Aksaray meteorogical station
Şekil 2. Aksaray istasyonunun ombrotermik diagramı

2. MATERIALS AND METHOD

The vegetation was sampled according to the method of Braun-Blaunquet (Braun-Blanquet, 1964). The sizes of the relevés were estimated by means of a "minimal area" that was 8 × 8 m^2 for steppe and 17 × 17 m^2 for scrub-woodland vegetation. 31 relevés were recorded between 1700 and 2100 m a.s.l. in floristically and physiognomically homogenous habitats.

The data were stored in a TURBOVEG database (Hennekens and Schaminée, 2001). The classification of data was carried out with cluster analysis and Detrended Components Analysis (DCA) using Ward's method and the Euclidean distance measure in the PC-ORD 5.0 and R-Project 2.10.1 (Anonymous, 2009; McCune and Mefford, 1999). Diagnostic species of the clusters were determined in the JUICE 7.0 software (Tichý, 2002). The threshold degrees of fidelity were subjectively selected as 0.35 for steppe and 0.70 for scrub-woodland vegetation. The results of the classification were given in relevé tables. The relationship between the communities and some ecological factors are examined by Principal Components Analysis (PCA) using the vegan package in R-Project (Anonymous, 2009).

The Flora of Turkey and The East Aegean Islands (Davis, 1965-1985) and The Checklist of the Flora of Turkey - Vascular Plants (Güner et al., 2012) were used to identify the specimens. The rules of the International Code of Phytosociological Nomenclature (Weber et al. 2000) were followed in naming the new syntaxa. Climatic data were provided by Turkish State Meteorological Service (www.mgm.gov.tr). Life forms were defined according to (Raunkiaer, 1934).

Soil samples were obtained from the top 30 cm of the soil profile in the sample plots representing the different plant formations. Particle-size measurement (Bouyoucos, 1962), organic matter measurement (Walkley and Black, 1934), plant-available soil phosphorus spectrophotometrically (Olsen, 1954), NaCl and pH (Tüzüner, 1990), $CaCO_3$ (calsimetric method), and potassium (ammonium acetate flame photometer method) were performed for the analysis of the soil samples.

3. RESULTS AND DISCUSSION

The *Asphodelino damascenae-Quercetum pubescentis* which resides in scrub-woodland vegetation and the *Ziziphoro clinopodioidis-Festucetum valesiacae* belonging to steppe vegetation are decribed below. Besides, the relationship between soil properties and syntaxa are discussed. In addition, the life forms and chorotypes of the species in the syntaxa are also explained.

3.1 Description of syntaxa

3.1.1 Scrub-woodland vegetation

Asphodelino damascenae-Quercetum pubescentis ass. nov. hoc loco
Typus: Relevé 17 in Table / Tablo 3.

Characteristic species: *Quercus pubescens* Willd., *Juniperus oxycedrus* L. subsp. *oxycedrus, Asphodeline damascena* (Boiss.) Baker subsp. *damascena, Bromus squarrosus* L., and *Ferula rigidula* Fisch. ex DC.

Quercus pubescens subsp. *pubescens* is a deciduous oak species and is characterized by short petioles, undulate-margined, lobed, and greyish leaves. It spreads West, Central, and South Europe. *Juniperus oxycedrus* subsp. *oxycedrus* is widespread and occurs in pine woods, oak scrub, and maquis up to 1800 m. *Asphodeline damascena* subsp. *damascena* is an Irano-Turanian element and occurs on rocky slopes, alpine meadows, steppe, forest clearings between 370 and 2000 m mainly in Central Anatolia. *Bromus squarrosus* spreads North Africa, South Europe, Southwest and Central Asia. It is widespread in Anatolia occurs at waste places, steppe hillsides, and forest clearings up to 2200 m. *Ferula rigidula* is a perennial and Irano-Turanian element. It occurs at rocky places between 850 and 2370 m. The species spreads East and Central Anatolia also Armenia and Northwest Iran (Davis, 1965-1985).

Physiognomy and ecology: The mean cover of the association varies between 80-95%. The soil texture of the association is sandy (63%), clay (17.04%), and loam (19.96%), and it contains 0.96 % organic matter. The pH is about 6.78. The herb layer is composed of herbaceous cushion forming species and xerophytic grasses.

Distribution: It spreads northwest of Göllüdağ between 1700 m and 1800 m.

Table 3. Relevé table of *Asphodelino damascenae-Quercetum pubescentis* (Holotype*)
Tablo 3. *Asphodelino damascenae-Quercetum pubescentis* birliğinin relevé tablosu (Holotip*)

Relevé number	***13***	***14***	***15***	***16***	***17****	***18***	***19***	***20***	***21***	**Presence**
Altitude (m)	1705	1697	1712	1720	1700	1730	1732	1801	1750	
Inclination (°)	25	45	15	5	15	5	5	5	5	
Relevé size (m²)	289	289	289	289	289	289	289	289	289	
Total cover (%)	80	95	85	85	80	95	95	90	85	
Herb layer (%)	75	85	75	75	70	90	85	85	80	
Tree layer (%)	15	25	30	25	30	30	30	30	30	
Aspect	N	E	NW	E	E	NW	NE	SE	N	
The characteristic species of *Asphodelino*										
Quercus pubescens subsp. *pubescens*	4	4	4	4	4	5	5	5	4	V
Juniperus oxycedrus subsp. *oxycedrus*	1	1	2	2	2	2	2	2	3	V
Asphodeline damascena subsp. *damascena*	+	+	+	+	+	+	+	.	.	IV
Bromus squarrosus	+	+	+	+	.	+	+	+	.	IV
Ferula rigidula	.	+	+	.	+	+	+	.	.	III
The characteristic species of *Quercion anatolicae* and *Querco-Carpinetalia orientalis*										
Trifolium elongatum	.	.	.	+	1	.	.	.	.	I
The characteristic species of *Querco-Cedretalia libani*										
Quercus infectoria subsp. *veneris*	.	.	.	.	1	.	.	.	.	I
Sorbus umbellata var. *umbellata*	.	.	+	.	.	.	.	.	.	I
The characteristic species of *Quercetea pubescentis*										
Cotoneaster nummularius	.	+	.	+	+	.	1	2	+	III
Teucrium chamaedrys subsp. *syspirense*	+	+	.	.	+	.	.	.	.	II
The characteristic species of *Astragalo-Brometea* and *Onobrychido armenae-Thymetalia leucostomi*										
Festuca valesiaca	1	2	2	2	2	2	2	2	2	V
Helichrysum plicatum subsp. *plicatum*	+	+	+	+	+	+	+	+	+	V
Allium scodoprosum subsp. *rotundum*	+	+	+	+	+	.	+	+	+	IV
Scabiosa argentea	+	.	+	+	+	+	+	+	+	IV

Table 3. Relevé table of *Asphodelino damascenae-Quercetum pubescentis* (Holotype*) (Continued)
Tablo 3. *Asphodelino damascenae-Quercetum pubescentis* birliğinin relevé tablosu (Holotip*) (Devam ediyor)

Ziziphora clinopodioides	+	.	+	+	+	+	+	+	+	IV
Teucrium polium subsp. polium	+	+	+	.	+	+	+	+	+	IV
Cota tinctoria	.	+	+	+	+	+	+	+	+	IV
Apera intermedia	+	+	+	+	+	+	.	+	+	IV
Astragalus microcephalus subsp. microcephalus	+	.	.	+	+	+	+	+	+	IV
Galium verum subsp. verum	+	+	+	+	+	.	.	+	.	III
Euphorbia macroclada	+	+	+	.	+	+	+	.	.	III
Minuartia recurva subsp. oreina	+	.	+	+	+	.	.	+	+	III
Inula montbretiana	.	+	+	.	.	+	+	+	+	III
Asyneuma limonifolium subsp. petolazzae	.	.	.	.	+	+	+	.	+	II
Dianthus anatolicus	.	.	.	.	.	+	+	.	+	II
Leontodon asperrimus	+	+	.	.	.	.	.	.	.	I
Acantholimon ulicinum var. *ulicinum*	+	.	.	.	.	.	.	.	+	I
Minuartia juniperina	.	.	+	+	.	.	.	.	.	I
Astragalus angustifolius subsp. *angustifolius*	.	.	.	+	.	.	.	.	.	I
Bromus tomentellus subsp. *tomentellus*	.	.	.	.	.	.	.	.	+	I
Anthemis cretica subsp. *anatolica*	+	.	.	.	.	.	.	.	.	I
Relevé number	***13***	***14***	***15***	***16***	***17****	***18***	***19***	***20***	***21***	**Presence**
Companions										
Poa bulbosa	.	+	+	+	+	+	+	+	+	IV
Centaurea virgata	+	.	+	+	+	+	+	.	.	III
Arenaria serpyllifolia subsp. *serpyllifolia*	+	+	+	+	+	.	+	.	.	III
Pilosella hoppeana subsp. cilicica	+	.	+	+	+	.	+	+	.	III
Xeranthemum annuum	+	.	.	.	+	+	+	+	+	III
Rumex acetosella	+	.	.	+	.	+	+	+	+	III
Dactylis glomerata subsp. *glomerata*	+	+	.	.	.	+	+	+	+	III
Phleum exaratum subsp. *exaratum*	.	+	.	+	+	+	.	+	+	III
Vincetoxicum fuscatum subsp. *fuscatum*	+	+	+	+	.	.	.	.	+	III
Prangos meliocarpoides var. *meliocarpoides*	.	+	+	+	.	.	.	+	.	II
Pilosella piloselloides subsp. *magyarica*	+	+	.	+	+	.	.	.	.	II
Daphne oleoides subsp. *oleoides*	.	.	+	.	.	+	+	+	.	II
Poa angustifolia	.	.	.	+	.	.	+	+	+	II
Verbascum asperuloides	.	.	.	+	.	+	+	+	.	II
Dianthus calocephalus	.	.	.	.	+	+	+	+	.	II
Alyssum desertorum	.	.	.	.	.	+	+	.	+	II
Scleranthus annuus subsp. *annuus*	.	.	+	+	+	.	.	.	.	II
Campanula stricta subsp. *stricta*	.	.	.	.	+	+	+	.	.	II
Silene caramanica var. *caramanica*	+	.	+	.	+	.	.	.	.	II
Linaria genistifolia subsp. *polyclada*	+	.	.	+	+	.	.	.	.	II
Filago arvensis	.	+	.	.	.	.	.	+	+	II
Astragalus condensatus	+	.	.	.	+	.	.	+	.	II
Silene latifolia subsp. *alba*	.	.	.	.	.	.	+	+	+	II
Lactuca orientalis	.	.	.	.	.	+	+	.	.	I
Trifolium stellatum var. *stellatum*	.	.	.	.	.	+	+	.	.	I
Velezia rigida	.	.	.	+	+	.	.	.	.	I
Hypericum linarioides subsp. *linarioides*	.	.	.	.	+	.	.	.	+	I
Scutellaria orientalis subsp. *pinnatifida*	+	.	+	.		.	.	.	.	I
Centaurea patula	.	.	.	.	+	.	.	.	.	I
Secale anatolicum	.	.	.	.	+	.	.	.	.	I
Fibigia clypeata subsp. clypeata var. *eriocarpa*	.	.	.	.	.	.	.	+	.	I
Arrhenatherum elatius	.	.	.	+	.	.	.	.	.	I
Orobanche anatolica	.	.	+	.	.	.	.	.	.	I
Veronica cinerea	.	+	.	.	.	.	.	.	.	I
Asperula stricta subsp. *stricta*	.	.	+	.	.	.	.	.	.	I
Picnomon acarna	+	.	.	.	.	.	.	.	.	I

13: N 38°16' 26.8" E 34° 33' 10.6", **14:** N 38°16' 27.2" E 34° 33' 12.5", **15:** N 38°16' 25.3" E 34° 33' 8.6", **16:** N 38°16' 22.7" E 34° 33' 7.5", **17:** N 38°16' 21.2" E 34° 33' 7.6", **18:** N 38°16' 19.4" E 34° 33' 5.5", **19:** N 38°16' 19" E 34° 33' 4.6", **20:** N 38°16' 17.1" E 34° 33' 4.4", **21:** N 38°16' 15.2" E 34° 33' 3"

3.1.2 Steppe vegetation

Ziziphoro clinopodioidis-Festucetum valesiacae ass. nov. hoc loco
Typus: Relevé 23 in Table / Tablo 4

Characteristic species: *Festuca valesiaca* Schleich. ex Gaudin, *Ziziphora clinopodioides* Lam., *Astragalus microcephalus* Willd. subsp. *microcephalus, Teucrium polium* L. subsp. *polium, Astragalus condensatus* Ledeb., *Potentilla recta* L., and *Elymus hispidus* (Opiz) Melderis subsp. *hispidus*.

Festuca valesiaca is a densely caespitose perennial and occurs in steppe, alpine meadows and, oak scrubs between 400-2800m. It spreads in the West, South, and Central Anatolia. *Ziziphora clinopodioides* is a mat-forming perennial and Irano-Turanian element. It occurs on rocky slopes and steppe between 760-4100 m. It spreads South and Central Anatolia and also Caucasia, North Iraq, Iran, Afghanistan, and Central Asia. *Astragalus microcephalus* subsp. *microcephalus* is an Irano-Turanian cushion-forming shrub and widespread between 850 and 2700 m in Central Anatolia. *Teucrium polium* subsp. *polium* is a widespread suffruticose perennial and occurs at rocky slopes, in *Quercus* scrub, steppe, and dunes up to 2050 m. *Potentilla recta* is widespread in Anatolia also spreads Central and South Europe, South Russia, Caucasia, Syria, Iran, Central Asia, and Northwest Africa. It occurs in meadows up to 2300 m. *Astragalus condensatus* is a dwarf cushion-forming endemic shrub occurs between 500 and 1200 m. It is Irano-Turanian element and spreads Central and Southwest Anatolia. *Elymus hispidus* subsp. *hispidus* occurs on scree below cliffs, limestone slopes, arid places between 1400 and 2300 m. It spreads Northwest, North, and South Anatolia, Central Europe, Mediterranean area, South Russia, Caucasia, Iran, Norh Iraq, and Central Asia (Davis, 1965-1985).

Physiognomy and ecology: The mean cover of the association varies between 50% and 85%. The soil texture of the association is sandy (84.87%), clay (8.71%), and loam (6.42%), and it contains 0.71% organic matter. The pH is about 6.58. The association is mostly composed of hemicryptophyte and chamaephytes.
Distribution: It spreads north and northeast of Göllüdağ between 1700 and 2100 m.

typicum subass. nov. hoc loco
Typus: the same as for the association name.

elymetosum divaricati subass. nov. hoc loco
Typus: Relevé 23 in Table / Tablo 4

Differential species: *Elymus divaricatus* Drobow subsp. *divaricatus, Minuartia juniperina* (L.) Maire & Petitm., *Paronychia chionaea* Boiss. subsp. *chionaea* var. *chionaea, Stipa pulcherrima* subsp. *crassiculmis* (P.A.Smirn.) Tzvelev, *Centaurea patula* DC., *Pilosella hoppeana* subsp. *testimonialis* (Nägeli ex Nägeli & Peter) P.D.Sell & C.West, and *Pilosella hoppeana* subsp. *cilicica* (Nägeli & Peter) P.D.Sell & C.West.

Elymus divaricatus subsp. *divaricatus* is a caespitose perennial with short rhizomes. It is an Irano-Turanian endemic. It occurs on rocky limestone slopes in Central and South Anatolia between 1000-2700 m. *Minuartia juniperina* is a cushion-forming herb occuring at rocky places between 900 and 2700 m. It is widespread in Anatolia and also spreads in Greece, West Syria, and North Iraq. *Paronychia chionaea* subsp. *chionaea* var. *chionaea* is a prostrate caespitose herb occuring at rocky places up to 2800 m. It spreads Central and West Anatolia. *Stipa pulcherrima* subsp. *crassiculmis* is widespread in Anatolia and also spreads from Central Europe to Iran. It occurs in stony places between 500-3000 m. *Centaurea patula* is an annual and Irano-Turanian element. It exists in steppe between 400 and 1400 m. *Pilosella hoppeana* subsp. *testimonialis* is a Euro-Siberian element existing North Anatolia and also being local in the South. It spreads Central Europe, Crimea, Balkan Peninsula, Caucasia, Syria, and Iran. It occurs in *Fagus* scrub and rocky slopes between 700 m and 2300 m. *Pilosella hoppeana* subsp. *cilicica* is widespread, mainly North and South Anatolia between 1550 m and 2760 m (Davis, 1965-1985).

Physiognomy and ecology: The mean cover of the association varies between 40% and 80%. The soil texture of the association is sandy (85.91%), clay (7.67%), and loam (6.42%), and it contains 1.43% organic matter. The pH is about 7.33.

Distribution: It spreads north and northeast of Göllüdağ between 1860 and 2090 m.

Table 4. Relevé table of *Ziziphoro clinopodioidis-Festucetum valesiacae* (Holotype*)
Tablo 4. *Ziziphoro clinopodioidis-Festucetum valesiacae* birliğinin relevé tablosu (Holotip*)

Relevé number	1	2	3	4	7	8	10	22	23*	24	26	30	31	5	6	9	11*	12	25	27	28	29
Inclination (º)	3	4	3	5	5	5	1	4	4	4	5	3	4	2	1	1	1	3	4	4	4	4
Relevé size (m²)	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Total cover (%)	6	7	7	7	7	8	6	5	7	6	6	6	7	6	7	7	6	6	6	4	6	8
Herb layer (%)	6	7	7	7	7	8	6	5	7	6	6	6	7	6	7	7	6	6	6	4	6	8
Aspect	N	N	N	N	S	S	N	N	N	N	N	N	N	N	S	S	N	N	N	N	N	N
The characteristic species of *Ziziphoro clinopodioidis-Festucetum valesiacae*																						
Festuca valesiaca	3	1	2	2	3	3	3	2	3	2	3	+	4	2	2	2	2	1	2	2	2	2
Ziziphora clinopodioides	2	2	.	2	2	.	1	3	1	3	1	1	.	+	1	1	.	1	2	+	+	+
Astragalus microcephalus subsp.	2	1	1	1	1	2	.	1	2	+	1	2	+	.	1	+	.	.	1	.	.	.
Teucrium polium subsp. *polium*	1	.	2	.	.	.	2	.	2	2	2	1	1	+	1	.	2	2	.	.	1	1
Astragalus condensatus	1	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla recta	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Elymus hispidus subsp. *hispidus*	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.
The differential species of *elymetosum divaricate*																						
Elymus divaricatus subsp.	.	.	.	.	.	.	.	.	.	+	.	+	.	3	3	3	3	3	3	3	3	4
Minuartia juniperina	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	+	.	+	+	.
Paronychia chionaea subsp.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.
Stipa pulcherrima subsp.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2	.	.	.	.	+
Centaurea patula	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
Pilosella hoppeana subsp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.
Pilosella hoppeana subsp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	+	.	.	.
The characteristic species of *Agropyro-Stachydion*																						
Pterocephalus pinardii	2	1	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	1	1	1	.
Marrubium globosum subsp.	.	+	.	.	+	.	.	+	1	.	.	.	.	.	.	.	.	.	.	+	.	.
The characteristic species of Onobrychido armeni–Thymetalia leucostomi																						
Dianthus anatolicus	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	+
Leontodon asperrimus	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	+
Salvia absconditiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
The characteristic species of Astragalo-Brometalia and Astragalo-Brometea																						
Bromus tomentellus subsp. *tomentellus*	+	+	+	1	.	.	1	+	+	1	+	+	+	1	1	.	1	1	1	+	2	1

Relevé number	1	2	3	4	7	8	10	22	23*	24	26	30	31	5	6	9	11*	12	25	27	28	29
Scabiosa argentea	+	1	+	+	+	.	.	+	+	.	+	+	+	.	+	.	.	.	+	.	.	+
Helichrysum plicatum subsp.	.	.	+	+	+	+	+	.	.	.	+	.	.	+	+	+	+	.	.	.	+	+
Minuartia recurva subsp. *oreina*	.	.	+	1	.	.	+	.	+	+	+	+	+	+	1	.	.	.	+	.	+	+
Galium verum subsp. *verum*	.	+	.	.	+	1	+	+	.	.	.	.	.	.	+	+	+	+	+	.	+	+
Astragalus angustifolius subsp.	.	.	.	1	.	.	1	.	.	.	.	.	.	1	2	+	+	+	+	.	.	.
Acantholimon ulicinum var.	.	.	.	.	1	2	.	.	.	.	.	+	.	.	+	+	+	.	.	.	.	.
Cruciata taurica	+	.	.	.	.	+	.	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.
Phlomis armeniaca	.	.	.	.	1	.	.	.	.	.	.	+	.	.	1	1	.	.	.	.	.	.
Asyneuma limonifolium subsp.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.
Anthemis cretica subsp.	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Inula montbretiana	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	1	.	.	.	.	.	.
Centaurea virgata	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Euphorbia macroclada	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Allium scodoprosum subsp.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sanguisorba minor subsp. *balearica*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Globularia trichosantha subsp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Alyssum murale subsp. *murale*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Campanula stricta subsp. *stricta*	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
The characteristic species of *Quercetea pubescentis*																						
Cotoneaster nummularius	.	+	.	.	.	.	.		.	+	.	.	.	.	.	.	.	.	.	+	.	.

Table 4. Relevé table of *Ziziphoro clinopodioidis-Festucetum valesiacae* (Holotype*) – (Continued)
Tablo 4. *Ziziphoro clinopodioidis-Festucetum valesiacae* birliğinin relevé tablosu (Holotip*) – (Devam ediyor)

Berberis crataegina	.	.	.	.	.	.	.	1	.		+	.	.	.	.	.	.	.	.	.		.	.	.
Juniperus oxycedrus subsp.	.	.	.	.	.	.	+	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Companions	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Phleum exaratum subsp.	.	+	.	.	.	.	+	+	.		+	1	1	+	+	.	.	1	+	+		+	+	+
Gypsophila laricina	.	1	+	1	.	.	+	.	.		+	+	.	.	1	.	.	+	1	+		+	+	+
Apera intermedia	1	+	+	+	.	.	.	+	+		+	.	+	.	.	.	.	.	.	+		.	+	+
Arenaria serpyllifolia subsp.	.	.	+	1	+	1	1	+	+		.	+	.	.	.	+	2	.	.	.		.	.	+
Veronica cinerea	+	1	+	1	+	.	1	.	.		.	.	.	.	1	.	.	1	1	.		.	.	.
Rumex acetosella	+	.	+	.	+	.	.	+	.		+	+	.	.	.	+	+	.	.	+		+	.	.
Dianthus micranthus	.	.	.	+	+	.	+	+	.		+	.	.	.	.	+	+	+	+	+		.	.	.
Scorzonera cinerea	.	.	.	1	.	.	+	.	.		.	+	+	.	.	+	+	.	+	+		.	.	+
Linaria genistifolia subsp.	+	+	.	.	.	.	.	+	+		+	.	+	.	.	+	.	.	.	+		+	.	.
Filago arvensis	+	.	.	.	+	.	+	+	+		+	.	.	+	.	.	.	+	.	.		+	.	.
Daphne oleoides subsp. *oleoides*	.	1	.	.	.	.	.	+	.		.	.	.	.	.	+	.	.	1	+		+	.	1
Poa bulbosa	.	.	.	.	.	.	.	+	+		+	+	.	.	.	.	.	.	.	+		.	+	+
Poa angustifolia	.	+	1	+	.	.	.	.	.		.	.	.	+	+	+	.	.	.	.		.	.	.
Hieracium pannosum	.	.	.	+	.	.	.	.	.		.	+	.	.	.	.	.	.	.	.		1	.	+
Alyssum desertorum	.	.	.	.	.	.	+	.	.		.	.	.	.	+	.	+	+	.	.		.	.	.
Senecio vernalis	.	.	.	.	.	.	.	+	.		.	.	.	+	.	.	.	+	.	.		+	.	.
Alyssum simplex	.	.	.	.	.	.	.	.	+		.	.	.	.	.	.	.	.	+	+		+	.	.
Rosa pulverulenta	1	1	.	.	.	.	.	.	.		+	.	.	.	.	.	.	.	.	.		+	.	.
Veronica thymoides subsp.	+	.	.	.	.	.	.	.	.		+	.	.	.	.	.	.	.	.	+		+	.	.
Xeranthemum annuum	.	+	.	.	.	.	.	.	+		.	.	.	+	.	.	.	.	.	.		.	.	.
Picnomon acarna	.	.	.	.	.	.	.	1	+		.	.	.	.	.	.	.	.	.	.		+	.	.
Cuscuta balansae	.	.	.	.	.	.	+	.	.		.	.	.	.	+	.	.	.	+	.		.	.	.
Asperula stricta subsp. *stricta*	.	.	.	.	.	.	.	.	+		+	.	.	.	+	.	.	.	.	.		.	.	.
Dactylis glomerata subsp.	+	.	.	+	.	.	.	.	.		.	.	.	.	.	+	.	.	.	.		.	.	.
Amblyopyrum muticum var.	.	.	.	.	+	+	.	.	.		.	.	.	.	.	.	+	.	.	.		.	.	.
Echinops ritro	.	.	.	.	+	+	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Rosa canina	.	.	.	.	.	.	.	.	.		.	.	+	1	.	.	.	.	.	.		.	.	.
Trifolium stellatum var.	+	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Chondrilla juncea	+	.	.	.	.	.	.	.	+		.	.	.	.	.	.	.	.	.	.		.	.	.
Verbascum lasianthum	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Trifolium arvense var. *arvense*	.	.	.	.	.	.	.	.	+		.	.	.	.	.	.	.	.	.	.		.	.	.
Cyanus lanigerus	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	+
Alkanna orientalis var.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Verbascum asperuloides	.	.	.	.	.	.	.	+	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Scleranthus annuus subsp.	.	.	.	.	.	.	.	+	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Cirsium leucocephalum subsp.	.	.	.	.	.	1	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Convolvulus arvensis	.	.	.	.	.	+	.	.	.		.	.	.	.	.	.	.	.	.	.		.	.	.
Reseda lutea var. *lutea*	.	.	.	.	.	.	.	.	.		.	.	.	.	.	.	.	+	.	.		.	.	.

1: N 38°16' 5.2" E 34° 33' 36.7", 1809 m **2:** N 38°16' 5.1" E 34° 33' 32.5", 1837 m **3:** N 38°16' 5" E 34° 33' 32.6", 1865 m **4:** N 38°16' 4.3" E 34° 33' 31.1", 1886 m **5:** N 38°15' 47.8" E 34° 32' 50.8", 2072 m **6:** N 38°15' 40.9" E 34° 32' 51.4", 2090 m **7:** N 38°15' 38.9" E 34° 32' 50.1", 2018 m **8:** N 38°15' 35" E 34° 32' 48.2", 2047 m **9:** N 38°15' 32.5" E 34° 32' 51.9", 2061 m **10:** N 38°15' 45.1" E 34° 32' 51.1", 2083 m **11:** N 38°15' 47.9" E 34° 32' 52.9", 2081 m **12:** N 38°15' 51.1" E 34° 32' 54", 2053 m **22:** N 38°16' 15.8" E 34° 33' 51.5", 1709 m **23:** N 38°16' 6" E 34° 33' 35.6", 1786 m **24:** N 38°16' 4.5" E 34° 33' 30.7", 1856 m **25:** N 38°16' 4.6" E 34° 33' 28.6", 1864 m **26:** N 38°16' 7.4" E 34° 33' 13.6", 1867 m **27:** N 38°16' 2.4" E 34° 33' 14.1", 1934 m **28:** N 38°16' 0.5" E 34° 33' 13.5", 1953 m **29:** N 38°15' 59.3" E 34° 33' 13", 1958 m **30:** N 38°65' 3" E 34° 33' 31.1", 1863 m **31:** N 38°15' 2.1" E 34° 33' 35"1832 m.

3.2 Numeric analysis (DCA and PCA ordination)

The pattern of floristic differentiation of syntaxa in the study area was visualized by DCA (Figure / Şekil 3). They are well separated into three distinct groups along axis 1 and 2 (Figure / Şekil 2a). The reléves of steppe vegetation, the *Ziziphoro clinopodioidis-Festucetum valesiacae* (1) and *elymetosum divaricati* (2), exist on left side of axis 1, the reléves of scrub-woodland vegetation the *Asphodelino damascenae-Quercetum pubescentis* are on right side of axis 1.

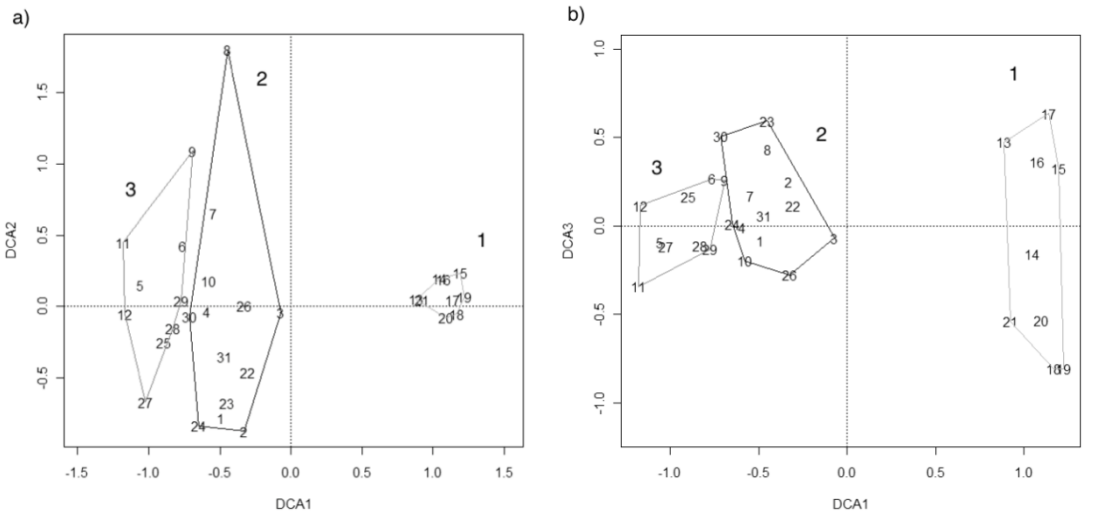

Figure 3. DCA ordination diagram of the communities in the study area (a) axis 1-2, (b) axis 1-3 (**1:** *Asphodelino damascenae-Quercetum pubescentis,* **2:** *Ziziphoro clinopodioidis-Festucetum valesiacae, **3:** elymetosum divaricati*)

Şekil 3. Araştırma alanındaki komünitelerin DCA ordinasyon diagramı (a) eksen 1-2, (b) eksen 1-3 (**1:** *Asphodelino damascenae-Quercetum pubescentis,* **2:** *Ziziphoro clinopodioidis-Festucetum valesiacae, **3:** elymetosum divaricati*)

The relation between topography, the soil characteristics and the communities are shown in Table / Tablo 5 and Figure / Şekil 4. The rest of variables except for $CaCO_3$, pH, and organic matter are correlated to the first PCA axis. The K^+ and NaCl show higher intensity at lower altitudes together with high plant cover. The *Asphodelino damascenae-Quercetum pubescentis* (3) is related to high K^+, P, NaCl, and plant cover. The inclination is also related to altitude but inversely K^+, P, and NaCl. The slopes with high inclination lead to greater runoff and displacement of soil materials (Hall 1983). The *Ziziphoro clinopodioidis-Festucetum valesiacae* (1) and *elymetosum divaricati* (2) are represented by higher inclination and thus, K^+, P, and NaCl may be removed from soil due to steeper slope. The organic matter content is quite low in all communities. However, *elymetosum divaricati* (2) is represented by higher pH and organic matter content, lower P amount in soil than the *Ziziphoro clinopodioidis-Festucetum valesiacae* (1) which has higher P, lower pH and organic matter content.

Table 5. The soil characteristics of the vegetation units in the study area
Tablo 5. Araştırma alanındaki vejetasyon birimlerinin toprak özellikleri

Vegetation type	**Sand (%)**	**Clay (%)**	**Silt (%)**	**NaCl (%)**	**Org. Matter (%)**	**P (kg/da)**	**K (kg/da)**	**CaCO 3 (%)**	**pH**
Ziziphoro clinopodioidis-Festucetum	84.87	8.71	6.42	0.0036	0.7119	1.7769	25.3369	0.2149	6.5
elymetosum divaricati	85.91	7.67	6.42	0.0035	1.4369	1.5879	29.8437	0.4292	7.3
Asphodelino damascenae-Quercetum	63	17.04	19.96	0.0041	0.964	2.6276	43.1084	0.2149	6.7

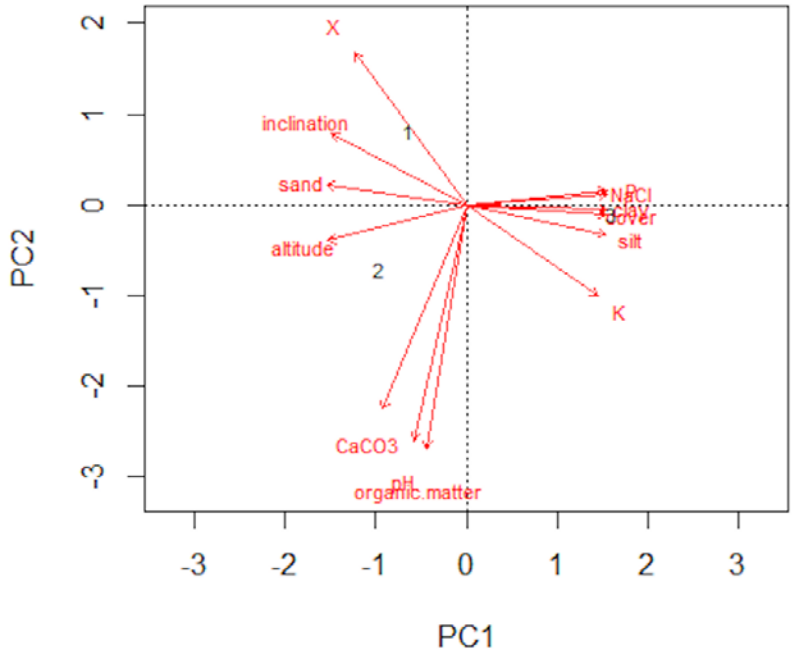

Figure 4. PCA ordination diagram of ecological factors of the study area (**1:** *Ziziphoro clinopodioidis-Festucetum valesiacae,* **2:** *elymetosum divaricati,* **3:** *Asphodelino damascenae-Quercetum pubescentis*)
Şekil 4. Araştırma alanındaki ekolojik faktörlerin PCA ordinasyon diagramı (**1:** *Ziziphoro clinopodioidis-Festucetum valesiacae,* **2:** *elymetosum divaricati,* **3:** *Asphodelino damascenae-Quercetum pubescentis*)

3.3. Life Forms and Chorotypes

The study area is phytogeographically situated in Irano-Turanian region. Therefore, the number of Irano-Turanian elements is high in both associations identified. Besides, the number of Irano-Turanian endemics is also higher than the elements of other phytogeographic regions (Figure / Şekil 5). The endemism ratio of *Ziziphoro clinopodioidis-Festucetum valesiacae* and *Asphodelino damascenae-Quercetum pubescentis* is 15% and 12% respectively.

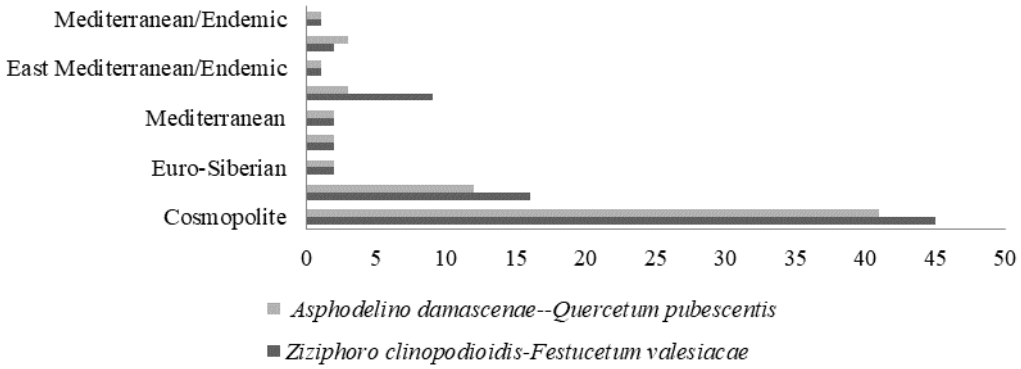

Figure 5. Percentage of species according to chorotypes in the communities
Şekil 5. Komünitelerdeki türlerin korotiplere göre yüzdesi

The life forms of the vegetation are considered to be an indicator of the climatic conditions. The Irano-Turanian region that has low rainfall and long dry season is characterized by the dominance of hemicryptophytes and chamaephytes (Djamali et al., 2012). Therophytes are also adapted to drought of Mediterranean climate (Giménez et al., 2004). Thus, hemicryptophytes dominate the flora of the study area followed by chamaephytes and therophytes, respectively (Figure / Şekil 6).

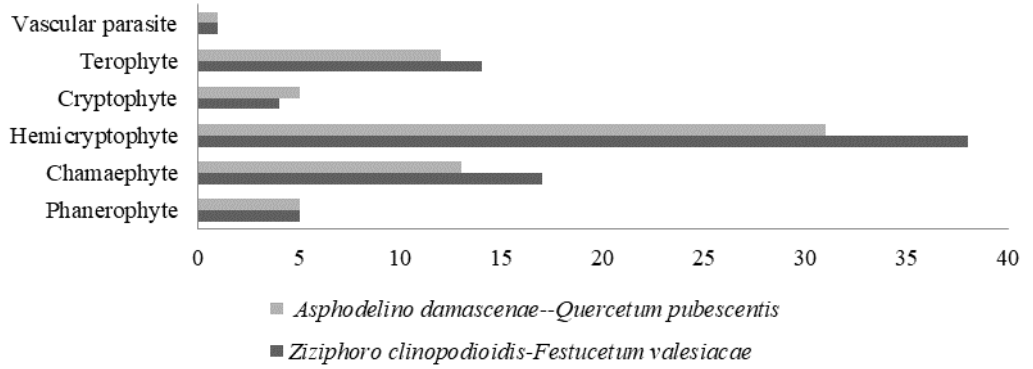

Figure 6. Percentage of species according to life forms in the communities
Şekil 6. Komünitelerdeki türlerin hayat formlarına gore yüzdesi

The study area is located in Irano-Turanian phytogeographic region. The semi-arid cold Mediterranean climate prevails over the study area, which makes the dominance of steppe vegetation adapted to xeric conditions in Central Anatolia. Besides, the development of the cultural landscapes led the formation of new plant communities over years and the most of these communities are the anthropogenic ones (Jalut et al., 2009). These communities which characterize the vegetation of the region are in equilibrium with the climatic conditions. *Festuca valesiaca* is resistant to grazing and replaces the species of *Bromus-Stipa* steppe that may be supported by climate in Central Anatolia (Imanberdieva, 2015; Walter, 1956). Therefore, the fescue dominated steppe represents a secondary vegetation due to human degradation today (Fırıncıoğlu et al., 2009; Kürschner and Parolly, 2012). Since *F. valesiaca* has wide range of ecological tolerance and adaptability to different environmental conditions, it is widely distributed (Imanberdieva, 2015). The species occurs in the alpine mountain belt of West, South, and Central Anatolia (Davis, 1965-1985).

The communities of *F. valesiaca* in the Balkans are included in *Festucetalia valesiacae* Br.-Bl. & R.Tx. Ex Br.-Bl. 1949 of the class *Festuco-Brometea* Br.-Bl. & R.Tx. 1943 ex Klika & Hadac 1944. This order mainly occurs in the Sub-mediterranean and Mediterranean montane zone and the belt of continental of the Dinaric Alps in the Balkans. The communities of *F. valesiaca* in Balkans are significantly distinctive from those in the West and Central Europe and also in the Eastern Europe in terms of the species that belong to different phytogeographic regions such as Balkan and Illyrian floral elements (Redzic, 1999). While the distribution of *Festuco-Brometea* which is Centro-European and South-Sibirian origin is restricted in the south-east and unable to exceed from Balkans (Aćić et al., 2015; Pignatti et al., 1995; Redzic, 1999), *Astragalo-Brometea* includes the grasslands in the deforested zone of Taurus Mountains (1500-1700m) and it is located in the montane and oro-Mediterranean zone of Central, Eastern Anatolia, and Taurus mountains in the south and also extends towards to the Alborz Mountains in Iran. The geographical situation of Anatolia explains that this class is influenced by both Irano-Turanian elements of Anatolian steppes and Mediterranean elements of Mediterranean forests. But yet, the delimitation of *Astragalo-Brometea* in the east (Eastern Anatolia and Iran) is mainly complicated and not clear yet (Hamzaoğlu, 2006; Noroozi et al., 2010).

F. valesiaca is a dominant or accompanying species with high presence of many communities in montane zone of Anatolia. In the east of Anatolia, communities of *F. valesiaca* are also classified in *Astragalo-Brometea,* but in different orders and alliances peculiar to the region (Hamzaoğlu, 2006; Ocakverdi et al., 2009). These communities spreading between 1800-3000 m belong to mountain steppes in the Eastern Anatolia. The *Onobrychido armenea-Thymetalia leucostomi* characterized by lowland steppe units includes mostly the communities dominated by *F. valesiaca* in Central Anatolia (Şanda and Küçüködük, 2000; Vural et al., 1995). While these communities occuring between 1200 and 1800 m, the *Ziziphoro clinopodioidis-Festucetum valesiacae* spreads between 1700 and 2100 m. Therefore, the steppe community in the study area is classified in the order *Astragalo-Brometalia* comprising montane zone consisting of xerophytic grasslands and thorn cushion communities in Taurus and in the alliance

Agropyro tauri-Stachydion lavandulifoliae Quézel 1973 due to being well supported characteristic species of the alliance and the order and occuring in sub-alpine zone (Parolly, 2004).

The characteristic species of the community of *F. valesiaca* in the south of Central Anatolia are *Eremogone ledebouriana*, *Elymus tauri* var. *kosaninii*, and *Paronychia argyroloba.* The community does have none tree or shrub (Şanda and Küçüködük, 2000). *Dianthus cinnamomeus* is an endemic and characteristic species of the community together with *F. valesiaca* in Karadağ. Although this community has high total cover and the soil of the community are rich in organic matter due to low erosion, the floristic composition of the community is poor. That is because ecological tolerance and vegetation period of some terophytes in the community are insufficient to the habitat, topographic, and climatic conditons (Ocakverdi and Ünal, 1991). Whereas the dominant species of the community of *F. valesiaca* in the northwest of Central Anatolia is *Thymus sipyleus*, *Hypericum pseudolaeve* is dominant with *F. valesiaca* in the community in the mid-Central Anatolia. In the study area *F. valesiaca* exists with high dominance of *Ziziphora clinopodioides* following *Astragalus microcephalus* subsp. *microcephalus,* and *Teucrium polium* subsp. *polium.* The reason of different co-occurrence of the steppe species with *F. valesiaca* may be altitude, bedrock, and edaphic factors.

The deciduous oak woodlands and shrublands enclose the peripheral of Central Anatolia and also occur as fragments in high altitudes of steppe vegetation. *Quercus pubescens* is a dominant species of these oak woodlands and shrublands in Central Anatolia. *Q. cerris, Q. infectoria, Q. ithaburensis* subsp. *macrolepis, Q. trojana* and *Juniperus oxycedrus* mostly co-exist with this oak species. The certain parts of these woodlands and shrublands occurred in moister conditions than present day. However, the existence of these oak communities were affected by drier climate progressively and even disappeared in destructed areas (Çetik, 1985).

The *Quercus* community in Karadağ mountain (south of Central Anatolia) is described as sub-climax vegetation followed by destructed forest vegetation for many years and it is stated that Karadağ was exposed heavy grazing and wood cutting because the cultivated areas have enclosed the mountain. Thus, whereas forests diminish, the steppe vegetation progressively expands in the area due to human impact at present (Ocakverdi and Ünal, 1991). The *Quercus* community in Northwestern Anatolia is described as a shrub vegetation and although it shows similarity in terms of floristic composition of the communities under xeric conditions of Inner Anatolia, it contains the mesophilic and Euxinian (Euro-Siberian) species (Ture et al., 2005). The *Quercus*-dominated community in the transition zone between Central and Northern Anatolia is remarked that it is a community of a degraded forest and has the steppe species as well as the species that are specific for forest. The destruction of *Pinus nigra* subsp. *pallasiana* forests in the area causes expansion of distribution of *Quercus*-dominated community (Kılınç, 1985). Another *Quercus* community in northern Anatolia is also described as a forest community and it is indicated that the high number of steppe species in the community is a sign to destruction of the area (Adıgüzel and Vural, 1995). Heavy overgrazing also allows the destruction of composition of the oak community in the study area. The canopy of many oak communities frequently opens and it allows to settle light-demanding species -especially steppe species- in the herb layer in Central Anatolia (Uğurlu et al., 2012). Thus, the undergrowth of the community in the study area has abundantly steppe species as in floristic composition of other oak communities in the region. The *Quercion anatolicae* includes most of *Quercus*-dominated forest communities in Central Anatolia and it spreads in the supra-Mediterranean zone where semi-arid and low precipitation cold and very-cold Mediterranean climate prevails in the peripheral zone of the Central Anatolia (Akman, 1995). The *Asphodelino damascenae-Quercetum pubescentis* in the study area is included in the alliance *Quercion anatolicae* of the order *Querco cerridis-Carpinetalia orientalis* in the class *Quercetea pubescentis.*

The inclination and altitude are effective in distribution of these communities in the study area. *Quercus*-dominated scrub-woodlands cannot reach above 2000 m in Central Anatolia. Moreover, small alterations in environmental drivers allow differentiation of floristic composition in this region (Hamzaoğlu et al., 2004). Therefore, the steppe vegetation of Central Anatolia appears as mosaic-like pattern due to this changes in short distance (Kurt et al., 2006). Also, the plant species richness and endemism ratio are quite high.

The most part of the steppe and steppe forest area in Central Anatolia has been degraded by reason of heavy grazing, deforestation and intensive agricultural activities particularly in the last thirty years. Heavy grazing causes soil erosion as well as destruction of the natural vegetation and loss of plant diversity and generally also leads to remain degraded ecosystems (Koç, 2000; Kürschner and Parolly, 2012; Yunusbaev et al., 2003). Besides, this type of vegetation is also strongly affected by agricultural and viticulture activities on semi-arid lands, deforestation, settlements and urban expansion. The steppe and steppe forest vegetation are one of the most sensitive ecosystems and have a great importance ecologically. They can satisfy the needs for sustainable use of the natural resources within semi-arid environments. Thus, heavy human impact should be avoided for preservation and regeneration of the natural vegetation in this type of ecosystems.

4. CONCLUSIONS

The study area which is located within the south-eastern part of Central Anatolia is involved in the Irano-Turanian floristic region phytogeographically. The regosols and brown soils without non-calcareous are found in the study area. The lower semi-arid very cold Mediterranean climate that mostly characterizes Central Anatolian climate are effective in the area.

The class *Astragalo-Brometea* described the Central Anatolian steppe is represented by the order *Astragalo–Brometalia* and the alliance *Agropyro tauri-Stachydion lavandulifoliae* which are composed of xerophytic grasslands and cushion-forming spiny xerophytic and chamaephytic communities in high altitudes. The *Ziziphoro clinopodioidis-Festucetum valesiacae* community described in the study area is classified in the order *Astragalo–Brometalia* and the alliance *Agropyro tauri-Stachydion lavandulifoliae* since it has the characteristic species of both two upper syntaxa and they represent the subalpine zone. The dominant species of the community is *Festuca valesiaca.* The other characteristic species are *Ziziphora clinopodioides, Astragalus microcephalus* subsp. *microcephalus, Teucrium polium* subsp. *polium, Astragalus condensatus*, *Potentilla recta,* and *Elymus hispidus* subsp. *hispidus.* The community is situated between 1700 and 2100 m. The content of soil of the community is poor due to high inclination.

The class *Quercetea pubescentis* includes deciduous forest formations in upper Mediterranean vegetation zone. The order *Querco cerridis-Carpinetalia orientalis* is characterized by *Carpinus orientalis* Mill. and *Quercus* sp. in Anatolia. This order is also vikariant in Anatolia of *Quercetalia pubescentis* Klika 1933 in Europe (Quézel et al., 1980). The alliance *Quercion anatolicae* spreads in the peripheral of Central Anatolia, in the upper Mediterranean vegetation zone, and in the places where semi-arid cold and very cold Mediterranean climate prevails. The characteristic species of upper syntaxa as well as situated in the vegetation zone the *Asphodelino damascenae-Quercetum pubescentis* is classified in *Quercion anatolicae, Querco cerridis-Carpinetalia orientalis,* and *Quercetea pubescentis. Quercus pubescens* is dominant species of the community. The other characteristic species are *Quercus pubescens*, *Juniperus oxycedrus* subsp. *oxycedrus, Asphodeline damascena* subsp. *damascena, Bromus squarrosus,* and *Ferula rigidula.* The community spreads between 1700 m and 1800 m and low inclination, thus soil is richer in terms of several mineral contents than the soil of steppe community in the study area.

The distribution, composition, and ecology of the syntaxonomic units in Central Anatolia should be determined for the prevention of present and further degradation of steppe and steppe forest vegetation. The data of the present vegetation will prepare a substructure for ecological requirements of the species under risk by geographical information systems and will provide improvement of recovery processes for the species in the steppe and steppe forest ecosystem. In addition, the data will also promote determination and monitoring of the effects of climate change on the biodiversity of these semi-arid environments and thus precautions will be taken to avoid these effects on the species eventually.

REFERENCES

Aćić, S., Šilc, U., Petrović, M., Tomović, G., Dajić Stevanović, Z. 2015. Classification, ecology and biodiversity of Central Balkan dry grasslands. *Tuxenia* 35: 329-353, doi: http://dx.doi.org/10.14471/2015.35.007.

Adıgüzel, N., Vural, M. 1995. The vegetation of Soğuksu National Park (Ankara). *Turkish Journal of Botany* 19(2): 213-234.

Akman, Y. 1974. Evolution regressive de la vegetation a l'etage du *Pinus nigra* ssp. *pallasiana* dans l'Anatolie Centrale dans un climat mediterraneen semi aride tres froid. *Communications Faculty of Sciences University of Ankara Series C: Biology* 18: 1-6.

Akman, Y. 1995. Türkiye Orman Vejetasyonu. Ankara Üniversitesi Fen Fakültesi Yayınları, Ankara.

Akman, Y., Ketenoğlu, O., Kurt, L., Vural, M. 2014. İç Anadolu Step Vejetasyonu. Palme Yayıncılık, Ankara.

Aksoy, A., Hamzaoğlu, E. 2006. Vegetation zones in the salty marshes of Central Anatolia and natural borders of agricultural usage (Turkey). In : Oztürk, M., Waisel, Y., Khan, M.A. and Görk G. Biosaline Agriculture and Salinity Tolerance in Plants, Switzerland, pp. 109-116.

Anonymous, 2009. R Version 2.10.1 for Windows [The R foundation for statistical computing].

Asouti, E. 2009. The relationship between Early Holocene climate change and Neolithic settlement in Central Anatolia, Turkey: current issues and prospects for future research. *Documenta Praehistorica* 36: 1-5, doi: http://dx.doi.org/10.4312/dp.36.1.

Aytuğ, B. 1970. Arkeolojik araştırmaların ışığı altında İç Anadolu stebi. *Journal of the Faculty of Forestry Istanbul University* 20: 127-143.

Aytuğ, B., Görecelioğlu, E. 1996. Tarih öncesi dönemde Kuzey Anadolu'da tarım, otlatma ve mevsimlik göçlerin bitki örtüsüne etkileri. *Journal of the Faculty of Forestry Istanbul University| İstanbul Üniversitesi Orman Fakültesi Dergisi* 46(1-2-3-4): 1-14.

Baş, R. 1968. Son 5 bin yıl içinde Anadolu'da orman durumu. *Journal of the Faculty of Forestry Istanbul University* 2 (18): 211-234.

Bottema, S. 1993. The palaeoenvironment of prehistoric man in the Near East: some aspects of palynological research. *Nichibunken Japan Review* 4: 129-140.

Bouyoucos, G.J. 1962. Hydrometer method improved for making particle size analyses of soils. *Agronomy Journal* 54: 464-465.

Braun-Blanquet, J. 1964. Pflanzensoziologie. Grundzüge der Vegetationskunde 3rd edn. Springer, Wien.

Cordova, C.E. 2005. The degradation of the ancient near eastern environment. In: Snell, D.C. (Eds.), A Companion to the Ancient Near East, Blackwell Publishing, Oxford, pp. 107-125.

Çetik, A.R. 1985. The vegetation of Turkey: The vegetation and ecology of Central Anatolia. Selçuk Üniversitesi Yayınları, Konya.

Davis, P.H. (Ed.), 1965-1985. Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh.

Dizdar, M.Y. 2003. Türkiye'nin Toprak Kaynakları. TMMOB Ziraat Mühendisleri Odası Teknik Yayınlar Dizisi, Ankara.

Djamali, M., Brewer, S., Breckle, S.W., Jackson, S.T. 2012. Climatic determinism in phytogeographic regionalization: a test from the Irano-Turanian region, SW and Central Asia. *Flora-Morphology, Distribution, Functional Ecology of Plants* 207(4): 237-249.

England, A., Eastwood, W.J., Roberts, C.N., Turner, R., Haldon, J.F. 2008. Historical landscape change in Cappadocia (central Turkey): a palaeoecological investigation of annually laminated sediments from Nar lake. *The Holocene* 18(8): 1229-1245, doi: 10.1177/0959683608096598.

Fırıncıoğlu, H.K., Seefeldt, S.S., Şahin, B., Vural, M. 2009. Assessment of grazing effect on sheep fescue (Festuca valesiaca) dominated steppe rangelands, in the semi-arid Central Anatolian region of Turkey. *Journal of Arid Environments* 73(12): 1149-1157, doi: http://dx.doi.org/10.1016/j.jaridenv.2009.05.012.

Giménez, E., Melendo, M., Valle, F., Gómez-Mercado, F., Cano, E. 2004. Endemic flora biodiversity in the south of the Iberian Peninsula: altitudinal distribution, life forms and dispersal modes. *Biodiversity and Conservation* 13(14): 2641-2660, doi: 10.1007/s10531-004-2140-7.

Güner, A., Aslan, S., Ekim, T., Vural, M., Babaç, M. 2012. Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul.

Hall, G.F. 1983. Pedology and geomorphology. In: Wilding, L.P., Smeck, N.E., Hall, G.F. (Eds.), Pedogenesis and Soil Taxonomy: I. Concepts and Interactions, Elsevier, Amsterdam, pp. 117-140.

Hamzaoğlu, E. 2006. Phytosociological studies on the steppe communities of East Anatolia. *Ekoloji* 15(61): 29-55.

Hamzaoğlu, E., Aydoğdu, M., Kurt, L., Cansaran, A. 2004. New syntaxa from the west part of Central Anatolia. *Pakistan Journal of Botany* 36(2): 235-246.

Hennekens, S.M. and Schaminée, J.H. 2001. TURBOVEG, a comprehensive data base management system for vegetation data. *Journal of Vegetation Science* 12(4): 589-591, doi: 10.2307/3237010.

Hopf, M. 1992. Plant remains from Boğazköy, Turkey. *Review of Palaeobotany and Palynology* 73(1): 99-104, doi: 10.1016/0034-6667(92)90048-L.

Imanberdieva, N. 2015. Flora and Plant Formations Distributed in At-Bashy Valleys–Internal Tien Shan in Kyrgyzstan and Interactions with Climate. In: Öztürk, M., Hakeem, K.R., Faridah-Hanum, I., Efe, R. (Eds.), Climate Change Impacts on High-Altitude Ecosystems, Springer, Switzerland, pp. 569-590.

Jalut, G., Dedoubat, J.J., Fontugne, M., Otto, T. 2009. Holocene circum-Mediterranean vegetation changes: climate forcing and human impact. *Quaternary International* 200(1): 4-18, doi: 10.1016/j.quaint.2008.03.012.

Kılınç, M. 1985. Iç Anadolu-Batı Karadeniz geçiş bölgesinde Devrez çayı ile Kızılırmak nehri arasında kalan bölgenin vejetasyonu. *Doğa Bilim Dergisi Seri A* 9(2): 238-314.

Kirwan, G., Demirci, B., Welch, H., Boyla, K., Özen, M., Castell, P., Marlow, T. 2010. The birds of Turkey. Bloomsbury Publishing, London.

Koç, A. 2000. Turkish rangelands and shrub culture. *Rangelands Archives* 22(4): 25-26, doi: 10.2458/azu_rangelands_v22i4_koc.

Kurt, L., Tuğ, G.N., Ketenoğlu, O. 2006. Synoptic view of the steppe vegetation of Central Anatolia (Turkey). *Asian Journal of Plant Science* 5: 733-739.

Kurt, L., Ketenoğlu, O., Tuğ, GN., Şekerciler, F. 2015. Highland Vegetation of Inner and Eastern Anatolia and the Effects of Global Warming, In: Öztürk, M., Hakeem KH., Faridah-Hanum, I., Efe, R., Climate Change Impacts on High-Altitude Ecosystems. Springer, Switzerland, pp. 275-288 doi: 10.1007/978-3-319-12859-7_11.

Kürschner, H., Parolly, G. 2012. The Central Anatolian Steppe, In: Marinus M.J.A. and Van Staalduinen, M.A. (Eds.), Eurasian Steppes. Ecological Problems and Livelihoods in a Changing World. Springer, Netherlands, pp. 149-171, doi: 10.1007/978-94-007-3886-7_4.

Kurt, L., Tuğ, G., Ketenoğlu, O. 2006. Synoptic view of the steppe vegetation of Central Anatolia (Turkey). *Asian Journal of Plant Science* 5: 733-739, doi: 10.3923/ajps.2006.733.739.

McCune, B., Mefford, M.J. 1999. PC-ORD: Multivariate Analysis of Ecological Data: Version 4. MjM Software Design, Gleneden Beach, Oregon.

Noroozi, J., Akhanı, H., Willner, W., 2010. Phytosociological and ecological study of the high alpine vegetation of Tuchal Mountains (Central Alborz, Iran). *Phytocoenologia* 40(4): 293-321, doi: 10.1127/0340-269X/2010/0040-0478.

Ocakverdi, H. and Ünal, A., 1991. Karadağ'ın (Karaman) bitki sosyolojisi ve ekolojisi yönünden araştırılması. *Doğa Turkish Journal of Botany* 15: 79-106.

Ocakverdi, H., Vural, M., Adıgüzel, N., 2009. Vegetation of Kısır Dağı (Kars-Ardahan/Turkey). *BioDiCon* 2(2): 1-37.

Olsen, S.R., 1954. Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. United States Department of Agriculture, Washington DC.

Parolly, G., 2004. The high mountain vegetation of Turkey-A state of the art report, including a first annotated conspectus of the major syntaxa. *Turkish Journal of Botany* 28: 39-63.

Pignatti, S., Oberdorfer, E., Schaminée, J., Westhoff, V., 1995. On the concept of vegetation class in phytosociology. *Journal of Vegetation Science* 6(1): 143-152, doi:10.2307/3236265.

Quézel, P., Barbero, M., Akman, Y. 1980. Contribution A l'etude De La Vegetation Forestiere D'anatolie Septentrionale. *Phytocoenologia* 8(3/4): 365-519.

Raunkiaer, C. 1934. Life Forms of Plants and Statistical Plant Geography, Clarendon, Oxford.

Redzic, S. 1999. The Syntaxonomical Differentiation of the *Festuco-Brometea* Br.-Bl. & R. Tx. 1943 ex Klika & Hadac 1944 in the Balkans. *Annali di Botanica* 57: 167-180, doi: http://dx.doi.org/10.4462/annbotrm-9056.

Şanda, M.A., Küçüködük, M. 2000. Hadim (Konya), Ermenek ve Bucakkışla (Karaman) bölgesinin orman ve çalı vejetasyonu. *Selçuk Üniversitesi Eğitim Fakültesi Fen Bilimleri Dergisi* 8: 73-95.

Tichý, L. 2002. JUICE, software for vegetation classification. *Journal of Vegetation Science* 13: 451-453, doi: 10.1111/j.1654-1103.2002.tb02069.x.

Türe, C., Tokur, S., Ketenoğlu, O. 2005. Contributions to the syntaxonomy and ecology of the forest and shrub vegetation in Bithynia, Northwestern Anatolia. Turkey. *Phyton* 45(1): 81-115.

Tüzüner, A. 1990. Toprak ve Su Analiz Laboratuarları El Kitabı. Mülga KHGM Yayınları, Ankara.

Uğurlu, E., Roleček, J., Bergmeier, E. 2012. Oak woodland vegetation of Turkey–a first overview based on multivariate statistics. *Applied Vegetation Science* 15(4): 590-608, doi: 10.1111/j.1654-109X.2012.01192.x.

Vural, M., Duman, H., Adıgüzel, N., Kol, Ü. 1995. Göreme Milli Parkı'nin (Nevşehir) vejetasyonu. *Turkish Journal of Botany* 19(3): 389-400.

Walkley, A., Black, I.A. 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science* 37(1): 29-38 doi: 10.1097/00010694-193401000-00003.

Walter, H. 1956. Das problem der Zentralanatolischen steppe. *Naturwissenschaften* 43(5): 97-102, doi:10.1007/BF00600866.

Weber, H.E., Moravec, J., Theurillat, J.P. 2000. International code of phytosociological nomenclature. 3rd edition. *Journal of Vegetation Science* 11: 739-768.

Woldring, H., Bottema, S. 2003. The vegetation history of East-Central Anatolia in relation to archaeology: The Eski Acıgöl pollen evidence compared with the Near Eastern environment. *Palaeohistoria* 43(44): 1-134.

Yunusbaev, U., Musina, L., Suyundukov, Y.T. 2003. Dynamics of steppe vegetation under the effect of grazing by different farm animals. *Russian Journal of Ecology* 34: 43-47, doi:10.1023/A:1021815005312