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A phytosociological study of the forest, shrub, and steppe vegetation of Kızıldağ and environs (Isparta, Turkey)

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Abstract: The phytosociological properties of the forest, shrub, and steppe vegetation of Kızıldağ (Isparta province) were investigated in 2010 and 2011. The vegetation of the area was analysed using a 3-dimensional ordination technique based on the Braun-Blanquet method. As a result, 5 new plant associations were determined as belonging to forest, shrub, and steppe vegetation and classified syntaxonomically. The associations and their higher units are as follows. *Quercetea-Pubescentis* Doing-Kraft ex Scamoni & Passarage 1959. *Querco-Cedretalia libani* Barbéro, Loisel & Quézel 1974. 1. *Meliloto bicoloris-Quercetum cocciferae* ass. nova. 2. *Hyperico heterophylli-Cistetum laurifolii* ass. nova. 3. *Atraphaxo billardieri-Amygdaletum orientalii* ass. nova. *Abieto-Cedrion* Akman, Barbéro & Quézel 1977. 4. *Veronico isauricae-Cedretum libani* ass. nova. *Astragalo-Brometea* Quézel 1973 em. Parolly. *Onobrychido armenae-Thymetalia leucostomi* Akman, Ketenoğlu, Quézel & Demirörs 1984. *Phlomido armeniacae-Astragalion microcephali* Ketenoğlu, Akman, Quézel & Demirörs 1984. 5. *Centauro detonsae-Thymetum sipylei* ass. nova

Key words: Syntaxonomy, vegetation, Kızıldağ, Isparta, Turkey

1. Introduction

Turkey has many vegetation types due to the climatic and topographic features of its mountains and plains. Vegetation studies reveal the interaction between plant communities and the climate or soil properties in a region. Phytosociological studies are essential for protecting the natural plant communities and biodiversity as well as understanding the changes experienced in the past and continuing on into the future. Most developed countries have completed these basic studies (Hamzaoğlu, 2005) and defined vegetation maps (Tel et al., 2010). However, the local vegetation studies performed so far are not sufficient for constructing a vegetation map of Turkey (Tel et al., 2010). The first vegetation studies in Turkey were started by Handel-Mazzetti in North-East Anatolia; Schwarz and Czeczott continued in the west, and Krause conducted studies in Central Anatolia (Geven et al., 2009). Several phytosociological studies were carried out in the localities close to the research area by Ocakverdi and Çetik (1982, 1987), Bekat (1987), Küçüködük (1994), Tatlı et al. (1994), Küçüködük and Ketenoğlu (1996), Serin (1996), Kargıoğlu and Tatlı (2005), Kargıoğlu (2007), and Sağlam (2007). Mutlu and Erik (2003) carried out a floristic study in some parts of the research area. However, there has been no phytosociological study on the vegetation of the area.

The objective of this article is to complete the classification of the plant formations of Kızıldağ and its environs, thus providing a guide for managers to use in determining vegetation types and their potential based on environmental factors such as climate and soil properties. The research focused mainly on identifying the synecological and syntaxonomical characteristics of the area.

2. Materials and methods

2.1. Vegetation sampling and phytosociological analysis

Vegetation was studied during vegetation periods from 2010 to 2011 using the Braun-Blanquet method (1964). This approach is a system in which all plant communities are arranged in a manner that is as natural as possible but at the same time practical (Poore, 1955). In order to determine the interaction between environmental factors and plant communities, 47 quadrats were taken from different vegetation types. The phytosociological releves were recorded according to the principles of the Zurich-Montpellier approach (Braun-Blanquet, 1964) and frequently using the modified 9-degree Braun-Banquet sampling scale (Barkman et al., 1964). The releves were also recorded according to the Braun-Blanquet (1932) method for the 3-dimensional ordination technique.

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The size of the releves was determined according to the minimal area method, which was 1000 m^2 in the forest community, 400 m^2 in the *Quercus coccifera* L. community, 200 m^2 in the *Cistus laurifolius* L. and *Amygdalus orientalis* Mill. communities, and 50 m^2 in the steppe community. Taxonomic nomenclature followed Davis (1965–1985), Davis et al. (1988), Tutin et al. (1964–1980), Güner et al. (2000), Özhatay et al. (2009, 2011), Aytaç and Türkmen (2011), Duran et al. (2011), and Aksoy et al. (2009). The International Code of Phytosociological Nomenclature (Weber et al., 2000) was used for naming the new associations. Sorensen's similarity index (Sorensen, 1948) was used to compare the associations with similar associations studied near the research area. Plant life-form categories were identified according to Raunkiaer's system of classification (Raunkiaer, 1934; Ellenberg & Mueller-Dombois, 1967). The World Geodetic System of 1984 (WGS84) was used to determine the coordinates of the localities by global positioning system (GPS). The plant specimens collected from the releves were stored in the herbarium of Selçuk University (KON). The Wisconsin polar ordination technique (Bray & Curtis, 1957) was used for grouping the releves and separating plant communities. This method is quite well suited to the modern interactive computer scenario. Bray and Curtis' ordination method has been successfully used in the past, and because it is simple it highlights the problems of polar ordination quite well. To statistically support the results obtained from the Braun-Blanquet method by phytosociological studies and 3-dimensional ordination, the following procedures were carried out. i). The scales of abundance-coverage of Braun-Blanquet (1932) were translated into Van der Maarel's (1979) ordinal values (+ = 2, 1 = 3, 2 = 5, 3 = 7, 4 = 8, 5 = 9). ii). The similarity (Is%) and dissimilarity (Id%) equivalence values of each releve were calculated using the similarity index formula of Sorensen (1948). iii). The values of x, y, and z were determined by creating a correlation matrix using the index of similarity. iv). The positions of the releves on these axes were determined according to the values of x, y, and z. A 3-dimensional ordination graphic was drawn according to the values obtained. Sampling areas were separated into associations according to the clusters in the ordination graphic. A software package was used for the classification of vegetation according to the method of ordination. A statistical program (SPSS 16.0) was used for creating the 3-dimensional ordination graphic. Syntaxonomical interpretations of taxa for the forest vegetation were made according to Quezel (1973), Akman et al. (1978a, 1978b, 1979), and Quézel et al. (1978, 1980). Classification of the taxa belonging to the steppe communities was made according to the studies carried out by Akman et al. (1984, 1985), Ketenoğlu et al. (1983), and Quézel et al. (1992).

The soil samples were collected from the top 30 cm of the profile of the vegetation type, where sociological quadrats were taken, and the following measurements were taken: pH (saturation slush, pH meter), electrical conductivity (saturation slush, EC meter), carbonate (calcimeter), organic matter (Smith-Weldon method), and P (Olsen method). Fe, Cu, Mn, and Zn analyses were done (0.005 M DTPA + 0.01 M $CaCl_2$ + 0.1 M triethanolamine, adjusted to pH 7.30). Exchangeable cations (Na, K, Ca, and Mg) were determined according to the method described by Thomas (1982). Soil minerals were analysed in 3 replications by inductively coupled plasma atomic emission spectrometry (ICP-AES Varian, Vista Axiel Simultaneous).

2.2. Description of the study area

The study area is located in B3 and C3 according to the grid system adopted in the *Flora of Turkey* (Davis, 1965). This area is situated in the transitional zone between the Mediterranean and Irano-Turanian phytogeographic regions (Zohary, 1973). The northern and eastern borders of the area are Şarkikaraağaç and Pınarbaşı village, the south-western border is Salur village, and the southern border is Lake Beyşehir (Figure 1). The Kızıldağ area is dominated by small mountain ranges that run from south-west to north-east. The altitude of the area is between 1100 m at Lake Beyşehir and 1910 m at the summit of Kızıldağ mountain. The region covers an area of about 400 km^2 with latitude between 37°58′ and 38°03′N and longitude between 31°16′ and 31°31′E.

Climatic factors are always interacting with each other, and vegetation is formed as a result of the combined effects of climatic elements. Temperature, length of the growing phase, moisture, and sunlight are the most important climatic factors that influence natural vegetation. The climate of the area was examined using data from the meteorology stations in Şarkikaraağaç and Beyşehir (MGM, 2011). The meteorological data were obtained from 1971 to 2011 for Beyşehir and from 1975 to 1996 in Şarkikaraağaç. The annual precipitation in the area is 478 mm, and the precipitation type is W. Sp. A. Sm. The most arid and hottest months are July and August, with a mean temperature of 28.8 °C. The mean annual temperature is 10.53 °C in the region. When the climatic data were applied to Emberger's formula of rain and temperature factors (Q: 49.63) it was determined that the research area has a Mediterranean semi-dry climate (Akman, 1990). The research area has characteristics of both Mediterranean and continental climates. The winters are colder and less rainy in the research area (Table 1). The highest temperatures are seen between July and October, and a dry spell occurs in this period. The lowest temperatures are seen from December to March, and there is likely to be frost in this period.

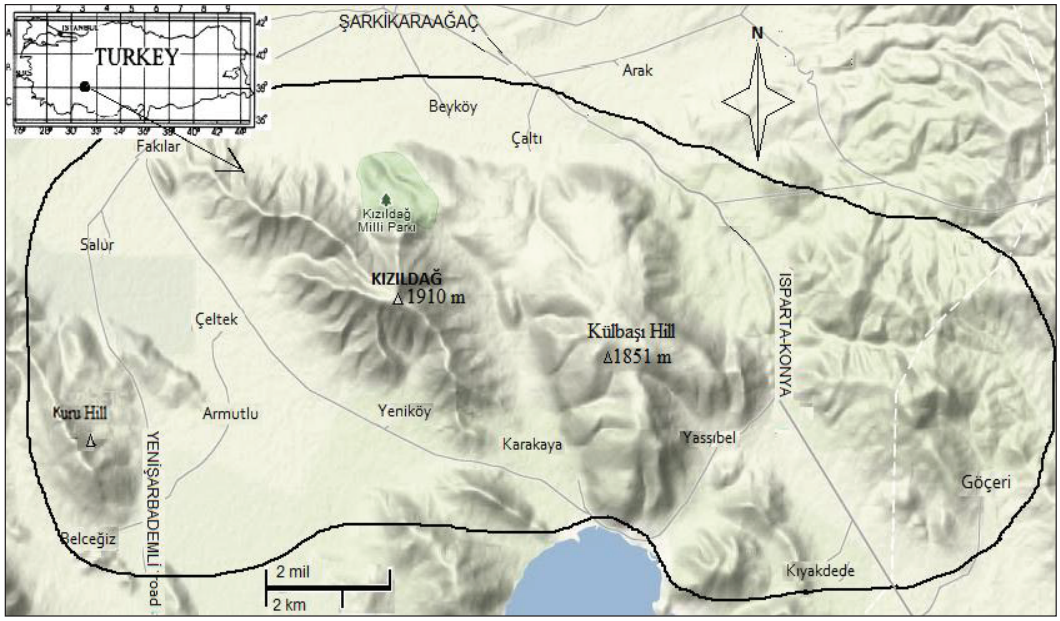

Figure 1. Geographic map of the study area. Dark line indicates the border of the research area.

A variety of different geological formations have composed the geological structure of the research area in different time periods. Mesozoic series are the oldest rocks around the villages of Belceğiz and Kızıldağ. Palaeozoic metamorphic elderly rocks are located in the north-east of Göçeri town. Serpentine and limestone constitute the main rock types in the area (Şenel, 1997). Serpentine rock is one form of ultramafic rock, an uncommon rock found in mountain-building zones. Serpentine rock is essentially a magnesium iron silicate formed by metamorphosis from peridotite. Soils formed from serpentine rock are usually reddish, brown, or grey in colour at the surface (Whittaker, 1954). Besides limestone rock, most of the Kızıldağ mountain consists of serpentine areas that are locally isolated from their rocky characteristics. Many local endemic species inhabit such serpentine areas (Duran et al., 2011).

Maroon soils are located around the villages of Yassıbel and Kıyakdede in the research area. These soils have an ABC profile and moderate limestone, and the amount of $CaCO_3$ increases towards the bottom of the profile. Limeless brown soils are present in the surroundings of Salur mountain pass and the environs of Göçeri town. These soils consist of calcareous, gravelly sandy clay and sandy clay blocks that are partly decomposed. Limeless brown forest soils also occur at the highest altitudes of Kızıldağ mountain where steppe vegetation was found. These soils are found on the schists, serpentine, and crystalline limestone. Base saturation and pH are high in these soils. Alluvial and colluvial soils used for agriculture are also found on the shore of Lake Beyşehir (KHGM, 1994).

3. Results

In this investigation 5 new plant associations belonging to forest, shrub, and steppe vegetation types were determined. The results of the analysis of 10 surface soil (0–30 cm) samples from different releves are presented in Table 2.

Table 1. Climatic data from the Şarkikaraağaç and Beyşehir stations.

Station	Altitude (m)	P (mm)	M (°C)	m (°C)	Q	PE	S	Precipitation regime	Bioclimate
Şarkikaraağaç (1975–1996)	1180	458.4	28.9	–5.3	47.03	56.6	1.96	W. Sp. A. Sm.	semi-dry, very cold
Beyşehir (1971–2011)	1141	497.7	29.2	–4.1	52.23	39.5	1.35	W. Sp. A. Sm.	semi-dry, very cold

Abbreviations: P (mm), annual precipitation; M (°C), mean maximum for the hottest month; m (°C), mean minimum for the coldest month; Q, Emberger's pluviometric quotient [2000 × P / (M + m + 546.4) (M – m)]; PE, summer rainfall; S, Emberger's index of xericity (PE/M); W, winter; Sp, spring; S, summer; A, autumn.

Table 2. Soil analyses of the associations.

Associations	Q. no.	Depth (cm)	Texture	pH	E.C. (µS/cm)	$CaCO_3$ %	O.M. %	Available elements (ppm)							
								P	Ca	K	Mg	Na	Fe	Mn	Zn	Cu
Veronico isauricae-	2	0–30	C	7.2	435	1.56	7.86	2.5	5582	408	387	15.1	49.4	21.6	0.6	0.68
Cedretum libani	7	0–30	CL	6.9	421	1.20	4.36	2.2	4711	324	396	14.2	41.5	31.0	0.9	0.46
Meliloto bicoloris-	13	0–30	CL	7.5	356	0.94	2.68	1.9	4750	455	363	15.1	11.6	55.6	8.0	1.27
Quercetum cocciferae	16	0–30	CL	7.6	286	1.14	2.85	6.8	5530	347	259	13.4	9.9	37.2	4.4	2.01
Hyperico heterophylli-	25	0–30	L	6.2	144	0.78	2.12	7.3	1969	57	256	12.9	12.7	46.4	0.5	0.29
Cistetum laurifolii	29	0–30	L	6.5	174	0.66	3.04	7.3	2027	74	241	15.2	13.2	43.8	0.8	0.38
Atraphaxo billardieri-	31	0–30	CL	7.3	626	0.78	4.36	41.7	6006	742	293	21.7	11.1	19.1	0.7	2.42
Amygdaletum orientalii	36	0–30	CL	7.0	582	1.13	3.92	38.4	5674	572	312	19.5	9.4	21.3	0.8	2.56
Centauro detonsae-	42	0–30	CL	6.7	261	1.56	4.64	2.7	1450	101	433	15.0	42.3	28.1	0.8	0.41
Thymetum sipylei	47	0–30	CL	6.9	286	0.87	5.20	2.6	1976	134	456	16.3	39.7	33.7	1.1	0.76

Abbreviations: C, clayey; L, loamy; E.C., electrical conductivity; O.M., organic matter; Q. no., quadrat number.

3.1. Forest vegetation

3.1.1. *Veronico isauricae-Cedretum libani* Sağlam ass. nova

Forest vegetation is commonly distributed between 1300 and 1650 m. *Cedrus libani* A.Rich. is dominant only on the northern side of Kızıldağ in this area. This association (holotype: Table 3, quadrat number: 2) occurs on the limeless brown forest soil formed by schist, serpentine, and crystal limestone. The soil of the association has a neutral character, has high organic matter, and is heavy clayey in texture. The available Fe and Mg are high in this soil. From a structural point of view this association shows a 3-layered structure. The coverage rates of tree, shrub, and herb layers are 70%–80%, 10%–20%, and 10%–25%; and the average heights are 22 m, 2 m, and 30 cm, respectively. Distributions of the life forms of associations are: 41.3% hemicryptophytes, 22% therophytes, 18.3% geophytes, 12.5% phanerophytes, and 6.7% chamaephytes. Characteristic and differential species of the association

Table 3. *Veronico isauricae-Cedretum libani* Sağlam ass. nova (*holotype: quadrat no.: 2).

Quadrat no.	1	*2	3	4	5	6	7	8	9	10		
Area (m^2) × 10	100	100	100	100	100	100	100	100	100	100	P	L
Altitude (m) × 10	141	145	143	140	146	140	143	143	136	148	r	i
Inclination (°)	15	20	30	20	35	25	30	20	20	30	e	f
Exposure	W	SW	N	W	NE	E	W	N	W	S	s	e
Tree cover (%)	75	75	80	80	80	80	80	70	75	75	e	
Average height of the tree layer (m)	25	18	22	25	20	25	22	22	25	18	n	f
Shrub cover (%)	15	15	20	15	15	20	15	15	15	20	c	o
Average height of the shrub layer (m)	2.5	2	2	2	1.5	2.5	2	2	2	1.5	e	r
Herb cover (%)	25	25	20	15	15	20	15	10	15	15		m
Average height of the herb layer (cm)	35	30	30	35	30	35	30	30	30	30		
Parent rock (Ser: serpentine)	Ser	Ser	Ser	Ser	Ser	Ser	Ser	Ser	Ser	Ser		
Characteristic species of association												
Cedrus libani	4	4	4	4	4	4	4	4	4	4	V	Ph
Veronica cuneifolia subsp. *isaurica*	1	1	1	1	.	1	1	.	1	.	IV	Ch
Colchicum burttii	.	1	.	1	1	1	.	1	.	+	III	G
Colutea melanocalyx subsp. *melanocalyx*	.	1	1	.	1	.	.	.	.	.	II	Np
Characteristic species of *Abieto-Cedrion*												
Veronica macrostachya subsp. *macrostachya*	.	1	+	.	+	+	+	1	.	.	III	Ch
Thlaspi perfoliatum	.	1	.	.	.	1	1	1	.	1	III	Th
Cephalorrhynchus tuberosus	+	.	.	.	+	+	.	.	.	.	II	G
Characteristic species of *Querco-Cedretalia Libani*												
Cotoneaster nummularia	1	1	2a	1	.	2a	1	1	2a	1	V	Np

Table 3. (Continued.)

Berberis crataegina	1	1	1	1	1	.	.	1	1	1	IV	Np
Cerastium brachypetalum subsp. *roeseri*	1	.	1m	1m	1m	.	1m	1	1	1	IV	Th
Trifolium speciosum	1	1	1	.	.	1	.	1	1	1	IV	Th
Viola kitaibeliana	+	+	+	.	1	.	1	1	.	1	IV	Th
Cerastium fragillimum	.	1m	1m	1	.	.	.	1	1	1	III	Th
Galium peplidifolium	1m	1m	.	.	1m	1m	1m	1m	.	.	III	Th
Briza humilis	.	1	.	1	.	1	1	.	1	.	III	Th
Geranium tuberosum subsp. *tuberosum*	.	.	.	.	+	+	.	+	+	.	II	G
Orthurus heterocarpus	.	+	.	.	+	.	.	+	.	+	II	H
Potentilla kotschyana	+	.	.	+	.	+	.	.	+	.	II	H
Bunium microcarpum subsp. *microcarpum*	1	1	.	.	.	1	.	.	1	.	II	G
Falcaria vulgaris	.	1	.	.	.	1	1	.	.	1	II	H
Juniperus excelsa	.	.	.	1	.	.	.	1	.	.	I	Ph
Milium vernale subsp. *vernale*	.	1	.	.	.	.	.	.	.	+	I	Th
Characteristic species of *Quercetea pubescentis*												
Teucrium chamaedrys subsp. *chamaedrys*	1	1	1m	1m	1	1	1m	1	1	1m	V	H
Quercus pubescens	1	.	1	1	.	1	1	1	1	2a	IV	Np
Silene italica	+	+	.	+	.	+	+	+	+	1	IV	H
Trifolium pannonicum subsp. *elongatum*	+	.	.	+	.	+	+	.	1	+	III	Th
Lathyrus digitatus	+	1	1	.	.	.	.	1	.	1	II	H
Lamium garganicum subsp. *reniforme*	1	.	.	.	1	.	1	1	.	1	III	H
Lathyrus laxiflorus subsp. *laxiflorus*	.	1	.	1	1	1	.	.	.	1	III	H
Festuca heterophylla	1	1	.	1	.	.	1	.	.	.	II	H
Pimpinella tragium subsp. *lithophila*	.	.	1	.	.	+	+	.	.	.	II	H
Silene pratensis subsp. *divaricata*	.	.	.	.	.	.	.	+	.	.	I	H
Characteristic species of *Quercetea ilicis*												
Juniperus oxycedrus subsp. *oxycedrus*	1	1	1	1	1	1	1	1	1	1	V	Ph
Lonicera etrusca var. *etrusca*	1	1	1	1	1	1	1	1	1	1	V	Np
Quercus coccifera	2a	2a	1	1	1	.	1	1	1	2a	V	Np
Jasminum fruticans	1	1	.	1	1	1	1	.	1	.	IV	Np
Ephedra major	.	1	.	.	1	.	.	.	.	1	II	Np
Piptatherum coerulescens	+	.	+	.	.	.	.	.	.	.	I	Th
Characteristic species of *Onobrychido armenae-Thymetalia leucostomi*												
Inula montbretiana	+	.	.	+	.	.	.	.	.	.	I	H
Malabaila secacul	1	.	1	.	.	.	.	.	.	.	I	H
Characteristic species of *Astragalo microcephali-Brometea tomentelli*												
Daphne oleoides subsp. *oleoides*	1	1	1	1	1	.	1	1	1	1	V	Ch
Anthemis tinctoria var. *tinctoria*	+	+	+	.	+	.	+	.	+	+	IV	H
Astragalus angustifolius subsp. *angustifolius*	.	1	1	1	1	.	.	1	1	1	IV	Ch
Aethionema iberideum	+	.	+	+	.	+	.	.	+	+	III	Ch
Scorzonera cana var. *jacquiniana*	+	+	.	+	.	+	+	.	.	+	III	H
Alyssum murale var. *murale*	1	1	1	.	.	1	1	.	.	.	III	H
Euphorbia kotschyana	+	.	.	.	.	+	.	+	.	.	II	H
Polygala anatolica	.	.	.	.	+	+	+	.	.	.	II	H
Potentilla recta	+	.	.	.	.	.	+	.	+	.	II	H
Companions												
Myosotis ramosissima subsp. *ramosissima*	.	1	1	.	1	1	1	1	1	1	IV	Th
Astragalus mesogitanus	.	1	1	.	1	+	+	.	+	+	IV	H
Crocus chrysanthus	.	1	1	1	1	.	1	.	1	1	IV	G
Crocus pallasii subsp. *pallasii*	1	1	1	1	1	.	1	.	.	1	IV	G
Medicago minima var. *minima*	.	1m	1m	.	.	1m	1m	1m	1	1	IV	Th
Dactylis glomerata subsp. *hispanica*	+	+	.	+	.	+	.	.	r	+	III	H
Ceterach officinarum	1	1	1	.	.	1	1	1	.	.	III	G
Sedum amplexicaule	1	1	.	.	1m	.	1m	.	1	1m	III	H
Asyneuma linifolium subsp. *linifolium*	.	+	.	.	+	+	+	.	.	1	III	H

Table 3. (Continued.)

Arabis caucasica subsp. *brevifolia*	1	.	1	.	.	1	.	1	.	1	III	H
Thymus sipyleus subsp. *sipyleus* var. *sipyleus*	1	.	1	1	1	.	.	.	1	.	III	Ch
Pilosella cymosa	1	1	+	+	.	.	.	.	+	.	III	H
Carex halleriana	+	.	1	.	.	+	.	.	+	.	II	H
Crepis pulchra subsp. *pulchra*	+	.	.	.	+	+	.	+	.	.	II	Th
Cruciata pedemontana	.	.	.	.	.	+	+	.	+	+	II	Th
Eryngium campestre var. *virens*	.	.	+	.	+	+	.	.	.	+	II	H
Fibigia eriocarpa	.	+	.	+	.	.	+	+	.	.	II	H
Muscari armeniacum	1	.	.	1	1	.	.	1	.	.	II	G
Ononis pusilla	+	.	.	.	.	.	+	+	+	.	II	H
Orchis mascula subsp. *pinetorum*	.	.	+	.	.	.	.	+	+	+	II	G
Rosa canina	1	.	.	.	1	.	.	1	.	1	II	Np
Torilis leptophylla	.	1	.	.	1	1	.	1	.	.	II	Th
Trifolium campestre	1	1	1	.	.	.	.	.	1	.	II	Th
Tripleurospermum callosum	+	.	.	+	+	.	.	.	+	.	II	H
Vinca herbaceae	1	.	+	1	1	.	.	.	.	.	II	H
Acantholimon caesareum	.	.	.	.	1	1	.	1	.	.	II	Ch
Bellevalia tauri	+	.	.	+	.	+	.	.	.	.	II	G
Centaurea triumfettii	.	.	1	.	.	+	.	+	.	.	II	H
Cheilanthes marantae	1	1	.	.	.	.	.	.	.	+	II	G
Chondrilla juncea	+	+	.	.	.	.	.	.	+	.	II	H
Galanthus elwesii	1	.	1	.	.	.	.	.	1	.	II	G
Geranium rotundifolium	.	1	.	+	.	.	+	.	.	.	II	Th
Iris schachtii	1	1	1	.	.	.	.	.	.	.	II	G
Poa bulbosa	1	1	.	.	.	.	.	1	.	.	II	G
Thlaspi ochroleucum	+	+	.	+	.	.	.	.	.	.	II	Th
Orchis mascula subsp. *pinetorum*	.	.	+	.	.	.	.	+	+	+	II	G
Ornithogalum narbonense	1	.	.	1	.	.	.	.	.	.	II	G
Ornithogalum armeniaca	.	.	.	.	.	+	+	.	.	.	II	G
Phleum montanum subsp. *montanum*	1	.	.	.	1	.	.	.	.	1	II	H
Ranunculus argyreus	.	.	.	.	.	1m	1m	1m	.	.	II	H
Pilosella hoppeana subsp. *pilisquama*	1	.	.	+	.	.	.	+	.	.	II	H
Pilosella piloselloides subsp. *megalomastrix*	.	.	.	.	.	.	.	.	+	+	II	H
Allium paniculatum subsp. *paniculatum*	1	.	.	.	.	.	.	.	1	.	I	G
Asyneuma virgatum subsp. *virgatum*	.	+	.	.	.	.	.	+	.	.	I	H
Avena barbata subsp. *barbata*	+	.	.	.	.	.	+	.	.	.	I	Th
Bromus sterilis	.	1	.	.	.	.	.	.	.	1	I	Th
Celtis tournefortii	1	.	.	.	.	.	.	.	.	1	I	Np
Fritillaria whittallii	1	.	1	.	.	.	.	.	.	.	I	G
Geranium lucidum	.	1	.	.	.	.	.	.	.	1	I	Th
Leontodon hispidus var. *hispidus*	+	.	.	.	.	.	.	.	+	.	I	H
Linaria simplex	r	.	.	.	.	.	.	+	.	.	I	Th
Scutellaria galericulata	1	.	.	.	.	.	.	+	.	.	I	H
Trifolium pratense subsp. *pratense*	1	1	.	.	.	.	.	.	.	.	I	Th
Ajuga chamaepitys subsp. *chia* var. *chia*	1	.	.	.	.	.	.	.	.	.	I	H
Anchusa undulata subsp. *hybrida*	.	.	.	.	.	1	.	.	.	.	I	H
Lathyrus saxatilis	+	.	.	.	.	.	.	.	.	.	I	H

Abbreviations: Ph, phanerophytes; Np, nanophanerophytes; Ch, chamaephytes; H, hemicryptophytes; Th, therophytes; G, geophytes; · = not present; r = 1 individual, (small plant); + = 2–5 (small) individuals, cover <5%; 1 = 6–50 individuals, cover <5% or few larger individuals (often given as 1–5) with a cover up to 5%; 1m = many individuals (>50), cover < 5%; 2a = cover 5%–12.4%; 2b = cover 12.5%–25%; 3 = cover 26%–50%; 4 = cover 51%–75%; and 5 = cover 76%–100%.

Table 4. *Meliloto bicoloris-Quercetum cocciferae* Sağlam ass. nova (*holotype: quadrat no.: 11).

Quadrat no.	*11	12	13	14	15	16	17	18	19	20		
Area (m^2)	400	400	400	400	400	400	400	400	400	400	P	L
Altitude (m) × 10	113	126	127	130	128	126	124	125	125	129	r	i
Inclination (°)	10	10	45	20	20	25	30	20	25	25	e	f
Exposure	S	N	N	N	S	NE	E	N	NE	S	s	e
Tree cover (%)	5	0	0	0	0	0	0	5	0	0	e	
Shrub cover (%)	80	80	75	75	80	70	70	70	75	85	n	f
Average height of the shrub layer (m)	1.5	1.4	1.3	1.2	1.2	1	1	0.8	0.8	2.5	c	o
Herb cover (%)	30	20	20	15	15	10	20	15	15	20	e	r
Average height of the herb layer (cm)	35	30	30	30	30	30	30	25	20	35		m
Parent rock (Lim: limestone)	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim		
Characteristic species of association												
Quercus coccifera	4	4	4	4	4	3	3	3	3	4	V	Np
Astragalus campylosema subsp. *atropurpureus*	+	+	+	+	+	+	.	+	.	+	IV	H
Melilotus bicolor	1	.	1	1	1	1	1	.	.	.	III	Th
Prangos meliocarpoides var. *meliocarpoides*	.	.	+	+	.	+	.	+	.	+	III	H
Characteristic species of *Querco-Cedretalia libani*												
Briza humilis	1m	1m	1m	1	1m	1	1m	1m	1m	1m	V	Th
Cotoneaster nummularia	1	1	.	1	1	1	1	1	1	1	V	Np
Galium peplidifolium	1m	1m	1m	.	1m	.	1m	1m	1m	1m	IV	Th
Bunium microcarpum subsp. *microcarpum*	1	.	1	.	.	1	1	.	1	.	III	G
Cerastium brachypetalum subsp. *roeseri*	1	1	.	1	.	.	1	.	1	1	III	Th
Cerastium fragillimum	.	.	1m	1m	1m	.	.	1	1m	.	III	Th
Alyssum strigosum subsp. *cedrorum*	1	.	1m	.	.	.	1	.	.	+	II	Th
Juniperus excelsa	1	.	.	.	.	.	.	1	.	.	I	Ph
Milium vernale subsp. *vernale*	.	+	.	.	+	.	.	.	.	.	I	Th
Vicia cracca subsp. *stenophylla*	.	1	.	.	.	.	.	1	.	.	I	H
Characteristic species of *Quercetea pubescentis*												
Festuca heterophylla	1	1	1	+	+	+	+	+	.	+	V	H
Teucrium chamaedrys subsp. *chamaedrys*	1	1	1	1	1	1	1	1m	.	1m	V	H
Cephalanthera rubra	.	+	+	+	+	+	.	+	+	.	IV	G
Lathyrus digitatus	1	.	1	.	.	1	1	1	1	1	III	H
Lotus aegaeus	.	1	1	1	.	.	.	1	.	1	III	H
Silene italica	+	+	.	.	+	+	+	.	.	.	III	H
Clinopodium vulgare subsp. *vulgare*	1	.	.	.	.	1	.	.	.	1	II	H
Coronilla varia subsp. *varia*	1	.	+	.	+	.	.	.	.	.	II	H
Lamium garganicum subsp. *reniforme*	1	1	.	.	1	.	.	.	.	.	II	H
Crataegus monogyna subsp. *azarella*	.	.	.	.	1	.	.	.	.	1	I	Np
Salvia tomentosa	.	.	+	1	.	.	.	.	.	.	I	H
Characteristic species of *Quercetea ilicis*												
Jasminum fruticans	1	1	1	1	1	1	1	1	1	1	V	Np
Juniperus oxycedrus subsp. *oxycedrus*	1	1	1	1	1	1	2a	1	2a	2a	V	Ph
Rubia tenuifolia subsp. *doniettii*	+	+	+	1	.	1	+	.	+	+	VI	Ch
Characteristic species of *Onobrychido armenae-Thymetalia leucostomi*												
Galium verum subsp. *verum*	+	+	1	1	.	.	1	.	.	1	III	H
Hypericum aviculariifolium subsp. *depilatum*	1	1	.	1	1	1	.	1	.	.	III	H
Acantholimon acerosum var. *acerosum*	1	.	1	.	.	1	1	.	.	.	II	Ch
Hedysarum varium	.	+	+	+	+		.	.	.	.	II	H
Dianthus crinitus var. *crinitus*	.	1	.	.	.	.	.	1	.	1	II	H
Characteristic species of *Astragalo microcephali-Brometea tomentelli*												
Astragalus angustifolius subsp. *angustifolius*	2a	2a	2a	.	1	1	1	1	1	1	V	Ch
Helianthemum kotschyanum	+	.	+	+	.	+	+	+	+	+	IV	H

Table 4. (Continued.)

Anthemis tinctoria var. *tinctoria*	+	.	+	+	.	+	.	.	+	+	III	H
Alyssum murale var. *murale*	.	1	1	1	1	.	.	.	1	.	III	H
Euphorbia kotschyana	+	+	.	+	.	+	+	.	.	.	III	H
Teucrium polium	1	.	1	1	.	.	1	.	1	.	III	H
Centaurea virgata	.	+	.	+	.	.	+	.	.	+	II	H
Cruciata taurica	+	.	+	+	+	.	.	.	.	.	II	H
Globularia orientalis	1	1m	.	.	.	.	.	1	1	.	II	H
Minuartia anatolica var. *anatolica*	1m	.	.	1m		1m	.	.	1m	.	II	Th
Bolanthus minuartioides	.	.	1	.	.	.	1	.	.	+	II	H
Daphne oleoides subsp. *oleoides*	1	.	.	.	.	.	.	.	1	.	I	Ch
Dianthus zonatus var. *zonatus*	.	1	1	.	.	.	.	.	.	.	I	H
Silene spergulifolia	.	.	.	.	.	.	+	+	.	.	I	H
Companions												
Paronychia argyroloba	1m	1	1m	.	1	1	1	1	1	1m	V	H
Ononis pusilla	+	.	1	+	+	+	+	+	+	+	V	H
Pilosella cymosa	1	1	.	1	1	.	1	1	+	.	IV	H
Vincetoxicum canescens subsp. *canescens*	+	.	.	+	+	+	+	.	+	+	IV	H
Asperula arvensis	.	+	+	1	.	.	.	+	.	+	III	Th
Fumana procumbens	.	.	1	1	1	+	.	.	1	.	III	Ch
Koeleria brevis	.	.	+	+	.	+	+	.	+	.	III	H
Lotononis genistoides	1m	1m	.	.	1m	1m	.	.	.	1m	III	H
Trigonella velutina	.	.	+	+	+	+	.	.	.	+	III	Th
Leontodon crispus subsp. *asper* var. *asper*	+	+	+	+	.	.	+	.	.	.	III	H
Scutellaria salviifolia	+	.	.	+	+	+	+	.	.	.	III	H
Medicago minima var. *minima*	1m	1m	.	.	.	1	1m	.	1m	.	III	Th
Sedum album	.	1	.	.	1	.	1	1	1	.	III	H
Asyneuma limonifolium subsp. *limonifolium*	+	+	+	+	.	+	.	.	.	.	III	H
Acinos rotundifolius	1	1	.	1	.	.	1	.	.	1	III	Th
Adonis flammea	+	.	+	.	.	.	+	+	.	.	II	Th
Allium paniculatum subsp. *paniculatum*	.	.	.	1	.	1	1	1	.	.	II	G
Silene armena	+	1	+	.	+	.	.	.	.	.	II	H
Ziziphora persica	1	1	1	.	.	.	.	.	.	1	II	Th
Ajuga chamaepitys subsp. *chia* var. *chia*	.	+	.	.	+	.	.	.	.	+	II	H
Arrhenatherum kotschyi	+	.	.	.	.	+	.	.	.	+	II	G
Aubrieta pinardii	1	.	.	1	.	.	.	.	1	.	II	H
Hypericum scabrum	+	+	+	.	.	.	.	.	.	.	II	H
Jurinea consanguinea	+	+	.	.	.	.	.	.	+	.	II	H
Lens orientalis	1	.	1	.	1	.	.	.	.	.	II	Th
Logfia arvensis	.	+	1	1	.	.	.	.	.	.	II	Th
Pelargonium endlicherianum	.	+	+		.	.	.	+	.	.	II	H
Poa bulbosa	.	1	1	.	1	.	.	.	.	.	II	G
Sanguisorba minor subsp. *muricata*	+	+	.	.	.	.	.	.	.	+	II	H
Senecio vernalis		1	1	.	1	.	.	.	.	.	II	Th
Telephium imperati subsp. *orientale*	+	.	.	+	.	.	.	.	+	.	II	H
Thymus zygioides var. *lycaonicus*	.	.	.	1	.	1	1	.	.	.	II	Ch
Tragopogon longirostris subsp. *longirostris*	+	.	.	.	.	+	.	.	.	+	II	H
Aegilops geniculata	.	.	.	.	.	1m	.	.	1m	.	I	Th
Astragalus mesogitanus	1	.	.	+	.	.	.	.	.	.	I	H
Astragalus oxytropifolius	+	.	.	.	.	.	+	.	.	.	I	H
Crepis foetida subsp. *foetida*	.	.	.	.	+	.	+	.	.	.	I	H
Crepis macropus	.	+	.	.	.	.	.	.	.	+	I	H
Fibigia eriocarpa	+	+	.	.	.	.	.	.	.	.	I	H
Galium floribundum subsp. *floribundum*	.	.	.	1m	.	1m	.	.	.	1m	I	Th
Scutellaria orientalis subsp. *alpina* var. *alpina*	.	1m	.	.	.	.	.	.	.	1	I	H
Galium verticillatum	1	.	.	.	1	.	.	.	.	.	I	Th

Table 4. (Continued.)

Herniaria glabra	.	1	1	.	.	.	.	.	.	.	I	H
Johrenia tortuosa	+	.	.	.	.	+	.	.	.	.	I	H
Astragalus micropterus	.	.	.	.	.	1	1	.	.	.	I	Ch
Pterocephalus pinardii	1	.	.	.	.	1m	.	.	.	.	I	H
Torilis leptophylla	1	1	.	.	.	.	.	.	.	.	I	Th
Trigonella astroides	.	.	.	.	.	+	.	+	.	.	I	Th
Trigonella lunata	.	.	.	.	.	.	+	+	.	.	I	Th
Valerianella coronata	+	+	.	.	.	.	.	.	.	.	I	H
Vincetoxicum fuscatum subsp. *fuscatum*	.	+	.	.	.	.	.	r	.	.	I	H
Vulpia fasciculata	.	1m	.	.	.	.	1m	.	.	.	I	Th
Lathyrus aphaca	.	.	.	.	+	.	.	.	.	.	I	H
Silene ispartensis	+	.	.	.	.	.	.	.	.	.	I	H
Silene otites	.	.	+	.	.	.	.	.	.	.	I	H

are *Cedrus libani* A.Rich., *Veronica cuneifolia* D.Don. subsp. *isauricae* P.H.Davis, *Colchicum burttii* Meikle, and *Colutea melanocalyx* Boiss. & Heldr. subsp. *melanocalyx* Boiss. & Heldr. This association is described by 10 sample plots on the northern slope of Kızıldağ mountain, and given the coordinates of the quadrats, ranges between 31°21′34″ and 31°22′26″E in longitude and 38°03′20″ and 38°01′58″N in latitude. The collection dates for the quadrats are as follows: 1–4: 16.05.2010; 5–7: 17.06.2010; 8–10: 01.07.2011.

3.2. Macchie vegetation

3.2.1. *Meliloto bicoloris-Quercetum cocciferae* Sağlam ass. nova

This association (holotype: Table 4, quadrat number: 11) occurs from Zeybek hill to the villages of Karakaya and Kıyakdede at altitudes of 1100–1350 m on the maroon soils formed by metamorphic elder rocks. The soil of this association has a slightly basic character, low organic matter, and is clayey-loamy in texture. This association exhibits shrub and herb layers. Total coverage of shrub layers is between 70% and 85% and reaches between 0.8 m and 2.5 m in height. Total coverage of herb layers is between 10% and 30% and reaches 20–35 cm in height. Distributions of the life forms of association are: 58.2% hemicryptophytes, 23.3% therophytes, 4.9% geophytes, 6.8% phanerophytes, and 6.8% chamaephytes. The characteristic and differential species of the association are *Q. coccifera* L., *Astragalus campylosema* Boiss. subsp. *atropurpureus* (Boiss.) Chamberlain, *Melilotus bicolor* Boiss. & Bal., and *Prangos meliocarpoides* Boiss. var. *meliocarpoides* Boiss. This association is described between Göçeri, Kıyakdede, and Karakaya villages by 10 sample plots, and the coordinates of the releves range between 37°58′01″ and 38°03′12″E and 31°22′36″ and 31°31′22″N. The localities and collecting dates of the quadrats are as follows:

Quadrat no.	Date	Locality
11–14	16.05.2010	between Karakaya village and Göçeri town
15–17	05.06.2010	east of Külbaşı hill
18–19	25.05.2011	between Kıyakdede and Yassıbel villages
20	16.06.2011	west of Külbaşı hill

3.2.2. *Hyperico heterophylli-Cistetum laurifolii* Sağlam ass. nova

This association (holotype: Table 5, releve number: 23) is dominant on the north side of Göçeri town and at 1350–1540 m. The soils of the association consist of the limeless brown soil, which is formed by metamorphic elder rocks. These soils are acidic and loamy in texture, and have an average organic matter of 2.58%. Because of the high inclination and erosion, available macroelements (Ca, K, Mg, and Na), microelements (Zn and Cu), organic matter, and salt are low. As a result, the floristic composition of this association is poor. This association is composed of shrub and herb vegetation layers. The general coverage of the shrub layer ranges from 75% to 90%, and heights range from 1 to 1.5 m. Total coverage of the herb layer is between 10% and 30%, and ranges from 20 to 30 cm in height. Distributions of the life forms of association are: 39.6% hemicryptophyte, 28.3% therophyte, 3.8% geophyte, 19% phanerophyte, and 9.4% chamaephyte. The characteristic and differential species of the association are *C. laurifolius* L., *Hypericum heterophyllum* Vent., and *Trifolium hirtum* All. This association is described in the north-east of Göçeri town by 10 sample plots. The coordinates of the quadrats range between 38°01′00″ and 38°01′58″E and 31°28′02″ and 31°31′29″N. The collecting dates of the quadrats are as follows: 21–23: 15.05.2010; 24–26: 11.06.2011; 27–30: 30.06.2011.

Table 5. *Hyperico heterophylli-Cistetum laurifolii* Sağlam ass. nova (*holotype: quadrat no.: 23).

Quadrat no.	21	22	*23	24	25	26	27	28	29	30		
Area (m^2)	200	200	200	200	200	200	200	200	200	200	P	L
Altitude (m) × 10	143	145	146	151	154	153	147	140	138	135	r	i
Inclination (°)	15	35	20	30	25	25	40	40	30	30	e	f
Exposure	NE	N	E	E	NE	S	N	N	S	W	s	e
Tree cover (%)	10	5	10	5	5	0	5	0	0	0	e	
Average height of the tree layer (m)	3	3	3.5	3	3	.	3	.	.	.	n	f
Shrub cover (%)	90	80	80	80	80	80	90	75	80	90	c	o
Average height of the shrub layer (m)	1.2	1	1.2	1	1.3	1	1	1.2	1	1.5	e	r
Herb cover (%)	20	15	25	10	10	25	15	25	10	20		m
Average height of the herb layer (cm)	20	20	20	20	20	25	25	25	30	30		
Parent rock (Lim: limestone)	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim		
Characteristic species of association												
Cistus laurifolius	4	4	4	4	4	4	4	4	4	4	V	Np
Hypericum heterophyllum	1	2a	2a	1	1	1	1	2a	1	1	V	Ch
Trifolium hirtum	1m	1	1	1m	+	1m	1	.	1	.	V	Th
Characteristic species of *Querco-Cedretalia libani*												
Dorycnium pentaphyllum subsp. *anatolicum*	1	1	1m	1m	.	1m	1	1m	1	1	V	Ch
Falcaria vulgaris	.	1	1	.	1	.	.	1	.	1	III	H
Berberis crataegina	.	.	1	.	1	.	1	.	.	1	II	Np
Cerastium fragillimum	1	.	1	.	.	1	1	.	.	1	II	Th
Coronilla varia subsp. *varia*	+	+	+	.	.	.	.	+	+	.	III	H
Crataegus monogyna subsp. *azarella*	1	.	1	.	.	.	.	.	1	1	II	Np
Trifolium speciosum	1	.	.	.	.	1	.	1	.	1	II	Th
Cotoneaster nummularia	.	.	.	.	1	.	.	1	.	1	II	Np
Juniperus excelsa	1	1	1	.	.	.	.	.	.	.	II	Ph
Vicia cracca subsp. *stenophylla*	.	+	+	.	.	.	.	+	.	.	II	H
Milium vernale subsp. *vernale*	.	.	+	+	.	.	.	.	.	.	I	Th
Characteristic species of *Quercetea pubescentis*												
Lathyrus digitatus	1	1	1	1	+	+	+	1	+	+	V	H
Lotus aegaeus	1	+	+	1	+	+	+	1	+	+	V	H
Teucrium chamaedrys subsp. *chamaedrys*	1	1	.	.	1	.	1	1	.	1	III	H
Cephalanthera rubra	.	+	+	+	.	.	.	+	+	.	III	G
Festuca heterophylla	+	.	+	.	.	+	.	+	.	.	II	H
Hypericum perforatum	1	.	.	.	.	1	.	1	.	.	II	H
Quercus pubescens	.	.	.	1	1	.	1	.	.	.	II	Np
Characteristic species of *Quercetea ilicis*												
Juniperus oxycedrus subsp. *oxycedrus*	1	.	1	1	1	1	.	.	1	1	IV	Ph
Quercus coccifera	1	.	.	.	1	.	.	1	1	1	III	Np
Jasminum fruticans	.	.	.	.	.	.	1	1	.	1	II	Np
Characteristic species of *Onobrychido armenae-Thymetalia leucostomi*												
Taeniatherum caput-medusae subsp. *crinitum*	.	1m	1	.	1	1	1	1	1	.	IV	Th
Astragalus vulneraria	1	.	.	.	.	.	.	1	+	.	II	Ch
Galium verum subsp. *verum*	1	.	1	1	.	.	.	.	.	.	II	H
Characteristic species of *Astragalo microcephali-Brometea tomentelli*												
Bolanthus minuartioides	1	1	1	1	.	1	1	.	.	.	III	H
Astragalus angustifolius subsp. *angustifolius*	1	.	.	1	.	1	.	.	1	.	II	Ch
Leontodon asperrimus	.	+	+	.	.	+	.	.	+	.	II	H
Festuca valesiaca	1	1	.	.	.	.	.	.	.	.	I	H
Companions												
Trifolium arvense	1m	1m	1	1m	1	1	1	1	1	1	V	Th
Pilosella hoppeana subsp. *cilicica*	+	+	+	.	.	+	.	+	.	+	III	H

Table 5. (Continued.)

Pilosella piloselloides subsp. *megalomastrix*	.	.	+	+	+	.	.	+	+	+	III	H
Vicia lathyroides	1	.	.	1	.	1	.	1	1	1	III	Th
Chamaecytisus pygmaeus	.	1	.	1	.	.	1	1	1	.	III	Ch
Medicago sativa subsp. *sativa*	+	+	+	.	.	+	.	.	+	.	III	H
Trifolium lucanicum	.	.	+	+	+	+	.	.	+	.	III	Th
Crocus pallasii subsp. *pallasii*	1	.	.	1	.	1	.	1	.	.	II	G
Phleum montanum subsp. *serrulatum*	.	.	.	.	.	+	1	1	1	.	II	H
Thesium billardieri	.	.	.	+	+	+	.	+	.	.	II	H
Bromus sterilis	1m	.	.	.	.	.	1m	1m	.	.	II	Th
Genista lydia subsp. *lydia*	+	.	.	.	+	+	.	.	.	.	II	Ch
Rosa canina	.	.	1	.	.	.	.	1	.	1	II	Np
Scutellaria salviifolia	.	.	+	.	.	.	+	+	.	.	II	H
Trifolium campestre	.	1	.	.	.	.	.	1	.	1	II	Th
Astragalus mesogitanus	1	.	.	.	.	.	.	1	.	.	I	H
Dactylis glomerata subsp. *hispanica*	.	.	.	+	.	+	.	.	.	.	I	H
Euphorbia herniariifolia var. *glaberrima*	+	.	.	.	.	+	.	.	.	.	I	H
Lens orientalis	.	.	.	.	.	.	.	.	1	1	I	Th
Logfia arvensis	1	.	.	.	.	.	.	.	.	1	I	Th
Pterocephalus plumosus	.	1m	.	.	.	.	1m	.	.	.	I	Th
Crucianella latifolia	.	+	.	.	.	.	.	.	.	.	I	Th

3.2.3. *Atraphaxo billardieri-Amygdaletum orientalii* Sağlam ass. nova

This association (holotype: Table 6, quadrat number: 37) has developed on the limeless brown soils from 1150 to 1230 m on the south side of the Salur village. The soil properties of the association are slightly salty and rich with available macro elements such as Ca, K, and P. This association exhibits 2 vegetation layers. The shrub layer is 0.8–1.5 m in height, with a 65%–55% general cover. Total coverage of the herb layer is between 15% and 25%, and reaches 25–35 cm in height. The distributions of the life forms of association are: 42% hemicryptophytes, 39.2% therophytes, 5.9% geophytes, 9.8% phanerophytes, and 3% chamaephytes. The characteristic and differential species of the association are *A. orientalis* Mill., *Atraphaxis billardieri* Jaub. & Spach var. *billardieri* Jaub. & Spach, *Salvia heldreichiana* Boiss. ex Bentham, *Silene squamigera* Boiss. subsp. *vesiculifera* (J.Gay ex Boiss.) Coode & Cullen, and *Centaurea cariensis* (Boiss.) subsp. *longipapposa* Wagenitz. Because of the low coverage and height of the shrub layer, the floristic composition of this association exhibits the characteristic species of the syntaxa belonging to both steppe and forest vegetations equally. The association is attached to the order of *Querco-Cedretalia libani*. No plant species was determined for the alliances belonging to the order of *Querco-Cedretalia libani* for this association. This association is described by 10 sample plots in Salur mountain pass located between Armutlu and Salur villages. The coordinates of the quadrats range between 38°00′28″ and 38°01′47″E and 31°16′29″ and 31°17′57″N. The localities and collecting dates of the quadrats are as follows:

Quadrat no.	Date	Locality
31–35	18.05.2010	south of Salur village
36–38	15.06.2011	north-east of Kuru hill
39–40	01.07.2011	between Salur and Armutlu villages

3.3. Steppe vegetation

3.3.1. *Centauro detonsae-Thymetum sipylei* Sağlam ass. nova

This association (holotype: Table 7, quadrat number: 43) occupies the limeless brown forest soils on the summit of Kızıldağ mountain with an inclination 5°–15° at 1860–1900 m. These soils are neutral (pH 6.8), clayey-loamy in texture, and have an average organic matter of 4.92%. The available Fe and Mg are high, but available Ca is low in these soils. The floristic composition of this association is well developed due to the well drained soils formed by serpentine parent rock. The distributions of the life forms of association are: 52% hemicryptophytes, 12.5% therophytes, 16.6% geophytes, and 18.8% chamaephytes. The characteristic and differential species of the association are *Thymus sipyleus* Boiss. subsp. *sipyleus* Boiss. var. *sipyleus* L., *Centaurea drabifolia* Sm. subsp. *detonsa* (Bornm.) Wagenitz., *Helichrysum arenarium* (L.) Moench. subsp. *aucheri* (Boiss.) Davis & Kupicha, *Tulipa sylvestris* L., *Onosma aksoyii* Aytaç & Türkmen, *Ferulago aucheri* Boiss., and *Silene ozyurtii* Aksoy & Hamzaoğlu. The coordinates of the releves range between 31°21′53″ and 31°21′50″E and 38°01′32″ and 38°01′12″N. All the quadrats of this association were taken from the summit

Table 6. *Atraphaxo billardieri-Amygdaletum orientalii* Sağlam ass. nova (*holotype: quadrat no.: 37).

Quadrat no.	31	32	33	34	35	36	*37	38	39	40		
Area (m^2)	200	200	200	200	200	200	200	200	200	200	P	L
Altitude (m) × 10	115	118	119	121	122	123	122	121	121	120	r	i
Inclination (°)	10	25	30	30	30	20	25	20	20	20	e	f
Exposure	S	W	E	N	W	N	NE	E	NE	E	s	e
Tree cover (%)	0	5	5	5	5	5	5	10	5	0	e	
Average height of the tree layer (m)	.	2.5	2.5	2.5	2	2.5	2.5	2.5	2.5	.	n	f
Shrub cover (%)	60	65	60	60	60	55	60	65	65	65	c	o
Average height of the shrub layer (m)	1.5	1.5	1.2	1.2	1.3	1.3	1.2	1.2	0.8	1	e	r
Herb cover (%)	20	20	15	15	20	20	25	15	15	15		m
Average height of the herb layer (cm)	35	35	35	35	30	30	30	30	25	30		
Parent rock (Lim: limestone)	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim	Lim		
Characteristic species of association												
Amygdalus orientalis	3	3	3	3	3	3	3	3	3	3	V	Np
Atraphaxis billardieri var. *billardieri*	1	1	1	1	1	1	1	1	1	1	IV	Np
Salvia heldreichiana	.	.	1	1	1	.	.	1	1	1	III	H
Silene squamigera subsp. *vesiculifera*	+	.	.	+	.	+	+	+	+	.	III	Th
Centaurea cariensis subsp. *longipapposa*	.	+	+	.	.	.	+	+	.	.	II	H
Consolida raveyi	.	.	.	1	.	1	1	1	.	.	II	Th
Asphodeline anatolica	+	.	.	.	+	.	+	.	.	.	II	G
Characteristic species of *Querco-Cedretalia libani*												
Berberis crataegina	.	1	1	1	1	1	1	1	1	1	V	Np
Cerastium fragillimum	.	1	1	1	1	1	1m	1m	.	.	IV	Th
Cerastium brachypetalum subsp. *roeseri*	1	1	1	.	1	.	1	.	.	1	III	Th
Cotoneaster nummularia	.	.	.	.	1	1	1	1	1	1	III	Np
Galium peplidifolium	1	1m	.	.	.	.	1m	.	1m	1m	III	Th
Viola kitaibeliana	+	.	+	.	.	+	+	.	.	+	III	Th
Bunium microcarpum subsp. *microcarpum*	1	.	1m	1m	.	.	.	.	.	.	II	G
Juniperus foetidissima	.	.	.	1	.	1	.	1	.	.	II	Ph
Characteristic species of *Quercetea pubescentis*												
Alyssum strigosum subsp. *cedrorum*	1	1	1	1m	.	1m	1m	1	1	1	V	Th
Quercus pubescens	.	1	1	.	1	.	1	1	1	.	III	Np
Crataegus monogyna subsp. *azarella*	.	1	1	.	1	1	.	1	.	.	III	Np
Lamium garganicum subsp. *reniforme*	.	.	+	.	.	.	+	.	+	.	II	H
Teucrium chamaedrys subsp. *chamaedrys*	.	.	.	.	.	1	1	1	.	.	II	H
Festuca heterophylla	.	.	.	+	.	.	.	+	.	.	I	H
Characteristic species of *Quercetea ilicis*												
Juniperus oxycedrus subsp. *oxycedrus*	.	.	1	1	1	1	1	.	1	1	IV	Ph
Pistacia terebinthus subsp. *palaestina*	1	1	1	.	.	.	1	1	.	.	III	Np
Jasminum fruticans	1	.	1	.	.	.	1	1	.	1	III	Np
Characteristic species of *Onobrychido armenae-Thymetalia leucostomi*												
Callipeltis cucullaria	.	.	1m	1	1	1	1	.	1	1	IV	Th
Taeniatherum caput-medusae subsp. *crinitum*	1	1	.	.	.	.	1	1m	.	1	III	Th
Salvia cryptantha	.	.	.	+	+	1	+	.	.	+	III	H
Stachys cretica subsp. *anatolica*	+	+	.	.	.	.	+	.	+	.	II	H
Hypericum avicullariifolium subsp. *depilatum*	.	1	.	.	.	1	.	1	.	.	II	H
Scabiosa argentea	+	+	+	.	.	.	.	.	.	.	II	H
Dianthus anatolicus	.	.	.	+	.	+	.	.	.	.	I	H
Characteristic species of *Astragalo microcephali-Brometea tomentelli*												
Astragalus angustifolius subsp. *angustifolius*	1	1	.	1	1	1	1	1	1	1	V	Ch
Sideritis montana subsp. *montana*	1	1	+	1	+	.	+	.	.	+	IV	H
Euphorbia kotschyana	+	+	+	+	.	.	+	.	+	.	III	H
Anthemis tinctoria var. *tinctoria*	+	.	+	+	.	+	.	.	.	+	III	H
Allium scorodoprasum subsp. *rotundum*	1	1	.	.	1	1	1	.	.	.	III	G
Minuartia anatolica var. *anatolica*	.	.	.	1m	.	1m	1m	.	.	1m	II	Th

Table 6. (Continued.)

Campanula stricta var. *stricta*	+	+	.	.	.	.	.	+	.	.	II	H
Koeleria cristata	+	+	.	.	.	.	+	.	.	.	II	H
Teucrium polium	1	1	.	.	.	.	.	1	.	.	II	H
Ziziphora capitata	1	.	.	.	1	1	.	.	.	.	II	Th
Companions												
Asyneuma linifolium subsp. *linifolium*	+	+	1	+	.	.	+	.	+	+	IV	H
Crepis sancta	1	1	1	1	.	1	.	1	.	1	IV	Th
Galium verum subsp. *glabrescens*	.	1	1	1	.	1	1	1	.	1	IV	H
Legousia pentagonia	1	1	.	1m	1	.	1	1m	.	1	IV	Th
Torilis leptophylla	1	1	1	.	.	1	.	1	1	1	IV	Th
Aegilops triuncialis	1m	1m	.	.	1m	.	1m	.	1m	1m	IV	Th
Crocus pallasii subsp. *pallasii*	1	1	1	.	.	.	1	1	1	.	III	G
Echinaria capitata	1	1m	.	.	1m	1m	.	1	.	1	III	Th
Galium verticillatum	1	.	1	.	1	1	1	.	.	1	III	Th
Medicago minima var. *minima*	.	1	.	.	1	.	1	.	1	1	III	Th
Onosma armenum	+	+	.	.	.	+	+	.	+	+	III	H
Sanguisorba minor subsp. *muricata*	+	.	.	+	+	+	+	.	.	+	III	H
Acinos rotundifolius	.	.	1	.	1	.	1	1	.	1	III	Th
Astragalus strictifolius subsp. *kutepovii*	1	1	1	1	.	.	.	1	.	.	III	Ch
Avena barbata subsp. *barbata*	+	+	.	.	.	.	1	.	+	+	III	Th
Bombycilaena erecta	1	1m	1m	.	.	.	1	.	.	1m	III	Th
Minuartia montana subsp. *wiesneri*	1	1	.	.	.	1	1	.	1	.	III	H
Sedum sartorianum subsp. *sartorianum*	1	1	1	.	.	.	1	1	.	.	III	H
Aegilops umbellulata subsp. *umbellulata*	1m	1m	.	1m	.	1m	.	.	.	.	II	Th
Allium paniculatum subsp. *paniculatum*	.	.	+	.	+	.	+	.	.	+	II	G
Catapodium rigidum subsp. *rigidum*	1	1	1	.	.	.	.	.	1	.	II	Th
Centaurea solstitialis	+	+	+	.	.	.	.	.	1	.	II	Th
Bromus japonicus subsp. *japonicus*	.	.	.	.	.	1	1	.	1	1	II	Th
Bromus sterilis	1	1	.	.	.	.	1	.	.	1	II	Th
Cerastium banaticum	.	.	+	+	.	+	.	.	+	.	II	Th
Crupina crupinastrum	1	1	.	.	.	1	1	.	.	.	II	Th
Dianthus zonatus var. *aristatus*	.	.	.	.	+	+	+	.	+	.	II	H
Eryngium campestre var. *virens*	+	+	+	.	+	.	.	.	.	.	II	H
Erysimum crassipes	+	+	+	.	.	.	.	.	+	.	II	H
Nigella arvensis var. *glauca*	.	+	.	.	+	.	+	.	+	.	II	Th
Onobrychis pisidica	.	+	.	+	.	+	.	1	.	.	II	H
Scabiosa rotata	1	+	.	.	.	+	.	1	.	.	II	Th
Stachys annua subsp. *annua*	+	+	+	+	.	.	.	.	.	.	II	H
Bromus tectorum	1	1	.	1m	.	.	.	.	.	.	II	Th
Euphorbia falcata subsp. *macrostegia*	.	+	.	.	.	.	.	.	+	+	II	Th
Galium dumosum	.	.	.	1	1	.	.	.	1	.	II	H
Micromeria myrtifolia	.	.	1m	1m	.	.	.	1m	.	.	II	H
Orobanche caucasica	.	.	.	+	+	+	.	.	.	.	II	H
Picnomon acarna	+	+	.	.	.	.	+	.	.	.	II	Th
Poa bulbosa	1	1	.	.	.	1	.	.	.	.	II	G
Pterocephalus pinardii	+	+	.	.	.	.	.	.	+	.	II	H
Pterocephalus plumosus	1	1m	.	1	.	.	.	.	.	.	II	Th
Scandix stellata	.	.	.	.	1m	.	1	1m	.	.	II	Th
Melica penicillaris	.	.	.	.	.	1	1	.	.	.	I	H
Coronilla scorpioides	.	.	+	.	.	+	.	.	.	.	I	Th
Acanthus hirsutus	.	.	.	.	.	+	.	.	1	.	I	H
Adonis flammea	1	.	.	.	.	.	1	.	.	.	I	Th
Anchusa undulata subsp. *hybrida*	.	.	.	.	.	+	.	.	+	.	I	H
Aristolochia maurorum	.	.	.	.	.	+	+	.	.	.	I	H
Camelina rumelica	.	.	.	+	+	.	.	.	.	.	I	Th
Carex halleriana	.	.	.	.	.	+	.	.	.	+	I	H
Crepis macropus	.	.	1	.	1	.	.	.	.	.	I	H
Crucianella macrostachya	.	.	+	.	+	.	.	.	.	.	I	Th
Pelargonium endlicherianum	.	.	.	.	.	+	+	.	.	.	I	H

Table 7. *Centauro detonsae-Thymetum sipylei* Sağlam ass. nova (*holotype: quadrat no.: 43).

Quadrat no.	41	42	*43	44	45	46	47	Presence from	Life from
Area (m^2)	50	50	50	50	50	50	50		
Altitude (m) × 10	190	189	187	189	186	190	187		
Inclination (°)	15	15	10	15	10	15	5		
Exposure	W	SW	SW	S	W	SW	S		
Coverage of the herb layer (%)	90	90	90	80	75	80	80		
Average height of the herb layer (cm)	25	25	30	25	30	25	25		
Parent rock (Ser: serpentine)	Ser	Ser	Ser	Ser	Ser	Ser	Ser		
Characteristic species of association									
Thymus sipyleus subsp. *sipyleus* var. *sipyleus*	3	3	3	3	3	3	3	V	Ch
Centaurea drabifolia subsp. *detonsa*	1	1	1	1	1	1	1	V	H
Helichrysum arenarium subsp. *aucheri*	1	1	1	1	1	1	1	V	H
Tulipa sylvestris	1	1	1	1	1	1	1	V	G
Onosma aksoyii	+	+	.	+	+	.	.	III	H
Ferulago aucheri	+	.	+	.	.	+	.	III	H
Silene ozyurtii	.	1	1	1	.	.	.	III	H
Characteristic species of *Phlomido armeniacae-Astragalion microcephali*									
Astragalus plumosus subsp. *plumosus*	1	1	1	1	1	1	1	V	Ch
Hypericum aviculariifolium subsp. *depilatum*	1	1	.	.	1	.	1	III	H
Alyssum pateri subsp. *pateri*	.	.	1	.	1	.	1	II	H
Characteristic species of *Onobrychido armenae-Thymetalia leucostomi*									
Astragalus vulneraria	2a	2a	2a	1	2a	2a	2a	V	Ch
Convolvulus compactus	1	2a	2a	1	1	1	1	V	Ch
Taeniatherum caput-medusae subsp. *crinitum*	1	1	.	1	.	1	1	IV	Th
Bromus cappadocicus subsp. *cappadocicus*	.	1	1	.	+	.	.	III	H
Fumana aciphylla	1	.	1	.	.	1	.	III	H
Characteristic species of *Astragalo microcephali-Brometea tomentelli*									
Minuartia juniperina	1m	1m	1m	1m	1m	1m	1m	V	H
Astragalus angustifolius subsp. *angustifolius*	.	1	1	2a	1	2a	1	V	Ch
Acantholimon ulucinum var. *ulucinum*	1	1	1	1	1	.	.	IV	Ch
Cruciata taurica	+	.	+	+	.	+	+	IV	H
Veronica multifida	+	+	+	.	.	+	+	IV	Ch
Festuca valesiaca	1	1	.	.	1	1	.	III	H
Myosotis lithospermifolia	.	+	1	.	1	.	1m	III	H
Allium flavum subsp. *tauricum* var. *tauricum*	1	.	1	1	.	.	.	III	G
Alyssum murale var. *murale*	1	.	1	.	1	.	.	III	H
Bromus tomentellus	.	.	.	1	1	1	.	III	H
Minuartia anatolica var. *polymorpha*	1m	1m	.	.	1m	.	.	III	Th
Poa alpina subsp. *fallax*	.	.	1	1	.	1	.	III	H
Anthemis cretica subsp. *anatolica*	.	.	.	+	.	+	.	II	H
Characteristic species of *Querco-Cedretalia libani*									
Briza humilis	1	.	1	.	1	1	1	IV	Th
Thlaspi perfoliatum	.	+	+	.	+	+	.	III	Th
Potentilla kotschyana	+	.	.	+	.	.	.	II	H
Companions									
Ranunculus argyreus	1	1	1	1	1	1	1	V	H
Chamaecytisus pygmaeus	1	1	1	.	1	1	1	V	Ch
Poa bulbosa	1	.	1	1	1	1	.	IV	G
Bellevalia tauri	.	+	+	+	.	.	+	III	G
Crepis sancta	.	1	1	.	1	.	1	III	Th
Silene pratensis subsp. *divaricata*	+	+	.	.	+	r	.	III	H
Alopecurus textilis subsp. *textilis*	.	.	.	1	1	1	1	III	G
Orchis mascula subsp. *pinetorum*	.	+	+	+	.	+	.	III	G
Muscari neglectum	.	1	.	1	1	.	1	III	G
Astragalus tmoleus var. *bounocanthus*	1	.	1	.	.	.	1	III	Ch
Phleum montanum subsp. *serrulatum*	1	.	1	.	1	.	.	III	H
Ornithogalum narbonense	.	1	1	1	.	.	.	III	G
Sedum amplexicaule	1	.	1	.	1	.	.	III	H
Cynoglossum montanum	.	1	.	1	.	.	+	III	H
Bromus tectorum	.	.	.	1	1	.	.	II	Th
Centaurea pichleri subsp. *pichleri*	.	.	.	+	+	.	.	II	H

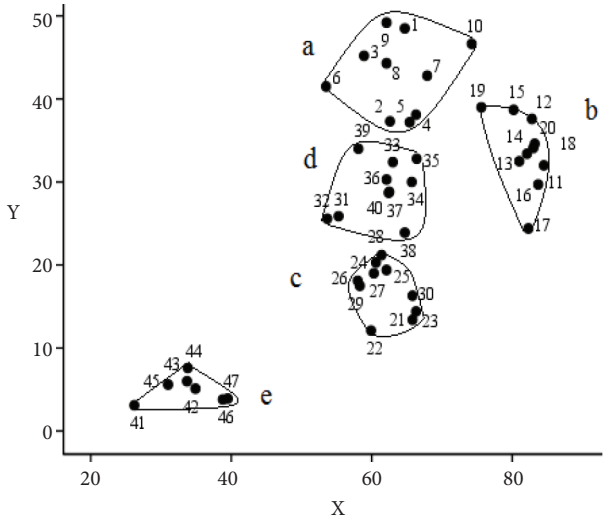

Figure 2. The x, y graphic of the associations. a: *Veronico isauricae-Cedretum libani*; b: *Meliloto bicoloris-Quercetum cocciferae*; c: *Meliloto bicoloris-Cistetum laurifolii*; d: *Atraphaxo billardieri-Amygdaletum orientalii*; e: *Centauro detonsae-Thymetum sipylei.*

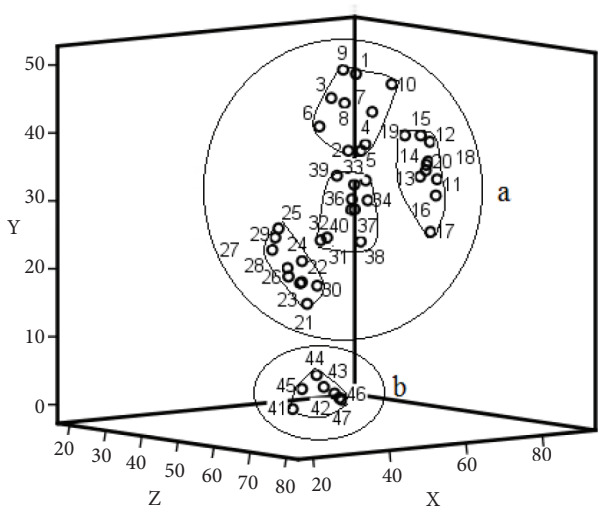

Figure 3. The 3-dimensional ordination (x, y, z) graphic of the associations. a: *Querco-Cedretalia libani*; b: *Onobrychido armenae-Thymetalia leucostomi*. Quadrat numbers of the associations: 1–10, *Veronico isauricae-Cedretum libani*; 11–20, *Meliloto bicoloris-Quercetum cocciferae*; 21–30, *Hyperico heterophylli-Cistetum laurifolii*; 31–40, *Atraphaxo billardieri-Amygdaletum orientalii*; 41–47, *Centauro detonsae-Thymetum sipylei.*

of Kızıldağ mountain. The collecting dates of the quadrats are as follows: 41–43: 20.05.2010; 44–46: 16.06.2011; 47: 11.07.2011.

4. Discussion

The phytogeographical distributions of the taxa in the area are Irano-Turanian (18.19%), Mediterranean (17.81%), Euro-Siberian (5.08%), and cosmopolitan (58.90%) (Mutlu & Erik, 2003). These results show that the area is located in the transitional zone between the Mediterranean and Irano-Turanian phytogeographic regions. According to Raunkiaer's life form system, the most represented classes in the floristic spectrum were hemicryptophytes (51.4%; 166) and therophytes (25.7%; 83); the others, in decreasing order, were geophytes (8%; 26), chamaephytes (7.4%; 24), and phanerophytes (7.1%; 23). In addition to the Braun-Blanquet approach, the Wisconsin multidimensional technique was used to determine the plant associations in this study. In the research area 5 new plant associations belonging to forest, macchie, and steppe vegetation from 2 habitats were determined (Figure 2).

The abundance of characteristic species belonging to the *Querco-Cedretalia libani* order and *Quercetea pubescentis* class in the releves (from 1 to 40) has led to a clustering of different habitats. On the other hand, the *Querco-Cedretalia libani* order has a wide distribution area in Anatolia. In addition, the abundance of species belonging to the *Onobrychido armenae-Thymetalia leucostomi* order and *Astragalo microcephali-Brometea tomentelli* class in some of the releves has prevented complete separation of the clusters into the associations for this habitat (Figure 3). In the serpentine area 2 associations belonging to forest and steppe vegetation types occur. The association of *Veronico isauricae-Cedretum libani*, belonging to forest vegetation, grows on the limeless brown forest soils found in the schists, serpentine, and crystalline limestone. The association of *Centauro detonsae-Thymetum sipylei*, belonging to steppe vegetation, occurs on the limeless brown soils formed from serpentine rocks. The available Fe and Mg concentrations and organic matter are high, but P concentration is low in these soils. All of the associations belonging to macchie vegetation occur on the limestone rocks. The association of *Meliloto bicoloris-Quercetum cocciferae* grows on the maroon soils formed by metamorphic elder rocks. The associations *Hyperico heterophylli-Cistetum laurifolii* and *Atraphaxo billardieri-Amygdaletum orientalii* occur on the limeless brown soils.

Syntaxonomical interpretation of these associations is shown below.

Quercetea pubescentis Doing-Kraft ex Scamoni & Passarage 1959

Querco-Cedretalia libani Barbéro, Loisel & Quézel 1974

1. *Meliloto bicoloris-Quercetum cocciferae* ass. nova
2. *Hyperico heterophylli-Cistetum laurifolii* ass. nova
3. *Atraphaxo billardieri-Amygdaletum orientalii* ass. nova

Abieto-Cedrion Akman, Barbéro & Quézel 1977

4. *Veronico isauricae-Cedretum libani* ass. nova

Astragalo-Brometea Quézel 1973 em. Parolly

Onobrychido armenae-Thymetalia leucostomi Akman, Ketenoğlu, Quézel & Demirörs 1984

Phlomido armeniacae-Astragalion microcephali Ketenoğlu, Akman, Quézel & Demirörs 1984

5. *Centauro detonsae-Thymetum sipylei* Sağlam ass. nova

4.1. The association of *Veronico isauricae-Cedretum libani* ass. nova

Forests of Lebanon cedar are found on different geological formations and different parent materials in the Taurus mountains. Although human impact has been a factor in Anatolia for thousands of years, the most inaccessible topography of the Taurus mountains prevented *Cedrus libani* from being totally destroyed. Currently, most of the *Cedrus libani* forests, especially those close to residential areas, are protected by inclusion in national parks. The soil of the association has high organic matter, Fe, Ca, and Mg. *Cedrus libani* associations were described by many researchers in previous studies (Table 8). Phytogeographically, plant associations belong to the forest vegetation that spreads along West and South Anatolia were included within the classes of *Quercetea pubescentis* and *Quercetea ilicis* (Akman et al., 1978). The dominant components of the peripheral vegetation around Central Anatolia have been included in the class *Quercetea pubescentis* (Akman et al., 1984). Cedar forests are placed under 2 different alliances; the order *Querco-Cedretalia* and the class *Quercetea pubescentis* (Akman et al., 1978; Mayer & Aksoy, 1986; Kavgacı et al., 2010). The components of the alliance, *Abieto-Cedrion* and the order of *Querco-Cedretalia libani*, are well represented in this association due to the extent of anthropogenic damage to the forest-steppe zone. The floristic composition of the association is rich with species of the *Astragalo microcephali-Brometea tomentelli* class. The floristic similarity percentages between associations described in the present study and those of the other, previously defined areas (Table 8), range between 9.7% and 25.4%. According to Özhatay et al. (2003), the cedar forests in Turkey are biologically, ecologically, and historically sensitive and relict ecosystems. As a result of this, many areas covered by cedar forests have been accepted as important plant areas. Despite its proximity to places of residence, the association was protected against unconscious cutting and over-grazing by its inclusion in Kızıldağ National Park.

4.2. The association of *Meliloto bicoloris-Quercetum cocciferae* Sağlam ass. nova

Quercus coccifera (kermes oak) is the most common species of the Mediterranean maquis with a wide distribution across the Mediterranean Basin. Climate and the anthropogenic pressure have been identified as the most important factors determining the structure and the floristic composition of *Q. coccifera* Mediterranean shrublands of Greece (Tsiourlis et al., 2009). The association of *Q. coccifera* in the west of Kıyakdede village has lost its normal floristic composition due to heavy grazing by goats. As a result, the destruction of this plant has readily spread (Karaer et al., 1999). Although overgrazing pressure by goats was observed in Kıyakdede, the floristic composition of this association is well protected in the east of Kızıldağ mountain. Its distribution is wide, particularly in limestone areas of the research area. The soil of this association has a slightly basic character, low organic matter and P, and a clayey-loamy texture. Because of the high degradation and canopy openness, numerous steppic and xerophilous species penetrated into the floristic structure of this association. Kermes oak extends from the Eumediterranean zone (*Quercetalia ilicis*) to the Submediterranean (*Quercetalia pubescentis*), according to Braun-Blanquet classification (Tsiouvaras, 1987). Many *Q. coccifera* associations were described in nearby regions (Table 8). Similarly, the *Q. coccifera* associations described in Aladağ, in the east of Dedegül (Dedegöl) mountain and in Hadim, Ermenek, and Bucakkışla were categorised under the *Querco-Cedretalia libani* order. The floristic composition of this association is well presented by the characteristic species of the order *Querco-Cedretalia libani* and the class *Quercetea pubescentis.* For these reasons, the association should be included in the syntaxa units mentioned above. The similarity percentages between the associations described in the present study and those of the other, previously defined areas (Table 8) range from 12.8% to 27.9%. The highest similarity percentage (27.9%) was found in the study by Serin (1996), due to its proximity to the research area.

4.3. The association of *Hyperico heterophylli-Cistetum laurifolii* Sağlam ass. nova

Communities of *C. laurifolius* usually emerge in transition belts from the inner Anatolia region to the Marmara, Aegean, and Mediterranean regions as a result of large-scale destruction of *Pinus nigra* subsp. *nigra* var. *caramanica. C. laurifolius* is the most invasive and dominant plant in the secondary formations as a result of forest degeneration (Hamzaoğlu & Duran, 2004). The soil of the association has a slightly basic character and low EC, $CaCO_3$, and K. Due to unsuitable environmental conditions such as drought, high inclination, erosion, and heavy grazing, the floristic composition of this association is extremely poor. *C. laurifolius* associations were determined by many researchers (Table 8). The highest similarity percentage was 23.8% in the study in Sultan Dağı by Ocakverdi and Çetik (1982), due to its proximity to the research area. The floristic composition of this association is well presented by the characteristic species of the *Querco-Cedretalia libani* order and *Quercetea pubescentis* class.

4.4. The association of *Atraphaxo billardieri-Amygdaletum orientalii* ass. nova Sağlam

The soils of the association are salty and rich with available elements such as Ca, K, P, and Cu. The classification of forest-steppe transitional associations is quite difficult due to the high number of steppic species (Akman et al.,

Table 8. The comparison of the associations with similar studies according to Sorensen's similarity formula [Is = 2W100/(A + B)].

Previous studies	Associations				
	Veronico isauricae - Cedretum libani	*Meliloto bicoloris - Quercetum cocciferae*	*Hyperico heterophylli - Cistetum laurifolii*	*Atraphaxo billardieri - Amygdaletum orientalii*	*Centauro detonsae - Thymetum sipylei*
Akman and Ketenoğlu (1976)			13.2		14.4
Akman (1974)					13.9
Bekat (1987)	20.3	17			
Çetik (1976)					14.6
Çetik and Vural (1979)			14.6		
Hamzaoğlu and Duran (2004)			16.3		
Karaer et al. (1999)		17.9			
Kargıoğlu (2007)			22.4		
Ocakverdi and Çetik (1982)			23.6		
Ocakverdi and Çetik (1987)	18.4			25.3	
Ocakverdi and Ünal (1991)					10.8
Sağlam (2007)	22.8	26.3			
Serin and Eyce (1994)	23.5	20.5			
Serin (1996)	25.4	27.9			
Şanda and Küçüködük (2000)	12	12.8			
Şanda et al. (2000)					8.2
Şanda et al. (2006)	18.8				
Tatlı et al. (1994)			22.3		
Vural et al. (1999)	9.7	13			

1978; Korkmaz et al., 2011). Due to the low coverage and height of the shrub layer, the floristic composition of this association exhibits the characteristic species of the syntaxa belonging to both steppe and forest vegetations equally. For this reason it is very difficult to classify this association syntaxonomically. According to the 3-dimensional ordination graphic, this association is located between shrub and forest communities (Figure 2). For this reason, the association should be assessed in macchie vegetation and included in the order of *Querco-Cedretalia libani*. In this association no species was found in the releves for the alliances belonging to the order *Querco-Cedretalia libani*. *A. orientalis* association was described by Ocakverdi and Çetik (1987) in the Seydişehir mine region. Assessed as a transition association from forest to steppe vegetation, it was assigned to the order *Querco-Cdretalia libani.* The floristic similarity between the 2 associations was 25.3%.

4.5. *Centauro detonsae-Thymetum sipylei* Sağlam ass. nova

This association grows on limeless brown forest soil formed by serpentine. Available Fe, Mg, and organic matter are high, but Ca and P are low in this clayey-loamy soil. Due to the high elevation, severe weather conditions cause a decrease in the number of therophytes. According to Altınözlü et al. (2011), ultramafic serpentine rocks contain less than 45% silica (SiO_2) and high concentrations of Fe, Mg, Cr, Ni, and Co, and the soils formed on these materials may have hundreds of times more Ni than many other soils. Not all serpentine soils share all these characteristics; however, the characteristics present combine in various ways to severely restrict plant growth on serpentine soils. Two of the differential species (*O. aksoyii* and *S. ozyurtii)* of the association are local and endemic in the region. The *Daphno-Festucetales* superclass includes the natural grasslands in the mountain ranges surrounding the Eastern Mediterranean and comprises 2 classes, *Daphno-Festucetea* and *Astragalo-Brometea*. The class *Daphno-Festucetea* has a distribution in the Balkan Peninsula (Akman et al., 1986). The steppe vegetation in Turkey is included in the class *Astragalo-Brometea*, which is represented in Anatolia by the order *Onobrychido armenae-Thymetalia leucostomi* (Akman et al., 1985). The communities that are spread out in the northern part of

the Central Anatolian Peninsula were attached to the order *Onobrychido armenae-Thymetalia leucostomi* (Akman et al., 1986). *Thymus sipyleus* subsp. *rosulans* associations were described in previous studies carried out by Ocakverdi and Ünal (1991) and Şanda et al. (2000) in the nearby region. Syntaxonomically, both associations were attached to the *Phlomido armeniacae-Astragalion microcephali* alliance and *Onobrychido armenae-Thymetalia leucostomi* order. The similarity percentages of the associations are rather low (below 11%) because all associations mentioned above grow in different habitats and at different altitudes. The floristic composition of this association is well presented by the characteristic species of the alliance *Phlomido armeniacae-Astragalion microcephali* and the order *Onobrychido armenae-Thymetalia leucostomi* included in the class *Astragalo microcephali-Brometea tomentelli*. *Thymus sipyleus* subsp. *sipyleus* associations were described by Akman (1974), Akman and Ketenoğlu (1976), and Çetik (1976), and the similarities were 13.9%, 14.4%, and 14.5%, respectively (Table 8).

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