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An International Journal is About Biological Diversity and Conservation With Refree

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Research article/Araştırma makalesi

Assessment of water quality in three sub-basins of Susurluk River (Northwest Anatolia) according to invertebrates and biotic indices

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Abstract

Turkey has 25 main drainage river basins by the hydrological features. One of the 25 main drainages is the Susurluk basin which is located in the Northwest of the Anatolia. The Orhaneli, Emet and Mustafakemalpaşa rivers are the three sub-basins of the Susurluk river system. The Mustafakemalpaşa River, which is formed by the joining of Emet and Orhaneli rivers, is one of the most important water resources feeding the Lake Uluabat. During the study period (November 2004, July 2005, May 2006 and June 2007) zoobenthic samples were collected in three sub-basins of Susurluk. Also some environmental variables (water temperature, pH, dissolved oxygen, biological oxygen demand, nitrate nitrogen, nitrite nitrogen and ammonium nitrogen) were analyzed. In addition some biological metrics (Shannon-Wiener diversity indices, Biological Monitoring Working Party (BMWP) score and Average Score Per Taxon (ASPT), dominance) were also calculated.

In Orhaneli, Emet and Mustafakemalpaşa Rivers, 35 taxonomic groups were identified on class, order and family level along with 36 Oligochaeta species. In the present study zoobenthic communities of these three rivers were dominated mainly by four taxa; Oligochaeta (41.3%), Chironomidae (18.2%), Gammaridae (10.7%) and Ephemeroptera (6%). The oligochaete fauna of the three sub-basins was dominated by widely distributed tubificid *Potamothrix hammoniensis* and naidid *Nais communis*. Shannon-Wiener diversity indices, BMWP score and ASPT values varied between 0.2-2.7; 9-95 and 2.3-5.9 respectively. Our results indicated that upper Orhaneli and Emet River rhitral zone (stations 10 and 19) was nonimpacted and their fauna diverse while the potamal zone (stations 1, 11, 16 and 17) was polluted. Our both biological and water quality parameters showed that ten out of the nineteen stations were determined as water quality classes I and II (nonimpacted and slighltly impacted) in the study area.

Key words: Water quality, Orhaneli, Emet and Mustafakemalpaşa Rivers, Oligochaeta

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Orhaneli, Emet ve Mustafakemalpaşa Çaylarının Oligochaeta faunası ve su kalitesi

Özet

Türkiye 25 akarsu havzasına sahiptir ve bu havzalardan bir tanesi de kuzeybatı Anadolu bölgesinde yer alan Susurluk Nehir Havzası'dır. Orhaneli, Emet and Mustafakemalpaşa nehirleri, Susurluk havzası içinde yer alan üç alt havzadır. Emet ve Orhaneli çaylarının birleşmesiyle oluşan Mustafakemalpaşa Çayı, Uluabat Gölü'nü besleyen en önemli su kaynaklarından biridir. Bu üç akarsu Karacabey yakınında birleşerek Kocasu Nehri'ni oluşturur ve denize dökülür. Çalışma süresince (Kasım 2004, Temmuz 2005, Mayıs 2006 ve Haziran 2007) zoobentik örnekler Susurluk'un üç alt havzasından toplanılmıştır. Ayrıca, bazı çevresel parametreler de (su sıcaklığı, pH, çözünmüş oksijen, biyolojik oksijen ihtiyacı, amonyum azotu, nitrat azotu ve amonyum azotu) analiz edilmiştir. İlaveten, bazı biyolojik metrikler de (Shannon-Wiener Çeşitlilik İndeksi, Biyolojik İzleme Çalışma Grubu (BMWP) ve her taksonun ortalama değeri (ASPT), baskınlık) hesaplanılmıştır.

Orhaneli, Emet ve Mustafakemalpaşa Çayları'nda 36 Oligochaeta türü ile birlikte sınıf, takım ve familya düzeyinde 35 taksonomik grup teşhis edilmiştir. Bu çalışmada; Mustafakemalpaşa, Orhaneli ve Emet çaylarının zoobentik komünitesi başlıca Oligochaeta (%41,3), Chironomidae (%18,2), Gammaridae (%10,7) ve Ephemeroptera (%6) olmak üzere dört gruptan oluşmaktadır. 3 alt havzanın Oligochaeta faunasında, geniş yayılış gösteren tubificid *Potamothrix*

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hammoniensis ve naidid *Nais communis* türleri baskındı. Shannon-Wiener Çeşitlilik İndeks, BMWP skor ve ASPT değerleri sırasıyla 0,2-2,7; 9-95 ve 2,3-5,9 arasında değişmektedir. Araştırma sonucunda Orhaneli e Emet Çay'ları üst kesimlerinin (rhitral bölge, 10 ve 19. istasyonlar) temiz ve faunasının yüksek çeşitlilik gödterdiği, buna karşılık potamal bölgelerin (1, 11, 16 ve 17.istasyonlar) kirlenmiş su sınıfında olup faunalarının fakir olduğu tespit edilmiştir. Hem biyolojik hem de su kalite parameter sonuçları ondokuz örneklem noktasından on tanesinin I. ve II. kalite su sınıfında olduğunu ortaya koymuştur.

Anahtar kelimeler: Orhaneli, Emet ve Mustafakemalpaşa Çayları, Oligochaeta

1. Introduction

Oligochaeta, or non-hirudinean Clitellata are common and widely distributed organisms, they inhabit estuarine, brackishwater, freshwater and terrestrial environments. To date, about 5,000 valid species have been known and about one third of them have been identified from aquatic environments (Martin et al., 2008). Lumbricidae and Enchytraeidae are mainly terrestrial but also include some species that live in fresh water as semiaquatic. The other families of Oligochaeta are predominantly freshwater. According to literature data, to date 1700 valid aquatic oligochaete species were reported around the world and approximately 1100 of them have been reported from freshwater systems.

Oligochaetes constitute almost half of the total benthic invertebrate community in several aquatic ecosystems. They can survive in very different environments, from small ponds, puddles to sewage. Some species of Oligochaeta (especially of the Tubificidae members) species have wide ecological tolerance to low concentration of dissolved oxygen, high or low pH, high temperature etc. Because of this they are widely used for monitoring river and lake pollution as biondicator organisms. A recent study indicated that 94 Oligochaeta species are recorded in fresh waters of Turkey (Arslan 2006). Later on, several studies were published on the freshwater Oligochaeta in Turkey and several additional species were identified (Arslan et al. 2006; Matamoros et al. 2007; Timm et al. 2013; Arslan et al. 2018). According to published data, the Turkish freshwater Oligochaeta fauna now consists of 149 described species Although studies on Turkey's aquatic Oligochaeta fauna have increased in the last 15-20 years, Oligochaeta species diversity is still maybe not fully known.

Turkey has 107 major rivers belonging to 25 main drainage basins by the hydrological features. One of the 25 main drainages is the Susurluk basin. The objective of this study were; i- to examine zoobenthic community structure in three sub-basin of the Susurluk River, ii- to determine the fauna and distribution of Oligochaeta in the Orhaneli, Emet and Mustafakemalpaşa Rivers, not investigated in detail before, iii- to determine the biological water quality of the sub-basins by using several metrics (diversity and biotic indices).

2. Materials and methods

2.1.Study Area

One of the 25 main drainages in Turkey is the Susurluk basin which is located in the Northwest of the Anatolia. Covering about 3.1% of Turkey's land, the total area of the river basin district is 26,790 km^2. The Orhaneli, Emet and Mustafakemalpaşa Rivers form the 3 different sub-basins (Figure 1),covering about 10,647 km^2 area of Susurluk (4,745 km^2, 4,921 km^2 and 981 km^2, respectively). The Mustafakemalpaşa River, which is formed by the joining of Emet (former name Aliova Creek) and Orhaneli rivers (former name Kocasu), is one of the most important water resources feeding the Lake Uluabat (in this study except station 1).

2.2.Sampling and Data Analysis

During the study period (November 2004, July 2005, May 2006 and June 2007) zoobenthic samples were collected in three sub-basins of Susurluk (seven stations from Orhaneli; nine stations from Emet River and three stations from Mustafakemalpaşa River). All zoobenthic samples were collected with hand net or grab sampler. All obtained materials were preserved in 70% ethyl alcohol in situ. Zoobenthic samples were examined under stereomicroscope in the laboratory and firstly they were identified at order-family level and only Oligochaeta specimens were identified at species level (Sperber 1948, 1950; Brinkhurst and Jamieson 1971; Timm 1999).

During each sampling period, the water temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), nitrate nitrogen, nitrite nitrogen and ammonium nitrogen were measured. All water samples were analyzed within 24 h after sampling. Water temperature, pH, dissolved oxygen (DO) and depth were measured during sampling in situ. Other variables [NO_2-N, NO_3-N, and NH_4-N) were measured in the laboratory following the standard methods (APHA, 1998). All parameters results measured in the study were compared with limit of Inland Water Quality Management in Turkey (Turkish Surface Water Quality Management Regulation, 2015).

Macroinvertebrate data were analyzed using ASTERICS 3.1 (AQEM/STAR Ecological River Classification System; AQEM Consortium, 2002) software. BMWP (Biological Monitoring Working Party (Spanish version), ASPT

(Average Score Per Taxon (Armitage et al., 1983), and diversity indices (Shannon-Wiener and Margalef diversity indices) were used to determine water quality. In addition, dominancy and frequency indices were also used (Bellan-Santini, 1969; Soyer, 1970).

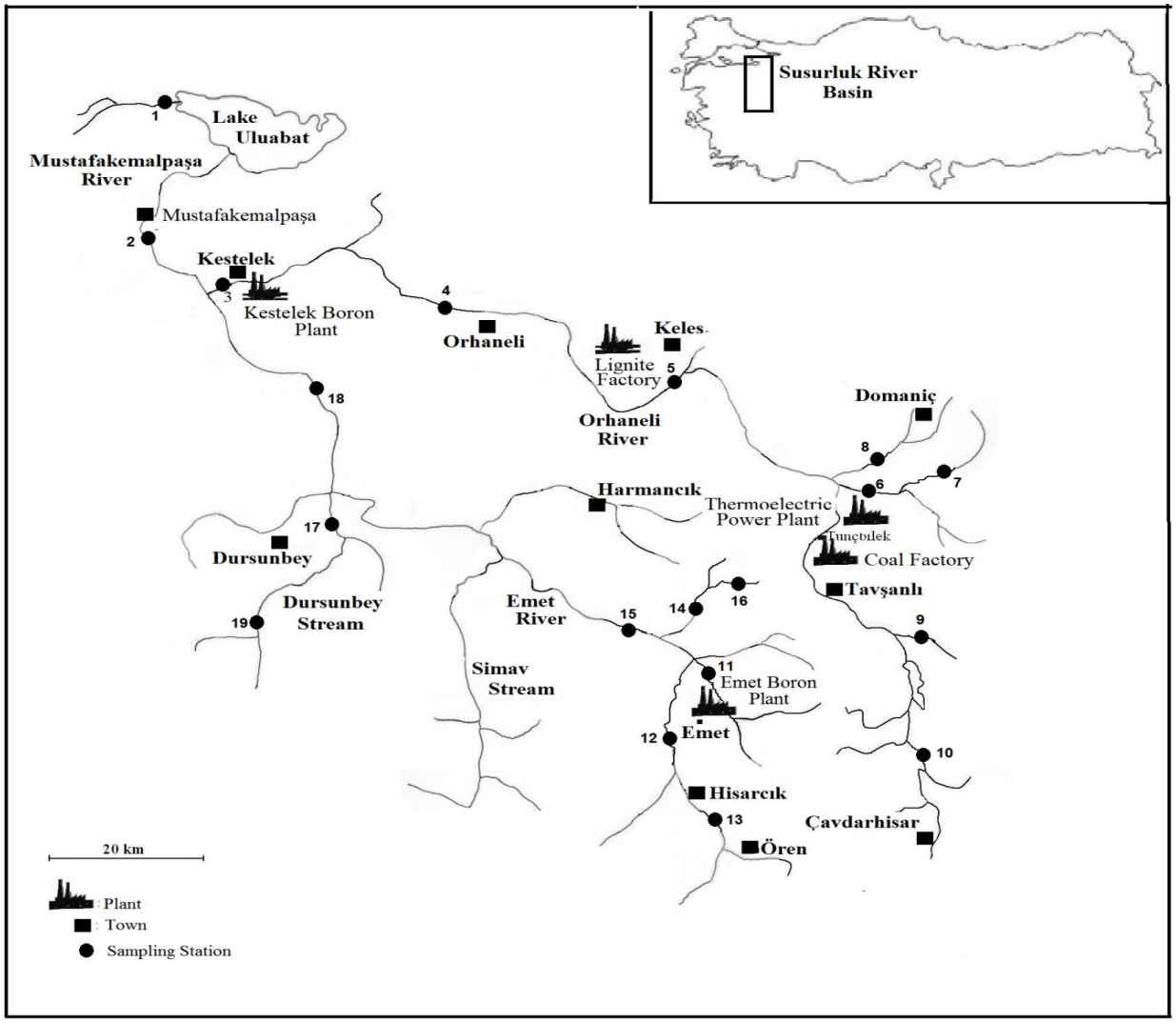

Figure 1. Geographical position of Susurluk River basin and sampling stations of three sub-basin (Orhaneli, Emet and Mustafakemalpaşa River Systems)

3. Results

3.1.Biological results

In Orhaneli, Emet and Mustafakemalpaşa Rivers, 35 taxonomic groups were identified on class, order and family level along with 36 Oligochaeta species (Tables 1 and 2). According to average dominancy value in the basin, the Class Oligochaeta was the most dominant taxon for over 41.3% of total abundance followed by families Chironomidae and Gammaridae with dominancy of 18.2% and 10.7% respectively. All the remaining taxa had relative abundance less than 10% (Table 1). Although the Ephemeroptera mean dominacy value is below 10%, it has a high population ratio at some stations in the basin. Especially at some stations (9, 10 and 18) their relative abundance was 14.2, 16.6 and 14.1 respectively. Similarly, mean dominancy value of Trichoptera which has also pollution sensitive species, was also high at the stations 2, 3, 9,10 and 18. The highest EPT (Ephemeroptera, Plecoptera, Trichoptera) values were recorded from the stations 18 and 19 on the sampling dates between 2004 and 2007 while Plecoptera had the lowest values in this group (Tables 1 and 2).

Thirty six Oligochaeta species were detected in the study area. During the whole study period, *Potamothrix hammoniensis* which was detected at 18 stations and *Nais communis* at 15 stations, were the most widespread species (Table 2). The highest taxonomic diversity of Oligochaeta fauna with 13 species was found at the station 17, followed by at the stations 14 and 19 with 12 species. On the other side, the station 13 had the lowest species diversity with 5 species.

Table 1. Average dominance values (as %) of taxa identified at the sampling stations during the research period in three sub-basin of Susurluk River (Orhaneli, Emet and Mustafakemalpaşa Rivers (MKP: Mustafakemalpaşa, RS: River system))

		MKP RS			Orhaneli RS							Emet RS									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**MD**
1	**Nematoda**	3,1	15,2	2,9	26,2	0,3	9,0	-	-	-	0,4	-	-	1,5	0,7	-	-	3,4	2,3	-	3,4
	Gastropoda (as total)	24,8	4,0	-	-	0,9	-	-	-	5,1	0,2	-	-	-	-	-	-	0,8	-	-	1,9
2	Valvatidae	7,5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,4
3	Lymnaeidae	1,2	-	-	-	-	-	-	-	1,6	-	-	-	-	-	-	-	-	-	-	0,1
4	Physidae	9,9	4,0	-	-	-	-	-	-	2,4	0,2	-	-	-	-	-	-	0,8	-	-	0,9
5	Planorbidae	6,2	-	-	-	0,9	-	-	-	1,2	-	-	-	-	-	-	-	-	-	-	0,4
6	**Bivalvia**	2,5	-	-	-	-	-	-	-	-	-	17,9	-	-	-	-	1,5	2,1	-	-	1,3
7	**Oligochaeta**	37,9	48,5	38,6	38,1	78,7	81,1	4	27,9	40,8	20,9	25,4	18,9	63,6	53,7	36,3	8,4	47,3	43,8	70,7	41,3
8	**Hirudinea**	1,9	-	-	-	-	0,8	-	-	-	-	3,7	-	3,0	-	-	1,3	2,1	-	-	0,7
9	**Asellidae**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,1	0,1
10	**Gammaridae**	2,5	-	3,6	3,6	5,9	-	1,3	54,1	25,5	17,3	-	78,6	-	-	9,8	0,4	0,4	-	-	10,7
11	**Hydracarina**	2,5	1,0	0,7	-	-	-	-	-	-	0,2	-	-	-	9,6	-	-	0,4	-	-	0,8
	Ephemeroptera (as total)	2,5	6,1	5,7	6,0	2,2	-	7,5	6,6	14,2	16,6	1,5	0,2	4,5	7,4	1,4	-	8,9	14,1	8,0	6
12	Potamanthidae	-	1,0	1,4	-	-	-	-	1,6	1,2	4,9	-	-	-	-	0,5	-	-	1,6	1,1	0,7
13	Baetidae	2,5	5,1	4,3	2,4	0,6	-	7,5	3,3	5,9	3,8	1,5	0,1	4,5	4,4	0,9	-	8,9	5,5	2,3	3,3
14	Caenidae	-	-	-	3,6	0,9	-	-	1,6	2,0	2,3	-	-	-	1,5	-	-	-	4,7	2,9	1,0
15	Oligoneuriidae	-	-	-	-	-	-	-	-	-	0,9	-	-	-	-	-	-	-	-	0,6	0,1
16	Heptageniidae	-	-	-	-	0,6	-	-	-	2,4	-	-	0,1	-	-	-	-	-	2,3	1,1	0,3
17	Ephemerellidae	-	-	-	-	-	-	-	-	2,7	4,7	-	-	-	1,5	-	-	-	-	-	0,5
	Odonata (as total)	2,5	-	2,9	-	0,9	-	-	-	2,4	12,4	-	0,7	-	-	3,7	-	-	8,6	1,7	1,9
18	Coenagrionidae	1,9	-	-	-	-	-	-	-	-	2,6	-	-	-	-	-	-	-	3,1	1,7	0,5
19	Calopterygidae	0,6	-	2,9	-	0,9	-	-	-	2,4	9,8	-	0,4	-	-	3,7	-	-	5,5	-	1,4
20	Gomphidae	-	-	-	-	-	-	-	-	-	-	-	0,3	-	-	-	-	-	-	-	-
	Hemiptera (as total)	5,6	3,0	24,3	-	-	-	26,3	-	-	-	-	-	-	5,1	-	-	3,0	-	-	3,5
21	Corixidae	1,9	-	18,6	-	-	-	15,0	-	-	-	-	-	-	-	-	-	3,0	-	-	2,0
22	Pleidae	1,2	-	-	-	-	-	-	-	-	-	-	-	-	3,7	-	-	-	-	-	0,3
23	Gerridae	2,5	3,0	5,7	-	-	-	11,3	-	-	-	-	-	-	1,5	-	-	-	-	-	1,3
24	**Chironomidae**	6,8	15,2	12,1	4,8	5,6	9,0	23,8	11,5	3,1	18,1	39,6	1,0	21,2	0,7	43,3	87,9	25,3	13,3	3,4	18,2
25	**Tipulidae**	-	-	-	-	-	-	-	-	1,6	-	-	-	6,1	-	-	-	-	-	-	0,4
26	**Simuliidae**	-	-	-	6,0	3,7	-	-	-	3,5	-	-	0,2	-	4,4	-	-	-	7,0	8,0	1,7
27	**Tabanidae**	-	-	-	-	-	-	-	-	-	-	3,7	-	-	-	-	0,4	1,3	-	-	0,4
28	**Ceratopogonidae**	6,2	-	-	15,5	-	-	-	-	0,4	6,6	8,2	0,1	-	11,0	-	-	3,0	-	-	2,7
28	**Psychodidae**	1,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,7	-	-	0,2
30	**Neuroptera**	-	-	-	-	-	-	-	-	-	0,4	-	-	-	-	-	-	-	-	-	-
	Trichoptera (as total)	-	5,1	8,6	-	1,9	-	-	-	3,5	5,3	-	0,3	-	4,4	4,7	-	-	7,0	3,4	2,3
31	Hydropsychidae	-	5,1	8,6	-	1,2	-	-	-	1,6	3,2	-	0,3	-	2,9	3,3	-	-	4,7	2,3	1,7
32	Rhyacophilidae	-	-	-	-	-	-	-	-	0,8	1,3	-	-	-	-	-	-	-	-	-	0,1
33	Hydroptilidae	-	-	-	-	0,6	-	-	-	-	-	-	-	-	1,5	-	-	-	2,3	1,1	0,3
34	Psychomyiidae	-	-	-	-	-	-	-	-	1,2	0,9	-	-	-	-	1,4	-	-	-	-	0,2
	Plecoptera																				0,8
35	Perlidae	-	2,0	-	-	-	-	1,3	-	-	1,5	-	-	-	2,9	-	-	-	3,9	3,4	0,8

Shannon-Wiener diversity index values varied between 0.2-2.7; the highest and lowest values were reported in the same basin (Orhaneli River, stations 9 and 6 respectively). The highest taxonomic diversity are reported with 29 taxa at the station 9 and 27 taxa at the stations 1and 10. On the other side, stations 3, 7 and 13 are the ones having the lowest taxa diversity with 10, 9 and10 species respectively. During the whole study period the highest Biological Monitoring Working Party (BMWP) score value was detected in station 9 (average score 95) and it is followed by stations 19, 10 and 18 (as average score 85, 80 and 72 respectively). Average Score Per Taxon (ASPT) score values varied between 2.3-5.8 in all sampling stations (Table 3). All zoobenthic community members are categorized according to the feeding types as given in Table 3.

3.2.Environmental Parameters

The minimum, maximum and average values and standard deviation of the environmental variables and water quality classes of the three sub-basins of Susurluk River (Mustafakemalpaşa, Emet and Orhaneli River system) during the study period are given in Table 4. All environmental variables results have been classified in Surface Water Quality Management Regulation of Turkey (Turkish Surface Water Quality Management Regulation, 2015). When the indices were examined in terms of environmental parameters (as water quality classes), the stations 10 (Orhaneli River) , 18 and 19 (Emet River) were determined as clean (class I); the stations 4, 5, 8, 9 (Orhaneli River), 12 and 15 (Emet River) were determined as clean but slightly impacted (Class II), 2, 3 (Mustafakemelpaşa River), 6, 7 (Orhaneli River) and 13 (Emet River) were determined as polluted (Class III) and while the other stations (1, 11, 16 and 17) were determined as polluted or impacted (Class IV). Only water temperature and pH did not present significant differences between the sampling sites.

Table 2. Average dominance values of Oligochaeta species at the 19 stations during the research (as %), (Ns: Number of stations where the species was detected; F: frequency in %, MD: Mean dominancy)

	Taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**Ns**	**F**	**MD**
1	*Haplotaxis gordioides*	-	-	-	-	-	-	-	-	-	7,1	-	-	-	-	-	-	-	8,9	4,9	3	15,8	1,1
2	*Lumbriculus variegatus*	-	-	-	-	-	-	-	-	-	-	-	3,5	-	11,0	-	-	-	-	3,3	3	15,8	0,9
3	*Chaetogaster diastrophus*	-	-	-	-	0,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5,3	-
4	*Chaetogaster diaphanus*	-	4,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,5	0,8	2	5,3	0,2
5	*Chaetogaster langi*	-	-	-	-	-	-	-	-	1,0	-	-	-	-	-	-	-	-	-	-	1	5,3	0,1
6	*Paranais frici*	-	4,2	3,7	-	1,6	-	-	-	3,8	6,1	8,8	-	-	2,7	2,6	-	0,9	76,8	-	10	52,6	5,9
7	*Paranais simplex*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5,3	0,6
8	*Dero dorsalis*	-	-	-	-	-	-	-	-	-	-	11,2	-	-	-	-	-	1,8	-	-	1	5,3	0,1
9	*Dero furcata*	8,2	-	-	-	-	-	-	-	-	-	23,5	-	-	-	-	20,5	3,6	-	-	4	21,1	2,9
10	*Pristina longiseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,8	-	-	1	5,3	0,1
11	*Pristinella jenkinae*	-	10,4	-	-	-	-	3,1	-	-	-	2,9	-	4,8	4,1	-	-	4,5	-	-	6	31,6	1,6
12	*Pristina aequiseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	1,4	-	-	-	-	-	1	5,3	0,1
13	*Pristina proboscidea*	-	-	-	15,6	-	-	-	-	-	-	-	-	-	-	-	-	-	7,1	2,4	3	15,8	1,3
14	*Stylaria lacustris*	-	10,4	-	3,1	0,8	-	-	-	1,9	20,4	-	-	-	1,4	-	11,4	-	-	1,6	8	42,1	2,7
15	*Nais pardalis*	-	-	-	21,9	2,4	-	-	-	-	-	-	-	-	12,3	7,7	6,8	-	-	-	5	26,3	2,7
16	*Nais bretscheri*	-	-	-	-	-	-	-	-	-	-	-	-	-	1,4	-	-	-	-	2,4	1	5,3	0,2
17	*Nais communis*	3,3	14,6	1,9	6,3	83,9	-	-	5,9	26,0	6,1	-	3,9	26,2	46,6	-	9,1	66,1	3,6	0,8	15	78,9	16,0
18	*Nais variabilis*	-	4,2	-	-	-	-	-	-	4,8	-	-	-	-	1,4	-	-	-	-	-	3	15,8	0,5
19	*Nais elinguis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,8	-	-	1	5,3	0,1
20	*Nais simplex*	-	4,2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5,3	0,2
21	*Nais pseudobtusa*	-	4,2	-	-	-	-	-	-	-	3,1	-	-	-	-	-	-	-	-	-	2	10,5	0,4
22	*Nais barbata*	-	18,8	-	-	-	-	-	-	-	9,2	-	-	16,7	-	-	-	-	-	-	3	15,8	2,3
23	*Ophidonais serpentina*	9,8	-	-	-	-	1,2	43,8	-	-	-	14,7	-	-	-	-	15,9	3,6	-	-	6	31,6	4,7
24	*Uncinais uncinata*	-	-	-	-	-	0,7	9,4	29,4	3,8	-	-	-	-	-	-	-	-	-	-	4	21,1	2,3
25	*Slavina appendiculata*	-	-	-	-	-	1,2	-	-	-	11,8		2,5	-	-	-	-	-	-	-	3	15,8	0,8
26	*Aulodrilus pluriseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,1	1	5,3	0,2
27	*Tubifex tubifex*	13,1	4,2	9,3	-	5,5	35,4	21,9	5,9	5,8	3,1	5,9	-	-	2,7	2,6	-	0,9	-	0,8	14	73,7	6,2
28	*Psammoryctides albicola*	1,6	-	-	6,3	-	-	-	5,9	28,8	-	2,9	-	-	-	1,3	6,8	0,9	-	-	8	42,1	2,9
29	*Psammoryctides barbatus*	3,3	-	-	3,1	0,8	-	3,1	-	7,7	-	5,9	12,7	-	-	5,1	-	-	-	0,8	9	47,4	2,2
30	*Psammoryctides moravicus*	6,6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5,3	0,3
31	*Potamothrix hammoniensis*	4,9	-	35,2	31,3	2,7	37,3	18,8	23,5	16,3	29,6	20,6	76,1	31,0	2,7	78,2	13,6	4,5	1,8	77,2	18	94,7	26,6
32	*Potamothrix heuscheri*	21,3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5,3	1,1
33	*Potamothrix bedoti*	-	12,5	14,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	10,5	1,4
34	*Limnodrilus hoffmeisteri*	3,3	2,1	1,9	-	-	9,4	-	-	-	-	-	-	-	-	1,3	15,9	2,7	-	0,8	8	42,1	2,0
35	*Limnodrilus claparedianus*	24,6	6,3	20,4	12,5	0,4	13,8	-	29,4	-	-	2,9	1,4	21,4	12,3	1,3	-	7,1	-	-	13	84,2	8,4
36	*Spirosperma ferox*	-	-	13,0	-	1,2	1,0	-	-	-	-	-	-	-	-	-	-	-	-	-	3	15,8	0,8
	Number of species at station	11	11	8	8	10	8	6	6	10	9	10	6	5	12	8	8	13	6	12			

Table 3. Index values calculated for 19 stations in the study area (EPT: Ephemeroptera-Plecoptera-Trichoptera; Olig: Oligochaeta; BMWP Score (Spanish version); Gat./Coll.: Gatherers/Collectors; Gra./Scr.: Grazers and scrapers; Oth.Fee.Typ.: Other Feeding types; Tax. Grp.: Taxonomic group)

	MKP RS			**Orhaneli RS**							**Emet RS**								
Indices\Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
ASPT	4,1	4,3	5,1	4,2	5,2	2,3	3,8	5,0	5,7	5,9	2,5	5,4	3,0	5,0	5,5	3,0	3,4	5,8	5,4
BMWP	59	28	46	26	54	9	19	27	95	80	18	53	15	44	48	16	34	72	85
Shannon-Wiener	2,3	1,8	2,0	1,7	1,0	0,2	1,7	1,2	2,7	2,4	1,5	0,6	1,1	1,7	1,4	0,4	1,6	2,1	2,3
Margalef Index	3,4	1,8	2,1	1,6	1,9	0,5	1,4	1,2	3,1	2,6	1,3	1,2	1,2	2,6	1,5	0,8	2,0	2,5	2,4
Feeding types																			
- [%]Gra./Scr.	6,1	8,3	11,2	2,5	2,3	0,4	14,6	4,3	6,4	8,9	9,9	0,3	7,0	5,5	10,1	18,2	11,2	7,8	3,1
- [%] Miners	1,3	1,9	7,6	0,6	0,8	0,2	8,7	1,3	0,3	1,9	4,5	0,1	2,3	0,9	4,5	9,1	3,6	2,4	0,9
- [%] Shredders	3,0	3,8	0,6	6,2	0,4	0,4	-	-	3,0	1,0	-	-	4,9	0,2	1,4	-	0,9	0,5	-
- [%]Gat./Coll.	45,3	51,8	51,3	43,4	81,5	97,3	47,1	30,4	49,0	35,2	29,0	18,4	72,5	58,9	48,5	32,4	61,1	54,3	73,9
- [%] Filter feeders	4,1	7,2	7,7	8,1	5,6	0,4	6,0	2,7	5,2	6,9	29,6	0,6	4,6	7,8	10,7	19,8	7,6	13,1	11,9
- [%] Predators	15,0	13,5	15,6	28,2	2,1	0,7	17,3	1,3	4,4	24,2	18,2	1,0	2,8	22,7	10,3	9,5	8,8	13,2	3,2
- [%] Parasites	3,4	5,8	2,0	6,8	0,6	0,7	3,0	1,3	0,3	2,0	8,8	0,1	5,9	0,3	4,5	10,5	5,6	1,9	0,4
- [%]Oth.Fee.Typ.	0,8	-	-	-	0,1	-	-	-	0,3	-	-	-	-	-	-	-	-	-	-
Tax. Grp [%]																			
- Oligochaeta [%]	37,9	48,5	38,6	38,1	78,7	81,1	4	27,9	40,8	20,9	25,4	18,9	63,6	53,7	36,3	8,4	47,3	43,8	70,7
- Ephemeroptera [%]	2,5	6,1	5,7	6,0	2,2	-	7,5	6,6	14,1	16,6	1,5	0,2	4,5	7,4	1,4	-	8,9	14,1	8,0
- EPT/Olig [%]	0,1	0,3	0,4	0,2	0,1	-	0,2	0,2	0,4	1,1	0,1	-	0,1	0,3	0,2	-	0,2	0,6	0,2
- EPT [%]	2,5	13,1	14,3	6,0	4,0	-	8,8	6,6	17,6	23,5	1,5	0,5	4,5	14,7	6,0	-	8,9	25,0	14,9

Table 4. Minimum, maximum, average and standard deviation of some environmental variables for 19 stations during the research period in the study area (Min-Max (Average) ±SD, WQC: Water Quality Class; ADL: Above detection limit). Numbers in parentheses indicate water quality classes

	Temperature °C	pH	D.O mg/l	BOD mg/l	NO_3^-N/L mg/l	NO_2^--N/L mg/l	NH_4^+N/L mg/l	WQC
1	16,6-25,2 (19,8)±4,6	7,9-8,9 (8,37) ±35,18	3-16 (8,20) ±6,88	1-22 (11,5) ±14,85	0,10-0,80 (0,40) ±0,36	0,02-0,04 (0,03) ±0,01	0,07-0,10 (0,09) ±0,02	IV
2	15,9-24,5 (18,9) ±4,85	8,20-8,50 (8,33) ±0,15	8,80-11,3 (10,07) ±1,25	0,00-16 (8,33) ±8,02	0,365-1,40 (0,76) ±0,56	0,014-0,06 (0,03) ±0,02	0,074-0,19 (0,09) ±0,09	III
3	14,4-23 (17,63) ±4,68	8,20-8,70 (8,37) ±0,29	10,10-11,20 (10,6) ±0,56	0,00-13 (7) ±6,56	0,70-1395 (466,17) ±804,39	0,011-0,10 (0,07) ±0,05	0,00-0,06 (0,06) ±0,00	III
4	13,7-21,5 (16,9) ±4,08	8-8,2 (8,07) ±0,11	8,9-11,7 (10,1) ±1,44	0,00-6 (2,33) ±3,21	0,30-1,815 (1,14) ±0,77	0,01-0,209 (0,09) ±0,11	0,00-0,09 (0,02) ±0,03	II
5	12,1-20,5 (15,13) ±4,66	7,9-8,28 (8,06) ±0,2	8,6-9,9 (9,4) ±0,7	1-8 (4,5) ±4,95	1,7-4,43 (2,84) ±1,42	0,021-0,10 (0,06) ±0,04	0,00-0,17 (0,06) ±0,09	II
6	11,8-21,7 (15,33) ±5,52	7,6-7,8 (7,73) ±0,12	2-5 (3,67) ±1,53	0,00-13 (6,67) ±6,51	0,595-2,2 (1,43) ±0,80	0,028-0,06 (0,04) ±0,02	0,61-1,846 (1,25) ±0,62	III
7	12,1-26,6 (17) ±8,31	8,4-8,75 (8,55) ±0,18	9,3-10,3 (9,9) ±0,53	0,00-5 (2,67) ±2,52	0,00-1,4 (0,06) ±0,72	0,01-0,19 (0,07) ±0,10	0,02-0,76 (0,27) ±0,42	III
8	10,4-19 (14,53) ±4,31	8,1-8,62 (8,37) ±0,26	8,5-11,6 (10,33) ±1,63	0,00-9 (3) ±5,20	0,10-1,905 (0,97) ±0,90	0,00-0,03 (0,02) ±0,02	0,00-0,08 (0,03) ±0,04	II
9	8,1-20,07 (14,23) ±6,31	7,4-8,2 (7,87) ±0,42	9,4-12,1 (10,67) ±1,36	0,00-8 (3,67) ±4,04	0,5-1,9 (1,2) ±0,99	0,009-0,02 (0,02) ±0,00	0,023-0,06 (0,05) ±0,01	II
10	8,6-21,2 (14,1) ±6,45	7,8-8,1 (7,9) ±0,17	8,5-12,4 (10,03) ±2,08	1-7 (3,33) ±3,21	0,535-1,9 (1,25) ±0,92	0,008-0,01 (0,01) ±0,00	0,00-0,11 (0,07) ±0,06	I
11	14-22,6 (17,67) ±3,21	7,9-8,5 (8,13) ±0,32	2,5-6,3 (4,17) ±1,19	2,6-17,8 (12,33) ±2,31	ADL(IV)	0,03-0,084 (0,04) ±0,01	ADL(IV)	IV
12	9-16,4 (12,1) ±3,84	7,5-8 (7,8) ±0,26	6,3-10,8 (8,63) ±2,25	0,00-3 (2) ±1,73	0,08-2,1 (1,7) ±0,57	0,017-0,04 (0,04) ±0,01	0,022-0,04 (0,04) ±0,01	II
13	14,9-19,7 (16,57) ±2,72	7,5-8,1 (7,8) ±0,30	7,2-9,6 (8,7) ±1,31	0,00-5 (2,33) ±2,52	0,08-2,2 (1,35) ±1,20	0,017-0,12 (0,09) ±0,05	0,022-0,11 (0,1) ±0,02	III
14	14,3-20,8 (16,7) ±3,57	7,8-8,6 (8,13) ±0,42	7,8-9,6 (8,9) ±0,96	0,00-10 (4) ±5,29	0,00-5,3 (2,85) ±3,46	0,02-0,028 (0,02) ±0,00	0,03-0,078 (0,04) ±0,01	II
15	15,7-23,2 (18,33) ±4,22	8-8,3 (8,1) ±0,17	8,4-16,4 (11,67) ±4,20	0,00-3 (1,67) ±1,53	0,00-2,1 (1,8) ±0,42	0,01-0,02 (0,02) ±0,01	0,028-0,16 (0,1) ±0,09	II
16	13,4-18,2 (15,53) ±2,44	7,6-8,5 (7,9) ±0,52	2,7-8,5 (5,5) ±2,91	10-15 (12,5) ±3,54	ADL(IV)	0,018-0,27 (0,19) ±0,12	0,006-1,98 (1,04) ±1,33	IV
17	14,3-23,9 (17,77) ±5,33	8,6-8,8 (8,67) ±0,12	5,8-10,9 (8,63) ±2,60	0,00-4 (1,67) ±2,08	0,00-1,3 (0,7) ±0,85	0,01-0,0075 (0,03) ±0,02	ADL(IV)	IV
18	16,8-23,9 (19,2)±4,1	7,3-7,6 (7,5) ±0,12	8,9-11,7 (10,2) ±1,1	1-3 (1,24) ±0,9	0,0-0,9 (0,6) ±0,75	0,006-0,01 (0,01) ±0,0	0,0-0,13 (0,08) ±0,07	I
19	12,4-19,2 (15,6))±3,1	7,8-8,6 (8,67) ±0,42	7,6-12,4 (9,03) ±1,6	1-3 (1,4) ±0,04	0,682-1,7 (1,5) ±0,84	0,008-0,01 (0,01) ±0,00	0,00-0,11 (0,07) ±0,06	I

4. Conclusions and discussion

According to the present study zoobenthic communities of Mustafakemalpaşa, Orhaneli and Emet Rivers were dominated mainly by four animal groups; Oligochaeta (41.3%), Chironomidae (18.2%), Gammaridae (10.7%) and Ephemeroptera (6%). Although the first three taxa contain tolerant species, Ephemeroptera includes pollution-sensitive species as well as semi-tolerant (such as family Baetidae) species. In addition, Plecoptera and Trichoptera which contain pollution-sensitive species were inabundant in all three sub-basins of Susurluk. The highest EPT values in the three sub-basins were identified in four stations; two out of four stations (9 and 10) and EPT ratio (17.6% and 23.5%, respectively) located on upper Orhaneli River (rhitral region, Figure 1), and remaining two stations (18 and 19 with EPT ratio 25% and 14.9%, respectively) located on Emet river. As seen in Table 4, three of the four stations (10, 18 and 19) demonstrated the first class water quality while station 9 had second water quality class.

The biological state in any freshwater system is the combination of the habitat and water quality. Biological situation is demonstrated by biological metrics (such as BMWP, ASPT, Shannon-Wiener, Margalef indices, EPT%, Oligochaeta% and EPT/Oligochaeta% ratio) depending on the zoobenthic community; water quality represents environmental variables (such as pH, dissolved oxygen, temperature etc.) and habitat quality represents geomorphological and some bioecological conditions (zonation) at the region (Hauer and Lamberti 2007). In nonimpacted freshwater systems (first class water quality, or the oligosaprobic region) zoobenthic community is diverse, and community is dominated by pollution-sensitive taxa including EPT as the stations 10 (Orhaneli River), 18 and 19 (Emet River) in the present study. The station 9 may categorized as slightly impacted (water quality class II). At all these four stations, not only is the EPT value but also the other biological metrics such as BMWP, ASPT, Shannon-Wiener and Margalef indices, are high (Table 3). According to the Turkish Surface Water Quality Management Regulation (2015) two stations of the Mustafakemalpaşa River (2 and 3) and two stations of Orhaneli River (6 and 7) are categorized as moderately impacted water quality class (III). The common characteristic of these four sampling points is that some factories (Boron, Lignite, Thermoelectric Power Plants and Coal Factory) are located upstream of these stations (Figure 1). At these stations, while the relative abundance of Oligochaeta increased, the decrease in EPT is not surprising due to poor habitat and water quality (Table 3 and 4).

The lowest EPT % were identified on the stations 11 and 16 (1.5% and 0 respectively) on Orhaneli River during the whole research period. These two stations were determined as belonging to quality class IV (severely impacted) and dominated by tolerant Oligochaeta (25.4%) and Chironomidae (39.6%) members, what constituted more than half of the zoobenthic community. It is known that in severely impacted region zoobenthic community has poor diversty and the community consist of low numbers of individuals or high numbers of a few taxa (Hauer and Lamberti 2007). Not only biological metrics (BMWP, ASPT, Shannon-Wiener, EPT%, Oligochaeta%) but also water quality parameters and habitat quality of these two stations support this information. In addition, severely impacted sites generally are receiving heavy wastewater inputs and agricultural or urban runoff. Station 11 is downstream of the Emet Boron Plant.

In a freshwater system, zoobenthic community structure diversity and distribution of taxa are controlled, besides the habitat and water quality, also by food and predators. Feeding types of the taxa and their percentages in habitat also provide information about the environment in which samples are collected. In running water system basic feeding groups are categorizes as scrapers (grazers) which consume algae and organic matter (some Gastropoda and Ephemeroptera); shredders which consume coarse particulate organic material including wood (Amphipoda, Isopoda and Trichoptera); collectors (gatherers) which consume fine organic matter from stream substrate (some Ephemeroptera, insect larvae and Oligochaeta); filterers which collect fine organic matter from the water column and predators which feed on other orgamisms, some Odonata, Coleoptera, Chironomidae and Plecoptera (Hauer and Lamberti 2007).

All zoobenthic community members are categorized according to the feeding types in Table 3. The zoobenthic community structure of all three sub-basins proved to be formed mainly by collectors (gatherers).The presence or absence of certain pollution-sensitive taxa (EPT) in the study area may of course be explained by the availability of nutrients in the habitat. The quality and amount of nutrients of the freshwater sites, which are receiving heavy wastewater inputs and agricultural or urban runoff, may change at short notice. In such a case, sensitive zoobenthic taxa either disappear or migrate to a different suitable habitat. If the biological and chemical quality of the habitat is changed, the zoobenthic community structure also changes.

In the present study a total of 35 higher taxonomic groups and 36 Oligochaeta species were identified. Oligochaeta proved to be most dominant higher taxon in the zoobenthos. Among them, *Potamothrix hammoniensis* and *Nais communis* were the most widespread species (Table 2). These two species are known as alfa-mesosaprobic (Brinkhurst and Jamieson 1971). Like *Potamothrix hammoniensis,* several other oligochaete species have been used as water quality indicators for freshwater systems. (Särkkä, 1994; Çamur-Elipek et al., 2006, Arslan et al. 2016).

P. hammoniensis is common at the bottom of lake and running water systems and can even survive in the high eutrophication and in brackish waters of low salinity (Timm, 2013; Erséus et al. 1999). The highest relative abundance value of the *P. hammoniensis,* which was found in eighteen out of nineteen stations, was detected at the station 15. This station is located on the Emet River and the water quality class was II. At the other stations where the species was detected, its dominancy values were also high, but the interesting thing is that although these stations had the third and fourth quality water class (especially stations 1, 11, 16 and 17), the dominancy value of *P. hammoniensis* was not as high as at the station 15. The station 1 is on the discharge of the Lake Uluabat and the temperature and BOD values were high (Table 4). Erséus et al. (1999) reported that *P. hammoniensis* can be replaced by *P. heuscheri* during a long time of oxygen deficiency combined with elevated temperature. Station 1 is the only station where *Potamothrix heuscheri* is detected on the study area as seen in Table 2. *P. heuscheri* was the second species (after the *Limnodrilus claparedianus*) which had its highest dominacy value (21.3%) at this station. Although there is no definite inference, *P. hammoniensis* was replaced by *P. heuscheri* because of changing environmental conditions at this station. The population density of both species should be monitored in order to be able to say this inference exactly. In addition, the polysaprobic *Limnodrilus claparedianus* was the dominant species at the same station. The station 11, another sampling point with the water quality class IV, is very close to the Emet Boron Plant.

Apart from *P. hammoniensis* (20.6%), the oligochaete fauna of the sampling point 11 also included several other tolerant species such as *Dero furcata* (23.5%), *Dero dorsalis* (11.2%), *Ophidonais serpentina* (14.7%) and *Paranais frici* (8.8%). *Dero* spp. tend to occur in various environments from swampy areas in ponds and rivers to slow moving marshy rivers (Hedge and Sreepadak, 2015). Thanks to their gills, they can tolerate very low levels of dissolved oxygen concentrations (Brinkhurst and Jamieson 1971). It is recognized that DO levels of this station dropped to 2.5 mg/L and BOD values raised to 17.8 mg/L (Table 4). The evident increase in the dominance values of the polysaprobic *Dero* spp. and other mesosaprobic species can be regarded as a biological response to the negative change in the environmental conditions.

Other widespread oligochaete species in the study area were *Tubifex tubifex, Psammoryctides barbatus, Psammoryctides albicola, Paranais frici* and *Stylaria lacustris,* which are tolerant to organic pollution and known as poly- and mesosaprobic species (Hellawell 1986). Several naidine species are cosmopolitan and occur across the world. They inhabit submerged vegetation and sediment (Wetzel et al. 2000). It is known that relative abundances of *Stylaria lacustris* and *Paranais frici* have increased especially in moderately dense macrophytes. Although some authors reported these species in relatively clean waters (Dumnicka 1978; Davis 1982).

Our results indicated that upper Orhaneli and Emet Rivers stations (10 and 19) were nonimpacted and their fauna was diverse while the stations 1, 11, 16 and 17 were polluted. Our both biological and water quality parameters showed that ten out of nineteen stations were determined as water quality classes I and II (nonimpacted and slighltly impacted) in

the study area (Tables 3 and 4). In freshwater systems, biological metrics of nonimpacted regions indicate good stream quality, and its benthic community is dominated by pollution sensitive taxa while slightly impacted regions' community is less diverse and dominated by few taxa including Epmeroptera, some Trichoptera, Oligochaeta and Chironomidae. Remaining nine stations are categorized as water quality classes III and IV (moderately and severely impacted). At these stations biological metrics indicate zoobenthic community dominated by tolerant higher taxa such as Oligochaeta and Chironomidae.

When all three sub-basins together were examined in terms of diversity and distribution of benthic invertebrates, Oligochaeta, Chironomidae and Gammaridae were highly dominant at all stations while Trichoptera and Plecoptera species had the lowest abundancy. The biological state in any freshwater system is the combination of the habitat and water quality (Hauer and Lamberti 2007). From water quality the most important parameters are dissolved oxygen, temperature and pH because of they directly affect aquatic life. Results of the present study on both water quality and biotic indices indicated that all stations of the Mustafakemalpaşa River and some stations of Emet and Orhaneli rivers' are polluted, and this pollution affects the zoobenthic community structure and diversity.

References

APHA. (1998). Standard Methods for the Examination of Water and Wastewater, Washington; American Public Health Association.

AQEM Consortium. (2002). Manual for the Application of the AQEM System. A Comprehensive Method to Assess European Streams Using Benthic Macroinvertebrates, Developed for the Purpose of the Water Framework Directive. Version 1.0.

Armitage, P. D., Moss, D., Wright, J. F. and Furse, M. T. (1983). The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running water sites. Water Research, 17(3), 333-347.

Arslan, N. (2006). Records of Aphanoneura and aquatic oligochaetes from Turkey. Fresenius Environmental Bulletin**,** 15(4), 1-7.

Arslan, N., Salur, A., Kalyoncu, H., Mercan, D., Barışık, B. and Odabaşı, D. A. (2016). The use of BMWP and ASPT Indices for Evaluation of Water Quality according to Macroinvertebrates in Küçük Menderes River (Turkey). Biologia, 71(1), 49-57.

Arslan, N., Timm, T. and Erséus, C. (2006). Aquatic Oligochaeta (Annelida) of Balıkdamı wetland (Turkey), with description of two new species of Phallodrilinae. Biologia, 62(3), 323-334.

Arslan, N., Timm, T., Rojo, V., Vizcaíno, A. and Schmelz, R. M. (2018). A new species of *Enchytraeus* (Enchytraeidae, Oligochaeta) from the profundal of Lake Van, the world's largest soda lake (Turkey, East Anatolia). Zootaxa, 4382(2), 367-380.

Bellan-Santini, D. (1969). Contribution à l'étude des peuplements infralittoraux sur substrats rocheux (étude qualitative et quantitative de la frange supérieure). Recueil des Travaux de la Station Marine d'Endoum, 63(47), 9-294.

Brinkhurst, R. O. and Jamieson, B. G. M. (1971). Aquatic Oligochaeta of the World. University of Toronto.

Çamur-Elipek, B., Arslan, N., Kırgız, T. and Öterler, B. (2006). Benthic Macrofauna in Tunca River (Turkey) and Their Relationships with Environmental Variables. Acta Hydrochimica et Hydrobiologica, 34, 360-366.

Davis, R. J. (1982). New records of aquatic Oligochaeta from Texas, with observations on their ecological characteristics. Hydrobiologia, 96, 15-29.

Dumnicka, E. (1978). Communities of oligochaetes (Oligochaeta) of the River Nida and its tributaries. Acta Hydrobiologica, 20, 117-141.

Erséus, C., Grimm, R., Healy, B., Lundberg, S., Rota, E. and Timm, T. (1999). Clitellate diversity in Nationalstadsparken, an urban national park in Stockholm, Sweden. Hydrobiologia, 406, 101-110.

Hauer, F. R. and Lamberti, G. A. (2007). Methods in Stream Ecology, Second Edition, Academic Press.

Hegde, R. P. and Sreepada, K. S. (2015). Freshwater Oligochaetes (Annelida) from Western Ghats and The West Coast of Karnataka (India). Turkish Journal of Zoology, 39, 523-526.

Hellawell, J. M. (1986). Biological Indicators of Freshwater Pollution and Environmental Management. Elsevier Applied Science Publishers, NY.

Martin, P., Martinez-Ansemil, E., Pinder, A., Timm, T. And Wetzel, M. J. (2008). Global diversity of oligochaetous clitellates (''Oligochaeta"Clitellata) in freshwater. Hydrobiologia, 595, 117-127.

Matamoros, L., Yıldız, S. and Erséus, C. (2007). A new species within the genus *Marionina* (Enchytraeidae: Annelida: Clitellata) from the southern Black Sea. Marine Biology Research, 3(6), 397-402.

Särkkä, J. (1994). Lacustrine, profundal meiobenthic oligochaetes as indicators of trophy and organic loading. Hydrobiologia, 278, 231-241.

Soyer, J. (1970). Bionomie benthique du plateau continental de la cote catalane française. III. Les peuplements de Copepodes harpacticoides (Crustacea). Vie et Milieu B, 21(2), 337-511.

Sperber, C. (1948). A taxonomical study of the Naididae. Zoologiska Bidrag från Uppsala, 28, 1-296.

Sperber, C. (1950). A guide for the determination of European Naididae. Zoologiska Bidrag från Uppsala, 29, 45-78.

Timm, T. (1999). A Guide to the Estonian Annelida. Naturalist's Handbooks 1, Tartu-Tallinn.

Timm, T. (2013). The genus *Potamothrix* (Annelida, Oligochaeta, Tubificidae): a literature review. Estonian Journal of Ecology, 62(2), 121-136.

Timm, T., Arslan, N., Rüzgar, M., Martinsson, S. and Erséus, C. (2013). Oligochaeta (Annelida) of the profundal of Lake Hazar (Turkey), with description of *Potamothrix alatus hazaricus* n. ssp. Zootaxa, 3716(2), 144-156**.**

Turkish Surface Water Quality Management Regulation (2015). Republic of Turkey Ministry of Environment and Forest. Surface Water Quality Management Regulation.

Wetzel, M. J., Kathman, R. D., Fend, S. V. and Coates, K. A. (2000). Taxonomy, Systematics and Ecology of Freshwater Oligochaeta. Workbook Prepared for North American Benthological Society Technical Information Workshop, 48th Annual Meeting, Keystone Resort, CO.

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Research article/Araştırma makalesi

Flora of Tunca Valley Natural Park and environs (Ardeşen-Rize/Turkey)

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Abstract

The aim of the study is to determine the flora of Tunca Valley Natural Park and environs (Ardeşen, Rize, Turkey). During the years 2016-2017, 1756 plant specimens were collected through comprehensive surveys. 408 taxa belonging to 244 genera and 64 families were identified. 1 of them is Lycopodiophyta, 16 of them are Pteridophyta and 391 were Magnoliophyta. The dispersion of Magnoliophyta is as follows; 2 Pinophytina and 389 Magnoliophytina. According to the total number of taxa, *Asteraceae* (44), *Poaceae* (31), *Fabaceae* (26), *Caryophyllaceae* (25) and *Rosaceae* (19) are the richest families. The distribution of phytogeographic elements are as follows: Euro-Siberian 237 (58.1%), Irano-Turanian 14 (3.4%), Mediterranean 5 (1.2%), and multiregional or of unknown phytogeographic origin 152 (37.3%). The life spectrum distrubition is as: hemicryptophytes 196 (48.0%), cryptophytes 110 (26.9%), therophytes 46 (11.3%), chamaephytes 28 (6.8%), phanerophytes 28 (6.8%), vascular parasites 1 (0.2%). The endemism ratio is 4.9% (20 takson).

Key words: flora, natural park, Tunca Valley, Rize, Turkey

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Tunca Vadisi Tabiat Parkı ve çevresinin florası (Ardeşen-Rize/Türkiye)

Özet

Çalışmanın amacı Tunca Vadisi Tabiat Parkı ve çevresinin florasının belirlenmesidir. 2016-2017 yılları arasında kapsamlı arazi çalışmaları sonucu 1756 bitki örneği toplanmıştır. 64 familya ve 244 cinse ait 408 bitki taksonu teşhis edilmiştir. Tespit edilen taksonların 1'i Lycopodiophyta, 16'sı Pteridophyta ve 391'i ise Magnoliophyta'dır.. Toplam takson sayısı bakımından *Asteraceae* (44), *Poaceae* (31), *Fabaceae* (26), *Caryophyllaceae* (25) ve *Rosaceae* (19) familyaları en zengin familyalardır. Fitocoğrafik elemanların dağılımı şu şekildedir: Avrupa-Sibirya 237 (%58,1), İran-Turan 14 (%3,4), Akdeniz 5 (%1,2), ve çok ya da bilinmeyen bölgeli 152 (%37,3). Hayat formu dağılımı: hemikriptofitler 196 (%48,0), kriptofitler 110 (%26,9), terofitler 46 (%11,3), kamefitler 28 (%6,8), fanerofitler 28 (%6,8), vasküler parazitler 1 (0,2%) şeklindedir. Endemizm oranı %4.9 (20 takson).'dir.

Anahtar kelimeler: flora, tabiat parkı, Tunca Vadisi, Rize, Türkiye.

1. Introduction

1.1. Geographical Features of The Study Area

Tunca Natural Park is in Rize, 55 km away from city centre and 18 km away from Ardeşen district. The study area covers a total 40820 decare. It lies between the latitudes 41^0 08' 506 and 41^0 07' 031 and the longitudes 41^0 20' 491 and 41^0 35' 769. Tunca Natural Park is at A8 square of Euro-Siberian phytogeographical region Davis (1965-1985). The lowest part of the study area is 1350 m and the highest part is 3159 m (Figure 1).

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1.2. Geology and Edaphic Features

Rize composed of Hemşimdere, Rize, Kaplıca, Melyat, Pazar and Hamidiye geological formations Even though the generalized columnar section is such mentioned the formation at the surface, changes in different part of Rize. Tunca Natural Park totally composed of Hemşindere formation of upper Cretaceous age, which comprises basic and acid volcanic such as basaltic andésite, rhyodacite, dacite, rhyolite, and some andesitic intermediate volcanies (Gedik et al., 1992).

The high parts of the study area consists of scars and rifts, the rest of the area has three main soil types, namely non-calcareous forest soil, grey-brown podzol soil and high mountain meadow soils (Anonymous, 2005).

1-3. Climatical Features

The climatic data of Pazar station (Anonymous, 2011) were interpolated (Çepel, 1978; Doğan 1977) for the altitude of 1700 m. According to these interpolated data Walter climate diagram for the research area was drawn. The climate in the study area is very-humid, mesothermal without any dry season. The precipitation regime is as autumn, winter, spring and summer (Au.Wi.Su.Si.). January, February, March and December are the frosty months while April and November are the probable frosty months (Figure 2).

Figure 1. Map of the study area

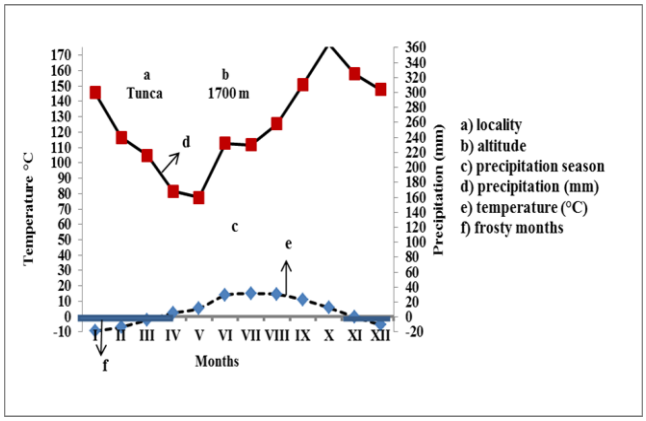

Figure2. Climatical diagram of the area

2. Materials and methods

The materials of the study are the vascular plant taxa collected (1756 plant taxa) from Tunca Valley Natural Park between the years 2016-2017. The samples for each taxon were dried and stuck according to herbarium rules (Erik et al., 1996) and preserved in the herbarium of Biology Department, Faculty of Arts and Sciences, Recep Tayyip Erdoğan University. The taxa were identified using The Flora of Turkey and the Aegean Islands (Davis, 1965-1985; Davis et al., 1988; Güner et al., 2000). The taxa also checked with Russian flora (Komarov and Shishkin, 1933-1964), Flora of Georgia (Ketzkhoveli and Gagnidze, 1971-2001) and related studies (Eminağaoğlu, 2003, 2004; Baykal & Atamov, 2016). The list of the identified taxa are given according to APG III (Angiospermi Phylogeny Group) in alphabetical order (Güner et al., 2012). The family and taxon name (including in Turkish), author and locations are given correspondingly (Güner et al., 2012). The endemism status (Güner, 2012), threatened categories (Ekim et al., 2000; Anonymous, 2017), phytogeographical regions (Davis, 1965-1985; 1988), and life forms (Raunkiaer, 1934; Ellenberg and Mueller-Dombois, 1967) were also given.

Abbreviations

m.: meter
Euro-Sib: Euro-Siberian element
Eux: Euxine element
Hyrc-Eux: Hyrcano-Euxine element
Ir-Tur: Irano-Turanian element
Medit: Mediterranean element
Cosm: Cosmopolitan
Hyrc-Eux, and Eux were evaluated as subcategories of Euro-Sib.
EN: Endangered
LC: Least concern
NE: Not evaluated
NT: Near threatened
VU: Vulnerable
HB: Hüseyin Baykal
Hcrp: Hemicryptophytes
Crp: Cryptophytes
Thp: Therophytes
Chp: Chamaephytes
Php: Phanerophytes

3. Results

The Floristic List

Lycopodiophyta / Kibritotu Bölümü

Lycopodiidae / Kibritotu Altsınıfı

Lycopodiaceae / Kibritotugiller

Huperzia selago (L.) Bernh. / dik hibritotu.
Among *Rhododendron* shrubs, 1550 m, 22.07.2016, HB 1564
Euro-Sib, Hcrp.

Pteridophyta / Eğreliti Bölümü
Equisetidae / Atkuyruğu Altsınıfı
Equisetaceae / Atkuyruğugiller
Equisetum arvense L. / atkuyruğu.
Streamsides, 1650 m, 08.06.2016, HB 1237, Crp.
Polypodiidae / Eğrelti Altsınıfı
Aspleniaceae / Saçakotugiller
Asplenium adiantum-nigrum L. / kara saçakotu.
On damp rocky surfaces, 1700 m, 12.08.2017, HB 1864
Crp.
A. scolopendrium L. / geyikdili.
Shady rocky surfaces, 2000 m, 06.08.2016, HB 1645
Crp.
A. septentrionale (L.) Hoffm. / devesakalı
At grikes, 1550 m, 05.09.2016, HB 1751
Eux, Crp.
A. trichomanes L. / saçakotu.
On rocky surfaces, 1900 m, 20.08.2016, HB 1699
Crp.
A. woronowii H. Christ. / kızıl baldırıkara.
Screes, 2200 m, 22.07.2016, HB 1588
Euro-Sib, Crp.
Athyriaceae / Yeleğreltisigiller
Athyrium filix-femina (L.) Roth. / yel eğreltisi.
Above forest, 1750 m, 14.07.2017, HB 1839
Crp.
A. alpestre (Hoppe). Clairv. / dağyeli.
Rocky surfaces, 2050 m, 06.08.2016, HB 1624
Crp.
Cystopteridaceae / Gevrekeğreltiler
Gymnocarpium dryopteris (L.) Newman / baldırıçıplak.
Rocky slopes, 1700 m, 23.06.2016, HB 1350
Crp.
Dennstaedtiaceae / Eğreltiler
Pteridium aquilinum (L.) Kuhn / eğrelti.
Above forest, 1850 m, 23.06.2016, HB 1330
Crp.
Dryopteridaceae / Piluçgiller
Dryopteris dilatata (Hoffm.) A. Gray. / ayu piluncu.
Screes, 1900 m, 12.08.2017, HB 1868
Crp.
D. filix-mas (L.) Schott. / erkek eğrelti.
Among rocks, 1600 m, 28.06.2017, HB 1804
Crp.
Polystichum woronowii Fomin. / çat piluncu.
Among rocks, 1600 m, 22.07.2016, HB 1540
VU, Hyrc-Eux, Crp.
Osmundaceae / Kraleğretisigiller
Osmunda regalis L. / kral eğreltisi.
Damp streamsides, 1600 m, 07.07.2016, HB 1450
Crp.
Polypodiaceae / Benlieğreltiler
Polypodium vulgare L. var. *vulgare* / benli eğrelti.
On rocky surfaces, 1600 m, 07.07.2016, HB 1480
Crp.
Pteridaceae/ Baldırıkaragiller
Cryptogramma crispa (L.) R. Br. ex Hook. / saklı eğrelti.
Screes, 2050 m, 27.07.2017, HB 1853
Euro-Sib, Crp.

Magnoliophyta / Tohumlu Bitkiler Bölümü
Pinophytina / Açık Tohumlular Sınıfı
Pinidae / Çamlar altsınıfı
Cupresaceae / Servigiller
Juniperus oxycedrus L. subsp. *oxycedrus* / katran ardıcı.
Mixed forest, 1700 m, 23.06.2016, HB 1317
Php.
Pinaceae / Çamgiller
Picea orientalis (L.) Peterm. / lâdin.
Mixed forest, 1700 m, 23.06.2016, HB 1325
Eux, Php.
Magnoliophytina / Kapalı Tohumlular Sınıfı
Adoxaceae / Mürvergiller
Sambucus ebulus L. / mürver otu.
Forest, 1700 m, 14.07.2017, HB 1824
Euro-Sib, Chp.
S. nigra L. / ağaç mürver.
Edge of forest, 1700 m, 23.06.2016, HB 1347
Euro-Sib, Php.
Viburnum orientale Pall. / katkat çalısı.
Shrub communities, 1750 m, 07.07.2016, HB 1485
Eux, Php.
Amaryllidaceae / Nergisgiller
Allium schoenoprasum L. / peynir sirmosu.
Alpine medows, 2500 m, 06.08.2016, HB 1668
Crp.
A. scorodoprasum L. subsp. *rotundum* (L.) Stearn / deli pırasa.
Stony paces, 1500 m, 24.05.2016, HB 1166
Crp.
A. szovitsii Regel / yayla körmeni.
Alpine meadows, 2550 m, 20.08.2016, HB 1710
Eux (mt), Crp.
Apiaceae / Maydonozgiller
Bupleurum falcatum L. subsp. *polyphyllum* (Lebed.) H.Wolff / bolşeytan.
Meadows, 2250 m, 06.08.2016, HB 1615
Eux (mt), Hcrp.
Carum carvi L. / kimyon.
Damp meadows, 2500 m, 22.07.2016, HB 1573
Chp.
Caulis platycarpos L. / kavkal.
Meadows, 2300 m, 27.07.2017, HB 1849
Thp.
Chaerophyllum astrantiae Boiss. & balnsa ex Boiss. / yılandokotu.
Stony places, 2600 m, 20.08.2016, HB 1713
NT, Eux, Hcrp.
Chamaesciadium acaule (Bieb.) Boiss. / hamotu.
Pastures, 2450m, 22.07.2016, HB 1592
Hyrc-Eux, Hcrp.
Heracleum apiifolium Boiss. / telehaş.
Streamsides, 1800 m, 22.07.2016, HB 1577
Eux (mt), Hcrp.
H. platytaenium Boiss. / öğrekotu.
Streamsides, 1700 m, 07.07.2016, HB 1471
LR (Ic), Eux, Hcrp.
H. sphondylium L. subsp. *cyclocarpum* (C.Koch.) P.H.Davis / çember koçuk.
Streamsides, 1700 m, 07.07.2016, HB 1490
Eux, Hcrp.
Pimpinella affinis Lebed. / enisen.
Meadows, 2100 m, 14.07.2017, HB 1822
Hcrp.
Sanicula europaea L. / sanikel.
Forest, 1700 m, 23.06.2016, HB 1358
Euro-Sib, Hcrp.
Seseli libanotis Koch / dağ havucu.
Meadows, 1700 m, 07.07.2016, HB 1454
Euro-Sib, Crp.
Aquifoliaceae / Işılgangiller
Ilex colchica Pojark / ışılgan.
Forest, 1700 m, 08.06.2016, HB 1228
Eux, Php.

Araliaceae / Sarmaşıkgiller
Hedera colchica (K.Koch.) K.Koch / kara sarmaşık.
On trees and rocky surfaces, 1700 m, 23.06.2016, HB 1355
Eux, Php.
Asparagaceae / Kuşkonmazgiller
Muscari aucheri (Boiss.) Baker / gök müşkürüm.
Stony meadows, 2200 m, 08.06.2016, HB 1232
Crp.
Ornithogalum oligophyllum E. D. Clarke / kurt soğanı.
Stony slopes, 2500 m, 16.06.2017, HB 1791
Crp.
Polygonatum verticillatum (L.) All. / mührüsüleyman.
Rhododendron shrubs, 2150 m, 08.06.2016, HB 1245
Euro-Sib, Crp.
Scilla monanthos K. Koch / sümbülcük.
Subalpine meadows, 2100 m, 24.05.2016, HB 1169
Eux, Crp.
Asteraceae /Papatyagiller
Achillea biserrata Bieb. / aksırıkotu.
Damp meadows, 2100 m, 22.07.2016, HB 1558
Eux, Hcrp.
A. latiloba Ledeb. ex.Nordm. / siporiş.
Alpine meadows, 2800 m, 06.08.2016, HB 1620
Eux (mt), Crp.
A. millefolium L. subsp. *millefolium* / civanperçemi.
Alpine meadows, 2900 m, 05.09.2016, HB 1757
Euro-Sib, Hcrp.
Anthemis cretica L. subsp. *iberica* (M. Bieb.) Grierson / kaf papatyası.
Screes, 2950 m, 20.08.2016, HB 1720
Eux (mt), Hcrp.
Archantemis marschalliana (Willd.) Lo Presti & Oberpr. subsp. *pectinata* (Boiss.) Lo Presti & Oberpr. / sarı sığırgözü.
Screes, 2850 m, 06.08.2016, HB 1653
Eux, Hcrp.
Arctium platylepis (Boiss. & Balansa) Sosn. ex. Grossh. / baldikeni.
Streamsides, 2350 m, 05.09.2016, HB 1760
Eux, Hcrp.
Aster amellus L. subsp. ibericus (Stev.) V.E.Avet / patçiçeği.
Stony slopes, 2350 m, 06.08.2016, HB 1629
Eux, Crp.
Bidens tripartita L. / üçsuketeni.
Streamsides, 1850 m, 20.08.2016, HB 1693
Thp.
Carduus adpressus C.A.Mey. / tomara.
Pastures, 2400 m, 22.07.2016, HB 1548
Eux, Hcrp.
Centaurea helenioides Boiss. / döknel sarıbaş.
Pastures, 2350 m, 22.07.2016, HB 1576
Endemic, NT, Hcrp.
Cirsium arvense (L.) Scop. / köygöçüren.
Streamsides, 2300 m, 12.10.2016, HB 1781
Hcrp.
C. echinus (M. Bieb.) Hand.-Mazz. / kirpi kangalı.
Screes, 2300 m, 22.07.2016, HB 1593
Ir-Tur, Hcrp.
C. osseticum (Adams) Petr. subsp. *osseticum* / garip kangal.
Pastures, 1700 m, 27.07.2017, HB 1852
Hcrp.
Crepis paludosa (L.) Moench. / su kıskısı.
Meadows, 1800 m, 22.07.2016, HB 1565
Euro-Sib, Crp.
Cyanus nigrifimbrius (C.Koch) Sojak / tay boncuğu.
Alpine meadows, 2500 m, 27.07.2017, HB 1846
Eux (mt), Hcrp.
Doronicum orientale Hoffm. / kaplanotu.
Under shrubs, 1750 m, 07.07.2016, HB 1491
Crp.
Erigeron annuus (L.) Pers. / hemşin şifatotu.
Streamsides, 1700 m, 12.08.2017, HB 1867
Hcrp.
E. caucasicus Steven subsp. *caucasicus* / kaf şifaotu.
Stony slopes, 2850 m, 22.07.2016, HB 1597
Euro-Sib, Hcrp.
E. caucasicus Stev. subsp. *venustus* (Botsch.) Grierson / zarif şifaotu.
Stony slopes, 2600 m, 22.07.2016, HB 1567
Hcrp.
Helichrysum arenarium (L.) Moench subsp. *aucheri* (Boiss.) Davis & Kupicha / yayla çiçeği.
Meadows, 2700 m, 06.08.2016, HB 1613
Ir-Tur, Hcrp.
Hieracium djimilense Boiss. & Balansa / cimil şahinotu.
Meadows among screes, 1750 m, 08.06.2016, HB 1239
Endemic, VU, Eux, Hcrp.
H. labillardierei Arv-Touv. / kızıl şahinoyu.
Stony slopes, 1900 m, 23.06.2016, HB 1336
Hcrp.
Inula orientalis Lam. / şark andızotu.
Damp pastures, 2600 m, 22.07.2016, HB 1563
Eux (mt), Crp.
Lactuca intricata Boiss. / güzel merhemotu.
Stony slopes, 1700 m, 27.07.2017, HB 1856
Euro-Sib, Hcrp.
L. serriola L. / eşekhelvası.
Stony slopes, 2300 m, 22.07.2016, HB 1546
Medit, Hcrp.
Lapsana communis L. subsp. *intermedia* (Bieb.) Hayek. / şebrek.
Streamsides, 2200 m, 20.08.2016, HB 1695
Hcrp.
Leontodon hispidus L. var. *hispidus* / gülikazer.
Screes, 2400 m, 22.07.2016, HB 1534
Euro-Sib, Crp.
Petasites albus (L.) P. Gaertn. / lapaza çiçeği.
Damp slopes close to stream, 1750 m, 24.05.2016, HB 1161,
Euro-Sib, Crp.
P. hybridus ((L.) P. Gaertn. / kabalak.
Streamsides, 1750 m, 08.06.2016, HB 1227
Euro-Sib, Crp.
Pilosella officinarum Vaill. / tırnakotu.
Stony slopes, 1700 m, 07.07.2016, HB 1458
Chp.
Prenanthes abietina (Boiss. & Balansa) Kirp. / sarı eğikçiçek.
Close to forest border, 2600 m, 06.08.2016, HB 1626
Eux, Hcrp.
Psephellus appendicigerus (K. Koch) Wagenitz / ovit tülübaşı.
Screes, 2600 m, 06.08.2016, HB 1635
Endemic, EN B2ab (ii, iii, v), Eux (mt), Hcrp.
Sonchus asper (L.) Hill subsp. *glaucescens* (Jord.) Ball / eşekgevreği.
Forest clearings, 1700 m, Hcrp.
Tanacetum kotschyi (Boiss.) Grierson. / pireotu.
Stony slopes, 2600 m, 06.08.2016, HB 1651
Ir-Tur, Hcrp.
T. macrophyllum (Waldst. & Kit.)Sch. / koca pireotu
Pastures, 2200 m, 06.08.2016, HB 1622
Euro-Sib, Hcrp.
Taraxacum buttleri Van. Soest / karahindiba.
Roadsides, 2100 m, 23.06.2016, HB 1349
Hcrp.
T. stevenii DC. / gelingöbeği.

Alpine meadows, 2550 m, 06.08.2016, HB 1669
Ir-Tur, Hcrp.
Telekia speciosa (Schreber.) Baumg. / puğre.
Stony meadows, 1700 m, 28.08.2017, HB 1874
Euro-Sib, Hcrp.
Tragopogon aureus Boiss. / sarı yemlik.
Pastures, 2150 m, 22.07.2016, HB 1578
Endemic, LC (lc), Eux, Hcrp.
Tripleurospermum caucasicum (Willd.) Hayek / akbabotu.
Damp meadows, 2550 m, 20.08.2016, HB 1709
Crp.
T. oreades (Boiss.) Rech. var. *tchihatchewii (*Boiss.) E. Hossain / hoşhoş.
Meadows, 2200 m, 22.07.2016, HB 1550
Crp.
Tussilago farfara L. / öksürükoyu.
Damp slopes, 2200 m, 24.05.2016, HB 1165
Euro-Sib, Crp.
Turanecio taraxacifolius (Bieb.) Hamzaoğlu var. *taraxacifolius* / kar turanotu.
Stony slopes, 2550 m, 22.07.2016, HB 1557
Hcrp.
Xanthium spinosum L. / pıtrak.
Roadsides, 1700 m, 20.08.2016, HB 1716
Cosmopolite, Thp.

Betulaceae / Huşgiller

Alnus glutinosa (L.) Gaertn. subsp. *barbata* (C.A. Mey.) Yalt. / yeykin.
Streamsides, 1650 m, 24.05.2016, HB 1160
Euro-Sib, Php.
Betula medwediewii Regel. / moşi.
Forest, 2000 m, 24.05.2016, HB 1171
Eux, Php.

Boraginaceae / Hodangiller

Asperugo procumbens L. / nevazilotu.
Stony places, 2100 m, 28.06.2017, HB 1819
Euro-Sib, Thp.
Buglossoides arvensis (L.) I. M. Johnston. / tala taşkeseni.
Stony slopes, 2300 m, 23.06.2016, HB 1342
Thp.
Cynoglossum holosericeum Steven / yayla köpekdili.
Screes, 3000 m, 22.07.2016, HB 1568
VU, Eux (mt), Hcrp.
Echium vulgare L. / engerekotu.
Roadsides, 2100 m, 27.07.2017, HB 1854
Euro-Sib, Crp.
Myosotis alpestris F.W. Schmidt. subsp. *alpestris* / boncukotu.
Alpine meadows, 2600 m, 20.08.2016, HB 1701
Hcrp.
M. laxa Lehm. subsp. *caespitosa* (Schutz) Hyl. ex Nordh. / hüthütgözü.
Damp meadows, 1900 m, 22.07.2016, HB 1570
LR (lc), Thp.
M. lazica M. Popov / laz kuşgözü.
Damp stony places, 07.07.2016, HB 1483
VU, Eux, Thp.
M. sylvatica Hoffm. subsp. rivularis Vestergr. / keleş unutmabeni.
Damp meadows, 2500 m, 06.08.2016, HB 1666
Hyrc-Eux (mt), Hcrp.
Nonea versicolor (Steven.) Sweet / çayır sormuğu.
Pastures, 2350 m, 14.07.2017, HB 1837
Eux (mt), Thp.
Symphytum ibericum Steven ex M. Bieb. / orman kafesotu.
Shady meadows, 1750 m, 07.07.2016, HB 1475
Eux, Hcrp.
Trachystemon orientalis (L.) G. Don / kaldirik.
Streamsides, 1700 m, 08.06.2016, HB 1241
Eux, Hcrp.

Brassicaceae / Turpgiller

Aethionema arabicum (L.) Andrz. ex DC. / arap taşçantası.
Stony slopes, 2000 m, 23.06.2016, HB 1320
Cosmopolite, Thp.
Alyssum murale Waldst & Kit. var. *alpinum* Boiss. ex Nyar. / seki kuduzotu.
Meadows, 2200 m, 07.07.2016, HB 1474
Hcrp.
A. murale Waldst & Kit. var. *murale* / seki kuduzotu.
Roadsides, 1900 m, 28.06.2017, HB 1806
Hcrp.
Barbarea plantaginea DC. / götlezgötü.
Streamsides, 2050 m. 23.06.2016, HB 1333
Hcrp.
Capsella bursa-pastoris (L.) Medik. / çobançantası.
Roadsides, 1900 m, 12.08.2017, HB 1866
Cosmopolite, Thp.
C. hirsuta L. / kıllı kodim.
Damp meadows, 2250 m, 22.07.2016, HB 1545
Cosmopolite, Crp.
Cardamine impatiens L. subsp. *Impatiens* / sultan kadimotu.
Shady slopes, 2300 m, 28.08.2017, HB 1871
Euro-Sib, Crp.
C. impatiens L. subsp. *pectinata* (Pall. ex DC.) Stoj. & Stef. / taraklı kadimoyu.
Damp spaces, 1750 m, 06.08.2016, HB 1649
Euro-Sib, Crp.
Draba hispida Willd. / kıllı dolama.
Rocky surfaces, 2500 m, 27.07.2017, HB 1857
Hyrc-Eux (mt), Chp.
D. huetii Boiss. / çayır dolaması.
Meadows, 1700 m, 24.05.2016, HB 1167
Chp.
D. polytricha Ledeb. / rize dolaması.
Rocky surfaces, 2600 m, 22.07.2016, HB 1536
Chp.
D. siliquosa M. Bieb. / yıldız dolama.
Rocky surfaces, 2100 m, 28.06.2017, HB 1809
Hyrc-Eux (mt), Chp.
Erysimum pulchellum (Willd.) J. Gay. / kaba zarife.
Screes, 2100 m, 28.08.2017, HB 1872
Thp.
Hesperis matronalis L. / akşam yıldızı.
Damp slopes, 2200 m, 22.07.2016, HB 1559
Crp.
Murbeckiella huetii (Boiss.) Rothm. / ovitkodimi.
Rocky slopes 2300 m, 14.07.2017, HB 1835
Hcrp.
Nasturtium officinale L. Br. / su teresi.
Streamsides, 1700 m, 23.06.2016, HB 1329
Crp.
Rorippa sylvestre (L.) Besser / çakandura.
Damp places, 1750 m, 05.09.2016, HB 1759
Hcrp.
Thlaspi arvense L. / ekin dağarcığı.
Ridgeways, 1750 m, 20.05.2017, HB 1787
Cosmopolite, Thp.

Campanulaceae / Çançiçeğigiller

Asyneuma amplexicaule (Willd.) Hand.-Mazz. subsp. *amplexicaule* / hoşdeğnek.
Stony slopes, 2350 m, 27.07.2017, HB 1847
Hcrp.
Campanula collina Sims / çayır cıngırağı.
Pastures, 2600 m, 22.07.2016, HB 1584

Eux, Crp.
C. lactiflora M. Bieb. / kupida.
Alpine meadows, 2400 m, 05.09.2016, HB 1746
Eux, Hcrp.
C. olympica Boiss. / orman çanı.
Alpin meadows, 2500 m, 06.08.2016, HB 1665
Eux, Hcrp.
*C. rapunculoide*s L. / elmacık.
Meadows, 2100 m, 22.07.2016, HB 1575
Euro-Sib, Hcrp.

Caprifoliaceae / Hanımeligiller

Cephalaria gigantea (Lebed.) Bobrov / dev pelemir.
Streamsides, 1800 m, 07.07.2016, HB 1453
Eux, Hcrp.
Knautia involucrata Sommier & Levier / deli eşekkulağı.
Alpine slopes, 2600 m, 12.08.2017, HB1863
Eux (mt), Hcrp.
Lonicera orientalis Pall. / has çakkana.
Roadsides close to shrub communities, 1800 m, 07.07.2016, HB 1478
Endemic, LR (lc), Chp.
Scabiosa columbaria L. subsp. *columbaria* / uyuzotu.
Meadows close to roadsides, 1800 m, 20.08.2016, HB 1717
Hcrp.
Valeriana alliariifolia Adams / piot.
Streamsides, 2300 m, 22.07.2016, HB 1598
Euro-Sib, Hcrp.
V. alpestris Steven / yayla kediotu.
Meadows, 2850 m, 06.08.2016, HB 1611
Eux (mt), Hcrp.

Caryophyllaceae / Karanfilgiller

Agrostemma githago L. / buğday karamuğu.
Roadside, 1700 m, 07.07.2016, HB 1484
Thp.
Arenaria rotundifolia M. Bieb. subsp. *rotundifolia* / yer kumotu.
Crevices, 2550 m, 20.08.2016, HB 1718
Thp.
A. serpyllifolia L. / tarla kumotu.
Meadows on rocky places, 2400 m, 22.07.2016, HB 1555
Thp.
Cerastium cerastioides (L.) Britt. / yumak boynuzotu.
Pastures, 06.08.2016, 2200 m, HB 1661
Hcrp.
C. glomeratum Thuill. / boynuzotu.
Meadow slopes, 1700 m, 12.08.2017, HB 1869
Cosmpolite, Thp.
C. purpurascens Adams / alaca boynuzotu.
Screes, 2300 m, 22.07.2016, HB 1547
Euro-Sib(mt), Hcrp.
Dianthus crinitus Sm. var. *crinitus* / uzunçanak.
Rocky slopes, 2300 m, 06.08.2016, HB 1672
Hcrp.
D. orientalis Adams / yar karanfili.
Screes, 2400 m. 05.09.2016, HB 1737
Hcrp.
Eremogone lychnidea (M. Bieb.) Rupr. / topaç kumotu.
Rocky surfaces, 2400 m, 06.08.2016, HB 1627
Thp.
Gypsophila glandulosa (Boiss.) Walp. / yer çevgeni.
Meadows, 2650 m, 20.08.2016, HB 1703a
Eux(mt), Hcrp.
G. silenoides Rupr. / furtuna çöveni.
Meadows, 2400 m, 06.08.2016, HB 1621
Endemic, Eux (mt), Hcrp.
G. tenuifolia M. Bieb. / kaçkar çevgeni.
Meadows, 2600 m, 20.08.2016, HB 1703b
VU, Eux(mt), Hcrp.
Minuartia imbricata (M. Bieb.) Woronow / kaya tıstısı.
Rocky slopes, 2700 m, 06.08.2016, HB 1612
Eux(mt), Hcrp.
M. recurva (All) Schinz & Thell. subsp. *oreine* (Mattf.) McNeil / eğri tıstıs.
Mountain slopes, 2900 m, 20.08.2016, HB 1690
Hcrp.
M. verna (L.) Hiern subsp. *verna* / yaz tıstısı.
Alpine meadows, 2700 m, 06.08.2016, HB 1636
Chp.
Petrorhagia saxifraga (L.) Link / şimal zarçiçeği.
Meadows, 1700 m, 12.08.2017, HB 1862
Euro-Sib, Hcrp.
Sagina saginoides (L.) Karst / yayla saginotu.
Meadows, 2250 m, 28.06.2017, HB 1811
Thp.
Saponaria orientalis L. / deli sabunotu.
Rocky slopes, 1900 m, 06.08.2016, HB 1664
LC, Thp.
Silene italica (L.) Pers. subsp. italica / yuğuşyüreği.
Meadows close to streams, 2100 m, 22.07.2016, HB 1542
Hcrp.
S. lazica Boiss. / laz nakılı.
Roadsides, 2050 m, 07.07.2016, HB 1476
Eux (mt), Hcrp.
S. odontopetala Fenzl / kunduzotu.
Meadows on rocky slopes, 2700 m, 05.09.2016, HB 1748
Hcrp .
S. saxatilis Sims / simotu.
Rocky slopes, 2500 m, 06.08.2016, HB 1643
Hcrp.
S. vulgaris (Moench) Garcke var. *vulgaris* / ecibücü.
Meadows, 2600 m, 06.08.2016, HB 1633
Hcrp.
Stellaria holostea L. / urgancık.
Under shrubs, 1750 m, 16.06.2017, HB 1790
Euro-Sib, Thp.
S. media (L.) Vill. / kuşotu.
Meadows, 2200 m, 08.06.2016, HB 1243
Thp.

Celastraceae / İğağacıgiller

Parnassia palustris L. / yürekyaprağı.
Streamsides, 2300 m, 20.08.2016, HB 1711a
Crp.

Cistaceae / Ladengiller

Helianthemum nummularium (L.) Mill. subsp. *nummularium* / güngülü.
Meadow slopes, 2150 m, 22.07.2016, HB 1561
Hcrp.

Colchicaceae / Acıçiğdemgiller

Colchicum speciosum Steven / şepart.
Alpine meadows, 2450 m, 05.09.2016, HB 1756
Euro-Sib, Crp.

Convolvulaceae / Tarlasarmaşığıgiller

Calystegia silvatica (Kit.) Griseb. / bürük.
Edge of forest, 1700 m, 23.06.2016, HB 1348
Hcrp.
Convolvulus arvensis L. / tarla sarmaşığı.
Roadsides, 1850 m, 07.07.2016, HB 1460
Cosmopolite, Hcrp.

Crassulaceae / Damkoruğugiller

Phedimus spurius (M. Bieb.) 't Hart / al pisikulağı.
Rocky surfaces, 2300 m, 07.07.2016, HB 1451
Hyrc-Eux, Crp.
P. stoloniferum (S.G.Gmel) 't Hart / pisikulağı
Screes, 2100 m, 28.06.2017, HB 1820

Hyrc-Eux, Crp.
Prometheum pilosum (M. Bieb) H. Obha / hoş kayagöbeği.
Rocky surfaces, 2200 m, 23.06.2016, HB 1353
Hyrc-Eux, Crp.
Sedum album L. / çobankavurgası.
Rocky surfaces, 2200 m, 22.07.2016, HB 1544
Hcrp.
S. alpestre Vill. / dağ koruğu.
Screes, 2450 m, 06.08.2016, HB 1628
Hcrp.
S. tenellum M. Bieb. / narin damkoruğu.
Rock fractures, 2900 m, 05.09.2016, HB 1738
Hcrp.
Sempervivum armenum Boiss. & A. Huet. var. *armenum* / gelinparmağı.
Rocky surafces, 2900 m, 05.09.2016, HB 1749
Endemic, LC, Eux (mt), Hcrp.
Cyperaceae / Hasırotugiller.
Carex atrata L. subsp. *atrata* / karasaparna.
Subalpine meadows, 2050 m, 12.08.2017, HB 1870a
Euro-Sib (mt), Crp.
C. digitata L. / parmaksaz.
Meadows, 2100 m, 22.07.2016, HB 1541
Eux, Crp.
C. echinata Murray subsp. *echinata* / küt ayakotu.
Marshy meadows, 2100 m, 14.07.2017, HB 1828
Euro-Sib, Crp.
C. nigra (L.) Reichard subsp. *dacica* (Heuffel) Soo / rumen ayakotu.
Marshy pastures, 2150 m, 27.07.2017, HB 1851
Eux, Crp.
C. nigra (L.) Reichard. subsp. *nigra* / kara ayakotu.
Marshy pastures, 2200 m, 22.07.2016, HB 1591
Crp.
C. oligantha Steudel / garipsaz.
Damp meadows, 2350 m, 14.07.2017, HB 1823
DD, Hyrc-Eux, Crp.
C. panicea L. / darı ayakotu.
Streamsides, 2300 m, 06.08.2016, HB 1662
Crp.
C. sylvatica Huds. subsp. *latifrons* (V.I.Krecz) Ö.Nilsson / enlisaz.
Damp meadows, 1900 m, 20 08.2016, HB 1711b
Eux, Crp.
Cyperus glaber L. / könüotu.
Streamsides, 1700 m, 05.09.2016, HB 1745
Crp.
Pycreus flavescens (L.) P. Beauv. & Rchb. / samanberdi.
Streamsides, 1600 m, 05.09.2016, HB 1753
Crp.
Ericaceae / Fundagiller
Epigaea gaultherioides (Boiss. & Balansa) Takht. / dağelması.
Among *Vaccinium* sp. and *Rhododendron* sp. communities, 2200 m, 16.06.2017, HB 1792
Eux, Php.
Pyrola minor L. / emrudotu.
Damp meadows, 2250 m, 07.07.2016, HB 1489
Euro-Sib, Hcrp.
Rhododendron luteum Sweet / zifin.
Subalpine slopes, 1800 m, 23.06.2016, HB 1361
Eux, Php.
R. ponticum L. / kumar.
Edge of *Piceae* forest, 1800 m, 23.06.2016, HB 1345
Eux, Php.
R. smirnovii Trautv. / kızıl kumar.
Under *Piceae* forest, 1900 m, 28.06.2017, HB 1801
Eux, Php.
V. arctostaphylos L. / likarpa.
Edge of forests, 1700 m, 14.07.2017, HB 1827
Eux, Php.
Vaccinium myrtillus L. / ayıüzümü.
Alpine meadows, 2500 m, 22.07.2016, HB 1590
Euro-Sib, Chp.
V. uliginosum L. / avcıüzümü.
Alpine meadows, 2600 m, 20.08.2016, HB 1700
Eux, Chp.
Euphorbiaceae / Sütleğengiller.
*Euphorbia djimilensi*s Boiss. / cimil sütleğeni.
Alpine meadows, 2350 m, 06.08.2016, HB 1650
Endemic, NT, Eux, Hcrp.
E. squamosa Willd. / hemşin sütleğeni.
Stony slopes, 1660 m, 08.06.2016, HB 1229
Hyrc-Eux, Hcrp.
Mercurialis annua L. / parşen.
Screes, 1600 m, 07.07.2016, HB 1466
Thp.
M. ovata Sternb. & Hoppe / ağcaotu.
1700 m, 23.06.2016, HB 1351
Euro-Sib, Hcrp.
Fabaceae / Baklagiller
Astragalus falcatus Lam. / orak geveni.
Meadows, 2150 m, 06.08.2016, HB 1641
Eux (mt), Hcrp.
A. fragrans Willd. / mis geven.
Alpine meadows, 230 m, 22.07.2016, HB 1537
Ir-Tur, Hcrp.
A. frickii Bunge / artvin geveni.
Alpine meadows, 2700 m, 22.07.2016, HB 1581
Eux (mt), Hcrp.
A. glycyphyllos L. / dev geven.
Meadows, 1900 m, 20.08.2016, HB 1689
Euro-Sib, Hcrp.
A. incerus Ledeb. / koçtaşağı.
Screes, 2700 m, 27.07.2017, HB 1848
Ir-Tur, Hcrp.
Lathyrus aureus (Steven) D. Brandza / koru mürdümüğü.
Under shrubs, 1900 m, 07.07.2016, HB 1448
Eux, Hcrp.
L. pratensis L. / yılan gürülü.
Streamside, 1900 m, 14.07.2017, HB 1821
Euro-Sib, Hcrp.
L. roseus Steven subsp. roseus / gül mürdümüğü.
Under shrubs, 1700 m, 07.07.2016, HB 1482
Hyrc-Eux, Hcrp.
Lotus corniculatus L. var. *corniculatus* / gazalboynuzu.
Meadows, 2400 m, 22.07.2016, HB 1566
Hcrp.
Medicago falcata L. / kart yonca.
Meadows, 2000m, 06.08.2016, HB 1659
Crp.
M. lupulina L. / bitçikotu.
Meadows, 1900 m, 07.07.2016, HB 1465
Crp.
Melilotus officinalis (L.) Desr. / kokulu yonca.
Roadsides, 1750 m, 28.08.2017, HB 1873
Hcrp.
Securigera orientalis (Mill.) Lassen subsp. *balansae* (Boiss.) Keskin / hoş körigen.
Alpine meadows, 2400 m, 07.07.2016, HB 1449
Hcrp.
S. varia (L.) Lassen subsp. *varia* / körigen.
Near screes, 2100 m, 12.08.2017, HB 1865
Medit, Hcrp.

Trifolium ambiguum M. Bieb. / pisikulağı.
Alpine meadow, 2500m, 06.08.2016, HB 1644
Hcrp.
T. aureum Pollich subsp. *aureum* / altuni üçgül.
Rocky slopes, 2100 m, 27.07.2017, HB 1855
Euro-Sib, Thp.
T. campestre Schreb. / üçgül.
Meadows, 2050 m, 08.06.2016, HB 1236
Thp.
T. canescens Willd. / sarı üçgül.
Meadows, 1900 m, 22.07.2016, HB 1572
Hyrc-Eux, Hcrp.
*T. pratens*e L. var. *pratense* / çayır üçgülü.
Meadows, 2100 m, 05.09.2016, HB 1740
Hcrp.
T. repens L. var. *repens* / ak üçgül.
Pastures, 2400 m, 20.08.2016, HB 1696
Hcrp.
T. spadiceum L. / çayır dutu.
Damp meadows, 2100 m, 14.07.2017, HB 1831
Euro-Sib, Hcrp.
Vicia cracca L. subsp. *cracca* / kuş fiği.
Damp meadows, 2200 m, 06.08.2016, HB 1673
Euro-Sib, Hcrp.
V. sativa L. subsp. *incisa* (Bieb) Arc. / ekin fiği.
Rock surfaces, 1700 m, 16.06.2017, HB 1794
Thp.
V. sativa L. subsp. *nigra* (L.) Ehrh. / eşek gürülü.
Screes, 1800 m, 08.06.2016, HB 1231
Thp.
V. sepium L. / dere baklası.
Among *Rhododendron* sp., 1800 m, 07.07.2016, HB 1459
Euro-Sib, Hcrp.
V. villosa Roth subsp. *villosa* / tüylü fiğ.
Damp meadows, 1650 m, 23.06.2016, HB 1321
Hcrp.

Fagaceae / Kayıngiller

Castanea sativa Mill. / kestane.
Mixed forests, 1550 m, 07.07.2016, HB 1479
Euro-Sib, Php.
Fagus orientalis Lipsky / kayın.
Mixed forests, 1800 m, 24.05.2016, HB 1164
Euro-Sib, Php.
Quercus pontica K.Koch. / yayla peliti.
Mixed forests, 2000 m, 20.08.2016, HB 1705
Eux, Php.

Gentianaceae / Gentiyangiller

Centaurium erythraea Rafn. subsp. *turcicum* (Velen.) Melderis / tukulotu.
Meadows, 2150 m, 28.06.2017, HB 1817
Euro-Sib, Hcrp.
Gentiana aquatica L. / su gentiyanı
Alpine meadows, 2900 m, 06.08.2016, HB 1614
Thp.
G. asclepiadea L. / sütlü güşad.
Meadows, 1900 m, 20.09.2016, HB 1770
Euro-Sib, Hcrp.
G. gelida M. Bieb. / dağ gentiyanı.
Pastures, 2600 m, 20.09.2016, HB 1771
Eux, Hcrp.
G. pyrenaica L. / pir gentiyanı.
Alpine meadwos, 2550, 20.08.2016, HB 1694
Euro-Sib, Hcrp.
Swertia iberica Fisch ex C.A. Mey. / safraca.
Damp streamsides, 2300 m, 06.08.2016, HB 1637
LR (lc), Eux (mt), Hcrp.

Geraniaceae / Turnagagasigiller

Geranium subacutum (Boiss.) Aedo. / hoş ıtır.
Screes, 2600 m, 20.08.2016, HB 1702
Endemic, EN, Ir-Tur, Crp.
G. platypetalum Fisch & C. A. Mey. / koru ıtırı.
Under shrubs, 1750 m, 23.06.2016, HB 1339
Hyrc-Eux, Crp.
G. psilostemon Ledeb. / zarif ıtır.
Meadows, 2100 m, 22.07.2016, HB 1574
Eux (mt), Crp.
G. purpureum Vill. / ebedön.
Damp meadows, 1800 m, 24.05.2016, HB 1159
Thp.
G. pyrenaicum Burm. / gelinçarşafı.
Streamsides, 2100 m, 07.07.2016, HB 1472
Crp.
G. rotundifolium L. / helilok.
Screes, 1750 m, 20.05.2017, HB 1785
Thp.

Hypericaceae / Kantarongiller

Hypericum hirsutum L. / tüylü kantaron.
Streamsides, 1950 m, 06.08.2016, HB 1618
Euro-Sib, Hcrp.
H. orientale L. / sandık çiçeği.
Meadow slopes, 2100 m, 14.07.2017, HB 1826
Eux, Hcrp.
H. perforatum L. / kantaron.
Meadows, 2000 m, 07.07.2016, HB 1452
Hcrp.

Iridaceae / Süsengiller

Crocus scharojanii Rupr. / yaylakovan.
Alpine meadows, 2400 m, 06.08.2016, HB 1671
VU, Eux, Crp.
C. vallicola Herb. / hozmancuk.
Subalpine meadows, 2100 m, 20.09.2016, HB 1765
Eux, Crp.

Juncaceae / Kofagiller

Juncus articulatus L. subsp. *articulatus* / camışotu.
Streamsides, 2300 m, 08.06.2016, HB 1240
Euro-Sib, Hcrp.
J. effusus L. subsp. *effuses* / has kofa.
Damp meadows, 1800 m, 07.07.2016, HB 1481
Cosm, Hcrp.
J. tenageia Ehrh. ex L. subsp. *tenageia* / kum kofası.
Damp meadows, 1800 m, 23.06.2016, HB 1356
Euro-Sib, Hcrp.
Luzula pallescens Sw. / çayır luzulu.
Meadows, 1650 m, 23.06.2016, HB 1332
Euro-Sib, Hcrp.

Lamiaceae / Ballıbabagiller

Ajuga reptans L. / meryemsaçı
Meadows, 1650 m, 23.06.2016, HB 1319
Euro-Sib, Crp.
Ballota nigra L. subsp. *nigra* / yalancı ısırgan.
Among shrubs, 1700 m, 07.07.2016, HB 1464
Euro-Sib, Hcrp.
Clinopodium grandiflorum (L.) Kuntze / kaba fesleğen.
Damp stony surfaces, 2100 m, 05.09.2016, HB 1739
Euro-Sib, Hcrp.
C. vulgare L. subsp. *vulgare* / yabani fesleğen.
Screes, 2400 m, 22.07.2016, HB 1586
Hcrp.
Lamium album L. subsp. *album* / balıcak.
Stony meadows, 2300 m, 14.07.2017, HB 1825
Euro-Sib, Hcrp.
L. album L. subsp. c*rinitum* (Montbret & Aucher ex Beth.) Mennema / kovanlık.
Meadows among screes, 2350 m, 22.07.2016, HB 1539

Eux, Hcrp.
L. moschatum Miller subsp. *micranthum* (Boiss.) Mennema / mis balıcak.
Meadows, 1650 m, 16.06.2017, HB 1795
Hcrp.
L. purpureum L. var. *purpureum* / ballıbaba.
Streamsides, 1700 m, 08.06.2016, HB 1233
Euro-Sib, Hcrp.
Melissa officinalis L. subsp. *officinalis* / oğulotu.
Forest clearings, 1750 m, 23.06.2016, HB 1340
Medit, Hcrp.
Mentha longifolia (L.) L. subsp. *longifolia* / punk.
Streamsides, 2100 m, 22.07.2016, HB 1589
LR (lc), Eux, Crp.
Nepeta nuda L. subsp. *albiflora* (Boiss.) Gams / karaküncü.
Alpine meadows, 2550 m, 07.07.2016, HB 1462
Chp.
Origanum vulgare L. subsp. *virdulum* (Martin-Donos) Nyman / istanbul kekiği.
Roadsides, 1700 m, 22.07.2016, HB 1595
Hcrp.
Prunella vulgaris L. / gelinciklemeotu.
Streamsides, 2650 m, 05.09.2016, HB 1736
Euro-Sib, Hcrp.
Salvia glutinosa L. / oklu şalba.
Damp shrub communities, 1700 m, 07.07.2016, HB 1456
Hyrc-Eux, Hcrp.
S. verticillata L. subsp. *verticilla* /dadırak.
Stony meadows, 2150 m, 14.07.2017, HB 1834
Euro-Sib, Hcrp.
Stachys macrantha (K.Koch.) Stearn. / koca soğulcan.
Alpine meadows, 2750 m, 05.09.2016, HB 1744
Eux, Hcrp.
S. sylvatica L. / hamısırgan.
Screes, 2350 m, 20.08.2016, HB 1719
Crp.
Teucrium chamaedrys L. subsp. *trapezunticum* Rech. / dalakotu.
Screes, 1630 m, 14.07.2017, HB 1840
Euro-Sib, Chp.
Thymus longicaulis C. Presl subsp. *longicaulis* / aş kekiği.
Pastures, 2100 m, , 07.07.2016, HB 1473
Euro-Sib, Chp.
Ziziphora clinopodioides Lam. / dağ reyhanı.
Rocky slopes, 2300 m, 05.09.2016, HB 1750
Ir-Tur, Hcrp.

Liliaceae / Zambakgiller

Fritillaria latifolia Willd. / yayla lalesi.
Alpine meadows, 2500m, 23.06.2016, HB 1346
Eux (mt), Crp.
Gagea glacialis K.Koch. / buz yıldızı.
Alpine meadows, 2600 m, 08.06.2016, HB 1238
Ir-Tur, Crp.

Melanthiaceae / Dokuztepegiller

Paris incompleta M. Bieb. / tilkiüzümü.
Damp slopes, 1800 m, 24.05.2016, HB 1168
Crp.
Veratrum album L. / dokuztepeli.
Damp slopes, 1800 m, 20.08.2016, HB 1712
Euro-Sib, Crp.

Oleaceae / Zeytingiller

Osmanthus decorus (Boiss. & Balansa) Kasaplıgil / poci.
Mixed forest, 1650 m, 08.06.2016, HB 1241
Eux, Php.

Onagraceae / Yakıotugiller

Epilobium angustifolium L. / yakıotu.
Streamsides, 2200 m, 06.08.2016, HB 1663
Crp.
E.ponticum Hausskn. / garapil.
Streamsides, 2900 m, 05.09.2016, HB 1755
Crp.

Orchidaceae / Salepgiller

Cephalanthera longifolia (L.) Fritsch. / kuğu salebi.
Edge of *Piceae orientalis* forest, 20.05.2017, 1800 m, HB 1788
Euro-Sib, Crp.
Dactylorhiza euxina (Nevski) H. Baumann & Künkele var. *euxina* / laz salebi.
Damp meadows, 2350 m, 28.06.2017, HB 1807
NT, Eux, Crp.
D. urvilleana (Steudal) Baumen & Künkele subsp. *urvilleana* / balkaymak.
Streamsides, 2200 m, 23.06.2016, HB 1354
Eux, Crp.
Listera ovata (L.) R. Br. / çalı salebi.
Meadows, 1750 m, 08.06.2016, HB 1235
Euro-Sib, Crp.
Orchis palustris Jacq. / çayır salebi.
Damp meadows, 1850 m, 16.06.2017, HB 1793
Crp.
Platanthera chlorantha (Custer) Rchb. / çarpık salep.
Edge of forests, 1800 m, 28.06.2017, HB 1805
Crp.

Orobanchaceae / Canavarotugiller

Euphrasia lebardensis Kem.-Nath. / yamaç gözotu.
Stony meadows, 2550 m, 06.08.2016, HB 1642
Eux (mt),Thp.
E. minima Jacq. ex DC. subsp. *davisii* Yeo / gözlükkıran.
Alpine meadows, 2650 m, 05.09.2016, HB 1742
Endemic, LR(lc), Eux, Thp.
Melampyrum arvense L. var. *arvense* / inek buğdayı.
Stony slopes, 2000 m, 20.08.2016, HB 1715
Euro-Sib, Thp.
Orobanche caesia Rchb. / mavi veremotu.
Parasite on *Telekia speciosa*, 1700 m, 28.06.2017, HB 1802
Vp.
Pedicularis caucasica M. Bieb. / kesgerotu.
Alpine meadows, 2500 m, 06.08.2016, HB 1632
Hyrc-Eux, Hcrp.
P. condensata M. Bieb. / kırk bitotu.
Alpine meadows, 2600 m, 20.08.2016, HB 1704
Eux, Hcrp.
P. pontica Boiss. / şimal bitotu.
Alpine meadows, 2650 m, 06.08.2016, HB 1648
Eux, Hcrp.
Rhinanthus angustifolius C. C. Gmel. subsp. *grandifloius* (Wallr.) D. A. Webb. / horozotu.
Meadows, 2100m, 07.07.2016, HB 1470
Thp.
Rhynchocorys elephas (L.) Griseb. subsp. *elephas* / filburnu.
Meadows, 2300 m, 22.07.2016, HB 1552
Euro-Sib, Hcrp.

Papaveraceae / Haşhaşgiller

Chelidonium majus L. / kırlangıçotu.
Under forest, 1600 m, 27.07.2017, HB 1845
Euro-Sib, Hcrp.
Corydalis alpestris C.A. Mey. / gök kazgagası.
Rocky slopes, 2100 m, 22.07.2016, HB 1583
Eux, Crp.
Fumaria schleicheri Soy.-Will. subsp. *microcarpa* (Hausskn.) Liden / şetere
Screes, 1700 m, 06.08.2016, HB 1652
Thp.
Papaver dubium L. subsp. *dubium* / köpekyağı.

Roadsides, 1500 m, 23.06.2016, HB 1334
Thp.
P. lateritium K. Koch subsp. *lateritium* / potot.
Screes, 2000 m, 06.08.2016, HB 1657
Endemic, VU, Eux, Hcrp.
Plantaginaceae / Sinirotugiller
Digitalis ferruginea L. subsp. *ferruginea* / arıkovanı.
Rocky alpine meadows, 2400 m, 20.08.2016, HB 1707
Euro-Sib, Hcrp.
Linaria simplex DC. / yalın nevruzotu.
Stony slopes, 1700 m, 28.06.2017, HB 1812
Medit, Hcrp.
P. lanceolata L. / damarlıca.
Streamsides, 1500 m, 23.06.2016, HB 1335
Hcrp.
Plantago major L. subsp. *major* / sinirotu.
Roadsides, 2100 m, 06.08.2016, HB 1619
Hcrp.
Veronica anagallis-aquatica L. / sugedemesi.
Streamsides, 1700 m, 22.07.2016, HB 1556
LR (lc), Hcrp.
V. biloba Schreber. / çifte maviş.
Meadows among screes, 2000 m, 28.06.2017, HB 1818
Ir-Tur, Thp.
V. chamaedrys L. / cancan.
Under shrubs, 1700 m, 23.06.2016, HB 1337
Euro-Sib, Crp.
Poaceae / Buğdaygiller
Agrostis stolonifera L. / tavusotu.
Damp meadows, 1700 m, 22.07.2016, HB 1594
Euro-Sib, Crp.
*Alopecurus arundinaceu*s Poir. / kamış tilkikuyruğu.
Roadsides, 2000 m, 06.08.2016, HB 1623
LR (lc), Euro-Sib, Crp.
A.laguroides Balansa / kar tilkikuyruğu.
Reefy slopes, 2600, 20.08.2016, HB 1708
Endemic, LR (lc), Euro-Sib(mt), Crp.
Brachypodium sylvaticum (Huds.) P.Beauv. / koru kılcanı.
Rocky slopes, 2300 m, 05.09.2016, HB 1747
Euro-Sib, Crp.
Briza marcowiczii Woronow / çıngırdak.
Alpine meadows, 2400 m, 06.08.2016, HB 1617
Thp.
Bromus danthoniae Trin. subsp. *Danthoniae* / ibubukotu.
Screes, 2200 m, 23.06.2016, HB 1357
Thp.
B. japonicus Thunb. subsp. *japonicus* / iyeotu.
Meadows, 1800 m, 28.06.2017, HB 1813
Thp.
B. scoparius L. / ibubuk ekini.
Meadows, 2000 m, 14.07.2017, HB 1830
Crp.
Calamagrostis arundinacea (L.) Roth. / kandıraotu.
Close to *Rhododendron* sp. shrubs, 1700 m, 06.08.2016, HB 1656
Euro-Sib, Crp.
Cynosurus cristatus L. / tarakotu.
Damp meadows, 2200 m, 12.10.2016, HB 1780
Euro-Sib, Hcrp.
Dactylis glomerata L. subsp. *glomerata* / domuzayrığı.
Meadows, 2100 m, 07.07.2016, HB 1488
Euro-Sib, Crp.
Elymus lazicus (Boiss.) Melderis / yayla buğdayı.
Rocky meadows, 1600 m, 05.09.2016, HB 1758
Endemic, VU, Eux, Hcrp.
Festuca anatolica Markgr.-Dann. subsp. *anatolica* / yurt yumağı.
Stony meadows, 2100 m, 20.08.2016, HB 1714
Endemic, LC, Chp.
F. cyllenica Boiss & Heldr. subsp. *uluana* Markgr.-Dann. / ulu yumak.
Subalpine meadows, 1750 m, 14.07.2017, HB 1836
Endemic, Eux, Chp.
F. woronowi Hack. subsp. *woronowi* / yayla yumağı.
Meadows, 2300 m, 22.07.2016, HB 1587
VU, Eux (mt), Chp.
Glyceria notate Cheval. / kıvrık tatlıçim.
Meadows close to streams, 2100 m, 20.09.2016, HB 1767
Hcrp.
Helictotrichon planiculme (Schrad.) Pilg. / cimil yulafı.
Rocky slopes, 2300 m, 05.09.2016, HB 1752
Eux, Crp.
Koeleria macrantha (Lebed) Schult. / koca kıral.
Screes, 2100 m, 23.06.2016, HB 1326
Hcrp.
Lolium perenne L. / çim.
Patures, 1900 m, 06.08.2016, HB 1660
Euro-Sib, Hcrp.
Melica uniflora Retz. / seyrek inciotu.
Rocky slopes, 1600 m, 05.09.2016, HB 1754
Euro-Sib, Crp.
Nardus stricta L. / kılotu.
Alpine meadows, 2400m, 20.09.2016, HB 1769
Euro-Sib, Hcrp.
Phleum phleoides (L.) Karsten / bayır itkuyruğu.
Pastures, 2100 m, 20.09.2016, HB 1766
Euro-Sib, Hcrp.
P. pratense L. / çayır itkuyruğu.
Damp meadows, 2450 m, 06.08.2016, HB 1654
Euro-Sib, Chp.
Poa alpina L. subsp. *fallax* F. Herm. / yayla salkımotu.
Alpine slopes, 2000 m, 20.08.2016, HB 1706
Chp.
P. angustifolia L. / dar salkımotu.
Pastures, 2250 m, 12.10.2016, HB 1783
LR (lc), Chp.
P. annua L. / salkımotu.
Damp meadows, 1900 m, 28.06.2017, HB 1808
Thp.
P. bulbosa L. / yumrulu salkımotu.
Pastures, 2300 m, 08.06.2016, HB 1244
Crp.
P. longifolia Trin. / ipek salkımotu.
Alpine meadows, 2400 m, 14.07.2017, HB 1832
Eux, Crp.
P. nemoralis L. / orman salkımı.
Pastures, 2300 m, 22.07.2016, HB 1532
Crp.
P. pratensis L. çayır salkımı.
Alpine meadows, 2500 m, 06.08.2016, HB 1658
Chp.
Stipa pontica P. A. Smirn / körpe kılaç.
Mountain slopes, 2400 m, 23.06.2016, HB 1328
Polygalaceae / Sütotugiller
Polygala alpestris Rchb. / yayla sütotu.
Pastures, 1900 m, 07.07.2016, HB 1455
Euro-Sib, Hcrp.
P. major Jacq. / koca sütotu.
Rocky slopes, 1900 m, 06.08.2016, HB 1630
Euro-Sib, Hcrp.
P. supina Schreb. subsp supina / gihaye sipirge.
Pastures, 2350 m, 27.07.2017, HB 1858
Cosmopolite, Hcrp.
P. vulgaris L. / sütotu.

Meadows, 1700 m, 28.06.2017, HB 1815
Euro-Sib, Hcrp.
Polygonaceae / Madımakgiller
Polygonum alpinum All. / eleyaz.
Screes, 2300 m, 06.08.2016, HB 1639
Euro-Sib, Hcrp.
P. arenastrum Boreau / bezmeceotu.
Arid slopes, 2300 m, 12.10.2016, HB 1782
Thp.
P. bistorta L. subsp. *carneum* (K. Koch) Coode & Cullen / dağlahanası.
Damp meadows, 22450 m, 22.07.2016, HB 1538
Eux(mt), Hcrp.
P. cognatum Meissn. / madımak.
Alpine meadows, 2500 m, 20.09.2016, HB 1768
Ir-Tur, Hcrp.
Rumex acetosella L. / kuzukulağı.
Arid slopes, 2250 m, 06.08.2016, HB 1647
Cosmopolite, Hcrp.
R. alpinus L. / şortah.
Streamsides, 2300 m, 07.07.2016, HB 1457
Crp.
R. caucasicus Rech. / tirişov.
Alpine slopes, 2800 m, 20.08.2016, HB 1692
Eux (mt), Hcrp.
R. crispus L. / labada.
Bog, 2150 m, 23.06.2016, HB 1331
Cosmopolite, Chp.
R. scutatus L. / ekşimen.
Screes, 2250 m, 22.07.2016, HB 1551
Chp.
Primulaceae / Çuhaçiçeğigiller
Androsace albana Steven / arınca.
Meadows, 01900 m, 07.07.2016, HB 1477
Hyrc-Eux(mt), Hcrp.
Cyclamen coum Mill var. *coum* / yersomunu.
Forest, 1700 m, 24.05.2016, HB 1172
Crp.
C. parviflorum Pobed. / filiski.
Stony meadows, 08.06.2016, 1900 m, HB 1234
Endemic, LR (lc), Eux (mt), Crp.
Primula algida Adams / dağtutyası.
Damp meadows, 2800 m, 06.08.2016, HB 1640
Hcrp.
P. acaulis (L.) L. Huds. subsp. *rubra* (Sm)Greuter & Burdet / evvvelbahar çiçeği
Damp slopes, 2000 m, 23.06.2016, HB 1352
Eux, Hcrp.
P.auriculata Lam. / felçotu.
Streamsides, 2400 m, 22.07.2016, HB 1600
Ir-Tur, LR (lc), Hcrp.
P. elatior (L.) L. subsp. *amoena* (Bieb.) Greuter & Burdet / yaylatutyası.
Streamsides, 2300 m, 07.07.2016, HB 1468
Euro-Sib, Hcrp.
P. elatior (L.) L. subsp. *pallasii* (Lehm.) W. W. Sm. & Forrest / sarıtutya.
Alpine meadows, 2600 m, 22.07.2016, HB 1580
Eux, Hcrp.
P. longipes Freyn & Sint. / zarif çuha.
Small streamsides, 2700 m, 20.08.2016, HB 1698
Endemic, LR (nt). Eux, Hcrp.
P. megaseifolia Boiss. & Balansa / martçiçeği.
Edge of Shrub communities, 1700 m, 24.05.2016, HB 1163, VU, Eux, Hcrp.
Ranunculaceae / Düğünçiçeğigiller
Aconitum orientale Mill. / kurtoğlan.
Meadows, 2100 m, 05.09.2016, HB 1743
Eux, Hcrp.
Adonis aestivalis L. subsp. *aestivalis* / kandamlası.
Pastures, 1600 m, 14.07.2017, HB 1829
Thp.
Anemone narcissiflora L. subsp. *narcissiflora* / mayısçiçeği.
Damp slopes, 1900 m, 23.06.2016, HB 1359
Euro-Sib, Hcrp.
Aquilegia olympica Boiss. / hasekiküpesi.
Damp meadows, 1750 m, 22.07.2016, HB 1533
Hcrp.
Caltha palustris L. / lilpar.
Streamsides, 1800 m, 07.07.2016, HB 1469
LR (lc), Hcrp.
Consolida orientalis (J. Gay.) Schrodinger / morçiçek.
Besides, small gardens, 1700 m, 22.07.2016, HB 1549
Ir-Tur, Thp.
Delphinium flexuosum M.Bieb. var. *buschianum* (Grossh.) Parsa. / eğri hazaren.
Screes, 2000 m, 22.07.2016, HB 1569
Eux, Hcrp.
D. formosum Boiss. & A. Huet / gür hezaren.
Streamsides, 1900 m, 06.08.2016, HB 1616
Endemic, LC, Eux, Hcrp.
Ranunculus arvensis L. / mustafaçiçeği.
Close to small gardens, 1700 m, 28.06.2017, HB 1816
Thp.
R. buhsei Boiss. / çingotu.
Rocky slopes, 1900 m, 06.08.2016, HB 1657
Hyrc-Eux (mt), Crp.
R. constantinopolitanus (DC.) d´Urv. / kağıthane çiçeği.
Damp meadows, 1800 m, 23.06.2016, HB 1341
Hcrp.
R. dissectus M. Bieb. subsp. *huetii* P.H.Davis / kaya kebikeci.
Pastures, 2100 m, 22.07.2016, HB 1535
Endemic, LC, Crp.
R. grandiflorus L. / katırnalı.
Damp meadows, 2000 m, 07.07.2016, HB 1487
Hcrp.
R. repens L. / tiktakdana.
Damp places, 2000 m, 22.07.2016, HB 1596
Hcrp.
Thalictrum foetidum L. / delialan maydonozu.
Screes, 1850 m, 06.08.2016, HB 1670
Euro-Sib, Hcrp.
T. minus L. var. *minus* / kaytaran.
DAmp meadows, 2050 m, 22.07.2016, HB 1579
Euro-Sib, Hcrp.
Trollius ranunculinus (Sm.) Stearn. / zarif çünkotu.
Damp places, 2100 m, 23.06.2016, HB 1323
Hcrp.
Rhamnaceae / Cehrigiller
Frangula dodonei Ard. subsp. *dodonei* / barutağacı.
Mixed forest, 1650 m, 24.05.2016, HB 1156
Euro-Sib, Php.
Rosaceae / Gülgiller
Alchemilla caucasica Buser / kaf şebnemlisi.
Alpine meadows, 2300 m, 22.07.2016, HB 1571
Eux (mt), Crp.
A. retinervis Buser / damarlı kelkat.
Among roks at pastures, 12.08.2017, HB 1870b
Eux (mt), Crp.
A. rizensis B. Pawl. / rize kelkatı.
Rocky slopes, 2800 m, 20.08.2016, HB 1697
Endemic, Eux (mt), Crp.
A. sericea Willd. / akpençe.
Rocky slopes, 2500 m, 06.08.2016, HB 1634

Eux (mt), Crp.
Aruncus vulgaris (Maxim.) Raf ex H. Hara / hoşkeçisakalı.
Streamsides on rocky surfaces, 1650 m, 07.07.2016, HB 1467
Euro-Sib, Hcrp.
Filipendula ulmaria (L.) Maxim. / çayırkraliçesi.
Roadsides, 1650 m, 14.07.2017, HB 1838
Euro-Sib, Hcrp.
Fragaria vesca L. / dağ çileği.
Damp places at pastures, 2250 m, 23.06.2016, HB 1338
Euro-Sib, Hcrp.
Geum urbanum L. / meryemotu.
Streamsides, 1750 m, 07.07.2016, HB 1486
Euro-Sib, Crp.
Laurocerasus officinalis Roemer. / karayemiş.
Forest, 1700 m, 28.06.2017, HB 1810
Php.
Padus avium Mill. / kuş kirazı.
Screes, 1900 m, 23.06.2016, HB 1318
Php.
Potentilla crantzii (Crantz.) Fritsch / beşparmakotu.
Alpine slopes, 2900 m, 20.09.2016, HB 1764
Euro-Sib, Hcrp.
P. elatior Wild ex Schlecht / ak parmakotu.
Damp meadows, 2000 m, 20.08.2016, HB 1691
Eux, Hcrp.
P. erecta (L.) Rauschel. / kurtpençesi.
Damp meadows, 2150 m, 06.08.2016, HB 1655
Eux, Crp.
P.ruprechtii Boiss. / mis parmakotu.
Pastures, 2300 m, 06.08.2016, HB 1625
Chp.
Rubus hirtus Waldst. & Kit. / tüntürük.
Mixed forest, 1700 m, 28.06.2017, HB 1803
Euro-Sib, Chp.
R. idaeus L. subsp. *ideaus* / ahududu.
Forest clearings, 1800 m, 07.07.2016, HB 1463
Php.
R. saxatilis L. / köslek.
Meadows, 1900 m, 23.06.2016, HB 1343
Hcrp.
Sibbaldia parviflora Willd. var. *parviflora* / fındıkotu.
Pastures, 2300 m, 22.07.2016, HB 1560
Chp.
Sorbus aucuparia L. / kuş üvezi.
Close to forest, 1700 m, 23.06.2016, HB 1327
Euro-Sib, Php.
Rubiaceae / Kökboyagiller
Asperula taurina L. / küçük fevve.
Meadows, 2000 m, 06.08.2016, HB 1638
Hyrc-Eux, Crp.
Crucianella gilanica Trin. subsp. *pontica* (Ehrend.) Ehrend. / köse haçotu.
Crevices, 1650 m, 28.06.2017, HB 1814
Eux, Crp.
Cruciata laevipes Opiz / sarılıkotu.
Pastures, 2550 m, 22.07.2016, HB 1585
Euro-Sib, Hcrp.
C. taurica (Pallas ex Willd.) Ehrend. / kırım güzeli.
Screes, 2900 m, 22.07.2016, HB 1562
Ir-Tur, Chp.
Galium album Mill. subsp. *prusense* (K. Koch.) Ehrend et Krendl / bursa iplikçiği.
Meadows, 2300 m, 06.08.2016, HB 1646
Hcrp.
G. odoratum (L.) Scop. / orman iplikçiği.
Forest, 1750 m, 22.07.2016, HB 1553
Euro-Sib, Hcrp.
G. spurium L. subsp. *spurium* / arsız iplikçik.
Screes, 2100 m, 23.06.2016, HB 1324
Euro-Sib, Thp.
G. verum L. subsp. *verum* / boyalık.
Stream beds, 2200 m, 06.08.2016, HB 1631
Euro-Sib, Hcrp.
Salicaceae / Söğütgiller
Populus tremula L. subsp. *tremula* / titrek kavak.
Mixed forests, 2000 m, 24.05.2016, HB 1158
Euro-Sib, Php.
Salix caprea L. / sorgun.
Streamsides, 2150 m, 24.05.2016, HB 1157
Euro-Sib, Php.
Sapindaceae / Akçaağaçgiller
Acer heldreichii Orp. ex Boiss subsp. *trautvetteri* (Medw.) A.E. Murray / kafkas akçaağacı.
Mixed forest, 1650 m, 24.05.2016, HB 1170
Eux, Php.
A. platanoides L. / çınar akçaağacı.
Mixed forest, 1700 m, 20.05.2017, HB 1786
Euro-Sib, Php.
Scrophulariaceae / Sıracaotugiller
Scrophularia kotschyana Benth. / darbeotu.
Shady screes, 2300 m, 22.07.2016, HB 1554
Hcrp.
S. nodosa L. / tavuk sıracası.
Stony meadows, 2050 m, 22.07.2016, HB 1582
Euro-Sib, Hcrp.
S. scopolii Hoppe ex Pers. var. *adenocalyx* Sommier & Levier / elköpürten.
Stony streamsides, 2000 m, 14.07.2017, HB 1833
Eux, Hcrp.
Verbascum gnaphalodes M. Bieb. / uslu sığırkuyruğu.
DAmp places, 2150 m, 27.07.2017, HB 1850
Eux, Hcrp.
V. thapsus L. / burunca.
Streamsides, 1650 m, 22.07.2016, HB 1599
Euro-Sib, Hcrp.
Solanaceae / Patlıcangiller
Atropa belladona L. / güzelavratotu.
Shady paces, 1700 m, 23.06.2016, HB 1322
Euro-Sib, Hcrp.
Solanum nigrum L. / itüzümü
Roadsides, 1650 m, 12.10.2016, HB 1784
Cosmopolite, Hcrp.
Thymelaeaceae / Sıyırcıkgiller
Daphne pontica L. / sırımağu.
Stony slopes, 2100 m, 22.07.2016, HB 1543
Eux, Chp.
Ulmaceae / Karaağaçgiller
Ulmus glabra Huds. / dağ karaağcı.
Mixed forest, 1700 m, 24.05.2016, HB 1162
Euro-Sib, Php.
U. minor Mill. / ova karaağacı.
Streamsides, 1650 m, 23.06.2016, HB 1360
Medit, Php.
Urticaceae / Isırgangiller
Urtica dioica L. subsp. *dioica* / ısırgan.
Streamsides, 2300 m, 05.09.2016, HB 1741
Euro-Sib, Hcrp.
Violaceae / Menekşegiller
Viola altaica Ker.-Gawl. / altay menekşesi.
Meadows, 2200 m, 07.07.2016, HB 1461
Hcrp.
V. sieheana W. Becker / çayır menekşesi.
Under shrubs, 1750 m, 08.06.2016, HB 1230
Hcrp.

V. tricolor L. / hercai menekşe Thp.
Under shrubs, 1900 m, 23.06.2016, HB 1344

4. Conclusions and discussion

The vascular flora results of the current study (CS.) are summarized and discussed below. Three specimens for each taxon were collected from Tunca Valley Park between the years 2016-2017. After detailed identification and checking 408 vascular plant taxa belonging to 244 genera and 64 families were determined. 1 of them is Lycopodiophyt, 16 of them are Pteridophytes and 391 were Magnoliophytes. The dispersion of Magnoliophytes are as follows; 2 Pinophytina and 389 Magnoliophytina (Table 1). The forest vegetation covers 2565 hectare of the study area (62.7%). The high dominancy of tree species can be one of the most important reasons of the low taxa number in the study area.

Table1. The dispersion of taxa into large taxonomical groups

Systematic categories	Families	Genera	Species	Subsp.	Var.	Taxa	Endemics
Lycopodiophyta	1	1	1	-	-	1	-
Pteridophyta	9	10	15	-	1	16	-
Magnoliophyta	54	231	284	88	19	391	-
Pinophytina	2	2	1	1	-	2	-
Magnoliophytina	52	229	283	87	19	389	20
Total	64	244	300	88	20	408	20

The order, number and ratio of the phytogeography element status are Euro-Siberian (Eux and Hyrc-Eux included) 237 (58.1%), Irano-Turanian 14 (3.4%), Mediterranean 5 (1.2%), and multiregional or of unknown phytogeographic origin 152 (37.3%), respectively (Table 2). The dominancy of the Euro-Siberian elements in the study (Table 2) confirms that the study areas are in the Euro-Siberian floristic province. The microclimates and microhabitats in the study area can be the reason of the Mediterranean and Irano-Turanian elements.

Table 2. Phytogeography elements

Phytogeography regions	Number	%
Euro-Sib.	105	25.7
Eux	114	28.0
Hyrc-Eux	18	4.4
Ir-Tur.	14	3.4
Medit.	5	1.2
Cosm and others	152	37.3
Total	408	100

In alpine and subalpine parts of any study the endemism ratio is much higher than the other parts. Even though there are alpine and subalpine vegetation in the study area, as mentioned above 62.7% of the study area covered with the tree species and this is the main reason of the low endemism.

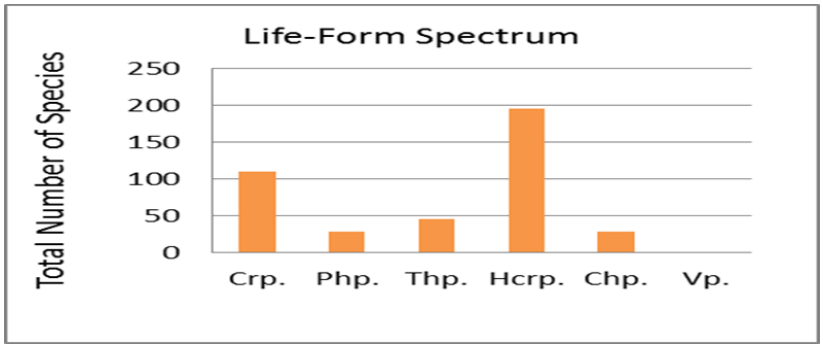

Figure 3. Life form spectrum of taxa

In the study area, Hemicryptophytes (196 taxa and 48.0%) are the dominant life spectra and cryptophytes 110 (26.9%), therophytes 46 (11.3%), chamaephytes 28 (6.8%), phanerophytes 28 (6.8%), vasicular parasites 1 (0.2%) are following them respectively (Table 3).

Table 3. The richest families in taxa

Families	Number of taxa	Ratio (%)
Asteraceae	44	10.8
Poaceae	31	7.6
Fabaceae	26	6.4
Caryophyllaceae	25	6.1
Lamiacea	21	5.1
Rosaceae	19	4.7
Ranunculaceae	17	4.2
Apiaceae	11	2.7
Cyperaceae	10	2.5
Primulaceae	10	2.5
Total	214	52.6

The richest families about total taxa numbers are *Asteraceae* (44), *Poaceae* (31), *Fabaceae* (26), *Caryophyllaceae* (25), *Lamiaceae* (21), *Rosaceae* (19), *Ranunculaceae* (17), *Apiaceae* (11), *Cyperaceae* (10), *Primulaceae* (10) (Table 3).

Poa (8), *Carex* (8), *Trifolium* (7), *Primula* (7), *Geranium* (6), *Ranunculus* (6), *Astragalus* (5), *Rumex* (5), *Vicia* (5), and *Asplenium* (5) are the richest genera in total taxa number (Table 4).

Table 4. The richest genera in taxa.

Genera	Number of taxa	Ratio (%)
Poa	8	2.0
Carex	8	2.0
Trifolium	7	1.7
Primula	7	1.7
Geranium	6	1.5
Ranunculus	6	1.5
Astragalus	5	1.2
Rumex	5	1.2
Vicia	5	1.2
Asplenium	5	1.2
Total	62	15.2

Table 5. Camparison of total taxa number, phytogeographic elements and endemism of study with nearby studies

Studies	Total taxa	Euro-Sib	Ir-Tur.	Medit.	Cosm. and other	End.
Current study	408	58.1	3.4	1.2	37.3	4.9
Eminağaoğlu (2003)	769	35.6	6.9	2.2	55.3	7.4
Eminağaoğlu (2004)	872	39.4	10.3	1.2	49.1	6.3
Baykal (2016)	518	43.2	4.1	2.1	50.6	7.0

The total taxa number in the study area (408) is smaller than the compared studies (Table 5). The total taxa number is closely related with the geographical size, diversity of habitat, and edaphic factors etc. Most of the study area is covered with the forest vegetation, so the vegetation types and hahitat diversity is lower than the compared studies. This factor can explain the reson of lower taxa number in the study. The phytogeographical element status of taxa are Euro-Siberian (including Eux and Hyrc-Eux) (58.0%), multiregional or of unknown phytogeographic origin (37.4%), Irano-Turanian (3.4%), Mediterranean (1.2%), respectively. The study area is in the borderlines of Euro-Siberian floristical provice and it clarifies the dominancy of Euro-Siberian elements and it is compatible with the compared studies (Table 5). Presence of Mediterranean and Irano-Turanian element can be explained by the presence of microclimates. The endemism ratio of the current study (4.9%) is lower than the compared studies (Table 5). The reasons of low endemism are of course related with homogeneity of climate and environment but especially the presence and abundance of tree species in the study area.

References

Anonymous (2005). Rize ili arazi varlığı. Ankara: T.C. Tarım ve Köyişleri Bakanlığı Köy Hizmetleri Genel Müdürlüğü Yayını.

Anonymous (2011). 1975-2010 dönemi Pazar meteoroloji istasyonuna ait rasat değerleri. Ankara: Devlet Meteoroloji İşleri Genel Müdürlüğü Yayınları.

Anonymous (2017). The IUCN red list of threatened species. http://www.iucnredlist.org/ (Erişim tarihi: 26.10.2017).

Baykal, H., Atamov, V. (2016). Floristic diversity in Bashemşin valley of Kaçkar Mountains National Park of Rize, Turkey. Pakistan Journal of Botany, 48, 1871-1876.

Çepel, N. (1978). Orman Ekolojisi. İstanbul: İstanbul Üniversitesi Orman Fakültesi yayınları.

Davis, P.H. (1965-1985). Flora of Turkey and the East Aegean Islands. Vol. 1-9. Edinburgh: Edinburgh University Press.

Davis, P.H., Mill, R.R., Tan, K. (1988). Flora of Turkey and the East Aegean Islands. Vol. 10. Edinburgh: Edinburgh University Press.

Doğan, S. (1977). Türiye Gerçek Sıcaklık Haritaları. Ankara: Meteoroloji Genel Müdürlüğü Yayınları.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N. (2000). Türkiye bitkileri kırmızı kitabı, eğrelti ve tohumlu bitkiler (Red data book of Turkish plants, Pteridophyta and Spermatophyta). Ankara: Türkiye Tabiatını Koruma Derneği ile Van Yuzuncuyıl Universitesi Yayınları.

Ellenberg, H., Mueller-Dombois, D. (1967). A key to Raunkiaer plant life forms with revised subdivisions. Berlin Geobotische Insttitute, ETH Stiftg Rubel Zurich 37, 56-73.

Eminağaoğlu, Ö., Anşin, R. (2003). Flora of Hatilla Valley National Park and its Close Environs (Artvin). Turkish Journal of Botany, 27, 1-27.

Eminağaoğlu, Ö., Anşin, R. (2004). Flora of the Karagöl-Sahara National Park (Artvin) and Its Environs. Turkish Journal of Botany, 28, 557-590.

Erik, S., Guner, A., Yıldırımlı, Ş., Sümbül, H. (1996). Tohumlu bitkiler sistematiği laboratuvar kılavuzu. Ankara: Literature Yayınları.

Gedik, A., Ercan, T., Korkmaz, S., Karataş, S. (1992). Rize-Fındıklı-Çamlıhemşin arasında (Doğu Karadeniz) yer alan magmatik kayaçların petrolojisi ve doğu pontitlerdeki bölgesel yayılımları. Türkiye Jeoloji Bülteni, 35.

Güner, A., Özhatay, N., Ekim, T., Başer, K.H.C. (2000). Flora of Turkey. Vol. 11. Edinburgh: University Press.

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

Ketzkhoveli, N.N., Gagnidze, R.I. (Eds.). (1971-2001). Flora of Georgia. Vols. 1-13. Tbilisi: Metsniereba Press.

Komarov, V.L., Shishkin, B.K. (Eds.). (1933-1964). Flora of USSR. Vols. 1-30. Moscow and Leningrad: Akademiya Nauk Press.

Raunkiaer, C. (1934). The life form of plants and statistical plant geography. London: Oxford University Press.

Saraç, D.U., Özkan, Z.C., Akbulut, S. (2013). Ethnobotanical features of Rize/Turkey province. Biological Diversity and Conversation, 6(3), 57-66.

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Research article/Araştırma makalesi

Genotoxicity of azadirachtin on *Galleria mellonella* L. (Lepidoptera: Pyralidae)

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Abstract

In this paper, genotoxic effects of the pure azadirachtin (AZA) on the larval hemocytes of model insect and storage pest *Galleria mellonella* L. (Lepidoptera: Pyralidae) was investigated. The comet assay was performed to measure and analyze DNA damage in larval hemocytes at Anadolu University (Eskisehir Technical University) between 2017 and 2018 years. For this purpose, sublethal AZA doses (0.5, 1, 1.5, and 2 µg/larva) given to *G. mellonella* larvae via insect force feeding method were used to monitor tail intensity, tail moment and tail migration the commonly known comet parameters. These DNA damage indicators were analyzed in hemocytes obtained from larvae at 24 and 72 h post force feeding. All comet parameters at all doses of AZA increased in comparison with negative and positive control at 24 and 72 h. At 72 h post force feeding with median lethal dose of AZA, a significant increase in DNA damage indicators was observed in larval hemocytes as compared with untreated groups. Consequently, this study showed that AZA caused significant damage in the genome of *G. mellonella* larvae even at sublethal doses and the comet assay was useful in the monitoring of in vivo genotoxicity of AZA in larva hemocytes.

Key words: azadirachtin, COMET, *Galleria mellonella*, genotoxicity, hemocytes

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Azadirachtin'in *Galleria mellonella* (Lepidoptera: Pyralidae) üzerindeki genotoksisitesi

Özet

Bu çalışmada, azadirachtin (AZA)'in model böcek ve depo zararlısı olan *Galleria mellonella* L. (Lepidoptera: Pyralidae)'nın larval hemositleri üzerindeki genotoksik etkileri araştırılmıştır. Larval hemositlerdeki DNA hasarının analiz edilmesi ve ölçülmesi comet analizi kullanılarak, 2017-2018 yılları arasında Anadolu Üniversitesi (Eskişehir Teknik Üniversitesi)'nde gerçekleştilmiştir. Bu amaçla, hemositlerdeki kuyruk yoğunluğu, kuyruk momenti ve kuyruk göçü gibi önemli comet parametrelerinin analiz edilmesi için *G. mellonella* larvalarına, böcekler için ağızdan besleme yöntemiyle verilen subletal AZA dozları (0.5, 1, 1.5 ve 2 µg/larva) kullanılmıştır. Ağızdan besleme uygulamasından 24 ve 72 saat sonra larvalardan elde edilen hemositlerde bu DNA indikatörleri analiz edilmiştir. AZA uygulanmasından 24 ve 72 saat sonra, larval hemositlerde belirlenen tüm comet parametrelerinde negatif ve pozitif kontrol grubuna kıyasla hem doza hem de zamana bağlı olarak artış meydana geldiği görülmüştür. Özellikle, ortalama letal doz AZA uygulamasından 72 saat sonra, larval hemositlerdeki DNA hasarı indikatörlerinde kontrol gruplarına kıyasla önemli bir artış gözlenmiştir. Sonuç olarak, bu çalışma AZA'nın subletal dozlarda bile *G. mellonella* larval genomunda önemli oranda hasara neden olduğunu ve larval hemositlerinde AZA'nın genotoksisitesinin *in vivo* değerlendirilmesinde comet analizinin kullanışlı olduğunu göstermiştir.

Anahtar kelimeler: azadirachtin, COMET, *Galleria mellonella*, genotoksisite, hemosit

1. Introduction

Many countries profoundly use chemical control methods to combat pests in agricultural and apicultural systems. Uncontrolled and unconscious use of chemicals such as arsenic, organic chlorides and organic phosphates containing compounds causes resistance in pests and also negatively affects non-target organisms (Nicolopoulou-Stamati et al.,

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2016). Due to the side effects imposed on the local ecosystems by these chemicals, most countries have imposed restrictions and bans on the use of these chemical compounds. For this reason, using of the eco-friendly chemicals such as biopesticides or plant-based insecticides as alternative methods of combating pests while protecting non-target beneficial insects, humans, and other living things has important in integrated pest management (IPM) programs (Olson, 2015; Nicolopoulou-Stamati et al., 2016). In recent years, among these plant-based insecticides, azadirachtin (AZA) formulations which have active ingredients with various insecticidal properties has gained importance among natural chemicals (Sanchez et al., 2010). Earlier experiments revealed that AZA has toxicity on physiological process which change with insect hormones (like juvenile hormone and 20-hydroxyecdysone as growth factors), oocyte structure, fecundity, oviposition, egg viability, immune system, nervous system, antioxidant system and some metabolic pathways in various insects (Qiao et al., 2013; Asaduzzaman et al., 2016; Boulahbel et al, 2015; Dere et al., 2015; Shao et al., 2016; Aribi et al., 2017; Er et al., 2017) but it is non-toxic to vertebrates including mammals (Saxena & Kesari, 2016). However, no studies determining effects of pure AZA on insect genome, in particular, wax moth and model insect *Galleria mellonella* L. (Lepidoptera: Pyralidae) have been found in open literature. For this reason, the deficiency of scientific data on the determination whether the AZA as a destructive effects on the genetic material of hemocytes has been overcome by this study.

The greater wax moth *G. mellonella* is an economic and storage pest worldwide in apiculture. Its adults lay their eggs on the honeycombs and larvae feed on pollen, honey and beeswax (Charriere & Imdorf, 1997). In the protection of honeycombs against *G. mellonella* infestation, various chemical (aluminum phosphide, ethylene dibromide, paradichlorobenzene (Naphthalene), sulfur, carbondioxide), physical (cold-hot) and biological techniques (B. thuringiensis) have been employed in various ways (Kwadha et al., 2017). In addition to these applications, eco-friendly pesticides such as AZA could be used as alternative botanical insecticides for the protection of honeycombs against larval infestation. On the other hand, the larval stage of wax moth is considered as a model organism used for immunological and ecotoxicological investigations of various environmental chemicals, and laboratory cultivation is economical, easier and faster (Dere et al., 2015; Altuntaş & Duman, 2017; Kwadha et al., 2017). For this reasons, the identification of genotoxicity of AZA against insects in particular pests was determined using model organism *G. mellonella* with this study.

It is well known that the comet assay also known as single cell gel electrophoresis (SCGE) is a fast, simple, and more susceptible method to assess the genotoxicity of various chemicals in environment, and commonly used for environmental monitoring, and ecogenotoxicology applications (Singh et al., 1988; Collins, 2004; Olive & Banáth, 2006). Previous studies also showed that comet assay is very useful for the biomonitoring studies in human exposed to various genotoxins (Anderson et al., 1997; Martelli et al., 2002; Rajaguru et al., 2002). However, there are limited studies performed on the evaluation of the DNA damaging potential of some chemicals on insects using comet assay (Mukhopadhyay et al., 2004; Maria-Packiam et al., 2015; Qari et al., 2017). Mukhopadhyay et al. (2004) determined the genotoxicity of cypermethrin in *Drosophila melanogaster* using comet assay. In other studies, the genotoxic effects of novel phytopesticide and some plant volatile oils in larval hemocytes of *Helicoperva armigera* (Maria-Packiam et al., 2015) and *Rhyzopertha dominica* (Qari et al., 2017) was determined with the comet assay. Despite all these studies with various environmental compounds, there has been no study to determine the sublethal effects of pure AZA on larval genome of *G. mellonella*. In the light of these informations, the aim of this study was to examine the genotoxicity of pure AZA on the larval hemocytes of model insect *G. mellonella* by comet assay and provide the new information to the available literature.

2. Materials and methods

2. 1. Insect rearing

Laboratory cultivation of *G. mellonella* was reared in an insectarium (D51-41) in the animal physiology laboratory at Eskisehir Technical University, Turkey. Photoperiodical conditions in insectarium were maintained at 28±2°C temperature, 60±5 % relative humidity (RH) and in continuous darkness to ensure stock and experimental culture continuity. The semi-artificial diet including 340 g of bran, 20 g of pollen, 75 ml of honey, 100 g of dark honeycomb, 150 ml of glycerol and 75 ml of bidistilled water as described by Dere et al. (2015) was used to feeding the larval instars.

2. 2. Force feeding assay

AZA (Sigma, St. Louis, MO, 2 mg/ml) to be used in the study was obtained as a pure powder. In a previous study by Dere et al. (2015), median lethal dose (LD_{50}) and lethal dose (LD_{99}) values of AZA, administered by force feeding assay to *G. mellonella* larvae, were reported to be 2.1 and 4.6 µg/larva respectively. For this reason, stock AZA was dissolved in 10 % ethanol and diluted to form solutions in sublethal doses at 0.5, 1, 1.5, and 2 µg/larva. Healthy larvae weighing 0.17±0.01 g selected from the stock culture were given 5 µl of the different prepared doses of AZA via force feeding method (Dere et al., 2015; Altuntaş et al., 2016). Prior the insect force feeding assay, all selected larvae were starved for 4 hours after which, they were kept on ice for 2 minutes to be anesthetized. Then 5 µl of AZA was

administered orally to each larva through the esophagus using a 10 µL hamilton injector (26 g gauge). For the negative and positive control groups, 5 µl of distilled water and 10 % ethanol solution were given to each larva, respectively. Each of the treated larvae was maintained in a 2 g artificial diet containing sterile plastic box (50 ml, Orlab) at 28±1°C, 60±5 % RH. At 24 and 72 h after force feeding treatment, hemolymph samples were collected from each larvae to analyze the changes in the DNA. For each of the doses and control groups, 45 larvae in total three replicate were used.

2. 3. Comet assay

The comet assay was carried out according to Singh et al. (1988) using larval hemocytes. At 24 and 72 h post AZA treatment, all force-fed larvae were sterilized with 70 % ethanol then, the third proleg of each larva was pierced with microscissors and five microliters of hemolymph were collected. The collected hemolymph (5 µl) samples were mixed in 1 % low melting agarose (95 µl) in PBS (Ca^{2+} and Mg^{2+} free). The hemocyte suspension was applied to the surface of a microscope slide which was precoated with 1 % normal melting point agarose and covered with a cover glass which was removed after 15 minutes at 4°C to form a microgel. After this process, slides were kept in lysis buffer (100 mM EDTA, 10 mM Tris-HCL, 2.5 M NaCl, 1 % TritonX-100, 10 % DMSO, pH = 10.0) for 1 h at 4°C in darkness. Subsequently, slides were transferred to electrophoresis tank containing alkaline buffer (200 mM EDTA, 10 N NaOH, pH > 13) for 45 minutes to facilitate DNA unwinding after which electrophoresis was run for 30 min (20 Volt, 300 mA). Then slides were washed in a neutralization (0.4 M Tris-HCl, pH = 7.4) solution and bidistilled water, respectively for 5 min. All slides were left to dry overnight at room temperature. After electrophoresis, slides were stained with SYBR Green I (1:10.000) (Sigma-Aldrich, Taufkirchen, Germany) overnight and washed with bidistilled water to remove excess stains then maintained to dry at room temperature. To analyze the stained DNA in the hemocytes, slides were examined under a Leica DM6000 B model fluorescent microscope at blue filter. Tail intensity, tail moment and tail migration were measured via software Comet Assay IV imaging system (Perceptive Instruments Ltd, UK-Italy) to determine DNA damage in larval hemocytes. One hundred randomly selected hemocytes were analyzed per larvae.

2. 4. Statistical analysis

All data were identified as mean±standard error (Mean±SE). The SPSS software program (version 18.0 for Windows, Chicago, IL) was used for statistical analysis. Dose-dependent changes in the means of tail intensity, tail migration and tail moment were verified to be normally distributed. To compare means, ANOVA (one-way analysis of variance) and to determine the significant differences LSD-post hoc tests (Least Significant Difference) were conducted. A t-test was carried out to analyisis the significance of the effects of the sublethal AZA doses on DNA structure in response to time interval (24 and 72 h). The results obtained in the experiments were evaluated as being statistically significant at a 95 % confidence interval with $P < 0.05$.

3. Results

The comet assay parameters, namely tail intensity (%), tail migration (µm), and tail moment (arbitrary units) were used to determine DNA damage in larvae exposed to ≤ LD_{50} doses of AZA. All results obtained in the study showed statistically significant a dose-time dependent increases in DNA damage of hemocytes post AZA treatment (Figure 1). Furthermore, a statistically significant elevation was evident in DNA damage indicators analyzed in hemocytes of force-fed larvae at LD_{50} doses of AZA with respect to control groups at 72 hours post treatment (Figure 1).

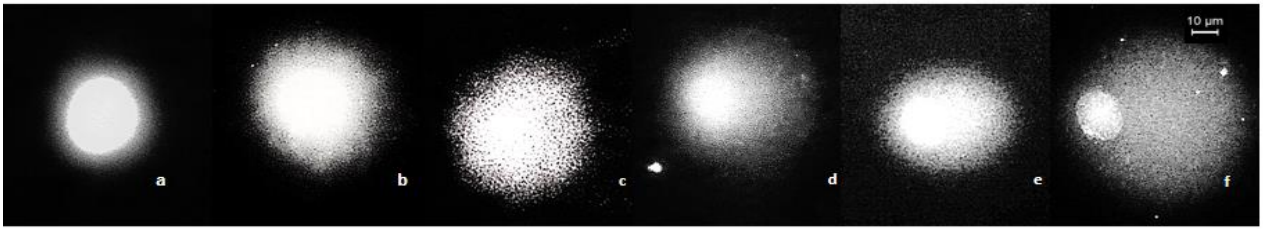

Figure 1. The comet assay images obtained in hemocytes of *G. mellonella* larvae at 72 h post force feeding. a) Negative control, b) Positive control, c) 0.5 µg/larva AZA, d) 1 µg/larva AZA, e) 1.5 µg/larva AZA, f) 2 µg/larva AZA

A significant increase in tail intensity (% DNA) of larval hemocytes was detected in all doses at 24 and 72 hours post AZA treatment when compared with control groups ($F_{24} = 20.042$; $df_{24} = 5, 2994$; $P_{24} = 0.000$; $F_{72} = 78.676$; $df_{72} = 5, 2994$; $P_{72} = 0.000$). A drastic increase in tail intensity was however observed at 2 µg/larvae (LD_{50}) with respect to controls and other sublethal doses of AZA (Figure 2).

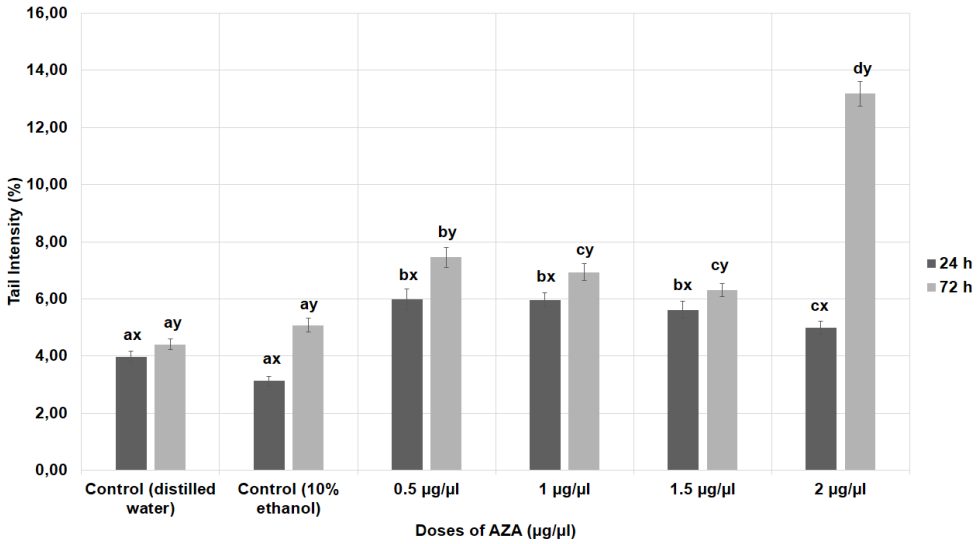

Figure 2. The tail intensity (Tail DNA %) results obtained from the hemocytes of *G. mellonella* larvae at 24 and 72 h
* All data represents as means ± standard error. Each column indicated by the different letter (a-d, LSD test) or between black and grey column indicated by the different letter (x-y, t-test) are significant statistically ($P < 0.05$)

Tail migration in hemocytes of *G. mellonella* larvae increased in both dose and time related manner with respect to negative and positive control groups ($P < 0.05$, Figure 3). At 24 and 72 hours post-AZA treatment, tail migration in larval hemocytes showed significant increases at all doses except at 0.5 µg/larva AZA dose compared to the results of the control groups ($F_{24} = 67.03$; $df_{24} = 5, 2994$; $P_{24} = 0.000$; $F_{72} = 66.212$; $df_{72} = 5, 2994$; $P_{72} = 0.000$). Similar to tail intensity, the highest tail migration level were detected in larvae treated with LD_{50} dose of AZA at 72 hours (Figure 3).

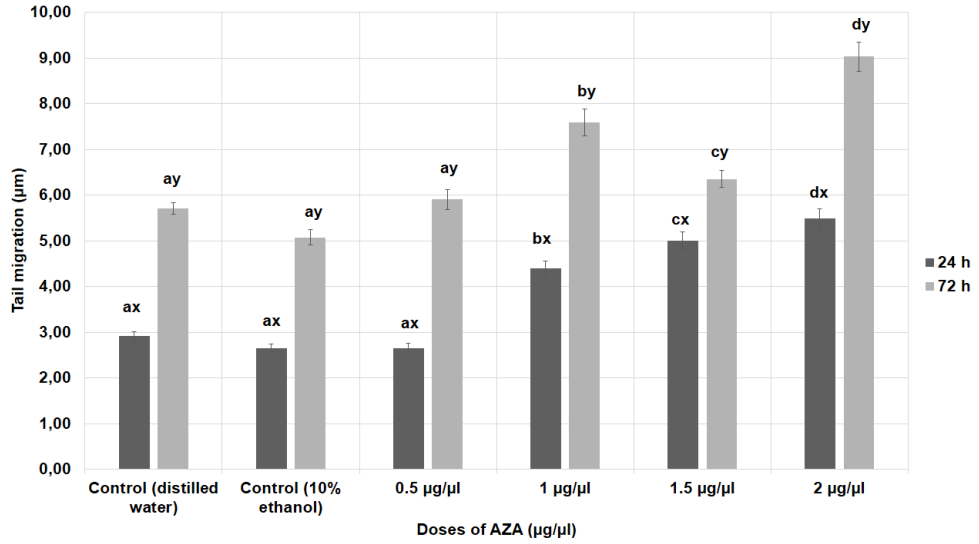

Figure 3. The tail migration (µm) results obtained from the hemocytes of *G. mellonella* larvae
* All data represents as means ± standard error. Each column indicated by the different letter (a-d, LSD test) or between black and grey column indicated by the different letter (x-y, t-test) are significant statistically ($P < 0.05$)

The tail moment results for hemocytes exposed to ≤ LD_{50} doses of AZA and the control groups are given in Figure 4. As is evident in figure 4, unlike data obtained from other comet parameters, tail moment increased only at 1.5 and 2 µg/larvae after 24 hours post-AZA treatment with respect to control and other experimental groups ($F = 20.268$; $df = 5, 2994$; $P = 0.000$). At 72 hours post AZA treatment however, dose dependent increase in tail moment was observed ($F = 46.892$; $df = 5, 2994$; $P = 0.000$) with values of up to 1.85 ± 0.12 at 2 µg/larva (Figure 4).

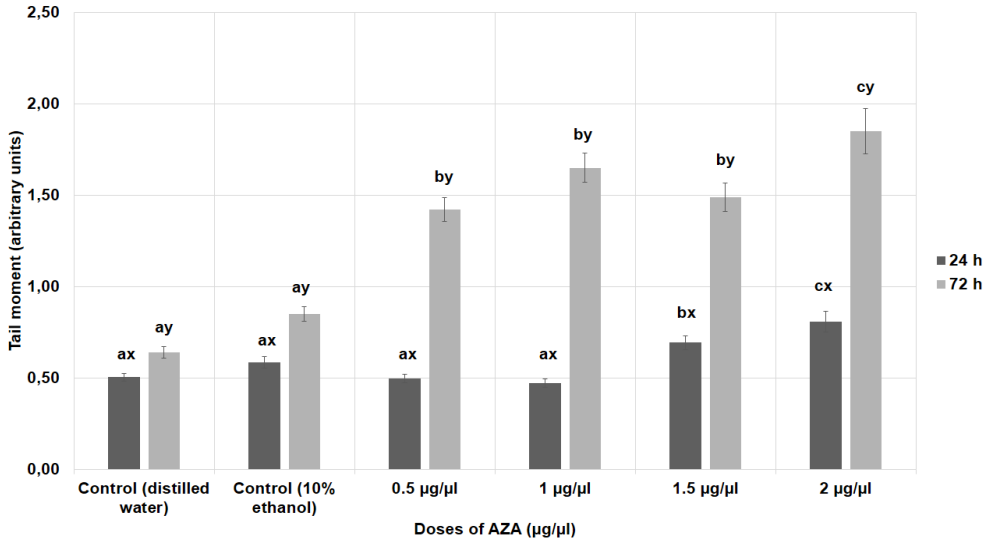

Figure 4 The tail moment ratio obtained from the hemocytes of *G. mellonella* larvae at 24 and 72 h.
* All data represents as means ± standard error. Each column indicated by the different letter (a-c, LSD test) or between black and grey column indicated by the different letter (x-y, t-test) are significant statistically (P< 0.05)

4. Conclusions and discussion

All data obtained from this study revealed that sublethal doses of pure AZA caused genomic damage in the hemocytes of model insect *G. mellonella* larvae. In a previous study, it was argued that using the comet parameters allows determining DNA damage in eukaryotic cells for biomonitoring and detection of genotoxic chemicals or physical agents in terrestrial ecosystems (Zhang et al., 2000). Therefore, the genotoxic effects of pure AZA on the larval hemocyte determined using comet assay within the scope of the present work.

The most commonly used DNA damage indicators by comet assay are tail migration, tail intensity (DNA percentage in tail) and tail moment (Knopper, 2005). Knopper (2005) suggest that tail migration can be used to measure of the DNA damage level in regards with the ratio of DNA fragmentation, while tail intensity (% DNA) and moment can be used to determine the severity of DNA damage when exposed to a chemical agent. According to the results from the present study, AZA caused important damage in DNA of *G. mellonella* larvae as indicated by the increase in tail migration at subLD$_{50}$ doses at the two time points. These results also concur with those of Qari et al. (2017) who reported increased DNA damage in *Rhyzopertha dominica* exposed to LC$_{50}$ of the different plant volatile oils. These observed time and dose dependent changes in the DNA damage may be due to the inhibition of the DNA repair mechanism whose occurrence is dependent on AZA doses and exposure period. For this reason, it was observed that there is reduced DNA repair activity in larval hemocytes exposed to lower doses of AZA following 72 hours of exposure due to increased DNA fragmentation.

Results obtained from comet parameters showed that AZA application at 2 µg/larva to larvae caused severe DNA damage and this severity increased with exposure periods. Consistent with our results, a previous study about genotoxic effects of PONNEEM, a newly developed phytopesticide including karanjin and AZA, on midgut cells of the green worm *Helicoverpa armigera* (Lepidoptera: Noctuidae), reported dose dependent increases in tail moment, tail length and tail DNA (%). Authors also emphasized that PONNEEM at concentrations above 10 ppm caused genotoxicity on midgut cells because it contains active principles such as AZA and karanjin (Maria-Packiam et al., 2015). However, Muangphra and Gooneratne (2011) showed that LD$_{50}$ (3.79 and 3.33 µg cm^{-2}) doses of commercial NEEM extract (containing AZA) had cytotoxic effects on the soil worm *Pheretima peguana* coelomocytes according to micronucleus analysis but no DNA damage according to the comet assay (Muangphra & Gooneratne, 2011). These differences between the studies suggest that the variations in the genotoxic potential of AZA on different organisms was depends on its formulation, concentrations and exposure time.

Genotoxicity of AZA on *G. mellonella* larvae could be explained by the induction of the autophagic or apoptotic pathways causing the cell death (Er et al., 2017) since AZA is known to reduce protein synthesis, inhibit cell division (Rembold & Annadurai, 1993), and induce apoptosis and autophagy in insect cells (Huang et al., 2011; Shu et al., 2015). Also, in previous studies, technical AZA has been reported to cause formational abnormality and oxidative stress by suppressing the antioxidant system (Dere et al., 2015), reduce cellular immunity, prolong adult emergence time and decrease number of eggs and productivity (Er et al., 2017) in the larvae of *G. mellonella*. Considering all results obtained from the present and earlier studies, it was concluded that increased DNA damage in hemocytes at 72 h post AZA application is associated with cytotoxicity arising from apoptosis. Moreover, several investigators have described apoptotic cells as large fan-like tails and small heads in comet assay due to extensive formation of double strand breaks in DNA during apoptosis (Fairbairn et al., 1996; Olive & Banáth, 2006). Similar cellular appearances were also observed

in comets at doses of 2 µg/larva AZA following a 72 h exposure of hemocytes of the *G. mellonella* larvae in this study. This indicates that the genotoxicity of AZA on hemocytes of *G. mellonella* larvae may be conducted by apoptotic pathways in cells. To prove our suggestions, more detailed investigations need to be carried out about the metabolic effects of pure AZA on cell death pathways.

In conclusion, the present study shows the time dependent genotoxic effects of AZA on insects and provides useful ecotoxicological information for safety data sheet of pure AZA and thus suggesting the use of AZA at low doses in IPM investigations as a phytopesticide for the control of *G. mellonella* and/or other Lepidopterous insect pests instead of harmful chemicals to protect the environment. And the results from the comet assay also demonstrated that hemocytes are useful in screening DNA damage caused by genotoxic xenobiotics.

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References

Altuntaş, H., Demirci, S. N. Ş., Duman, E., Ergin, E. (2016). Toxicological and physiological effects of ethephon on the model organism, *Galleria mellonella* L. 1758 (Lepidoptera: Pyralidae). Türkiye Entomoloji Dergisi, 40(4), 413-423.

Altuntaş, H., Duman, E. (2017). Toxicological effects of the entomopathogenic *Purpureocillium lilacinus* on the model organism *Galleria mellonella*. Biological Diversity and Conservation, 10(1), 153-159.

Anderson, D., Dobrzynka, M. M., Jackson, L. I., Yu T. W., Brinkworth, M. H. (1997). Somatic and germ cell effects in rats and mice after treatment with 1,3-butadiene and its metabolites, 1,2-epoxybutane and 1,2,3,4-diepoxybutane. Mutation Research, 391, 233-242.

Aribi, N., Oulhaci, M. C., Kilani-Morakchi, S., Sandoz, J. C., Kaiser, L., Denis. B., Joly, D. (2017). Azadirachtin impact on mate choice, female sexual receptivity and male activity in *Drosophila melanogaster* (Diptera: Drosophilidae). Pesticide Biochemistry and Physiology, http://dx.doi.org/10.1016/j.pestbp.2017.09.002.

Asaduzzaman, M., Shim, J. K., Lee, S., Lee, K. Y. (2016). Azadirachtin ingestion is lethal and inhibits expression of ferritin and thioredoxin peroxidase genes of the sweetpotato whitefly *Bemisia tabaci*. Journal of Asia-Pacific Entomology, 19, 1-4.

Boulahbel, B., Aribi, N., Kilani-Morakchi, S., Soltani, N. (2015). Insecticidal activity of azadirachtin on *Drosophila melanogaster* and recovery of normal status by exogenous 20-hydroxyecdysone. African Entomology, 23, 224-233.

Charriere, J. D., Imdorf, A. (1997). Protection of honey combs from moth damage. Swiss Bee Research Center Federal Dairy Research Station, CH-3003, Communication, Nr. 24, Liebefeld, Bern, Switzerland, 3-4.

Collins, A. R., (2004). The comet assay for DNA damage and repair: principles, applications, and limitations. Molecular Biotechnology, 26, 249-261.

Dere, B., H. Altuntaş, H., Nurullahoğlu, Z. U. (2015). Insecticidal and oxidative effects of azadirachtin on the model organism *Galleria mellonella* L. (Lepidoptera: Pyralidae). Archives of Insect Biochemistry and Physiology, 89, 138-152.

Er, A., Taşkıran, D., Sak, O. (2017). Azadirachtin-induced effects on various life history traits and cellular immune reactions of *Galleria mellonella* (Lepidoptera: Pyralidae). Arch Archives of Biological Sciences, 69(2), 335-344.

Fairbairn, D. W., Walburger, D. K., Fairbairn J. J., O'Neill, K. L. (1996). Key morphologic changes and DNA strand breaks in human lymphoid cells: Discriminating apoptosis from necrosis. Scanning, 18, 407-416.

Huang, J. F., Shui, K. J., Li, H. Y., Hu, M. Y., Zhong, G. H. (2011). Antiproliferative effect of azadirachtin on *Spodoptera litura* Sl-1 cell line through cell cycle arrest and apoptosis induced by upregulation of p53. Pesticide Biochemistry and Physiology, 99, 16-24.

Knopper, L. D. (2005). Use of the Comet Assay to Assess Genotoxicity in Mammalian, Avian, and Amphibian Species. Canadian Wildlife Service, Technical Report Series, 429.

Kwadha, C. A., Ong'amo, G. O., Ndegwa, P. N., Raina, S. K., Fombong, A. T. (2017). The Biology and Control of the Greater Wax Moth, *Galleria mellonella*. Insects, 8, 61.

Maria-Packiam, S., Emmanuel, C., Baskar, K., Ignacimuthu, S. (2015). Feeding Deterrent and Genotoxicity Analysis of a novel Phytopesticide by using Comet Assay against *Helicoverpa armigera* (HÜbner) (Lepidoptera: Noctuidae). Archives of Biology and Technology, 58(4), 487-493.

Martelli, A., Carrozzino, R., Mattioli, F., Bucci, G., Lamarino, G., Brambilla, G. (2002). DNA damage in tissues of rat treated with potassium canrenoate. Toxicology, 171, 95-103.

Muangphra, P., Gooneratne, R. (2011). Toxicity of Commercial Neem Extract to Earth worms (*Pheretima peguana*). Corporation Applied and Environmental Soil Science, doi:10.1155/2011/925950.

Mukhopadhyay, I., Chowdhuri, D. K., Bajpayee, M., Dhawan, A. (2004). Evaluation of in vivo genotoxicity of cypermethrin in *Drosophila melanogaster* using the alkaline Comet assay. Mutagenesis, 19(2), 85-90.

Nicolopoulou-Stamati, P., Maipas, S., Kotampasi, C., Stamatis, P., Hens, L. (2016), Chemical pesticides and human health: the urgent need for a new conceptin agriculture. Front Public Health, 4, 148.

Olive, P. L., Banáth, J. P. (2006). The comet assay: a method to measure DNA damage in individual cells. Nature Protocols, 1, 23-29.

Olson, S. (2015). An analysis of the biopesticide market now and where it is going. Outlooks on Pest Management, 26, 203-206.

Qari, S. H., Abdel-Fattah, N. A. H., Shehawy, A. A. (2017). Assessment of DNA Damage and Biochemical Responses in *Rhyzopertha dominica* Exposed to Some Plant Volatile Oils. Journal of Pharmacology and Toxicology, 12(2), 87-96.

Qiao, J., Zou, X., Lai, D., Yan, Y., Wang, Q., Li, W., Deng, S., Xu, H., Gu, H. (2013). Azadirachtin blocks the calcium channel and modulates the cholinergic miniature synaptic current in the central nervous system of Drosophila. Pest Management Science, 70, 1041-1047.

Rajaguru, P., Vidya, L., Baskarasethupathi, B., Kumar, P. A., Palanivel, M., Kalaiselvi, K. (2002). Genotoxicity evaluation of polluted groundwater in human peripheral blood lymphocytes using the comet assay. Mutation Research, 517, 29-37.

Rembold, H., Annadurai, R. S. (1993). Azadirachtin inhibits proliferation of Sf9 cells in monolayer culture. Z Naturforsch, 48, 495-499.

Sanchez, L. E. C., Osornio, J. J. J., Herrera, M. A. D. (2010). Secondary metabolites of the annonaceae, solanaceae and meliaceae families used as biological control of insects. Tropical and Subtropical Agroecosystems, 12, 445-462.

Saxena, A., Kesari, V. P. (2016). Lack of genotoxic potential of pesticides, spinosad, imidacloprid and neem oil in mice (*Mus musculus*). Journal of Environmental Biology, 37, 291-295.

Shao, X., Lai, D., Zhang, L., Xu, H. (2016). Induction of autophagy and apoptosis via PI3K/ AKT/TOR pathways by Azadirachtin A in *Spodoptera litura* Cells. Scientific Reports, 6, 35482.

Shu, B., Wang, W., Hu, Q., Huang, J., Hu, M., Zhong, G. (2015). A comprehensive study on apoptosis induction by azadirachtin in *Spodoptera frugiperda* cultured cell line Sf9. Archives of Insect Biochemistry and Physiology, 89, 153-168.

Singh, N. P., Mccoy, M. T., Tice, R. R., Schneider, E. L. (1988). A Simple Technique for Quantitation of Low Levels of DNA Damage in Individual Cells. Experimental Cell Research, 175, 184-191.

Zhang, Y., Zhong, Y., Luo, Y., Kong, Z. M. (2000). Genotoxicity of two novel pesticides for the earthworm, *Eisenia fetida*. Environmental Pollution, 208(2), 271-278.

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Research article/Araştırma makalesi

Evaluation of antifungal activity of cardamom oil against standard and clinical Candida isolates

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Abstract

Candida species are the members of the human normal flora and they may cause oppurtunistic fungal infections in immuncompromised patients. The available antifungal treatment regiments is quite limited due to the toxicity, high cost and presence of multidrug resistant strains. Recently, natural essential oils and their constituents have drawn attention for their antimicrobial and antibiofilm efficacies. Cardamom essential oil has strong antimicrobial effects. Cardamom can be isolated from the seeds of the ginger family *Zingiberaceae*. The aim of this study is to investigate the effects of cardamom essential oil against standard and clinical *Candida* strains. The minimum inhibitory concentration (MIC) of cardamom was determined using the broth microdilution method according to the Clinical Laboratory Standards Institute. Amphotericin B was used as a positive standard control antibiotic. Cardamom oil have shown strong antifungal activity the tested all *Candida* isolates (MIC $\leqslant$ 0.1% (vol/vol). Our MIC and transmission electron microscopic (TEM) studies confirms that cardamom oil possess in vitro antifungal activity. It may be used as an alternative antifungal agent or natural food preservatives. In addition it may helpful for the discovery of new antifungal drug. However efficacy, safety and toxicity profiles of this oil will need to be addressed.

Key words: *Candida*, cardamom oil, antifungal, TEM, MIC

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Kardamom yağının standart ve klinik *Candida* izolatlarına karşı antifungal etkinliklerinin değerlendirilmesi

Özet

Candida türleri insan normal florasının üyelerinden olup, bağışıklığı baskılanmış hastalarda fırsatçı fungal infeksiyonlara yol açabilmektedirler. Mevcut antifungal tedavi rejimleri toksisite, yüksek maliyet ve çoklu ilaç dirençli suşların bulunuşu sebebiyle bir hayli sınırlıdır. Son yıllarda doğal esansiyal yağlar ve bunların bileşenleri, sahip oldukları antimikrobiyal ve antibiyofilm etkinliklerinden dolayı büyük dikkat çekmektedir. Kardamom esansiyal yağı da güçlü antimikrobiyal etkilere sahiptir ve *Zingiberaceae* ailesi tohumlarından izole edilebilmektedir. Çalışmamızın amacı standart ve klinik *Candida* suşlarına karşı bu yağın etkinliğini araştırmaktır. Kardamomun Minimum İnhibisyon Konsantrasyonu (MİK), Klinik Laboratuar Standartları Enstitüsü'nün talimatlarına göre sıvı mikrodilüsyon testi ile elde edilmiştir. Çalışmada pozitif standart kontrol olarak Amfoterisin B antibiyotiği kullanılmıştır. Kardamom yağı, test edilen tüm *Candida* izolatları üzerine güçlü bir antifungal aktivite göstermiştir ((MİK $\leqslant$ %0.1 (vol/vol). MİK ve geçirimli elektron mikroskobik (TEM) çalışmamız kardamom yağının in vitro antifungal etkinliğini onaylamaktadır. Kardamom yağı alternatif bir antifungal ajan ya da doğal besin koruyucusu olarak kullanılabilir. Ayrıca yeni antifungal ilaçların keşfi için faydalı olabilir. Ancak bu yağın etkinlik, güvenlik ve toksisite profillerinin iyi bir şekilde aydınlatılmasına ihtiyaç bulunmaktadır.

Anahtar kelimeler: *Candida*, kardamom yağı, antifungal, TEM, MİK

1. Giriş

Candida türleri sağlıklı insanların deri ve mukozal yüzeylerini kommensal olarak kolonize edebilen, bağışıklığın baskılandığı durumlarda ise fırsatçı enfeksiyonlara yol açabilen önemli mikroorganizmalardır (Doughari ve Naya, 2008). Özellikle *C. albicans*, gastrointestinal alan, oral kavite ya da vajinada yaygın olarak bulunur ve sıklıkla yüzeysel

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enfeksiyonlara neden olurken; *Candida* türleri dışındaki enfeksiyonların sıklığı da giderek artmaktadır (Movar vd., 2005; Pfaller vd., 2003). *Candida*'ların virülansına katkıda bulunan en önemli faktörler arasında farklı hidrolitik enzimlerin üretimi, morfolojik dimorfizm, germ-tüp oluşumu ya da konakçı hücre ve dokulara yapışarak biyofilm oluşturabilme yetenekleri sayılabilir (Karkowska-Kuleta vd., 2009). Özellikle biyofilm oluşturabilen mikroorganizmaların antimikrobiyal tedaviye yüksek bir direnç gösterdikleri ve ısrarcı enfeksiyonların kaynağı olabildikleri bilinmektedir (Chandra vd., 2001). Biyofilm üretimi sırasında gerçekleşen ekzopolisakkarit (EPS) üretimi, hücrenin fizyolojik durumu, membran üzerindeki atım pompaları ve planktonik hücrelerden farklı olarak meydana gelen gen ekspresyon paternleri de biyofilm direncine katkıda bulunabilmektedir (Rabin vd., 2015). Bu direnç, aynı mikroorganizmaların planktonik formlarına göre 100-1000 kat daha fazla olabilmekte ve biyofilm bir kez oluştuktan sonra yok edilmesi de çok güçleşmektedir (Taff vd., 2013; Rabin vd., 2015). Ökaryotik özellik gösteren mantar hücrelerine etkili antifungaller, insan hücreleri üzerine de etkili olabileceklerinden toksisite riskleri fazladır ve bu sentetik bileşenler antifungal direnç gelişimine yol açabildiklerinden tedaviyi de güçleştirmektedirler (Mazu vd., 2016). Bu enfeksiyonlarla mücadelede fungisidal ve daha az yan etkili yeni alternatiflerin geliştirilmesi önem taşımaktadır. Son yıllarda bitkilerin farklı bölümlerinden çeşitli yollarla elde edilen esansiyal yağların antibakteriyal, antioksidan ve antifungal özellikleri üzerine yapılan çalışmalar çok dikkat çekmektedir (Burt, 2004; Şengün ve Yücel, 2015). Bu çalışmaların büyük çoğunluğu *Staphylococcus aureus, Escherichia coli* ve *Bacillus cereus* gibi patojen bakteriler üzerine yoğunlaşmıştır fakat antifungal aktivite verileri daha sınırlıdır. *Zingiberaceae* familyasına ait *Eletteria cardamomum* bitkisinin kurutulmuş meyvesi olan kardamom, et ürünlerinde baharat olarak kullanımına ek olarak, tıpta da güçlü aromatik, antiseptik, uyarıcı, karminatif, mide için, antispazmodik ve diüretik amaçlarla kullanılmaktadır (Agaoglu vd., 2005). Ayrıca karaciğer üzerine yararlı etkileri, soğuk algınlığı, ateş ve ağız inflamasyonları üzerine de olumlu etkileri rapor edilmektedir (Al-Abdalall, 2016). Kardamom yağının yapısında bulunan en önemli bileşenler α-terpinil asetat, linalol, linalil asetat, geraniol, limonen, a-terpinen, safrol, metilöjanol ve öjanöldür. Bu biyoaktif bileşenlerin içeriği depolama koşulları yada prosese bağlı olarak değişiklik gösterebildiğinden, çalışma süresince dikkatle korunmalıdır (Kubo ve ark., 1991). Son yıllarda bitkisel ürünlerden alternatif terapötik moleküllerin geliştirilmesi üzerine çok fazla çalışma bulunmaktadır ancak bitkisel ürünlerin antimikrobiyal aktiviteleri ve etki mekanizmaları halen tam olarak aydınlatılamamıştır. Kardamom yağının antifungal etkinliği hakkında da sınırlı sayıda veri mevcuttur. Çalışmamızın amacı kardamom yağının klinik ve standart *Candida* izolatları üzerine antifungal etkilerini mikrobiyolojik ve elektronmikroskobik yollarla araştırmaktır.

2. Materyal ve yöntem

2.1. *İzolatlar ve kimyasallar*

Çalışmamızda kullanılan kardamom yağı Sigma-Aldrich firmasından saf halde temin edilmiştir (W224111). Antifungal aktivite araştırmaları için ise 6 *C. albicans,* 2 *C.kefyr,* 3 *C. krusei,* 2 *C. glabrata,* 2 *C. parapsilosis* ve 1 *C. tropicalis* izolatı kullanılmıştır. İzolatlar Eskişehir Osmangazi Üniversitesi Sağlık Uygulama ve Araştırma Hastanesi Mikrobiyoloji Anabilim Dalı'ndan sağlanmıştır. Klinik izolatların 10'u kan, 3'ü idrar, 1'i periton sıvısı ve 1'i de vajen örneklerinden izole edilmiştir. İzolatlar %15 gliserol içeren Yeast Pepton Dekstroz sıvı besiyerine alınarak -86°C'de stoklanmıştır. *Candida albicans* ATCC 10231 izolatı standart mikroorganizma olarak kullanılmıştır. Kullanılan *Candida* türleri ile bu türlerin elde edildiği klinik örnek ve departmanlar Tablo 1'de sunulmuştur.

Tablo 1. Çalışmada kullanılan *Candida* türleri ile elde edildikleri klinik örnek ve departmanlar

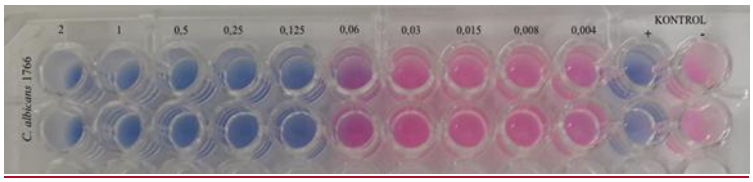
C. albicans 1710	(Kan-Pediatri)	*C. krusei* 1561	(Periton sıvısı-Pediatri)
C. albicans 1724	(Kan-Dahiliye**)**	*C. krusei* 1670	(Vajen-Kadın Doğum)
C. albicans 1766	(Kan-Nefroloji)	*C. glabrata* 1744	(Kan-Dahiliye)
C. albicans 1802	(Kan-Endokrin)	*C. glabrata* 1797	(Kan-Yenidoğan)
C. albicans 1697	(Kan-Çocuk)	*C. parapsilosis* 1806	(Kan-Onkoloji)
C. kefyr 1620	(İdrar-Çocuk)	*C. parapsilosis* 1799	(Kan-Beyin Cerrahi)
C. albicans 1706	(İdrar-Göğüs Hastalıkları)	*C. tropicalis* 1678	(Kan-Hematoloji)
C. krusei 1675	(İdrar-Dahiliye)		

2.2. *Maya süspansiyonları*

Taze kültür eldesi için stok besiyerinden alınan maya izolatları, öncelikle RPMI 1640 sıvı besiyerinde ve 37 °C'de 24 saat inkübe edilmiştir. Örnekler buradan 5 ml %0.85'lik serum fizyolojik içine alınmış ve süspansiyon bulanıklığı 0.5 McFarland (1-5 x 10^6 hücre/mL) olacak şekilde ayarlanmıştır. Hazırlanan başlangıç süspansiyonları önce steril serum fizyolojik ile 1/50 oranında, daha sonra da RPMI 1640 ile 1/20 oranında sulandırılarak 1-5 x 10^3 hücre/mL konsantrasyonuna ulaşılmıştır.

2.3. *Antifungal duyarlılık testleri*

Kardamom yağının Minimum İnhibisyon Konsantrasyon (MİK) değerinin belirlenmesi amacıyla Klinik ve Laboratuvar Standartlar Enstitüsü mikrodilüsyon referans yöntemi esas alınmıştır (CLSI M27-A2). Kardamom esansiyal yağı, başlangıç konsantrasyonu 40 µl/ml olacak şekilde 10 dakika süreyle sonikasyona alınarak homojen bir hale getirilmiştir. Çalışmada kardamom yağının %0.04, %0.08, %0.16, %0.31, %0.63, %0.13, %0.25, %0.5, %1 ve %2 hacim/hacim konsantrasyonlarındaki iki katlık dilüsyonları, 96 kuyulu mikroplakalarda ve RPMI 1640 besiyeri kullanılarak hazırlanmıştır (her kuyu için 100 µl). Daha önceden hazırlanan maya süspansiyonları da her kuyucuğa 100 µl olacak şekilde inoküle edilmiştir. 11 ve 12. sütunlar pozitif ve negatif kontrol olarak kullanılmıştır. Mikroplakalar 37°C de 24 saat inkübe edilmiş ve MİK değerlendirmeleri yapılmıştır. %0.01 konsantrasyonda distile su ile hazırlanan resazurin çözeltisi 0.22 µm çapındaki membran filtreden geçirilerek steril edilmiştir. Plaklar her kuyuya 30 µl resazurin ilave edildikten sonra 1 saat bekletilmiş ve sonuçlar görsel olarak değerlendirilmiştir. MİK değeri, pozitif kontrol ile karşılaştırıldığında fungal gelişimi inhibe eden en düşük yağ konsantrasyonu olarak tanımlanmıştır. Minimum fungisidal konsantrasyon (MFK) değerlerinin belirlenebilmesi için, temiz ve üreme gözlenmeyen MİK kuyucuklarından 0.1'er ml alınarak Yeast Pepton Dekstroz katı besiyerine ekimler yapılmıştır (Canton vd., 2004). MFK, hücrelerin %99.9'unu öldüren en düşük ilaç konsantrasyonu olarak belirlenmiştir. *Candida albicans* ATCC 10231'e karşı standart antibiyotik olarak Amfoterisin B kullanılmıştır. Tüm deneyler tekrarlı olarak çalışılmış ve sonuçların ortalaması alınmıştır. Uygulanan mikrodilüsyon testini gösteren ve *C. albicans* 1766 izolatına ait MİK sonuçlarını ifade eden temsilci resim Şekil 1'de sunulmuştur.



Şekil 1. Kardamomum *Candida* izolatlarına karşı inhibitör etkisinin sıvı mikrodilüsyon testi değerlendirilmesi

2.4. *Geçirimli elektron mikroskopi (TEM)*

Çalışmamızda, kardamom yağının *Candida* türleri üzerinde gösterdiği morfolojik değişiklikleri değerlendirmek amacıyla TEM kullanılmıştır. Bu amaçla, standart referans mikroorganizma olarak kullanılan *Candida albicans* ATCC 10231, 10 mL hücre süspansiyonları halinde, 2xMIC, MIC ve ½ MIC konsantrasyonda kardamoma maruz bırakılmış ve daha sonra 37°C'de 48 saat inkübe edilmiştir. Kardamom yağı içermeyen kontrol grubu da çalışmaya dahil edilmiştir. Hücre süspansiyonları steril plastik santrifüj tüpleri içerisinde 5000 g'de 15 dakika süreyle santrifüje tabi tutulmuş ve PBS (fosfat tamponlu salin tamponu) ile üç kez (10'ar dakika) ardışık olarak yıkanmıştır. Süpernatantı atılıp pelet haline getirilen hücresel içerik, bir gece boyunca +4°C' de ve %2.5 glutaraldehit içeren PBS tamponunda primer fiksasyona alınmıştır. Numuneler daha sonra oda sıcaklığında PBS tamponunda çözündürülmüş ve sekonder fiksasyon amacıyla %1 osmiyum tetrokside içerisine alınarak 2 saat bekletilmiş ve PBS içinde yıkanmıştır (üç kez ve her biri 15 dakika). Fikse olan hücreler %5 agar içerisine gömülmüş ve %1 uranil asetat ile blok boyamaları yapılmıştır. Daha sonra da her biri 15'er dakika süreyle ve dereceli olarak artan etanol serilerinden (%40, %60, %75, %80 ve %95) geçirilerek dehidrate edilmiştir. Son dehidrasyon basamağı ise %100 etanol içinde, 1 saat boyunca ve her 30 dakikada bir değiştirilerek gerçekleştirilmiştir. Örnekler Epoksi resin içerisine gömülerek 48 saat boyunca ve 60°C'de polimerize edilmişlerdir. Blok haline getirilen numunelerin 60 nm kalınlığındaki tam ince kesitleri bir ultramikrotom (Leica Ultracut R) yardımıyla bakır gridler üzerine alınmıştır. Kesitler son olarak uranil asetat ve kurşun sitrat ile boyanmıştır (Dag vd., 2012). Örnekler JEOL JEM 1220 marka/model geçirimli elektron mikroskopu ile analiz edilmiştir..

3. Bulgular

Kardamom için sıvı mikrodilüsyon testi ile elde edilen MİK değerleri çalışılan tüm izolatlarda MİK $\leqslant$ 0.1% (vol/vol) şeklinde elde edilmiş ve sonuçlar Tablo 2' de özetlenmiştir. Amfoterisin B için elde edilen MİK değeri ise 0.08 olarak bulunmuştur. Çalışmada elde ettiğimiz verilere göre kardamom yağı fungal hastalıklarının tedavisinde yaygın biçimde kullanılan Amfoterisin B ile karşılaştırıldığında, *Candida* izolatları üzerine oldukça etkili sonuçlar vermiştir. Standart ve klinik izolatların duyarlılıkları arasında önemli bir farklılık gözlenmemiştir. Çalışılan 6 farklı türe ait izolatın kardamoma duyarlılıkları da benzer oranlarda bulunmuştur. En etkili sonuç 0.031 MİK değeri gösteren *C. albicans* 1802 izolatında tespit edilmiştir. İzolatların MFK değerleri ise MİK değerlerinden iki kat daha yüksek bulunmuştur.

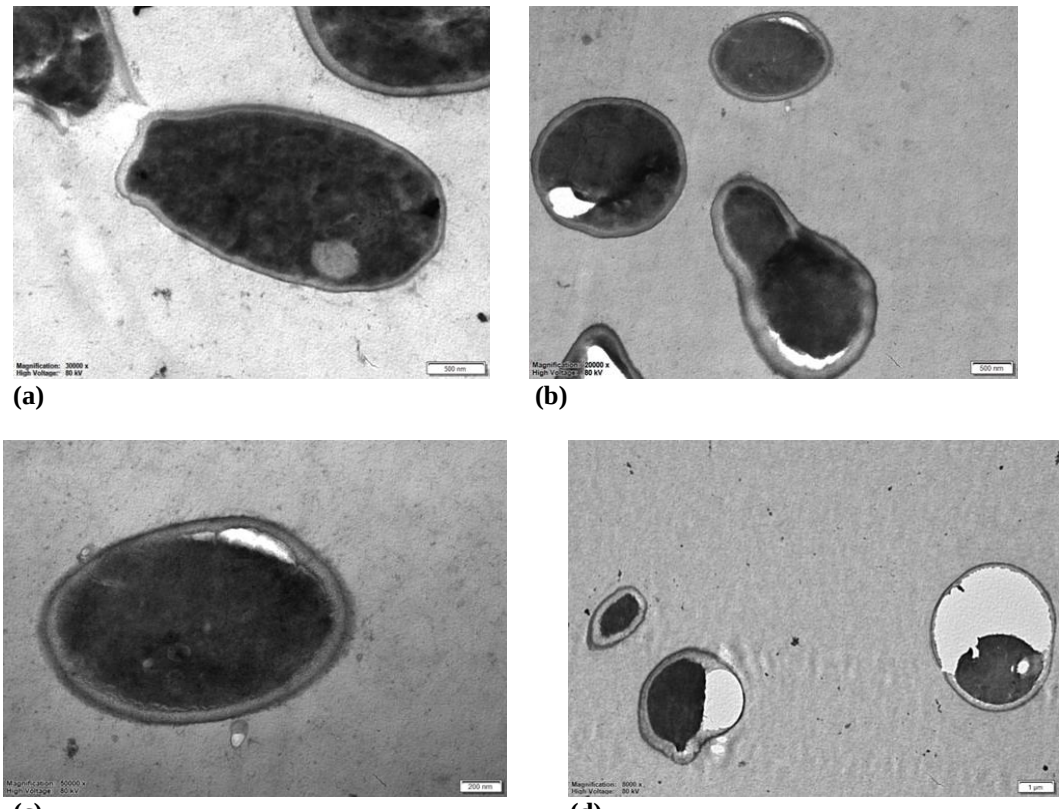
C. albicans ATCC 10231 izolatının TEM ile elde edilen kontrol grubuna ait incelemelerinde tipik *Candida* morfolojisine sahip sağlıklı yapıda hücreler tespit edilmiştir; çekirdek belirgin ve merkezi yerleşimli, stoplazma düzenli, hücre duvarı ve stoplazmik membran yapısı bütün olarak izlenmiştir (Şekil 1a). Hücreler subinhibitör konsantrasyonda (1/2 MİK) ve 24 saat kardamom yağına maruz bırakıldıklarında ise stoplazmanın plazma membranından ayrılarak içe çekildiği, hacminin azaldığı ve bazı hücrelerde hücrenin belirli bir kutbuna doğru yer değiştirdiği tespit edilmiştir. Az

sayıda hücrede ise stoplazmada çok belirgin bir organizasyon bozukluğu izlenmiştir. Hücrelerin çoğunda hücre duvar yapısı anormal şişmeler göstermekle beraber yırtılma olmamıştır ancak stoplazma yer değiştirmesi ile birlikte bleb oluşumu gözlenmiştir (Şekil 1b, c, d). Örnekler MİK ve 2xMİK konsantrasyonlarda kardamoma maruz bırakıldıklarında ise hücreler tamamen parçalandığı için görüntü alınamamıştır.

Tablo 2. Kardamom yağının Candida izolatlarına karşı sıvı mikrodilüsyon testi ile elde edilen MİK ve MFK değerleri(vol/vol)

***Candida* türü**	***MİK (v/v)**	***MFK (v/v)**
C. albicans ATCC 10231	0.06	0.1
C. albicans 1710	0.1	0.2
C. albicans 1724	0.1	0.2
C. albicans 1766	0.06	0.1
C. albicans 1802	0.031	0.06
C. albicans 1697	0.1	0.2
C. kefyr 1620	0.1	0.2
C. kefyr 1706	0.06	0.1
C. krusei 1675	0.06	0.1
C. krusei 1561	0.1	0.2
C. krusei 1670	0.1	0.2
C. glabrata 1744	0.06	0.1
C. glabrata 1797	0.1	0.2
C. parapsilosis 1806	0.1	0.2
C. parapsilosis 1799	0.1	0.2
C. tropicalis 1678	0.1	0.2

*MİK: Minimum İnhibisyon Konsantrasyonu, *MFK: Minimum Fungisidal Konsantrasyon



(a) **(b)** **(c)** **(d)**

Şekil 2. *C. albicans* ATCC 10231 izolatının kontrol (a) ve kardamom yağıyla muamele sonrası (b, c ve d) elde edilen TEM görüntüleri

4. Sonuçlar ve tartışma

Candida türleri hastane kaynaklı enfeksiyonların temel sebeplerinden olup, kan akımı enfeksiyonlarından da en sık izole edilen fungal patojenler arasındadır (Wenzel ve Gennings, 2005). Sebep oldukları yüzeyel ya da invaziv infeksiyonlar insan sağlığı açısından büyük bir problem teşkil etmektedir (Sardi vd., 2013). Tedavide kullanılan antifungal ilaçlar oldukça sınırlıdır ve bunların yaygın biçimde kullanılması ilaç direnci gelişimine yol açarak hastalığın şiddetini iyice artırmaktadır (Morace vd., 2014). Diğer yandan, konakçıdaki düşük immünite ya da biyofilm ilişkili ilaç direnci gelişimi de hayatı tehdit eden fungal infeksiyonları artırmaktadır. Örneğin biyofilm oluşturan *Candida* türlerinin tedavide çok sık kullanılan azollere karşı direnç geliştirme yetenekleri bulunmaktadır (Silva vd., 2017). Diğer yandan antifungal ilaçların daha yüksek dozlarda kullanımı toksisiteye de yol açabilmektedir. Tüm bu sebeplerden dolayı araştırıcılar yeni moleküller araştırmakta ve bitki esansiyel yağları da bu konuda yoğun ilgi görmektedir.

Esansiyal yağların antimikrobiyal etkilerini araştıran pek çok çalışma bulunmasına rağmen, literatürdeki sonuçlar nispeten çelişkilidir ve genelde esansiyal yağın etki spektrumu hakkında çok detaylı bilgi vermemektedir. Çünkü bitkilerdeki esansiyal yağların kimyasal bileşenleri türler arasında farklılık göstermektedir (Swamy vd., 2016). Ayrıca coğrafi lokasyon, çevre koşulları ya da olgunluk safhası gibi parametreler de bu bileşenleri etkilemektedir (Swamy vd., 2015). Böylece çeşitli patojen mikroorganizmalara karşı gösterilen antimikrobiyal etki de farklı olabilmektedir. Antimikrobiyal aktiviteyi tayin etmede kullanılan metod, mikrobiyal gelişmedeki farklılıklar, mikroorganizmanın bitkisel yağa maruziyet süresi, esansiyal yağ ya da komponentinin çözünürlüğü ya da bazen farklı bitki türlerinden türevlenebilen ve aynı yaygın isme sahip yağların etkinlikleri de farklı olabilmektedir (Swamy vd., 2016). Çalışmamızdan elde edilen bulgular, kardamom yağının standart ve klinik *Candida* izolatları üzerine güçlü bir inhibitör etki gösterdiğini ortaya koymuştur. Bulgularımıza benzer bir çalışmada Vijalayalakshmi ve arkadaşları, 202 klinik *Candida* izolatına karşı *Elettaria cardamomum*'un antimikrobiyal aktivitesini araştırmışlardır. Çalışmaya alınan izolatlar, çoklu ilaç direnci gösteren biyofilm pozitif izolatları kapşamıştır. Araştırma sonucunda *E. cardamomum*'un etanolik ve asetonik ekstraktları tarafından patojenik *Candida* türlerinin inhibe edildiği rapor edilmiştir. Ayrıca asetonik ekstrakt ile 125 µl (56.25 µg) konsantrasyondaki biyofilm üretimi tamamen inhibe edilmiştir (Vijalayalakshmi vd., 2016). Bizim çalışmamızda da biyofilm pozitif izolatlar deneylere alınmış ve kardamom yağının güçlü etkileri ortaya konmuştur. Diğer bir araştırmada Radhakrishnan ve arkadaşları, klinik *C. albicans* izolatlarına karşı kardamom ve hindistan cevizinin antifungal etkinliklerini araştırmışlardır. Yazarlar her iki bitki ekstraktının da *Candida* izolatlarına karşı güçlü inhibitör etkisini göstermiş ve hücrelerde ergosterol içeriğinin de azaldığını rapor etmişlerdir. Ayrıca elektron mikroskopla da hücrelerde duvar kalınlaşması, membran düzensizlikleri ve stoplazmanın yer değiştirmesi gibi bulgular elde etmişlerdir (Radhakrishnan vd., 2015). Bizim sonuçlarımızda da stoplazmanın yer değiştirmesi belirgin bir bulgu olarak gözlense de hücre duvarındaki kalınlaşma çok net olarak tespit edilememiştir. Hücre duvarındaki ileri derece şişmeler ve stoplazmada büzüşmeler çok belirgin bulgular olarak izlenmiştir. Badei ve arkadaşları bazı bakteri ve küfler üzerine kardamom yağının antimikrobiyal aktivitelerini araştırmış ve MİK değerini 0,5-0,9 mg/mL arasındaki oranlarda bulmuşlardır (Badei vd., 1991a, b). Aneja ve Sharma'nın araştırmalarında 6 farklı tür kulak patojeni üzerine *E. cardamomum* meyve ekstraktlarının etkileri araştırılmış ve en yüksek antimikrobiyal aktivite *S. aureus*'a karşı ve 25 mg/ml lik bir MİK ile elde edilmiştir (Aneja ve Sharma, 2010). Genel olarak esansiyal yağlarla ilgili yapılan benzer antimikrobiyal aktivite çalışmaları değerlendirildiğinde bakterilerin çok daha yoğun olarak araştırıldığı görülmektedir. Bu çalışmalarda gram pozitif bakterilerin gram negatiflere oranla esansiyal yağlara daha duyarlı oldukları rapor edilmekte ve bu farklılığın hücre duvar yapısından kaynaklanabileceği ifade edilmektedir. Esansiyal yağların mantarlar üzerine olan etkileri ile ilgili çalışmalar ise daha sınırlıdır. Bnasod ve Rai, *Aspergillus fumigatus* ve *A. niger* küflerine karşı kardamom yağının agar dilüsyon metodu ile MİK tayinini gerçekleştirmişlerdir (%v/v). Elde edilen MİK değerleri %2'den büyük bulunmuş; minimal fungisidal konsantrasyon ve MİK değerleri birbirine eşit olarak elde edilmiştir (Bnasod ve Rai, 2008). Mejdi ve arkadaşları yeşil kardamomdan su distilasyonu ile ekstrakte ettikleri esansiyal yağı önce kimyasal kompozisyonu bakımından GC-MS ile karakterize etmişler, sonra da çeşitli bakteri ve mantar izolatlarına karşı disk difüzyon ve mikrodilüsyon testleri yaparak antibakteriyal aktivite bakımından karşılaştırmışlardır. Elde edilen sonuçlar bu esansiyal yağın yüksek ve geniş spektrumlu bir antibakteriyal aktivitesi olduğunu ortaya koymaktadır. Araştırıcılar aynı çalışmada kardamom yağının 16 maya türü üzerine (15 *Candida* türü ve 1 *Saccharomyces cerevisiae*) antifungal etkilerini de araştırmışlardır. Kardamom yağı için elde edilen MİK değerleri 0.023-0.046 mg/ml aralığında bulunmuş ve standart kontrol antibiyotiği olarak kullanılan Amfoterisin B'ye göre (MİK 0.015-0.39 mg/ml) belirgin bir antifungal etkisi olduğu rapor edilmiştir (Mejdi vd., 2015). Çalışılan izolatların MFC değerlerinin tespiti yapıldığında ise maya izolatları kardamom için 3-12 aralığında bir değer göstermiştir. Aynı izolatlar amfoterisin B kullanıldığında ise 0.39-3.125 arasında bir MFC aralığına sahip olmuşlardır. Bu sonuçlardan yola çıkılarak kariyojenik mantarların gelişimini inhibe edebilmek için esansiyal yağ konsantrasyonunun 3-12 mg/ml (MFC değerleri) aralığında olması gerektiğini belirtmişlerdir. Araştırıcılar elde ettikleri düşük MİK değerleri (0.023-0.046) ile bu yağın besin kaynaklı patojenlerin inhibe edilmesi ve kariyojenik bakteri ve mantarlar tarafından oluşturulan diş çürüklerinin kontrolünde katkı sağlayabileceğini rapor etmişlerdir (Mejdi vd., 2015). Bizim çalışmamızda da kardamom yağı amfoterisin B'ye oranla oldukça güçlü bir etki sergilemiş, MFC değerlerimiz MİK değerlerimizden iki kat daha yüksek bulunmuştur. Elgayyar ve arkadaşları kardamomu da içeren 8 farklı esansiyal yağın patojenik ve saprofitik mikroorganizmalar üzerine etkilerini araştırdıkları çalışmalarında, kekik, reyhan ve kişnişten ekstrakte edilen esansiyal yağların 4000 ppm konsantrasyonda *Pseudomonas*

aeruginosa, *Staphylococcus aureus* ve *Yersinia enterocolitica* üzerine inhibitör etkileri olduğunu göstermişlerdir (Elgayyar vd., 2001). Al- Abdalall tarafından yapılan bir çalışmada da kardamom, tarçın, zencefil, karanfil ve mür ekstraktlarının farklı konsantrasyonlarının *C. albicans* ve *S. aureus* üzerine etkilerini araştırmışlardır. Araştırıcılar baharatların sulu ekstraktlarının test edilem mikroorganizmaların gelişimi üzerine inhibitör etki yapmadığını, sadece mür sulu ekstraktının iki tipinin inhibitör etki gösterdiğini açıklamışlar ve endüstriyal antibiyotik kullanımı yerine mür kullanımının daha etkili olabileceğini belirtmişlerdir (Al-Abdalall, 2016). Tüm bu çalışmalarda da görüldüğü gibi esansiyal yağlarla yapılan invitro çalışmaların karşılaştırılması oldukça güçtür. Çünkü bitkisel yağ ve ekstraktlarının kompozisyonları yerel iklimsel ya da çevre durumlarına göre değişiklikler göstermektedir ya da antimikrobiyal aktiviteyi değerlendirmede seçilen metod ve kullanılan mikroorganizmalar büyük değişkenlikler gösterebilmektedir. Ancak esansiyal yağların medikal amaçlarla kullanımı için etki, güvenlik ve toksisitelerinin çok iyi şekilde belirlenmesi gerekmektedir.

Esansiyal yağların hücre membranını tahrip ederek etki gösterdikleri belirtilmektedir ancak ilgili mekanizmalar tam olarak açıklanamamıştır. Bu konuda ileri sürülen en önemli görüşlerden biri esansiyal yağların sahip olduğu hidrofobisitenin, hücre membranı lipidlerinde parçalanmaya yol açarak, onu daha geçirgen bir hale getirdiği ve hücre içeriğinin zayıflamasına yol açtığı şeklindedir (Trombetta vd., 2005).

Son yıllarda antifungallerin uygunsuz şekillerde kullanımları sonucu çoklu-ilaç direnci sorunu ortaya çıkmıştır. Diğer yandan antifungal ilaçlar antibakteriyallere göre çok daha sınırlıdır; tedavide sıkça kullanılan amfoterisin B çok etkili olmakla beraber, yüksek toksisitesi kullanımını sınırlamaktadır. Araştırmamızda elde ettiğimiz sonuçlar kardamomun *Candida* izolatları üzerine düşük MİK değerleri ile güçlü bir antifungal etkinlik gösterdiğini ortaya koymaktadır. TEM analizlerinde ise etkisini özellikle stoplazma ve membran ayrılması ile başlayarak, ileri derecede stoplazmik hasarla gösterdiği tespit edilmiştir. Kardamom yağı antifungal tedavide kullanım için umut verici olabilir ancak etki mekanizmaları, toksisite ve stabilite üzerine ayrıntılı çalışmalara ve in vivo etkinliğin değerlendirilmesine de ihtiyaç bulunmaktadır.

Kaynaklar

Agaoglu, S., Dostbil, N., Alemdar, S. (2005). Antimicrobial effect of seed extracts of cardamom (Elettaria cardamomum Maton) Yüzüncü Yıl Üniversitesi Veteriner Fakültesi Dergisi, 16(2), 99–101.Al-Abdalall, A. (2016). Effect of plants extracts on the growth of Candida albicans and Staphylococcus aureus. African Journal of Pharmacy and Pharmacology, 10(16), 337-345.

Aneja, K.R., Sharma, C. (2010). Antimicrobial potential of fruit extracts of Elettaria cardamomum maton (chhoti elaichi) against the pathogens Causing ear infection. PharmacologyOnline. 3,750-6.

Badei, A.Z.M., El-Akel, A.T.M., Morsi, H.H.H. (1991). Evaluation of chemical, physical and antimicrobial properties of cardamom essential oil. Bulletin of Faculty of Agriculture, Cairo University, 42(1), 183-197.

Badei, A.Z.M., Morsi, H.H.H., El-Akel, A.T.M. (1991). Chemica composition and antioxidant properties of cardamom essential oil. Bulletin of Faculty of Agriculture, Cairo University, 42(1), 199-215.

Bansod S., Rai. M. (2008). Antifungal activity of essential oils from Indian medicinal plants against human pathogenic Aspergillus fumigatus and A. niger. World Journal of Medical Sciences, 3, 81-88.

Burt, S. (2004). Essential oils: Their antibacterial properties and potential applications in foods—a review. International Journal of Food Microbiology, 94(3), 223–253.

Canton, E., Peman J., Gobernado, M., Viudes, A., Espinel-Ingroff A. (2004). Patterns of amphotericin B killing kinetics against seven Candida species. Antimicrobial Agents and Chemotherapy, 48(7), 2477-2482.

Chandra, J., Kuhn, D.M., Mukherjee, P.K., Hoyer, L.L., McCormick, T., Ghannoum, M.A. (2001) Biofilm formation by the fungal pathogen Candida albicans: development, architecture, and drug resistance. Journal of Bacteriology, 183(18), 5385–5394.

Clinical Laboratory Standards Institute (2002). Reference Method for Broth Dilution Antifungal Susceptibility Testing of Yeasts. Approved Standard M27-A2. Wayne PA.

Dag, I., Oz, Y., Kiraz, N. (2012). Effect of disinfectants on biofilm development by five species of Candida. African Journal of. Microbiology Research, 6(10), 2380-2386.

Doughari, J.H. ve Naya, P. (2008). In vitro antifungal activity of determium microcarpum. Pakistan Journal of Medical Sciences, 24(1), 91-95.

Elgayyar, M., Draughon, F.A., Golden D.A., Mount J.R. Antimicrobial activity of essential oils from plants against selected pathogenic and saprophytic microorganisms. Journal of Food Protection, 64(7), 1019–1024.

Karkowska-Kuleta, J., Rapala-Kozik, M., Kozik, A. (2009). Fungi pathogenic to humans: molecular bases of virulence of Candida albicans, Cryptococcus neoformans and Aspergillus fumigatus. Acta Biochimica Polonica, 56(2), 211–224.

Kubo, İ., Himejima, M., Muroi H. 1991. Antimicrobial activity of flavor components of Cardamom Elattaria cardamomum (Zingiberaceae) Seed. Journal of Agricultural and Food Chemistry, 39, 1984-1986.

Mazu, T.K., Bricker, B.A. Flores-Rozas, H., Ablordeppey, S.Y. (2016). The Mechanistic Targets of Antifungal Agents: An Overview. Mini-Reviews in Medicinal Chemistry, 16(7), 555–578.

Mejdi, A., Emira, N., Ameni, D., Guido, F., Mahjoub, A., Madiha, A., Abdulbasit, A. (2015). Chemical Composition and Antimicrobial Activities of Elettaria Cardamomum L. (Manton) Essential Oil: A High Activity against a Wide Range of Food Borne and Medically Important Bacteria and Fungi. Journal of Chemical, Biological and Physical Sciences, 6(1), 248-259.

Morace, G., Perdoni, F., Borghi, E. (2014). Antifungal drug resistance in Candida species. The American Journal of Medicine, 2(4), 254-259.

Movar, A., Thewes, S., ve Hube, B. (2005). Systemic fungal infections caused by Candida species: epidemiology, infection process and virulence attributes. Current Drug Targets, 6(8), 863-874 .

Pfaller, M.A., Diekema, D.J., Messer, S.A., Boyken, L., Hollis, R.J., Jones, R.N. (2003). In vitro activities of voriconazole, posaconazole, and four licensed systemic antifungal agents against Candida species infrequently isolated from blood. Journal of Clinical Microbiology, 41(1), 78-83.

Rabini, N., Zheng, Y., Opoku-Temeng, C., Du, Y., Bonsu, E., ve Sintim. H.O. (2015). Biofilm formation mechanisms and targets for developing anti-biofilm agents. Future Medicinal Chemistry, 7(3), 493–512.

Radhakrishnan, V.S., Kurub, A., ve Dwivedi, S.P., Prasad, T. (2015). Multidisciplinary approach for studying and combating microbial pathogens, Chapter: Formulated natural plant extracts from nutmeg and cardamom show antifungal activity against clinical isolates of Candida albicans and affect cellular morphology and ergosterol, Publisher: BrownWalker Press, Editors: Antonio Méndez-Vilas, pp.85-90.

Sardi, J.C.O., Scorzoni, L., Bernardi, T., Fusco-Almeida, A.M., Giannini, M.M. (2013). Candida species: current epidemiology, pathogenicity, biofilm formation, natural antifungal products and new therapeutic options. Journal of Medical Microbiology, 62(1), 10-24.

Silva, S., Rodrigues, C., Araújo, D., Rodrigues, M. ve Henriques, (2017). Candida Species Biofilms' Antifungal Resistance. Journal of Fungi, 3(1)-8.

Swamy M.K., Akhtar M.S., ve Sinniah U.R. (2016). Antimicrobial properties of plant essential oils against human pathogens and their mode of action: An updated review. Evidence-Based Complementary and Alternative Medicine, 3012462. p. 21 ID 3012462

Swamy, M.K., Sinniah, U.R., Akhtar, M.S. (2015). In vitro pharmacological activities and GC-MS analysis of different solvent extracts of Lantana camara leaves collected from tropical region of Malaysia. Evidence-Based Complementary and Alternative Medicine, 2015, 1–9.

Şengün İ.Y., Yücel, E. (2015). Antimicrobial properties of wild fruits. Biological Diversity and Conversation 8(1), 69-77.

Taff, H.T., Mitchell, K.F., Edward, J.A., Andes, D.R. (2013) Mechanisms of Candida biofilm drug resistance. Future Microbiology, 8(10),1325–1337.

Trombetta, D., Castelli, F., Sarpietro, M. G., Venuti, V., Cristani, M., Daniele, C., Saija, A., Mazzanti, G., Bisignano, G. (2005). Mechanisms of antibacterial action of three monoterpenes. Antimicrobial Agents and Chemotherapy, 49(6), 2474–2478.

Vijalayalakshmi, P., Thenmoshi, S., ve Rajeswari, P. (2016). The evaluation of the virulence factors of clinical Candida isolates and the antibiofilm activity of Elettaria cardamomum against multidrug resistant Candida albicans. Current Medical Mycology, 2(2), 8-15.

Wenzel, R.P., Gennings, C. (2005). Bloodstream infection due to Candida species in the intensive care unit: identifying especially high–risk patients to determine prevention strategies. Current Medical Mycology, 41(6), 5389–93.

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Research article/Araştırma makalesi

The larval food-plant of *Agonopterix dideganella* (Amsel, 1972) (Lepidoptera: Depressaridae) and its new larval parasitoid *Copidosoma sosares* (Walker) record

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Abstract

In this study, host-plant *Prangos* sp. and larval parasitoid *Copidosoma sosares* of *Agonopterix dideganella* has been detected for the first time. Also, *C. sosares* is reported as a new record for Chalcidoidea fauna of Turkey. Besides, photos of development stages of *A. dideganella* with its host plant, parasitoid and habitat are presented in the study.

Key words: *Agonopterix dideganella*, *Copidosoma sosares*, *Prangos*, Nemrut Caldera, Bitlis, Turkey

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Agonopterix dideganella (Amsel, 1972) (Lepidoptera: Depressaridae)'nın larva besin bitkisi ve yeni larva parazitoidi *Copidosoma sosares* (Walker)'in kaydı

Özet

Bu çalışmada, *Agonopterix dideganella*'nın larva parazitoidi *Copidosoma sosares* ve konukçu bitkisi *Prangos* sp. ilk kez için tespit edilmiştir. Öte yandan, *C. sosares* Türkiye'nin Chalcidoidea faunası için yeni bir kayıt olarak rapor edilmektedir. Ayrıca, *A. dideganella* gelişim aşamaları ile konukçu, parazitoid ve habitat resimleri çalışmada sunulmuştur.

Anahtar kelimeler: *Agonopterix dideganella*, *Copidosoma sosares*, *Prangos*, Nemrut Kalderası, Bitlis, Türkiye

1. Introduction

Depressaridae is now regarded as a family group in Gelechioidea (Heikkilä et al., 2014). The genus of Depressaridae *Agonopterix* was established by Hübner (1825) and it has 51 species in Turkey (Koçak and Kemal, 2018; Buchner, 2017a). *Agonopterix dideganella* was described in Iran by Amsel (1972). Later, Buchner (2017b) discovered the species in Gümüşhane, Erzincan and Elazığ Provinces in Turkey. In literature, there are few relevant data about the species.

The genus *Prangos* has 19 taxa in Turkey (Menemen, 2012: 75-76). It is known with two species from Nemrut Caldera (Bitlis Prov.); *P. uloptera* Dc. and *P. pabularia* Lindl. (Herrnstadt and Heyn, 1972). The plant is important in point of the roots of *P. pabularia* Lindl. (as called "Çakşır" locally in Turkish) has been used in increasing body resistance, infertility, gastrointestinal disturbances, indigestion, giving strength, diabetes and sperm formation (Korkmaz and Karakurt, 2015).

The genus *Copidosoma* includes species that have a potential to be used as biocontrol agents of lepidopteran pests and has more than 200 species (Guerrieri and Noyes, 2005; Noyes, 2018). *Copidosoma sosares* is a specialized polyembriyonic parasitic wasp native to Europe and attacks Depressariine moths that feed on plants in the family Apiaceae. Host range of *C. sosares*, which is limited to a few species belong to *Agonopterix* and *Depresaria* that these species are; *A. angelicella*, *A. heracliana*, *A. nervosa*, *A. perstrigella*, *D. angellicella*, *D. daucella*, *D. nervosa*, *D. pastinacella* and *D. petasitis*. These species are special herbivores of plants within the Apiaceae genera *Angelica*,

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Heracleum, *Oenanthe* and *Pastinaca* (Noyes, 2018). Although *Copidosoma sosares* native to Europe its presence in North America was reported in last decade (Carroll et al., 2007).

In this study, the larval food-plant of *A. dideganella* and its larval endoparasitod (*C. sosares*) have been detected for the first time. Besides, the study has contributed to distribution of *C. sosares* from Turkey.

2. Materials and methods

While the larvae were feeding on *Prangos* plant, they were collected from Nemrut Caldera (Bitlis Prov.) in Yayla Kalıntısı upper road (38°36'34.20"K 42°15'53,95"D, 2421 m) locality by the first and third authors on 25.05.2017 (Figures 1, 2). Later, they were taken to feeding boxes under laboratory conditions (Figure 3). After a while, it is observed that some of the larvae got parasitized and stopped feeding and were transferred to separate boxes (Figure 4a). The adult depressarids emerged pupas were stretched in the form of museum material, and its genital was prepared by made the first author (G.P. 269 K.A) according to Robinson (1976) (Figures 4b, c, d). Parasitoid *C. sosares* specimens emerging from parasitized larvae were kept in %70 alcohol and identified by the second author by according to Guerrieri and Noyes (2005), Noyes and Hayat (1984), Noyes (2018) (Figure 5).

3. Results

In this study, 39 larvae of *A. dideganella* were collected from Nemrut Caldera on 25.05.2017, and they were put in the feeding boxes. Of the 39 larvae, 8 larvae got parasitized, 3 larvae died while 28 larvae pupated on 29-30.05.2017. The 8 parasitized larvae were kept in separate boxes. And, the parasitoids (*C. sosares*) emerged from the 8 parasitized larvae on 23-24.06.2017. Furthermore, only17 adult depressarids emerged from the 28 pupae on 18-19.06.2017 (Table 1).

Table 1. The numbers of specimens belong to *Agonopterix dideganella*

	Number of larvae forming pupae	Number of parasitized larvae	Dead larvae
	28	8	3
Not emerged pupae	11		
Emerged pupae	17		

It was observed that larvae of *A. dideganella* died because they could not feed. As the larvae of *A. dideganella* were fed they were moving towards into the plant and fed in collectively. When *A. dideganella* were collected from the field they formed a communal tent and were fed under this property. There was a tendency to form the pupae through plant.

4. Conclusions and discussion

The genus *Prangos* is known to have two species (*P. uloptera* Dc. and *P. pabularia* Lindl.) from Nemrut Caldera (Bitlis Prov.) (Herrnstadt and Heyn, 1972). When the larvae were collected, *Prangos* plant was young and did not have any fruit. So, which species of the *Prangos* the larvae feed on could not be detected as these two species are distinguished from fruit type (Murat Kurşat pers. com.) (Fig. 2).

Copidosoma sosares; head and thorax with dark green reflections, gaster black with metallic green reflections, antenna, venation, legs brown; antenna with scape about 7 times as long as broad, F1 about 1-5 times as long as broad, clava solid, apical truncation of clava extending not more than 0,5 times its length; mesoscutum and scutellum with same sculpture; gaster with ovipositor not exserted.

C. sosares mostly prefers species of Depressaridae feeding on Apiaceae: *Agonopterix angelicella* on *Angelica sylvetris*, *A. heracliana* on *Pastinaca obliva*, *A. nervosa* on *Oenanthe crocata*, *A. petasitis*, *A. perstrigella*, *Depressaria daucella*, *D. pastinacella* on *Heracleum sosnowskyi*, on *Heracleum sphondylium*, on *Heracleum antegazzianum* and on *Heracleum trachytoma*. *C. sosares* is a polyembryonic parasitic wasp and is reported to be polyembryonic our study. These results suggest that *C. sosares* and its host *A. dideganella* should be studied together in detail. Becasuse, it may give important information for biological control studies for both *A. dideganella* and its larval food-plant.

Although *C. sosares* was not used as a biological control agent *C. koehleri* and *C. floridanum* were successfully used as a biological control agent in field. Especially in recent year, there has been a study on *C. sosares* with host plant, host plant chemistry and parasitoid indirect effects in a tritrophic interaction (Ode et al., 2004). Thus host-plant (*Prangos* sp.) and parasitoid (*C. sosares*) relationship and to be new record is important for biodiversity and in terms of suitability for biological control. A new natural enemy record can be base for the control of harmful species.

As a result;

-By now, *A. dideganella* has been only known from Gümüşhane, Erzincan and Elazığ in Turkey (Buchner, 2017b). It is the first record for the Bitlis province with this study.

- The host-plant (*Prangos* sp.) and parasitoid (*C. sosares*) of *A. dideganella* are detected for the first time.
- *Copidosoma sosares* a new record for the Chalcidoidea fauna of Turkey.

More detailed studies are needed to be able to say that it will be possible to use of *C. sosares* as biological control agent and its distribution in Turkey.

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References

Amsel, H. G. (1972). Depressarienaus Afghanistan, Iran, Irak und Arabien (Lepidoptera: Oecophoridae). Beiträge zur naturkundlichen Forschung in Südwestdeutschland, 31, 133-144.

Buchner, P. (2017a). Redescription of *Agonopterix selini* (Heinemann, 1870) with description of *Agonopterix lessini* sp.n. and *Agonopterix paraselini* sp.n. (Lepidoptera, Gelechioidea). Gortania, 38, 71-101. Udine.

Buchner, P. (2017b). Faunistic records of Depressariidae (Lepidoptera, Gelechioidea) from Turkey – a result of studies for „Microlepidoptera of Europe: Depressariinae". Cesa News, 134, 1-34.

Carrol, M. J., Lampert, E. C., Berenbaum, M. R., Noyes, J. S., Ode, P. J. (2007). New Records of *Copidosoma sosares* (Walker) (Hymenoptera: Encyrtidae), a Parasitoid of the Parsnip Webworm (*Depressaria pastinacella* (Duponchel)) (Lepidoptera: Elachistidae), in Western North America. Journal of The Kansas Entomological Society, 80 (4), 309-318.

Guerrieri, E., Noyes, J. (2005). Revision of the European species of *Copidosoma* Ratzeburg (Hymenoptera: Encyrtidae), parasitoids of caterpillars (Lepidoptera). Systematic Entomology, 30, 97-174.

Heikkilä, M., Mutanen, M., Kekkonen, M., Kaila, L. (2014). Morphology reinforces proposed molecular phylogenetic affinities: a revised classification for Gelechioidea (Lepidoptera). Cladistics, 30 (6), 563-589.

Herrnstadt, I., Heyn, C. C. (1972). *Prangos* Lindl. *In:* Davis PH, (Ed.) Flora of Turkey and East Aegean Islands. Vol. 1-9. Edinburgh University Press. Edinburgh, Vol.4. 382-388.

Hübner, J. (1816-[1826]). Verzeichnis bekannter Schmetterlinge. Augsburg, 431.

Koçak, A. Ö., Kemal, M. (2018). A synonymous and distributional list of the species of the Lepidoptera of Turkey. Cent. ent. Stud., Memoirs, 8, 1-487.

Korkmaz, M., Karakurt, E. (2015). An ethnobotanical investigation to determine plants used as folk medicine in Kelkit (Gümüşhane/Turkey) district. Biodicon, 8(3), 290-303.

Menemen, Y. (2012). *Prangos*. *In:* Güner A, Aslan S, Ekim T, Vural M, Babaç MT, (Eds.) Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını. İstanbul, 75-77.

Noyes, J. S., Hayat, M. (1984). A review of the genera of Indo-Pacific Encyrtidae (Hymenoptera: Chalcidoidea). Bulletin of the British Museum (Natural History) (Entomology), 48, 131-395.

Noyes, J. (2018). Universal Chalcidoidea Database. World Wide Web electronic publication at http://www.nhm.ac.uk/entomology/chalcidioids/ (Erişim tarihi: 05.03.2018).

Ode, P. J., Berenbaum, M. R., Zangerl, A. R., Hardy, I. C. W. (2004). Host plant, host plant chemistry and the polyembryonic parasitoid Copidosoma sosares: indirect effects in a tritrophic interaction. Oikos, 104, 388-400.

Robinson, G. S. (1976). The Preparation of slides of Lepidoptera genitalia with special reference to the Microlepidoptera. Entomologist's Gazette, 27, 127-132.

1.

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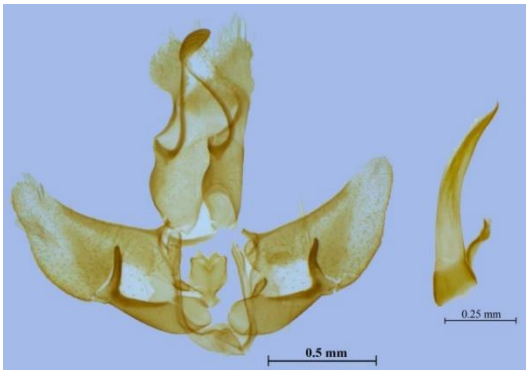
4a.

4b.



4c.

4d.

5.

Figure 1. Locality of study, Figure 2. Larva food-plant *Prangos* sp., Figure 3. Larva taken to feeding boxes, Figure 4. *A. dideganella* Ams.: (a: Parasitized larva, b**:** Pupa, c: Male genital, d: Adult), Figure 5 Adult of *C. sosares* Walk.

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Research article/Araştırma makalesi

Wolf spiders (Araneae: Lycosidae) from Bursa and Balıkesir (Northwest Anatolia) in Turkey

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Abstract

The investigation was carried out in Northwest Anatolia in the period 2006–2011. From 24 localities, 14 wolf spider species in six genera were reported. The species represent lowland as well as mountain spider fauna of the Palaearctic region. In this study, *Alopecosa farinosa, Aulonia albimana, Pardosa consimilis*, *Pardosa hortensis* and *Pardosa monticola* are the first records for Marmara region in Turkey. *Trabea paradoxa* is the first record for Anatolia.

Key words: Turkey, Asia Minor, fauna, inventory, wolf spider

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Türkiye'de Bursa ve Balıkesir'den (Kuzeybatı Anadolu) Kurt örümcekleri (Araneae: Lycosidae)

Özet

Araştırma, 2006–2011 yılları arasında Kuzeybatı Anadolu'da gerçekleştirilmiştir. 24 lokaliteden 6 cinse ait 14 türe ait kurt örümceği rapor edilmiştir. Türler, Paliarktik bölgedeki hem dağ örümceklerini hem de ova örümceklerini temsil eder. Bu çalışmada , *Alopecosa farinosa, Aulonia albimana, Pardosa consimilis*, *Pardosa hortensis* and *Pardosa monticola* Marmara bölgesi için ilk kayıtlardır. . *Trabea paradoxa* Anadolu için ilk kayıttır.

Anahtar kelimeler: Türkiye, Anadolu, fauna, envanter, kurt örümceği

1. Introduction

Turkey consists of two general parts, Thrace and Anatolia. Thrace is a European part of Turkey, Anatolia is the Asian part. From the geographical point of view, Turkey is divided into Marmara, Aegean, Black Sea, Central Anatolia, Eastern Anatolia, South-eastern Anatolia and Mediterranean. Turkey belongs to a zoogeographically very diversified area: Several zoogeographic zones overlap (European, Caucasian, Turanian and Eremial) (Gümuş and Neubert, 2009) and biodiversity hotspots meet (Caucasus, Irano-Anatolian and Mediterranean), including a high rate of endemism (Gür, 2016). The Turkish fauna has relationship to Palaearctic, central European, Mediterranean and also Gondwanian and Far East fauna (Kosswig, 1955). Therefore, Turkish spider fauna is very rich: To date, 1117 spider species belonging to 52 families have been reported in Turkey. The list is dominated by members of families Gnaphosidae (145 species), Salticidae (143 species) and Linyphiidae (128 species) (Demir and Seyyar, 2017). Lycosidae, a globally distributed family with 2421 species belonging to 123 genera (WSC, 2017), contains 87 species from 15 genera in Turkey (including two endemics, *Arctosa simoni* Guy, 1966 and *Pardosa ilgunensis* Nosek, 1905): *Allocosa* – 1, *Alopecosa* – 13, *Arctosa* – 10, *Aulonia* – 2, *Geolycosa* – 1, *Hogna* – 2, *Lycosa* – 5, *Ocyale* – 1, *Pardosa* – 37, *Pirata* – 2, *Piratula* – 4, *Trabea* – 1, *Trochosa* – 5, *Wadicosa* – 1 and *Xerolycosa* – 2 (Demir and Seyyar, 2017; Uyar and Dolejš, 2017). Here, for comparative purposes, we have provided data on the diversity of Lycosidae in some countries such as: Armenia – 8, Azerbaijan – 77, Georgia – 78 (Otto, 2017), Bulgaria – 80 (Blagoev et al., 2017), Greece – 65 (Bosmans and Chatzaki, 2005) and Iran – 65 (Zamani et al., 2017). Recent works on the spider fauna of West Anatolia were published by Kaya and Uğurtaş (2008, 2011) – Araneidae and Theridiidae; Yılmaz et al. (2009) – Thomisidae; Kunt et al. (2009) – Dysderidae; Uyar et al. (2010, 2015) – Philodromidae and Theridiidae; Uyar and Uğurtaş (2012) – Salticidae. Considering the zoogeographical diversification (Kosswig, 1955; Gümuş and Neubert, 2009) and size of Turkey, the faunal studies on the diversity of Turkish spider fauna is not from being completed. Thus, the aim of the study is to contribute to knowledge of Turkish wolf spider fauna.

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1.1 Study Areas

Majority of localities in the Bursa province (Table 1) were situated in the Uludağ Mt. which is the highest mountain in Northwest Anatolia. It is located immediately behind the city of Bursa (40°N, 29°E). The dimension of Uludağ in the northwest to southeast direction is about 40 km long and 15–20 km wide. The highest peak reaches 2543 m. The mountain is naturally bordered by a Nilüfer stream on the west and south, and by the Bursa city and the town of İnegöl on the north and east. Extensive exposures of both acid granite, gneiss and schist and calcareous crystalline limestone has given rise to a wide range of habitats, many in excellent condition, including broadleaved and coniferous forest, subalpine moorland, seasonal moorland pools, extensive alpine cliff communities, glacial lakes, and exposed summit communities. The flora is exceptionally rich. The principal summit ridge of the mountain (above 2200 m) is composed of hard crystalline limestone, whilst at lower altitudes a range of acidic rocks (including gneiss, granites and schist) predominate, with more localised outcrops of serpentine to the South. Overall, the climate can most closely be regarded as Mediterranean in character, although it is considerably modified by humid air originated from the Sea of Marmara that is trapped by the step nature of the site and the considerable height of peak (Kaynak et al., 2005, Güleryüz et al., 2005).

Uludağ has six vegetation belts characterised by the following vegetation:

Lauretum belt (up to 350 m): *Arbutus unedo* L., *A. andrachne* L., *Erica arborea* L., *Laurus nobilis* L., *Olea europea* L., *Quercus coccifera* L., *Phillyrea latifolia* L., *Juniperus oxycedrus* L. subsp. *oxycedrus*, *Pistacia terebinthus* L. subsp. *Palaestina* (Boiss.) Engler, *Cercis siliquastrum* L., subsp. *siliquastrum*, *Calicotome villosa* (Poiret) Link, *Spartium junceum* L., *Cistus creticus* L. and C. *salviifolius* L.

Castanetum belt (350–700 m): *Castanea sativa* L., *Quercus* spp., *Corylus avellana* L. var. *avellana*, *Crataegus monogyna* Jacq. subsp. *monogyna*, *Cornus mas* L. and *Rosa canina* L.

Fagetum belt (700–1500 m): *Fagus orientalis Carpinus betulus* L., *C. sativa* Miller, *Populus tremula* L., *Pinus nigra*, *Quercus* sp. Arn. subsp. *nigra* var. *caramanica* (Loudon) Rehder

Pinetum belt (1000–1200 m): *P. nigra* subsp. *nigra* var. *caramanica*, *F. orientalis* and *C. Betulus*

Abietum belt (1500–2100 m): *Abies nordmanniana* (Stev.) Spach subsp. *bornmuelleriana* (Matff.) Coode & Cullen, *Juniperus communis* L. var. *saxatilis* Pall., *Vaccinium myrtillus* L., *Prunus divaricata* Ledeb. var. *divaricata*, *Sorbus aucuparia* L., *Salix caprea* L.

Alpinetum belt (1900–2543 m): it can be distinguished as subalpine and alpine. This belt is characterized by hard cushion plant communities consisting of *Acatholimon ulucinum* (Willd. ex Schultes) Boiss. ssp. *ulucinum* var. *ulucinum*, *Astragalus ptilodes* Boiss. var. *ptilodes*, *Festuca punctoria* Sm. and *F. cyllenica* Boiss. The most of endemic plants are distributed in these areas (Kaynak et al., 2005, Güleryüz et al., 2005).

Two localities were situated in the Balıkesir province (Table 1). The specimens were collected in the agricultural landscape. The Kaymak area (Loc. 13) is a walnut field surrounded by a *Pinus nigra* forest. The Ova area (Loc. 19) is a field.

2. Materials and methods

The spiders were collected in 2006–2011 by the first author by means of hand collecting, sweeping dry leaves and grass. The study took place at 24 localities (Table 1) in Balıkesir and Bursa (Marmara region) (Figure 1). A total of 139 specimens were collected of which 14 species were recognised. Specimens were preserved in 70% ethanol and inspected under Leica EZ4 and Olympus SZX12 stereomicroscopes. The works of Tongiorgi (1966), Töpfer-Hofmann et al. (2000), Buchar and Thaler (2002), Heimer and Nentwig (1991) and Roberts (1996) were used for species identification. The taxonomy and general distribution of all species follows World Spider Catalog (2017). The material is deposited in the private collection of the first author. Faunistic data of each species are sorted according to collecting date and are provided in the following order: Number of locality (see Table 1) introduced by an acronym "Loc.": collecting date, number and sex of specimens.

Figure 1. The survey areas, Balıkesir and Bursa

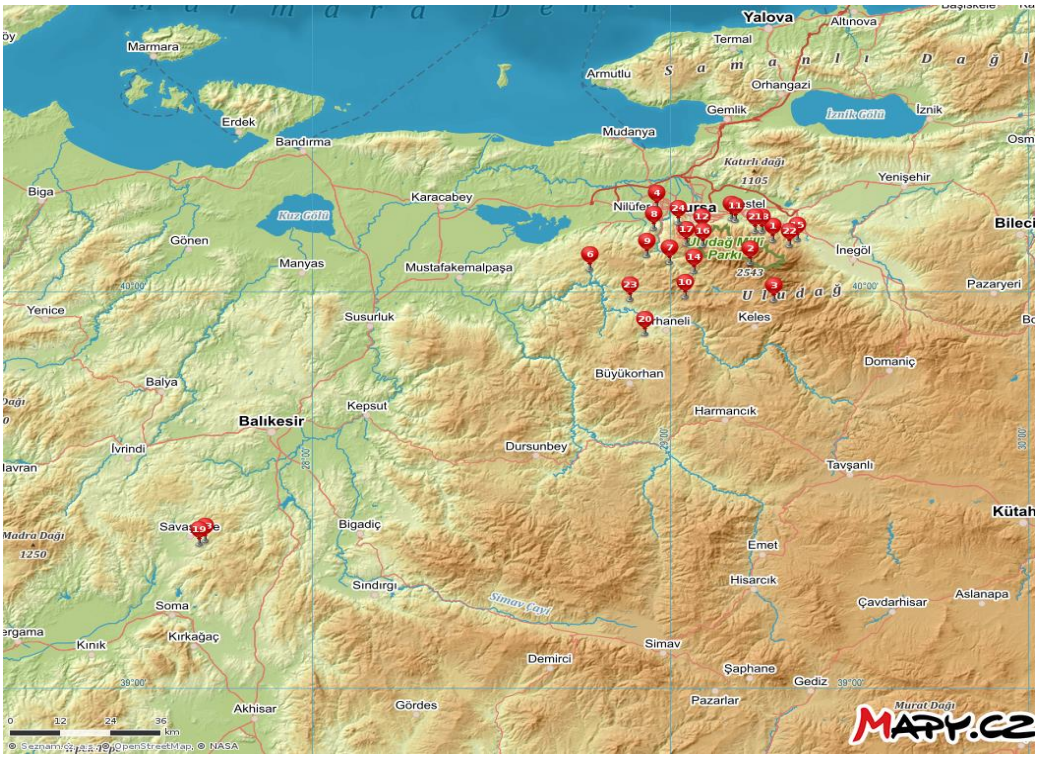

Figure 2. Localities in Bursa and Balıkesir provinces.

Table 1. The list of localities where the spiders have been collected.

NO	LOCALITIES	COORDINATES	ALTITUDE
1	Alaçam, Kestel, Bursa prov.	40°06'55"N, 29°17'17"E	770 m
2	Alpin zone, Uludağ Mountain, Bursa prov.	exact locality unknow	
3	Around the Baraklı Pond, Keles, Bursa prov.	39º58'35"N, 29º17'20"E	1271 m
4	Beşevler, Nilüfer, Bursa prov.	40º12'30"N, 28º57'44"E	138 m
5	Cumalıkızık, Yıldırım, Bursa prov.	40°10'53"N, 29°10'12"E	272 m
6	Near to Çınarcık dam, Orhaneli, Bursa prov.	40°03'18"N, 28°46'28"E	240 m
7	Dağakça village, Osmangazi, Bursa prov.	40º04'20"N, 28º59'53"E	346 m
8	Around the Dağyenice village pond, Bursa prov.	40°09'17"N, 28°57'17"E	366 m
9	Around the Doğanca dam, Nilüfer, Bursa prov.	40º05'20"N, 28º56'06"E	384 m
10	Around the Göynükbelen village, Orhaneli, Bursa prov.	39º59'09"N, 29º02'35"E	900 m
11	Hamamlıkızık, Bursa prov.	40°10'33"N, 29°10'53"E	304 m
12	Kadıyayla, Uludağ Mountain, plateau surrounded by forest, Bursa prov.	40º09'01"N, 29º05'19"E	1233 m
13	Kaymak area, Aşağıdanışment village, Savaştepe, Balıkesir prov.	39º22'17"N, 27º42'01"E	475 m
14	Keles road, 26. km, Bursa prov.	40°02'55"N, 29°03'57"E	556 m
15	Kozluören village, Inegöl, Bursa prov.	40º07'43"N, 29º21'17"E	480 m
16	Kirazlıyayla, Uludağ Mountain, Bursa prov.	40º06'50"N, 29º05'25"E	1522 m
17	About 3 km to National Park, Uludağ Mountain, Bursa prov.	40°07'04"N, 29°02'43"E	1175 m
18	Near to Osmaniye, Kestel, Bursa prov.	40°08'55"N, 29°15'24"E	619 m
19	Ova, Aşağı Danışment, Savaştepe, Balıkesir prov.	39°21'52"N, 27°41'09"E	439 m
20	Sadağı Canyon, Orhaneli, Bursa prov.	39º52'96"N, 28º55'49"E	443 m
21	Saitabat village, Kestel, Bursa prov.	40°08'58"N, 29°14'08"E	653 m
22	Sayfiye village, Inegöl, Bursa prov.	40°06'48"N, 29°19'56"E	874 m
23	After Setat Mining Büyükorhan road, Bursa prov.	39°58'43"N, 28°53'14"E	521 m
24	Around Yiğitali village, Osmangazi, Bursa prov.	40º10'10"N, 29º01'17"E	660 m

3. Results

Genus *Alopecosa* Simon, 1885

***Alopecosa albofasciata* (**Brullé, 1832)
Collected Material: Loc. 10: 07.05.2007, 1 ♂, 05.05.2008, 1 ♂; **Loc. 13**: 17.04.2010, 1 ♀, 30.06.2010, 2 ♀♀, 13.05.2011, 1 ♀; **Loc. 7**: 16.05.2010, 1 ♂, 1 ♀, 11.07.2010, 1 ♀; **Loc. 9**: 16.10.2010, 1 ♂, 01.05.2011, 2 ♀♀, 23.04.2011, 1 ♂; **Loc. 8**: 08.05.2011, 3 ♀♀; **Loc. 23**: 09.05.2011, 2 ♀♀, 2 ♂♂. (Collected under stones and on herbs.)
Distribution: Mediterranean to Central Asia

Alopecosa farinosa (Herman, 1879)
Collected Material: Loc. 16: 23.04.2006, 1 ♂; **Loc. 17**: 23.04.2006, 1 ♀; **Loc. 5**: 11.07.2006, 1 ♀; **Loc. 1**: 02.05.2007, 2 ♂♂, 3.05.2007, 1 ♂, 1 ♀. (Collected on the ground or on herbs.)
Distribution: Palaearctic

Alopecosa pentheri (Nosek, 1905)
Collected Material: Loc. 24: 23.04.2006, 3 ♂♂; **Loc. 1**: 03.05.2007, 3 ♂♂; **Loc. 3**: 07.05.2007, 3 ♀♀. (Collected on the ground near water or under stones.)
Distribution: Albania, Bulgaria, Greece to Azerbaijan

Alopecosa pulverulenta (Clerck, 1757)
Collected Material: Loc. 1: 02.05.2007, 1 ♂, 4 ♀♀; **Loc. 4**: 10.05.2010, 1 ♀.
Distribution: Palaearctic

Genus: *Aulonia* C. L. Koch, 1847

Aulonia albimana (Walckenaer, 1805)
Collected Material: Loc. 22: 16.07.2006, 2 ♀♀; **Loc. 18**: 08.07.2007, 1 ♀.
Distribution: Palaearctic

Gen: *Geolycosa* Montgomery, 1904

Geolycosa vultuosa (C. L. Koch, 1838)
Collected Material: Loc. 9: 01.05.2011, 1 ♀. (Collected among herbs.)
Distribution: Southeastern Europe to Central Asia

Genus: *Hogna* Simon, 1885

Hogna radiata (Latreille, 1817)
Collected Material: Loc. 6: 13.07.2006, 3 ♀♀; **Loc. 14**: 26.07.2006, 2 ♀♀; **Loc. 15**: 20.06.2010, 4 ♂♂; **Loc. 19**: 01.07.2010, 1 ♂; **Loc. 7**: 11.07.2010, 1 ♂. (Collected under stones, on the ground or under dry herbs.)
Distribution: Central Europe to Central Asia, Iran, Central Africa

Genus *Pardosa* C. L. Koch, 1847

Pardosa atomaria (C. L. Koch, 1847)
Collected Material: Loc. 18: 03.06.2006, 1 ♂, 2 ♀♀; **Loc. 20**: 22.02.2007, 1 ♂; **Loc. 10**: 07.05.2007, 1 ♀. (Collected on herbs, near water or on the ground.)
Distribution: Balkans, Crete, Cyprus, Rhodes, Aegean Is.

Pardosa consimilis Nosek, 1905
Collected Material: Loc. 12: 23.07.2006, 2 ♀♀.
Distribution: Macedonia, Bulgaria, Turkey

Pardosa hortensis (Thorell, 1872)
Collected Material: Loc. 24: 23.04.2006, 6 ♀♀; **Loc. 16**: 23.04.2006, 1 ♀; **Loc. 18**: 1 ♀; **Loc. 2**: 08.07.2006, 1 ♀; **Loc. 11**: 11.07.2006, 1 ♀; **Loc. 21**: 02.05.2007, 1 ♀; **Loc. 1**: 02.05.2007, 24 ♀♀, 03.05.2007, 6 ♀♀; **Loc. 3**: 07.05.2007, 6 ♀♀; **Loc. 10**: 07.05.2007, 1 ♂; **Loc. 20**: 22.07.2007, 7 ♀♀, 02.06.2008, 1 ♀; **Loc. 9**: 01.05.2011, 1 ♀. (Collected on the ground, under stones or on herbs.)
Distribution: Palaearctic

Pardosa monticola (Clerck, 1757)
Collected Material: Loc. 2: 08.07.2006, 1 ♂, 2 ♀♀. (Collected on the ground.)
Distribution: Europe

Pardosa pertinax von Helversen, 2000
Collected Material: Loc. 16: 23.04.2006, 2 ♂♂; **Loc. 1**: 02.05.2007, 2 ♂♂; **Loc. 9**: 01.05.2011, 2 ♂♂. (Collected on herbs.)
Distribution: Greece, Turkey

Pardosa proxima (C. L. Koch, 1847)
Collected Material: Loc. 5: 11.07.2006, 1 ♀; **Loc. 11**: 11.07.2006, 1 ♂ (too small); **Loc. 1**: 02.05.2007, 1 ♀; **Loc. 9**: 01.05.2013, 4 ♀♀; **Loc. 8**: 08.05.2011, 1 ♀ (Collected on herbs.)
Distribution: Palaearctic, Canary Is., Azores

Genus: *Trabea* Simon, 1876

Trabea paradoxa Simon, 1876
Collected Material: Loc. 13: 25.07.2011, 1 ♀. (Collected on the ground in *Pinus nigra* forest.)
Distribution: Southern Europe, Turkey

4. Conclusions and discussion

In total, 14 species from six genera have been registered in this study, *Trabea paradoxa* for the first time in Anatolia. The genus *Pardosa* exhibited the largest number of species (five species). *Pardosa hortensis* was the most widespread species in the surveyed area. *Aulonia* is small genus and up to now, only two species [*Aulonia albimana* (Walckenaer, 1805) and *Aulonia kratochvili* Dunin, Buchar and Absolon, 1986)] are known in Turkey.

From a zoogeographic point of view, Turkey acts as a connection between European lowlands and Mediterranean basin on the one hand, and two Asian mountain ranges: the Caucasus and the Iranian Plateau on the other hand. Thus, spiders occurring in Turkey may have affinities to all these zoogeographical regions. However, the species recorded in this study have affinities mainly to Europe. Almost all wolf spider species (except *A. pentheri*, *P. consimilis* and *P. pertinax*) recorded in this study are the lowland species reaching to various parts of Europe (Buchar, 2009). *Alopecosa albofasciata*, *A. pentheri*, *G. vultuosa*, *H. radiata*, *P. atomaria*, *P. hortensis*, *P. proxima* and *T. paradoxa* are typical representatives of Mediterranean species. Of these, only *P. hortensis* reach up to central Europe and even to the British Islands (Buchar 1993). *Alopecosa farinosa*, *A. pulverulenta* and *A. albimana* are the extra-Mediterranean species; *P. monticola* is a temperate species, *P. pertinax* is a boreo-montane species (Buchar, 2009) and *A. pentheri* inhabit mountain ranges (Thaler et al., 2000; Buchar and Dolanský 2011). All of them, with the exception of *P. pertinax* and *A. pentheri*, are widespread in Europe (Buchar, 1993). On the other hand, *P. consimilis* was reported only from three countries (Macedonia, Bulgaria, Turkey).

To sum up, mostly widespread species were documented in this study. The most important records were those of *A. pentheri*, *P. consimilis*, *P. pertinax* and *T. paradoxa* because they are rare or less frequently found species. To date, the family Lycosidae contains 87 species in 15 genera in Turkey. In this study, *A. farinosa*, *A. albimana*, *P. consimilis*, *P. hortensis* and *P. monticola* are the first records for the Marmara region in Turkey.

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References

Blagoev, G., Deltshev, C., Lazarov, S., Naumova, M. (2018). The spiders (Araneae) of Bulgaria. Version: August 2018. National Museum of Natural History, Bulgarian Academy of Sciences. http://www.nmnhs.com/spiders-bulgaria/ (accessed on: 16.12.2018).

Bosmans, R., Chatzaki, M. (2005). A catalogue of the spiders of Greece. A critical review of all spider species cited from Greece with their localities. Arachnological Contributions. Newsletter of the Belgian Arachnological Society, 20(Suppl. 2), 1-124.

Buchar, J. (1993). Biogeographical relations of wolf spiders in Czechoslovakia and in Central Europe. Bolletino dell'Accademia Gioenia di Scienze Naturali, 26(345), 27-34.

Buchar, J. (2009). Distribution patterns of wolf spiders (Araneae: Lycosidae) along a transect from Greece to the Czech Republic. Contributions to Natural History, 12, 315-340.

Buchar, J., Dolanský, J. 2011. New records of wolf spiders (Araneae: Lycosidae) in the Mediterranean. Klapalekiana, 47, 5-11.

Buchar, J., Thaler, K. (2002). Über *Pardosa atomaria* (C. L. Koch) und andere *Pardosa*-Arten an Geröllufern in Süd- und Mitteleuropa (Araneae: Lycosidae). Linzer Biologische Beiträge, 34(1), 445-465.

Demir, H., Seyyar, O. (2017). Annotated Checklist of the Spiders of Turkey. Munis Entomology & Zoology, 12(2), 433-469.

Güleryüz, G., Malyer, H., Kaynak, G., Özhatay, N. (2005). Uludağ A2 (A) Bursa. Bölüm 18. In: Türkiye'nin Önemli Bitki Alanları (ÖBA). Eds: Özhatay, N., Byfield, A., Atay, S. WWF Türkiye (Doğal Hayatı Koruma Vakfı), İstanbul, 2005.

Gümuş, B. A., Neubert, E. (2009). The biodiversity of the terrestrial malacofauna of Turkey – status and perspectives. ZooKeys, 31, 105-117.

Gür, H. (2016). The Anatolian diagonal revisited: Testing the ecological basis of a biogeographic boundary. Zoology in the Middle East, 62(3), 189-199.

Heimer, S., Nentwig, W. (1991). Spinnen Mitteleuropas. Berlin: Verlag Paul Parey.

Kaya, R. S., Uğurtaş, İ. H. (2008). The Orb-weaver spiders (Araneae, Araneidae) of Uludağ Mountain, Bursa. Turkish Journal of Arachnology, 1(2), 160-165.

Kaya, R. S., Uğurtaş, İ. H. (2011). The cobweb spiders (Araneae, Theridiidae) of Uludağ mountain, Bursa. Serket, 12(4), 144-153.

Kosswig, C. (1955). Zoogeography of the Near East. Systematic Zoology, 4(2), 49-73 + 96.

Kaynak, G., Daşkın, R., Yılmaz, Ö. (2005). Bursa Bitkileri. Uludağ Üniversitesi, Kent Tarihi ve Araştırmaları Merkezi. Bursa.

Kunt, K. B., Yağmur, E. A., Kürşat, A. (2009). A new record for spider fauna of Turkey, *Stalagtia thaleriana* Chatzaki & Arnedo, 2006 (Araneae; Dysderidae). Biological Diversity and Conservation, 2(2), 45-49.

Otto, S. (2018). Caucasian spiders. A faunistic database on the spiders of the Caucasus Ecoregion. Database version 08.2018. http://caucasus-spiders.info (accessed on: 16.12.2018)

Roberts, M. J. (1996). Spiders of Britain and Northern Europe. London: Harper Collins Publishers.

Thaler, K., Buchar, J., Knoflach, B. (2000). Notes on wolf spiders from Greece (Araneae, lycosidae). Linzer Biologische Beiträge, 32(2), 1071-1091.

Tongiorgi, P. (1966). Italian wolf spiders of the genus *Pardosa* (Araneae, Lycosidae). Bulletin of the Museum of Comparative Zoology, 134(8), 275-334.

Töpfer-Hofmann, G., Cordes, D., von Helversen, O. (2000). Cryptic species and behavioural isolation in the *Pardosa lugubris* group (Araneae, Lycosidae), with description of two new species. Bulletin of the British arachnological Society, 11(7), 257-274.

Uyar, Z., Dolejš, P. (2017). New records and notes on some spiders (Araneae: Lycosidae, Salticidae, Theridiidae) from Turkey. Entomological News, 127(1), 51-63.

Uyar, Z., Kaya, R. S., Uğurtaş, İ. H. (2010). Systematics of philodromid spider fauna of Uludağ Mountain region (Araneae: Philodromidae) with a review of Philodromidae in Turkey. Serket, 12(2), 47-60.

Uyar, Z., Uğurtaş, İ. H. (2012). Jumping spiders (Araneae: Salticidae) of Northwest Anatolia (Turkey). Acta zoologica bulgarica, 64(3), 235-240.

Uyar, Z., Bosmans, R., Uğurtaş, İ. H. (2015). New localities of cobweb spiders (Araneae: Theridiidae) in West Anatolia, Turkey. Serket, 14(4), 202-208.

Zamani, A., Mirshamsi, O., Marusik, Y. M., Moradmand, M. (2017). The Checklist of the Spiders of Iran. Version 2018, Online at http://www.spiders.ir (accessed on: 16.12.2018).

World Spider Catalog (2018). World Spider Catalog. Natural History Museum Bern, version 19.5. http://wsc.nmbe.ch (accessed on: 12.12.2018).

Yılmaz, Z., Kaya, R. S., Uğurtaş, İ. H. (2009). The crab spiders (Araneae, Thomisidae) of Uludağ Mountain. Journal of Biological & Environmental Sciences, 3(7), 11-16.

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Research article/Araştırma makalesi

Characterization studies of *Onobrychis hypargyrea* Boiss

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Abstract

In characterization study of Onobrychis hypargyrea Boiss. ecotypes, collected from Eskişehir region; crops were evaluated by some criteria of Variety Registration and Seed Certification Center (VRSCM) and International Plant Genetic Resources Institute (IBPGR). Mean values in crops were found as 61.57±15.56 (cm) in flower crown diameter, 60.84±11.46 (cm) in main stem length, 0.81±0.11 (mm) in main stem width, 6.37±2.10 (number) in of main stem number, 5.33±1.54 (number) in auxiliary stem number, 22.15±6.23 (cm) in cluster length, 36.9±6.96 (mm) in leaflet length, 19.40±3.09 (mm) in leaflet width, 15.24±1.12 (mm) in fruit length, 12.83±1.09 (mm) in fruit width, 166.15±12.82 (days) in maturation date, 6.67±4.16 (%) in germination speed, 35.07±26.14 (%) in germination power, 45.96±11.17 (gr) in thousand seed weight, 292.02±157.05 (gr/crop) in total fresh hay yield, 78.69±37.55 (gr/crop) dry hay yield, 25.63±4.40 (%) in crude cellulose, 4.53±0.54 (%) in crude ash, 15.32±1.16 (%) in crude protein, 42.37±4.20 (%) in nitrogen free matter, 86.91±0.84 (%) in digestible protein, 84.81±0.66 (%) in organic matter, 1.50±0.39 (%) in crude oil, 89.39±0.37 (%) in dry matter. Cluster analysis revealed that, four maim groups and nine subgroups occurred. Besides, biplot analysis showed that, fresh hay yield in PC1 and flower crown diameter in PC2 are the most effective components. Fruit width, cluster height, flower crown diameter, fresh hay yield, auxiliary branch number, leaf length and width influenced PC1 and PC2 distributions in crops. Effects of components as % in PC1, PC2 and cumulative are 34.11, 22.62 and 55.73, respectively.

Key words: *Onobrychis, hypargyrea*, morphological, characterization, nutrien

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Onobrychis hypargyrea Boiss (Tüylü Korunga) karakterizasyonu çalışmaları

Özet

Eskişehir bölgesinden toplanan *Onobrychis hypargyrea* Boiss. ekotiplerinin karakterizasyonu çalışmasında; Tohumluk Tescil Sertifikasyon Test Merkezi Müdürlüğü (TTSTMM) ve International Plant Genetic Resources Institute (IBPGR) 'nin bazı kriterleri üzerinden tekerrürsüz, sıra arası 1 m ve her sırada 10 adet bitki olacak şekilde müşahedeler alınmıştır. Buna göre: Taç Çapı (cm) ortalama 61.57±15.56, Ana Sap uzunluğu (cm) ortalama 60.84±11.46, Ana Sap Kalınlığı (mm) ortalama 0.81±0.11, Ana Sap Sayısı (adet) ortalama 6.37±2.10, Yan Dal Sayısı (adet) ortalama 5.33±1.54, Salkım Boyu (cm) ortalama 22.15±6.23, Yaprakçık Boyu (mm) ortalama 36.9±6.96, Yaprakçık Eni (mm) ortalama 19.40±3.09, Meyve Boyu (mm) ortalama 15.24±1.12, Meyve Eni (mm) ortalama 12.83±1.09, Tohum Olgunlaştırma Tarihi (gün) ortalama 166.15±12.82, Çimlenme Hızı (%) ortalama 6.67±4.16, Çimlenme Gücü (%) ortalama 35.07±26.14, Bin Meyve Ağırlığı (gr) ortalama 45.96±11.17, Toplam Yaş Ot Verimi (gr/bitki) ortalama 292.02±157.05, Toplam Kuru Ot Verimi (gr/bitki) ortalama 78.69±37.55, Ham Selüloz (%) ortalama 25.63±4.40, Ham Kül (%) ortalama 4.53±0.54, Ham Protein (%) ortalama 15.32±1.16, Nitrojensiz Öz Maddeler (%) ortalama 42.37±4.20, Hazmolunabilir Protein (%) ortalama 86.91±0.84, Organik Madde (%) ortalama 84.81±0.66, Ham Yağ (%) ortalama 1.50±0.39 ve Kuru Madde (%) ortalama 89.39±0.37 olarak belirlenmiştir. Ekotiplerin dendogramik gruplamasında, dört ana gurup ve dokuz alt gurubun oluştuğu, benzerliklerin alt guruplarda % 98 seviyelerinden başlayıp ana guruplardaki benzerliklerin ise % 98,04 den fazla olduğu görülmektedir. Bitkilerin bipolt analizinde PC1 yaş ot toplam verimi, PC2 ise taç çapı olup, Principal component vektörleri incelendiğinde etkili olan özellikler meyve eni, salkım boyu, taç çapı, yaş ot toplam verimi, yan dal sayısı, yaprak boyu, yaprak eni olup, PC1 ve PC2 değerleri bitkilerin dağılımını etkilemiştir. PC1'in tek başına dağılımın % 34.11' ini izah etmekte olup, PC2 ise dağılımı % 22.62, PC1 ve PC2 'nin toplamı ise % 55.73 oranında açıklık getirmiştir.

Anahtar kelimeler: *Onobrychis, hypargyrea*, morfolojik, karakterizasyon, besin madde

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1. Giriş

Dünya'da Fabaceae familyası içerisinde 162'dan fazla cinsi tanımlanmış olup (Boissier, 1872; Sirjaev, 1925a,b,1926; Bal1, 1968; Hayek, 1970; Hedge, 1970b; Mouterde, 1970; Schischkin and Bobrov, 1972a,b; Townsend, 1974; Meikle, 1977; Rechinger, 1984; Tan and Sorger, 1986; Zohary, 1987; Davis vd., 1988; Duman ve Vural, 1990), bu yabani korungaların Baltık Denizi'nden Akdeniz, Ön Asya ve Sibirya'ya kadar uzanan çok geniş bir alana yayıldıkları, özellikle Anadolu İran- Kafkasya üçgeninde yoğunlaşıp çeşitlendikleri bildirilmiştir. Bu bölgelerden İran'da 53 türden 32'si (% 60.4), Türkiye'de 52 türden 27'si (% 51.9) ve Kafkasya'da 39 türden 21'i (% 53.4) endemik

olup İber yarımadasında ise sadece 8 tür bulunmaktadır (Boissier, 1872; Ball, 1968; Hedge, 1970b;

Mouterde, 1970; Schischkin and Bobrov, 1972a,b; Meikle, 1977; Rechinger, 1984; Zohary, 1987; Yıldız et al. 1999, Emre vd., 2007).

Yetiştikleri bölgelerin sıcaklık, yağış, kuraklık, tuzluluk, hastalık ve zararlılar gibi çeşitli çevresel koşullarına yüzyıllardan beri uyum sağlamış türlerden oluşan bu gen kaynakları, gen çeşitliliği bakımından oldukça zengindir (Hart, 2001). Türkiye'de yalnızca baklagillere ait 900 türün varlığı ve bunlardan 46 türün korunga (*Onobrychis* L.) olduğu (Harlan, 1951; Davis, 1970; Yaltırık, 1989) belirlenmiştir. Davis'e (1970) göre; belirlenen 46 türün *Dendrobrychis, Lophobrychis, Hymenobrychis, Heliobrychis, Onobrychis* seksiyonlarında yer aldığını, Yıldız vd., (1999) ise Anadolu'da yoğun olarak 52 tür ve bu türlerin de *Dendrobrychis, Lophobrychis, Hymenobrychis, Heliobrychis* ve *Onobrychis* seksiyonlarında yer aldığını, Avcı ve Kaya (2013) ise çalıştıkları 35 türün *Lophobrychis, Hymenobrychis, Heliobrychis* ve *Onobrychis* seksiyonlarına dâhil olduğunu bildirmişlerdir. Elçi (1954), Anadolu'nun önemli yem bitkilerinden olan korunga bitkisinin bazı türleri üzerinde (*Onobrychis cana* Boiss., *Onobrychis arenia* (Kit.) Dc., *Onobrychis arenaria* (Kit.) (yabani form) ve *Onobrychis armena* Boiss.) morfolojik ve biyolojik çalışmalar yapmıştır. Bu çalışmada; ele alınan korunga türleri üzerinde farklı devrelerde (çiçeksiz, çiçekli ve meyveli) sap, yaprak, çiçek ve meyve özellikleri gibi bazı morfolojik karakterler incelenmiştir.

Eski çağlardan beri yetiştirilmekte olan korunga, ülkemizin de yer aldığı Yakın Doğu florasında yaygın olan bir bitki türüdür. Türkiye'de yonca, mercimek, fiğ ve üçgül türleri ile birlikte korunga için de mikro gen merkezlerini içermektedir (Harlan, 1951). Korunganın 450 yıldan daha fazla bir süredir Asya ve Avrupa'nın bazı bölümlerinde kültürü yapıldığı bilinmektedir (Hybner, 2013).

Fabaceae familyası, *Onobrychis adan*s cinsi içerisinde bulunan *Onobrychis hypargyrea* Boiss. Gümüş renkli korunga bildirilmiştir (Anonim, 2017b). *O. hypargyrea'* da kromozom sayısı 2n = 14 olarak bildirilmiştir (Akçelik vd., 2012). Çok yıllık otsu bir bitki olup nisan-haziran ayları arasında çiçeklenen, kayalık yamaçlar, özellikle kireçtaşı, nadas tarlaları, meşe çalılıklarında, 300-1200 m' de yetiştiği (Anonim, 2007a) ve toplama esnasındaki tespitlerimizde ise killi yamaçlarda ve kayalık alanlarda bulunduğu gözlenmiştir. Ülkemizde yayılış alanları ise Davis (1969) göre; A2, A4, A5, B2, B3, B4, C2, C3, C4 karelerinde, İstanbul, Çankırı, Kastamonu, Ankara, Antalya, Bilecik, Isparta, Konya, Manisa illerinde bulunduğu belirtilmektedir (Anonim. 2007a).

Fransızca sain ve foin kelimelerinin birleşmesinden oluşan sainfoin sağlıklı yem manasına gelmektedir (Sottıe, 2014). Korunga, potansiyel olarak uzun ömürlü, çok sayıda dik veya yarı dik gelişen, içi boş saplı ve uzunluğu 100 cm'ye ulaşan uzun ömürlü bir baklagildir (Frame, 2005).

Onobrychis hypargyrea Boiss. otsu çok yıllık bir bitki olup, yetişme ortamı ve yükseklik: taşlı ve kalkerli yamaçlar, çayırlıkla, step orman açıklığı, jipsli yamaçlardır (Akçelik, 2009). Korunganın orijini Türkiye, İran ve Avrupa olup, ilk defa Fransa'nın kuzeyinde (Delgado, 2008) ve İngiltere'de kültüre alınmıştır (Koivisto vd., 2001). Bilinen yayılış alanları ise ılıman Avrupa olarak bilinen İsveç, Asya, Akdeniz ülkeleri ve kuzey batı Amerika'dır. Korunga, çimlenme ve erken çıkış için diğer baklagillerden daha geniş bir optimum sıcaklık aralığına sahiptir (Smoliak et al., 1972). *O. hypargyrea* Boiss.'in hemikriptofit bir bitki olduğunu Özaydın ve Yücel (2004) bildirmişlerdir. Tarman (1954)' a göre*; Onobrychis cana, Onobrychis armena, Onobrychis hypargyrea*' nın Türkiye'nin kurak ve dağlık bölgelerinde yetiştiğini bildirmiştir.

Derin, iyi drene edilmiş kalkerli topraklarda iyi performansı vardır. 6.0 pH seviyesindeki topraklar ve nemli sıcak iklimlerde fide büyümesi güçlüdür (Frame et al., 1998). Kurağa ve soğuğa toleranslıdır. Toprağa azot bağlayarak azot rezervlerini temin eder. Toprağa azot fikse ettiğinden yeşil gübre olarak kullanılabilir. Terk edilmiş alanlarda ve yamaç alanlar gibi sorunlu alanlarda tohumlamak suretiyle çölleşmeyi ve erozyonu önleyerek toprağı zenginleştirir. Çiçekleri, arıları ve kuşları cezbederek biyoçeşitliliği arttırır (Waghorn, 2008).

Tan ve Iatrou (1996); *Onobrychis aliacmonia* RECH.f.'nın yeni bir tür olarak çizimini yaparken *Onobrychis hypargyrea* Boiss. bir Anadolu türünün en güneydeki Yugoslavya'ya kadar uzandığını ve yıllar sonra Rechıngerr (1973) tarafından *Onobrychis aliacmonia* RECH.f.'nın farklı bir tür olduğunu bildirmişlerdir.

Bazı bitkilerin yağ asitlerinin belirlenmesi çalışmasında Bagci vd., (2004) Stearik asitin *Onobrychis hypargyrea*'da (%4.20), oleik ve linoleik asitin (% 34.4) ve tokochanolanol analizi yüksek tokotrienol içeriğinin (% 65.6),tokoferoller, tokotriyenler ve plastokinonlar, tokrokromanoller olarak bilinen (Seher ve İvanov, 1973; Velasco et al., 2000) ve E vitamini aktivitesi sergileyen doğal tokoferollerin potansiyel kaynakları olarak *Onobrychis hypargyrea'* da bolca bulunduğu bildirilmiştir.

2. Materyal ve yöntem

2014 yılında Eskişehir'in 241-358 m arası yüksek mera, mezarlık, taşlı eğimli, toprak yapısı killi mera ve terk edilmiş tarla alanlarından toplanan 27 *Onobrychis hypargyrea* Boiss. tek bitki örneklerinin karşılaştırılması yapılmış olup, karakterizasyon kriterleri olarak Tohumluk Tescil Sertifikasyon Test Merkezi Müdürlüğü (TTSTMM) ve International Plant Genetic Resources Institute (IBPGR) 'nin bazı kriterleri üzerinden gerçekleştirilmiştir. Bitkiler

tekerrürsüz, her sırada 10 adet bitki ve sıra arası 1 m olacak şekilde fide halinde ekilmişlerdir. Kültürel işlemlerde, ekimden önce 3 kg/da azot ve 6 kg/da fosfor verilmiştir. Yabancı otlarla mücadele için çıkış yapan otlar ROUNDUP STAR (441 g/lt Glyphosate potasyum tuzu) adlı total herbisit 600 ml/da hesabıyla kimyasal ilaç kullanılmıştır. Yabancı otlarla özellikle tesis yılında ve daha sonraki yıllarda mücadele yapılmıştır. Fideler şaşırtılırken damlama sulama yapılmıştır.

İncelenen özellikler: gözlemler hasattan önce ve her sırada bulunan 10 adet bitki üzerinde yapılmıştır. Ortalamalar alınarak değerlendirilmiştir. Çiçeklenme gün sayısı (gün), ana sap uzunluğu (cm), ana sap kalınlığı (mm), ana sap sayısı (adet), çiçek rengi, yatma durumu (1-5), taç çapı(cm), yan dal sayısı (adet), salkım boyu (cm), yaprakçık boyu (mm), yaprakçık eni (mm), meyve boyu (mm), meyve eni (mm), tohum olgunlaştırma tarihi (gün), çimlenme hızı (%), çimlenme gücü (%), bin meyve ağırlığı (gr), toplam yaş ot verimi(gr/bitki), toplam kuru ot verimi (gr/bitki), biçim sayısı (adet), seyrekleşme oranı (%), kışa dayanıklılık (%), kuru madde(%), ham kül (%), ham yağ (%), ham protein (%), ham selüloz (%), nitrojensiz öz madde (%), hazmolabilir ham protein (%), organik madde (%) olarak alınmıştır. *Onobrychis hypargyrea* Boiss.'in eko tiplerine ait besin madde analizleri ise Near Infrared Reflektans Spektroskopisi (NIRS) teknolojisi kullanılarak yapılmıştır. Örneklerin temel istatistikleri (MS Excel), Dağılım dendogramları Minitab 17 paket programı, Ana birleşenler analizleri ise GenStat (VSN International) paket programları kullanılarak yapılmıştır.

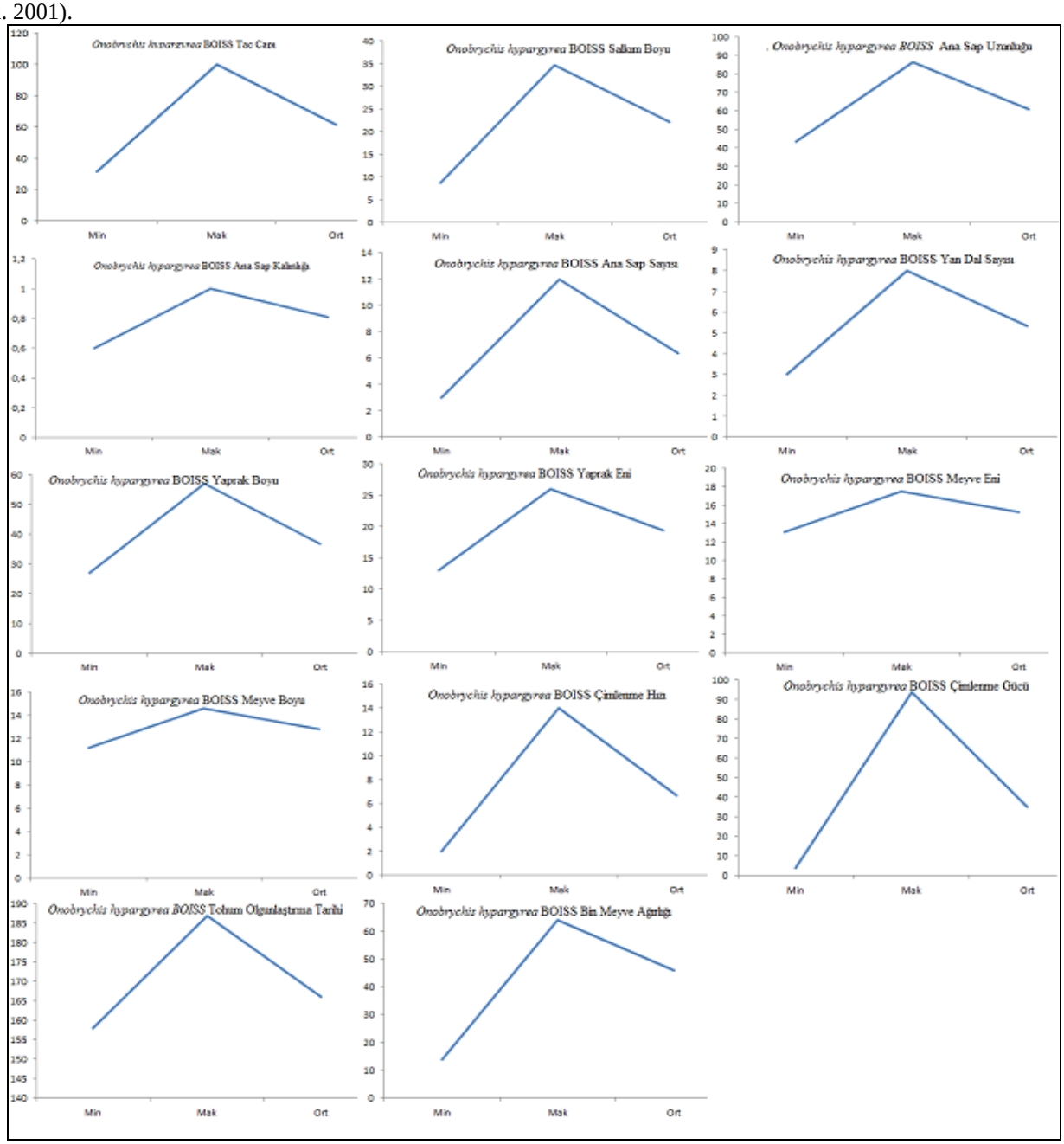
3. Bulgular

Hymenobrychis De. seksiyonunda yer alan (8) türden birisi olan *Onobrychis hypargyrea* Boiss.'in çiçeklenme gün sayısı ortalama 147 gün, çiçek rengi kirli beyaz renkte olup, dik gelişen bir yapıdadır. Yağışa bağlı olarak 2 ve 3 kez biçilme ve otlatma durumu söz konusudur. Gözlem süresince bitkilerde herhangi bir hastalık ve zararlıya rastlanmamıştır. *Onobrychis hypargyrea* Boiss.'in incelenen kriterlerine ait minimum, maksimum ve ortalama değerler Tablo 1'de verilmiştir.

Tablo 1. *Onobrychis hypargyrea* Boiss.'in incelenen kriterlerine ait minimum, maksimum ve ortalama değerler

İncelenen Kriterler	Minimum	Maksimum	Ortalama
Taç Çapı (cm)	31.70	100.00	61.57±15.56
Ana Sap uzunluğu (cm)	43.3	86.63	60.84±11.46
Ana Sap Kalınlığı (mm)	0.6	10.00	0.81±0.11
Ana Sap Sayısı (adet)	3.00	12.00	6.37±2.10
Yan Dal Sayısı (adet)	3.00	8.00	5.33±1.54
Salkım Boyu (cm)	8.70	34.70	22.15±6.23
Yaprakçık Boyu (mm)	27.00	57.00	36.9±6.96
Yaprakçık Eni (mm)	13.00	26.00	19.40±3.09
Meyve Boyu (mm)	13.01	17.50	15.24±1.12
Meyve Eni (mm)	11.20	14.60	12.83±1.09
Tohum Olgunlaştırma Tarihi (gün)	158.00	187.00	166.15±12.82
Çimlenme Hızı (%)	2.00	14.00	6.67±4.16
Çimlenme Gücü (%)	4.00	94.00	35.07±26.14
Bin Meyve Ağırlığı (gr)	13.80	64.00	45.96±11.17
Toplam Yaş Ot Verimi (gr/bitki)	85.30	670.70	292.02±157.05
Toplam Kuru Ot Verimi (gr/bitki)	21.00	167.00	78.69±37.55
Ham Selüloz (%)	19.61	34.13	25.63±4.40
Ham Kül (%)	3.67	5.35	4.53±0.54
Ham Protein (%)	13.65	17.62	15.32±1.16
Nitrojensiz Öz Maddeler (%)	34.35	49.10	42.37±4.20
Hazmolunabilir Protein (%)	85.23	88.36	86.91±0.84
Organik Madde (%)	83.51	86.23	84.81±0.66
Ham Yağ (%)	0.92	2.33	1.50±0.39
Kuru Madde (%)	88.82	89.91	89.39±0.37

Dünyada mevcut korunga türlerinin morfolojik yapılarını ve tarımsal özelliklerini ortaya çıkarmaya yönelik çok az çalışma mevcuttur. Dünyada ve Türkiye'de yapılan çalışmalar genellikle tarımsal önemi olan korunga türlerinin morfolojik özelliklerini incelemeye yönelik yapılmıştır (Avcı, 2010). Türlerin tanımlanmasında ilk dikkate alınan ölçütlerin morfolojik karakterler olup, genellikle dominanttırlar, analizleri çok kolaydır, olumsuz yanlarından bazıları ise heterozigotları belirleyemezler, mutasyonlarla oluşmuş olabilirler, çevresel faktörlerden etkilenirler (Parmaksız, 2004). Bitkinin agronomik özelliklerinden kök yapısının derin olması bitkinin kuraklığa karşı dirençli olması ve içerdiği değerli protein ve hayvanlarda şişime yapmayan özellikleri ile bitkiyi değerli kılmaktadır (Ahuja et al., 1983; Koivisto vd. 2001).

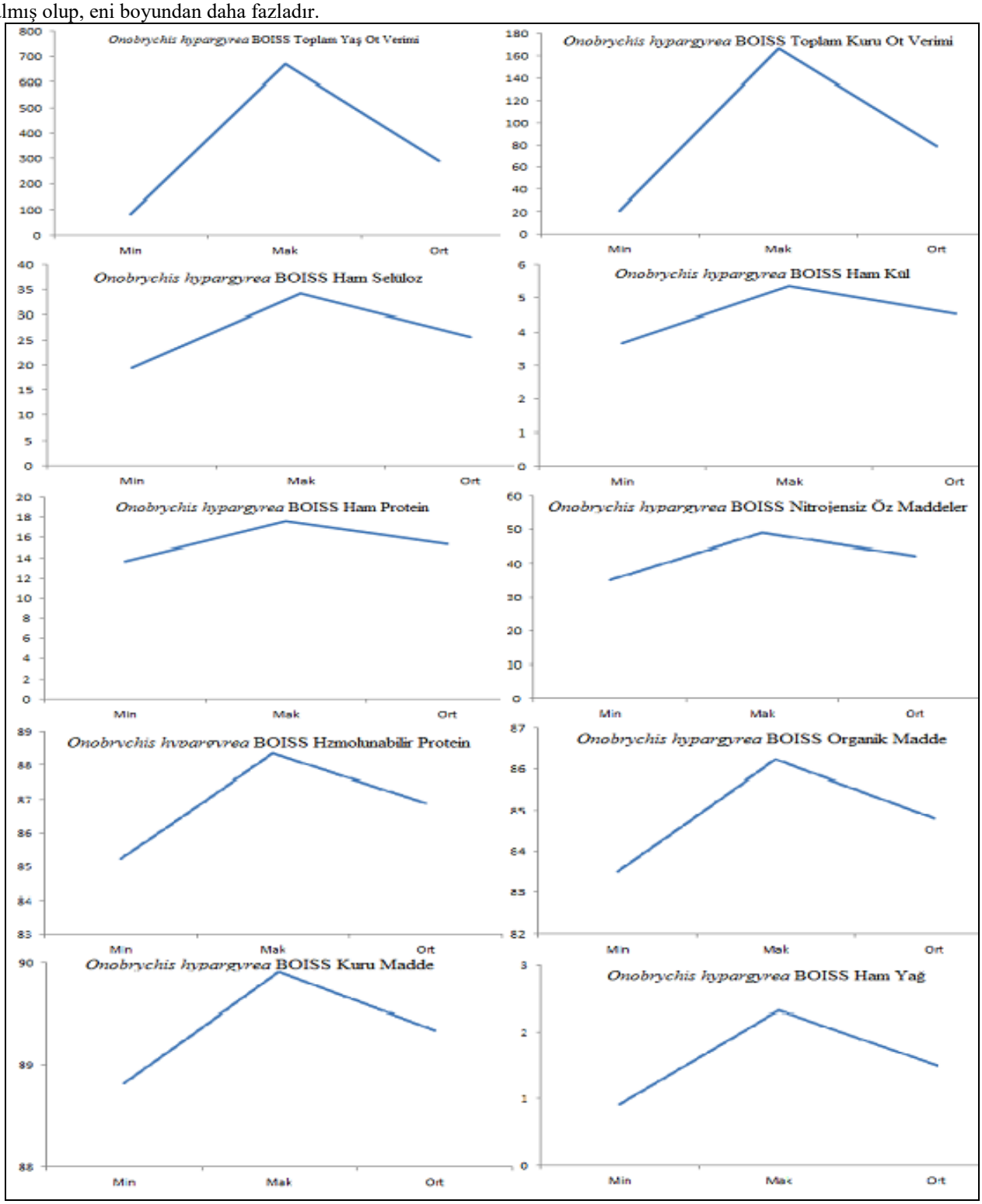


Şekil 1**.** *Onobrychis hypargyrea* Boiss.'in morfolojik özellikleri minimum, maksimum ve ortalama verimleri.

2014 yılında yapılan karakterizasyon çalışmasında bitkinin dik geliştiği, taç çapının 31.70-100, ortalama 61.57 cm olarak belirlenmiş olup, salkım boyu ise 8.70-34.70 ortalama 22.15 cm olarak ölçülmüştür. Çiçeklenme gün sayısı tüm tek bitkilerde 147 gün olarak tespit edilmiş olmakla birlikte, çiçeklenme uzun sürmekte olup, alttan yukarıya doğru bitki büyüdükçe devam etmektedir. Çiçek durumu seyrek, çok çiçekli olup, çiçeklenme meyve dönemine kadar uzar. Korolla açık sarı veya krem rengi, genellikle kırmızı damarlı, bazen damarsız, çiçeklenme zamanı nisandır (Akçelik, 2009). Tozlaşma genellikle bambus arıları tarafından yapılmakta olup, bunun nedeninin çiçeklerinin büyük olması ve göz alıcı olmasından kaynaklandığı sanılmaktadır. Korunga, çimlenme ve erken çıkış bakımından diğer baklagillerden daha geniş bir optimum sıcaklık aralığına sahiptir (Smoliak et al., 1972). Bitkinin dik gelişen, en çok 70 cm boyunda

olduğu bildirilmektedir (Akçelik, 2009). Ana sap sayısı ise minimum 3 adet, maksimum 12 ve ortalama 6 adet olarak sayılmıştır. Bitkide yan dal sayısı minimum 3 adet, maksimum 8 ve ortalama 5 adet olarak belirlenmiştir.

Yaprakçık boyu ise; minimum 27.0 mm, maksimum 57.0 mm ve ortalama 36.9 mm, yaprakçık eni minimum 17.0 mm, maksimum 26.0 mm ve ortalama ise 19.4 mm olarak ölçülmüştür. Avcı (2010), yaprakçık eni 22.39 mm, yaprakçık boyu 41.11 mm, dal uzunluğu 83.45 cm, salkım boyu 8.62 cm, meyve boyu 2.59 ve meyve eni 6.39 mm olarak bildirmiştir. Meyve eni minimum 13.10 mm, maksimum 17.50 ve ortalama 15.24 mm, meyve boyu ise minimum 11.20 mm, maksimum 14.60 ve ortalama 12.83 mm olarak belirlenmiştir. Bitkinin meyve yapısı enine yassı bir şekil almış olup, eni boyundan daha fazladır.



Şekil 2. *Onobrychis hypargyrea* Boiss.'in ot verimi ve besin madde içerikleri minimum, maksimum ve ortalama verimleri

Çimlenme hızı ise % 2-14 arasında değişmiş olup ortalama % 6.67 olmuştur. Çimlenme gücü ise % 4-94 arasında değişmiş, ortalama ise 35.00 olmuştur. Yabanilik özelliği gösteren bitkilerde çimlenme hızı ve gücü düşük olmuştur. İncelenen popülasyonlar içerisinde yaş ot verimi olarak 27 bitkinin tamamının bir kez biçildiği, buna göre birinci biçimin 85.30- 606.70 g/bitki, ortalama olarak ise 263.46 g/bitki olarak tespit edilmiştir. İkinci biçim olarak ise 16 bitki ikinci kez biçime gelmiş, buna göre 19 -70 g/bitki arasında olup, ortalama 48.19 g/bitki olarak belirlenmiş olup toplam yaş ot verimleri ise 85.30 – 670.70 g/bitki, ortalama ise 292.02 g/bitki olarak tespit edilmiştir.

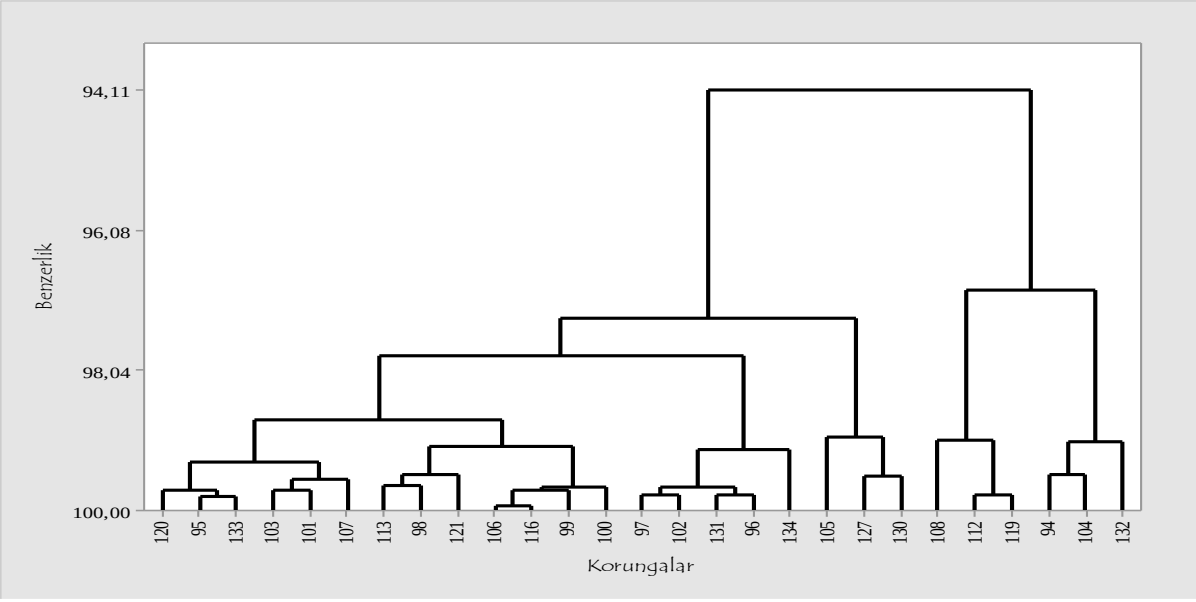
Kuru ot verimleri incelendiğinde ise; 21.00-143.00 g/bitki, ortalama ise 66.02 g/bitki olarak tespit edilmiştir. Toplam kuru ot verimi ise; 21.00-167.00 g/bitki, ortalama ise 78.69 g/bitki olarak belirlenmiştir. 11 popülasyon bir kez, 16 popülasyon ise 2. ve 3. kez biçime gelmiş olup, üçüncü biçimler ihmal edilecek kadar az olmuş ancak bitki biçim sonrası o yıl ki yağışın etkisiyle yeniden sürmüştür. Bitkinin kışa dayanıklılığı incelendiğinde ise 9 popülasyonun % 100 dayanıklı olduğu, 8 bitkinin % 90 dayanıklılık gösterdiği, 4 popülasyonun % 80-90 arasında, 4 popülasyonun % 70 ve 1 popülasyonun ise % 40 civarında kışa dayanıklılık gösterdiği belirlenmiştir. Bunun tersi ise seyrekleşme oranlarıdır. Tohum olgunlaştırma tarihi ise 158-187 gün arasında değişiklik göstermiş olup ortalama 187 gün olarak tespit edilmiştir. Bin meyve ağırlığı ise tohumdan yapılmış olup 13.80-64.00 arasında, ortalama 45.96 gr olarak tespit edilmiştir. Avcı (2010), tarafından bildirilen değerlere yakın değerler elde edilmiştir. Meyve zamanı ağustos ayı olup, Meyve yuvarlaktan böbreksiye kadar, gençken tüylü, olgunlaştıkça tüyler dökülür; kenar çok kısa dişli veya hemen hemen tam kenarlı; disk kısa ve sert dikenli veya dikensizdir (Akçelik, 2009).

Bitkilerde organik madde ise % 83.51-86.23, ortalama ise % 84.81olarak belirlenmiştir. Hazmolunabilir protein açısından bakıldığında ise % 85.23-88.36, ortalama ise % 86.91 olarak tespit edilmiştir.

Nitrojensiz öz madde olarak % 34.35-49.10, ortalama ise % 42.37 olarak belirlenmiştir. Ham protein olarak ise; % 13.65-17.62, ortalama % 15.32 olarak tespit edilmiştir.

Kuru madde içeriklerine bakıldığında; % 88.82-89.91 arasında, ortalama % 89.39 olarak belirlenmiştir. Ham Kül ise %3.67-5.35, ortalama % 5.53 olarak tespit edilmiştir.

Karakterizasyonu yapılan popülasyonlardan ortalamanın üstünde veya kontrol çeşitleri geçen bitkilerde ileri safhalarda ıslahta kullanılma imkanları değerlendirilirken yine TTSM kriterlerinden besin madde analizleri yapılmış olup buna göre Onobrychis hypargyrea Boiss. bitkilerinde ileri ıslahta değerlendirilmesi uygun olan bitkilerde de teknolojik değerler olarak belirlenen besin madde analizleri sonuçlarının değerlendirilmesinde; ham selüloz değerleri % 19.61-34.13, ortalama ise %25.63, ham kül değerleri% 3.67-5.65, ortalama % 4.53 olarak tespit edilmiştir. % kuru madde ise su uçurulduktan sonra geriye kalan kısım olarak 88.20-89.91, ortalama ise 89.34 olarak bulunmuştur. Yemlerde en önemli kısım olan ham protein ise % 13.65-17.62 arasında değişirken ortalama % 15.32 olmuştur. Ham yağ ise % 0.92-2.33 arasında iken ortalama % 1.50 olarak belirlenmiştir. Yukarıda belirlenen sonuçlar Kaplan (2001) ve Avcı (2010) ile benzerlik göstermektedir.



Şekil 3. *Onobrychis hypargyrea* Boiss.'in dağılım dendogramı

Şekil 3 incelendiğinde, dört ana gurup, onun altında ise dokuz alt gurubun oluştuğu, benzerliklerin alt guruplarda % 98 seviyelerinden başlayıp ana guruplardaki benzerliklerin ise % 98,04 den fazla olduğu görülmektedir. Bitkilerin Biplot analizinde PC1 Yaş ot toplam verimi, PC2 ise taç çapı olup, Principal component vektörleri

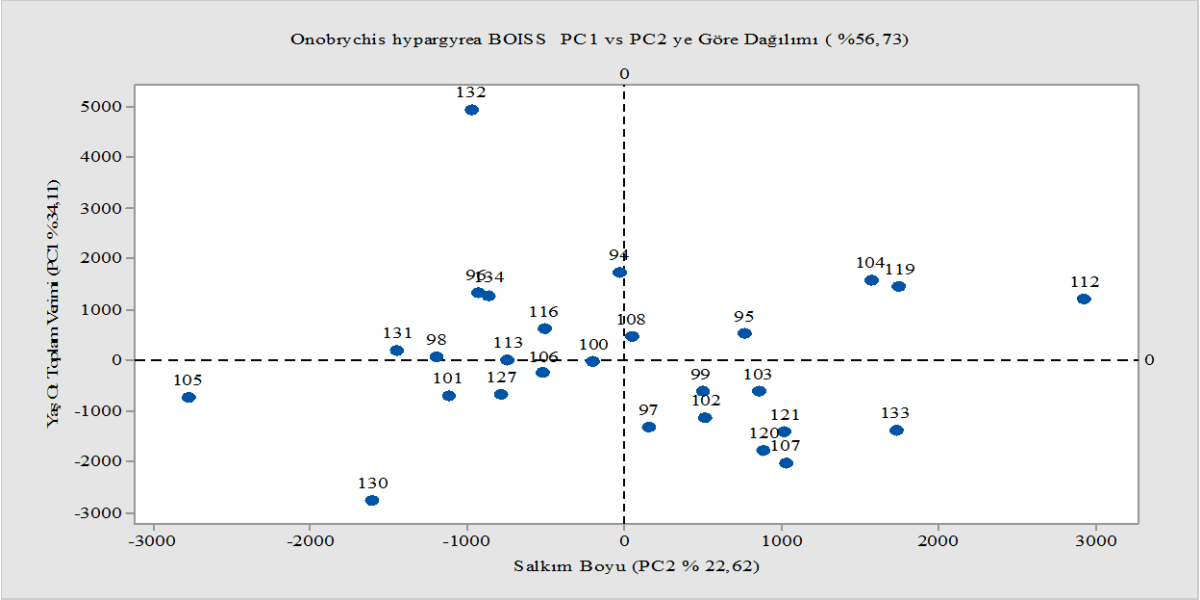
incelendiğinde etkili olan özellikler Meyve eni, Salkım boyu, Taç çapı, yaş ot toplam verimi, Yan dal sayısı, Yaprak boyu, Yaprak eni olup, PC1 ve PC2 değerleri bitkilerin dağılımını etkilemiştir. PC1 in tek başına dağılımın % 34.11' ini izah etmekte olup, PC2 ise dağılımı % 22.62, PC ve PC2 'nin toplamı ise % 55.73 oranında açıklık getirmiştir. Yapılan Biplot analizi neticesinde grafiğin pozitif tarafında bulunan eko tiplerin incelenen değerler bakımından daha stabil olduğu belirlenmiş olup, ıslah amaçlı bitki seçiminde kullanılabilecekleri belirlenmiştir. Yabani olmaları nedeniyle tür içerisinde dahi farklılıklar olduğu belirlenmiştir.

Tablo 2. *Onobrychis hypargyrea* Boiss. Principal Component Vektörleri

pcpsave['data']	PC1	PC2
Meyve Eni	-0.28497	0.12778
Salkım Boyu	0.14962	0.41561
Taç Çapı	0.48417	0.33597
Yaş Ot Toplam Verimi	0.50362	0.17233
Yan Dal Sayısı	0.40152	0.14775
Yaprak Boyu	0.45662	-0.44411
Yaprakçık Eni	0.19657	-0.67030

Tablo 3. *Onobrychis hypargyrea* Boiss. Principal Component Değerleri

PC1	PC2	PC1	PC2
-1.773	0.886	0.635	-0.513
0.459	0.045	-0.597	0.852
-0.743	-2.778	-1.379	1.731
-1.325	0.158	1.588	1.569
-0.667	-0.786	1.326	-0.940
-0.006	-0.745	4.946	-0.976
-1.123	0.517	-0.704	-1.123
1.286	-0.861	1.222	2.925
0.534	0.761	-0.021	-0.203
-0.255	-0.517	-0.620	0.492
-1.402	1.019	-2.036	1.022
0.064	-1.193	1.448	1.746
1.726	-0.036	-2.774	-1.606
0.194	-1.445		



Şekil 4. *Onobrychis hypargyrea* Boiss.'in Biplot Analizi

4. Sonuçlar ve tartışma

Çok yıllık olması, derin kök sistemi, hızlı büyüme kabiliyeti, güçlü bitki yapısı ile kıraç alanların iyi bir bitkisi olup, bu özelliklerine ilaveten bitki başına yaş ve kuru ot verimlerinin yanında yüksek ham protein içeriği ile yem olarak kullanılabileceği, marjinal alanlarda değerlendirilmesi gereken önemli bir materyal olup, yem olarak dikkate alınması gerektiği kanaati hazıl olmuştur.

Kaynaklar

Ahuja, P. S., D. Y. Lu, E. C. Cocking., M. R. Davey. (1983). An assessment of the cultural capabilities of *Trifolium repens* L. (white clover) and *Onobrychis viciifolia* Scop. (sainfoin) mesophyll protoplasts. Plant Cell. Rep.5 (2), 269- 272.

Akçelik, E., Avcı, S., Uzun, S., Sancak, C. (2012). Karyotype analysis of some Onobrychis (Sainfoin) species in Turkey, Arch. Boil. Sci., Belgrade, 64(2), 567571.

Anonim, (2007a). Türkiye Bitkileri Veri Servisi. http://www.tubives.com/index.php?sayfa=1&tax_id=3505 (Erişim Tarihi: 22.11.2017)

Anonim, (2017b). Türkiye'nin Yabani Çiçekleri. http://yabanicicek.com/onobrychis-hypargyrea-ek-bilgi.php(Erişim Tarihi: 22.11.2017)

Avcı, S., Çöçü S., Sancak, C., Özcan, S. (2010). Heliobrychis Seksiyonuna Ait Bazı Korunga (*Onobrychis sp*.) Türleri Üzerinde Morfolojik Araştırmalar. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, (19) 1-2.

Avcı, S., Kaya, M. D. (2013). Seed and germination characteristics of wild Onobrychis taxa in Turkey. Turkish Journal of Agriculture and Forestry. (37), 555-560.

Bagci, E., L Bruehl., Özçelik, H., Aitzetmuller, K.., Vural, M., Sahim, A. (2004). A study of the fatty acid and tocochromanol patterns of some Fabaceae (Leguminosae) plants from Turkey. IGrasas y Aceites. 55.(4), 378-384

Ball, P.W. (1968). *Onobryehis* Miller. In: Tutin, T.G. and Heywood, V.H., eds. Flora Europaea. Vol. 2. Cambridge University Press, Cambridge, pp. 187-191.

Boissier, P.E. (1872). Flora Orientalis, sive Enumarito Plantarum in Oriente: AGraecia et Aegypto ad Indiae fines hucusque observatarum. Vol. 2, Genevae. 1810-1885: Buser Robert., 1857.

Davis P H. (1969). Flora of Turkey. (3). 560-589.

Davis, P.H. (1970). Flora of Turkey and the East Aegean Island. Volume III. Universty of Edinburg.

Davis, P.H. (1988). Flora of Turkey and East Aegean Islands. Edinburgh Universty Press.

Delgado M. (2008). La esparceta o pipirigallo. Informaciones tecnicas Dirección General de Desarrollo Rural

Centro de Transferencia Agroalimentaria. 201.

Duman, H. Vural, M. (1990). New taxa from south Anatolia 1.Turkısh Journal of Botany.1(14) 4-48.

Emre, I., Turgut-Balık, D., Sahin, A., Kursat, M. (2007). Total Elektroforetic Band Patterns of *Onobrychis* Species Growing in Turkey. American-Eurasian Journal of Agricultural & Environmental Sciences., 2(2): 123-126.

Frame. J., Charlton. J.F.L., Laidlaw. A.S. (1998). Temperate forage legumes. CAB International. Wallingford. 1998.

Frame, J. (2005). Forage Legumes for Temperate Grasslands. FAO and Science Publishers, Inc., Enfield, NH, USA.

Harlan, J.G. (1951). Anatomy of Gene Centres. American Naturalist.(85) 97-103.

Hart, G.E.(2001). Molecular-marker maps of the cultivated wheats and other Triticum species. DNA Based Markers in Plants. Phillips, R.L. and Vasil, I.K. (eds), Second Edition, Kluwer Academic Publishers, London,

Hayek, A. (1970). Prodromus florae peninsulae Bakanica. Band 1, Koeltz, Germany.

Hedge, L.C. (1969). Materials for a flora of Turkey, XVII: *Onobryehis* and *Hedysarum.* Notes R. Bot. Gard. Edinburgh, (29): 33-37

Hybner, R. M. (2013). United States Department of Agriculture Natural Resources Conservatıon Servıce Plant Materials Technical Note No. MT-91 September 2013.

Koivisto, J. M., G, P. F. Lane. (2001). Sainfoin. Worth Another Look. http://www.fao.org/AG/AGp/agpc/doc/ Gbase/AddInfo/sainfoin.pdf. (Erişim Tarih: 20 February 2013).

Meikle, R.D. (1977). Flora of Cyprus. The Bentham-Moxon Trust, Royal Botanic Gardens, Kew, Robert MacLehose and Campany Limited Printers to the University of Glasgow.

Mouterde, P. (1970). Nouvelle flore du Liban et de la Syrie. Dar EI-Machreq Editeurs (Imprimerie Catholique), Beyrouth.

Özaydın B. U., E Yücel. (2004). Mihalıççık İlçesinin (Eskişehir) Florası. Anadolu Üniversitesi Bilim ve Teknoloji Dergisi. Cilt/Vol.: 5 (1) : 83-106.

Rechinger, K. H. (1973). *Onobrychis aliacmonia,* eine neu griechisch-mazedonische Art aus der Section *Hymenobrychis* - Ann. Mus. Goulandris (1): 127 - 131.

Rechinger, K. H. (1984). Flora Iranica: Papilionaceae. Akademische Druck Verlangsanstalt, Graz, Austria.

Schischkin, B.K., Bobrov, E.G. (1972a). Flora of U.S.S.R. Leguminosae: *Oxytropis, Hedysarum.* Israel Program for Scientific Translations (translated from Russian), Jerusalem.

Schischkin, B.K., Bobrov, E.G. (1972b). Flora of U.S.S.R: Diagnose plantarum novarum in Tomo 8 Florae USSR. Israel Program for Scientific Translations (translated from Russian), Jerusalem.

Seher, A., Ivanov S. (1973). Natural antioxidants I: antioxidative action of tocotrienols, Fette Seifen Anstrichm., (75), 606-608.

Sirjaev, G. (1925a). *Onobryehis* generis revisio critica. Publication Faculty of Science University Masaryk (56) 96-97.

Sirjaev, G. (1925b). *Onobryehis* generis revisio critica, Publication Faculty of Science University Masaryk. (56) 121-122.

Sirjaev, G. (1926). *Onobryehis* generis revisio critica, Publication Faculty of Science University Masaryk. (76). 1-165.

Smoliak, S., Johnston, A., Hanna, M.R. (1972). Germination and seedling growth of alfalfa, sainfoin and cicer milkvetch. Canadian Journal of Plant Science. *(*52). 757-762.

Sottıe, E.T. (2014). Characterızatıon Of New Saınfoın Populatıons For Mıxed Alfalfa Pastures In Western Canada. B.Sc. Agriculture, University of Cape Coast, Ghana, 1991 M.Phil. Animal Science, University of Ghana, Legon, Ghana.

Tan. K., Sorger, F. (1986). New taxa from Turkey. Plant System. Evolution. (154).117-120.

Tan. K., G. Iatrou. (1996). Onobrychis aliacmonia RECH.f. - a new slant on an old story . Annalen des Naturhistorischen Museums in Wien, Dezember.

Townsend, C.C. (1974). *Hedysarum* L.. Ministry of Agriculture and Agrarian Reform, Republic of Iraq, Baghdad.

Tarman, Ö. (1954). Forages growth from legumes. Publication of Agriculture Ministry.

Velasco, L., Goffman, F., Pujadas-Salva, A. J. (2000). Fatty acids and tocochromanols in seeds of Orobanche. Phytochemistry. (54). 295-300.

Waghorn, G. (2008). Beneficial and detrimental effects of dietary condensed tannins for sustainable sheep and goat production - progress and challenges. Animal Feed Science and Technology. 147 (1/3): 116-139.

Yaltırık, F., (1989). Otsu Bitkiler Sistematiği. Istanbul Üiversitesi, Fen Bilimleri Enstitüsü Yayın No. 3, İstanbul.

Yıldız, B., Çıplak, B., Aktoklu, E. (1999). Fruit morphology of section of the genus *Onobrychis* Miller (Fabaceae) and its phylogenetic implications. Israel Journal of Plant Sciences. 47 (4). 269-282.

Zohary, M. (1987). Flora Palaestina: Platanaceae to Umbelliferae. The Israel Academy of Sciences and Humanities, Jerusalam.

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Research article/Araştırma makalesi

Nine new records from high mountain lakes (Artabel Lakes Nature Park, Gümüşhane/Turkey) for the freshwater diatom flora of Turkey

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Abstract

This study was carried out in 17 high mountain lakes and a pond in the Artabel Lakes Nature Park (Gümüşhane) on August 15, 2013 and August 13, 2016. In the present study, epipelic, epilitic and epiphytic algal flora of lakes were determined and a total of 95 taxa were recorded belonging to Bacillariophyta division. 9 of the taxa belonging to Bacillariophyta were determined to be new records for the freshwater diatom flora of Turkey. These taxa were identified as *Aulacoseira lacustris* (Grunow) Krammer f. *tenuior* Houk, Klee and Passauer, *Orthoseira roeseana* (Rabenhorst) Pfitzer, *Cyclotella ambigua* Grunow, *Planothidium distinctum* (Messikommer) Lange-Bertalot, *Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round, *Diploneis petersenii* Hustedt, *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer, *Eunotia mucophila* (Lange-Bertalot, Nörpel–Schempp and Alles) Lange-Bertalot and *E. paludosa* Grunow

Key words: Diatom, new record, high mountain lakes, Artabel Lakes Nature Park, Turkey

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Türkiye tatlı su diyatome florası için yüksek dağ göllerinden (Artabel Gölleri Tabiat Parkı, Gümüşhane/Türkiye) dokuz yeni kayıt

Özet

Bu çalışma, Artabel Gölleri Tabiat Parkı (Gümüşhane) içerisinde yer alan 17 yüksek dağ gölü ve bir gölette 15 Ağustos 2013 ve 13 Ağustos 2016 tarihlerinde gerçekleştirilmiştir. Araştırmada, göllerin epipelik, epilitik ve epifitik alg florası tespit edilmiş ve Bacillariophyta divizyouna ait toplam 95 takson belirlenmiştir. Bacillariophyta divizyosuna ait taksonlardan 9 'u Türkiye tatlı su diyatome florası için yeni kayıt olarak belirlenmiştir. Bu taksonlar, *Aulacoseira lacustris* (Grunow) Krammer f. *tenuior* Houk, Klee and Passauer, *Orthoseira roeseana* (Rabenhorst) Pfitzer, *Cyclotella ambigua* Grunow, *Planothidium distinctum* (Messikommer) Lange-Bertalot, *Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round, *Diploneis petersenii* Hustedt, *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer, *Eunotia mucophila* (Lange-Bertalot, Nörpel–Schempp and Alles) Lange-Bertalot and *E. paludosa* Grunow olarak tespit edilmiştir.

Anahtar kelimeler: Diyatome, yeni kayıt, yüksek dağ gölleri, Artabel Gölleri Tabiat Parkı, Türkiye

1. Introduction

Diatoms are a large group of algae and they, together with other algal groups are one of the most important primary food sources of aquatic areas (Round et al., 1990; Wichard et al., 2007). They are generally the dominant group of algae in aquatic ecosystems, in terms of both biodiversity and abundance (Zhuzbayeva and Atıcı, 2016). Also, diatoms are one of the important indicators of the ecological conditions of aquatic ecosystems because they react quickly to changes in nutrient concentrations. Therefore, diatom-based indices are being used to determine the trophic status of aquatic ecosystems (Rusanov et al., 2009). Because of these properties, diatoms can give us more information about the

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situation in all times (past, present and future) of aquatic ecosystems (Meriläinen et al., 1982). Because of that researches on diatom species are very important.

Compared to Europe, studies on freshwater algae in Turkey are quite new. In the first published check-list of the Turkish freshwater algae, 1293 taxa were given and 601 of them belong to Bacillariophyta (Gönülol et al., 1996). In the second published check-list of the Turkish freshwater algae, 2030 taxa were given. Of these, 781 belong to diatoms and constitute 38.47% of the total species number of algae (Aysel, 2005). Nowadays, information about algae flora in Turkey is given in the database. In this database there are 4187 taxa spreading in various habitats of Turkey. Of these, 1000 belong to diatoms and constitute 23.88% of the total species number of algae (Gönülol, 2017). However, this number does not reflect the actual situation. Because, Turkey is surrounded on three side by the sea (shoreline length 8333), has a rich freshwater ecosystem (906000 hectares of the lakes, 439800 hectares of dam lakes and ponds and 178000 km long of streams and rivers) (Güner and Aysel, 1996; Sasi and Berber, 2012) and, especially from high mountain lakes, significant contributions are still made to the freshwater algal biodiversity of Turkey (Şahin, 2007, 2009; Akar and Şahin, 2014).

The aim of this research is to make taxonomic definitions of diatom taxa, which are determined as new record for freshwater algal flora of Turkey, to give information about their ecological preferences and distributions in the studied area.

2. Materials and methods

2.1. Description of study area

Artabel Lakes Nature Park which located within Torul district, Gümüşhane province in the Eastern Black Sea region of Turkey was included as a nature park in the list of Turkey's nature parks by the Turkish Republic Ministry of Forestry in 1998. The park, which has 5859 hectares, is located between 39º0'24"-39º8'23" east longitudes and 40º21'36"-40º26'42" northern latitudes. Artabel Lakes Nature Park is formed result of volcanic activities that take place in two different geological time periods. Gümüşhane has semi-arid and humid climate. While annual weather temperature averages in the lower parts of the valleys (2100 m) in the park is 4 ºC, it is between 0 and 1 ºC at the altitudes where the lakes (2600-3000 m) and however the temperature at the summit of the area (above 3000 m) is below -3 ˚C. There are four large soil groups which are colluvial, non-calcareous brown, high mountain meadow soils and bare rocks and debris in the Artabel Lakes Nature Park (Anonymous, 2013).

Artabel Lakes Nature Park has very rich invaluable terrestrial and aquatic ecosystems and it is a very important factor in the conservation of biodiversity in Turkey. There are many endemic taxa which are included in the International Union for Conservation of Nature (IUCN) and Bern Convention Annex I, II and III lists (Anonymous, 2013).

In Artabel Lakes Nature Park, aquatic ecosystem consist of three sub-basins belonging to three different stream systems which are Artabel Stream basin (Artabel Lakes), the Gümüştuğ Stream basin (Kara and Beş Lakes) and the Kongel Stream basin (Yıldız and Acembol Lakes). The total basin area is approximately 58.2 km^2. There are 23 glaciers lakes, which are Artabel Lakes (6), Beş Lakes (5), Kara Lakes (6), Yıldız Lakes (3) and Acembol Lakes (3). They are superficially connected to each other or independent, in different locations and in different sizes (Figure 1). There are also a small pond and one lake which are not named before. Abbreviations have been made in the names of the lakes for convenience. For example; Artabel Lakes (ARL), Beş Lakes (BL), Kara Lakes (KL), Yıldız Lakes (YL) and Acembol Lakes (ACL). This system was taken from the report (Anonymous, 2013). Others names (İsimsiz Lake (IL) and Yıldız Lakes Pond (YLP)) were put on by us, following the same rule.

2.2. Sampling and laboratory studies

Due to the difficulty of the land conditions, Kara Lakes (6) were not visited. Also, there was no water in the BL5 lake, so algal and water samples could not be taken. A total of 43 samples of epipelic, epilithic and epiphytic were taken from littoral zone of 17 lakes and a pond in 15 August 2013 and in 13 August 2016. Samples of epipelic diatom were collected by means of a glass tube from sediment surface at all the water bodies except Lake BL2. Epilithic samples were taken from ARL1, ARL2, BL2, ACL1, ACL2, ACL3 and IL lakes. Randomly chosen stones were scraped with a toothbrush and then washed into plastic bottles. For epiphytic diatom samples, mosses (*Hygrohypnum luridum* (Hedw.) Jenn.) and filamentous algae (*Microspora* sp.) were taken from ARL1, ARL3, YL1, YL2, YL3, ACL2, ACL3, IL lakes and YLP Pond. All samples were fixed in solution of 4% formaldehyde. In order to identify diatoms, organic compounds must be removed from diatom samples. So it was treated with H_2SO_4 and HNO_3, and then the acidity of the samples was removed by washing a few times with distilled water. After that, they dried on the cover glasses were identified in Entellan microscope mounting medium (Round, 1953; Sládečková, 1962). Microscopic examinations of diatom samples were performed on a Leica DM 2500 model light microscope and it was photographed camera Leica DFC 290 attached the microscope.

Physical and chemical parameters (dissolved oxygen, electrical conductivity, pH and water temperature) of all lakes were measured with portable devices Orion-4Star and YSI-55. For taxonomic identification Hustedt (1930); Huber-

Pestalozzi (1962); Patrick and Reimer (1966); Krammer and Lange-Bertalot (1986, 1991a,b); Joh (2010, 2012); Genkal et al. (2008); Buczkó et al. (2013) and Jovanovska et al. (2015) books and articles were used. The validity of the taxa name was checked from AlgaeBase (Guiry and Guiry, 2017) and the new record taxa were checked from Gönülol (2017).

Frequencies of diatom taxa were determined according to the following scale based on the number of lakes studied in Artabel Lakes Nature Park. Very rare (VR): taxa recorded in %1-20 of investigated lakes; rare (R): taxa recorded in %21-40 of investigated lakes; common (C): taxa recorded in %41-60 of investigated lakes; frequent (F): taxa recorded in %61-80 of investigated lakes; very frequent (VF): taxa recorded in %81-100 of investigated lakes (Kocataş, 1992).

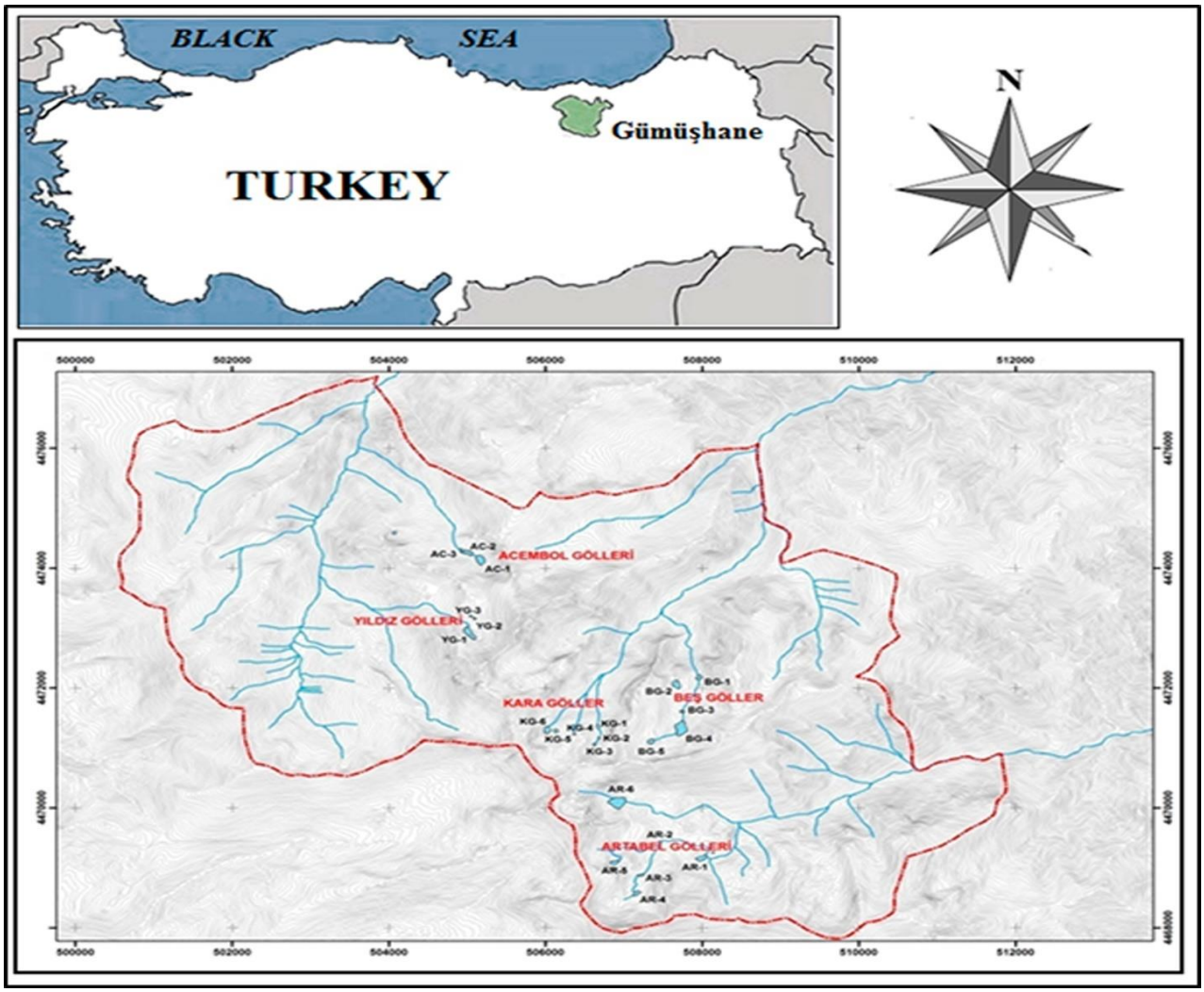

Figure 1. Map of Artabel Lakes Nature Park (Anonymous, 2013)

3. Results

At the end of study, 95 taxa belonging Bacillariophyta is determined and 9 of these has been identified as new records for diatom flora of Turkey.

Phylum: Bacillariophyta
Subphylum: Coscinodiscophytina
Class: Coscinodiscophyceae
Order: Aulacoseirales
Family: Aulacoseiraceae
Genus: Aulacoseira

***Aulacoseira lacustris* (Grunow) Krammer f. *tenuior* Houk, Klee and Passauer 2007 (Figure 2a)**

Krammer and Lange-Bertalot, 1991a, p. 39, pl. 36, figs. 3-18.
Basionym: *Melosira lyrata* f. *tenuior* Grunow in Van Heurck 1882, pl. 87, fig. 3.
Homotypic synonym: *Melosira lyrata* f. *tenuior* Grunow 1882.
Heterotypic synonym: *Aulacoseira tenuior* Krammer 1991.

Description: The filament of this taxon was not observed. The identification of taxon was made according to valve shape. Valve is circular. The medium area of the valve is flat and limited by a wall-like raised ring. Very thin and uniform areolae form stripe patterns. Diameter: 12.22 µm, striae 13-14 in 10 µm.
Ecology: This taxon was found in Finland, Northgland, Scotland, Sweden and USA in low electrolyte waters (Krammer and Lange-Bertalot, 1991a). In our study, *Aulacoseira lacustris* f. *tenuior* was only found in epipelic habitat of the ARL3 with abundance very rare (VR). It was also collected in habitat with altitude: 2875 m asl, water temperature: 16.3 ºC, dissolved oxygen 8.76 mg/L, pH: 6.19, TDS: 24 mg/L and conductivity: 49.9 µS/cm.
Distribution: No information is available on the geographical distribution of the species (Guiry and Guiry, 2017).
Subclass: Melosirophycidae
Order: Melosirales
Family: Orthoseiraceae
Genus: Orthoseira
***Orthoseira roeseana* (Rabenhorst) Pfitzer 1871 (Figure 2b)**
Hustedt, 1930, p. 93, fig. 59.
Krammer and Lange-Bertalot, 1991a, p. 13, pl. 10, figs. 1-11.
Joh, 2010, p. 117, fig. 90.
Basionym: *Melosira roeseana* Rabenhorst
Homotypic Synonyms: *Melosira roeseana* Rabenhorst 1853
Gaillonella roeseana (Rabenhorst) Petit 1880
Melosira dendroteres var. *roeseana* (Rabenhorst) R.Ross 1947
Heterotypic Synonym: *Melosira roeseana* var. *typica* Grunow 1882
Description: Valve is circular and 26.16 µm in diameter, striae 14-20 in 10 µm. Valve has a flat face. Areolate punctas on valve arranged in radiating pattern and fainter from the margin to the central. There are 2 carinoportulae which are a type of pore specific to the genus Orthoseira, on the central part of the valve.
Ecology: According to Krammer and Lange-Bertalot (1991a), *Orthoseira roeseana* is commonly an aerophytic diatom on wet rock faces, bryophytes and trees, especially in alkaline areas all over the World. In addition, Joh (2010) pointed out that this taxon is a cold water taxon and is frequently observed in arctic regions. In this study, it was observed at epipelic habitat of the YL3 with abundance very rare (VR). It was also collected in habitat with altitude: 2980 m asl, water temperature: 14.1 ºC, dissolved oxygen 3.12 mg/L, pH: 7.01, TDS: 24.05 mg/L and conductivity: 29.5 µS/cm.
Distribution: (as *Melosira roeseana* Rabenhorst) *Europe* (France, Ireland, Romania, Slovakia, Spain), *Atlantic Islands* (Iceland), *North America* (Alaska, Great Lakes, Northwest Territories, Ohio, United States of America), *South America* (Argentina, Brazil), *Africa* (Ghana), *South-west Asia* (Iraq), *Asia* (Taiwan), (as *Orthoseira roeseana* (Rabenhorst) Pfitzer) *Europe* (Baltic Sea, Britain, France, Germany, Hungary, Ireland, Macedonia, Romania, Slovakia, Spain), *North America* (Mexico, NW USA, Tennessee, United States of America), *Asia* (Korea, Russia (Far East), Taiwan), *Australia and New Zealand* (New Zealand), *Antarctic and the subantarctic islands* (Maritime Antarctica) (Guiry and Guiry, 2017).
Subphylum: Bacillariophytina
Class: Mediophyceae
Subclass: Thalassiosirophycidae
Order: Stephanodiscales
Family: Stephanodiscaceae
Genus: Cyclotella
***Cyclotella ambigua* Grunow 1880 (Figure 2c)**
Hustedt, 1930, p. 102, fig. 71.
Huber-Pestalozzi, 1962, p. 397, fig. 482.
Krammer and Lange-Bertalot, 1991a, p. 46, pl. 45, figs. 5a-b.
Genkal et al., 2008, p. 8, fig. 1.
Homotypic synonym: *Cyclotella striata* var. *ambigua* (Grunow) Grunow 1882
Description: Valve is round and a diameter of 24.27 µm, striae 8-10 in 10 µm. The marginal zone occupies about 1/3 of the valve diameter. There are more or less regularly distributed indentations and elevations in the central area of the valve. Striae are equal in length. Hustedt (1930) and Huber-Pestalozzi (1962) have reported that the diameter of the valve does not usually exceed 30 µm. Our findings support this data.
Ecology: This taxon is cosmopolitan in the littoral zone of the brackish and marine waters (Krammer and Lange-Bertalot, 1991a). Genkal et al., (2008) stressed that *Cyclotella ambigua* is a planktonic in brackish water and freshwater. In this study, it was recorded at epipelic habitat in the ARL4 with abundance very rare (VR). It was also collected in habitat with altitude: 2890 m asl, water temperature: 15.7 ºC, dissolved oxygen 9.45 mg/L, pH: 6.73, TDS: 10 mg/L and conductivity: 21.5 µS/cm.
Distribution: (as *Cyclotella ambigua* Grunow) *Europe* (Netherlands), (as *Cyclotella striata* var. *ambigua* (Grunow) Grunow) *Europe* (Britain), *North America* (United States of America), *Asia* (Taiwan), *Australia and New Zealand* (New South Wales) (Guiry and Guiry, 2017).
Class: Bacillariophyceae
Subclass: Bacillariophycidae
Order: Cocconeidales
Family: Achnanthidiaceae
Genus: Planothidium
***Planothidium distinctum* (Messikommer) Lange-Bertalot 1999 (Figure 2d)**

Krammer and Lange-Bertalot, 1991b, p. 32, pl. 18, figs. 1-8.
Buczko et al., 2013, p. 6, figs. 1-10, 19-28.
Basionym: *Achnanthes distincta* Messikommer 1954
Homotypic Synonyms: *Achnanthes distincta*
Achnanthes hirta Carter 1970
Achnantheiopsis distincta (Messikommer) Lange-Bertalot 1997
Description: Valve 17 µm in lenght and 8.5 µm in breadth, striae 14-18 in 10 µm. Valve lanceolate with broadly protracted, rounded apices. Raphe straight, filiform, terminal fissures turned in opposite directions. Central area is small, transversely rectangular and asymmetrical. In addition, there are 1-2 asymmetrically shortened striae in central area. Striae are radiate throughout valve.
Ecology: Krammer and Lange-Bertalot (1991b) indicated that *Planothidium distinctum* is distributed in oligotrophic, circumneutral and electrolytically poor mountain waters in the northern hemisphere. In this study, it was recorded at epipelic habitat in the BL4 with abundance very rare (VR). It was also collected in habitat with altitude: 2924 m asl, water temperature: 15.5 ºC, dissolved oxygen 8.30 mg/L, pH: 7.04, TDS: 6 mg/L and conductivity: 13.2 µS/cm.
Distribution: (as *Achnanthes distincta* Messikommer) *Europe* (Britain, Germany), (as *Achnantheiopsis distincta* (Messikommer) Lange-Bertalot) *Europe* (Romania), (as *Planothidium distinctum* (Messikommer) Lange-Bertalot) *Europe* (Romania) (Guiry and Guiry, 2017).
Genus: Psammothidium
***Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round 1996 (Figure 2e)**
Krammer and Lange-Bertalot, 1991b, p. 18, pl. 10, figs. 12-27.
Joh, 2012, p. 70, fig. 65.
Basionym: *Achnanthes austriaca* var. *helvetica* Hustedt 1933
Homotypic Synonyms: *Achnanthes austriaca* var. *helvetica*
Achnanthes helvetica (Hustedt) Lange-Bertalot 1989
Achnanthidium helveticum (Hustedt) O.Monnier, Lange-Bertalot and Ector 2007
Heterotypic Synonym: *Achnanthidium lauenburgianum* (Hustedt) Monnier, Lange-Bertalot and Ector 2007
Description: Valve is linear-elliptical shaped and apices are obtusely rounded. Raphe straight, axial area narrow and linear and central area rectangular up to the margin. Valve 18.28 µm in length and 7.5 µm in breadth, striae 23-28 in 10 µm.
Ecology: According to Krammer and Lange-Bertalot (1991b) this taxon occurs in oligotrophic to dystrophic, low nutrient content, circumneutral to slightly acidic habitats in mountain waters. Catalan et al., (2009) pointed out that *Psammothidium helveticum* was an indicative taxon in 235 alpine lakes in the Alps, the Pyrenees and the Tatra Mountains in Europe. In the Artabel Lakes Nature Park, the taxon was only found in epipelic habitat of the ARL6 with abundance very rare (VR). It was also collected in habitat with altitude: 2863 m asl, water temperature: 15.9 ºC, dissolved oxygen 8.97 mg/L, pH: 6.98, TDS: 10 mg/L and conductivity: 21.3 µS/cm.
Distribution: (as *Achnanthes austriaca* var. *helvetica* Hustedt) *Europe* (Britain, France, Netherlands, Slovakia), *North America* (Québec, United States of America), (as *Achnanthes helvetica* (Hustedt) Lange-Bertalot) *Arctic* (Canada (Arctic), Ellesmere Island), *Europe* (Germany, Ireland, Netherlands, Romania, Russia (Europe), Slovakia), *North America* (Canada, Tennessee, United States of America), *South America* (Colombia), *Asia* (Korea), (as *Psammothidium helveticum* (Hustedt) Bukhtiyarova and Round) *Arctic* (Ellesmere Island, *Europe* (Britain, Czech Republic, France, Macedonia, Netherlands, Poland, Romania), *North America* (NW USA, Tennessee, United States of America), *Asia* (Bering Island, Russia (Far East)), *Antarctic and the subantarctic islands* (Maritime Antarctica), (as *Achnanthidium helveticum* (Hustedt) O.Monnier, Lange-Bertalot and Ector) *Europe* (France, Germany, Ireland, Romania), (as *Achnanthidium lauenburgianum* (Hustedt) Monnier, Lange-Bertalot and Ector) *Europe* (France, Germany) (Guiry and Guiry, 2017).
Order: Naviculales
Suborder: Diploneidineae
Family: Diploneidaceae
Genus: Diploneis
***Diploneis petersenii* Hustedt 1937 (Figure 2f)**
Krammer and Lange-Bertalot, 1986, p. 293, pl. 110, figs. 16,17.
Jovanovska et al., 2015, p. 238, figs. 246-249.
Homotypic synonym: *Diploneis minuta* var. *peterseni* (Hustedt) A.Cleve 1953
Description: Valve is lanceolate-elliptical with convex margins and rounded apices. Axial area is linear throughout the whole length. Central area is small and rectangular. Raphe is straight. Valve length is 28.67 µm and breadth is 9.80 µm, striae 26-27 in 10 µm.
Ecology: The optimal distribution of *Diploneis petersenii* is in circumneutral and oligosaprobic waters (Van Dam et al., 1994). This species prefers oligosaprobic waters with low to moderate electrolyte content in northern alps (Krammer and Lange-Bertalot, 1991b). Jovanovska et al., (2015) pointed out that *Diploneis petersenii* was found on rocks in shallow habitats in southern Lake Hövsgöl and in small streams in Arkhangai province. In this study, this taxon has been recorded in epiphytic samples in YLP with abundance very rare (VR). It was also collected in habitat with altitude: 2980 m asl, water temperature: 14.5 ºC, dissolved oxygen: 2.34 mg/L, pH: 7.20, TDS: 23.40 mg/L and conductivity: 29.2 µS/cm.
Distribution: *Arctic* (Svalbard (Spitsbergen)), *Europe* (Britain, France, Germany, Ireland, Macedonia, Netherlands, Poland, Romania), *Atlantic Islands* (Iceland), *North America* (Alaska, Great Lakes, Mexico, NW USA, Tennessee, United States of America), *Africa* (Sudan) (Guiry and Guiry, 2017).
Suborder: Neidiineae

Family: Amphipleuraceae
Genus: Frustulia
***Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer 1996 (Figure 2g)**
Patrick and Reimer, 1966, p. 307, pl. 22, fig. 1.
Krammer and Lange-Bertalot, 1986, p. 258, pl. 95, figs. 6,7
Basionym: *Navicula crassinervia* Brébisson ex W.Smith
Homotypic Synonyms: *Navicula crassinervia* Brébisson ex W.Smith 1853
Navicula rhomboides var. *crassinervia* (Brébisson) Grunow 1880
Frustulia rhomboides var. *crassinervia* (Brébisson ex W.Smith) Ross 1947
Heterotypic Synonym: *Frustulia rhomboides* f. *undulata* Hustedt 1930
Description: The length of the valve is 40.58-45.69 µm and breadth is 11.86-12.35 µm, striae 40 in 10 µm. The valve of the taxon is rhomboid shape and has undulate margins. Apices are narrowly rounded and moderately protracted. Both the raphe and the longitudinal ribs are slightly curved. At valve center, the ribs are slightly constricted.
Ecology: Patrick and Reimer (1966) pointed out that this taxon usually prefers oligotrophic water. This taxon is very well represented in Artabel Lakes Nature Park, it was found in epipelic and epiphytic samples in the ARL1 (altitude: 2687 m asl, water temperature: 17.5 ºC, dissolved oxygen: 8.71 mg/L, pH: 6.19, TDS: 16 mg/L and conductivity: 32.6 µS/cm), BL1 (altitude: 2831 m asl, water temperature: 13.9 ºC, dissolved oxygen: 9.14 mg/L, pH: 7.06, TDS: 10 mg/L and conductivity: 21.4 µS/cm), BL4 (altitude: 2924 m asl, water temperature: 15.5 ºC, dissolved oxygen: 8.30 mg/L, pH: 7.04, TDS: 6 mg/L and conductivity: 13.2 µS/cm), YL2 (altitude: 2980 m asl, water temperature: 11.5 ºC, dissolved oxygen: 2.88 mg/L, pH: 6.89, TDS: 26.66 mg/L and conductivity: 30.7 µS/cm) and YLP (altitude: 2980 m asl, water temperature: 14.5 ºC, dissolved oxygen: 2.34 mg/L, pH: 7.20, TDS: 23.40 mg/L and conductivity: 29.2 µS/cm) with abundance rare (R).
Distribution: (as *Navicula crassinervia* Brébisson ex W.Smith) *Europe* (Slovakia), (as *Frustulia rhomboides* var. *crassinervia* (Brébisson ex W.Smith) Ross) *Europe* (Britain, Germany, Ireland, Netherlands, Russia (Europe)), *North America* (Great Lakes, Québec, United States of America), *Pacific Islands* (Hawaiian Islands), (as *Frustulia crassinervia* (Brébisson ex W.Smith) Lange-Bertalot and Krammer) *Europe* (Belgium, Czech Republic, France, Germany, Ireland, Italy, Netherlands, Norway, Romania, Russia (Europe), Sweden), *North America* (NW USA, Tennessee, United States of America), *South America* (Brazil, Colombia), *Africa* (Sudan), *Asia* (Bering Island, Russia (Far East), Tajikistan), *Australia and New Zealand* (New Zealand) (Guiry and Guiry, 2017).
Subclass: Eunotiophyceae
Order: Eunotiales
Family: Eunotiaceae
Genus: Eunotia
***Eunotia mucophila* (Lange-Bertalot, Nörpel Schempp and Alles) Metzeltin, Lange-Bertalot in Metzeltin and Lange-Bertalot 2007 (Figure 2h)**
Krammer and Lange-Bertalot, 1991a, p. 180, pl. 138, figs. 10-24.
Basionym: *Eunotia bilunaris* var. *mucophila* Lange-Bertalot, Nörpel-Schempp and E.Alles
Homotypic synonym: *Eunotia bilunaris* var. *mucophila* Lange-Bertalot, Nörpel-Schempp and E.Alles.
Description: The valve is slender and arcuate. Dorsal and ventral margins parallel. Apices are rounded. Terminal nodules are small and raphe is indistinct. The overall contour of the valve has a smooth appearance. Length: 35.39-59.51 µm. Breadth: 5-7.88 µm, striae 20-28 in 10 µm.
Ecology: This taxon is very well represented in Artabel Lakes Nature Park, it was found in epipelic, epilithic and epiphytic samples in the ARL1 (altitude: 2687 m asl, water temperature: 17.5 ºC, dissolved oxygen: 8.71 mg/L, pH: 6.19, TDS: 16 mg/L and conductivity: 32.6 µS/cm), ARL3 (altitude: 2875 m asl, water temperature: 16.3 ºC, dissolved oxygen: 8.76 mg/L, pH: 6.19, TDS: 24 mg/L and conductivity: 49.9 µS/cm), ACL2 (altitude: 2712 m asl, water temperature: 15.3 ºC, dissolved oxygen: 2.10 mg/L, pH: 7.09, TDS: 30.55 mg/L and conductivity: 38.5 µS/cm), YL2 (altitude: 2980 m asl, water temperature: 11.5 ºC, dissolved oxygen: 2.88 mg/L, pH: 6.89, TDS: 26.66 mg/L and conductivity: 30.7 µS/cm), IL (altitude: 2668 m asl, water temperature: 19.1 ºC, dissolved oxygen: 4.25 mg/L, pH: 6.78, TDS: 9.10 mg/L and conductivity: 12.0 µS/cm) with abundance rare (R). This taxon is commonly found in water of low mineral content and commonly found in acid water (Krammer and Lange-Bertalot, 1991a). In addition, Krammer and Lange-Bertalot (1991a) reported that this taxon is found on filamentous algae, mosses and silicate rocks.
Distribution: (as *Eunotia bilunaris* var. *mucophila* Lange-Bertalot, Nörpel-Schempp and E.Alles) *Europe* (Baltic Sea, Belgium, France, Germany, Netherlands, Poland, Russia (Europe), Slovakia), *North America* (Arkansas, Québec, United States of America), *South America* (Colombia), *Asia* (Korea), (as *Eunotia mucophila* (Lange-Bertalot, Nörpel-Schempp and Alles) Lange-Bertalot) *Europe* (France, Macedonia, Netherlands, Poland, Romania), *South America* (Colombia). *Asia* (Bering Island, Russia (Far East)), *Australia and New Zealand* (New Zealand) (Guiry and Guiry, 2017).
***E. paludosa* Grunow 1862 (Figure 2i)**
Hustedt, 1930, p. 178, fig. 228.
Krammer and Lange-Bertalot, 1991a, p. 203, pl. 155, figs. 1-20.
Homotypic synonym: *Himantidium paludosum* (Grunow) Lagerstedt 1873
Description: Valve is weakly curved. Ventral margin is moderately concave. Dorsal margin is convex. Valve apices are rounded and slightly dorsally reflexed. Striae are parallel. Length: 73.74 µm, Breadth: 4.62 µm, striae 19-25 in 10 µm.
Ecology: Patrick and Reimer (1966) pointed out that *Eunotia paludosa* is usually attached on mosses in acidic waters having low mineral content, also it is present in bogs and small streams. In addition, Van Dam et al. (1994) reported that this taxon is

acidobiontic: optimal occurrence at pH<5.5. This taxon is not very well represented in the study area, it was observed only in the IL with abundance very rare (VR). It was collected in epilithic habitat with pH: 6.78, TDS: 9.10 mg/L, conductivity: 12.0 µS/cm.

Distribution: *Europe* (Belgium, Britain, Czech Republic, France, Germany, Hungary, Netherlands, Poland, Romania, Russia (Europe), Slovakia), *North America* (NW USA, Tennessee, United States of America), *South America* (Brazil, Colombia), *Asia* (Bering Island, Korea, Russia (Far East)), *Australia and New Zealand* (Australia, Queensland) (Guiry and Guiry, 2017).

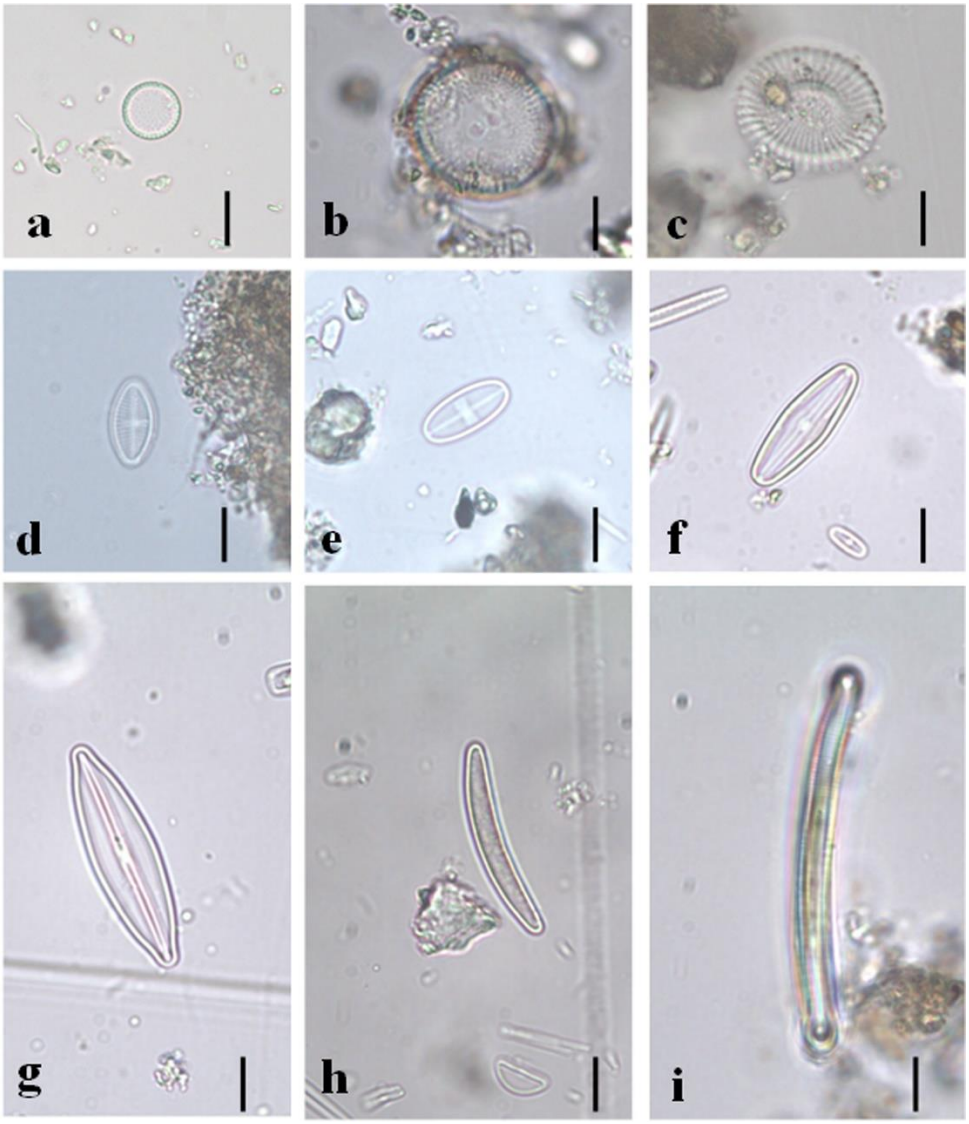

Figure 2. a. *Aulacoseira lacustris* f. *tenuior*, b. *Orthoseira roeseana*, c. *Cyclotella ambigua*, d. *Planothidium distinctum*, e. *Psammothidium helveticum*, f. *Diploneis petersenii*, g. *Frustulia crassinervia*, h. *Eunotia mucophila*, i. *Eunotia paludosa*, Scale bar 10 µm.

4. Conclusions and discussion

Turkey has different geographical and climatic characteristics. Therefore, it has a rich biological diversity. Although biodiversity in terrestrial ecosystems is largely determined, it is not sufficient in freshwater ecosystems. Studies on the freshwater algae in Turkey will contribute to the as ecological monitoring and determination of the aquatic biodiversity of the inland waters. The Turkish Government has decided to follow the European Water Framework Directive and try to improve specific diatom indices for freshwaters. Therefore, studies that take the subject of diatoms are very important. In conclusion, this study showed that as the number of studies on water ecosystems in high mountains of Turkey increases, the numbers of diatom will also increase.

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References

Akar, B., Şahin, B. (2014). New desmid records of Karagöl Lake in Karagöl-Sahara National Park (Şavşat-Artvin/Turkey). Turkish Journal of Fisheries and Aquatic Sciences, 14(1), 269-274.

Anonymous (2013). Artabel Gölleri Tabiat Parkı Uzun Devreli Gelişme Planı Analitik Etüt ve Sentez Raporu, Doğa Koruma ve Milli Parklar Genel Müdürlüğü, Ankara.

Aysel, V. (2005). Check-list of the freshwater algae of Turkey. Journal of the Black Sea / Mediterranean Environment, 11, 1-124.

Buczkó, K., Wojtal, A.Z., Magyari, E.K. (2013). Lectotypification, emended description and distribution of *Planothidium distinctum* (Achnanthidiaceae, Bacillariophyceae). Phytotaxa, 117(1), 1-10.

Catalan, J., Barbieri, M.G., Bartumeeus, F., Bitušik, P., Botev, I., Branceilj, A., Cogăniceanu, D., Manca, M.,, Marchetto, A., Ognjanova-Rumenova, N., Pla, S., Rieradevall, M., Sorvari, S., Štefkova E., Stuchlik, E., Ventura, M. (2009). Ecological thresholds in European alpine lakes. Freshwater Biology, 54(12), 2494-2517.

Genkal, S.I., Pautova, V.N., Nomokonova, V.N., Tarasova, N.G. (2008). Occurence of *Cyclotella ambigua* Grunow (Bacillariophyta) in the Kuibyshev Reservoir. Inland Water Biology, 1(1), 7-13.

Gönülol, A., Öztürk, M., Öztürk, M. (1996). A Check-list of the freshwater algae of Turkey. Ondokuz Mayıs Üniversitesi Fen-Edebiyat Fakültesi, Fen Dergisi, 1, 8-46.

Gönülol, A. (2017). Turkish algae electronic publication, Retrieved from http://turkiyealgleri.omu.edu.tr (Accessed October 2017).

Guiry M.D., Guiry, G.M. (2017). AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. http://www.algaebase.org (Accessed October 2017)

Güner, H., Aysel, V. (1996). Turkey. In W. Schramm and P. Nienhuis (Eds). In Marine Benthic Vegetation. Berlin, Germany: Springer, pp. 421-432.

Huber–Pestalozzi, G. (1962). Das Phytoplankton des Süßwassers. (Die Binnengewässer, Band XVI). Teil 2., 2. Hälfte. Diatomeen. Stuttgart, Germany: Schweizerbart'sche Verlagsbuchhandlung.

Hustedt, F., (1930). Heft 10: Bacillariophyta (Diatomeae). In A. Pascher (eds.), Die Süsswasser-Flora Mitteleuropas. Jena. Zweite Auflage: Verlag von Gustav Fischer.

Joh, G. (2010). Algal Flora of Korea. Volume 3, Number 1, Chrysophyta: Bacillariophyceae: Centrales, Freshwater Diatoms. Korea: National Institute of Biological Resources.

Joh, G. (2012). Algal Flora of Korea. Volume 3, Number 7, Chrysophyta: Bacillariophyceae: Pennales: Raphidineae: Achnanthaceae, Freshwater Diatoms. Korea: National Institute of Biological Resources.

Jovanovska, E., Levkov, Z., Edlund, M.B. (2015). The genus *Diploneis* Ehrenberg ex Cleve (Bacillariophyta) from Lake Hövsgöl, Mongolia. Phytotaxa, 217(3), 201-248.

Kocataş, A. (1992). Ekoloji (Çevre Biyolojisi), Ege Üniversitesi Fen Fakültesi No: 142. İzmir: Ege Üniversitesi Matbaası.

Krammer, K., Lange-Bertalot, H. (1986). Susswasserflora von Mitteleuropa, Bacillariophyceae, Band 2/1, 1. Teil: Naviculaceae. Stuttgart: Gustav Fischer Verlag.

Krammer, K., Lange-Bertalot, H. (1991a). Susswasserflora von Mitteleuropa, Bacillariophyceae, Band 2/3, 3. Teil: Centrales, Fragilariaceae, Eunotiaceae. Stuttgart: Gustav Fischer Verlag.

Krammer, K. Lange-Bertalot, H. (1991b). Susswasserflora von Mitteleuropa, Bacillariophyceae, Band 2/4, 4. Teil: Achnanthaceae, Kritische Ergänzungen zu Navicula (Lineolatae) und Gomphonema Gesamtliteraturverzeichnis. Stuttgart: Gustav Fischer Verlag.

Meriläinen, J., Huttunen, P., Pirttiala, K. (1982).The effect of land use on the diatom communities in lakes. Hydrobiologia, 86, 99-103.

Patrick, R., Reimer, C. W. (1966). The Diatoms of the United States, Exclusive of Alaska and Hawaii: Fragilariaceae, Eunotiaceae, Achnanthaceae, Naviculacae. Philadelphia, USA: Academy of Natural Sciences.

Round, F.E. (1953). An investigation of two benthic algal communities in Malharm Tarn, Yorkshire. Journal of Ecology, 41(1), 174-197.

Round, F.E., Crawford, R.M., Mann, D.G. (1990). The Diatoms: Biology and Morphology of the Genera. New York: Cambridge University Press.

Rusanov, A.G., Stanislavskaya, E.V., Acs, E. (2009). Distribution of periphytic diatoms in the rivers of the Lake Ladoga basin (Northwestern Russia). Acta Botanica Croatica, 68(2), 301-312.

Sládečková, A. 1962. Limnological investigation methods for the periphyton ("Aufwuchs") community. Botanical Review, 28: 286-350.

Şahin, B. (2007). Two new records for the freshwater algae of Turkey. Turkish Journal of Botany, 31(2), 153-156.

Şahin, B. (2009). Contribution to the desmid flora of Turkey. Turkish Journal of Botany 33(6), 457-460.

Sasi, H., Berber, S. (2012). Freshwater fish Fauna and Restock Fish Activities of Reservoir in the Dardanelles (Canakkale-Turkey). Journal of Central European Agriculture, 13(2), 368-379.

Van Dam, H., Mertens, A. Sinkeldam, J. (1994). A coded checklist and ecological indicator values of freshwater diatoms from The Netherlands. Netherlands Journal of Aquatic Ecology, 28, 117–133.

Wichard, T., Gerecht, A., Boersma, M., Poulet, S.A., Wiltshire, K., Pohnert, G. (2007). Lipid and fatty acid composition of diatoms revisited: rapid wound-activated change of food quality parameters influences herbivorous copepod reproductive success. Chembiochem, 8(10), 1146-1153.

Zhuzbayeva, A., Atıcı, T. (2016). Algae and water qualities of Badam Dam Reservoir (Kazakhstan). Biological Diversity and Conservation, 9(2), 34-43.

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Research article/Araştırma makalesi

Changes in pigment content of green algae (*Desmodesmus* sp. *and Chodatodesmus mucranulatus*) exposed to alumina oxide (Al_2O_3) nanoparticles

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Abstract

Nanoparticles (NPs) have emerged as a new class of environmental pollutants with the emergence of nanotechnology. Al_2O_3 NPs released from different industries, personal care products and wide range of applications necessarily end up in aquatic environments. Algal growth inhibition tests are an significant indicator model of monitoring programs designed to predict the effect of NPs on aquatic environments. This study investigated the effects of varying-duration and *concentration* exposure on the chlorophyll (Chl) contents of Al_2O_3 NPs to two species of freshwater green algae (*Desmodesmus sp.*, and *Chodatodesmus mucranulatus*) recommended for use in standard algal growth inhibition tests. To induce Al_2O_3 NPs effect, we exposed algae to 3- 96 mg/L for 96 hours. In the test groups treated with Al_2O_3 NPs in both algae cells, chlorophyll content decreased in 48 hours exposure compared to the control groups and a clear increase in exposure time to 72 hours was observed. As a result, it was noted that the chlorophyll content of this study varied at the varying duration and concentrations. Variation in chlorophyll (Chla and Chlb) concentrations for *Desmodesmus sp.* and *Chodatodesmus mucranulatus.*was recorded at the significance level of $p<0.01$.

Key words: alumina, chlorophyll, nanotoxicology, nanoparticles, microalgae

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Alümina oksit (Al_2O_3) nanopartiküllerine maruz kalan yeşil alglerin (*Desmodesmus* sp. ve *Chodatodesmus mucranulatus*) pigment içeriğindeki değişiklikler

Özet

Nanopartiküller (NP'ler), nanoteknoloji ile birlikte çevre kirleticilerinin yeni bir sınıfı olarak ortaya çıkmıştır. Al_2O_3 NP'leri kişisel bakım ürünleri, farklı endüstriler ve geniş uygulama yelpazesinden salınır ve mutlaka sucul çevrelere ulaşır. Algal büyüme inhibisyon testleri, bu sucul çevrelerde NP'lerin etkisini öngörmek için tasarlanmış izleme programlarının önemli bir göstergesidir. Bu çalışmada, Al_2O_3 NP'lerinin değişen süresi ve konsantrasyonlarda, iki tatlısu yeşil alg (*Desmodesmus* sp. ve *Chodatodesmus mucranulatus*) türlerinde, standart alg büyüme inhibisyon testi ile klorofil (klf) muhteviyatını üzerine etkisi araştırılmıştır. Al_2O_3 NP etkisini değerlendirmek için algler 72 saat boyunca 3-96 mg/L konsantrasyonlarında Al_2O_3 NP'lerine maruz bırakıldı. Al_2O_3 NP'leri uygulanan test gruplarında, kontrol grupları ile karşılaştırıldığında klorofil muhtevasında net bir azalma gözlemlendi. Her iki alg hücresinde Al_2O_3 NP'leri ile muamele edilen test gruplarında klorofil muhteviyatı kontrol gruplarına kıyasla 48 saat sonra azaldı, maruz kalma süresi 72 saate uzadığında ise belirgin bir klorofil muhteviyatında artış gözlendi. Sonuç olarak, bu çalışmanın klorofil muhteviyatı Al_2O_3 NP'lerinin değişen süre ve konsantrasyonlarda değiştiği kaydedilmiştir. *Desmodesmus* sp. ve *Chodatodesmus mucranulatus* için klorofil (klfa ve klfb) konsantrasyonlarında değişimi $p<0.01$ anlamlılık seviyesinde önemli olduğu kaydedilmiştir.

Anahtar kelimeler: alüminyum oksit, klorofil, nanotoksikoloji, nanopartiküller, mikroalgler

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1. Introduction

Nanotechnology is one of the most effective research fields in technology science. Nanotechnology involves the creation and manipulation of materials at the nanometer level. Nanotechnology uses engineering materials or devices with nanometer-scale dimensions, typically ranging from 1 to 100 nm. The application and development of many industrial nanotechnologies increases the potential for harmful effects of nanoparticles (NPs) on the environment. NPs display entirely new, improved and unique properties based on specific properties such as size, distribution, synthesis method and morphology (Sadiq et al., 2011; Özkan et al., 2015). Recently, the widespread use of NPs, especially metal oxide NPs, has drawn great attention. It is now widely known that the ability of nanoparticle-sized materials to respond is potentially dangerous for the environment (Gosteva et al., 2015; Çolak and Nas 2016). It is necessary to assess the NP toxicity of aquatic ecosystems as the surrounding water resources are contaminated by the nanotechnology industry products in various ways. Among these, the most popular NP are aluminum oxide (Al_2O_3) NPs. Aluminum is one of the most produced chemicals in nano-sized particles. Aluminum is estimated to account for about 20% of the 2005 world market NPs (Arul Prakash et al., 2011). Al_2O_3 NPs have been applied in catalysis, reinforcement, polymer modification, functionalization of textiles, heat transfer fluids, wastewater treatment and structural ceramics. In addition, Al_2O_3 NPs have broad biological applications such as biosensors, antigen presentations for biofiltration, drug delivery and immunization purposes (Arul Prakash et al., 2011). Despite the potential benefits of NPs, they cause concern because of their negative effects on human health and the environment impacts. Although Al_2O_3 NPs are published data on biological effects in the aquatic environment, their results are inconsistent. These contradictions in the literature are due to a variety of factors such as physicochemical properties of NPs, form of synthesis, experimental conditions, indicator organisms susceptibility, etc., but the real problem is the lack of valid and common analytical evaluations of nanoparticle toxicity.

Alg toxicity tests are widely used to assess the aquatic effects of hazardous substances. Algae play an important role in the balance of aquatic ecosystems that are at the first level of the organic and oxygen producing trophic chain (Sadiq et al., 2011). Microalgae have a very rich carbohydrate content, especially fatty acid content (Çiçek et al., 2017). Algae differs basically in terms of cell structure, pigment composition, storage nutrient and presence, number and structure of flagella (Shelknanloymılan et al., 2012; Coşan et al., 2015). Therefore, the purpose of the current research was to study the differences changes in pigment content response of nanosized alumina particles toward green algae (*Desmodesmus* sp. *and Chodatodesmus mucranulatus*) isolated from the aquatic environment.

2. Materials and methods

2.1. Nanoparticles preparation

Nanopowder alumina oxide (Al_2O_3) were obtained from Nanografi Co. Ltd. (Purity 99+%, average particle size 20–80 nm, Hydrophilic) (Ankara, Turkey). Nanopowder alumina oxide SEM photographs were taken and dimensions were measured Figure 1. SEM photographs were obtained by using Jeol brand SEM.

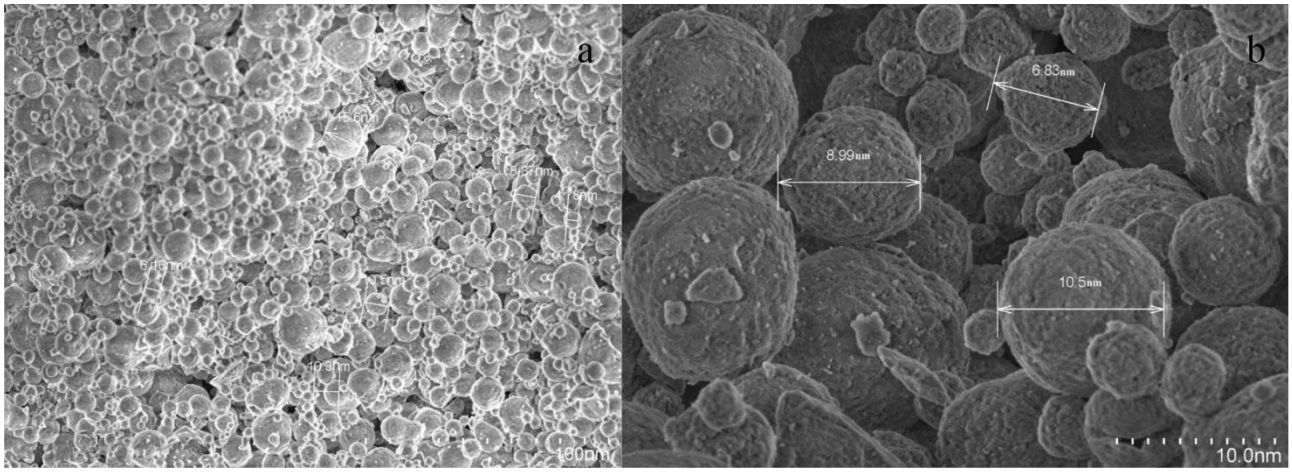

Figure 1 a and b) Nanopowder alumina oxide (Al_2O_3) SEM image

2.2. Test organisms and cultivation conditions

Environmental water samples were taken from the following localities Apa Dam Lake (37°22'10''N 32°29'40''E), and Eber Lake (38°39'09''N 31°10'08''E). The local samples like stone, mud and plants were collected from their natural habitats carried to the laboratory in glass bottles filled with lake water. In order to obtain monocultures, the dilution method was applied Rippka. Specimens taken from various aquatic environments placed in glass bottles and

brought to the laboratory. Inverted microscope was used to obtain single cells from mixed species with pasteur pipette technique. Subsequently, the single cells obtained were transferred to BG 11 medium (Table 1). These cell were then inoculated into test tubes containing medium BG-11 medium to form a pure culture according to Rippka's method (Rippka, 1988). The cultures were incubated at 25 °C for 15-20 days in accordance with photosynthesis, with 12 h light, 12 h darkness under 3000 lux fluorescein light.

2.3. Preparation of Test Solutions

The stock solution of Al_2O_3 NPs was prepared in deionized water. The solution was then vortexed for 20 seconds and sonicated for 30 minutes in an ultra sonic water bath (Bandelin, SonoRex) to ensure maximum distribution in water. After all these steps, the test concentrations determined by preliminary studies were prepared by stock solution dilution. The prepared test solutions were added to the BG-11 medium.

2.4. Acute toxicity studies

Cells were counted with thoma slide after they were increased. 90 ml of BG-11 medium and 10 ml of test solution containing 10^6 cells were added to 200 ml of the erlenmeyer to perform the exposure of the algae species (*Desmodesmus* sp., *Chodatodesmus mucranulatus*) to the Al_2O_3 NPs. Exposure studies were also carried out in orbital shakers (wiseshake) to prevent agregations in the stationary environment of Al_2O_3 NPs, to achieve the desired constant temperature and natural conditions of algae. The speed of the shaker was set so that the cells would not be damaged, but at the same time would block the aggregate formation of the particles (85 rpm). The test conditions were set at 25 °C, 12:12 (daylight:darkness). After the experiment was established, 2 ml samples were taken at 24, 48, 72 hours after each concentration. The algal chlorophyll content measurements were performed at 72 h as described in the OECD method (Test, 1984).Cell counts and pigment measurements were made on these samples. Exposure studies were performed in 3 replicates independently of each other.

Table 2. BG-11 medium used in the purification of species

BG-11 Medium	**g/L**		
$NaNO_3$	15	**Trace elements**	**mg/L**
K_2HPO_4	0.4	H_3BO_3	61
$MgSO_4$. $7H_2O$	0.75	$MnSO_4$. H_2O	169
$CaCl_2$. $2H_2O$	0.36	$ZnSO_4$.$7H_2O$,	287
Citric acid	0.06	$CuSO_4$. $5H_2O$	2.5
Iron (III) ammonium citrate	0.06	$(NH_4)_6Mo_7O_{24}$. $4H_2O$	12.5
Na_2-EDTA	0.01		
Na_2CO_3	0.2		

2.5. Chlorophyll measurement

Chlorophyll a (Chla), chlorophyll b (Chlb) and carotenoids (Chlc) were identified according to Lichtenthaler and Wellburn (1983). Briefly, 2 ml algae cultures were centrifuged at 2000 rpm, then the supernatant was discarded and 80% (v/v) acetone was added to the samples and placed at 4 °C for 24 hours. Then, the light absorption of these samples were measured with a spectrophotometer (Hange-Lange brand DR 2800) at 663, 646 and 470 nm. Pigment contents were calculated with the formula given below.

$$Chla = 12.21A_{663} - 2.81A_{646}$$
$$Chlb = 20.13A_{646} - 5.03A_{663}$$
$$Chlc = (1000A_{470} - 3.27C_{Chla} - 104C_{Chlb})/229$$

2.6. Statistical analyzes

All experiments were repeated independently three times and the data were recorded as mean value with standard deviation. Analyzes were performed using SPSS one-way analysis of variance (ANOVA), tukey multiple comparison analysis.

3. Results

3.1. Algae culture

When isolating the algae, an inverted microscope was used and continued until the single cell was lowered. single cells were transferred to the BG-11 medium and the result was determined as *Desmodesmus* sp. and *Chodatodesmus mucranulatus* species were obtained from the Apa Dam lake and Eber lake. Light microscope images of species after Al_2O_3 NPs exposure are given in Fig. 2 and 3.

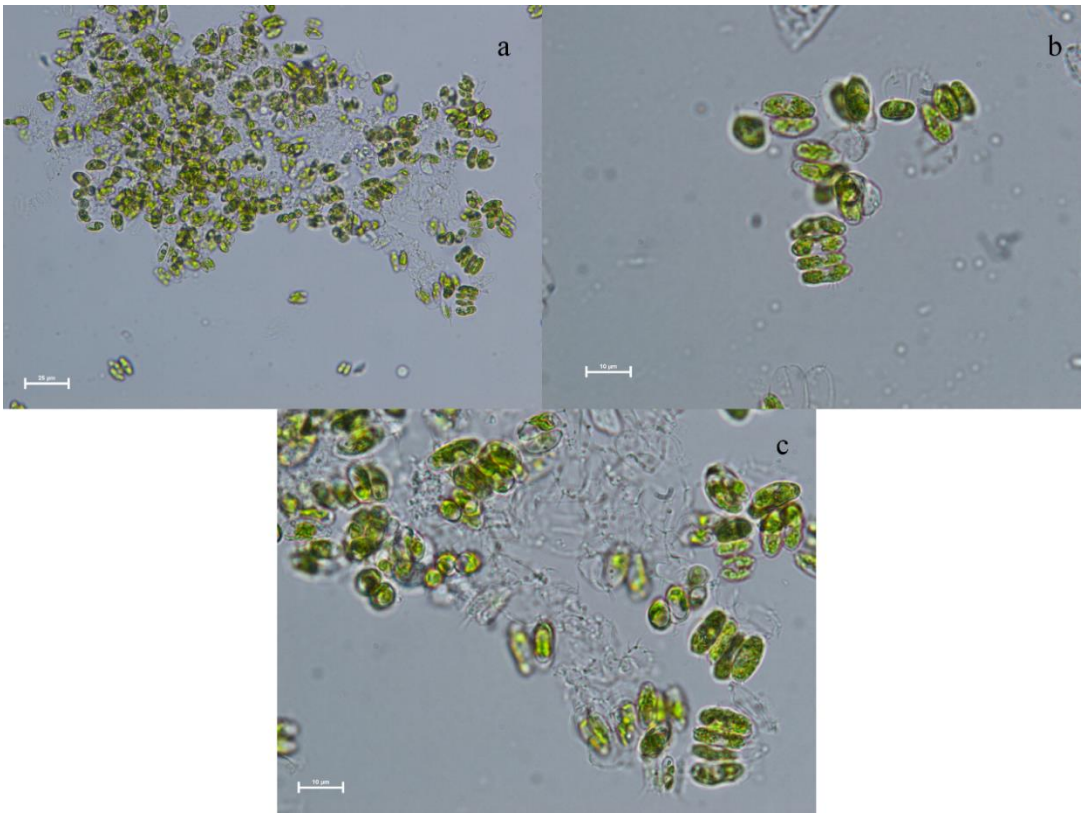

Figure 2. Light microscope images of *Desmodesmus* species after Al_2O_3 NPs exposure: a and b) X40, c) X100

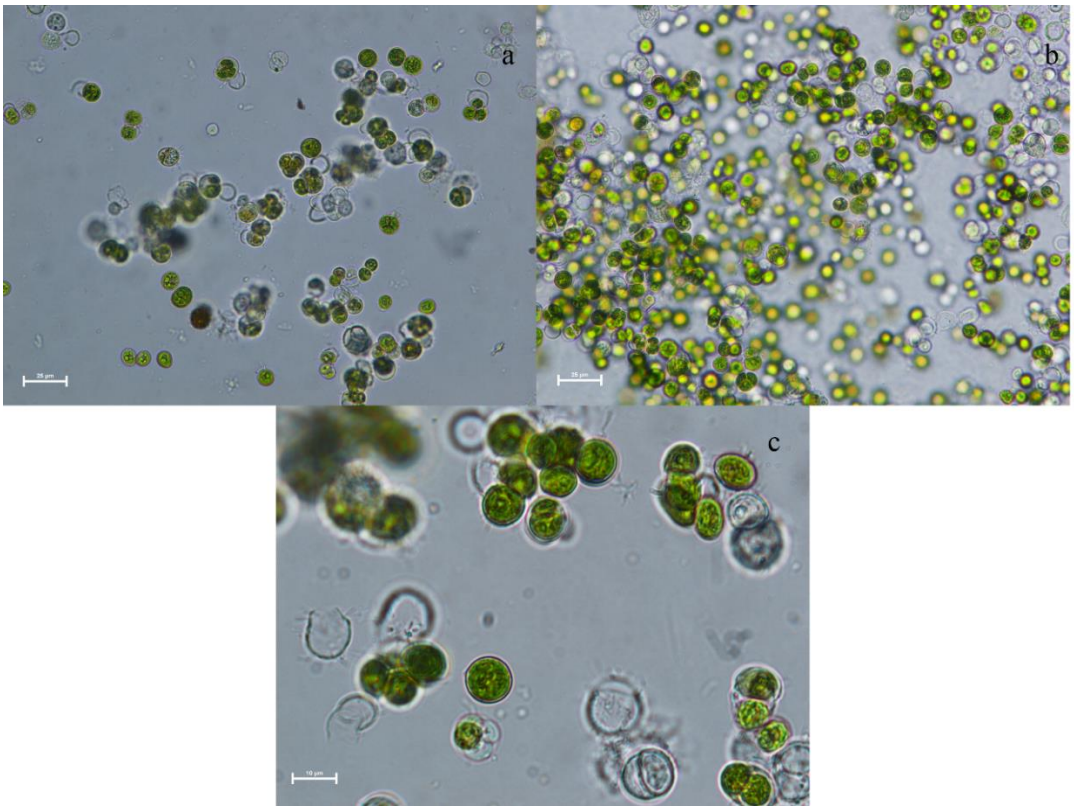

Figure 3. Light microscope images of *Chodatodesmus mucranulatus* after Al_2O_3 NPs exposure: a and b) X40, c) X100

3.2. Pigment content

Desmodesmus sp. and *Chodatodesmus mucranulatus* were exposed to 5-80 nm Al_2O_3 nanoparticles for 72 h at 3, 6, 12, 24, 48 and 96 mg /L concentrations in BG-11 medium.

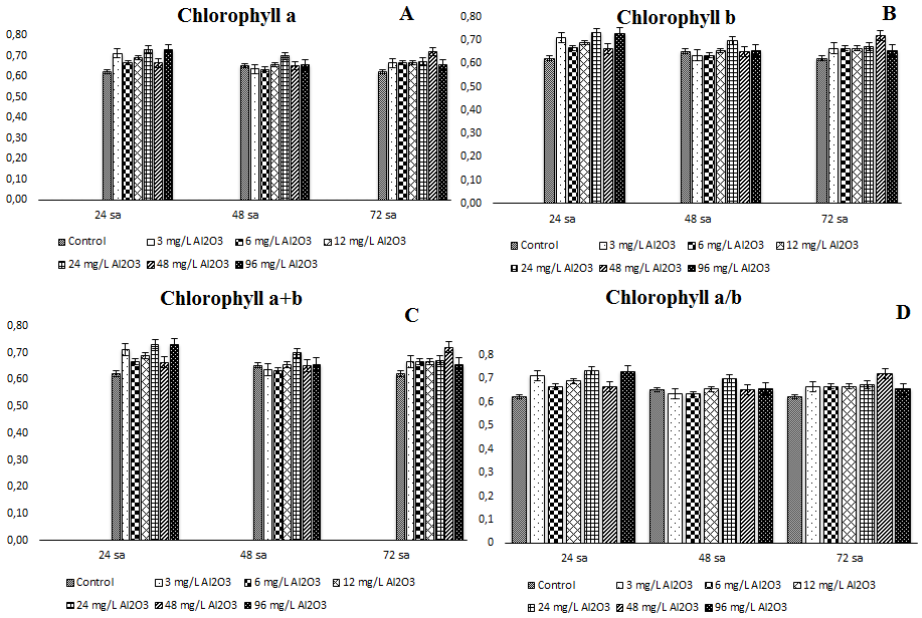

Figure 4. Chlorophyll (a, b, a+b, a/b) values of *Chodatodesmus mucranulatus* exposed to Al_2O_3 NPs

In treatment groups, Chla content increased with prolonged exposure duration. Generally, In the treatment groups of *Chodatodesmus mucranulatus*, the Chla content increased as the duration of exposure prolonged. However, at the 48 mg /L test concentration, the Chla content decreased for 48 hours exposure and increased again when the exposure duration prolonged to 72 h. Generally, when we look at the content of chlb, the content of Chlb is increased as the duration of exposure is prolonged. As is the case in Chla, during 48 h exposure at 48 mg/L, Chlb content decreased by 7% compared to 24 h and increased again when exposure duration prolonged to 72 (Figure 4).

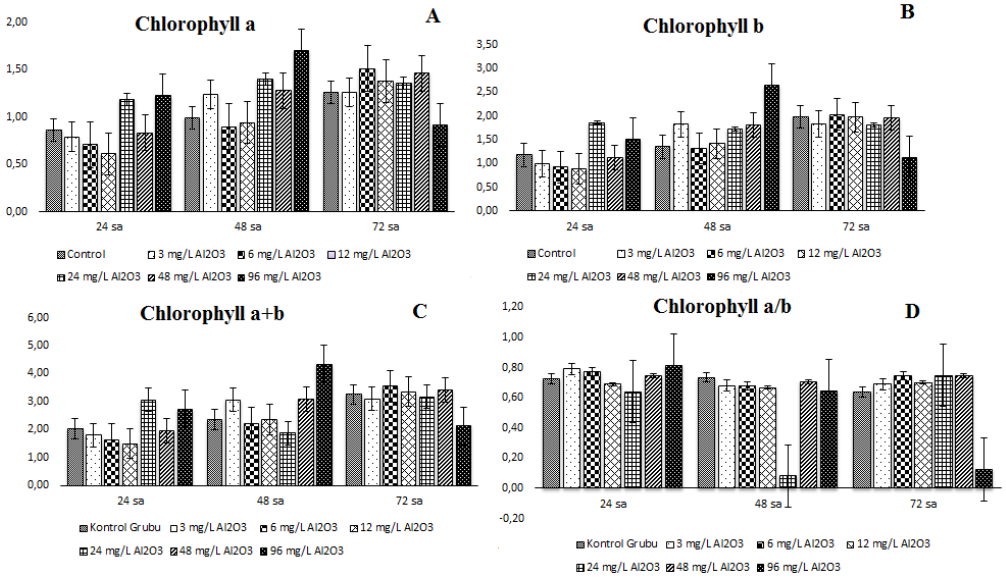

Figure 5. Chl (a, b, a+b, a/b) values of *Desmodesmus* sp. exposed to Al_2O_3 NPs

In the *Desmodesmus* sp. as *Chodatodesmus mucranulatus* was generally increased Chla content in the treatment groups as the duration of exposure prolonged. In the 96 mg/L only, Chla content reduced at 72 h exposure. Chlb content of *Desmodesmus* sp. increased as exposure duration prolonged, as was Chla in Chlb content. At 24 h of exposure at 24 mg/L and at 72 h at 96 mg/L, Chlb content reduced by 8% and 44% respectively (Figure 5). Compared the two green algae pigments, the content of Chla and Chlb in the control and treatment groups of *Desmodesmus* sp. is generally higher..

4. Conclusions and discussion

NPs have begun to be used more and more in the last 30 years due to their unique properties such as many different consumer products, electronics, catalysis, biomedical applications, drugs and drug delivery, cosmetics, energy, and materials (Nowack and Bucheli, 2007). For this reason, NPs have a potential to pollute the environment nowadays

much more than in the past (Burklew et al., 2012). However, the positive and hazardous effects of NPs on ecosystems are still entirely unknown (Oberdörster et al., 2005). Thus, the environmental risk of NPs, the physicochemical properties of NPs are referable their nano/small size, synthetic, impurity ratio, large surface area, chemical composition, surface reactivity, charge, shape and environment interactions (Oberdorster et al., 2005; Qukarroum et al., 2012).

Metal oxide nanoparticles, such as aluminum oxide (Al_2O_3) are interesting for a wide variety of applications due to their unique physical and chemical properties (Huang et al., 2010). It has important applications especially in the ceramic industry and is used as abrasive materials, absorbents and biomaterials and strengthens metal matrix composites. (Sadiq et al., 2009). Since Al_2O_3 NPs are highly preferred, many *in vivo* and *in vitro* studies have been conducted in the literature on many cell lines (such as human, mouse), as well as a large number of indicator organisms such as yeast, bacteria and nematodes. For example, Zhang et al., 2011 studied the toxic effects of nanoparticles of Al_2O_3 NPs in human fetal lung fibroblasts (HFL1) *in vitro*. The results show that Al_2O_3 NPs lead to cellular mitochondrial dysfunction, morphological modifications and apoptosis at a concentration range of 0.25-1.50 mg /mL, and that toxic effects are clearly visible in a dose-dependent manner. Jeng and Swanson 2006, in their study of toxicity of Al_2O_3 NPs in Neuro-2A (mouse neuroblastoma) cells, noted that Al_2O_3 NP reduced mitochondrial function at 100 µg/mL concentration. The effect on the cellular plasma membrane was demonstrated by measuring LDH leakage and did not cause LDH leakage after 24 hours exposure. In addition, it showed less than 2% apoptosis at 100 µg / mL. Shrivastava et al., 2014 show subacute exposure effects of Al_2O_3 NPs with oxidative stress and histological changes in mouse brain and liver. As a result, it is confirmed that the interaction of absorpted Al_2O_3 NPs with cellular components can produce reactive oxygen species (ROS), and that the size of ROS production may lead to cellular toxicity if the cell undergoes antioxidant defense. Pakrashi et al., 2011 evaluated the cytotoxicity of Al_2O_3 NPs at low exposure levels in freshwater bacterial isolates (*Bacillus licheniformis*). Exposure to 1 µg / mL Al_2O_3 NP for 2 hours caused a 17% decrease in cell viability according to the results of the plate count and MTT assay. Wang et al., 2009, evaluated the toxicity of Al_2O_3 NPs in *Aenorhabditis elegans* (nematode). Al_2O_3 NPs are toxic to C. elegans, especially their reproductive ability. García-Saucedo et al., 2011 noted that low toxicity of Al_2O_3 NPs did not show low or no toxicity in *Saccharomyces cerevisiae* (yeast) cells.

Algal toxicity tests are widely used to assess effects of hazardous substances in the aquatic environments. Algae plays a significant task in the stabilization of water environments, the first level of the trophic chain producing oxygen and organic matter. In our study, the aqueous media employed was BG-11 (Stanier et al., 1971). Because, these media contain metal ions in trace amounts to maximize the growth of algae. Algae as other plants cells have cell walls that form the primary site for interaction. This cell wall is a barrier to entry of the NPs into the cells. The main cell wall components are carbohydrates which are bound to form a complex network and proteins (Sadiq et al., 2011; Knox 1995). In our study, responses of *Desmodesmus* sp. and *Chodatodesmus mucranulatus* to the Al_2O_3 NPs were dependent on consantration and duration of exposure. The chla, chlb, chl a+b, chl a/b contents of the six group of treatments are found in Figure 4, 5. chl contents of the Al_2O_3 NPs outspread an order of magnitude. In the obtained data, the content of the pigment in the *Desmodesmus* sp. is calculated more than the *Chodatodesmus mucranulatus*. This suggests that Al_2O_3 NPs give more toxicity to the *C. mucranulatus*. However, it is interesting that when the exposure time is up to 72 hours, the content of chlorophyll is very low of *Desmodesmus* sp., and the *C. mucranulatus* remain almost the same. This is probably due to the increased internalization of Al_2O_3 NPs by *Desmodesmus* sp. , which increased the content of chlorophyll in the first days of the ending exposure and then showed a severe toxic effect. Sadiq et al., 2011, a marked decrease in chl content was observed in cells treated with Al_2O_3 NPs compared to those not applied and it was noted that cells were more effective. Namely, during the experiment a concentration-dependent reduce in chl content was recorded, corroborating that growth inhibitory effect was due to increased concentration of the particles. In another study, the toxic effect of $(ZnO\text{-}TiO_2)_{NCM}$ on photosynthetic pigment contents was investigated on freshwater *Desmodesmus multivariabilis* which was exposed for 72 h to 0.1, 0.01 and 0.001 mg l^{-1} of $(ZnO\text{-}TiO_2)_{NCM}$. According to this study, the effect of the photosynthetic pigment contents of (ZnO-TiO2)NCM in varying concentrations indicated differences depending on the exposure duration and concentration (Dağlıoğlu and Öztürk, 2018). In the Kulacki and Cardinale (2012) study, the most common ten species of freshwater pelagic algae in North America were exposed to n-TiO_2. The results indicated that TiO_2 NPs may affect some aspects of the population growth of phytoplankton, but the effects on environmentally relevant concentrations are low. Dağlıoğlu and Türkiş at study, effects on the amount of pigment after exposure to the TiO_2 NPs of duckweed (*Lemna minor)* Which the indicator organism of the aquatic environment have researched. At the end of the 96-h exposure period, chlorophyll a and b levels were discovered important differences between 50-200 mg^{-1} concentrations at $p<0.001$ level. Dağlıoğlu and Öztürk (2016) have been observed that boron particles (nano and micro) accumulate in different amounts in the *Desmodesmus multivariabilis*.

Our study; there are studies on the photosynthetic activity and growth of different algae species of aluminum nanoparticles. Aluminum oxide exhibited toxicity, both different time duration, and varying concentrations. In both species of algae (*Desmodesmus* sp. and *Chodatodesmus mucranulatus*) the concentration-dependent decrease in chlorophyll content was observed. However, the responses of the algae to the aluminum oxide has similar.

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References

Arul Prakash, F., Dushendra Babu, G.J., Lavanya, M., Shenbaga Vidhya, K., Devasena, T. (2011). Toxicity studies of aluminium oxide nanoparticles in cell lines. Int J Nanotechnol Appl, *5*(2), 99-107.

Burklew, C.E., Ashlock, J., Winfrey, W.B., Zhang, B. (2012). Effects of aluminum oxide nanoparticles on the growth, development, and microRNA expression of tobacco (*Nicotiana tabacum*). PloS one, 7(5), e34783.

Coşan, E.D., Tezcan, N., Coşan, D.T. (2015). The effects of chemical and biological plant fertilizer types for used to ıncrease agricultural production on Chlorophyll A, Chlorophyll B, Vitamin C, the length of plants, mitosis and chromosomes of Onion (*Allium cepa*). Biological Diversity and Conservation, 8(2) (2015) 16-22

Çiçek, L.N., Ertan, O.Ö., Erdoğan, Ö., Didinen H., Boyacı, Ö.Y., Kara, D., Zeybek, M., Diken, G. (2017). Distribution of phytoplankton and its relationship with physicochemical parameters in Lake Eğirdir (Isparta/Turkey). Biological Diversity and Conservation, 10(3), 150-162

Çolak, A.D., Nas, B. (2016). $NiFe_2O_4$ Nanokompozitinin Olası Toksik Etkisine Karşı Olueropein'in Koruyucu Rolü. Erzincan University Journal of Science and Technology, 9 (Special Issue I), 172-183.

Dağlıoğlu Y, Özturk Y.B. (2016b). *Desmodesmus multivariabilis*'in bor partikullerine maruz kalmada biyolojik birikiminin değerlendirilmesi. Biological Diversity and Conservation. 9(3), 204–209.

Dağlıoğlu, Y., Çelebi, S.M., Önalan, Ş., (2016a). Determination of Acute Toxic Effects of Poly (Vinylferrocenium) Supported Palladium Nanoparticle (Pd/PVF+) on *Artemia salina*". Pakistan Journal of Zoology vol. 48(1), 187-193.

Dağlıoğlu, Y., Öztürk, Y.B. (2018). Effect of concentration and exposure time of ZnO-TiO_2 nanocomposite on photosynthetic pigment contents, ROS production ability, and bioaccumulation of freshwater algae. *Caryologia*, *71*(1), 13-23.

Dağlıoğlu, Y., Türkiş S., **(**2017)**.** TiO_2 nanopartikül Uygulamasının Su Mercimeğinin (*Lemna minor* L.) Fotosentetik Pigment İçeriği Üzerine Etkisi. Acta Biologica Turcica, 30(4), 108-115.

García-Saucedo, C., Field, J.A., Otero-Gonzalez, L., Sierra-Álvarez, R. (2011). Low toxicity of HfO_2, SiO_2, Al_2O_3 and CeO_2 nanoparticles to the yeast, Saccharomyces cerevisiae. Journal of hazardous materials, 192(3), 1572-1579.

Gosteva, I., Morgalev, Y., Morgaleva, T., Morgalev, S. (2015). Effect of Al_2O_3 and TiO_2 nanoparticles on aquatic organisms. In IOP Conference Series: Materials Science and Engineering, Vol. 98, No. 1, p. 012007. IOP Publishing.

Huang, Y.W., Wu, C.H., Aronstam, R.S. (2010). Toxicity of transition metal oxide nanoparticles: recent insights from in vitro studies. Materials, 3(10), 4842-4859.

Jeng, H. A., Swanson, J. (2006). Toxicity of metal oxide nanoparticles in mammalian cells. Journal of Environmental Science and Health Part A, 41(12), 2699-2711.

Knox, J.P. (1995). The extracellular matrix in higher plants. 4. Developmentally regulated proteoglycans and glycoproteins of the plant cell surface. The FASEB Journal, *9*(11), 1004-1012.

Kulacki, K. J., Cardinale, B. J. (2012). Effects of nano-titanium dioxide on freshwater algal population dynamics. PLoS One, *7*(10), 1-7.

Lichtenthaler, H. K., Wellburn, A. R. (1983). Determinations of total carotenoids and chlorophylls a and b of leaf extracts in different solvents, 603rd Meeting, Liverpool, 591-592.

Nowack, B., Bucheli, T.D. (2007). Occurrence, behavior and effects of nanoparticles in the environment. Environmental pollution, 150(1), 5-22.

Oberdorster, G., Oberdorster, E., Oberdorster, J., (2005). Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. Environmental Health Perspectives, 113, 823–839.

Özkan, Y., İrende, İ., Akdeniz, G., Kabakçı, D., Sökmen, M., (2015). Evaluation of the Comparative Acute Toxic Effects of TiO_2, Ag-TiO_2 and ZnO-TiO_2 Composite Nanoparticles on *Apis mellifera* (Honey Bee) ". Jornal of International. Environmental Application&Science, 10(1), 26-36.

Pakrashi, S., Dalai, S., Sabat, D., Singh, S., Chandrasekaran, N., Mukherjee, A. (2011). Cytotoxicity of Al_2O_3 nanoparticles at low exposure levels to a freshwater bacterial isolate. Chemical Research in Toxicology, 24(11), 1899-1904.

Qukarroum, A., Bras, S., Perreault, F., Popovic, R. (2012). Inhibitory effects of silver nanoparticles in two green algae, *Chlorella vulgaris* and *Dunaliella tertiolecta*. Ecotoxicology and Environmental Safety, 78, 80-85.

Rippka, R. (1988). [1] Isolation and purification of cyanobacteria. In Methods in enzymology, Vol. 167, 3-27. Academic Press.

Sadiq, I.M., Chowdhury, B., Chandrasekaran, N., Mukherjee, A. (2009). Antimicrobial sensitivity of *Escherichia coli* to alumina nanoparticles. Nanomedicine: Nanotechnology, Biology and Medicine, 5(3), 282-286.

Sadiq, I.M., Pakrashi, S., Chandrasekaran, N., Mukherjee, A. (2011). Studies on toxicity of aluminium oxide (Al_2O_3) nanoparticles to microalgae species**:** *Scenedesmus* sp and *Chlorella* sp. Journal of Nanoparticle Research, 13, 3287-3299

Shelknanloymılan, L., Atıcı, T., Obal, O. (2012). Removal of nitrogen and phosphate by using *Choleralla vulgaris* on synthetic and organic materials waste water. Biological Diversity and Conservation. 5/2 (2012) 89-94.

Shrivastava, R., Raza, S., Yadav, A., Kushwaha, P., Flora, S.J. (2014). Effects of sub-acute exposure to TiO_2, ZnO and Al_2O_3 nanoparticles on oxidative stress and histological changes in mouse liver and brain. Drug and chemical toxicology, 37(3), 336-347.

Stanier, R. Y., Kunisawa, R., Mandel, M., Cohen-Bazire, G. (1971). Purification and properties of unicellular blue-green algae (Order Chroococcales). Bact. l~ev. 85, 171-205.

Test, O.A.G.I. (1984). OECD guideline for testing of chemicals 201. Paris, France: Organisation of Economic Cooperation and Development.

Wang, H., Wick, R. L., Xing, B. (2009). Toxicity of nanoparticulate and bulk ZnO, Al_2O_3 and TiO_2 to the nematode *Caenorhabditis elegans*. Environmental Pollution, 157(4), 1171-1177.

Zhang, X. Q., Yin, L. H., Meng, T.A.N.G., Pu, Y.P. (2011). ZnO, TiO_2, SiO_2, and Al_2O_3 nanoparticles-induced toxic effects on human fetal lung fibroblasts. Biomedical and Environmental Sciences, 24(6), 661-669.

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Research article/Araştırma makalesi

Geophytes of Kızıldağ, Masa Mountain and Yılanlı Mountain (Muğla/Turkey)

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Abstract

Kızıldağ, Masa Mountain and Yılanlı Mountains are located within the borders of Menteşe district in Muğla province. Plant species that compose our research subjects were collected between 2000 and 2017 years from Yılanlı Mountain, between 2009-2017 years from Kızıldağ and Masa Mountain. As a result of identification of the plant species, 77 geophyte taxa belonging to 18 families were identified and 11 of them were determined as endemic and rare geophyte taxa. Of the identified taxa, 21 were Mediterranean elements (27,3%), 28 were East Mediterranean elements (36,4%), 2 were European-Sibirian elements (2,6%), 2 were Iran-Turanian elements (2,6%) and phytogeographical of 24 taxa (31,1%) was unknown or widespread.

Key words: geophyte, Kızıldağ, Masa Mountain, Muğla, Yılanlı Mountain

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Kızıldağ, Masa Dağı ve Yılanlı Dağı (Muğla)'nın geofitleri

Özet

Kızıldağ, Masa Dağı ve Yılanlı Dağları Muğla İli Menteşe İlçe sınırları içerisinde yer almaktadır. Araştırma konumuzu oluşturan bitkiler Kızıldağ ve Masa Dağı'ndan 2009-2017 yılları arasında, Yılanlı Dağı'ndan da 2000-2017 yılları arasında toplanmıştır. Bitkilerin teşhisleri neticesinde 18 familyaya ait 77 geofit bitki tespit edilmiş olup bunlardan 11 tanesi endemik ve nadir geofit taksonu olarak belirlenmiştir. Tespit edilen taksonlardan 21 tanesi Akdeniz Elementi (27,3%), 28 tanesi Doğu Akdeniz Elementi (36,4%), 2 tanesi Avrupa-Sibirya Elementi (2,6%), 2 tanesi İran-Turan Elementi (2,6%) ve 24 takson (31.1%) geniş yayılışlı ya da fitocoğrafik bölgesi bilinmemektedir.

Anahtar kelimeler: geofit, Kızıldağ, Masa Dağı, Muğla, Yılanlı Dağı

1. Giriş

Türkiye, doğal bitki zenginliği açısından, Dünyada ılıman iklim kuşağındaki ülkelerin ilk sıralarında yer almaktadır. İklim farklılıkları topoğrafik çeşitlilikler, jeolojik ve jeomorfolojik çeşitlilikler, deniz, göl, akarsu gibi değişik su ortamı çeşitlilikleri, 0-5000 m'ler arasında değişen yükseklik farklılıkları, üç değişik bitki coğrafya bölgesinin birleştiği yerde oluşu, Anadolu diyagonalinin doğusu ve batısı arasında ekolojik farklılıklar bulunması ve bütün bu ekolojik çeşitliliğin floristik çeşitliliğe yansıması bu zenginliğin sebepleridir. Ancak, bilinçsizce uygulanan aşırı otlatma, artan nüfus ile orantılı olarak çoğalan tarla açma olayları, orman yangınları, kirlenme ve ticari amaçla doğadan bilinçsiz ve aşırı miktarda bitki toplanması nedenleriyle bu zenginliğimiz tehdit altındadır (Ekim, 2005).

Yılın büyük bölümünü toprak altında soğan, tuber ve rizom halinde geçiren, geofit (yer bitkileri) ya da kriptofit (saklı bitkiler) olarak bilinen bitkiler de ülkemizdeki floristik zenginliğin önemli bir parçasını oluştururlar (Baydar, 2016). Anadolu, önemli geofit merkezlerinden birisidir, yaklaşık 100 tohumsuz geofit, 1000-1200 dikotiledon geofit, 200-250 kadar petaloid olmayan monokotiledon geofit ve 1000 civarında petaloid monokotiledon geofit taksonuna sahiptir (Demir ve Eker, 2015).

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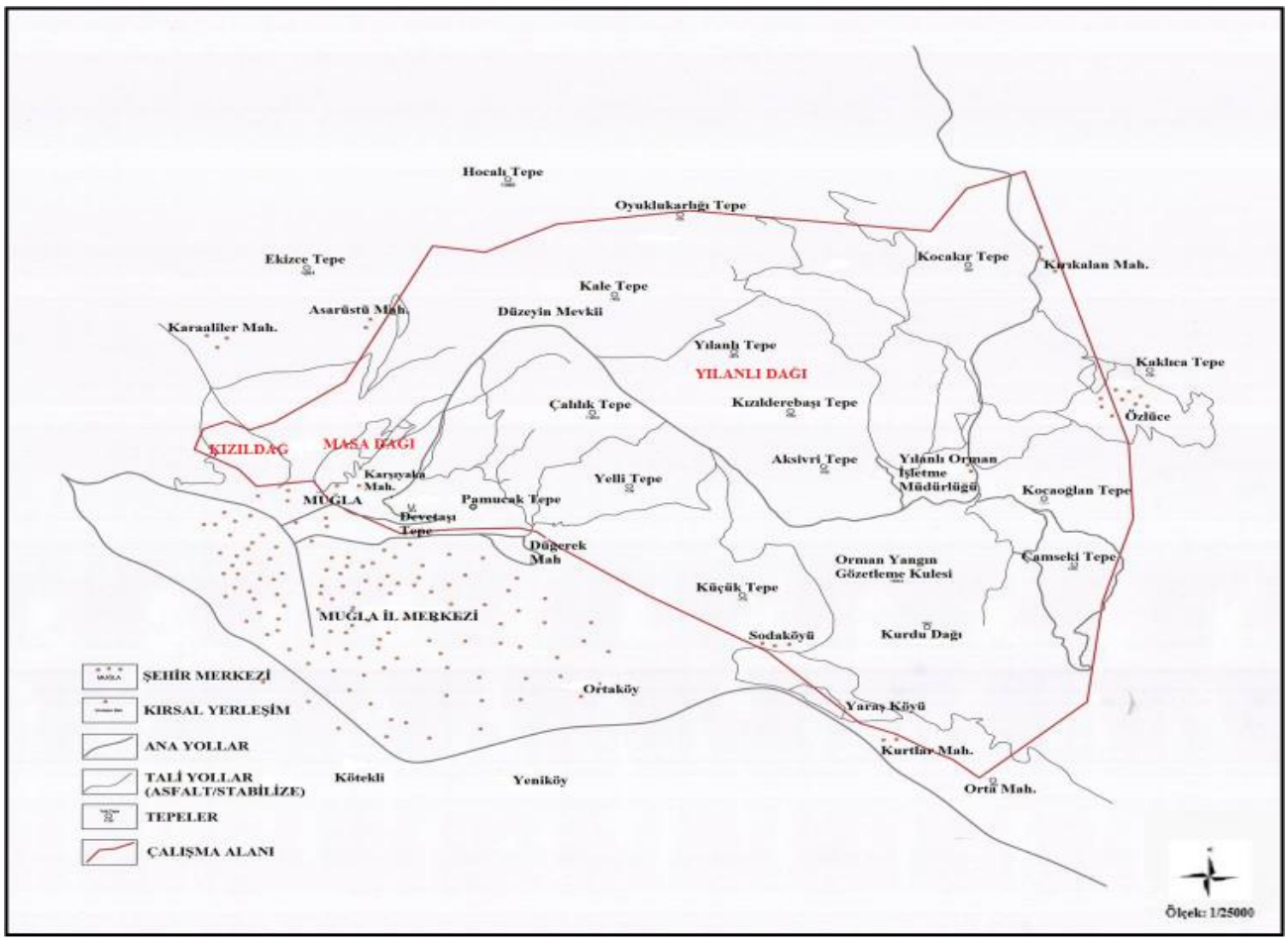
Bu çalışma daha çok geofit taksonların belirlenmesine yönelik olup ileride yapılacak geofit çalışmalarına kaynak teşkil etmesi amaçlanmıştır. Muğla il merkezinde bulunan Kızıldağ, Masa Dağı ve Yılanlı Dağı Akdeniz fitocoğrafik bölgesi içerisinde yer alıp Davis'in kullandığı Grid sistemine göre C2 karesine girmektedir. Çalışma alanının haritası Şekil 1'de gösterilmiştir.



Şekil 1. Çalışma alanının genel haritası

2. Materyal ve yöntem

Çalışma alanımızın materyalini Kızıldağ, Masa Dağı ve Yılanlı Dağı'nda doğal yayılış gösteren geofit bitkiler oluşturmaktadır. Bitkiler, Kızıldağ ve Masa Dağı'ndan 2009-2017 yılları arasında, Yılanlı Dağı'ndan 2000-2017 yılları arasında ismi geçen alanlarda vejetasyon dönemlerinde periyodik olarak arazi çalışmaları yapılmaya devam edilmiştir. Türlerin teşhisinde "Flora of Turkey and the East Aegean Islands", "The revision of the genus *Fritillaria* L. (Liliaceae) in the Mediterranean region (Turkey)", isimli kaynaklardan yararlanılmıştır (Davis, 1978; Davis, 1984; Davis ve ark., 1965; Güner ve ark., 2000; Tekşen ve Aytaç, 2011). Tespit edilen türlerin isimleri "Türkiye Bitkileri Listesi (Damarlı Bitkiler)" kitabına göre düzenlenmiştir (Güner ve ark., 2012). Endemik ve nadir taksonların tehlike kategorileri "Türkiye Bitkileri Kırmızı Kitabı (Ekim ve ark, 2003)" ve IUCN (2003) kriterleri'nden yararlanılarak belirlenmiştir. Herbaryum materyali haline getirilen bitkiler Muğla Sıtkı Koçman Üniversitesi Fen Fakültesi Biyoloji Bölümü Herbaryumu'nda muhafaza edilmektedir.

3. Bulgular

Kızıldağ, Masa Dağı ve Yılanlı Dağları'nda yapılan çalışmalar neticesinde 18 familyaya ait 39 cins 77 geofit bitki türü tespit edilmiş olup, bunlardan 11 taksonun endemik ve nadir olduğu belirlenmiştir. Endemik ve nadir taksonlardan 1'i EN, 4'ü VU, 5'i LC ve 1'i NT kategorilerinde sınıflandırılmıştır. Çalışma alanında 14 geofit taksonla Orchidaceae ve aynı takson sayısıyla Asparagaceae familyaları öne çıkmaktadır. Bunu 9 taksonla Amaryllidaceae ve 9 taksonla Iridaceae familyaları takip etmektedir (Tablo 1).

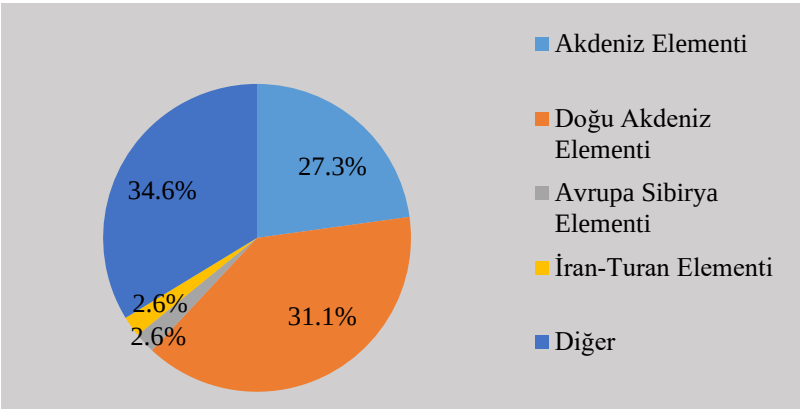
Tablo 1. Kızıldağ, Masa Dağı ve Yılanlı Dağı'nın geofitleri ve endemizm/nadirlik durumları

Familya	**Takson**	**Endemizm/ Nadirlik**	**Tehlike Kategorisi**
Amaryllidaceae	*Allium ampeloprasum* L.	-	-
	Allium deciduum Özhatay & Kollmann subsp. *deciduum*	Endemik	LC
	Allium flavum L. subsp. *tauricum* (Besser ex Rchb.) Stearn var. *tauricum*	-	-
	Allium guttatum Steven subsp. *sardoum* (Moris) Stearn	-	-
	Allium hirtovaginum Candargy	-	-
	Allium scorodoprasum L. *subsp. rotundum* (L.) Stearn	-	-
	Galanthus gracilis Celak.	-	-
	Sternbergia clusiana (Ker-Gawl.) Ker Gawl.	-	-
	Sternbergia lutea (L.) Ker-Gawl.	-	-
Araceae	*Biarum marmarisense* (P.C. Boyce) P.C. Boyce	-	-
	Dracunculus vulgaris Schott	-	-
Asparagaceae	*Asparagus acutifolius* L.	-	-
	Muscari armeniacum Leichtlin ex Baker	-	-
	Muscari comosum (L.) Mill.	-	-
	Muscari neglectum Guss.	-	-
	Muscari racemosum Mill.	Endemik	VU
	Ornithogalum alpigeum Stapf	Endemik	NT
	Ornithogalum armeniacum Baker	-	-
	Ornithogalum comosum L.	-	-
	Ornithogalum lanceolatum Labill.	-	-
	Ornithogalum nivale Boiss.	Endemik	LC
	Ornithogalum nutans L	-	-
	Ornithogalum oligophyllum E.D. Clarke	-	-
	Prospero autumnale (L.) Speta	-	-
	Scilla bifolia L.	-	-
Asteraceae (Compositae)	*Leontodon tuberosus* L.	-	-
Caprifoliaceae	*Valeriana dioscoridis* Sm.	-	-
Colchicaceae	*Colchicum atticum* Spruner	-	-
	Colchicum variegatum L.	-	-
Cypericaceae	*Carex flacca* Schreb. subsp. *erythrostachys* (Hoppe) Holub	-	-
Dioscoreaceae	*Dioscorea communis* (L.) Caddick & Wilkin	-	-
Iridaceae	*Crocus biflorus* Mill. subsp. *nubigena* (Herb.) B. Mathew	-	-
	Crocus cancellatus Herbert subsp. *mazziaricus* (Herbert) B. Mathew	-	-
	Crocus chrysanthus (Herb.) Herb.	-	-
	Crocus fleischeri J. Gay	-	-
	Gladiolus anatolicus (Boiss.) Stapf	Nadir	VU
	Gladiolus illyricus W.D.J.Koch	-	-
	Iris germanica L.	-	-
	Iris unguicularis Poir. subsp. *carica* (Wern. Schulze) A.P.Davis & Jury var. *carica*	Endemik	LC
	Romulea tempskyana Freyn	-	-
Juncaceae	*Juncus acutus* L. subsp. *acutus*	-	-
	Juncus sparganiifolius Boiss. & Kotschy	Endemik	LC

Tablo 1. (devam ediyor)

Liliaceae	*Fritillaria bithynica* Baker	-	-
	Fritillaria sibthorpiana (Sm.) Baker subsp. *enginiana* Byfield & N. Özhatay	Endemik	EN
	Gagea bohemica (Zauschn.) Schultes & Schultes	-	-
	Gagea graeca (L.) Irmsch	-	-
	Gagea peduncularis (J. & C. Presl) Pascher	-	-
	Tulipa agenensis DC.	-	-
	Tulipa orphanidea Boiss	-	-
Orchidaceae	*Anacamptis pyramidalis* (L.) L.C.M.Richard	-	-
	Cephalanthera epipactoides Fisch. & C.A.Mey	-	-
	Cephalanthera longifolia (L.) Fritsch	-	-
	Cephalanthera rubra (L.) L.C.M. Rich.	-	-
	Epipactis helleborine (L.) Crantz subsp. *helleborine*	-	-
	Ophrys holoserica (Burm.f) Greuter subsp. *heterochila* Renz & Taubenheim	-	-
	Ophrys vernixia Brot. *subsp. vernixia*	-	-
	Orchis anatolica Boiss.	-	-
	Orchis coriophora L. subsp. *coriophora*	-	-
	Orchis laxiflora Lam. subsp. *laxiflora*	-	-
	Orchis tridentata Scop.	-	-
	Orchis quadripunctata Cyr. ex Ten	Nadir	VU
	Platanthera chlorantha (Cruster) Rchb.	-	-
	Spiranthes spiralis (L.) Chevall.	-	-
Papaveraceae	*Corydalis solida* (L.) Clairv. subsp. *solida*	-	-
	Corydalis tauricola (Cullen & Davis) Lidén	Endemik	LC
Poaceae (Graminea)	*Dactylis glomerata* L. subsp. *hispanica* (Roth) Nyman	-	-
	Hordeum bulbosum L.	-	-
	Poa bulbosa L.	-	-
Polygonaceae	*Rumex tuberosus* L. subsp. *tuberosus*	-	-
Primulaceae	*Cyclamen coum* Mill. subsp. *coum*	-	-
	Cyclamen hederifolium Aiton	Nadir	VU
Ranunculaceae	*Anemone blanda* Schott & Kotschy	-	-
	Anemone coronaria L.	-	-
	Ranunculus isthmicus Boiss. subsp. *stepporum* P.H.Davis	-	-
	Ranunculus sprunerianus Boiss.	-	-
Xanthorroeaceae	*Asphodeline brevicaulis* (Bertol.) J. Gay. subsp. *brevicaulis*	-	-

Tabloda familyalar ve familyalara ait taksonlar harf sırasına göre verilmiştir (Tehlike kategorileri: EN: Tehlikede, VU: Zarar görebilir, NT: Tehlike altına girebilir, LC: En az endişe verici) Tespit edilen taksonlardan 21 tanesi Akdeniz Elementi (27,3%), 28 tanesi Doğu Akdeniz Elementi (36,4%), 2 tanesi Avrupa-Sibirya Elementi (2,6%), 2 tanesi İran-Turan Elementi (2,6%) ve 24 takson (31.1%) geniş yayılışlı ya da fitocoğrafik bölgesi bilinmemektedir (Şekil 2).



Şekil 2. Araştırma alanındaki geofitlerin fitocorafik bölgelere göre dağılımı

4. Sonuçlar ve tartışma

Kızıldağ, Masa Dağı ve Yılanlı Dağı'nda 18 familya, 39 cinse ait 77 geofit bitki taksonu tespit edilmiştir. Ülkemizde, diğer illere kıyasla Muğla İli'nde oldukça ciddi bir yayılış alanına sahip olan Orchidaceae familyasına ait taksonların yumruları sahlep ve dondurma yapımında kullanılmasından dolayı büyük ticari öneme sahiptir. Ülke ekonomisine katkı sağlayan bu taksonlarımızın toplanması ve ihracatına yönelik yönetmelikler sayesinde iyileştirmeler yapılmış olsa da, doğal çiçek soğanlarımız hala bilinçsiz toplama, otlatma baskısı, turizm faaliyetleri ve buna benzer birçok nedenden dolayı önemli ölçüde risk altındadır. Biyolojik çeşitliliğimizin sürdürülmesi ve aynı zamanda ülke ekonomisi açısından değer taşıyan bu bitkilerimizin korunmasına yönelik çalışmalar yapılmalı, maddi kaynak sağlamak amacıyla toplama yapan kamuoyunun da bilinçlendirilmesi gerekmektedir.

Teşekkür

Bu çalışma 15/263 numaralı BAP projesi ile desteklenmiştir. Muğla Sıtkı Koçman Üniversitesi Bilimsel Araştırma Projeleri Koordinasyon Birimi'ne yardımlarından dolayı teşekkürü bir borç biliriz.

Kaynaklar

Akbaş, K., Varol, Ö. (2017). Bozburun Yarımadası'nın Geofitleri. Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 7(2), 107-115.

Baydar, H. (2016). Tıbbi ve Aromatik Bitkiler Teknolojisi. 5. Baskı, Isparta, Türkiye.

Davis, P.H., Coode, M.J.E., Cullen, J. (1965). Flora of Turkey and The East Aegean Islands. Vol. 1, Edinburgh University Press, Edinburgh, UK.

Davis, P.H. (1978). Flora of Turkey and the East Aegean Islands. Vol. 2, Edinburgh University Press, Edinburgh, UK.

Davis, P.H. (1978). Flora of Turkey and the East Aegean Islands. Vol. 5, Edinburgh University Press, Edinburgh, UK.

Davis, P.H. (1978). Flora of Turkey and the East Aegean Islands. Vol. 6, Edinburgh University Press, Edinburgh, UK.

Davis, P.H. (1984). Flora of Turkey and The East Aegean Islands. Vol. 8, Edinburgh University Press, Edinburgh, UK.

Davis, P.H. Mill, R.R., Tan, K. (1985). Flora of Turkey and The East Aegean Islands. Vol. 9, Edinburgh University Press, Edinburgh, UK.

Demir, S.C., Eker, İ. (2015). Petaloid monocotyledonous flora of Bolu Province, including annotations on critical petaloid geophytes of Turkey. Pegem Akademi, Ankara.

Demirelma, H., Ertuğrul, K. (2016). The geophytes of the region between Derebucak (Konya/Turkey) – Ibradı and Cevizli (Antalya/Turkey). Biological Diversity and Conservation, 9(3), 52-57.

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

Ekim, T. (2005). Türkiye'nin Biyolojik Zenginlikleri. Türkiye Çevre Vakfı, Ankara.

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

IUCN (2003). Guidelines for Application of IUCN Red List Criteria at Regional Levels, Version 3.0. Gland, Switzerland and Cambridge, UK.

Varol, Ö., Doğru, A., Kaya, E. (2004). Yılanlı Dağı (Muğla)'nın Florası. Ekoloji, 13(50), 23-36.

Varol, Ö. (2004). Muğla İli Geofitleri Üzerine Araştırmalar. Muğla Üniversitesi Yayınları, Muğla.

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Research article/Araştırma makalesi

Anatomy of *Ferulago sandrasica* Peşmen & Quezel and *Ferulago mughlae* Peşmen (Apiaceae) species

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Abstract

Ferulago W. Koch belongs to Apiaceae family and 34 species of this genus grow in Turkey, of which 19 are endemic. *Ferulago* species are known in various regions of our country as "çakşır, asaotu, çakşırotu, çağşır, kılkuyruk, kişniş, geyikotu, kuzukişnişi", etc. Since ancient times, these species have been utilized against intestinal worms, for haemorrhoid treatment, as tonic, sedative, stimulant, digestive facilitator, carminative aphrodisiac and food (as spiceor salad-). In this study, anatomical structures of stem, peduncle, ray, pedicel and leaf parts of *F. mughlea* and *F. sandrasica* were investigated. Characteristic elements were defined with sections taken from aforementioned parts of these species and their structures were demonstrated with photographs. In the transverse section of stem of these species, vascular bundles are regularly lined up in a ring-shaped along the stem. The anatomy of peduncles, rays, and pedicles of the species are generally similar, however, the number of secretory canals of the peduncle, rays, and pedicles have reduced and the pith regions are narrowed. In the superficial sections of the leaves of the species, no cover feathers were observed, the leaf is monofacial and the stoma guard cells are characteristic kidney shaped, usually 3, and one of the neighboring cells is smaller than the others.

Key words: Apiaceae, anatomy, *Ferulago*

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Ferulago sandrasica Peşmen & Quezel ve *Ferulago mughlae* Peşmen (Apiaceae) türlerinin anatomisi

Özet

Apiaceae familyasına ait *Ferulago* W. Koch cinsinin Türkiye'de 34 türü yetişmekte olup bu türlerin 19'u endemiktir. *Ferulago* türleri ülkemizin çeşitli yörelerinde "çakşır, asaotu, çakşırotu, çağşır, kılkuyruk, kişniş, geyikotu, kuzukişnişi vb." adlarıyla bilinmektedir. Eski zamanlardan beri bu türlerden bağırsak solucanlarına karşı, hemaroit tedavisinde, tonik, sakinleştirici, uyarıcı, hazmı kolaylaştırıcı, gaz söktürücü, afrodizyak ve gıda (baharat veya salata olarak) olarak faydanılmaktadır. Bu çalışmada, *F. mughlea* ve *F. sandrasica* türlerinin gövde, pedunkul, ışın, pedisel ve yaprak kısımlarının anatomik yapıları incelenmiştir. Türlerin bu kısımlardan alınan kesitlerle karekteristik elemanları saptanmış ve aydınlatılmıştır. Her iki türde de gövde enine kesitinde iletim doku demetleri gövde boyunca halka şeklinde düzenli olarak sıralanmıştır. Türlerin pedunkul, ışın ve pedisel anatomisi de genel olarak gövdenin anatomisine benzemekte olup ancak pedunkul, ışın ve pedisellerde iletim doku salgı kanallarının sayısı azalmış ve öz bölgesi daralmıştır. Türlerin yaprak yüzeyel kesitlerinde örtü tüyleri gözlenmemiş olup, yapraklar monofasiyaldir ve stoma bekçi hücreleri karakteristik böbrek şekilli, sayıları genellikle 3'tür ve komşu hücrelerden birisi diğerlerinden daha küçüktür.

Anahtar kelimeler: Apiaceae, anatomi, *Ferulago*

1. Giriş

Türkiye ve Doğu Ege Adaları Florası'nda Anadolu'da *Ferulago* cinsinin 32 türünün bulunduğu ve bunlarında 17'sinin endemik olduğu rapor edilmiştir (Peşmen, 1972). Son kayıtlara göre ise *Ferulago* cinsinin ülkemizde 34 türü doğal olarak yetişmekte olup, bunların da 19'unun endemik olduğu bildirilmiştir (Güner, 2012). *Ferulago* cinsi çok yıllık, dik, çıplak veya skabrit tüylerle kaplı olup, otsu bitkilerde kalın kazık kökün çevresinde lifli özellikte yaprak kalıntılarına

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rastlanır. Taban yaprakları 3-6 pinnat, orbikular, üçgenimsi-ovat, oblong, lineer, lanseolat -ipliksi veya setaya benzer şekildedir. Gövde dik, dallanmış veya basittir. Gövde yaprakları taban yapraklarından daha küçük olup, aşağıdan yukarıya doğru tabanı saran bir şekildedir veya nadiren yoktur. Kın genellikle yoktur, kın olan türlerde ise kın şekli lanseolat olup, hafifçe şişkindir. Çiçek durumu korimboz, panikulat korimboz veya tirsoiddir ve ortadaki umbellalar fertil, yandaki umbellalar ise sterildir. Çoğunlukla hepsi uzun saplıdır. Umbellaların bazılarında saplar eşit uzunlukta bazılarında ise çok değişik uzunlukta olabilir. Brakte ve brakteoller iyi gelişmiş, sayıları 5'ten fazladır, ovat, oblong lanseolat veya lineer şekilli olup, sıklıkla kenarları 1-2 mm uzunluğunda ve beyaz zarımsı bir şerit biçimindedir. Sepaller küçük ve 5 adettir. Ovat, lineer, rotundat veya lanseolat şekillidir. petallerin sayısı da 5 adet olup, sarı renkli, lanseolat, ovat, üst ve alttan içeriye doğru kıvrıktır, sırt kısmı ise koyu kahverengidir. Stamenlerin sayısı da 5 adet olup, sıklıkla petallerin iç kısmında saklanmıştır. Ovaryum 2 karpelden meydana gelmekte olup alt durumludur. Stilus sayısı 2 adettir ve dip tarafları disk veya basık koni biçimindedir, üst kısımları ise incelmiştir. İki merikarpa ayrılan şizokarp meyve sırttan basık, eliptik, oblong, rotundat veya ovat şekillidir. Meyvenin yan kostaları sıklıkla az veya çok kanatlıdır, sırttaki kostalar ise belirgin olmayıp ipliksi, kalın süngerimsi veya kanatlıdır, kanatlar dalgalı veya düzensizdir ve krenat dişlidir. Salgı kanallarının sayısı sırt tarafında 15-40 adet arasında olup, merikarpların birleştiği kısımda ise 6-30 adet arasında değişmektedir. Salgı kanallarıtohumun etrafında düzenli dizilmiş, mezokarpta ise dağılmıştır (Peşmen, 1972).

Filogenetik olarak *Ferulago* W. Koch, *Peucedanum* L. ve *Ferula* L. cinsleri birbirine çok yakın üç cinstir ve bu üç cinse ait türler dış görünüşleri birbirine benzediğinden dolayı, halk tarafından cinsel gücü artırıcı, hazmettirici, sedatif, kurt düşürücü ve karminatif olarak benzer amaçlarla kullanılmaktadır. Cinslerin birbirine yakınlığı çok fazla olduğu için cinsleri birbirinden kesin olarak ayırt etmek türleri ayırmak kadar zordur (Akalın, 1996). *Ferulago* türleri yurdumuzun değişik bölgelerinde "çakşırotu, geyikotu, asaotu, mayasılotu, kimyonotu, kuzukulağı, kılkuyruk, kuzukişnişi, kişniş, kurtkulağı, kuzu kemirdi, kuzubaşı ve kuyrukotu" isimleriyle bilinmekte ve kullanılmaktadır (Akalın, 1999).

Eski çağlardan beri *Ferulago* türlerinin halk arasında sinir sistemi yatıştırıcısı, tonik, hazmettirici, antihelmentik ve cinsel gücü artırıcı olarak ve hemoroit tedavisinde kullanıldığı bildirilmiştir. Ayrıca bu türlerin yılan ısırmalarında, baş ağrısında, ülserde ve dalak rahatsızlıklarında yararlı olduğu da rapor edilmiştir. Bazı türlerin köklerine çizik atılmasıyla ortaya çıkan zamktan baharat ve parfümeride koku verici olarak da faydanılmaktadır (İşcan vd., 2002). Bu türlerin kendilerine has kokularının meyve ve köklerinde bulunan salgı kanallarının taşıdığı reçine, uçucu yağ ve zamk karışımından kaynaklandığı saptanmıştır. Kendilerine has bu kokularından ötürü de bilhassa geyik ve keçilerin çok severek tükettikleri bir besindir, bu türleri yiyen hayvanların sütünde de hoş, aromatik bir koku meydana gelmektedir. Ayrıca bu kokularından dolayı halk arasında bu türlerden salata veya baharat olarak da yararlanılmaktadır (Rosselli vd., 2009). Anadolu'da halk arasında salamura ve turşu şeklinde besin olarak tüketilmekte, yörelere özgü peynirlerde koku verici ve koruyucu olarak da kullanılmaktadır (Bulut vd., 2014).

Ferulago türleri kumarin, kumarin esterleri, flavonoitler, seskiterpenler ve uçucu yağlar bakımından çok zengin bitkilerdir (Curini vd., 2006). Bazı *Ferulago* türleri üzerinde yapılan çalışmalarla bu türlerin sitotoksik (Rosselli vd., 2009), asetil kolinesteraz inhibitör (Dall'Acqua vd., 2010), α-amilaz ve α-glukozidaz inhibitör (Karakaya vd., 2018), antikoagülan (Golfakhrabadi vd., 2016), antimikrobiyal ve antioksidan (Basile vd., 2009) etkili ve erektil disfonksiyon üzerinde (Ozturk vd., 2012) olumlu etkileri olduğu görülmüştür.

Bu çalışmada, *F. mughlae* Peşmen ve *F. sandrasica* Peşmen & Quezel türlerinin gövde, pedunkul, ışın, pedisel ve yaprak kısımlarının anatomik özellikleri incelenerek karakteristik yapıları ortaya konmuştur. Bu çalışma, *F. mughlae* ve *F. sandrasica* türlerinin gövde, pedunkul, ışın, pedisel ve yaprak kısımlarının incelendiği ilk anatomik çalışmadır.

2. Materyal ve yöntem

Anatomik incelemeler için türler toplanma esnasında %70'lik alkol içerisinde muhafaza edilmiştir. Türlerin %70'lik alkol içerisinde bulunan gövde, pedunkul, ışın, pedisel ve yapraklarından elle enine ve yüzeyel kesitler alınmış, kesitlerin Sartur Reaktifi ile preparatları hazırlanarak incelenmiş ve fotoğrafları çekilmiştir (Leica CME ve ZEISS Primostar 415500, Almanya). Türlerin makroskobik görüntüleri ise Nikon D90 Digital (Almanya) marka fotoğraf makinası ile detaylı bir şekilde görüntülenmiştir. Bitkilerin toplandığı lokaliteler ve herbaryum numaraları Tablo 1'de verilmiştir.

Tablo 1. *Ferulago mughlea* ve *F. sandrasica* türlerinin toplandığı lokaliteler ve herbaryum numaraları

Tür Adı	**Toplandığı Lokalite**	**Herbaryum Numarası**
F. mughlea	C2 Muğla: Marmaris Milli Parkı girişi, Gönlücek mevkii 22.08.2013	AEF 26356
F. sandrasica	C2 Muğla: Sandras Dağı, Ağla Yaylası, Ağla Köyü 4 km üzeri karaçam altları, Kartal Gölüne varmadan 3 km öncesi, 1675 m, 10.06.2013	AEF 26274

3. Bulgular

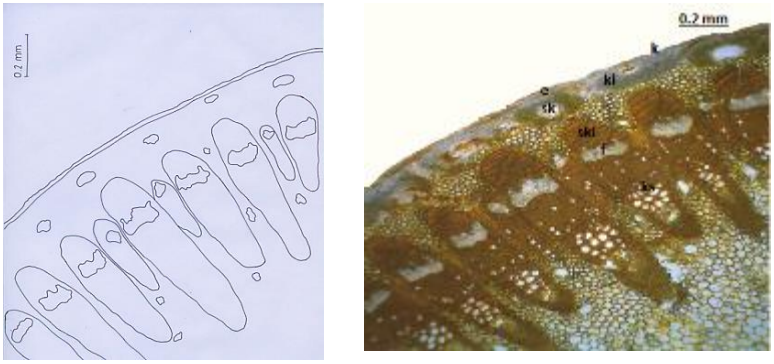
3.1. Ferulago mughlea

A B C

Şekil 1. *Ferulago mughlea*'nın A: Habitat, B: Genel görünüş ve C: Herbaryum örneği

3.1.1. Gövde Anatomisi

Gövde silindirik şekilli, kenarları hafif krenat ve tüysüzdür. En dışta kütikula tabakası, bunun altında da tek sıralı, düzgün, ince çeperli dikdörtgenimsi hücrelerden meydana gelen epiderma tabakası bulunmaktadır. Epidermanın hemen altında almaşık dizilişli renkli parenkima ve kollenkima hücrelerine rastlanmaktadır. Kollenkima hücreleri arasına gömülü halde salgı kanalları bulunmakta ve salgı kanallarının altında ise birkaç sıralı ince çeperli parenkimatik hücreler mevcuttur. Kabuk parenkimasının içerisinde açık kısımları öz dokuya bakacak biçimde at nalı şeklinde öbekler meydana getirmiş sklerenkima demetleri vardır. Bu demetler gövde boyunca halka şeklinde bir küçük bir büyük olmak üzere sıralanmıştır. Küçük sklerenkima demetlerinin üzerinde ise birer tane salgı kanalı bulunmaktadır. Trakeler oldukça büyük olup, öz bölgesine yakın yerlerde 10-12 tanesi bir aradadır ve epidermaya doğru sklerenkima demetlerine yaklaştıkça birbirlerinden ayrılmaktadırlar. Sklerenkima demetleri iletim demetlerini sarar durumdadır. Öz bölgesi parenkimatik hücrelerden oluşmakta ve içerisinde çok miktarda salgı kanalına rastlanmaktadır. (Şekil 2).

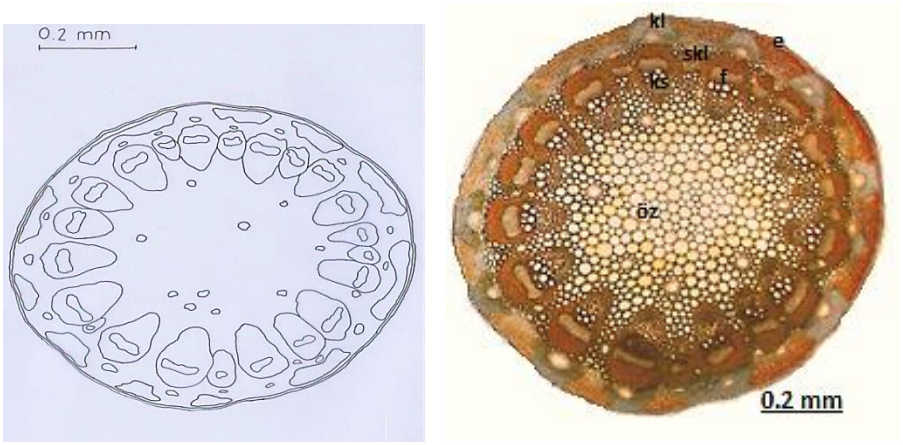


Şekil 2. *Ferulago mughlae*- Gövdenin Enine Kesiti (anatomik), k: kütikula, e: epiderma, kl: kollenkima, sk: salgı kanalı, f: floem, ks: ksilem

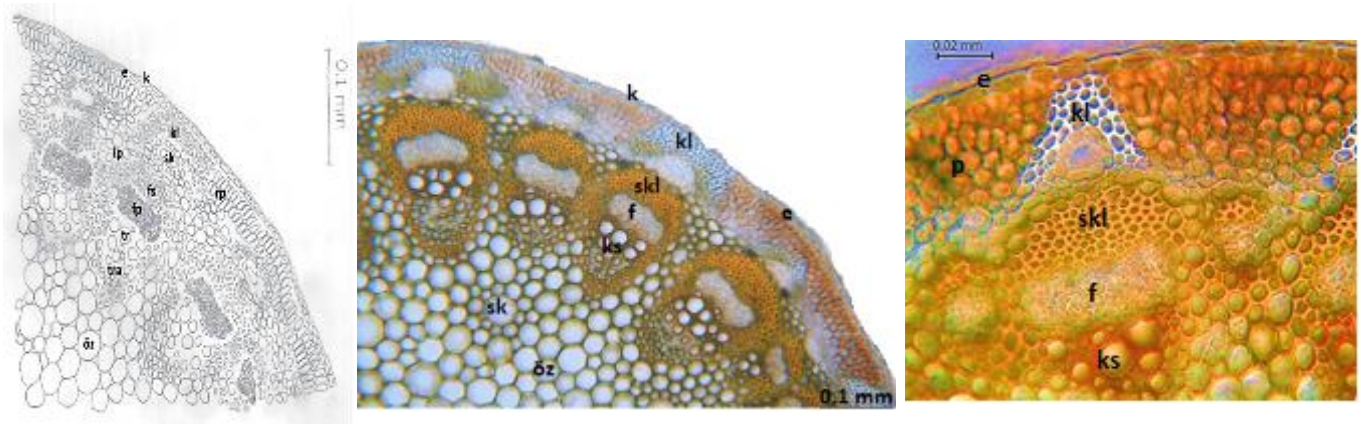
3.1.2. Pedunkul Anatomisi

Silindirik yapıda ve tüysüzdür. Anatomik yapısı gövdeye benzemektedir, farkları ise iletim demetlerinin kapladığı alanın gövdeye kıyasla daha kısa olmasıdır dolayısıyla öz bölgesi de daralmıştır. Gövde anatomisinde olduğu gibi en dışta kütikula tabakası vardır, bunun altında ise tek sıralı, düzgün, ince çeperli dikdörtgenimsi hücrelerden meydana gelen epiderma tabakası mevcuttur. Epidermanın hemen altında almaşık dizilişli renkli parenkima ve kollenkima hücrelerine rastlanmaktadır. Kollenkima hücreleri gövdeye kıyasla daha az, aralarına gömülü halde salgı kanalları ve parenkimatik hücreler bulunmaktadır. Salgı kanallarının hemen altında ise sklerenkima demetleri görülmektedir. İletim

demetleri sklerenkima demetlerinin meydana getirdiği halkaların içerisindedir ve öz kolları yoktur, öz kısmı az sayıda parenkimatik hücrelerden oluşmaktadır. Pedunkuller pedisellere nazaran hafif krenattır (Şekil 3-4).



Şekil 3. *Ferulago mughlae*- Pedunkulun Enine Kesiti (şematik ve anatomik), k: kütikula, e: epiderma, kl: kollenkima, skl: sklerenkima, f: floem, ks: ksilem.

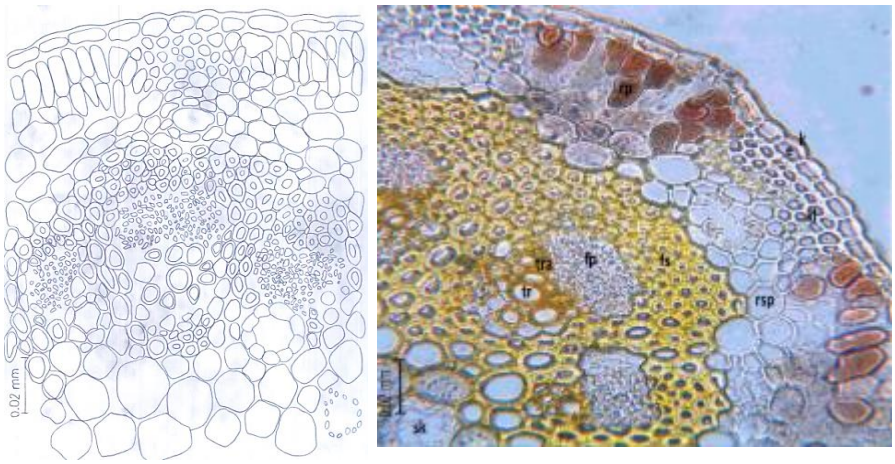


Şekil 4. *Ferulago mughlae*- Pedunkulun Enine Kesitinin Anatomisi, k: kütikula, e: epiderma, rp: renkli p., kl: kollenkima, sk: salgı kanalı, lp: ligninleşmiş p., p: parenkima, f: floem, ks: ksilem, fs: floem sklerenkiması, skl:sklerenkima, fp: floem p., tr: trake, tra: trakeit.

3.1.3. Işın Anatomisi

Işınlar silindirik yapıdadır ve tüysüzdür. Gövde ve pedunkul ile anatomik olarak benzer yapıya sahiptir. Sadece kollenkimanın hemen altından sklerenkima hücreleri ile başlar ve gövdedeki gibi at nalı şeklinde diziliş göstermemektedir. İletim demetleri yine sklerenkima demetleriyle sarılıdır ancak gövdedekilere kıyasla daha kısadır. Trake ve trakeit sayıları ise daha azdır ve öz bölgesi daralmıştır (Şekil 5-6).

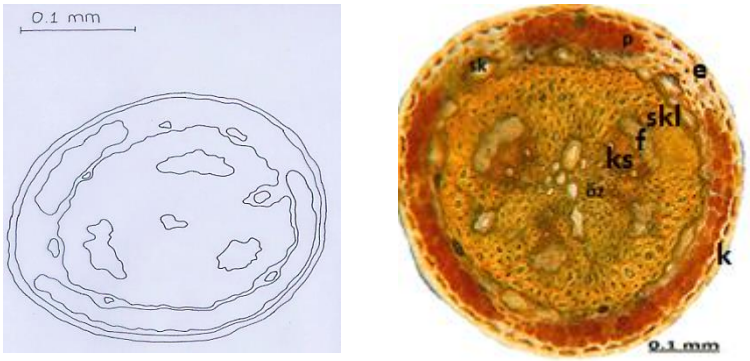
Şekil 5. *Ferulago mughlae*- Işının Enine Kesiti (şematik ve anatomik), e: epiderma, kl: kollenkima, sk: salgı kanalı, f: floem, ks: ksilem, skl: sklerenkima



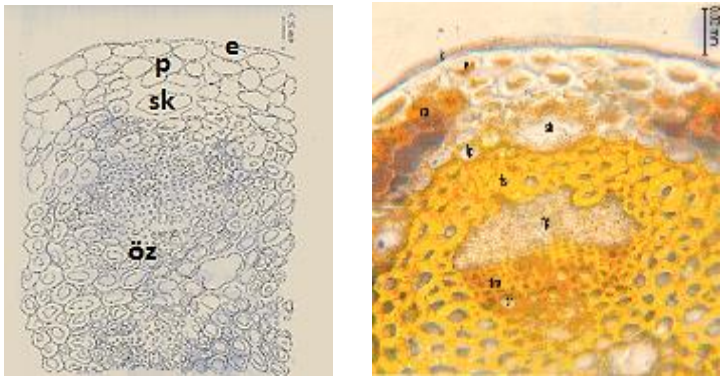
Şekil 6. *Ferulago mughlae*- Işının Enine Kesitinin Anatomisi (anatomik), k: kütikula, e: epiderma, rp: renkli parenkima, rsp: renksiz parenkima, kl: kollenkima, fs: floem sklerenkiması, fp: floem p., tr: trake, tra: trakeit

3.1.4. Pedisel Anatomisi

Pedisel çok hafif krenat ve tüysüzdür. En dışta kütikula tabakası mevcuttur ve bu tabakanın altında tek sıralı, düzgün, ince çeperli dikdörtgenimsi hücrelerden meydana gelen epiderma tabakası bulunmaktadır. Epidermanın hemen altında almaşık dizilişli renkli parenkima ve kollenkima hücreleri görülür. Kollenkima hücreleri gövdeye kıyasla daha azdır ve aralarına gömülü halde salgı kanalları ve parenkimatik hücreler bulunmaktadır. Salgı kanallarının hemen altında sklerenkima demetlerine rastlanmaktadır. İletim demetleri sklerenkima demetlerinin meydana getirdiği halkaların içerisindedir. Öz kolları yoktur ve öz kısmı çok az sayıda parenkimatik hücreden oluşur (Şekil 7-8).



Şekil 7. *Ferulago mughlae*- Pediselin Enine Kesiti (şematik ve anatomik), k: kütikula, e: epiderma, p: parenkima, kl: kollenkima, f: floem, ks: ksilem, skl: sklerenkima



Şekil 8. *Ferulago mughlae*- Pediselin Enine Kesiti (anatomik), k: kütikula, e: epiderma, rp: renkli p., lp: ligninleşmiş p., sk: salgı kanalı, fs: floem sklerenkiması, fp: floem p., tr: trake, tra: trakeit.

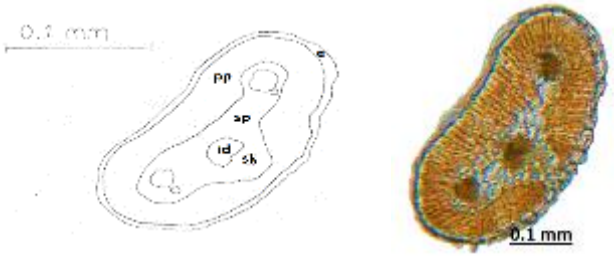
3.1.5. Yaprak Anatomisi

3.1.5.1. Yaprak Orta Damar Enine Kesiti

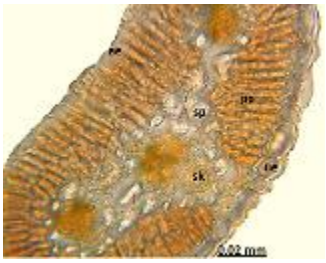
Yaprak monofasiyaldir. Tüy gözlenmemiştir, kütikula tabakasının altında tek sıralı ve farklı büyüklüklere sahip, ince çeperli hücrelerden meydana gelmiş epiderma tabakası yer almaktadır. Üst epiderma tabakasının altında, orta damarın üst tarafında kollenkima hücreleri görülmektedir. Diğer bölgelerde ise epidermanın hemen altında ince çeperli, uzun ve gayri muntazam dizilişli hücrelerden meydana gelen 1(-2) sıralı palizat parenkiması ve hemen onun altında da genelde iri hücrelerden meydana gelen ince çeperli bir sünger parenkima tabakası bulunmaktadır. Sünger parenkima tabakasının hemen altında ise 1-2 sıralı palizat parenkima hücreleri yer alır. Hem palizat hem de sünger parenkima tabakalarında karakteristik elementlere rastlanmamıştır. İletim demetlerinde floem ve ksilem tabakaları rahatlıkla görülebilmektedir ve iletim demetlerinin hemen altında az sayıda kollenkima hücrelerine rastlanmaktadır. Kollenkima hücrelerinin hemen üzerinde ise küçük bir salgı kanalı mevcuttur (Şekil 9,10).

3.1.5.2. Yaprak üst ve alt epiderma yüzeyel kesiti:

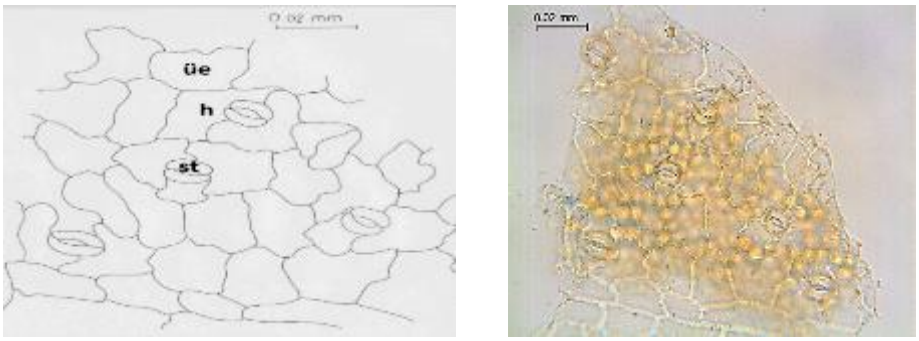
Hem alt hem üst epiderma tabakalarında stomalar bulunmaktadır. Stoma bekçi hücreleri karakteristik böbrek şekilli olup, komşu hücre sayısı 2-3 arasında değişmektedir ve çoğunlukla sayısı da 3'tür ve komşu hücrelerden biri diğerlerinden daha küçük yapıya sahiptir, anizositik tipte stomadır. Epiderma hücreleri çoğunlukla stoma komşu hücrelerinden daha büyük ve üst epidermadakiler köşeli şekillere sahip olup, alt epidermadakiler ise girintili yapıdadır. Kütikula kırışıklığı ise görülmemiştir (Şekil 11, 12).



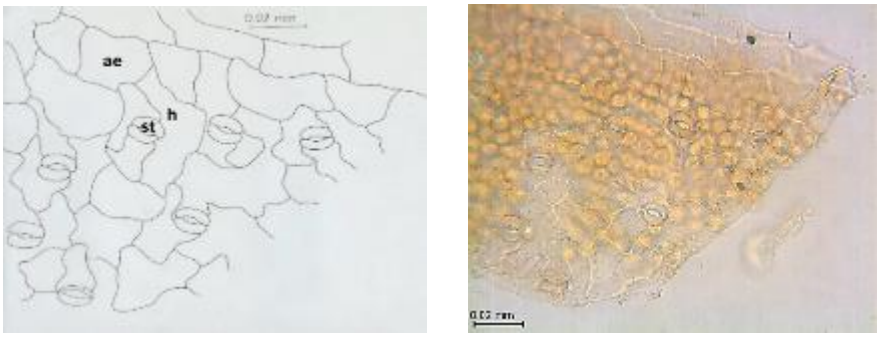
Şekil 9. *Ferulago mughlae*'nin Yaprak Orta Damar Enine Kesiti (şematik ve anatomik), e: epiderma, pp: palizat p., sp: sünger p., id: iletim demeti, sk: salgı kanalı.



Şekil 10. *Ferulago mughlae*'nin Yaprak Orta Damarının Enine Kesiti (anatomik), üe: üst epiderma,ae: alt epiderma, pp: palizat p., sp: sünger p., kl: kollenkima, ks: ksilem, fl: floem, sk: salgı kanalı.

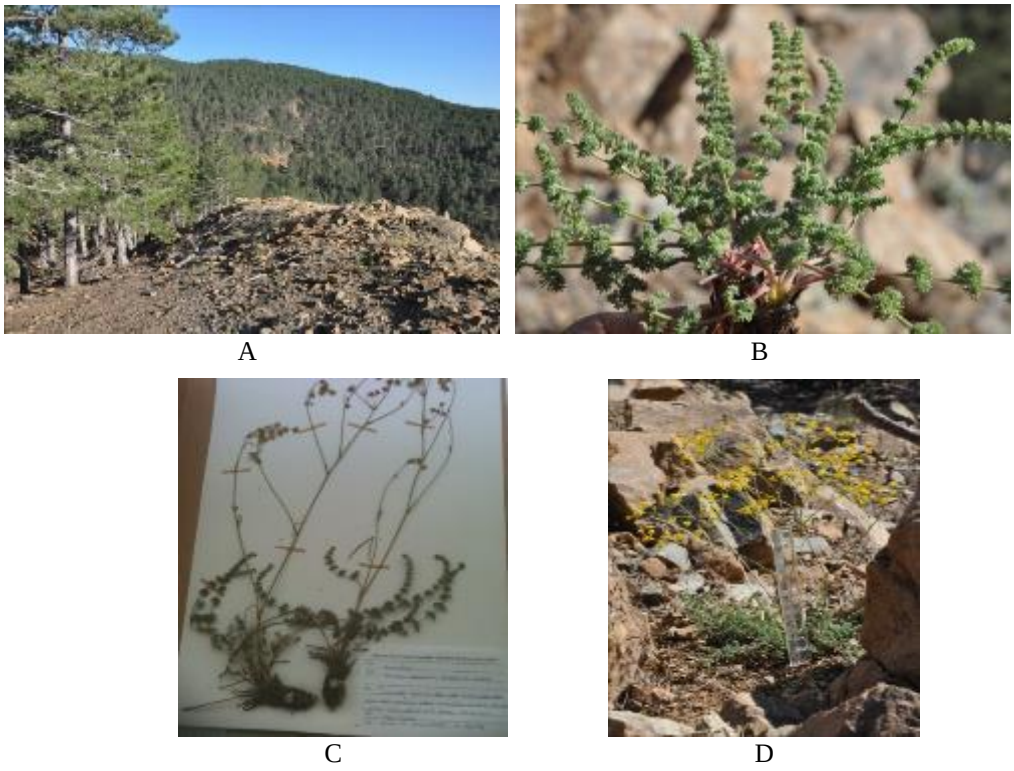


Şekil 11. *Ferulago mughlae*- Üst Epiderma yüzeyel kesit, st: stoma, üe: üst epiderma, h: stoma komşu hücresi.



Şekil 12. *Ferulago mughlae*- Alt Epiderma Yüzeyel Kesit, st: stoma, ae: alt epiderma, h: stoma komşu hücresi.

3.2. Ferulago sandrasica



Şekil 13. *Ferulago sandrasica'*nın A: Habitat, B: Yaprak, C: Herbaryum örneği ve D: Genel görünüşü

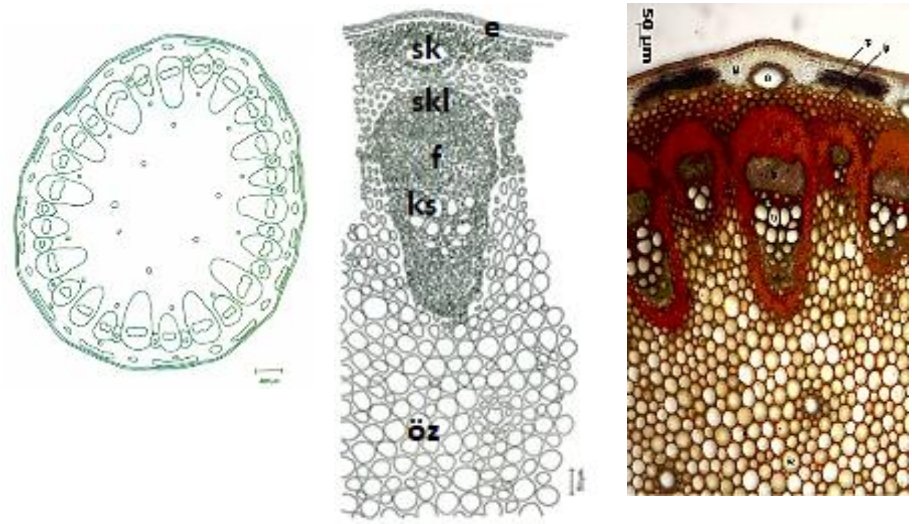
3.2.1. Gövde Anatomisi

Gövde silindirik yapıda ve tüysüzdür. En dışta kütikula tabakası, bu tabakanın altında tek sıralı, düzgün, ince çeperli dikdörtgenimsi hücrelerden meydana gelen epiderma tabakası vardır. Epiderma tabakasının hemen altında almaşık dizilişli renkli parenkima ve kollenkima hücreleri görülmektedir. Kollenkima hücrelerinin arasına gömülü halde salgı kanallarına rastlanmaktadır ve salgı kanallarının altında çeperleri süberinleşmiş kabuk parenkiması hücreleri bulunmaktadır. Kabuk parenkimasının içerisinde açık kısımları öz dokuya bakacak şekilde at nalı şeklinde öbekler meydana getirmiş sklerenkima demetlerine rastlanır ve bu demetler bir küçük bir büyük olmak üzere gövde boyunca halka şeklinde sıralanmıştır. Merkez silindirin kalınlığı kabuk kısmından fazladır. Sklerenkima demetleri iletim demetlerini sarar durumdadır. Öz bölgesi parenkimatik hücrelerden oluşmakta ve içerisinde bol miktarda salgı kanalı bulunmaktadır. (Şekil 14-15).

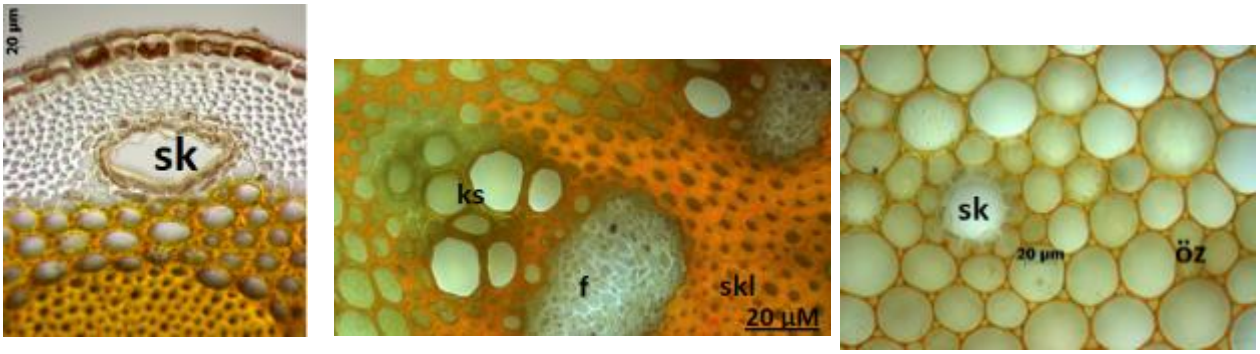
3.2.2. Pedunkul Anatomisi

Anatomik yapı gövde ile benzer yapıdadır ancak gözlenebilen tek fark iletim demetlerinin kapladığı alanın daha kısa olmasıdır. En dışta kütikula tabakası, bu tabakanın altında tek sıralı, düzgün, ince çeperli dikdörtgenimsi hücrelerden meydana gelen epiderma tabakası bulunmaktadır. Epidermanın hemen altında 2-6 sıralı renkli parenkima hücreleri görülmektedir. Salgı hücreleri renkli parenkima hücrelerinin arasına gömülü ya da hemen altında bulunmakta ve salgı

kanallarının hemen altında parenkima hücreleri ve iletim demetlerine rastlanmaktadır. Öz kolları yoktur, öz kısmı parenkimatik hücrelerden meydana gelir ve öz bölgesinde 1 ya da 2 salgı kanalı bulunmaktadır (Şekil 16-18).

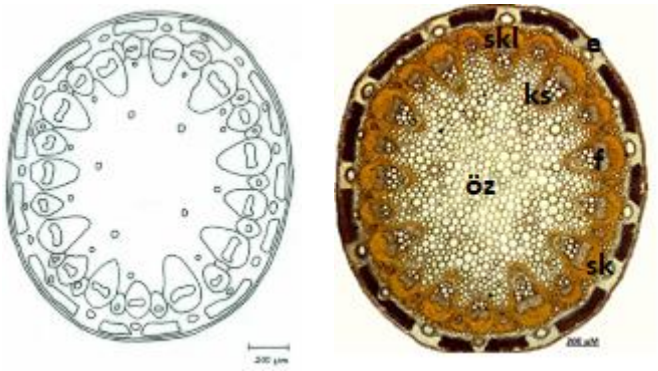


Şekil 14**.** *Ferulago sandrasica*- Gövdenin Enine Kesiti (şematik ve anatomik), e: epiderma, kl: kollenkima, rp: renkli p., sk: salgı kanalı, lp: ligninleşmiş p., fs: floem sklerenkiması, fp: floem p., ksp: ksilem p., tr: trake, tra: trakeit.

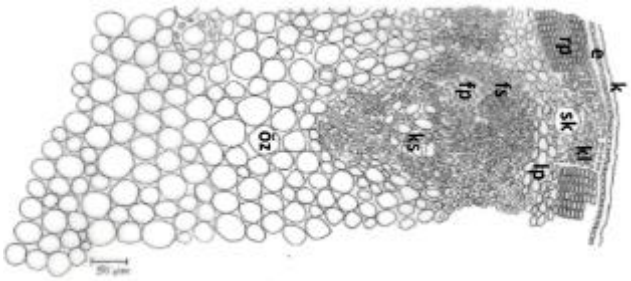


A B C

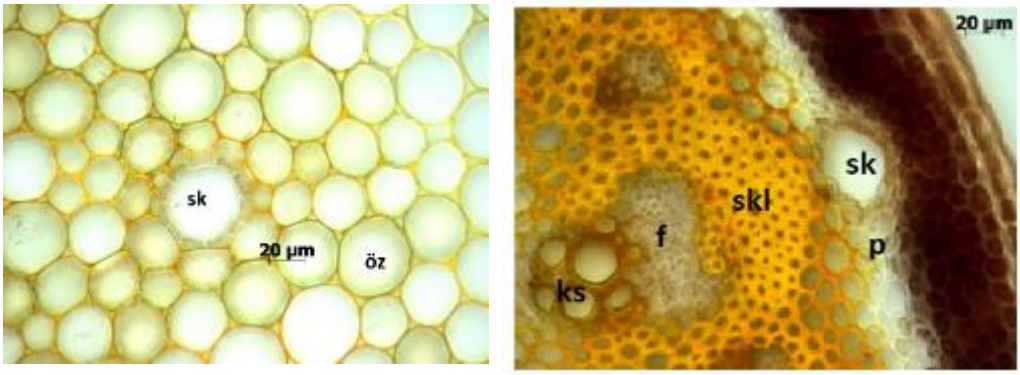
Şekil 15. *Ferulago sandrasica*- A: Gövdede Öz Bölgesinde Salgı Kanalı, B: Sklerenkima ve C: İletim Demeti ve Kollenkima ile Çevrili Salgı Kanalı, sk: salgı kanalı, ks: ksilem, f: floem, skl: sklerenkima.



Şekil 16**.** *Ferulago sandrasica*- Pedunkulun Enine Kesiti Şematik ve Anatomik Görünümü, e: epiderma, sk: salgı kanalı, ks: ksilem, f: floem, skl: sklerenkima.



Şekil 17. *Ferulago sandrasica*- Pedunkulun Enine Kesiti (anatomik), k: kütikula, e: epiderma, rp: renkli p., kl: kollenkima, sk: salgı kanalı, lp: ligninleşmiş p., fs: floem sklerenkiması, fp: floem p., ks: ksilem

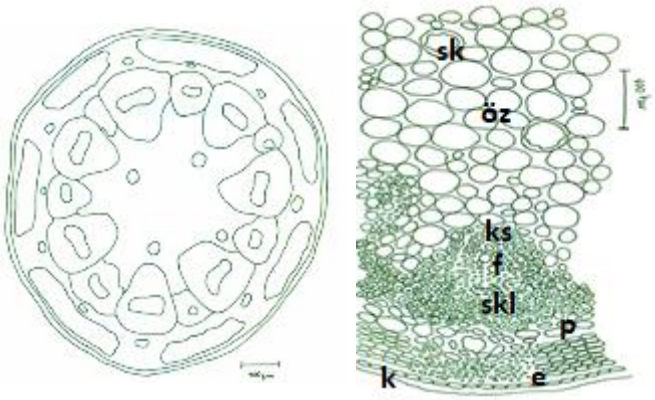


A B

Şekil 18. *Ferulago sandrasica*- A: Özde Salgı Kanalı ve B: Renkli Parenkima Hücreleri Altında Salgı Kanalı ve Ligninleşmiş Parenkimatik Hücreler, sk: salgı kanalı, ks: ksilem, f: floem, skl: sklerenkima, p: parenkima.

3.2.3. Işın Anatomisi

Gövde ile benzer anatomik yapıya sahiptir. Silindirik şekilli olup kenarları çok hafif krenattır ve tüysüzdür. Sadece kollenkimanın altında çeperleri ligninleşmiş parenkima hücreleri daha seyrek olarak bulunmaktadır. At nalı biçiminde dizilen sklerenkima demetleri eşit büyüklüktedir ve iletim demetleri yine sklerenkima demetleriyle sarılı ancak gövdedekilere kıyasla daha kısadır, trake ve trakeit sayıları da daha azdır (Şekil 19-20).

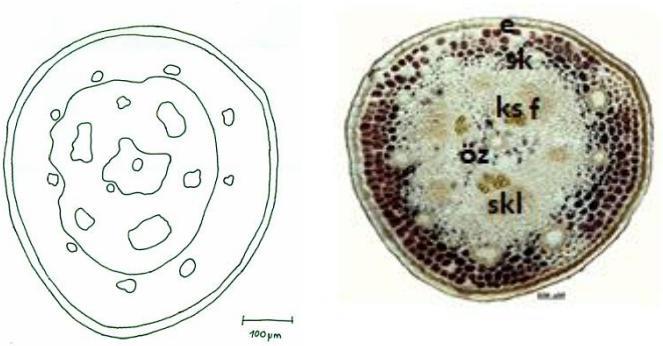


Şekil 19. *Ferulago sandrasica*- Işının Enine Kesiti (şematik ve anatomik), k: kütikula, e: epiderma, kl: sk: salgı kanalı, p: parenkima, f: floem, ks: ksilem, skl: sklerenkima.

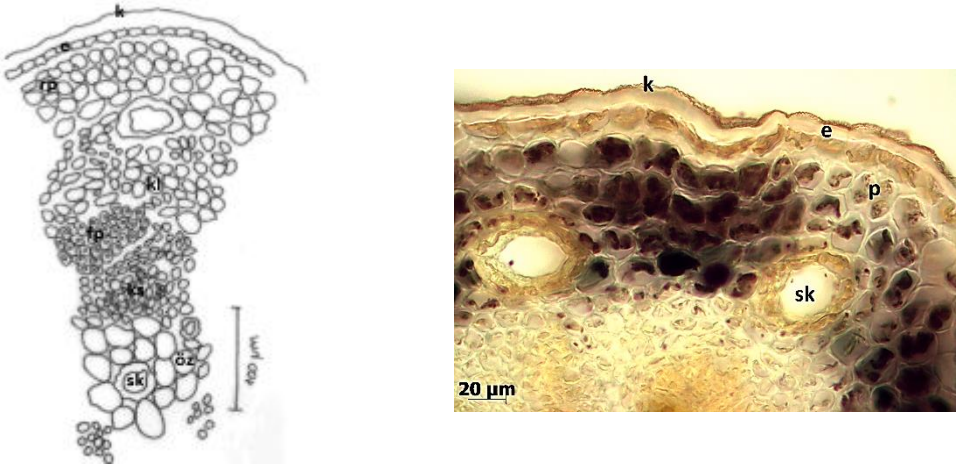
Şekil 20. *Ferulago sandrasica*- Işının Enine Kesiti, k: kütikula, e: epiderma, rp: renkli p., kl: kollenkima, sk: salgı kanalı, lp: ligninleşmiş p., fs: floem sklerenkiması, fp: floem p., tr: trake, tra: trakeit, ks: ksilem.

3.2.4. Pedisel Anatomisi

Pedisel silindirik, çok hafif krenat ve tüysüzdür. En dışta kütikula tabakası, bu tabakanın altında tek sıralı, düzgün, ince çeperli dikdörtgenimsi hücrelerden meydana gelen epiderma tabakası bulunmaktadır. Epidermanın hemen altında 2-6 sıralı renkli parenkima hücrelerine rastlanır. Salgı hücreleri renkli parenkima hücrelerinin arasına gömülü ya da hemen altında bulunmakta ve salgı kanallarının hemen altında parenkima hücreleri ve iletim demetleri görülmektedir. İletim demetlerinin etrafını saran sklerenkima demetleri ve öz kolları yoktur ve öz kısmı parenkimatik hücrelerden oluşmaktadır. Öz bölgesinde 1 ya da 2 salgı kanalı bulunmakta ve pedunkul da silindirik yapıda ama pedisele kıyasla hafif dalgalıdır, krenat değildir (Şekil 21-22).



Şekil 21**.** *Ferulago sandrasica*- Pediselin Enine Kesiti (şematik ve anatomik), e: epiderma, f: floem , ks: ksilem, sk: salgı kanalı, skl: sklerenkima.



Şekil 22. *Ferulago sandrasica*- Pediselin Enine Kesiti (anatomik), k: kütikula, e: epiderma, rp: renkli p., kl: kollenkima, fp: floem p., ks: ksilem, sk: salgı kanalı, p: parenkima.

3.2.5. Yaprak Anatomisi

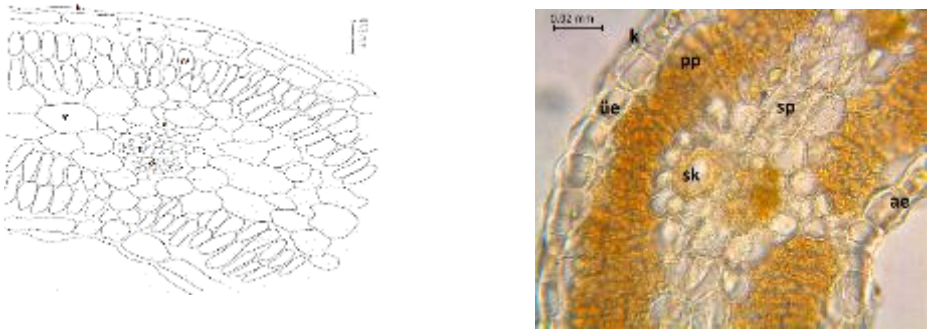
3.2.5.1. Yaprak Orta Damar Enine Kesiti

Monofasiyal tipte yapraktır. Tüy gözlenmemiştir. Kütikula tabakasının altında tek sıralı ve farklı büyüklüklere sahip, ince çeperli hücrelerden meydana gelmiş epiderma tabakası bulunur. Üst epiderma tabakasının altında, orta damarın üzerinde kollenkima hücreleri yer almaktadır. Diğer bölgelerde ise epidermanın hemen altında ince çeperli, uzun ve gayri muntazam dizilişli hücrelerden meydana gelen 2(-3) sıralı palizat parenkiması ve hemen altında da genelde iri hücrelerden oluşan ince çeperli bir sünger parenkima tabakası mevcuttur. Sünger parenkimasının hemen altında yine 2(-3) sıralı palizat parenkima tabakası yer almaktadır. Hem palizat hem de sünger parenkima tabakalarında karakteristik elementler görülmemiştir. İletim demetlerinde floem ve ksilem tabakaları rahatlıkla görülebilmektedir. İletim demetlerinin hemen altında az sayıda kollenkima hücresine ve kollenkima hücrelerinin hemen üzerinde küçük bir salgı kanalına rastlanmaktadır.

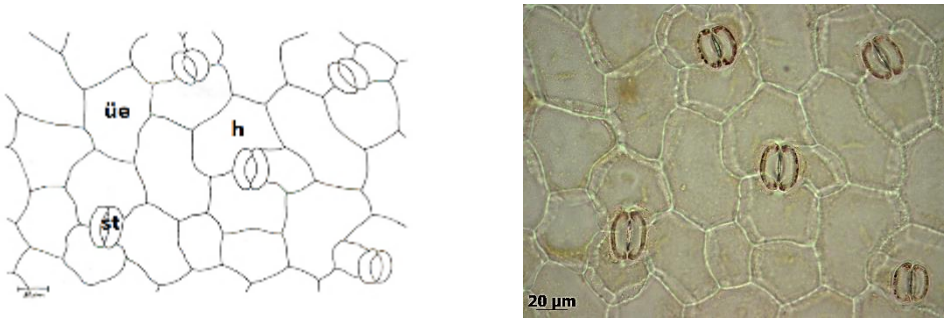
3.2.5.2. Yaprak üst ve alt epiderma yüzeyel kesiti

Hem üst hem alt epiderma tabakalarında stomalara rastlanmaktadır. Stoma bekçi hücreleri karakteristik böbrek şekilli olup, komşu hücre sayısı 2-4 arasında değişmektedir ve çoğunlukla sayısı 3'tür ve anizositik tipte stomadır. Komşu hücrelerden birisi diğerlerinden daha küçüktür ve hem alt hem de üst epiderma hücreleri sıklıkla stoma komşu hücrelerinden daha büyük ve daha köşeli şekillidir (Şekil 23-26).

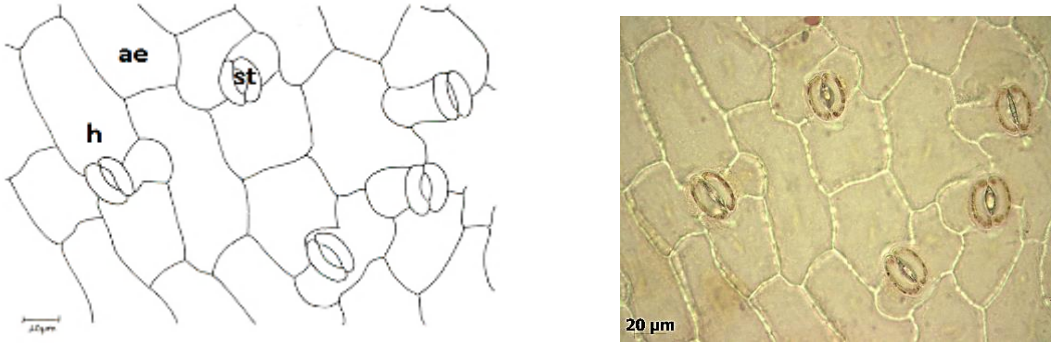
Şekil 23. *Ferulago sandrasica*- Yaprak Orta Damar Enine Kesiti (şematik ve anatomik), e: epiderma, pp: palizat parenkiması, sp: sünger parenkiması, id: iletim demeti



Şekil 24. *Ferulago sandrasica* Türünün Yaprak Orta Damarı Enine Kesiti (anatomik), k: kütikula, üe: üstepiderma, ae: alt epiderma, pp: palizat p., sp: sünger p., kl: kollenkima, ks: ksilem, fl: floem



Şekil 25. *Ferulago sandrasica*- Üst Epiderma Yüzeyel Kesiti, st: stoma, üe: üst epiderma, h: stoma komşu hücresi



Şekil 26. *Ferulago sandrasica*- Alt Epiderma Yüzeyel Kesiti, st: stoma, ae: alt epiderma, h: stoma komşu hücresi

4. Sonuçlar ve tartışma

Çalışmamıza konu olan *Ferulago mughlea ve F. sandrasica* türlerinin gövde, pedunkul, ışın, pedisel ve yaprak (enine ve yüzeyel) enine kesitlerinin şematik ve anatomik çizimleri yapılmış, ayrıca anatomik fotoğrafları da çekilmiştir (Şekil 2-12, 14-26). Metcalfe (1965)'te Apiaceae familyasının genel anatomik özellikleri verilirken incelenen cinsler arasında *Ferulago* cinsi bulunmamaktadır. Metcalfe'e (1965) göre Apiaceae familyasının gövde anatomisi genellikle dalgalıdır ve çıkıntılarda kollenkima veya nadiren sklerenkima görülmektedir. Gövdenin iletim doku demetleri halka biçiminde birleşmiş veya serbest haldedir ve aralarında öz kolları veya nadiren kabuk şeritlerine rastlanmaktadır (Metcalfe, 1965). Çalışılan 2 türün gövdelerinin anatomik bulguları Metcalfe'in verileri ile karşılaştırıldığında uyumlu olduğu görülmekte ve çıkıntılarda kollenkima ve iletim doku demetleri serbest ve aralarında öz kollarının bulunmadığı, çoğunlukla da iletim demetlerinin düzenli olduğu saptanmıştır. 2 türün gövdelerinde kambiyuma da rastlanmamıştır ve bu durum dikotiledon olan türlerin monokotiledonlara benzerlik göstermesi olarak düşünülmüştür. Elde edilen bu sonuçlar Karakaya ve ark. 2016 çalışması ile benzerlik göstermektedir. *F. mughlea ve F. sandrasica* türlerinin genel olarak anatomik karakterlerinin benzerlik gösterdiği saptanmıştır. *F. mughlea ve F. sandrasica'nın,* pedunkul, ışın ve pedisel anatomisi genel olarak gövde anatomisine benzemektedir. Ancak ışın ve pediseldeki salgı kanallarının sayısı azalmış ve öz bölgesi de daralmıştır. Her iki türün de yaprağı monofasiyal tiptedir. Gövde, pedunkul, ışın, pedisel ve yapraklarda tüye rastlanmamıştır. Metcalfe'e (1965) göre salgı kanalları gövdenin kabuk, perisikl, öz ve bazen sekonder floeminde bulunmaktadır. Ayrıca petiyol, yaprak ve kökte de görülmektedir (Metcalfe, 1965). *F. mughlea ve F. sandrasica*'nın gövdelerinde hem kabukta hem özde salgı kanallarına rastlanmaktadır ve her iki türün de yapraklarında da salgı kanalları görülmüştür (Şekil 2-12, 14-26). İncelenen 2 türün yaprak anatomik özellikleri Metcalfe'in verileri ile karşılaştırıldığında çoğunlukla benzerlik gösterdiği gözlemlenmiştir. Yaprak enine kesitlerinde kütikula tabakasının altında tek sıralı ve farklı büyüklüklere sahip, ince çeperli hücrelerden meydana gelmiş epiderma tabakaları bulunmaktadır. Üst epiderma tabakasının altında, orta damarın üzerinde kollenkima hücreleri görülmektedir. Gerek palizat gerekse sünger parenkimasında karakteristik elementler görülmemiştir. Yüzeysel kesitlerde her iki türde de hem alt hem üst epidermada stomalar bulunur. Komşu hücre sayısı 2-4 arasında değişmekte olup sıklıkla 3 olduğu ve komşu hücrelerden birinin diğerlerinden daha küçük olduğu görülmüştür. Epiderma hücreleri genellikle stoma komşu hücrelerinden daha büyük ve üst epidermadaki hücrelerin köşeli şekilli, alt epidermadakilerin ise girintili olduğu saptanmıştır. Çalışılan her türde gövde, pedunkul, ışın, pedisel ve yaprak için elde edilen anatomik bulgular kendi aralarında karşılaştırılarak Tablo 2'de verilmiştir.

Tablo 2. *Ferulago mughlea* ve *F. sandrasica* türlerinin anatomik özelliklerinin karşılaştırılması

Organ	***F. mughlea***	***F. sandrasica***
Gövde	Silindirik, hafif krenat, tüysüz. Kollenkima hücreleri arasına gömülü halde salgı kanalları bulunur. Salgı kanallarının altında birkaç sıralı ince çeperli parenkimatik hücre vardır. Kabuk parenkimasının içerisinde açık kısımları öz dokuya bakacak şekilde at nalı şeklinde öbekler oluşturmuş sklerenkima demetleri bulunur. Bu demetler bir küçük bir büyük olmak üzere gövde boyunca halka şeklinde sıralıdır. Küçük sklerenkima demetlerinin üzerinde birer adet salgı kanalı bulunur. Trakeler oldukça büyük, öz bölgesine yakın yerlerde 10-12 tanesi bir arada, epidermaya doğru sklerenkima demetlerine yaklaştıkça birbirlerinden ayrıdırlar. Sklerenkima demetleri iletim demetlerini sarar. iletim doku demetleri gövde boyunca halka şeklinde sıralanmıştır. Öz bölgesi parenkimatik hücrelerden oluşur, içerisinde bol miktarda salgı kanalına rastlanır.	Silindirik, tüysüz. Epidermanın hemen altında almaşık dizilişli renkli parenkima ve kollenkima hücreleri görülür. Kollenkima hücrelerinin arasına gömülü halde salgı kanalları bulunur. Salgı kanallarının altında çeperleri süberinleşmiş kabuk parenkiması hücreleri vardır. Kabuk parenkimasının içerisinde açık kısımları öz dokuya bakacak şekilde at nalı şeklinde öbekler oluşturmuş sklerenkima demetleri bulunur. Bu demetler bir küçük bir büyük olmak üzere gövde boyunca halka şeklinde sıralıdır. Merkez silindirin kalınlığı kabuk kısmından fazladır. Sklerenkima demetleri iletim demetlerini sarar. iletim doku demetleri gövde boyunca halka şeklinde sıralanmıştır. Öz bölgesi parenkimatik hücrelerden oluşur, içerisinde bol miktarda salgı kanalı bulunur.
Pedunkul	Silindirik yapıda, tüysüz. pedisellere nazaran hafif krenat. Anatomik yapı gövdeninkine benzer, farkı iletim demetlerinin kapladığı alanın gövdeye nazaran daha kısa olmasıdır.	Silindirik yapıda ama pedisellere nazaran hafif dalgalı, krenat değil. Anatomik yapı gövde ile benzer yapıda. Gözlenebilen tek fark iletim demetlerinin kapladığı alanın daha kısa oluşudur.
Işın	Gövde ve pedunkul ile benzer anatomik yapıya sahiptir. Sadece kollenkimanın hemen altından sklerenkima hücreleri başlar ve gövdedeki gibi at nalı şeklinde diziliş göstermez. İletim demetleri yine sklerenkima demetleriyle sarılı fakat gövdedekilere nazaran daha kısa, trake ve trakeit sayıları daha azdır ve öz bölgesi daralmıştır.	Gövde ve pedunkul ile benzer anatomik yapıya sahiptir. Sadece kollenkimanın altında çeperleri ligninleşmiş parenkima hücreleri daha seyrek bulunur. At nalı şekllinde dizilen sklerenkima demetleri eşit büyüklüktedir. İletim demetleri yine sklerenkima demetleriyle sarılı fakat gövdedekilere nazaran daha kısa, trake ve trakeit sayıları daha az ve öz bölgesi daralmıştır.
Pedisel	Gövde ve pedunkul ile benzer anatomik yapıya sahiptir. İletim demetleri sklerenkima demetlerinin oluşturduğu halkaların içerisindedir. Öz kolları yoktur, öz kısmı çok çok az sayıda parenkimatik hücreden oluşur. Öz bölgesi daralmıştır.	Gövde ve pedunkul ile benzer anatomik yapıya sahiptir. Öz bölgesi daralmıştır.
Yaprak	Tüysüz, monofasiyal yaprak, Üst epidermanın altında, orta damarın üzerinde kollenkima hücreleri bulunur. Diğer bölgelerde ise epidermanın hemen altında ince çeperli, uzun ve gayri muntazam dizilişli hücrelerden oluşan 1(-2) sıralı palizat parenkiması ve hemen altında da genelde iri hücrelerden oluşan ince çeperli bir sünger parenkiması tabakası bulunur. Sünger parenkiması tabakasının hemen altında 1-2 sıralı palizat parenkiması hücreleri bulunur. İletim demetlerinde floem parenkiması ve ksilem rahatlıkla görülebilir. İletim demetlerinin hemen altında az sayıda kollenkima hücresi görülür. Kollenkima hücrelerinin hemen üzerinde küçük bir salgı kanalı vardır. Stoma bekçi hücreleri karakteristik böbrek şekilli, komşu hücre sayısı 2-3 arasında değişmekte olup çoğunlukla 3'tür. Komşu hücrelerden birisi diğerlerinden daha küçüktür. Epiderma hücreleri genellikle stoma komşu hücrelerinden daha büyük ve üst epidermadakiler köşeli şekillere sahip, alt epidermadakiler ise girintilidir.	Tüysüz, monofasiyal yaprak, Üst epidermanın altında, orta damarın üzerinde kollenkima hücreleri bulunur. Diğer bölgelerde ise epidermanın hemen altında ince çeperli, uzun ve gayri muntazam dizilişli ve aralarında hücreler arası boşlukları olan hücrelerden oluşan 2(-3) sıralı palizat parenkiması ve hemen altında da genelde iri hücrelerden oluşan ince çeperli bir sünger parenkiması tabakası bulunur. Sünger parenkimasının hemen altında yine 2(-3) sıralı palizat parenkiması tabakası bulunur. İletim demetlerinde floem parenkiması ve ksilem rahatlıkla görülebilir. İletim demetlerinin hemen altında az sayıda kollenkima hücresi görülür. Kollenkima hücrelerinin hemen üzerinde küçük bir salgı kanalı bulunur. Stoma bekçi hücreleri karakteristik böbrek şekilli, komşu hücre sayısı 2-4 arasında değişmekte olup çoğunlukla 3'tür, komşu hücrelerden birisi diğerlerinden daha küçüktür. Hem alt hem de üst epiderma hücreleri genellikle stoma komşu hücrelerinden daha büyük ve daha köşeli şekillere sahiptir.

Teşekkür

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Kaynaklar

Akalın, E., Özhatay, N. (1996). Üç yakın tıbbı cinsin ayırt edici morfolojik özellikleri: *Peucedanum, Ferula, Ferulago*. XI. Bitkisel İlaç Hammaddeleri Toplantısı, 22-24 Mayıs Bildiri Kitabı, Ankara, 195.

Akalın, E. (1999). Türkiye' nin Batısında Yetişen Ferulago Türleri Üzerinde Farmasötik Botanik Araştırmalar. Doktora Tezi. İstanbul Üniversitesi Eczacılık Fakültesi, İstanbul.

Basile, A., Sorbo, S., Spadaro, V. (2009). Antimicrobial and antioxidant activities of coumarins from the roots of *Ferulago campestris* (Apiaceae). Molecules, 14 (3), 939-952.

Bulut, G., Tuzlaci, E., Doğan, A. (2014). An ethnopharmacological review on the Turkish Apiaceae species. Journal of Faculty Pharmacy of Istanbul University, 44 (2), 163-179.

Curini, M., Cravotto, G., Epifano, F., Giannone, G. (2006). Chemistry and biological activity of natural and synthetic prenyloxycoumarins. Current Medicinal Chemistry, 13, 199-222.

Dall'Acqua, S., Maggi, F., Minesso, P., Salvagno, M., Papa, F., Vittori, S., Innocenti, G. (2010). Identification of nonalkaloid acetyl cholinesterase inhibitors from Ferulago campestris (Besser) Grecescu (Apiaceae). Fitoterapia. 81, 208-212.

Golfakhrabadi, F,, Ardakani, M.R.S., Saeidnia, S., Akbarzadeh, T., Yousefbeyk, F., Jamalifar, H., Khanavi, M. (2016). *In vitro* antimicrobial and acetylcholinesterase inhibitory activities of coumarins from *Ferulago carduchorum*. Medicinal Chemistry Research, 25, 1623-1629.

Güner A, Aslan S, Ekim T, Vural M, Babaç MT (eds). (2012). Türkiye Bitkileri Listesi (Damarlı Bitkiler). İstanbul: Nezahat Gökyiğit Botanik Bahçesi Yayınları.

İşcan, G., Demirci, F., Kirimer, N., Kürkçüoğlu, M., Başer, K.H.C. Kivanç M. (2002). Bazı Umbelliferae türlerinden elde edilen uçucu yağların amtimikrobiyal etkileri. 14. Bitkisel İlaç Hammaddeleri Toplantısı, 29-31 Mayıs 2002 Bildiri Kitabı. Eskişehir, Turkey.

Karakaya S, Kılıç C.S. (2016). Anatomy of *Ferulago blancheana* Post, *F. pachyloba* (Fenzl) Boiss., *F. trachycarpa* Boiss., and *F. bracteata* Boiss. & Haussk. (Apiaceae) Plants. Journal of Faculty Pharmacy Ankara, 40 (3), 1-28.

Karakaya, S., Gözcü, S., Güvenalp, Z., Özbek, H., Yuca, H., Dursunoğlu, B., Kazaz, C., Kılıç, C.S. (2018). The α-amylase and α-glucosidase inhibitory activities of the dichloromethane extracts and constituents of *Ferulago bracteata* roots. Pharmaceutical Biology, 56 (1), 18-24.

Metcalfe, C.R., Chalk, L. (1965). Anatomy of the Dicotyledones. London: Oxford University Press.

Ozturk, B., Gur, S., Coskun, M., Kosan, M., Erdurak, C.S., Hafez, G., Gonulalan, U., Cetinkaya M. (2012). A new relaxant on human corpus cavernosum: *Ferulago syriaca* root extract. African Journal of Pharmacy and Pharmacology, 6(37), 2652-2656.

Peşmen, H. (1972). Flora of Turkey and the East Aegean Islands. Vol.?? Edinburgh: Edinburgh University Press.

Rosselli, S., Maggio, A.M., Faraone, N. (2009). The cytotoxic properties of natural coumarins isolated from roots of *Ferulago campestris* (Apiaceae) and of synthetic ester derivatives of aegelinol. Natural Product Communications, 4(12), 1701-1706.

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Research article/Araştırma makalesi

Macrofungi of Datça Peninsula (Turkey)

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Abstract

This aim of this study was to determine of the diversity of macrofungi of Datça Peninsula between the years of 2011 and 2013. A number of 247 macrofungi samples were collected during the field studies, which took place in the spring and autumn seasons. As a result of field and laboratory studies, a number of 99 taxa belonging to 64 genus, 36 family and 2 divisions were identified. While, four of them belong to Ascomycota and the remaining samples are found to be Basidiomycota. Four of these taxa are new records for Turkey.

Key words: macrofungi, biodiversity, taxonomy, Datça Peninsula, Turkey

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Datça Yarımadası'nın Makrofungusları (Türkiye)

Özet

Bu çalışma 2011-2013 yılları arasında Muğla ili Datça Yarımadası makrofungus çeşitliliğini ortaya koymak amacıyla yapılmıştır. Arazi çalışmaları özellikle ilkbahar ve sonbahar aylarında yapılmış olup, 247 makrofungus örneği toplanmıştır. Arazi ve laboratuvar çalışmaları sonucunda 64 cins, 36 familya ve 2 şubeye ait toplam 99 takson belirlenmiştir. Bunlardan 4'ü Ascomycota, 95'i Basidiomycota'ya aittir. Bunlardan 4'ü Türkiye için yeni kayıttır.

Anahtar kelimeler: makrofungi, biyoçeşitlilik, taksonomi, Datça Yarımadası, Türkiye

1. Introduction

The Datça Peninsula is located in the province of Muğla in the Aegean Region. It is located between the 27º40'-28º eastern meridians and the 36º60'-36º75 'northern parallels. In the Datça Peninsula, which is a mountainous and hilly ridge, predominantly the species of *Pinus brutia* Ten., *Liquidambar orientalis* Mill., *Eucalyptus camaldulensis* Dehnh. and *Cupressus sempervirens* L. trees are wide-spread. Datça has a typical Mediterranean climate. It ranks second in the world and first in Turkey in terms of oxygen abundance (Figure 1).

In the study area of the Datça Peninsula, there were no comprehensive studies prior to this current one, except that only two parasitic macrofungi species were reported before (Allı and Işıloğlu, 2000). These parasitic species are *Porodaedalea pini* (Brot.) Murrill and *Fomitiporia robusta* (P. Karst.) Fiasson & Niemelä. Therefore, in this study, we aimed to collect and identify the macrofungi of the region in order to contribute to the macrofungal diversity of the area as well as the Turkish macromycota. In recent years, several studies have been carried out on Turkish mycota. Some examples of these studies: Akata and Uzun (2017), Altuntaş et al. (2017), Demirel et al. (2017), Doğan and Kurt (2016), Öztürk et al. (2017), Sesli and Topçu Sesli (2017), Taşkın et al. (2016), Vizzini et al. (2016).

2. Materials and methods

Macrofungi specimens were collected from the region during the field studies conducted in the years 2011 to 2013. After the photographs of the collected samples were taken, their morphological and ecological characteristics were noted. Fresh samples were subjected to chemical tests and the resulting reactions were recorded. Spore prints were taken

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Figure 1. Map of the study area

from the samples brought to the laboratory under appropriate conditions. The microscopic characteristics of the specimens were examined and then dried and conserved in the Fungarium of Muğla Sıtkı Koçman University. The literature used for the purpose of identification included the following: Breitenbach and Kränzlin (1984 - 2000), Buczacki (1989), Dähncke (1993), Ellis and Ellis (1990), Hansen and Knudsen (2000), Kibby (2007), Knudsen and Vesterholt (2008), Noordeloos (1992), Moser (1983), Pacioni (1985), Phillips (1981).

3. Results

The names of the identified species as well as the details including the habitat types, collection locations and the specific dates are given below.

Ascomycota Whittaker

Helvellaceae
Helvella acetabulum (L.) Quél.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia* Ten., *Liquidambar orientalis* Mill. mixed forest, 14.03.2013, Allı 4684.
Helvella leucomelaena (Pers.) Nannf.: Çubucak, 0 m (sea level), *P. brutia* forest, 11.03.2012, Allı 3997; Datça, Muğla road 25. km, *P. brutia - L. orientalis* mixed forest,11.03.2012, Allı 4008; Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 14.03.2013, Allı 4678; Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4692.
Pyronemataceae
Scutellinia umbrorum (Fr.) Lambotte: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, on *P. brutia* cones, 14.03.2013, Allı 4676.
Geopyxis carbonaria (Alb. & Schwein.) Sacc.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 14.03.2013, Allı 4680.

Basidiomycota R.T. Moore

Agaricaceae
Agaricus campestris L.: Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4639.
Atractosporocybe inornata (Sowerby) P. Alvarado, G. Moreno & Vizzini: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4591.
Crucibulum laeve (Huds.) Kambly: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, on *P. brutia* needle, 27.12.2012, Allı 4612B.
Lepiota brunneoincarnata Chodat & C. Martín: Çubucak, sea level, *P. brutia* forest, 22.01.2012, Allı 3937.
Lepiota castanea Quél.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4566, 4576.
Lepiota cristata (Bolton) P. Kumm.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4606.
Lepiota subgracilis Kühner: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4687.
Lycoperdon lividum Pers.: Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4634. Çubucak, sea level, *P. brutia* forest, 22.01.2012, Allı 3947; Knidos, *P. brutia* forest, 11.03.2012, Allı 4010.

Lycoperdon perlatum Pers.: Emecik Village, *P. brutia* forest, 22.01.2012, Allı 3985.
Lycoperdon umbrinum Pers.: Aktur Kurucabük around, *P. brutia* - *Cupressus* sp. L.- *Eucalyptus* sp. L'Hér. mixed forest, 147 m, 22.01.2012, Allı 3968.
Macrolepiota mastoidea (Fr.) Singer: Çubucak, sea level, *P. brutia* forest, 22.01.2012, Allı 3950; Allı 3966. Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4640; Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4695.
Panaeolus papilionaceus (Bull.) Quél.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia*, *L. orientalis* mixed forest, 14.03.2013, Allı 4682.
Rhizocybe vermicularis (Fr.) Vizzini, G. Moreno, P. Alvarado & Consiglio: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia*, *L. orientalis* mixed forest, 14.03.2013, Allı 4686; Mesudiye, *P. brutia* forest, 14.03.2013, Allı 4707.
Amanitaceae
Amanita mairei Foley: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia*, *L. orientalis* mixed forest, 27.12.2012, Allı 4586, 4614.
Auriculariaceae
Auricularia auricula-judae (Bull.) Quél.: Değirmenyanı around, *L. orientalis* forest, 10.01.2012, Allı 3934a.
Bolbitiaceae
Bolbitius titubans (Bull.) Fr.: Çubucak, sea level, *P. brutia* forest, 22.01.2012, Allı 3954; Çubucak, *P. brutia* forest, 11.03.2012, Allı 4000; Allı 4002; Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4688.
Clavulinaceae
Clavulina coralloides (L.) J. Schröt.: Aktur Kovanlık, *P. brutia* forest, 22.01.2012, Allı 3978.
Dacrymycetaceae
Calocera cornea (Batsch) Fr.: Bördübet, *L. orientalis*, *P. brutia* mixed forest, on *L. orientalis* wood piece, 27.12.2012, Allı 4629.
Entolomataceae
Entoloma caesiocinctum (Kühner) Noordel.: Aktur Kurucabük around, *P. brutia* - *Cupressus* sp. - *Eucalyptus* sp. mixed forest, 147 m, 22.01.2012, Allı 3973.
Pileus 5-40 mm, hemispherical or conical-convex, then convex or low convex, with depressed to umbilicate centre, deeply translucently striate, brown, yellow brown or red brown (Figure 2a). **Lamellae** adnate-emarginate, medium spaced, white, then grey pink, with blue-black, serrulate edge (Figure 2b). **Stipe** 20-50 x 1-5 mm, glabrous or with scattered fibrils, grey brown or yellow brown with distinct blue tinge when fresh, base white tomentose (Figure 2b). **Basidiospores** 8.5-11.5(-12.5) x 6.5-7(-8) µm, 5-7-angled (Figure 2c) **Cheilocystidia** 20-120 x 7-20 µm, cylindrical to clavate with blue, intra cellular pigment (Figure 2d).

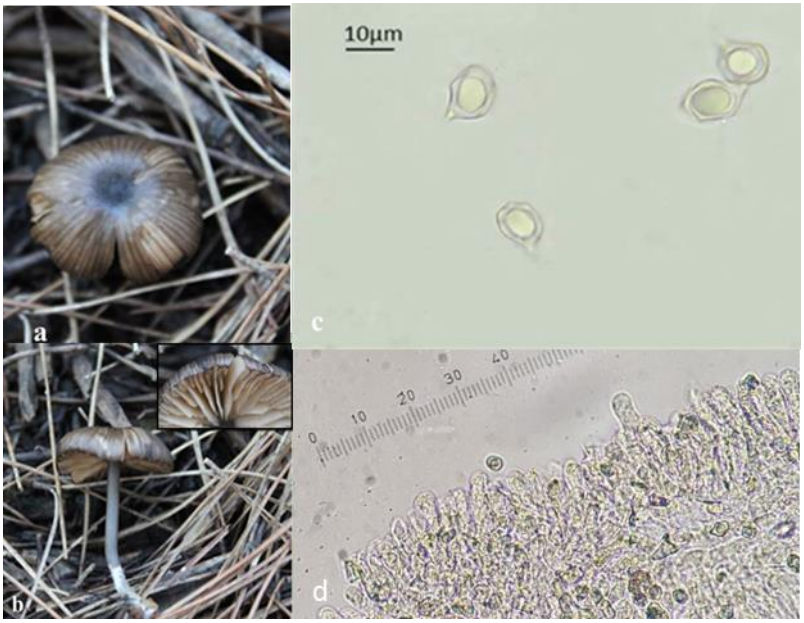

Figure 2. *Entoloma caesiocinctum*, a, b. basidiocarps, c. basidiospores, d. cheilocystidia

Entoloma pleopodium (Bull.) Noordel.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia*, *L. orientalis* mixed forest, 27.12.2012, Allı 4605.
Pileus 10-30 mm in diameter, central part dimpled and dark brown-black, surface striate, olive-yellow, yellowish grey tones (Figure 3a). **Lamellae** white at first, then turning yellow to brownish pink. **Stipe** 20-60 x 1,5-3 mm, cylindrical, hollow, olive brown, base is white hairy (Figure 3b). **Basidiospores** 8-11,9 x 6,1-8,7 µm, 5-6 angled (Figure 3c). **Cheilocystidia** absent.

Figure 3. *Entoloma pleopodium*, a, b. basidiocarps, c. basidiospores

Entoloma scabiosum (Fr.) Quél.: Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4693.
Pileus 15-80 mm, conico- convex then expanding to plano-convex, usually with distinct umbo, not hygrophanous, not translucently striate, dark red-brown to blackish brown fibrillose finely scaly on an almost white background (Figure 4a). **Lamellae** fairly crowded, deeply emerginate, ventricose, white or grey then pinkish grey finally brownish pink with serrate or fimbriate, concolorous edge. **Stipe** 20-80 x 2-15 mm, fi brillose striate, paler than pileus, white tomentose at base (Figure 4b). **Basidiospores** 7-8(-9) x 5.5-7 µm, heterodiametrical, 5-7-angled in side-view (Figure 4c). **Cheilocystidia** 25-90 x 5-20 µm, lecithiform to tibiiform, neck often moniliform, capitulum often mucronate (Figure 4d).

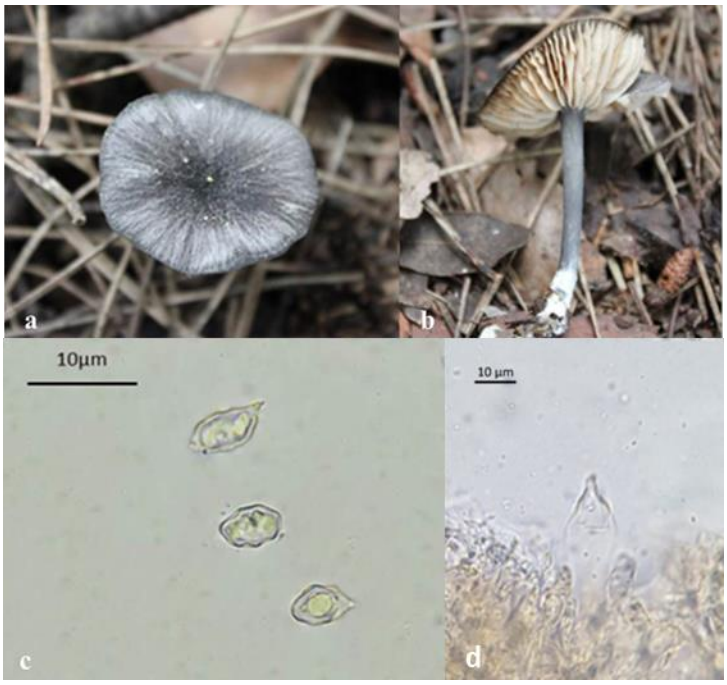

Figure 4 . *Entoloma scabiosum*, a, b. basidiocarps, c. basidiospores, d. cheilocystidia

Entoloma subradiatum (Kühner & Romagn.) M.M. Moser: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia*, *L. orientalis* mixed forest, 27.12.2012, Allı 4593.
Entoloma rusticoides (Gillet) Noordel.: Kovanlık mevki, *L. orientalis* forest, 01.05.2012, Allı 4139.
Ganodermataceae
Ganoderma lucidum (Curtis) P. Karst.: Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 25.10.2011, Allı 3935b; Değirmenyanı around, *L. orientalis* forest, on *L. orientalis* root, 10.01.2012, Allı 3934b – Allı 3934d; Datça – Muğla road 25. km, *P. brutia - L. orientalis* mixed forest, on *L. orientalis* root, 11.03.2012, Allı 4007; Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, on *L. orientalis* root, 01.05.2012, Allı 4122.
Geastraceae
Myriostoma coliforme (Dicks.) Corda: Çubucak, 0 m, *P. brutia* forest, 10.04.2012, Allı 4021.
Gomphaceae
Ramaria gracilis (Pers.) Quél.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, on *L. orientalis* wood piece, 27.12.2012, Allı 4590.
Gomphidiaceae

Chroogomphus helveticus (Singer) M.M. Moser: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3958; Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4620.
Chroogomphus rutilus (Schaeff.) O.K. Mill.: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3936; Çubucak, 0 m, *P. brutia* forest, 10.04.2012, Allı 4019; Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4636; Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4691.

Hydnangiaceae

Laccaria laccata (Scop.) Cooke: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4597.

Hygrophoraceae

Hygrocybe conica (Schaeff.) P. Kumm.: Aktur Kurucabük around, *P. brutia* - *Cupressus* sp. - *Eucalyptus* sp. mixed forest, 147 m, 22.01.2012, Allı 3971; Bördübet, *L. orientalis* forest, 01.05.2012, Allı 4129.

Hymenochaetaceae

Fuscoporia torulosa (Pers.) T. Wagner & M. Fisch.: Kovanlık around, *L. orientalis* forest, on *L. orientalis*, 01.05.2012, Allı 4140; Emecik Village, *P. brutia* forest, 14.03.2013, Allı 4705.
Phellinus igniarius (L.) Quél.: Değirmenyanı *Eucalyptus* sp. - *P. brutia – L. orientalis* mixed forest, on *L. orientalis* stump, 11.03.2012, Allı 3992.
Trichaptum fuscoviolaceum (Ehrenb.) Ryvarden: Emecik Village, *P. brutia* forest, on *P. brutia* stump, 22.01.2012, Allı 3981.
Porodaedalea pini (Brot.) Murrill: Mesudiye, *P. brutia* forest, 11.03.2012, Allı 4011. Marmaris – Datça road 13.km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, on *P. brutia*, 01.05.2012, Allı 4125.

Hymenogastraceae

Deconica coprophila (Bull.) P. Karst.: Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4689.
Hebeloma birrus (Fr.) Sacc.: Aktur Kovanlık, *P. brutia* forest, 22.01.2012, Allı 3974; Çubucak, *P. brutia* forest, 22.01.2012, Allı 3953.
Hebeloma laterinum (Batsch) Vesterh.: Bördübet, *P. brutia* forest, 14.03.2013, Allı 4698.
Hebeloma stenocystis J. Favre: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3967.

Inocybaceae

Crepidotus mollis (Schaeff.) Staude: Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 10.01.2012, Allı 3934c; Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4622; Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4653.
Crepidotus variabilis (Pers.) P. Kumm.: Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4627.
Inocybe amethystina Kuyper: Çubucak, 0 m, *P. brutia* forest, 22.01.2012, Allı 3962.
Inocybe catalaunica Singer: Çubucak, 0 m, *P. brutia* forest, 22.01.2012, Allı 3941.
Inocybe cookei Bres.: Çubucak, *P. brutia* forest, 11.03.2012, Allı 3996.
Inocybe erubescens A. Blytt: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3945; Çubucak, 0 m, *P. brutia*-*Quercus* sp. mixed forest, 27.12.2012, Allı 4652.
Inocybe fuscidula Velen.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4577.
Inocybe geophylla (Bull.) P. Kumm.: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3960; Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4568; 4569; 4589; 4608; Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 14.03.2013, Allı 4677.
Inocybe godeyi Gillet: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3959.
Inocybe hystrix (Fr.) P. Karst.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4573.
Inocybe lacera (Fr.) P. Kumm.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4582.
Inocybe lanuginosa (Bull.) P. Kumm.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 14.03.2013, Allı 4681.
Inocybe maculata Boud.: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3944.
Inocybe nitidiuscula (Britzelm.) Lapl.: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3939; Çubucak, 0 m, *P. brutia* forest, 22.01.2012, Allı 3940.
Inocybe phaeoleuca Kühner: Çubucak, 0 m, *P. brutia* forest, 22.01.2012, Allı 3935; Allı 3964; Bördübet, *P. brutia* forest, 14.03.2013, Allı 4697.
Inocybe whitei (Berk. & Broome) Sacc.: Çubucak, 0 m, *P. brutia* forest, 22.01.2012, Allı 3946.

Marasmiaceae

Gymnopus ocior (Pers.) Antonín & Noordel.: Kovanlık around, *P. brutia* forest, 11.03.2012, Allı 4005.
Marasmius rotula (Scop.) Fr.: Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4647.

Mycenaceae

Mycena galopus (Pers.) P. Kumm.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4578.

Mycena pura (Pers.) P. Kumm.: Aktur Kurucabük Around, *P. brutia* - *Cupressus* sp. - *Eucalyptus* sp. mixed forest, 147 m, 22.01.2012, Allı 3970.
Mycena stipata Maas Geest. & Schwöbel: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4600.
Mycena strobilicola J. Favre & Kühner: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4603.
Xeromphalina cauticinalis (Fr.) Kühner & Maire: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4580.
Phallaceae
Clathrus ruber P. Micheli ex. Pers.: Bördübet, *P. brutia* forest, 14.03.2013, Allı 4699.
Pleurotaceae
Hohenbuehelia tremula (Schaeff.) Thorn & G.L. Barron: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4579.
Pluteaceae
Volvariella caesiotincta P.D. Orton
Emecik Village, *L. orientalis* mixed forest, 22.01.2012, Allı 4143.
Volvopluteus gloiocephalus (DC.) Vizzini, Contu & Justo: Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4633.
Polyporaceae
Daedaleopsis tricolor (Bull.) Bondartsev & Singer: Emecik Village, *P. brutia- Eucalyptus* sp. mixed forest, on *Eucalyptus* sp. stump, 22.01.2012, Allı 3982.
Basidiocarp 40-100 (150) mm in diameter, attached to the substrate, fan-shaped, three different colored layers at the surface (Figure 5a). Grey-ocher brown margin and more interior It was stratification in reddish brown and light brown tones. **Hymenium** like a lamellae (especially this structure is separated from the *Daedaleopsis confragosa*), reddish brown (Figure 5b). **Basidiospores** 6,5-8,5 x 2,5 µm, hyalin, cylindrical and sligthly virgule shaped, sometimes droplets, smooth (Figure 5c).

Figure 5. *Daedaleopsis tricolor*, a, b. basidiocarps, c. basidiospores (with congo red)

Fomes fomentarius (L.) Fr.: Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 25.10.2011, Allı 3935c.
Lentinus tigrinus (Bull.) Fr.: Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 10.01.2012, Allı 3934e. Hisarönü, *L. orientalis* forest, 01.05.2012, Allı 4148.
Trametes versicolor (L.) Lloyd: Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 25.10.2011, 3935d; Bördübet, *L. orientalis* forest, 01.05.2012, Allı 4133; Allı 4126; Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4626.
Porotheleaceae
Phloeomana hiemalis (Osbeck) Redhead: Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4624.
Psathyrellaceae
Psathyrella candolleana (Fr.) Maire: Kovanlık around, L. orientalis forest, 01.05.2012, Allı 4136.
Psathyrella clivensis (Berk. & Broome) P.D. Orton: Bördübet, *L. orientalis* forest, on *L. orientalis*, 01.05.2012, Allı 4134.
Psathyrella obtusata (Pers.) A.H. Sm.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4615.
Rhizopogonaceae
Rhizopogon luteolus Fr.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4588.
Rhizopogon roseolus (Corda) Th. Fr.: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3949; Allı 3956; Bördübet, *L. orientalis* forest, 01.05.2012, Allı 4133; Allı 4135; Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4641; Bördübet, *P. brutia* forest, 14.03.2013, Allı 4696.
Russulaceae

Lactarius deliciosus (L.) Gray: Aktur Kovanlık, *P. brutia* forest, 22.01.2012, Allı 3979; Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4610; Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4618; Emecik Village, *P. brutia* forest, 14.03.2013, Allı 4702.
Russula xerampelina (Schaeff.) Fr.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4602; Çubucak, 0 m, *P. brutia* forest, 27.12.2012, Allı 4650.
Schizophyllaceae
Schizophyllum commune Fr.: Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 25.10.2011, 3935e; Değirmenyanı around, *L. orientalis* forest, on *L. orientalis*, 10.01.2012, 3934f.
Sclerodermataceae
Pisolithus arhizus (Scop.) Rauschert: Çubucak, *P. brutia* forest, 09.11.2012, Allı 4455.
Scleroderma bovista Fr.: Çubucak, *P. brutia* forest, 22.01.2012, Allı 3949; Allı 3955.
Stereaceae
Stereum hirsutum (Willd.) Pers.: Aktur Kurucabük around, *P. brutia - Cupressus* sp. - *Eucalyptus* sp. mixed forest, on *Eucalyptus* sp., 147 m, 22.01.2012, Allı 3972; Çubucak, 0 m, *P. brutia* forest, 10.04.2012, Allı 4020; Emecik Village, *P. brutia* forest, 14.03.2013, Allı 4706.
Strophariaceae
Agrocybe praecox (Pers.) Fayod: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 01.05.2012, Allı 4119.
Cyclocybe cylindracea (DC.) Vizzini & Angelini
Bördübet, *L. orientalis* forest, on *L. orientalis* stump, 01.05.2012, Allı 4130.
Suillaceae
Suillus collinitus (Fr.) Kuntze: Aktur Kurucabük around, *P. brutia - Cupressus* sp. - *Eucalyptus* sp. mixed forest, 147 m, 22.01.2012, Allı 3969; Aktur Kovanlık, *P. brutia* forest, 22.01.2012, Allı 3976.
Thelephoraceae
Thelephora terrestris Ehrh.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4595.
Tricholomataceae
Clitocybe costata Kühner & Romagn.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia*, L. orientalis mixed forest, 27.12.2012, Allı 4596; 4616.
Infundibulicybe geotropa (Bull.) Harmaja: Aktur Kovanlık, *P. brutia* forest, 22.01.2012, Allı 3980.
Lepista multiformis (Romell) Gulden: Emecik Village, *P. brutia* forest, 22.01.2012, Allı 3983.
Lepista nuda (Bull.) Cooke: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4617.
Melanoleuca brevipes (Bull.) Pat.: Çubucak, 0 m, *P. brutia* forest, 11.03.2012, Allı 3998.
Melanoleuca strictipes (P. Karst.) Jul. Schäff.: Bördübet, L. orientalis, *P. brutia* mixed forest, 27.12.2012, Allı 4631b; Çubucak, 0 m, *P. brutia* forest, 14.03.2013, Allı 4690.
Resupinatus applicatus (Batsch) Gray: Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4630.
Tricholoma terreum (Schaeff.) P. Kumm.: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4584.
Tubariaceae
Tubaria furfuracea (Pers.) Gillet: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4575.
Tubaria romagnesiana Arnolds: Marmaris – Datça road 13. km. İçmeler Stream, *P. brutia, L. orientalis* mixed forest, 27.12.2012, Allı 4567; 4607; Bördübet, *L. orientalis, P. brutia* mixed forest, 27.12.2012, Allı 4621.

4. Conclusions and discussion

In this study, 36 families, 64 genera and 99 taxa belonging to 2 (Ascomycetes and Basidiomycetes) class were identified. Out of all the identified taxa, four of them are new records for Turkey. These species are *Daedaleopsis tricolor*, *Entoloma caesiocinctum* , *Entoloma pleopodium* and *Entoloma scabiosum* (Sesli and Denchev, 2008; Solak et al., 2015). The statistical analysis of the 99 species indicates that 32% are edible, 21% are poisonous and 47% are inedible (Figure 6).

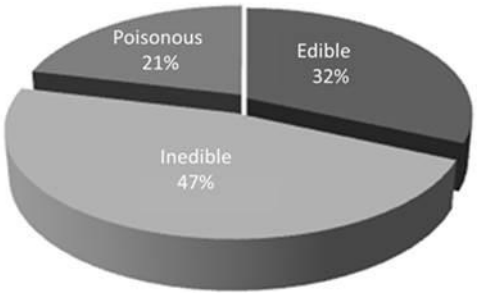

Figure 6. Edibility of the macrofungi of Datça Peninsula

In the study area, the most predominant families were found to be Inocybaceae followed by Agaricaceae, Tricholomataceae, Mycenaeae and Entolomataceae (Figure 7).

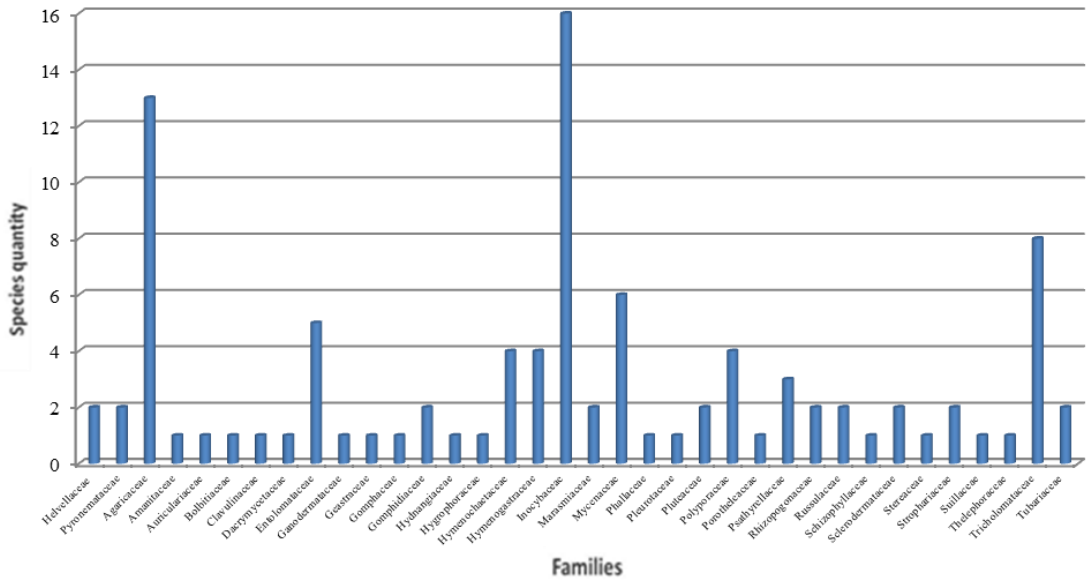

Figure 7. The graph illustrating the number of species in the specific families identified in the study

Similarity ratios obtained from the similar studies in the near vicinity of this current study are given in Table 1.

Table 1. Similarity percentages of neighbouring studies with Datça Peninsula

Investigations	**Number of identical taxa**	**Total taxa**	**Similarity percentage**
Solak & Yılmaz Ersel (2005)	37	178	20.7
Güngör et al. (2016)	35	211	16,5

Acknowledgements

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References

Akata, I., Uzun,Y. (2017). Macrofungi Determiıned in Uzungöl Nature Park (Trabzon). Trakya University Journal of Natural Sciences, 18(1), 15-24.

Allı, H., Işıloğlu, M. (2000). The Parasite Macrofungi of Muğla Province. The Herb Journal of Systematic Botany 7(1), 249-255.

Altuntaş, D., Allı, H., Akata, Ilgaz (2017). Macrofungi of Kazdağı National Park (Turkey) and its close environs. Biodicon, 10(2),17-25.

Breitenbach, J. and Kränzlin, F. (1984). Fungi of Switzerland. Vol: 1, Ascomycetes, Switzerland: Verlag.

Breitenbach, J. and Kränzlin, F. (1986). Fungi of Switzerland. Vol: 2, Nongilled Fungi, Switzerland: Verlag.
Breitenbach, J. and Kränzlin, F. (1991). Fungi of Switzerland Vol: 3, Boletes and Agarics 1, Switzerland: Verlag.
Breitenbach, J., Kränzlin, F. (1995). Fungi of Switzerland. Vol: 4, Agarics 2. Part. Switzerland: Verlag Mykologia.
Buczacki, S. (1989). Fungi of Britain and Europe. Glasgow: W. Collins Ltd.
Dähncke, R. M. (1993) 1200 Pilze. Stuttgart: AT Verlag Aarau.
Demirel, K., Uzun Y., Keleş A., Akçay M. E., Acar I. (2017). Macrofungi of Karagöl–Sahara National Park (Şavşat-Artvin/Turkey). Biodicon, 10(2), 32-40.
Doğan, H.H, Kurt, F. (2016). New macrofungi records from Turkey and macrofungal diversity of Pozantı-Adana. Turkish Journal of Botany, 40, 209-217.
Ellis, M.B. and Ellis, J.P. (1990). Fungi Without Gills (Hymenomycetes and Gasteromycetes). London: Chapman and Hill.
Güngör, H., Solak, M.H., Allı, H., Işıloğlu, M., Kalmış, E. (2016). Contributions to the macrofungal diversity of Muğla province (Turkey). Mycotaxon, 131(256), 1-26.
Hansen, L. and Knudsen, H. (2000). Nordic macromycetes (Ascomycetes). Vol. 1. Nordsvamp, Copenhagen.
Knudsen, H. and Vesterholt, J. (2008). Fungi Nordica. Denmark: Nordsvamp, Copenhagen.
Moser, M. (1983). Keys to Agarics and Boleti. Stutgart: Gustav Fischer Verlag.
Noordeloos, M. E. (1992). Entoloma s.l. Fungi Europaei. 5th ed. Italy: Saronno.
Öztürk, C., Pamukçu, D., Aktaş, S. (2017). Macrofungi of Nallıhan (Ankara) District. Mantar Dergisi, 8(1),60-67.
Pacioni, G. (1985). Mushrooms and Toadstools. London: Mac Donald and Ltd.
Phillips, R. (1981). Mushrooms and other fungi of Great Britain and Europe. London: Pan books Ltd.
Sesli, E., Denchev, CM. (2008). Checklist of the myxomycetes and macromycetes in Turkey. Mycotaxon, 106.+[complete version, 1–136, new version uploaded in February 2014].
Sesli, E., Topçu Sesli, A. (2017). Entoloma majaloides (Entolomataceae): Türkiye Mikotası İçin Yeni Bir Kayıt. Mantar Dergisi, 8 (2), 85-89.
Solak, M.H., Yılmaz Ersel, F. (2005). Macrofungi of Muğla Province. Afyon Kocatepe University Journal of Science 5(1-2), 15-24.
Solak, M.H., Işıloğlu, M., Kalmış, E., Allı, H. (2015). Macrofungi of Turkey, Checklist. Vol:2., İzmir: Üniversiteliler Ofset.
Taşkın, H., Doğan, H.H., Büyükalaca, S., Clowez, P., Moreu, P.A., O'Donnell, K.. (2016). Four new morel (Morchella) species in the elata subclade (M. sect. Distantes) from Turkey. Mycotaxon, 131, 467-482.
Vizzini, A., Baroni, T.J., Sesli, E., Antonin, V., Saar, I. (2016). *Rhodocybe tugrulii* (Agaricales, Entolomataceae), a new species from Turkey and Estonia based on morphological and molecular data, and a new combination in Clitocella (Entolomataceae), Phytotaxa, 267(1), 1–15.

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Research article/Araştırma makalesi

Soil radioactive pollution in Falluja-Iraq

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Abstract

Applying the CR-39, Solid State Nuclear Track Detector, the radioactivity of the soil in Fallujah City was measured at the ground depths 0-20, 20-40 and 40-60 cm respectively. The soil samples were collected during summer 2014. At the surface, 0-20 cm depth, the measured radioactivity corresponding to depleted uranium concentration of 1.1-2.5 ppm, showed lower values as compared with the tolerated average value of 2.8 ppm (DU). The detected activity values at the 20-40 cm and 40-60 cm depths were not negligible, (1.0-2.3) ppm and (0.9-2.0) ppm respectively. The results indicate the diffusion of the radioactive material, accepted as depleted Uranium, down the soil layer within the 3 levels. Adding the ppm values at the three depths together yields radioactivity values of (3.1-6.8) ppm, which are greater than the IAE tolerated value of 2.8 ppm. The 'accumulated activity' represents the initial value for the contamination. The formation process dates back to the year 2005, of the 2nd Falluja confrontation. The period required for the diffusion down the soil extends over 9-10 years. The high numeric value of the radioactive contamination 3.0-6.8 ppm DU can permit us to understand the origin of the increase in cancer disease cases, women repetitive abortions, malformations and generic deformations of newly borne babies, following the year 2005, as reported by the health administrations of the city.

Key words: Falluja, Iraq, soil, radioactivity, CR-39

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Falluja-Irak'ta toprak radyoaktif kirliliği

Özet

CR-39, Katı Hal Nükleer Yol Dedektörünü uygulayarak, Felluce Şehri'ndeki toprağın radyoaktivitesi, sırasıyla 0-20, 20-40 ve 40-60 cm'lik toprak derinliklerinde ölçülmüştür. Toprak örnekleri 2014 yılının yaz mevsimi boyunca toplanmıştır. Yüzeyde, 0-20 cm derinliğinde, 1.1-2.5 ppm'lik tükenmiş uranyum konsantrasyonuna karşılık gelen ölçülen radyoaktivite değeri, tolere edilen 2.8 ppm ortalama değerine kıyasla daha düşük değerler göstermiştir. 20-40 cm ve 40-60 cm derinliklerinde tespit edilen aktivite değerleri, sırasıyla, 1.0-2.3 ppm ve 0.9-2.0 ppm olarak göz ardı edilemezdi. Sonuçlar, tükenmiş uranyum olarak kabul edilen radyoaktif malzemenin, 3 kattaki toprak tabakasında aşağı doğru yayıldığını göstermektedir. Üç derinlikte ppm değerlerinin toplanması, 3.1-6.8 ppm'nin radyoaktivite değerlerini verir, bu da 2.8 ppm'lik IAE tolere edilen değerden daha büyüktür. "Birikmiş etkinlik", kirlenmenin başlangıç değerini temsil eder. Formasyon süreci, 2. Felluce çatışmasının 2005 yılına kadar uzanmaktadır. Toprak aşağı difüzyon için gerekli süre 9-10 yıl boyunca uzanır. Radyoaktif kontaminasyon 3.0-6.8 ppm DU'nın yüksek sayısal değeri, 2005 yılından itibaren, şehrin sağlık yönetimi dikkate alındığında, kanser hastalarında görülen artış, kadınların tekrarlayan düşükleri, yeni doğan bebeklerin sakat olması ve genel deformasyonlarını anlamamızı sağlayabilir.

Anahtar kelimeler: Felluce, Irak, toprak, radyoaktivite, CR-39

1. Introduction

The major sources of radioactive material are the products of nuclear fission and naturally occuring radionuclides. These are carried by the particles ranging from less than 1 μ up to a few mm. One of the main routes in their incorporation in to food chain are plants. Plants are the first organisms which get effected by the radioactivite pollution created by

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naturally produced radioisotopes and products of nuclear fission. They form one of the primary inlets in the food chain. However, it is very difficult to put forward the damages in these silent observers, unless the radioactivity levels exceed the natural ones. Radionucleid accumulation is seen to reach a very high level in a short time in lichens which are accepted as the best bioaccumulators. Lately much attention has been paid towards the researches concerning the determination of species which can be used as indicators in radioactive pollution. However, their damaging effects on the plants cannot be detected unless the levels are not above the natural ones. The sensitivity of the plants is related to the size of nucleus and growth form of the plants. Climatic conditions, particularly rain plays a great role in the deposition and removal of the radionuclides from the plants surfaces. (Ozturk et al., 1987, 1994).

Radionuclides existing in soil can be dissolved in solution, or ion exchanged in reaction, complexed with soil organics or precipitate as pure or mixed solids. Their immobility in uppermost soil layers represents a problem for environment and human health, due to their easy integration in the food chain (Cazzola et al., 2004; Gavrilescu et al., 2009). Igwe et al. (2005) have proposed a scheme for radionuclides movement in the soil, a major part is released into the environment which either accumulates in the upper layer of soils, inducing a risk for the ecosystems and health (Gavrilescu et al., 2009).

During the last six decades uranium mining and milling has lead to much damage to the environment through abandoned radioactive waste accumulation and its improper disposal, dumping of the wastes after uranium prospections. Large amounts of both high- and low-level uranium-containing wastes is generated from fuel fabrication and reprocessing as well as research and development producing negative effects. These influence the environmental quality mainly surface-ground waters, and soils. Its potential risk in soil contamination is a global problem. These also pollute large land areas endangerring the catchments of drinking water (Gavrilescu et al., 2009). Uranium also generates an important issue against human health (Gongalsky, 2003). Its solubility in soil depends on pH, redox potential, temperature, soil texture, organic and inorganic compounds, moisture and microbial activities (Rivas, 2005). Soluble forms move with soil water, which are absorbed by plants or aquatic organisms or volatilized (Igwe et al., 2005). In view of this, the contamination by uranium has severe negative biological effects on important groups of the soil food web (IAEA, 2005a, b). Its contamination in soil and water has been identified globally at many sites, therefore measures for preventing their assimilation by plants needs to be considered as the first step in the remediation of contaminated sites (Navratil, 2001; Gongalsky, 2003; Cazzola et al., 2004; Gavrilescu et al., 2009). Different *in situ* technologies like alkaline leaching with carbonate and hydrocarbonate ions, or acid leaching were used commercially in a large number of deposits (IAEA 2001, 2002a, b; Normon and Raforth, 1998; Groudev et al., 2007).

The political, economical and environmental reasons have lead to a stopping of all commercial-operations for uranium leaching (IAEA, 2005a, b). Inspite of these preventive and remedial actions many natural ecosystems have sufferred heavily from radioactive element pollution due to uranium recovery, mainly through the seepage of acid drainage waters (Savchenko, 1996; Gupta, 2006; Gavrilescu et al., 2009). Later are still a persistent environmental problem at many abandoned sites, because the soils alongside the water flow path are polluted with radioactive elements, and these have become unsuitable for agricultural use, as such soil remediation is an important task at such sites (AbdEl-Sabour, 2007). The depleted uranium too poses a problem at such places, because this has increased public health concerns due to the chemical toxicity of DU at elevated doses. There is need to develope U removal methods from contaminated sites (Gavrilescu et al., 2009). The remediation of radionuclide-contaminated soils is a matter of high priority. If these soils are left untreated, they will pose a great threat for human health and will be hazardous for our environment. For this purpose methods can be used to extract uranium from its ores to achieve remediation of contaminated soils and water (Merritt, 1971; Roh et al., 2000).

^{238}U, ^{235}U and ^{234}U are the three isotpes of uranium usually occurring in the soil. Their relative abundance is 9.27, 0.720 and 0.0055 percent respectively. Uranium is found in the soil (80-90%) in the +VI oxidation states as uranyl cations (UO_2^{+2}), a predominant species of U in soil under acidic conditions (Ebbs, 1997). Its behaviour in soil is similar to other heavy metals and toxicity mimics that of Pb. Later is toxic to kidneys and some insoluble U-compounds are carcinogenic (Ibrahim et al., 2015). The behaviour of U in soil is complex and the metal speciation (especially pH-dependent) is very difficult to investigate. According to Baes (1982) rare amounts of uranyl cations are present in available forms because of high solid-liquid distribution (Kd).

Not much is known about the uptake and translocation of uranium by the plants under diverse soil conditions. Generally U contents of plants growing under U-contaminated environments have been investigated (Whicker and Ibrahim, 1984; Ibrahim and Whicker, 1988). In some cases the uptake of U by field and garden crop having importance to humans and animals has been studied (Sheppard et al., 1985, 1989; Ibrahim et al., 2015). The soil to plant transfer is usually known as transfer factor (TF), which varies with plant species and plant part. The roots generally are reported to contain higher uranium than stems, leaves and shoots (Apps et al., 1988; Ebbs et al., 1998). Leafy vegetables too show higher U-TFs followed by root, fruit and grain crop plants. The TFs are reported to exceed a value of 0.01 rarely, with the exception of some plants growing on very highly contaminated (acidic) U-mining soils. The TFs of different crops also depend on the soil pH and some are very sensitive to pH. The sage brush has shown the highest TF under natural conditions rarely grown at pH below 4 (Ibrahim et al., 2015). The free UO_2^{+2} is most readily taken up and translocated by plants, being present at a pH of 5.5 or less, and acidification of uranium-contaminated sites is necessary for phytoextraction. This species is also responsible for binding soil solids with organic matter; as such a reduction in plant

uptake has been reported. Some soil amendments in addition to acidification may increase the availability of U by the formation of complexes (Sheppard et al., 1984; Ebbs, 1997; Ibrahim et al., 2015).

Fallujah is a city of ca 750,000 inhabitants, located about 70 km northwest of Baghdad, Iraq (Figure 1). It was the scene of heavy military operations in the years 2004 and 2005. In the years following these operations peculiar health abnormalities appeared among its population (Anonymous, 2017). In the following years high number of child blood cancer cases, genetically deformed malbirths, repetitive abortions of pregnant women and multifold increase in adult cancer cases were reported by the local health authorities (Anonymous, 2013). A thorough inspection of the causes of this catastrophic health situation was called for (Anonymous, 2012). For this purpose an intensive study of the soil contamination was needed. The soil analysis aimed primarily at the estimation of radioactive as well as heavy metal contaminations. The subject of this paper deals primarily with the soil radioactive contamination.

Solid state nuclear track detectors (SSNTD) are appropriate and economic device for the quantitative estimation of nuclear radioactivity (Fleischer et al., 1975). Both organic and inorganic materials are used for their production. The organic detectors are mostly composed of polymeric resins (Szydlowski et al., 1999). When exposed to radioactive material, they get chemically changed due to the collision with α or ß particles. The spots of collision appear on the resin sheet and can be counted applying a proper magnifying microscope (Durrani and Bull, 1987). Among the SSNTD, CR-39 seems to be most favored for such studies (UNSCEAR, 1994).

Figure 1. Location of Fallujah City in Iraq

2. Materials and methods

The soil samples were randomly collected from 50 different locations, designated relative to schools and mosques, in the city. From each location 5 different samples were collected from the following depths; 0-20, 20-40, and 40-60 cm. After removal of "garbage" material, the samples were dried under 105°C for 24 hours and then submitted for the radioactivity analysis. CR-39 SSNTD, Landauer, England; optical microscope with 400 x magnifying power, Nicon, Japan and Heraeus furnace with a temperature range of 0-250 °C were used during the evaluation of soil samples. The sensitive balance used was of the type Sartorious-BP 3015. ^{241}Am-Be neutron source of an activity 5.92 x 10^{11} Bq and a neutron flux of $5x10^3$ n $cm^{-2}.s^{-1}$ were used for the irradiation. 1 gm pellet of the sample material was prepared through pressing with a 15 atm. press. It was placed in front of a 1 cm^2 sheet of CR-39, both placed in the radiation container with the neutron source (Figure 2a). The neutron irradiation continued for 7 days, after which the CR-39 was removed and immersed in a (6.25N) NaOH bath at 60°C for 5 hours (Figure 2b). The tracks formed in the Cr-39 sheet were inspected applying the optical microscope. The measured track density (spot/cm^2) was used to evaluate the amount of radioactivity contamination, calculated in ppm of natural uranium according to a correlation curve (Figure 2c).

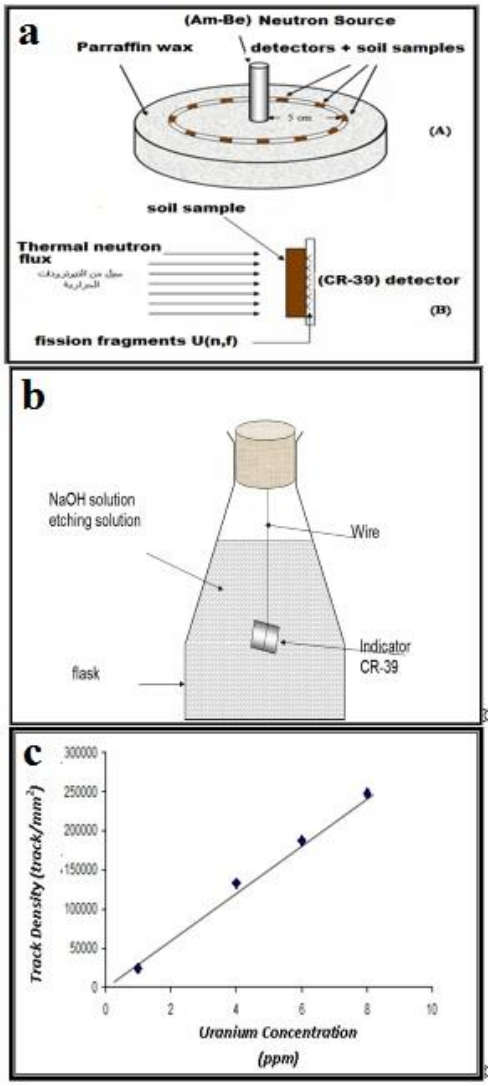

Figure 2. (**a**) the radiation measurement container applied for the estimation of soil radioactivity; (**b**) NaOH bath used for etching the irradiated Cr-39 sheets; (**c**) correlation curve of the measured track density, CR-39, with the Uranium concentration (ppm).[**)] Prof. N. F. Tawfiq, Dept. of Physics, Al-Nahrain University, personal communication

3. Results

The table 1 shows measurement results for most of the chosen sampling locations. The amount of radioactive contamination calculated as ppm values of Uranium, are lower than the internationally permitted values of 2.8 ppm (IAEA, 2005a, b), showing that at the depths of 20 and 40 cm the amount of contamination is not negligible.

Table 1. Measured radioactive contamination, calculated as ppm, Uranium, at some sampling sites in Fallujah

Sample Location	**Depth (cm) - U (ppm)**		
	20 cm	**40 cm**	**60 cm**
Alhhurriya School	1.118	0.952	0.786
Almaamun School	1.433	1.276	1.173
Aljamhurriya School	1.391	1.214	1.147
Alturath Alaraby School	1.251	1.048	0.873
Alkhaleel School	1.250	1.170	0.987

The low U-ppm values at the soil surface, 0-20 cm, suggest that the contamination in the city is not threatening and might be neglected, Figures 3a and 3b.

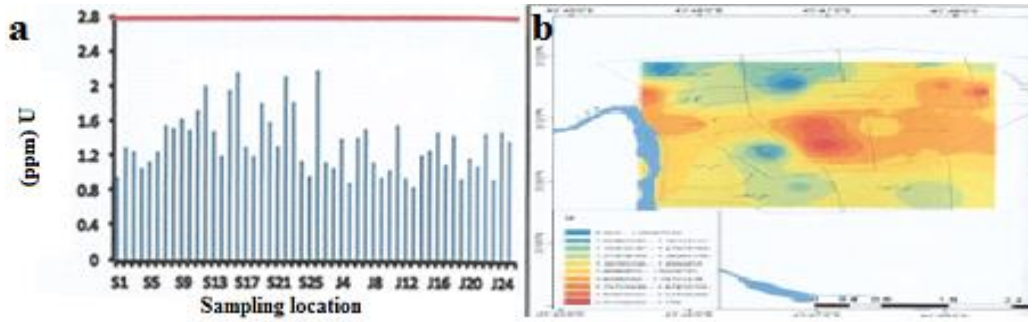

Figure 3. **(a)** Plots of the measured U concentration at 50 different soil sampling locations taken at the depth 0-20 cm; (**b**) Area **c**ontours of the measured U concentration at 50 different soil sampling locations taken at the depth 0-20 cm.

However, the situation is different on considering the sums of all three concentrations at the three depths (Figure 4). The calculated cumulative concentration values are all higher than the average tolerated (2.8 ppm) value of U (Table 2). Based on the cumulative concentration values we can conclude that the initial U concentrations, compelled in the years 2004-2005, were several folds higher than 2.8 ppm. Figure 5 describes the concentration change relative to the soil depths. The solid lines represent the measured concentration values, the dotted lines represent the calculated concentration values applying the gradient method. By this calculation we defined the concentration gradient as the difference quotient of the concentration (ppm) over the change in depth (cm).

C_i = the concentration at the depth d_i (1)
C_{i+1} = the concentration at the depth d_{i+1} (2)
$\Delta^c = C_i - C_{i+1}$ (3)
$\Delta^d = d_i - d_{i+1}$ (4)
$\blacktriangledown_{i-i+1} = \Delta^c / \Delta^d$ is the gradient of concentration change.
$C_{i+1} = C_i (1 - \blacktriangledown_{i-i+1})$ (5)

Table 2. Cumulative soil radioactive contamination values (ppm, Uranium) at some sampling sites in Fallujah

	Depth (cm) - U concen. (ppm)			
Sample Location	**20 cm**	**40 cm**	**60 cm**	**Sum**
Aljumhurriya school	1.391	1.214	1.147	**3.752**
Alturath alaraby	1.251	1.048	0.873	**2.299**
Alkhaleel School	1.250	1.170	0.987	**2.420**
Alzaytoona School	1.472	1.322	0.952	**2.794**
Alfalluja School	1.713	1.563	1.378	**4.654**
Alsuudad School	1.712	1.548	1.293	**4.553**

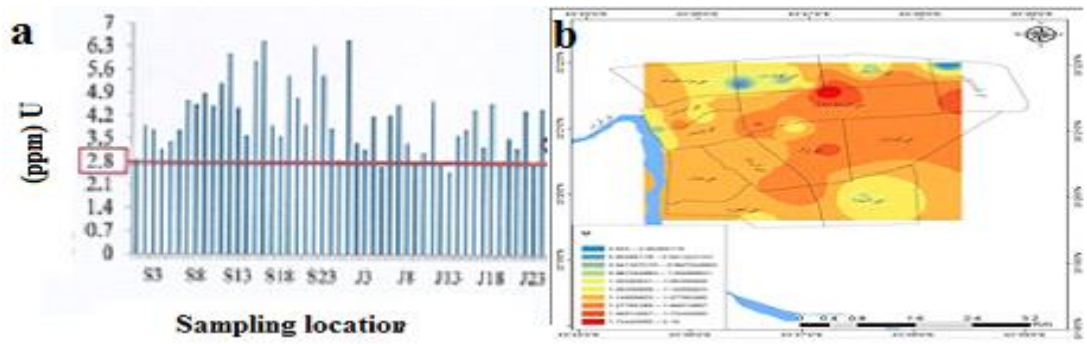

Figure 4. **(a)** Plots of the calculated cumulated U concentrations at 50 different soil sampling locations; (**b**) Area **c**ontours of the cumulative U concentration at 50 different soil sampling locations

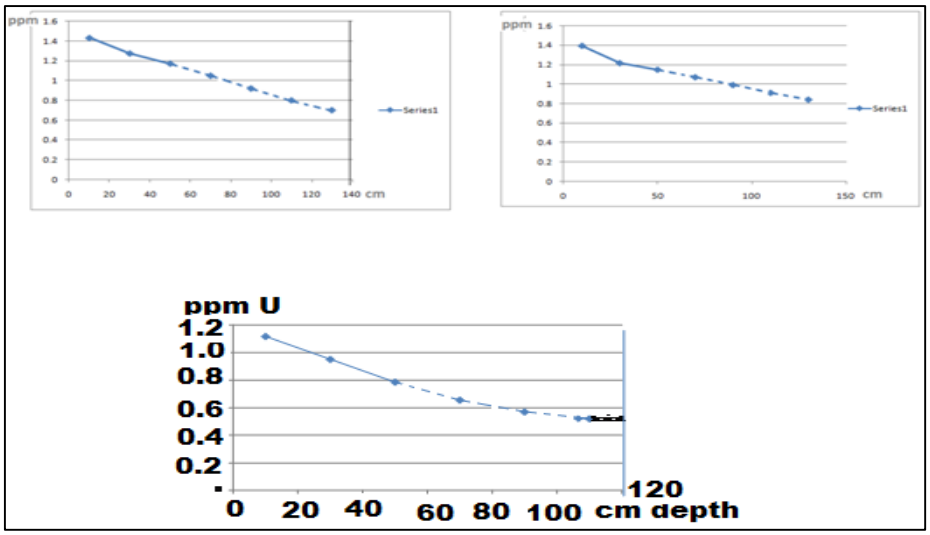

Figure 5. Measured and calculated U concentration as a function of soil depth (cm) from 3 different sample collection locations in Fallujah city

Two interesting results appear in these figures;

a- the diffused concentration values are not negligible even at the depths of 100 cm and

b- the concentration change due to the diffusion might extend to depths of several meters.

A thorough calculation of the total cumulative concentrations at different sampling locations should yield ppm values that are in multiple folds of the tolerated value (2.8 ppm). The cumulative concentration is by definition equivalent to the initial radioactive concentration (U-ppm) at the time of its initiation, i.e. in the years 2004-2005. Such radioactive contamination levels should be considered on discussing the peculiar health abnormalities that were reported by the Fallujah health authorities in the years following 2005.

The nuclear industry, which involved the mining, milling, and fabrication of various U products has been responsible for uranium contamination of surface soils. Its contamination now poses significant health risks for living beings and limits the future use of many sites formerly used for U production and processing. There are large areas of U-contaminated soils in the world, engineering-based remediation methods such as excavation require millions of tons of soils to be disposed of as low-level radioactive waste. This process is expensive, fills up scarce landfill space, and requires additional site restoration. Remediation of U-contaminated soils represents a significant expense to many industries and governmental agencies. According to Huang et al. (1998) development of a cost-effective method to remove U from contaminated soils could accelerate the cleanup process and reduce remediation costs.

4. Conclusions and discussion

Uranium sorption strongly dependends on the pH of the solution because of the changes in solution speciation, and surface species and surface charge as a function of pH (Ibrahim et al., 2015). Presence of uranium in soil generates an important issue against public perception on the risk which contamination poses to the environmental and human health. In spite of some preventive and remedial actions during the uranium recovery, many natural ecosystems have got heavily polluted with radioactive elements (Gavrilescu et al., 2009).

Our results clearly show that significant radioactive contamination has occurred in the city of Fallujah during the years 2004-2005. Diffusion of the radio-active material has taken place into the depths of its soil in the following years. The diffusion is expected to proceed to several meters in depth and will reach the ground water level. Monitoring of the radioactivity of the ground water of the city and its surroundings is important and strongly called for. It is expected that similar diffusion behavior of radioactive contamination in other areas of Iraq must have taken place, therefore continuous monitoring of the activity is needed in Iraq and its neighbouring countries.

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References

AbdEl-Sabour, M.F. (2007). Remediation and bioremediation of uranium contaminated soils. Electron. J. Environ. Agric. Food Chem., 6, 2009-2023.

Anonymous. (2017). Category Archives, Birth Defects Iraq, April 1, 2017, Fallujah General Hospital.

Anonymous. (2013). Dahr Jamail, March 18, 2013. Aljazeerah English, Fallujah Babies and Depleted Uranium, America's Toxic Legacy in Iraq, Alternet. a- Dahr, Jamail, Jan. 2012, Fallujah Babies under a new kind of Siege, Aljazeerah.

Anonymous (2012). Thomas Gaist, World Socialists Website, Oct. 2012, Toxic Fallout from US war produces record child birth defects in Iraq.

Apps, M.J., Duke, M.J.M., Stephens-Newsham, L.G. (1988). A study of radionuclides in vegetation on abandoned uranium tailings. J. Radioanalytical Nuclear Chem., 123, 133-147.

Baes, C.F. (1982). Environmental transport and monitoring: Prediction of radionuclide Kd values from soil-plant concentration ratios. Trans. Am. Nucl. Soc., 42, 53-54.

Cazzola, P., Cena, A., Ghignone, S., Abete, M.C., Andruetto, S. (2004). Experimental system to displace radioisotopes from upper to deeper soil layers: chemical research. Environmental Health, 3(1), 5.

Durrani, S., Bull, R. (1987). Solid State Nuclear Track Detectors, Principles, Methodology and Application. Elsevier Book Company.

Ebbs, S.D. (1997). Identification of plant species and soil amendments that improve the phytoextraction of zinc and uranium from contaminated soil. Faculty of Graduate Studies. Cornell University, Michigan, 174.

Ebbs, S.D., Norvell, W.A., Kochian, L.V. (1998). The effect of acidification and chelating agents on the solubilisation of uranium from contaminated soil. J. Environ. Qual., 27, 1486-1494.

Fleischer, L., Price, B., Robert, W. (1975). Nuclear Track in Solid; Principles and Applications. University of California Press.

Gavrilescu, M., Pavel, L.V., Cretescu, I. (2009). Characterization and remediation of soils contaminated with uranium. Journal of Hazardous Materials, 163(2-3), 475-510.

Gongalsky, K.B. (2003). Impact of pollution caused by uranium production on soil macrofauna. Environmental Monitoring and Assessment, 89(2), 197-219.

Groudev, S.N., Georgiev, P.S., Spasova, I., Nicolova, M. (2007). Bioremediation of acid mine drainage in an uranium deposit. Advanced Materials Research, 20, 248-257.

Gupta, C.K. (2006). Chemical metallurgy: principles and practice. John Wiley & Sons.

Huang, J.W., Blaylock, M.J., Kapulnik, Y., Ensley, B.D. (1998). Phytoremediation of uranium-contaminated soils: role of organic acids in triggering uranium hyperaccumulation in plants. Environmental Science & Technology, 32(13), 2004-2008.

IAEA. (2001). Manual of Acid In situ Leach Uranium Mining Technology, IAEATECDOC-1239, Nuclear Fuel Cycle and Materials Section, IAEA-International Atomic Energy Agency, Vienna, Austria.

IAEA. (2002a). Technologies for the treatment of effluents from uranium mines, mills and tailings, in: Proceedings of a Technical Committee Meeting Held in Vienna, November 1-4, 1999, IAEA-TECDOC-1296, Nuclear Fuel Cycle and Materials Section, IAEA-International Atomic Energy Agency, Vienna, Austria.

IAEA. (2002b). Non-technical Factors Impacting on the Decision Making Processes in Environmental Remediation, IAEA-International Atomic Energy Agency TECDOC-1279, IAEA, Vienna, Austria.

IAEA. (2005a). Environmental contamination from uranium production facilities and their remediation, In: Proceedings of an International Workshop on Environmental Contamination from Uranium Production Facilities and Their Remediation organized by The International Atomic Energy Agency in Lisbon, February 11-13, 2004, Vienna.

IAEA. (2005b). Status and Trends in Spent Fuel Reprocessing, Nuclear Fuel Cycle and Materials Section International Atomic Energy Agency, IAEA-TECDOC-1467, Vienna.

Ibrahim, S.A., Whicker, F.W. (1988). Comparative uptake of U and Th by native plants at a U production site. Health Phys., 54(4), 413-419.

Ibrahim, M., Adrees, M., Rashid, U., Raza, S.H., Abbas, F. (2015). Phytoremediation of radioactive contaminated soils. Soil Remediation and Plants, 599-627.

Igwe, J.C., Nnororm, I.C., Gbaruko, B.C. (2005). Kinetics of radionuclides and heavy metals behaviour in soils: Implications for plant growth. African Journal of Biotechnology, 4(13), 1541-1547.

Merritt, R.S. (1971). The extractive metallurgy of uranium. Colorado School of Mines Research Institute, Golden, Colorado.

Navratil D.J. (2001). Advances in treatment methods for uranium contaminated soil and water. Archive of Oncology, 9(4), 257-260.

Norman, D.K., Raforth, R.L. (1998). Innovations and trends in reclamation of metal-mine tailings in Washington. Washington Geology, 26(2/3), 29-42.

Ozturk, M., Turkan, I., Selvi, S. (1987). Plants and Radioactive pollution. Doğa TU Botanik D., 11(3), 322-329.

Ozturk, M., Ozdemir, F., Gokler, I., Guvensen, A. (1994). Plants as silent witnesses of radioactivity. E.U. Fen Fak. Dergisi Seri B Ek, 16(1), 53-57.

Rivas, M.D.C. (2005). Interactions between soil uranium contamination and fertilization with N, P and S on the uranium content and uptake of corn, sunflower and beans, and soil microbiological parameters. Bundesforschungsanstalt für Landwirtschaft (FAL).

Roh, Y., Lee, S.R., Choi, S.K., Elless, M.P., Lee, S.Y. (2000). Physicochemical and mineralogical characterization of uranium-contaminated soils. Soil and Sediment Contamination, 9(5), 463-486.

Savchenko, V.K. (1996). The ecology of the Chernobyl catastrophe. Scientific outlines of an International programme of collaborative research. Man and Biosphere Series, vol. 16, Informa Health Care Publisher.

Sheppard, M.I., Sheppard, S.C., Thibault, D.H. (1984). Uptake by plants and migration of uranium and chromium in field lysimeters. J. Environ. Qual., 13, 357-361.

Sheppard, M.I., Thibault, D.H., Sheppard, S.C. (1985). Concentrations and concentration ratios of U, As and Co in Scots Pine grown in waste site soil and an experimental contaminated soil. Water. Air. Soil. Pollut., 26, 85-94.

Sheppard, S.C., Evenden, W.G., Pollock, R.J. (1989). Uptake of natural radionuclides by field and garden crops. Can. J. Soil Sci., 69, 751-767.

Szydlowski, A., Sazowski, M., Czyzewski, T., Jasskola, M., Korman, A. (1999). Comparison of Response of CR-39, PM-355 and PM-600 Track Detectors to Low Energy Nitrogen and Helium Ions" Nucl. Inst. and Meth. in Phys. Res., 149, 113.

UNSCEAR. (1994). United Nations Scientific Committee on the Effect of Atomic Radiation, "Sources, Effects and Risks of Ionizing Radiation. Report to the General Assembly with Scientific Annexes, United Nations.

Whicker, F.W., Ibrahim, S.A. (1984). Radioecological investigations of uranium mill tailings systems. Colorado State Unv, Fort Collins, 48.

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Research article/Araştırma makalesi

Artemisia taurica Willd. var. *vanensis* Kursat & Civelek (Asteraceae: Anthemideae), a new variety from Eastern Anatolia of Turkey

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Abstract

During our revisionary study on the taxa of the genus *Artemisia* L. (Asteraceae) distributed in Turkey, we came across two populations that we anticipated could be a new variety of the species *Artemisia taurica* Willd. belonging to the subgenus *Seriphidium* (Besser) Fourr. In the morphological and cytological studies, we found that the new variety should be included in the species *A. taurica* but it also has some considerable morphological differences. These morphological differences include the length of stems, peduncles, pistils, styles, forks of stigmas, stamens, filaments, and dimensions of leaves, phyllaries, corollas, ovaries, anthers, achenes, the direction of synflorescens branches, the orientation of the capitula on the synflorescens branches, colour of corolla, and the type of indumentum. The new variety was also different in terms of chromosome number. Based on these differences, we suggested that a new variety of the species *A. taurica* should be described, as *A. taurica* var. *vanensis* which is only distributed in a very limited area in the Eastern of Turkey. In this article, an identification key for all taxa in the subgenus *Seriphidium* and a rearranged description of the species *A. taurica* for including its two varieties, a diagnosis and an identification key for two sister varieties, a distribution map and a few descriptive figures of the new variety have been given.

Key words: *Artemisia taurica*, Asteraceae, *Seriphidium*, taxonomy, Turkey

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Artemisia taurica Willd. var. *vanensis* Kursat & Civelek (Asteraceae: Anthemideae), Türkiye'nin Doğu Anadolu'sundan yeni bir varyete

Özet

Türkiye'de yayılış gösteren *Artemisia* L. (Asteraceae) cinsinin taksonlarına yönelik yaptığımız revizyon çalışması sırasında, *Seriphidium* (Besser) Fourr. altcinsinde yer alan *Artemisia taurica* Willd. türünün yeni bir varyetesi olabileceğini tahmin ettiğimiz iki populasyonla karşılaştık. Morfolojik ve sitolojik çalışmalar neticesinde, bu yeni varyetenin *A. taurica* türüne dahil edilmesi gerektiğini, aynı zamanda bazı önemli morfolojik farklılıklara sahip olduğunu bulduk. Bu morfolojik farklılıklar; gövdelerin, kapitulum saplarının, pistillerin, situlusların, stigma çatallarının, stamenlerin, filamentlerin uzunlukları, yaprakların, fillarilerin, korollaların, ovaryumların, anterlerin, akenlerin boyutları, sinfloresens dallarının yönelimleri, kapitulumların sinflorosens dalları üzerindeki düzenlenişleri, corolla rengi ve tüy örtüsü tipini kapsamaktadır. Bu yeni varyete, kromozom sayısı bakımından da farklıydı. Bu farklılıklara dayanarak, Türkiye'nin doğusunda sınırlı bir alanda yayılış gösteren *A. taurica* türünün yeni bir varyetesinin *A. taurica* var. *vanensis* olarak tanımlanması gerektiğini önerdik. Bu makalede, *Seriphidium* altcinsindeki tüm taksonlar için bir teşhis anahtarı, *A. taurica* türünün iki varyeteyi de kapsayacak şekilde yeniden düzenlenmiş betimi, kardeş varyeteler için bir diyagnoz ve teşhis anahtarı, yeni varyetenin bir yayılış haritası ve birkaç tanımlayıcı resim verilmiştir.

Anahtar kelimeler: *Artemisia taurica*, Asteraceae, *Seriphidium*, taksonomi, Türkiye

1. Introduction

The genus *Artemisia* Linnaeus includes nearly 500 species in the world, and is distributed widely in the north hemisphere (Bremer and Humphries, 1993; Bremer, 1994). The majority of species of the genus *Artemisia* grow sparsely

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or form small populations, but several taxa form large, expansive populations and characterize landscapes (Vallès and McArthur, 2001).

The most commonly accepted subdivisions of the genus *Artemisia* are separated into 4 subgenera as the subgenus *Artemisia* Lessing, the subgenus *Dracunculus* (Besser) Rydberg, the subgenus *Seriphidium* (Besser) Fourr and the subgenus *Tridentatae* (Rydberg) McArthur (McArthur et al., 1981). McArthur et al., (1981) have created the new subgenus *Tridentatae* by taking members of the genus *Artemisia* of the "New World" that are composed by eleven taxa that have habitus of xerophilous shrub and homogamous capitula, distributed in North-East America and placed in the subgenus *Seriphidium* formerly (McArthur et al., 1981; Mcarthur et al., 1992; Mcarthur and Sanderson, 1992). While the taxa of subgenera *Artemisia*, *Dracunculus* and *Seriphidium* are naturally growing in Turkey, the subgenus *Tridentatae* lacks naturally growing taxa in Turkey (Civelek et al., 2010; Kursat, 2010; Guner et al., 2012).

There are 22 species that belong to the genus *Artemisia* in the 5th volume of the Flora of Turkey (Cullen, 1975). Later, *Artemisia verlotiorum* Lamotte is added as a new record for Turkey on the 10th volume of the Flora of Turkey, which is a supplementum, so the species numbers of this genus in Turkey became 23 in total (Davis et al., 1988). Recently, Civelek et al. (2010) carried out a revision study of the genus *Artemisia* distributed in Turkey, and according to their results, there are 22 species and 25 taxa which include these species and their infraspesific taxa belong to 3 subgenera. When we publish this new variety, the number of taxa of the genus *Artemisia* in Turkey will increase to 26.

The species *Artemisia bashkalensis* Kursat & Civelek is identified as a new species globally (Kursat et al., 2015). The taxa, *Artemisia fragrans* Willdenow, *Artemisia sieberi* Besser subsp. *sieberi* and *Artemisia santonicum* Linnaeus subsp. *patens* (Neilreich) Persson are identified as new records for Turkey (Civelek et al., 2010; Guner et al., 2012; Kursat, 2010; Kursat et al., 2011a; Kursat et al., 2011b; Kursat et al., 2014). Recently, New taxa have been published in the Eastern Anatolian Region (Fidan et al., 2017;. Hamzaoğlu and Koç, 2018).

During our revisionary study, we have observed that all samples identified as the species *Artemisia herba-alba* in the Turkish herbaria are actually the taxon *A. sieberi* subsp. *sieberi*, and the species *Artemisia herba-alba* are not distrubed in Turkey (Civelek et al., 2010; Kursat, 2010; PlantList, 2010). In addition, the species *Artemisia alba* Turra is only known from the East Aegean Islands which are outside Turkey's borders. For these reasons, the taxa *A. alba* and *A. herba-alba* were removed from the Turkey's species list (Civelek et al., 2010; Guner et al., 2012; Kursat, 2010; Kursat et al., 2011a; Kursat et al., 2014).

The general distribution regions of the species *Artemisia taurica* on the earth are Europe, southern Russia (Caucasus), Crimea, Turkey. The species *Artemisia taurica* shows the wide distribution in the steppes of Central, Eastern and Southeastern Anatolia in Turkey. This species is one of the three species have wide distribution in Turkey. The other two species have a wide distribution in Turkey are *Artemisia absinthium* L. and *Artemisia campestris* L. (Civelek et al., 2010; Kursat, 2010).

As a result of the systematical, morphological and cytologycal evidence studies executed within the framework of *Artemisia taurica*, which belongs to the subgenus *Seriphidium* of the genus *Artemisia*, this was defined as a new variety in present study (Civelek et al., 2010; Kursat, 2010).

2. Materials and methods

The present study is one of the results of our revisionary study which was carried out between the years 2007–2010 under the research project titled 'The Researches of Taxonomical, Chemical (Flavonoids and Essential Oils), Karyological, Palynological and Antimicrobial Activities on Taxa of the Genus *Artemisia* L. (Asteraceae) Growing in Turkey'(Civelek et al., 2010; Kursat, 2010).

For the revisionary study, hundreds of samples were collected from all over the country, and the samples were transformed into herbarium materials, and vouchers were deposited in the Fırat University Herbarium (FUH). Examined materials of the new variety, *A. taurica* var. *vanensis* were collected between September and November of the years 2007 and 2009. The samples of the new variety were compared with other allied taxa of the genus *Artemisia* in the herbaria WU, LE, W, FUH, EGE, ANES, AIBU, AEF, ANK, GAZI, CU, CUFH, HUB, HUEF, ISTE, KNYA, OMUB and VANF (acronyms according to Thiers, 2015). Examined all samples of the species *A. taurica* are given appendix 1.

3. Results and discussion

3.1. Artemisia taurica Willd. var. *vanensis* Kursat & Civelek, var. nov. (Figs 1- 6)

Type : Turkey, B9 Van, 30th km of the highway from Van to Hakkari, slopes around Zernek irrigation dam lake, mountain steppe, 1960 m., 38º 20.872N, 43º 41.867E, 20 September 2007, S. Civelek & M. Kursat 1056 (holotype FUH) (Fig. 5).
Paratypes : Turkey, B9 Van, Gurpinar district, between Cavustepe castle and Zernek irrigation dam lake, at field edges and roadsides, 1851 m., 38º 21.936N, 43º 33.846E, 20 September 2007, *M. Kursat 1052* (FUH) ; B9 Van, 30th km of highway from Van to Hakkari, slopes of around of Zernek irrigation dam lake, mountain steppe, 1960 m., 38º 20.872N, 43º 41.867E, 24 November 2007, *M. Kursat 1112* (FUH) ; ibid, 31 October 2009, *S. Civelek & M. Kursat 1208* (FUH).

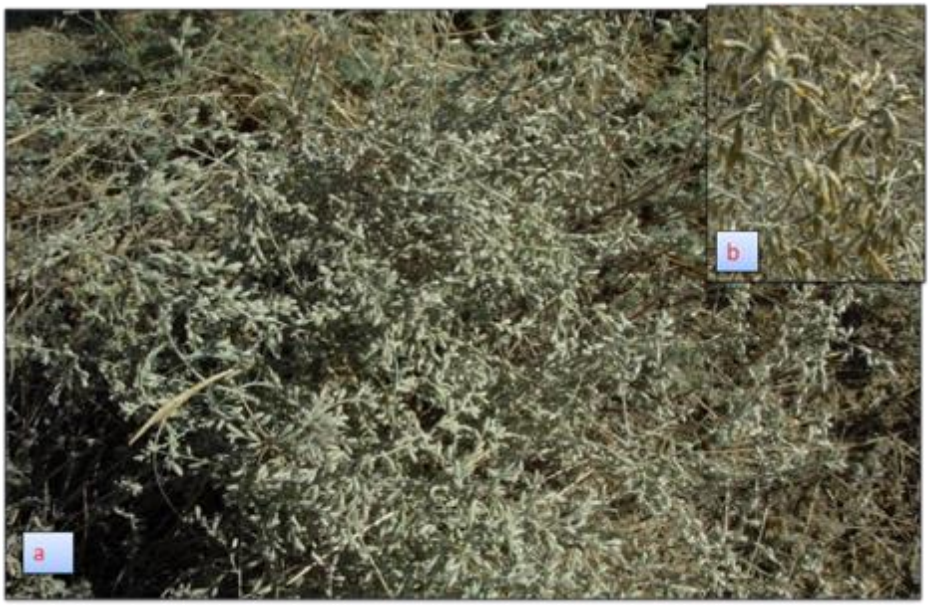

Figure 1. **a.** A general wiev in the natural habitat, **b.** Orientation of capitula of *A. taurica* var. *vanensis*

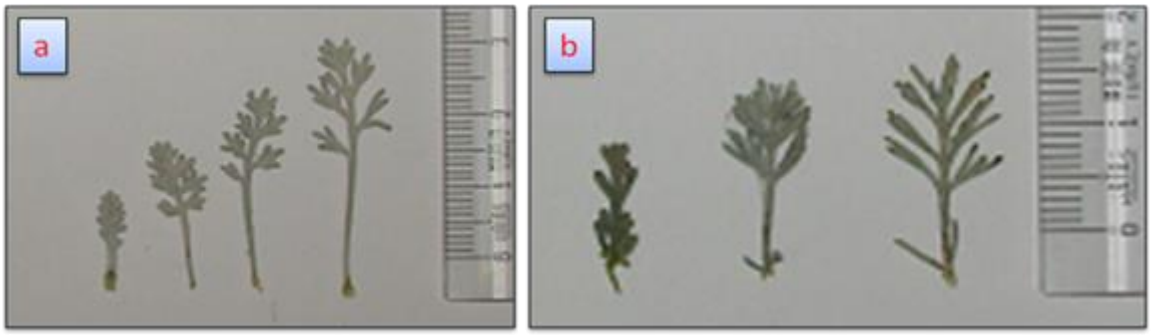

Figure 2. **a.** The detailed appearance of different sized lower dryed leaves, **b.** The detailed appearance of different sized lower fresh leaves of *A. taurica* var. *vanensis*

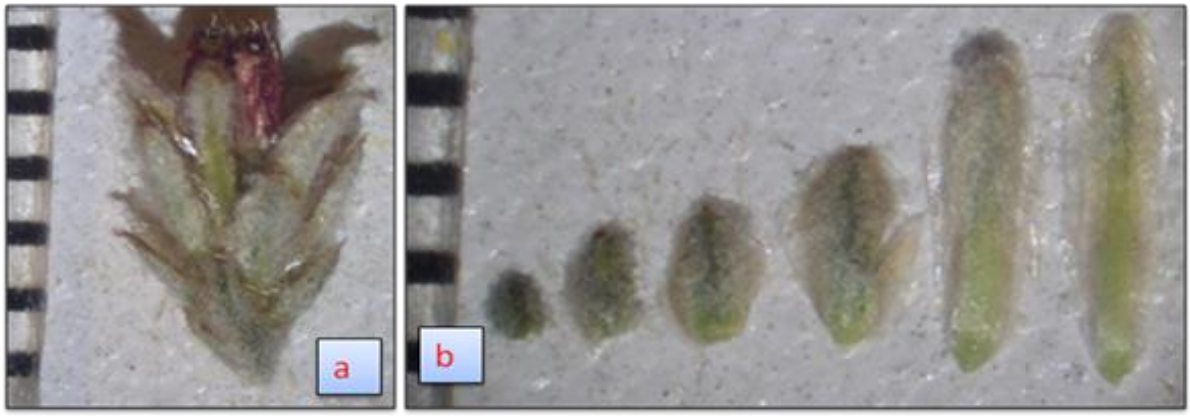

Figure 3. **a.** A capitulum (head), **b.** Phyllaries of capitulum from outside to inside of *A. taurica* var. *vanensis* (each range of the scale is 1mm)

3.2. Description of the species Artemisia taurica Willd.

Suffruticose perennial, stock stout and woody, Stems many, usually ascending, rarely more or less erect, to 15–60 cm high, sulcate, densely dark grayish arachnoid or tomentse hairy at pre-flowering stage, later partially poured. Basal rosettes present at flowering stage. Leaves densely dark greyish arachnoid or tomentse hairy; lower leaves and leaves of sterile shoots petiolate, 0.5–2.5 × 0.5–1.2 cm, twice or thrice pinnately (pinnatisect) divided, their lobes linear-oblong, apex of lobes acute; middle and cauline leaves sessile, pinnatisect divided, their lobes linear, apex of lobes obtuse-acute;

floral (uppermost) leaves sessile, from pinnatisect to linear with two basal lobes, 0.1–1 × 0.1–0.4 cm, apices of their lobes obtuse-acute. Synflorescence rasemose-paniculate, branches of synflorescens ascendant (spread and upwards) or horizontal ; capitula oblong-obovate, 3–6 × 1.5–3.2 mm, spread or drooping (pendulose), usually pedunculate, peduncle to (1–) 3–5 mm long, capitula becoming sessile towards the end of synflorescens branches, arachnoid-tomentose and punctate-glandular (glands-dotted or sessile glands); phyllaries (involucral bracts) 4–6 series, from ovate-oblong to lanceolate, outer phyllaries divided or not to base, 0.2–0.9 × 0.1–0.8 mm, middle phyllaries 0.8-2.2 x 0.6-1.7 mm, inner phyllaries 2-4.2 x 1- 1.5 mm; reseptacle glabrous; all flowers hermaphrodite and fertile,, 3–8 per capitula; corollas tubulate, 2.8–4.2 × 0.5–1 mm, yellow or pinkish red or purplish red, punctate-glandular (glands-dotted or sessile glands); pistils 2.6–3.9 mm long, ovaries 0.5–1 × 0.2–0.7 mm in dia; stigmas bifid (forked), ciliate at apices forks of bifid stigma 0.3-0.7 mm long; stamens 2.2–4.2 mm long, filaments 0.8–1.5 mm long, anthers with lanceolate apical appendage, 1.2–2.7 × 0.1–0.3 mm in dia. Achenes (cypselae) 1.2–2.7 × 0.5–1.4 mm in dia, oblong-obovate, longitudinally ribbed, bright brown. Somatic chromosome numbers 2*n*=4*x*=36 or 2*n*=6*x*=54 (Figure 6).

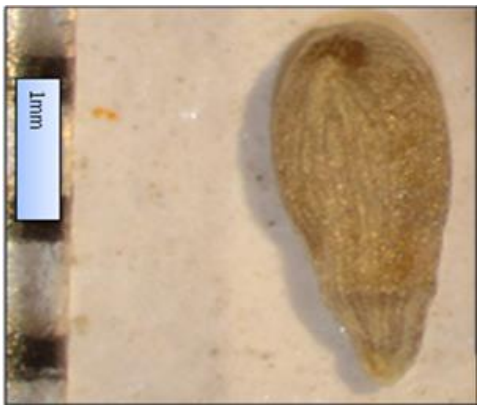

Figure 4. A fruit (cypsela or achene) of *A. taurica* var. *vanensis*

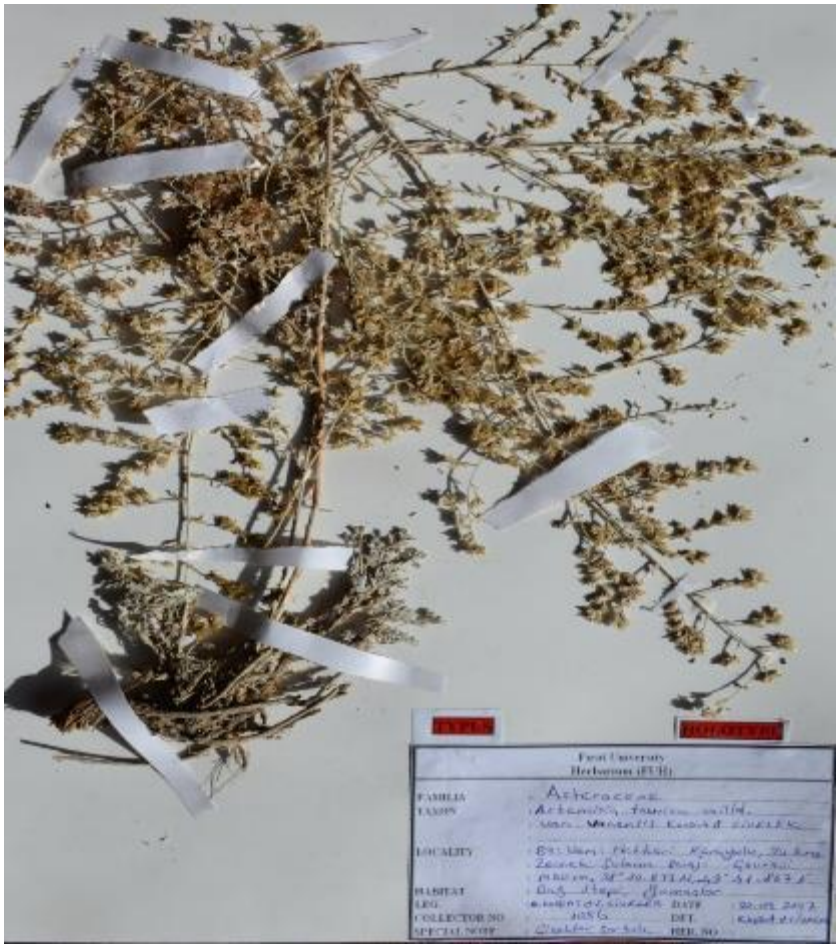

Figure 5. Holotype of *Artemisia taurica* var. *vanensis* Kursat & Civelek, var. nov. (*M. Kursat 1056*, FUH)

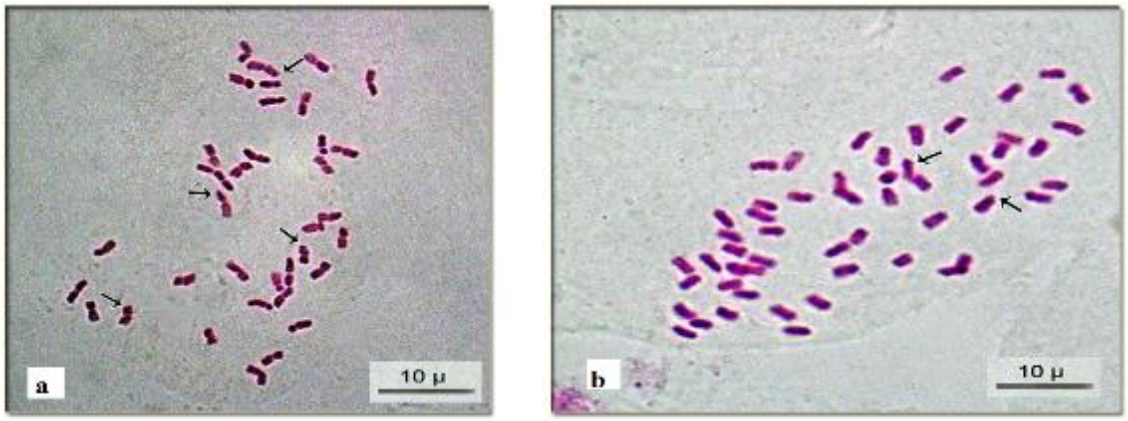

Figure 6. Mitotic metaphase chromosomes of two sister variety of the species *Artemisia taurica*. (**a:** var. *taurica*, 2*n*=4*x*=36) and (**b:** var. *vanensis*, 2*n*=6*x*=54; arrows show the satellite chromosomes) (Civelek et al., 2010)

3.3. Diagnosis for the sister varieties of the species of A. taurica in Turkey

The new variety *A. taurica* var. *vanensis* differs from its sister variety *A. taurica* var. *taurica*; with fertile stems 20–45(–60) cm high [15–35 (–45) cm high in var. *taurica*]; indumentum densely arachnoid [tomentose in var. *taurica*]; synflorescence branches usually horizontal [usually ascendant i.e spread to erect in var. *taurica*]; capitula usually drooping (pendulose) at flowering and fruiting stages and loose after pressing process [spread, not drooping at flowering and fruiting stages and remains tight after pressing process in var. *taurica*]; outer phyllaries usually not divided to base [usually divided to base in var. *taurica*]; corolla yellow or pinkish-red or purplish-red [yellow in var. *taurica*]; pistils and stamens usually not exerted the corolla [pistils and stamens usually exerted the corolla in var. *taurica*]; somatic chromosome number 2*n*=6*x*=54 [2*n*=4*x*=36 in var. *taurica*] (Table 1).

3.4. Diagnostic key for for the sister varieties of the species of A. taurica in Turkey

I. Synflorescence branches ascendant (spread and upwards); outer phyllaries usually divided to base; capitula not drooping (pendulose) at flowering and fruiting stages, remains tight after pressing process; corolla yellow
var. *taurica*

- Synflorescence branches horizontal; outer phyllaries usually not divided to base; capitula drooping (pendulose) at flowering and fruiting stages, start to loose and seperated comparatively after pressing process; corolla yellow or pinkish red or purplish red
var. *vanensis*

3.5. Distribution, habitat and ecology

The general distribution regions of the species *Artemisia taurica* on the earth are Europe, southern Russia (Caucasus), Crimea, Turkey. The species *A. taurica* shows the wide distribution in the steppes of Central, Eastern and Southeastern Anatolia in Turkey (Fig. 7). In Turkey apparently confined to the Irano – Turanien region.

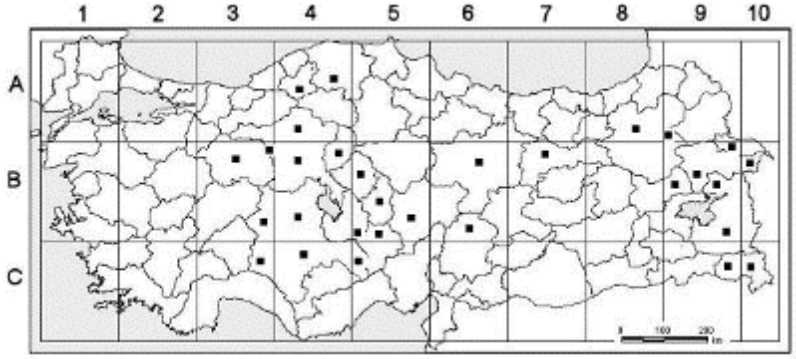

Figure 7. The distribution of the species *A. taurica* in Turkey

The new variety *A. taurica* var. *vanensis* is endemic to Van province in Eastern Anatolia of Turkey and to the Irano-Turanian element. It is distributed in the Eastern Anatolia of Turkey, mountain steppe and slopes, at altitudes between 1800–1960 m. The habitats of the plant are stony, gravelley and sandy slopes on mountain steppe. Its currently known two close populations may be shown as one point on the map of Turkey (Fig. 8).

Table 1. Comparison in terms of key features that distinguish the sister varieties of the species of *Artemisia taurica* in Turkey

Characters	**var. *vanensis***	**var. *taurica***
Stem length (cm)	20–45(–60)	15–35(–45)
Indumentum	densely arachnoid	arachnoid-tomentose
Dimensions lower leaves (cm)	1–2.5 × 0.5–1.2	0.5–2.5 × 0.5–0.9
Dimensions of cauline leaves (cm)	0.5–2.5 × 0.3–1	0.5–1 × 0.1–0.6
Dimensions of floral leaves (cm)	0.1–1 × 0.1–0.4	0.1–0.5 × 0.1–0.3
Orientation of synflorescens branches	usually horizontal	usually ascendant (spread and upwards)
Orientation of capitula	usually drooping (pendulose) at flowering and fruiting stages, loose after pressing process	spread, not drooping (pendulose) at flowering and fruiting stages, remains tight after pressing process
Peduncules of capitula length (mm)	(1–) 3–5 mm long, becoming sessile towards the end of synflorescence branches	1–3 mm long, becoming sessile towards the end of synflorescence branches
Capitula dimensions	4.3-6 x 2-3.2 mm in dia	3-5 x 1.5-2.3 mm in dia
Overview of outer phyllaries	usually not divided to base	usually divided to base
Outer phyllaries dimensions (mm)	0.6–0.9 × 0.5–0.8	0.2–0.4 × 0.1–0.3
Middle phyllaries dimensions (mm)	1–2.2 × 1.3–1.7	0.8–2.2 × 0.6–1.7
Inner phyllaries dimensions (mm)	4–4.2 × 1.2–1.5	2–2.5 × 1–1.2
Corolla colour	yellow or pinkish red or purplish red	yellow
Corolla dimensions (mm)	2.8–3.3 × 0.5–1	2.8–4.2 × 0.5–1
Comprasion of pistil and stamens length with corolla length	pistils and stamens usually not exerted to the corolla	pistils and stamens usually exerted to the corolla
Pistil length (mm)	3.1–3.9	2.6–3.5
Ovarium dimensions (mm)	0.7–1 × 0.2–0.7	0.5–0.8 × 0.3–0.6
Style length (mm)	1.5–2.2	1.2–1.5
Forks length of bifid stigma (mm)	0.4–0.7	0.3–0.6
Stamens length (mm)	3–4.2	2.2–3.2
Filaments length (mm)	1–1.5	0.8–1.2
Anhters dimensions (mm)	2–2.7 × 0.1–0.3	1.2–2 × 0.1–0.3
Achenes (cypselas) dimensions (mm)	1.8–2.7 × 0.8–1.4	1.2–2.5 × 0.5–0.9
Somatic chromosome number	2*n*=6*x*=54	2*n*=4*x*=36

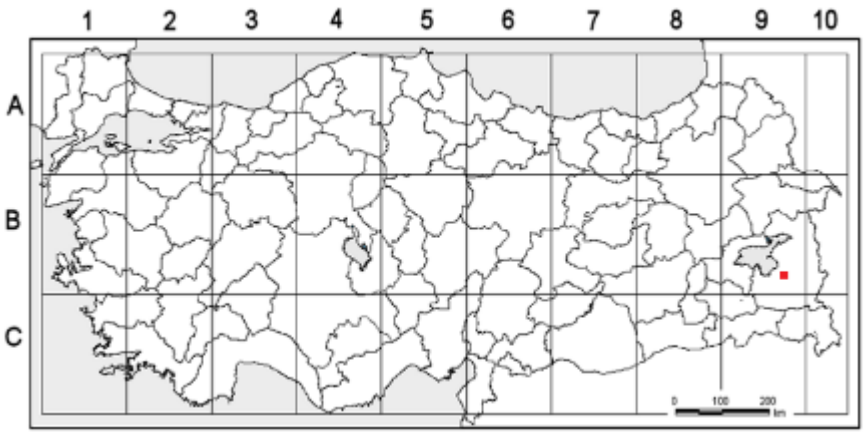

Figure 8. Currently known very close two populations of *A. taurica* var. *vanensis* (square mark ■)

3.6. Phenology

Flowering samples were collected in September and October, and fruiting samples in October and November.

3.7. Etymology

Plant samples were collected from the Van province of Turkey. The epithet of the new variety (var. *vanensis*) is derived from the province name.

3.8. Conservation status

The variety *A. taurica* var. *vanensis* is only known from very close two localities in Eastern Turkey:

1. B9 Van: Gurpınar district, between Cavustepe castle and Zernek irrigation dam lake, at field edges and roadsides,

2. B9 Van: 30th km of the highway from Van to Hakkari, at slopes around Zernek irrigation dam lake, mountain steppe (Fig. 8). The main location of the new variety is slopes around the Zernek irrigation dam lake near the highway from Van to Hakkari.

If grazing pressure increases and the road widening work is completed, the plant may become extinct in the near future. On the basis of the IUCN Red List categories and criteria (IUCN, 2014), due to the small populations size and an inferred decline of the populations, it is here suggested to consider the new species under the Endangered threat category, as EN (endangered) according to criteria C2(a)I of IUCN.

3.9. The identification key for taxa of the subgenus Seriphidium in Turkey

1a. Suffruticose, woody stock evident, thick and in the shape of a trunk 2
1b. Suffrutescent, woody stock not evident, thin, and cylindrical 6
2a. Plant very sparsely hairy at flowering stage after hair shedding or glabrous every stage, stems dark brown; lower leaves 2- times pinnately divided, all floral leaves usually undivided and linear 3
2b.Plant usually hairy at flowering stage, stems grey; lower leaves 2-3-times pinnately divided, floral leaves generally divided, only the ones of top undivided and linear 4
3a. Stems glabrous at fruiting, stems dark-brown; 3 – 5 florets per capitulum *A. spicigera*
3b. Stems sparse hairy at fruiting, stems grayish to light brown; 5 – 8 (-10) florets per capitulum *A. fragrans*
4a. Branches of synflorescence usually horizontal and intertwined into each other, with an appearance of bushy *A. sieberi* subsp. *sieberi*
4b. Branches of synflorescence usually erect or ascendant (spread), if horizontal when not intertwined into each other, don't like an appearance of bushy 5
5a. Synflorescence branches erect or ascendant; capitula usually erect or spread, not nodding (pendulose) at flowering and fruiting stages, remain tight after pressing process; outer phyllaries usually divided to the base; corolla yellow *A. taurica* var. *taurica*
5b.Synflorescence branches usually horizontal; capitula usually nodding (pendulose) at flowering and fruiting stages, start to loose and seperated comparatively after pressing process; outer phyllaries usually not divided to the base; corolla yellow or pinkish-red or purplish-red *A. taurica* var. *vanensis*
6a. Fertile stems 25–60 cm, hairy and with yellowish punctuated glands (glands-dotted or sessile glands), stems grey-brown colored; margins of the phyllaries membranous and usually transparent, very rarely partially purplish 7
6b. Fertile stems 25–100 cm, glabrous or very sparsely hairy, usually with only white punctuated glands (glands-dotted or sessile glands), stems brown-red colored; margins of the phyllaries membranous and usually purplish *A. bashkalensis*
7a. Synflorescence branches erect or ascendant; capitula usually erect or spread, or very rarely nodding (pendulose); corolla usually yellow, very rarely partially reddish at mature stage *A. santonicum* subsp. *santonicum*
7b.Synflorescence branches usually horizontal; capitula usually nodding (pendulose); corolla usually red, very rarely yellowish *A. santonicum* subsp. *patens*

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References

Bremer, K., Humphries C.J. (1993). Generic monograph of the Asteraceae-Anthemideae. Bulletin of the British Museum (Natural History). Botany 23 (2):71–177.

Bremer, K. (1994). Asteraceae*:* Cladistics and Classification. Timber press, Portland, Oregon pp 1-752.

Civelek, S., Yılmaz, O., Bagci, E., Kırbag S., Gur, N., Turkoglu, I., Tabur, S., Kursat, M. (2010). The researches of taxonomical, chemical (Flavonoids and Essential oils), karyological, palynological and antimicrobial activities on taxa of *Artemisia* L. (Asteraceae) genus growing in Turkey. TÜBİTAK, Project no. TBAG-106T559. Turkey.

Cullen, J. (1975). *Artemisia* L. In: Davis, P.H. (Ed.) Flora of Turkey and the East Aegean Islands, vol. 5. Edinburgh University Press, Edinburgh, pp 311–324.

Davis, P.H., Mill, R.R., Tan K. (1988). Flora of Turkey and the East Aegean Islands, vol. 10. Edinburgh University Press, pp163–164.

Fidan, M., Özgökçe, F., Pınar, M. (2017). A new monotypic genus (*Diptychocarpus* Trautv.) record from Brassicaceae (Cruciferae) family for the Flora of Turkey. Biological Diversity and Conservation 10(3): 20-24.

Guner, A., Aslan, S., Ekim, T., Vural, M., Babac, M.T. (2012). Turkiye Damarli Bitkiler Listesi, Nezahat Gökyigit Botanik Bahcesi ve Flora Araştirmalari Dernegi Yayini, Istanbul, pp118–120.

Hamzaoğlu, E., Koç, M. (2018). *Dianthus sancarii* (Caryophyllaceae), a new species from eastern Turkey, Biological Diversity and Conservation 11(1) : 30-34.

IUCN (2014). Guidelines for Using the IUCN Red List Categories and Criteria. Version 11. Prepared by the Standards and Petitions Subcommittee. Available from. http://www.iucnredlist.org/documents/RedListGuidelines.pdf (accessed 11 May 2016).

Kursat, M. (2010). The taxonomic revision of *Artemisia* L. (Asteraceae) genus growing in Turkey Fırat University, Institute of Science and Technology, Biology Department, PhD thesis, Elazığ, Turkey.

Kursat, M., Civelek, S., Turkoglu, I., Tabur, S. (2011a). *Artemisia sieberi* Besser subsp. *sieberi* a new record for Turkey and a delete record for Turkey *Artemisia herba-alba* Asso. (Asteraceae). Pakistan Journal of Botany 43(4):1819–1821.

Kursat, M., Turkoglu, I., Civelek, S., Tabur, S. (2011b). A new subspecies record for the flora of Turkey: *Artemisia santonicum* L. subsp. *patens* (Neilr.) K.M.Perss. (Asteraceae). Turkish Journal of Botany 35(1): 89.

Kursat, M., Sancar, P.Y., Civelek, S. (2014). New record for the flora of Turkey, *Artemisia fragrans* Willd. (Asteraceae). OT Sistematik Botanik Dergisi 21(2): 49–58.

Kursat, M., Civelek, S., Turkoglu, I., Tabur, S., Gur, N. (2015). A new species of subgenus *Seriphidium* of *Artemisia* L. (Asteraceae) from Turkey. Turkish Journal of Botany 39:88–95.

Mcarthur, E.D. (1981). Asteraceae, *Artemisia*, subgenus *Tridentatae* (Rydberg) McArthur. American Journal of Botany 68(5):590.

Mcarthur, E.D., Pope, C.L., Freeman, D.C. (1981). Chromosomal Studies of subgenus *Tridentatae* of *Artemisia*, Evidence for Autopolyploidy. American Journal of Botany 68:589–605.

Mcarthur, E.D., Sanderson, S.C., Anderson, W.R. (1992). Assay Of Controlled Between Populations of Sagebrush (*Artemisia* Subgen. *Tridentatae*) Using Morphological, Chemical, Seed Set and Dna Data. American Journal of Botany 79(8):98.

Mcarthur, E.D., Sanderson, S.C. (1992). Cytogeography and Chromosome Evolution subgenus *Tridentatae* of *Artemisia* (Asteraceae). American Journal of Botany 86(12):1754–1775.

The Plant list (2010). Version 1. Publish on the internet; http://www.theplantlist.org/ (accessed April 2016).

Thiers, B. (2015). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium.

Vallès, J., McArthur, E.D. (2001). *Artemisia* Systematics and Phylogeny: Cytogenetic and Molecular Insights, USDA Forest Service Proceedings RMRS-P-21.

Willdenow, C.L. (1803). *Artemisia taurica* Willdenow, Species Plantarum, ed. 4, Willdenow 3(3): 1837.

Appendix 1. Examined additional specimens of the species Artemisia taurica

Our collected samples: A4 Kastamonu: The highway from Kastamonu to Samsun, Ilgaz road junction, edges of the road and slopes, 10 October 2009, 40º 54.458N, 33º 37.372E, *M. Kursat 1202* (FUH); Kastamonu: The highway from Kastamonu to Samsun, 10 km to Tosya, roadsides and slopes, 10 October 2009, 866 m., 40º 57.437N, 33º 57.901E, *M. Kursat 1204* (FUH); B3 Eskisehir: Between Polatli and Sivrihisar, 35 km to Sivrihisar, roadsides and slopes, 23 October 2007, 837 m, 39º 34.476N, 31º 51.103E, I. *Turkoglu & M. Kursat 1098* (FUH); B4 Aksaray: Ihlara Valley, between Yaprakhisar village and Aksaray, slopes, 07 July 2007, 1140 m, 38º 19.766N, 34º 13.790E, I. *Turkoglu & M. Kursat 1008* (FUH); Ankara: Şereflikoçhisar, Hamzalı village, Kayacık (Mutlucan) Saltworks, 07 July 2007, 933 m, 38 50.381N, 33 26.922E, I. *Turkoglu & M. Kursat 1009* (FUH); ibid., 03 September 2007, *I. Turkoglu* & *M. Kursat 1020* (FUH); ibid., 22 October 2007, *M. Kursat 1092* (FUH); ibid., 06 December 2007, *M. Kursat 1129* (FUH); Ankara: Şereflikoçhisar, the southern slope of Akin village, steppe, 07 July 2007, 989 m, 39º 06.821N, 33º 15. 624E, *M. Kursat 1011* (FUH); ibid., 22

October 2007, *M. Kursat 1094* (FUH); Ankara: Polatli highway, 37 km to Polatli, roadsides and slopes, 10 September 2007, 843m, 39º 45.799N, 32º 28.355E, *M. Kursat 1028* (FUH); ibid., 23 October 2007, I. *Turkoglu & M. Kursat 1095* (FUH); ibid., 06 December 2007, *M. Kursat 1131* (FUH); Ankara: Golbasi higway, 5 km to Golbasi, steppe, 10 September 2007, 1032 m, 39º 47.977N, 32º 47.486E, *M. Kursat 1031* (FUH), Ankara: from Golbasi to Bayindir dam lake, 14th km, steppe, 10 September 2007, 994 m, 39º 52.206N, 32º 54.367E, *M. Kursat 1032* (FUH), Ankara: Between Lalahan-Elmadag, arround the Military zone, slopes and field edges, 10 September 2007, 1225 m, 39º 57.756N, 33º 11.727E, *M. Kursat 1033* (FUH); B5 Nigde: from Nigde to Kayseri hingway, 5 km, between railway and hingway, 06 July 2007, 1250-1300m, 38º 03. 022 N, 34º 45.740 E, *M. Kursat 1007* (FUH), Kırsehir: the road from Hirfanlı Dam Lake to Sereflikochisar, 5th km, hills and roadsides, 11 September 2007, 972 m, 39º 16.523N, 33º 30.135E, *M. Kursat 1036* (FUH), Kayseri: 39th km the highway from Kayseri to Avanos, roadsides and slopes, 22 October 2007, 1121 m, 38º 43. 377N, 35º 04.811E, *M. Kursat 1089* (FUH), B6 Kahramanmaras: Goksun, open places of forest above Findiklikoyak village, 04 July 2007, 1640 m, 37º 60. 021N, 36º 32.325E, *I. Turkoglu & M. Kursat 1005* (FUH), Kahramanmaras: Goksun, around Findiklikoyak village, 22 October 2007, 1450 m, 37º 60.021N, 36º 32.325E, *M. Kursat 1090* (FUH), Sivas: Ulas, Tecer mountains, *Quercus* community, slopes, 13 July 2008, 1817 m, 39º 25.003N, 37º 07.220E, *M. Kursat 1150* (FUH); B9 Van: 21th km of the highway from Adilcevaz to Ercis highway, slopes, 23 September 2007, 1750m, 38º 57.134N, 43º 13.308E, *M. Kursat 1071*(FUH), Muş: Malazgirt, Aktuzla village, eastern slope, 24 September 2007, 1632 m, 39º 19. 572N, 42º 18.008E, *M. Kursat 1079* (FUH), Ağrı: 4th km of highway from Habur to Tutak, steppe, 26 November 2007, 1605 m, 39º 35.994N, 42º 55.698E, *M. Kursat 1114* (FUH), Mus: Malazgirt, Aktuzla, around the Karıncalı village, slopes, 26 November 2007, 1550 m, 39º 21.474N, 42º 15.551E, *M. Kursat 1119* (FUH),Van: Ercis, Zernaki mountain, Irşat site, steppe, slopes, 02 November 2008, 1712 m, 39º 03.216N, 43º 20.599E, *M. Kursat 1185* (FUH); B10 Ağrı: Dogubeyazıt, around Ishakpasa Palace and Murat camping, 26 August 2008, 1935 m, 39º 31.190N, 44º 07.780E, *M. Kursat 1172* (FUH); C5 Aksaray: the highway from Adana to Aksaray, plains of Konya province border, steppe,11 Steptember 2007, 1202 m, 37 57.851N, 34. 04.924E, *M. Kursat 1037* (FUH); ibid., 22 October 2007, *M. Kursat 1091* (FUH); ibid., 06 December 2007, *M. Kursat 1128* (FUH); C10 Hakkari: the highway from Van to Hakkari, 37 km to Hakkari, steppe, slopes, 20 Steptember 2007, 1496m, 37º 41.720N, 43º 58.504E, *M. Kursat 1058*(FUH).

Herbarium samples: A4 Karabük: locations opposite the Sand quarry, 21 June 1985, ca.700 m, *M.Demirors* (ANK1285)!; Kirikkale: around Sulakyurt, steppe, slopes, 19 August 1990, 950m, *A.A.Donmez 2801* (HUB 29858)!; Ankara: the highway from Kalecik to Çankırı, 10 km to Çankırı, 09 October 1992, 650-700m, *Z. Aytac* (GAZI5605)!; Ankara: Cubuk dam lake, *Festuca-Thymus* steppe, 16 November 1996, 1000m, *N. Adıguzel & S. Seven* (ANK 2751)!; A8 Erzurum: 10 km to Ispir, steppe and *Quercus* forest, 25 July 1976, 2000-2400 m, *A.Tatli 5459* (HUB 29854)!; A9 Erzurum: the eastern of Horasan, 24 August 1957, ca.1600 m, *Davis & Hedge* (ANK 32619)!; B3 Eskisehir: Belpinar, Southern of the Cifteler, 9 km to Cifteler, 17 October 1973, 950 m, A. Baytop & *E.Tuzlaci* (ISTE 26908)!, Konya: Cihanbeyli, halophilic steppe, 09 August 1974, 950m, *H. Pesmen & A. Guner 1217* (HUB 29901)!; Ankara: Sereflikochisar, Highway Adana, arround of Tuz Lake, salty lands, 19 October 1982, 800 m, *B. Yildiz 3870* (HUB 29902)!; Ankara: Sereflikochisar, the highway of Adana, 9 October 1984, 900-1000 m, *Demirkus 2777* (HUB29880)!; Eskisehir: Sivrihisar, Yavsan village, 13 October 1987, *T. Baytop* (ISTE 58234)!; B4 Kırıkkale: Keskin, Böbrek Mountain, steppe, 22 June 1991, 600m, *U.Guler* (GAZI 1770)!; Ankara: Sereflikochisar, Hamzalı village, arround the Tuz lake, steppe 17 October 1992, 920 m, *A.A. Donmez, Z.Aytac & F. Karaveliogulları 3068* (HUB 29881)!; Ankara: Ahlatlibel, steppe, 22 October 1994, 1100 m, *M. Vural & H. Duman 7267* (ISTE 72054); Kayseri:İncesu road, Behind of Garipsu Factory, 9 October 1977, 1100 m, *O. Soner* (HUB 29882)!; Kayseri to Develi road: 60 km to Develi, salty soils, 04 August 1978, 1200 m, *A. Ozturk* (VANF)!; Nevsehir, 2 km west of Goreme, 18 October 1989, 1100 m, *M.Vural & U.Kul* (GAZI5602)!; Nigde: around of Dundarlı, 24 May 2004, *E. Ozdemir* (ISTE 81473)!; Nevsehir: Gulsehir, from Egrikuyu to Tuzkoy, volcanic rocks, steppe, 20 October 2005, 982 m, *A.A. Donmez 12612* (HUB)!; B6 Kahramanmaras: 3 km west of Goksu, field edges, 26 August 1977, 1500 m, *B.Yildiz, 1597* (HUB)!; B9 Mus: Malazgirt, from Aktuzla to Karıncalı, steppe, 06 October 2001, 1550 m, *S. Almanar 1870* (VANF)!; Van: Ercis, arround Y. Isıklı village, steppe, 28 October 2006, 1661 m, 39˚02.895N, 45˚20.877E, *O. Karabacak 5591* (VANF 12744)!; Mus: Malazgirt, Karıncalı valley, steppe, 26 October 2006, 1552 m, 39˚21.456N, 42˚15.582E, *L. Behcet, F. Ozgokçe & M. Unal 2558*, (VANF 7399)!; Igdır: Tuzluca, from Hadimli to Sariabdal village, 02 October 2008, 1280 m, *E. Altundag 1086* (ISTE 85839)!; C3 Konya: Cihanbeyli, Tuz Lake, 23 Steptember 1961, ca. 940 m, *K.Karamanoglu* (ANK 706)!; Konya: Tuz Lake, Yavsan village, ca. 900 m, *P.H. Davis* (ANK 16648)!; C4 Konya: from Karaman to Seyithasan village, steppe, ca.1200m. 20 of June 1979, *M. Vural* (GAZI 1896)!; C9 Hakkari: Culemerik, 10 April 1954, ca.1600m, *P.H.Davis & O.Polinim* (ANK 24351)!.

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Research article/Araştırma makalesi

Application of water quality index method for assessing the surface water quality status of Mert Stream in Turkey

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Abstract

In this study, the water quality data obtained from 6 sampling stations between July 2011 and June 2012 monitoring period at Mert stream was evaluated. In order to assess the present water quality of Mert stream, different WQI approach (modified WQImin) was applied to a data set expressly collected for the present study. The mean WQI value of the stream is 81.9, which lies on the mid water classification region, so the water is considered at fair quality. The resulted WQI shows that 91.6, 92.5, 74.3, 91.6, 75.2 and 62.5 for sites St1, St2, St3, St4, St5 and St6 respectively. Among stations, there was significant variations in water quality index from poor quality to good quality that St5 and St6 in urban part and St3 in rural part of the stream are under the pressure of pollution. While the reason of the low water quality in 5th and 6th stations is based on domestic and industrial wastes, the reason of poorness in 3th station arises from poultry farm wastes poured intensely from chicken farms near the station into the stream in Kavak district. The most effective water quality parameters are pH, electrical conductivity (EC) and total suspended solids (TSS) on the determination of WQI for the present study.

Key words: water quality index, water pollution, Mert Stream, Samsun, Turkey

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Türkiye'deki Mert Irmağı'nın Yüzey Suyu Kalitesini Değerlendirmek için Su Kalite İndeksi Metodunun Uygulanması

Özet

Bu çalışmada, Mert Irmağı'ndaki 6 istasyondan Temmuz 2011 ve Haziran 2012 tarihleri arasında yapılan izleme çalışmasından elde edilen su kalitesi bilgileri değerlendirilmiştir. Bu çalışmada, Mert ırmağının mevcut su kalitesini değerlendirmek için toplanan verilere farklı bir WQI yöntemi (modifiye WQImin) uygulanmıştır. Hesaplanan ortalama WQI değeri 81.9 olup bu değer su sınıflandırma açısından orta-kaliteye karşılık gelmekte ve buda ırmak suyu için çokta kötü olmayan bir kalitede olduğunu göstermektedir. İst1, İst2, İst3, İst4, İst5 ve İst6 için ölçülen WQI değerleri sırasıyla 91.6, 92.5, 74.3, 91.6, 75.2 ve 62.5'dır. İstasyonlar arasındaki su kalite indeksi değerlerinde, düşük kaliteden iyi su kalitesine kadar çeşitlenme vardır. Buna göre ırmağın şehir bölümünde kalan 5. ve 6. istasyonları ile ırmağın kırsal kesiminde kalan 3. istasyonları kirlilik baskısı altındadır. 5. ve 6. istasyonlarda ırmak suyundaki düşük su kalitesinin nedeni evsel ve endüstriyel atıklar olmasına karşın 3. istasyondaki kalite düşüklüğünün nedeni, Kavak ilçesinde istasyonun yakınında bulunan tavuk çiftliklerinden ırmağa dökülen atıklardan kaynaklanmaktadır. Bu çalışmada su kalite indeksini (WQI) belirlemede en etkili su kalitesi parametreleri pH, elektriksel iletkenlik ve toplam askıda katı madde olmuştur.

Anahtar kelimeler: su kalite indeksi, su kirliliği, Mert Irmağı, Samsun, Türkiye

1. Introduction

Water quality is a major problem all over the world due to the general pollution caused by human activities. Water quality indices are an easy application for assessig water quality, controlling water pollution, restoring or improving

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water quality, and assessing the impacts of best management practices in the basin (Quilbe et al., 2006). Water quality index reflects the general water quality conditions in the aquatic ecosystem. For this reason, water quality index are a simple and understandable application for managers and decision makers on the quality and possible uses of wetlands (Bordalo et al., 2001).

Water quality indices have been used in the United States and most European countries since the 1970s. In the literature there are many different water quality index models and comparative studies on best reflecting water quality. All of these indices consist of eight or more water quality parameters such as dissolved oxygen (DO), conductivity, temperature, pH, and total suspended solids. However, monitoring and testing of all 15 parameters used in water quality indices is not very practical and economical. Instead, water quality criteria can be obtained by selecting a few of the most dominant and easily measurable parameters. Therefore, temperature, pH, dissolved oxygen, total suspended solids, and electrical conductivity were selected among the previously mentioned 15 variables. These five variables used in WQImin are the water quality parameters commonly used in drinking water. The parameters except total suspended solids can be measured easily in the field using multiparameter water quality instruments (Akkoyunlu and Akiner, 2012).

Growing population, rapid urbanization, increased economic activity and industrialization have caused reduction and abuse of water resources.

The tributaries of rivers and streams passing through the cities carry pollutant loads in large amount released from industrial, domestic/sewage wastes in urban areas, while pesticides and fertilizers used in agricultural activities in rural areas are reach wetlands through washing with rain. This triggers the eutrophication in the wetlands, which makes freshwater resources unusable. This environmental problems stimulate the eutrophication in the wetlands, which makes freshwater resources unusable (Qadir et al., 2007). These pollutant effluents are discharged to the aquatic environment without purification, resulting in water pollution problems and these polluted waters are no longer used for drinking and agricultural activities (Fent, 2004). Therefore, it is important to monitor water quality levels in river basins to control water pollution (Simeonov et al., 2003) and to interpret changes in water quality (Dixon and Chiswell, 1996; Singh et al., 2004). Spatio-temporal monitoring of stream water quality has been used as one of the most important tools for water quality assessment (Singh et al., 2004; Shrestha and Kazama, 2007).

The objective of this research was to evaluate spatial and seasonal trends in water discharge, nutrients and also to compare data with water quality criteria and with certain quality indices such as water quality index (WQI), identifying the environmental pressures and assessing the impact of the loads to Mert basin. In accordance with this purpose, WQI values station-based for the water in the Mert Stream was created through easily measurable parameters. These results are of great importance to decision-makers and managers for water management who will have a general knowledge of the water quality in wetlands during a specific period of time, instead of attempting to understand complex water quality data. At the same time, this study will provide important information on how well the WQI index reflects the water quality in Mert stream.

2. Materials and methods

1.1. Description of the study area

Mert Stream is located within the border of Samsun Province in the Central Black Sea Region of Turkey (between 41°09'02"–41°17'04" N and 35°48'04"–36°21'50" E). The west of the stream is located by Kızılırmak River and Mert River Basins, the south by Yeşilırmak River Basin and the east by Abdal Creek Basin. Mert stream originates from Karadağ locality, known as Toptepe, located at 1150 m altitude in the Ladik district. In Kavak district, after the stream merges with Karataş Creek, 24 km from the sea and it's the largest tributary, it takes its name which is called the Mert. Supplying the utility water needs of some villages on the route, Mert stream is very important as it constitutes the irrigation resource of fertile lands of the region. Its maximum flow is 750 m^3/s. The width of the stream bed is 50 m. While the depth of the stream decreases to less than 50 cm in summer months, in winter the depth reaches again 4-5 m.

The locations of the stations in this study have been determined as follows in order to represent the whole stream (Figure 1). The features of the sites determined at six sampling areas on the stream are as follows:

1st station (41°09'50″ N, 36°05'59″ E) is located on Çamlıdere creek, which is the side branch of the stream located in Samsun-Kavak district Küçükçukur and Ahurlar Village. The altitude is 820 m and the distance to the Black Sea is 67 km. The coast of the site is covered with stones and pebbles.

2nd station (41°03'38″ N, 35°58'41″ E) is located at the point where the discharge waters of Güven Pond, which is located near the highway of Kavak-Ankara, are poured into the stream with Çamlıdere creek. The altitude is 780 m and the distance to the black sea is 65 km. The coast and ground of the site are covered with stone and mud.

3rd station (41°03'23″ N, 36°06'20″ E) is next to the Germiyan1 highway bridge located in Germiyan Village on the Kavak-Asarcık highway. The altitude is 650 m and the distance to the black sea is 51 km. The water in this section of the stream is extremely turbid due to the fact that the chicken and egg farms located near 300 m discharge their wastes from this section to the stream.

4th station (41°07'13″ N, 36°09'41″ E) was selected from the point where Karataş Creek, which is the largest of the stream, carries the water of the Divanbaşı Pond in Mert Village at Kavak Boğaziçi District to the stream and merges with the Mert Stream. The altitude is 410 m and the distance to the black sea is 35.4 km.

5th station (41˚ 15'54″ N, 36˚20'35″ E) is at the point where Mert stream merges with Yılanlı creek where the pollution is intense due to the landfill area of Samsun province for a while. The altitude is 20 m and the distance to the black sea is 2.3 km.

6th station (41˚16'43″ N, 36˚21'06″ E) is at the stream mouth part in Canik district where the Mert stream flows into the Black Sea. This site is also located on the Samsun-Ordu highway next to the shopping center of Piazza.

Figure 1. Location and sampling stations of Mert Stream

1.2. Sampling and sample analysis

Water samples were taken seasonally from six sites starting in July 2011 until June 2012. The sampling stations were given in Figure 1. The sampling stations were selected according to the point and non-point pollution load possibilities of the basin mainly from agricultural and minor industrialactivates. Samples were collected at 30 cm depth from the surface. All measurements were carried out in triplicate, and the results were expressed as averages. The measurement at sampling site, Dissolved oxygen, Electric conductivity, pH and water temperature were recorded. The water samples were held in ice boxes and immediately transported to laboratory of Ondokuz Mayıs University for water analysis following common protocols. Electrical conductivity (EC), pH, temperature (T) and dissolved oxygen (DO) were measured locally by field instruments (WTW 340i Multi-Parameter). Gravimetric method was used to determine the total suspended solids in the water. TSS was analyzed according to Standard Methods for the Examination of Water and Wastewater (APHA, 1995).

1.3. Water Quality Index (WQImin)

While WQI is an index using 15 water quality parameters, WQImin developed by Akkoyunlu and Akiner (2012) is a modified index that uses 5 most predominant and easily measurable parameters. A linear relation was observed between WQI and WQImin with R^2 value of 0.84 as seen in the following equation 1. To get the WQI, it is sufficient to calculate WQImin value. To get the WQImin, the Q-value should be determined for each variable and also weighting and normalization factors are assigned to each variable (Table 1). The WQI values that are calculated separately for each variable obtain through the arithmetic weighted sum of the WQImin values. Following calculating the WQImin value, the value of the lake or stream's WQI obtains practically by placing these value in aforecited Eq. (1). Eq. (1) shows nothing but the correlation between WQI and WQImin. Regression fits well since the determination coefficient is sufficiently close to one. Water quality can be ranked as very poor (0–60), poor (61–80), fair (81–90), good (91–95), excellent (96–100), according to the "Modified WQI" scale (Akkoyunlu and Akiner, 2012). The water quality status (WQS) according to WQI is shown in Table 1.

$$WQI = 1.0011\ (WQImin) + 0.5179 \quad (R^2 = 0.8358,\ p<0.000) \quad (Eq.1)$$

Table 1. WQI range, status and possible usage of the water sample (Akkoyunlu and Akiner, 2012)

WQI	Water quality status (WQS)	Possible usage
0–60	Very poor	Proper treatment required before use
61–80	Poor	Irrigation
81–90	Fair	Irrigation and industrial
91–95	Good	Drinking, irrigation and industrial
96–100	Excellent	Drinking, irrigation and industrial

3. Results

1.1. The physicochemical variables of water quality

Seasonal average of physicochemical field measurements of the stream water (2011-2012) was given at Table 2. It was observed that seasonal averages for all parameters in the surface water of Mert Stream.

Table 2. Some physicochemical analysis results of the Mert Stream (2011-2012)

	Parameters	Summer	Autumn	Winter	Spring	*Average*
Station 1	*Temperature (ºC)*	18.4	10.8	3.9	13.7	*11.7*
	Dissolved Oxygen (mg/L)	9.4	11.2	13.1	10.4	*11*
	pH (pH unit)	7.9	7.6	8	7.2	*7.7*
	Electrical Conductivity (µs/cm)	1087	923	807	860	*919*
	Total suspended solid (mg/L)	1.6	4.5	1	0.4	*1.9*
Station 2	*Temperature (ºC)*	24.9	14.2	4.2	16.5	*15*
	Dissolved Oxygen (mg/L)	8	10.4	13.3	9.9	*10.4*
	pH (pH unit)	7.4	7.8	7.7	7.1	*7.5*
	Electrical Conductivity (µs/cm)	873	743	603	720	*735*
	Total suspended solid (mg/L)	1.6	4.5	1	0.4	*1.9*
Station 3	*Temperature (ºC)*	23.3	12.2	5.4	16.3	*14.3*
	Dissolved Oxygen (mg/L)	8.6	11.1	12.6	9.9	*10.6*
	pH (pH unit)	7.4	7.5	8.4	7.5	*7.7*
	Electrical Conductivity (µs/cm)	1270	1130	900	897	*1049*
	Total suspended solid (mg/L)	103.7	81	63.3	71.3	*79.8*
Station 4	*Temperature (ºC)*	21.8	10.8	4.2	15.5	*13.1*
	Dissolved Oxygen (mg/L)	8.7	11.3	13	9.9	*10.7*
	pH (pH unit)	7.3	7.9	7.9	7.5	*7.7*
	Electrical Conductivity (µs/cm)	1173	940	763	907	*946*
	Total suspended solid (mg/L)	34.7	18.3	9.7	6.3	*17.2*
Station 5	*Temperature (ºC)*	25.4	15	6.1	15.8	*15.6*
	Dissolved Oxygen (mg/L)	8.2	10.3	12.4	9.9	*10.2*
	pH (pH unit)	7.1	7.6	7.4	7.8	*7.5*
	Electrical Conductivity (µs/cm)	1410	1020	723	920	*1018*
	Total suspended solid (mg/L)	123.7	95.3	58.3	73.7	*87.8*
Station 6	*Temperature (ºC)*	26	16.5	6.5	15.3	*16.1*
	Dissolved Oxygen (mg/L)	4.4	6.2	8.8	6.8	*6.6*
	pH (pH unit)	6.8	7.5	8	7.5	*7.5*
	Electrical Conductivity (µs/cm)	3067	1867	940	1543	*1854*
	Total suspended solid (mg/L)	153.7	134.3	91.3	88	*116.8*

The temperature values of Mert stream varied between months, seasons, and among measurement stations. The mean water temperature value during one year of monthly measurement is 14.3°C. The lowest value was measured in November 2011 as 1.5°C in 4st station, while the highest value has been observed in 6th station in July 2011 as 27.6°C. Also the seasonal mean temperature values between July 2011 and June 2012 are as follows, respectively; winter 5.1°C, spring 15.5°C, summer 23.3°C, and autumn 13.3°C (Table 2).

The dissolved oxygen amount in Mert stream has varied monthly and seasonally during the study period. The mean value observed during one-year period is 9.9 mg/L, the lowest value is 3.5 mg/L in July 2011 at 6th station, while the highest value has been observed in November 2011 in 4st station as 14 mg/L. As a result of a study conducted for one year in 4 seasons, the mean dissolved oxygen values in winter, spring, summer and autumn seasons have been observed as follows, respectively; 12.2 mg/L, 9.5 mg/L, 7.9 mg/L and 10.1 mg/L (Table 2).

The electrical conductivity (EC) values of Mert stream have varied between months, seasons and among 6 stations. The mean electrical conductivity value of 6 stations where the study has been conducted was found to be 1087 µs/cm. The electrical conductivity values, in parallel with saltiness and temperature values, have decreased in winter months and increased in months where the water temperature has been high. The value in December 2011 in 2st station was 550 µs/cm while it reached to its highest point in July 2012 in 6th station as 3420 µs/cm. Also during one year of measurements between between July 2011 and June 2012, the seasonal mean electrical conductivity values have been found to be 789 µs/cm for winter, 974 µs/cm for spring, 1480 µs/cm for summer and 1104 µs/cm for autumn (Table 2).

The monthly mean pH value of six stations one year-round is 7.6. The highest pH value has been observed in 3th station in December 2011 as 9.2, while the lowest value has been observed in August 2011 in 6st station as 6.4. The mean values in winter, spring, summer and autumn of Mert stream following one-year sampling period are 7.9, 7.4, 7.3 and 7.7, respectively (Table 2).

The total suspended solid (TSS) values of the stream have varied between months, seasons and among four stations. During the one year of measurement, the lowest value has been observed at St1 in Mart 2012 as 0.3 mg/L, while the highest value has been observed at St6 in July 2011 as 164 mg/L and the mean suspended solid matter (TSS) amount has been found to be 50.9 mg/L for six stations in Mert stream. Also the seasonal mean suspended solid matter values during measurements between 2011 and 2012 have been found to be 37.4 mg/L for winter, 40 mg/L for spring, 56.3 mg/L for autumn and 69.8 mg/L for summer.

1.2. The water quality index calculations

In order to assess the present water quality and possible eutrophication risk level of Mert stream, different WQI approaches (modified WQImin) were applied to a data set expressly collected for the present study. Table 3 shows results and evaluations of WQI types for Mert stream. WQI values of the six stations are not in good agreement. While St1, St2 and St4 indicate good environmental conditions in terms of water quality, St3, St5 and St6 infer low water quality. The average WQI value of the stream is 82, which lies on the mid water classification region, so the stream water is considered at fair quality in terms of average values. According to WQI values, Water Pollution Map of Mert Stream is also given in the Figure 2.

Table 3. Results and Evaluations of Water Quality Index for Mert Stream

Water quality index			
Sampling stations	WQImin	WQI	*Station-based evaluation*
1	91	92	*good*
2	92	93	*good*
3	74	74	*poor*
4	91	92	*good*
5	75	75	*poor*
6	62	63	*poor*
Average	*81*	*82*	*fair*

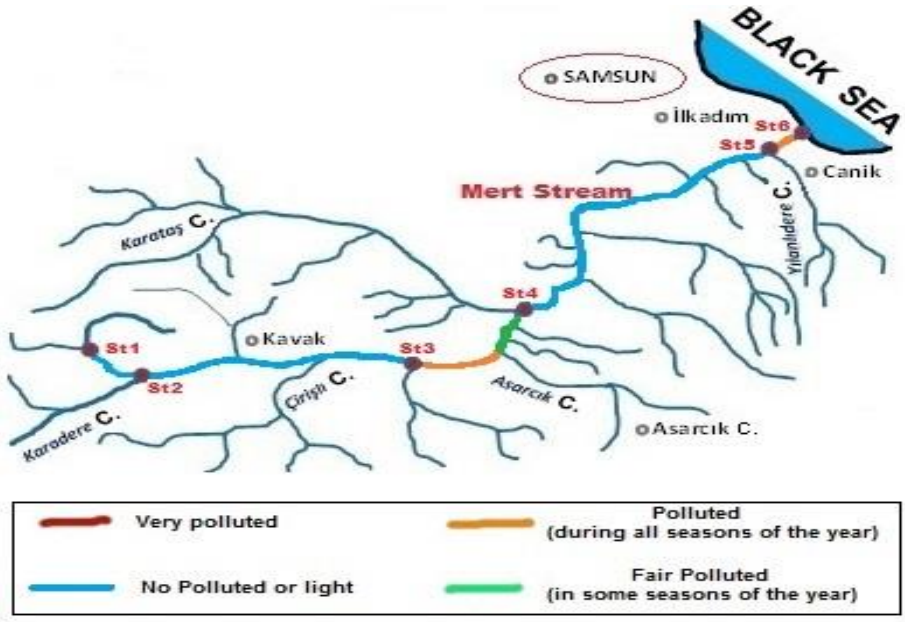

Figure 2. According to WQI values, Water Pollution Map of Mert Stream

4. Conclusions and discussion

In this study, a modified water quality index model (WQImin) was applied, allowing spatial and temporal variations to be assessed through only a few simple parameters. Temperature, pH, dissolved oxygen, conductivity and total suspended solids are the most important water quality indicators among all 15 parameters. WQImin is modified index which is developed considering aforementioned five important water quality parameters. Dissolved oxygen is a key factor for aquatic life. Temperature is also an important parameter from the aspect of aquatic life as it alters the viscosity and density of water and affects the speed of biochemical reactions and solubility of gases. The pH showing the balance between acid and bases in water is a basic parameter which should be assessed in any study about water chemistry and pollution. Conductivity should indicate the presence of salts, mineral acids, or similar contaminants discharged to the stream. TSS (total suspended solids) is associated with suspended material and also with bacteriological contamination. It should also be noted that total suspended solids (TSS) gives a measure of the turbidity of the water and eutrophication is apparent as increased turbidity. Considering the high concentrations of TSS, it was decided to assign relatively high weight for it. The aggregation of suspended solid matters leads the amount of dissolved oxygen to decrease and eutrophication to occur. Furthermore, these five parameters can be easily evaluated. So far, WQImin gives reasonable results for trend analysis at a lower cost. WQImin value is also 81 indicating fair quality (Table 3).

The current study was conducted to measure water quality of the stream which is the main irrigation water source of the Kavak district. According to the results we can state that Water Quality Index (WQImin) was useful tool to obtain the accurate decision and assessing water quality. In addition, this index model also provided a comparative assessment of the water quality for different sampling sites and different temporal samplings. During the study the average values of WQI for six stations (St1, St2, St3, St4, St5, St6) were categorized as poor water quality for the human use (92, 93, 74, 92, 75, 63 respectively) from 2011 to 2012. Generally, there was significant temporal variations in water quality index among poor quality to good quality. The computed average WQI (91.9) for stream points St1, St2 and St4 indicate fairly good quality of water while the average WQI (70.6) for the stream points St3, St5 and St6 indicate poor quality of water due to domestic and industrial discharges at St5, St6 and poultry farm wastes poured intensely from chicken farms near the 3rd station into the stream. This is not surprising as St1, St2 and St4 are upstream, and at the edge of the part of the stream that is unaffected by direct runoff from the waste dump. In contrast, St5 and St6 are located at the urban part of the stream that receives direct runoff from the waste fill. Especially the WQI value of 6th station (62.5) to be too close which is the lowest water quality means that the water in the urban part of the stream can be used after a serious treatment. Initially, it has been a surprise for us that 3th station has low water quality despite situating at the upper part of the stream which is far from city impact. But after seeing that there were chicken farms near the station, it was not surprising that the water quality in the third station was low. The index results coincided with water pollution map of Mert stream in Figure 2. The higher TSS values were noticed in St6 station, that may be mainly related to the domestic and industrial wastes discharged from industrial facilities and residential area in İlkadım and Canik district. pH, EC and TSS were being the most effective parameters in the low water quality index values at the 3rd, 5th and 6th stations, and also low of dissolved oxygen became effective at 6th station which had the lowest water quality of the stream.

During the study which has been conducted about the monthly and seasonal changes of Mert stream's water quality characteristics between July 2011 and June 2012 in 6 stations, the water samples obtained from stations were evaluated with regard to water quality and aquaculture through WQI method. As a result of this study, it was seen that there is not any important problem from the aspect of water pollution in the upstream except 3th station. If the agricultural activities and animal breeding facilities in the fields near the stream in Kavak district increase widely, the leakage water from fields through surface waters and wastes from animal breeding facilities near Mert stream may pollute in time the upper part of the stream. Therefore, it must be obligatory to built recycling facilities for wastes in the chicken and bovine farms established in the region and the use of organic fertilizers in agricultural activities should be encouraged especially in villages where the stream passes through. Even if it seems that there is no problem in terms of the average values of WQI, the urban part of the stream is under the pressure of pollution. It is the best evidence that massive fish deaths due to lack of oxygen and leakage water have been observed at times. So, the regulations about the protection of rivers should be carefully implemented, and the ecological disruption should be prevented. Also in order to protect Mert stream from pollution, to improve the water quality, to protect the natural fish stocks, to sustain the natural ecological balance of other aquatic organisms, and because of its importance from the aspect of irrigation of near agricultural fields in upstream, the stream should be periodically monitored.

The following suggestions can be made in order to increase the surface water quality in the Mert stream. (A) Point and nonpoint source pollution arising from chicken farms at 3th station in Kavak district should be prevented and solid and liquid wastes from the farms should be either disposed or utilized as fertilizer or biogas. (B) In order to enhance the water quality of the stream at St5 and St6, the wastewater and seepage water arrived to the stream from the settlements and industrial facilities in İlkadım and Canik districts should be prevent.

As a results, this study has shown that WQImin based on five parameters is a simple, yet a understandable tool, that can be used to provide a preliminary information about the level of pollution in surface water caused by urban and industrial wastes in wetlands. Çiçek et al. (2017) said that the overall assessment of an aquatic ecosystem is possible only by revealing all of the physical, chemical and biological data of that ecosystem. The fact that the results of index support

the pollution detection study using algal organisms made earlier by Bektaş (2016) in the Mert stream indicate that WQI model can be used together with algal organisms in rapid evaluation of water quality in wetlands..

References

Akkoyunlu, A., Akiner, M. E. (2012). Pollution evaluation in streams using water quality indices: A case study from Turkey's Sapanca Lake Basin. Ecological Indicators, 18, 501-511. doi: 10.1016/j.ecolind.2011.12.018

APHA (American Public Health Association), (1995). Standard methods for the examination of water and wastewater. 19th Ed., Washington DC, USA.

Bektaş, S. (2016). Investigations on The Algal Flora of Samsun Mert Stream [Master's Thesis]. Ondokuz Mayıs University, 85 p. [in Turkish]

Bordalo, A. A., Nilsumranchit, W., Chalermwat, K. (2001). Water quality and uses of the Bangpakong River (Eastern Thailand). Water Research, 35, 3635–3642. doi:10.1016/ S0043-1354(01)00079-3

Çiçek, N. L., Ertan, Ö. O., Erdoğan, Ö., Didinen, H., Boyacı Y. Ö., Kara D., Zeybek M., Diken G. (2017). Distribution of phytoplankton and its relationship with physicochemical parameters in Lake Eğirdir (Isparta/Turkey). Biological Diversity and Conservation, 10 (3), 150-162. [in Turkish]

Dixon, W., Chiswell, B. (1996). Review of aquatic monitoring program design. Water Research, 30, 1935-1948. doi:10.1016/0043-1354(96)00087-5.

Fent, K. (2004). Ecotoxicological effects at contaminated sites. Toxicology, 205, 223-240. doi:10.1016/j.tox.2004.06.060

Qadir, A., Malik, R. N., Husain, S. Z. (2007). Spatio-temporal variations in water quality of Nullah Aik-tributary of the river Chenab, Pakistan. · Environmental Monitoring and Assessment, 140 (1-3), 43-59. doi:10.1007/s1066100798464

Quilbe, R., Rousseau, A. N., Duchemin, M., Paulin, A., Gangbazo, G., Villeneuve, J. P. (2006). Selecting a calculation method to estimate sediment and nutrient loads in streams: Application to the Beaurivage River (Quebec, Canada). Journal of Hydrology, 326 (1-4), 295-310. doi: 10.1016/j.jhydrol.2005.11.008

Said, A., Stevens, D. K., Sehlke, G. (2004). An innovative index for evaluating water quality in streams. Environmental Management, 34(3), 406-414.

Shrestha, S., Kazama, F. (2007). Assessment of surface water quality using multivariate statistical techniques: A case study of the Fuji river basin, Japan. Environmental Modelling and Software, 22 (4), 464-475. doi:10.1016/j.envsoft.2006.02.001.

Simeonov, V., Stratis, J. A., Samara, C., Zachariadis, G., Voutsa, D., Anthemidis, A. (2003). Assessment of the surface water quality in Northern Greece. Water Research, 37, 4119-4124. doi:10.1016/S0043-1354(03)00398-1

Singh, K. P., Malik, A., Mohan, D., Sinha, S. (2004). Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India): A case study. Water Research, 38, 3980-3992. doi:10.1016/j.watres.2004. 06.011.

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Research article/Araştırma makalesi

Alticini (Coleoptera: Chrysomelidae) species occurring on Akşehir extensions (Konya) of the Sultan Mountains, Turkey

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Abstract

Alticini (Chrysomelidae, Galerucinae) species were determined from the Akşehir extensions of the Sultan Mountains which is known as one of the most important mountains of Turkey with respect to its zoogeographical mission. Totally, 25 species belonging to 6 genera were listed from the region. Among the species 13 are new records for Konya province.

Key words: Sultan Mountains, Akşehir, Chrysomelidae, flea beetles, fauna

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Sultan Dağları'nın (Türkiye) Akşehir uzantılarındaki (Konya) Alticini (Coleoptera: Chrysomelidae) türleri

Özet

Çalışmada, üstlendiği zoocoğrafik misyonu nedeniyle Türkiye'nin en önemli dağlarından biri olarak bilinen Sultan Dağları'nın Akşehir uzantılarının Alticini (Chrysomelidae, Galerucinae) türleri belirlenmiştir. Toplamda 6 cinse ait 25 tür bölgeden listelenmiştir. Bunlardan 13 tanesi Konya ili için yeni kayıt niteliğindedir.

Anahtar kelimeler: Sultan Dağları, Akşehir, Chrysomelidae, yaprak pire böcekleri, fauna

1. Introduction

Alticini comprises one of the most species rich groups of Chrysomelidae, with its closely related tribe Galerucini (Bouchard et al., 2011). They are generally the smallest sized chrysomelids with swollen metafemora, and called as "flea beetles" because of their locomotory ability of jumping (Furth, 1988). The adult and larvae feed on foliage of herbaceous plants, bushes, and trees in a wide spectrum of angiosperms with few exceptions (Jolivet and Verma, 2002). The remarkable diversity of the group is well correlated with their distinct phytophagous diet. It is probably the largest tribe of Chrysomelidae represented by 8.000 to 11.000 species and ca. 600 genera worldwide, but is aggregated in a few large, cosmopolitan genera in the Palaearctic with nearly 3000 species and approximately 90 genera (Nadein and Bezdek, 2014; Korotyaev et al., 2017). Currently, Turkish Alticini fauna includes about 350 species classified in 23 genera (Aslan and Başar, 2016; Özdikmen et al., 2017).

Within Chrysomelidae, Alticini is a widely studied group by using different collecting methods in different regions of the world. In many biomes, they represent a big part of the herbivorous insect fauna. In Turkey, the flea beetle fauna is comparatively poorly studied and relatively much higher actual diversity should be assumed than that recorded in the current literature. Knowledge of species numbers on local scale is important for not only determining biodiversity but also providing reference to estimate actual biodiversity loss. The aim of this study is; to present Alticini species occurring in Akşehir extensions of Sultan Mountains which is known as one of the most important highlands of Turkey in terms of its zoogeographical location, and to contribute local fauna with new locality records.

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2. Materials and methods

2.1. Study area

The study was conducted in the Akşehir extensions of the Sultan Mountains which is located as a natural corridor between the Lakes District and Central Anatolia, separating Isparta from Konya. Akşehir is a favorable region for the species that prefer Central Anatolian steppe climate and the Mediterranean climate. This position accompanied with various habitats has positive effects on the floristic composition, an important factor for the occurrence of Alticini species. Field surveys were carried out in the eastern slopes of the mountain. Different vegetation types, including forest, shrubby vegetation, steppe and meadow exist in the area. The dominant vegetation includes populations of *Quercus* spp., *Cedrus* spp., *Juniperus* spp., *Pinus* spp., *Corylus* spp., *Cistus* spp., *Astragalus* spp., and *Verbascum* spp.

2.2. Sampling and identification

Surveys were performed at 15-day intervals from March to October in 2015 and 2016. Adult flea beetles were collected by using an entomological sweep-net and mouth aspirator from various plants. Specimens were collected extensively from the widest possible area and all kinds of vegetation. Collected beetles were taken to the laboratory for the mounting, labelling and preserving processes. All the specimens were identified to species level under an Olympus SZ61 stereomicroscope with the help of the taxonomic keys and figures given by Čížek & Doguet (2008), Warchałowski (2010) and Konstantinov et al. (2011). Voucher specimens are deposited at the Systematic Entomology Laboratory in Biology Department of Süleyman Demirel University, Isparta..

3. Results

Based on the material collected from Akşehir extensions of the Sultan Mountains in 2015 and 2016, a total of 25 Alticini species and 717 individuals belonging to 6 genera were identified (Table 1). *Longitarsus picicollis* Weise, *L. nigrofasciatus* (Goeze), *L. albineus* (Foudras), *L. luridus* (Scopoli) and *Chaetocnema tibialis* Illiger were determined as the most abundant species in the area, respectively. Species numbers according to genera are as following; *Altica* 2, *Aphthona* 3, *Chaetocnema* 3, *Longitarsus* 7, *Phyllotreta* 6 and *Psylliodes* 4.

Table 1. List of Alticini species gathered from Akşehir extensions of the Sultan Mountains (Konya) with individual numbers and distributional data; (*) means first record for Konya province

Alticini species	**Number of individuals**	**Distribution records in Turkey****
***Altica* Geoffroy**		
A. carduorum Guérin-Méneville, 1858	5	Ankara, Aksaray, Artvin,Çankırı, Çorum, Erzurum, Eskişehir, Kayseri, Kırıkkale, Kırşehir, Konya, Nevşehir, Ordu, Sivas, Yozgat
A. oleracea (Linnaeus, 1758)	4	Ankara, Antalya, Aydın, Bayburt, Burdur, Edirne, Erzurum, Eskişehir, Isparta, Kayseri, Konya, Kars, Nevşehir, Rize, Samsun, Sivas, Zonguldak
***Aphthona* Chevrolat**		
**A. franzi* Heikertinger, 1944	3	Amasya, Ankara, Artvin, Erzincan, Erzurum, Kayseri, Kars
**A. nigriceps* Redtenbacher, 1842	2	Ankara, Antalya, Edirne, Erzurum, Isparta
**A. warchalowskii* Fritzlar, 2001	4	Antalya, Aydın, Isparta
***Chaetocnema* Stephens**		
**C. conducta* (Motschulsky, 1838)	3	Adana, Aksaray, Ankara, Burdur, Edirne, Erzurum, Eskişehir, Isparta, İstanbul, İzmir, Kırklareli
C. hortensis (Geoffroy, 1785)	7	Adana, Aksaray, Ankara, Bayburt, Burdur, Edirne, Erzurum, Isparta, İstanbul, İzmir, Kayseri, Konya, Mersin, Sivas
C. tibialis Illiger, 1807	78	Aksaray, Amasya, Ankara, Antalya, Aydın, Balıkesir, Burdur, Çanakkale, Düzce, Erzincan, Erzurum, Eskişehir, Isparta, İzmir, Kocaeli, Konya, Kars, Malatya, Samsun
***Longitarsus* Latreille**		
L. albineus (Foudras, 1860)	97	Antalya, Aydın, Burdur, Erzurum, Isparta, İzmir, Kayseri, Konya, Mersin, Niğde
L. alfierii (Pic, 1923)	9	Antalya, Erzurum, Isparta, Konya

Table 1. Continued

**L. luridus* (Scopoli, 1763)	84	Ankara, Antalya, Artvin, Aydın, Bayburt, Burdur, Erzurum, Eskişehir, Isparta, İstanbul, Kırşehir, Sivas, Yozgat
**L. nigrofasciatus* (Goeze, 1777)	103	Ankara, Antalya, Aydın, Bursa, Burdur, Düzce, Edirne, Erzurum, Eskişehir, Isparta, Mersin
**L. pellucidus* (Foudras, 1860)	27	Adana, Amasya, Ankara, Antalya, Artvin, Aydın, Bayburt, Erzincan, Erzurum, Gümüşhane, Iğdır, Isparta, İzmir, Kars, Sivas, Tokat
**L. picicollis* Weise, 1900	122	Ankara, Antalya, Burdur, Erzurum, Isparta, İzmir, Kahramanmaraş
**L. succineus* (Foudras, 1860)	34	Antalya, Aydın, Burdur, Denizli, Erzurum, Eskişehir, Isparta, İstanbul, Mersin
***Phyllotreta* Chevrolat**		
**P. atra* (Fabricius, 1775)	16	Afyon, Ankara, Antalya, Aydın, Bartın, Bayburt, Bolu, Burdur, Çankırı, Edirne, Erzurum, Eskişehir, Gümüşhane, Isparta, Karaman, Kayseri, Kocaeli, Niğde, Rize, Samsun, Sivas, Trabzon, Zonguldak
P. corrugata Reiche,1858	31	Adana, Afyon, Ankara, Antalya, Aydın, Burdur, Çankırı, Hatay, Isparta, İzmir, Kayseri, Konya, Sivas, Şanlıurfa, Yozgat
P. cruciferae (Goeze, 1777)	28	Adana, Amasya, Ankara, Bilecik, Bartın, Bursa, Burdur, Çanakkale, Çankırı, Çorum, Edirne, Erzurum, Eskişehir, Isparta, İzmir, Kayseri, Konya, Manisa, Niğde, Tokat, Trabzon, Zonguldak
P. erysimi Weise, 1900	2	Ankara, Antalya, Aydın, Bartın, Bayburt, Burdur, Çankırı, Erzurum, Isparta, Kayseri, Konya, Manisa, Samsun, Trabzon
P. nigripes (Fabricius, 1775)	23	Adana, Afyon, Ankara, Antalya, Aydın, Bartın, Bayburt, Bilecik, Bolu, Burdur, Çankırı, Edirne, Erzincan, Erzurum, Eskişehir, Hatay, Iğdır, Isparta, Kayseri, Konya, Kars, Manisa, Mersin, Sivas, Yozgat
**P. vittula* (Redtenbacher, 1849)	4	Ankara, Antalya, Aydın, Burdur, Edirne, Erzurum, Isparta, İzmir
***Psylliodes* Latreille**		
**P. anatolica* Gök and Cilbiroglu, 2004	8	Antalya, Aydın, Isparta
P. chalcomera (Illiger, 1807)	3	Adana, Ankara, Antalya, Bayburt, Burdur, Edirne, Erzurum, Eskişehir, Hatay, Isparta, İstanbul, İzmir, Konya, Kırşehir, Nevşehir, Osmaniye, Sivas, Yozgat
**P. isatidis* Heikertinger, 1912	15	Amasya, Antalya, Aydın, Burdur, Erzincan, Erzurum, Isparta
P. tricolor Weise, 1888	5	Aksaray, Ankara, Antalya, Artvin, Bayburt, Burdur, Diyarbakır, Erzincan, Erzurum, Eskişehir, Hatay, Isparta, Konya, Kayseri, Kırşehir, Nevşehir, Niğde, Osmaniye, Samsun

** Distribution records were arranged based on the following literature: Ekiz et al., 2013; Aslan et al., 2015; Bayram and Aslan, 2015; Aslan and Başar, 2016; Özdikmen et al., 2017).

Longitarsus Latreille was evidently dominant among the genera in terms of individuals comprising about 66% of the total specimens collected during study. Among the determined species 13 (52%) were recorded first time from Konya province, namely; *Aphthona franzi, A. nigriceps, A. warchalowskii, Chaetocnema conducta, Longitarsus luridus, L. nigrofasciatus, L. pellucidus, L. picicollis, L. succineus, Phyllotreta atra, P. vittula, Psylliodes anatolica*, and *P. isatidis.* Konya has been added to the local distributional data of these species. Also, this study represents the fourth locality record as Konya (after Antalya, Aydın and Isparta) for the two species *Psylliodes anatolica* and *Aphthona warchalowskii*, which are endemic to South Anatolia.

4. Conclusions and discussion

Studies on Alticini fauna of Turkey are still limited, or focused around some particular regions. This study adds Konya province to the local distribution area of 13 flea beetle species. Members of Alticini are well specialized

phytophagous insects; therefore the Alticini diversity is closely related with the herbaceous vegetation types. High plant diversity and less anthropogenic impacts are important determinants on the occurrence of this group (Aslan and Gök, 2006; Aslan and Ayvaz, 2009; Aslan, 2010). In the study region, the herbaceous cover was mainly dominated by plants from the families Lamiaceae, Brassicaceae and Scrophulariaceae. *Longitarsus* represented the majority of the specimens, indicating its wide range of host plant and habitat preference compared to most other genera (Furth, 1980).

Turkey has great diversity in topography, climate, and vegetation because of its significant geographical location. However, for many insect groups, faunistic data is actually inadequate throughout the country. Determining the species numbers, from local to global scale, is important for serving as a reference point to estimate diversity of all organisms. Unfortunately, natural habitats have been destroyed rapidly, indicating alarming consequences for biodiversity loss. Human activities have contributed much on this decline, reducing animals' ability to adapt different conditions (Alao, 2009). Therefore, faunistic surveys and taxonomic efforts should be encouraged for all groups in order to display the biodiversity before it is too late. The potential species numbers are probably much more than the estimated. This is important not only for making certain zoogeographical generalizations, but also for using the obtained data in conservation activities.

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References

Alao, J.S. (2009). Need for biodiversity conservation in Nasarawa State, Nigeria. *Biological Diversity and Conservation*, 2(1), 14-20.

Aslan, B., Yılmaz, A., Bayram, F., Aslan, E.G. (2015). Contributions to the insect fauna of Burdur Province (Turkey) in terms of Hydrophilidae, Helophoridae and Chrysomelidae (Coleoptera) with Chorotype Analyses. *Fresenius Environmental Bulletin*, 24(5b), 1932-1939.

Aslan, E.G., Gök, A. (2006). Host-plant relationships of 65 flea beetle species from Turkey, with new associations (Coleoptera: Chrysomelidae: Alticinae). *Entomological News*, 117, 297-308.

Aslan, E.G., Ayvaz, Y. (2009). Diversity of Alticinae (Coleoptera: Chrysomelidae) in Kasnak Oak Forest Nature Reserve, Isparta, Turkey. *Turkish Journal of Zoology*, 33, 251-262.

Aslan, E.G. (2010). Comparative diversity of Alticinae (Coleoptera: Chrysomelidae) between Çığlıkara and Dibek Nature Reserves in Antalya, Turkey. *Biologia*, 65(2), 316-324.

Aslan E.G., Başar M. (2016). Flea beetles collected from olive trees of Antalya province including the first record of the monotypic genus *Lythraria* Bedel, 1897 (Coleoptera: Chrysomelidae) for Turkey. *Turkish Journal of Entomology*, 40(3), 243-248.

Bayram, F., Aslan, E.G. (2015). Comparation of Alticini (Coleoptera: Chrysomelidae: Galerucinae) species diversity in different habitats selected from Bafa Lake Natural Park (Aydın) basin with a new record for Turkish fauna. *Turkish Journal of Entomology*, 39(2), 147-157.

Bouchard, P., Bousquet, Y., Davies, A.E., Alonso-Zarazaga, M.A., Lawrence, J.F., Lyal, C.H.C., Newton, A.F., Reid, C.A.M., Schmitt, M., Slipinski, S.A., Smith, A.B.T. (2011). Family-group names in Coleoptera (Insecta). *ZooKeys*, 88, 1-972.

Čížek, P., Doguet, S. (2008). Klic k urcovani drepciku (Coleoptera: Chrysomelidae: Alticinae) Ceska a Slovenska. Mestske muzeum, Nove Mesto nad Metuji, Slovenska.

Ekiz, A.N., Şen, İ., Aslan, E.G., Gök, A. (2013). Checklist of leaf beetles (Coleoptera: Chrysomelidae) of Turkey, excluding Bruchinae. *Journal of Natural History*, 47(33-34), 2213-2287.

Furth, D.G. (1980). Zoogeography and host plants of *Longitarsus* in Israel, with descriptions of six new species (Coleoptera: Chrysomelidae). *Israel Journal of Entomology*, 13, 79-124.

Furth, D.G. (1988). The jumping apparatus of flea beetles (Alticinae) – the metafemoral spring. In: The Biology of Chrysomelidae (Jolivet, P., Petitpierre, E., Hsiao, T.H. eds.), pp. 287-297, Kluwer Academic Publishers.

Jolivet, P., Verma, K.K. (2002). Biology of Leaf Beetles. United Kingdom, Intercept Publisher.

Konstantinov, A.S., Baselga, A., Grebennikov, V.V., Prena, J., Lingafelter, S.W. (2011). Revision of the Palearctic *Chaetocnema* Species (Coleoptera: Chrysomelidae: Galerucinae: Alticini). Bulgaria, Pensoft Publishers.

Korotyaev, B.A., Konstantinov, A.S., Volkovitsh, M.G. (2017). Insect Biodiversity in the Palearctic Region. In: Insect Biodiversity: Science and Society, Volume I, Second Edition. (Foottit, R.G., Adler, P.H. eds.), pp. 141-202, John Wiley & Sons Ltd.

Nadein, K., Bezděk, J. (2014). Galerucinae Latreille, 1802. In: Handbook of Zoology. Coleoptera, beetles. Morphology and systematics. Volume 3. (Leschen, R.A.B., Beutel, R.G. eds.), pp. 251-259, Walter de Gruyter, Berlin/Boston.

Özdikmen, H., Coral Şahin, D., Bal, N. (2017). *Phyllotreta* Chevrolat in Turkey with a new record (Chrysomelidae: Galerucinae: Alticini). *Munis Entomology & Zoology*, 12(1), 199-216.

Warchalowski, A. (2010). The Palearctic Chrysomelidae: Identification Keys, Vol: 2. Natura Optima Dux Foundation, Warszawa.

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Research article/Araştırma makalesi

The flora of Hiro Plateau (Adaklı-Bingöl/ Turkey) and ıts surroundings

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Abstract

This research covers the flora of Hiro plateau and its surroundings (Adaklı-Bingol). As a result of the field survey carried out the years between 2013 and 2016, 2250 plant specimens were collected. Considering taxonomical diagnosis of these samples, a total of 846 taxon were identified including 548 species of 74 families and 361 genus, 200 subspecies and 98 varieties. A total of 72 (8.51%) endemic taxa have been determined from the area. The distributions of 75 taxa which are endemic and non endemic however are under the risk and risk categories are as follows: 5 taxa in critically "**CR**", 3 taxa in endangered "**EN"**, 13 taxa in vulnerable "**VU**", 6 taxa in near threatened "**NT"**, 48 taxa in least concern "**LC**" and 2 taxa in data deficient "**DD**". The distribution of taxa determined in the study area according to phytogeographical regions is as follows; Irano–Turanian 294 (34.75%), Euro–Siberian 67 (7.91%), Mediterranean 45 (5.31%) The multi-regional or unknown phytogeographic region 444 (52.48%). According to their taxa content, the greatest 10 families are ordered respectively as follows: Asteraceae (105), Fabaceae (83), Poaceae (67), Brassicaceae (61), Lamiaceae (57), Caryophyllaceae (54), Apiaceae (39), Boraginaceae (27), Rosaceae (26) and Plantaginaceae (22). Greatest 10 genus are ordered respectively as follows: *Astragalus* (23), *Trifolium* (16), *Centaurea* (12), *Salvia* (12), *Veronica* (12), *Alyssum* (12), *Ranunculus* (11), *Silene* (11), *Vicia* (10) and *Medicago* (10).

Key words: Flora, Hiro Plateau, Adaklı, Bingöl, Turkey

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Hiro Yaylası (Adaklı-Bingöl/Türkiye) ve çevresinin florası

Özet

Bu çalışma ile Hiro Yaylası ve çevresinin (Adaklı-Bingöl) florası araştırıldı. 2013-2016 yılları arasında gerçekleştirilen arazi çalışmaları sonucunda 2250 bitki örneği toplandı. Toplanan bitki örneklerinin teşhisi sonucu; 74 familya ve 361 cins'e ait 548 tür, 200 alttür ve 98 varyete olmak üzere toplam 846 takson tespit edildi. Araştırma alandan toplam 72 (%8,51) endemik takson belirlenmiştir. Endemik ve endemik olmayıp risk altında olan toplam 77 taksonun tehlike kategorilerine dağılımları şöyledir: 5 takson kritik "**CR**", 3 takson tehlikede "**EN**", 13 takson zarar görebilir,"**VU**", 6 takson tehdit altına girebilir "**NT**", 48 takson az endişe verici "**LC**" ve 2 takson veri yetersiz "**DD**"dir. Çalışma alnında tespit edilen taksonların fitocoğrafik bölgelere göre dağılımı şöyledir; İran-Turan elementi 290 (%34,7523), Avrupa-Sibirya elementi 67 (%7,91), Akdeniz elementi 45(%5,31) ve çok bölgeli veya fitocoğrafik bölgesi bilinmeyenler 444 (%52,48) şeklindedir. İçerdikleri takson sayılarına göre alanda en büyük ilk 10 familya sırasıyla; Asteraceae (105), Fabaceae (83), Poaceae (67), Brassicaceae (61), Lamiaceae (57), Caryophyllaceae (54), Apiaceae (39), Boraginaceae (27), Rosaceae (26) ve Plantaginaceae (22)'dir. En büyük ilk 10 cins ise sırasıyla; *Astragalus* (23), *Trifolium* (16), *Centaurea* (12), *Salvia* (12), *Veronica* (12), *Alyssum* (12), *Ranunculus* (11), *Silene* (11), *Vicia* (10),and *Medicago* (10)'dur.

Anahtar kelimeler: Flora, Hiro Yaylası, Adaklı, Bingöl, Türkiye

1. Giriş

Bu çalışma, Ülkemizin'in Doğu Anadolu Bölgesinde Bingöl ilinin kuzeyindeki Adaklı ilçesinde yer alan Hiro yaylası ve çevresinin florasını araştırmak amacıyla yapılmıştır. Türkiye ılıman iklim kuşağında üç faklı fitocoğrafik bölgenin ve bu

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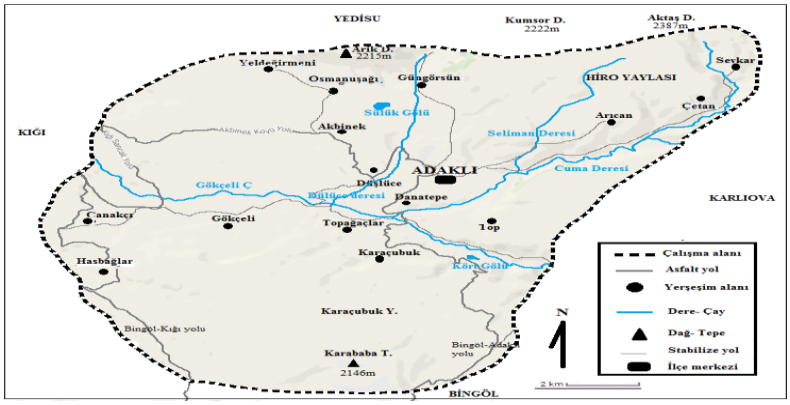
bölgelere ait iklim tiplerinin hüküm sürdüğü coğrafik konumu, jeomorfolojik yapısı ile ender ülkelerden biridir (Ekim, 2014). Bu nedenlerden dolayı farklı ekolojiye sahip olan Türkiye, bitki çeşitliliği bakımından oldukça zengin bir bitki potansiyeline sahiptir. Bu çalışma alanımızda yapılan ilk floristik çalışmadır. B8 karesi içerisinde bulunan Bingöl ili sınırları içerisinde yapılan çalışmalar; Altıkardeş Dağı ve Çevresinin (Genç, Bingöl) Florası (Sinan ve Behçet, 2014), Dikme (Kür) Yaylası (Merkez-Bingöl) ve Çevresinin Florası (Kılıç ve Yıldırımlı, 2015), Bingöl Dağı ve Çevresindeki İlçelerin (Hınıs, Tekman, Çat, Varto, Karlıova) Bitkilerinin Floristik Araştırılması (Engin, 1990)'dır.

Araştırma alanımız Doğu Anadolu Bölgesinde, Bingöl ilinin kuzeyinde yer almaktadır. Alanın kuzeyinde Kumsor (2222 m) ve Akdaş (2387 m) dağları, doğusunda Sevkar (Çatmaoluk) ve Çevreli köyleri, batısında Kığı barajı, güneyinde Sancak beldesi bulunur. Hiro Yaylası doğuda Sevkar köyünden başlayarak Adaklı merkezine kadar uzanır. Adaklı, Karaçubuk, Düşlüce, Gökçeli, Hasbağlar arası asfalt yol olup diğer yerleşim alanlarına stabilize yollardan ulaşılmaktadır (Şekil 1).



Şekil. 1. Araştırma alanının coğrafi haritası

Araştırma alanının büyük toprak grupları bazaltik topraklar, kolüvyal topraklar, kireçsiz kahverengi topraklar ve kireçsiz kahverengi orman topraklarıdır (Anonim, 1996; Avcı, 2016). Araştırma alanımızın iklimi Bingöl, Karlıova (Bingöl), Kığı (Bingöl), Çat (Erzurum), istasyonlarından alınan meteorolojik veriler hesaplanarak değerlendirilmiştir. İklim bilgileri Başbakanlık Devlet Meteoroloji İşleri Genel Müdürlüğü'nden (DMİ, 2013) temin edilmiştir. Alanımız Akdeniz ikliminin etkisi altındadır (Akman, 1990). Emberger (1955) $Q=2000.p/M^2-m^2$ formülünü Akdeniz biyoiklim katlarını belirlemek için geliştirmiştir (Tablo 1).

Tablo 1. Araştırma alanı ve çevresindeki istasyonların Biyoiklim tipleri ve bunlar ile ilgili veriler

İSTASYON	Yükseklik (m)	P (mm)	M °C	m °C	Q	PE	S	Biyoiklim Katı
BİNGÖL	1151	946,5	34,4	-6,1	81,3	30,4	0,8	Az Yağışlı, Çok Soğuk Akdeniz iklimi
KARLIOVA	1823	694,3	27,7	-14,3	47,6	55,1	1,9	Yarı Kurak Üst, Buzlu Akdeniz iklimi
KIĞI	1430	968,5	29,7	-7,3	92,1	51,2	1,7	Az yağışlı, Son Derece Soğuk Akdeniz iklimi
ÇAT	1921	488,6	27,7	-14	41,8	64	2,3	Yarı Kurak Alt, Buzlu Akdeniz iklimi

P= Yıllık yağış miktarı, M= En sıcak ayın maksimum sıcaklık ortalaması m= En soğuk ayın minimum sıcaklık ortalaması, Q: Emberger yağış sıcaklık emsali, PE: Yaz yağışı ortalaması, S: kurak devre

Araştırma alanımız İran-Turan fitocoğrafik bölgesi içerisinde yer almaktadır. Alanımızda orman, çalı-yarıçalı, step, kayalık ve sucul formasyonlar gelişmiş olmakla beraber orman ve step formasyonu daha yaygındır. Orman formasyonu 1220 m'den başlar 2000 m yüksekliklere kadar çıkar. Arıcan, Sevkar, Karaçubuk, Güngörsün, Hasbağlar, Topağaçlar, Çanakçı, Gökçeli gibi yerleşim alanlarının çevresinde, Karaçubuk yaylası doğusunda, Kört gölü çevresinde meşelerin (*Quercus petraea* (Matt.) Liebl. subsp. *pinnatiloba* (K. Koch) Menitsky ve *Q. libani* Oliv.) dominatlığını oluşturduğu orman formasyonu yoğun bir örtü oluşturmuştur.

Araştırma alanımızda orman üst sınırının üzerindeki kesimlerde veya ormanın yok edildiği sahalarda kserofit karekterli step formasyonu gelişme göstermiştir. Bu formasyada daha çok yastık formu türler geniş yayılış göstermişlerdir. Hiro yaylası, Sevkar köyü kuzeyi, Karababa tepesi, Karaçubuk yaylası çevresindeki step sahalarda; *Astragalus muschianus* (Kotschy & Boiss.) D.F.Chamb. ve *A. gummifer* Labill. toplulukları hakim olarak bulunmaktadır..

2. Materyal ve yöntem

Araştırma alanının materyalini 2013-2016 yılları arasında toplanan 2250 vasküler (damarlı) bitki örnekleri oluşturmaktadır. Herbaryum materyali haline getirilen bitki örnekleri Bingöl Üniversitesi, Fen-Edebiyat Fakültesi Biyoloji Bölümü Herbaryumunda bulunmaktadır (BIN).

Bitki örneklerin teşhisinde (Türkiye Florası) "Flora of Turkey and the East Aegean Islands" (Davis, 1965-1985; Davis et al., 1988; Güner et al., 2000) adlı eserden faydalanılmıştır. Bazı bitki örneklerinin teşhisinde Türkiye Florasının yanısıra, Flora Iranica (Rechinger, 1965-1977), Flora Europaea (Tutin et al. 1964-1981), Flora of Iraq (Towsend and Guest 1960, 1985), Flora Palaestina (Zohary, 1966-1986), Flora of USSR (Komarov, 1933-1964) eserlerden de yararlanılmıştır. Bunlara ek olarak bazı tür ve cinslerle ilgili çalışmalarından da (Podlech and Zarre 2013; Behçet and Almanar, 2004, Kandemir vd., 2014, Behçet et al., 2017; Scholz, 1998, Saya, 1992, Yıldırımlı, 2014) faydalanılmıştır. Örneklerden bazılarası BIN'da (Bingöl Üniversitesi Fen Edebiyat Fakültesi Herbaryumu)

bulunan bitki örnekleri ile karşılaştırılarak kontrol edilmiştir. Bütün taksonlar floristik liste bölümünde,kullanılan APG III (Haston vd., 2009; Reveal ve Chase, 2011) sistemine göre ve alfabetik olarak verilmiştir. Lokalite bilgileri yazılırken alanının tamamı B8 karesi, Bingöl ili ve Adaklı ilçesi sınırları içerisinde yer aldığından dolayı tekrardan kaçınmak için B8; Bingöl ve Adaklı ilçesi yazılmamıştır. Örneklerin lokalite bilgileri verilirken: Lokalite numarası, toplayıcı rumuzu ve numarası, endemik olanlar END. kısaltması ile, risk altında olanların tehlike kategorisi (kısaltma şeklinde), biliniyor ise hangi fitocoğrafik bölge elementi olduğu, Raunkiaer (1934)'e göre hangi hayat formunda olduğu (kısaltma şeklinde) yazılmıştır. Bitkilerin endemizim, güncel drumları, yazar isimleri ve türkçe isimleri Türkiye bitkileri listesi (Güner vd 2012) adlı eserden kontrol edilmiştir. Endemik ve nadir bitkilerin tehlike kategorileri yönünden durumlarının değerlendirilmesinde başta Ekim vd. (1989; 2000) olmak üzere Vural (2006) ve IUCN (2013) çalışmalarından da yararlanılmıştır. B8 karesi için yeni olan taksonların sonuna (▲) işareti konularak belirtilmiştir.

3. Bulgular

Bitki Toplama İstasyonları Adaklı merkez güneyi, çayır alanlar, 10.04.2016, 39°. 221'. 58" N, 40°.487'.83" E, 1427 m,

1. Sevkar köy yolu, bahçe kenarları, 15.04.2014, 39°.238'.19" N, 40°.535'.06" E, 1502 m
2. Adaklı merkez güneyi, bahçe kenarları, 14.04.2014, 39°.225'.48" N, 40°.484'.91" E, 1447 m
3. Ganya hiva mela çeşmesi çevresi, step, 12.04.2014, 39°.229'.00" N, 40°.490'.55" E, 1478 m,
4. Arıcan mah. yol kenarları, 12.04.2014, 39°.233'.98" N, 40°.503'.91" E 1536 m,
5. Arıcan mah. güneyi yamaçlar, 14.04.2014, 39°.236'.02" N, 40°.530'.41" E 1503 m,
6. Ganya hiva mela çeşmesi çevresi, step yamaçlar, 26.04.2014, 39°.230'.44" N, 40°.491'.34" E, 1480 m,
7. Adaklı merkez doğusu, step yamaçlar, 26.04.2014, 39°.228'.44" N, 40°.489'.96" E, 1484 m,
8. Adaklı merkez güney-doğusu, bahçe içi, 26.04.2014, 39°.221'.76" N, 40°.488'.18" E, 1425 m,
9. Adaklı merkez güney-doğusu, cuma deresi kenarı, 26.04.2014, 39°.222'.06" N, 40°.495'.42" E, 1350 m,
10. Adaklı merkez güneyi, tarla kenarları, 26.04.2014, 39°.225'.71" N, 40°.497'.35" E, 1421 m,
11. Adaklı merkez güneydoğusu, Cuma çayı kenarı, step yamaçlar, 26.04.2014, 39°.215'.12" N, 40°.484'.57" E, 1309 m,
12. Hiro yaylası güneyi, (Şelale) Arıcan mah. yolu, step, 05.05.2014, 39°.233'.17" N, 40°.503'.13" E, 1542 m,
13. Adaklı merkez, nemli alanlar, 05.05.2014, , 39°.215'.15" N, 40°.479'.66" E, 1396 m,
14. Adaklı merkez güneyi, nemli alanlar, bahçe kenarları, 05.05.2014, 39°.225'.48" N, 40°.484'.91" E, 1447 m,
15. Sevkar köyü mezarlık çevresi, step, 17.05.2014, 39°.269'.94" N, 40°.575'.36" E, 1845 m,
16. Hiro yaylası güneyi, orman açıkları, 17.05.2014, 39°.252'.71" N, 40°.559'.63" E, 1744 m,
17. Çetan köyü, yol kenarları, 17.05.2014, 39°.248'.28" N, 40°.554'.54" E, 1592 m,
18. Çetan köyü güneyi, step alanlar, 17.05.2014, 39°.241'.64" N, 40°.543'.66" E, 1549 m,
19. Sevkar köyü, Merdanos mevki, step, 17.05.2014, 39°.280'.81" N, 40°.566'.69" E, 1967 m,
20. Adaklı güneyi, köprü çevresi, step, 25.05.2014, 39°.214'.06" N, 40°.472'.78" E, 1296 m,
21. Adaklı güneyi, Cuma deresi kuzeyi, yamaçlar, 25.05.2014, 39°.215'.38" N, 40°.482'.16" E, 1387 m,
22. Adaklı merkez güneydoğusu, çayır, 25.05.2014, 39°.221'.25" N, 40°.489'.13" E, 1403 m,
23. Adaklı merkez güneyi, step, 25.05.2014, 39°.217'.03" N, 40°.486'.70" E, 1400 m,
24. Danatepe mah. güneyi, step, 25.05.2014, 39°.214'.44" N, 40°.475'.75" E, 1342 m,
25. Adaklı merkez, bahçe içi, 25.05.2014, 39°.229'.29" N, 40°.479'.73" E, 1500 m,
26. Sevkar köyü batısı, çayır, 25.05.2014, 39°.272'.48" N, 40°.570'.94" E, 1853 m,
27. Çetan köyü doğusu, step, 25.05.2014, 39°.249'.59" N, 40°.553'.13" E, 1654 m,
28. Ganya hiva mela çeşmesi çevresi, step yamaçlar, 25.05.2014, 39°.229'.10" N, 40°.490'.56" E, 1480 m,
29. Adaklı merkez güneyi, step yamaçlar, 31.05.2014, , 39°.216'.52" N, 40°.482'.54" E, 1375 m,
30. Adaklı merkez kuzeybatısı, doğuya bakan step yamaçlar, 31.05.2014, , 39°.254'.40" N, 40°.462'.23" E, 1518 m,
31. Düşlüce mah. kuzeyi, yol kenarları, 31.05.2014, 39°.247'.39" N, 40°.464'.39" E, 1510 m,
32. Düşlüce mah. kuzeyi, step yamaçlar, 31.05.2014, 39°.241'.61" N, 40°.457'.24" E, 1518 m,
33. Düşlüce mah. çevresi, step, 31.05.2014, 39°.240'.15" N, 40°.462'.62" E, 1482 m,
34. Sülük gölü güneydoğusu, step, 31.05.2014, 39°.250'.47" N, 40°.458'.73" E, 1579 m,
35. Sülük gölü çevresi, step, 31.05.2014, 39°.255'.79" N, 40°.458'.79" E, 1627 m,
36. Sülük gölü, göl içi, 31.05.2014, , 39°.252'.87" N, 40°.453'.39" E, 1640 m,
37. Sülük gölü, göl kenarı, 31.05.2014, 39°.252'.87" N, 40°.453'.39" E, 1640 m,
38. Düşlüce mah. kuzeyi, step, 31.05.2014, 39°.242'.36" N, 40°.456'.42" E, 1567 m,
39. Ganya hiva mela çeşmesi batısı, 31.05.2014, , 39°.229'.27" N, 40°.489'.59" E, 1493 m,
40. Adaklı merkez kuzeybatısı, taşlık yamaçlar, 31.05.2014, 39°.249'.39" N, 40°.452'.95" E, 1664 m,
41. Arıcan mah, yolu, köprü çevresi, 19.06.2014, 39°.234'.75" N, 40°.504'.80" E, 1525 m,
42. Adaklı merkez güneyi, step orman açıkları, 19.06.2014, 39°.216'.94" N, 40°.487'.54" E, 1376 m,
43. Adaklı merkez güneydoğusu, dere kenarı, 19.06.2014, 39°.221'.95" N, 40°.496'.57" E, 1351 m,
44. Adaklı merkez doğusu yıkık su deposu çevresi, step, 19.06.2014, 39°.223'.88" N, 40°.497'.64" E, 1368 m,
45. Adaklı merkez güneyi, orman açıkları, 19.06.2014, 39°.216'.41" N, 40°.485'.92" E, 1400 m,
46. Adaklı merkez doğusu, çöp döküm alanı çevresi, step, 19.06.2014, 39°.228'.15" N, 40°.495'.16" E, 1430 m,
47. Adaklı merkez güneyi, step yamaçlar, 19.06.2014, 39°.217'.60" N, 40°.488'.26" E, 1301 m,
48. Adaklı merkez güneydoğusu, orman, 19.06.2014, 39°.218'.69" N, 40°.491'.61" E, 1328 m,
49. Sevkar köyü yol ayrımı, step yamaçlar, 19.06.2014, 39°.227'.15" N, 40°.496'.16" E, 1435 m,
50. Adaklı merkez güneyi, tarik çeşmesi çevresi, 19.06.2014, 39°.226'.23" N, 40°.484'.64" E, 1449 m,
51. Karaçubuk köyü, step, 14.07.2014, 39°.199'.64" N, 40°.463'.02" E, 1420 m,
52. Ganya hiva mela çeşmesi batısı, step, 04.08.2014, 39°.229'.58" N, 40°.490'.63" E, 1465 m,
53. Sevkar köyü ilköğretim okulu batısı, orman açıkları, 04.08.2014, 39°.269'.93" N, 40°.575'.39" E, 1845 m,
54. Sevkar köyü kuzeybatısı, orman içi, 04.08.2014, 39°.270'.98" N, 40°.572'.09" E, 1840 m,
55. Sevkar köyü kuzey batısı, dere kenarı, 04.08.2014, 39°.272'.19" N, 40°.571'.09" E, 1829 m,
56. Sevkar köyü kuzey batısı, göl içi, 04.08.2014, 39°.272'.25" N, 40°.570'.47" E, 1821 m,
57. Çetan köyü girişi, yol kenarları, 04.08.2014, 39°.247'.46" N, 40°.552'.22" E, 1567 m,
58. Hiro yaylası güneyi, kayalık yamaçlar, 13.08.2016, 39°.270'.39" N, 40°.568'.80" E, 1879 m,
59. Sevkar köyü kuzeyi, step, 14.08.2014, 39°.284'.18" N, 40°.572'.36" E, 2121 m,
60. Sevkar-Çetan Köyleri arası köprü çevresi, 04.08.2014, 39°.266'.27" N, 40°.574'.38" E, 1788 m,
61. Sevkar köyü çıkışı, güneye bakan step yamaçlar, 04.08.2014, 39°.276'.87" N, 40°.580'.19" E, 1911 m,
62. Arik dağı güneyi, step, 09.08.2014, 39°.276'.36" N, 40°.449'.72" E, 1980 m,
63. Topağaçlar köyü, yol kenarı, 23.08.2014, 39°.208'.30" N, 40°.451'.12" E, 1286 m,
64. Karacubuk köyü yaylası batısı, step, 23.08.2014, 39°.147'.84" N, 40°.469'.61" E, 2004 m,
65. Sülük gölü, göl kenarı, 23.08.2014, 39°.252'.89" N, 40°.452'.98" E, 1632 m,
66. Gökçeli köyü, yol kenarları, 23.08.2014, 39°.211'.94" N, 40°.392'.23" E, 1227 m,
67. Sevkar yolu üzeri, Yapay gölet çevresi, dere kenarları, 13.09.2014, 39°.232'.74" N, 40°.523'.20" E, 1461 m,
68. Sevkar yolu üzeri, Yapay gölet çevresi, kayalık, 13.09.2014, 39°.232'.74" N, 40°.523'.20" E, 1461 m,
69. Sevkar köyü, Merdanos mevkii, step, 13.09.2014, 39°.281'.33" N, 40°.566'.34" E, 1850 m,
70. Adaklı merkez doğusu, kuzeye bakan yamaçlar, orman açıkları, 13.09.2014, 26.04.2014, 39°.235'.48" N, 40°.485'.33" E, 1460 m,

71. Sevkar yolu üzeri, nemli alan, 13.09.2014, 39°.235'.39" N, 40°.516'.69" E, 1452 m,
72. Arıcan mah. güneyi, çayır, 25.10.2014, 39°.236'.02" N, 40°.530'.41" E 1515 m,
73. Karaçubuk köyü girişi, çayır, 21.03.2015, 39°.188'.73" N, 40°.491'.04" E, 1484 m,
74. Danatepe mah. girişi köprü çevresi, step, 21.03.2015, 39°.213'.15" N, 40°.469'.75" E, 1305 m,
75. Danatepe mah. grişi köprü batısı kuzeye bakan çayır alanlar, 21.03.2015, 39°.213'.15" N, 40°.469'.75" E, 1303 m,
76. Arıcan mah. yolu, yol kenarları, 21.03.2015, 39°.233'.17" N, 40°.503'.13" E, 1542 m,
77. Kozlu köyü, yol ayrımını geçtikten sonra, meşe açıkları, 28.03.2015, 39^0.186'.91" N, 40^0.489'.57" E, 1569 m,
78. Adaklı merkez güneyi, kuzeye bakan yamaçlar, 28.03.2015, 39°.211'.27" N, 40^0.474'.48" E, 1323 m,
79. Adaklı merkez güneyi, güneye bakan yamaçlar, 28.03.2016, 39°.213'.65" N, 40°.478'.06" E, 1310 m,
80. Karacubuk köyü, Kört gölü çevresi, çayır, 28.03.2015, 39°.189'.38" N, 40°.491'.98" E, 1483 m,
81. Sülük gölü çevresi, step, 12.04.2015, 39°.252'.00" N, 40°.456'.15" E, 1627 m,
82. Çanakçı mezrası, horhor köprüsü çevresi, 12.04.2015, 39°.215'.62" N, 40°.389'.85" E, 1178 m,
83. Hasbağlar köyü girişi, step, 12.04.2015, 39°.194'.54" N, 40°.372'.71" E, 1557 m,
84. Hasbağlar köyü karakol çevresi, step, 12.04.2015, 39°.178'.98" N, 40°.170'.13" E, 1622 m,
85. Danatepe mah. girişi, köprü doğusu, step, 12.04.2015, 39°.213'.15" N, 40°.469'.75" E, 1303 m,
86. Hasbağlar köyüne 1-2 km kala, step, 26.04.2015, 39°.194'.54" N, 40°.372'.71" E, 1553 m,
87. Hasbağlar köyüne 2-3 km kala, meşelik, 26.04.2015, 39°.195'.504" N, 40°.380'.71" E, 1550 m,
88. Hasbağlar köyüne 1-2 km kala vadi, kayalık, 26.04.2015, 39°.160'.75" N, 40°.382'.68" E, 1682 m,
89. Hasbağlar köyüne çıkışı, step, 26.04.2015, 39°.194'.54" N, 40°.372'.71" E, 1557 m,
90. Kozlu köyü yol ayrımı, step, 26.04.2015, 39°.157'.84" N, 40°.497'.75" E, 1790 m,
91. Adaklı merkez güneyi, step, 26.04.2015, 39°.217'.03" N, 40°.486'.70" E, 1400 m,
92. Gökçeli köyü, tarla içi, 26.04.2015, 39°.211'.94" N, 40°.392'.23" E, 1227 m,
93. Çetan köyü yolu, güneye bakan nemli yamaçlar, 01.05.2015, 39°.247'.46" N, 40°.552'.22" E, 1567 m,
94. Karacubuk köyü, yol kenarı, 01.05.2015, 39°.205'.10" N, 40°.462'.37" E, 1337 m
95. Danatepe mah. güneyi, çayır, 01.05.2015, 39°.213'.15" N, 40°.469'.75" E, 1303 m,
96. Karacubuk köyü yaylası, step, 01.05.2015, 39°.142'.01" N, 40°.473'.64" E, 1860 m,
97. Karacubuk köyü girişi, çayır, 01.05.2015, 39°.188'.73" N, 40°.491'.04" E, 1484 m,
98. Hiro yaylası güneyi, step, 16.05.2015, 39°.253'.44" N, 40°.521'.15" E, 1860 m,
99. Hiro yaylası güneyi, çayır, 16.05.2015, 39°.260'.95" N, 40°.518'.97" E, 1900 m,
100. Hiro yaylası, step, 16.05.2015, 39°.268'.66" N, 40°.515'.78" E, 2030 m,
101. Erbaşlar köyü yol ayrımı çevresi, korunmuş alanlar, 16.05.2015, 39°.208'.06" N, 40°.469'.17" E, 1289 m,
102. Adaklı merkez kuzeydoğusu, meydan mevkii, 16.05.2015, 39°.231'.36" N, 40°.501'.14" E, 1560 m,
103. Adaklı merkez, bahçe kenarları, 16.05.2015, 39^0.228'.77" N, 40°.487'.76" E, 1508 m,
104. Arıcan mah. yolu, şelale çevresi, step, 16.05.2015, 39°.234'.75" N, 40°.504'.80" E, 1526 m,
105. Arıcan mah. yolu, yol kenarı, 16.05.2015, 39°.231'.82" N, 40°.506'.49" E, 1549 m,
106. Karacubuk köyü, bahçe içi, 16.05.2015, 39°.199'.64" N, 40°.463'.02" E, 1420 m,
107. Hasbağlar köyü çıkışı, trafo çevresi, step, 31.05.2015, 39°.194'.54" N, 40°.372'.71" E, 1553 m,
108. Hasbağlar köyü girişi, kayalık vadi, 31.05.2015, 39°.160'.75" N, 40°.382'.68" E, 1682 m,
109. Adaklı merkez doğusu yapay gölet çevresi, step, 31.05.2015, 39°.234'.10" N, 40°.516'.66" E, 1500 m,
110. Çanakçı mezrası, yol kenarı, 31.05.2015, 39°.219'.00" N, 40°.364'.73" E, 1313 m,
111. Arıcan mah. güneyi, 31.05.2015, 39°.240'.27" N, 40°.535'.80" E, 1565 m,
112. Sevkar köyü çevresi, 31.05.2015, 39°.276'.87" N, 40°.580'.19" E, 1911 m,
113. Gökçeli köyü girişi, çayır, 31.05.2015, 39°.211'.94" N, 40°.392'.23" E, 1227 m,
114. Karaçubuk köyü, step, 31.05.2015, 39°.199'.64" N, 40°.463'.02" E, 1420 m,
115. Çanakçı mezrası çevresi, step, 05.06.2015, 39°.219'.00" N, 40°.364'.73" E, 1313 m,
116. Karababa tepesi, step, 11.06.2015, 39°.144'.23" N, 40°.453'.67" E, 2139 m,
117. Osmanuşağı köyü (Arik dağı güneyi), step, 11.06.2015, 39°.272'.45" N, 40°.445'.06" E, 1840 m,
118. Arik dağı, step, 11.06.2015, 39°.287'.00" N, 40°.438'.18" E, 2200 m,
119. Erbaşlar köy yolu, yol kenarları, 11.06.2015, 39°.207'.74" N, 40°.469'.87" E, 1288 m,
120. Erbaşlar köy yolu, kayalık, 11.06.2015, 39°.207'.74" N, 40°.469'.87" E, 1290 m,
121. Karaçubuk köyü girişi, yol kenarları, 11.06.2015, 39°.205'.10" N, 40°.462'.37" E, 1337 m,
122. Adaklı merkez, bahçe kenarı, 11.06.2015, 39°.229'.29" N, 40°.479'.73" E, 1524 m,
123. Karaçubuk köyü güneyi köprü çevresi, step, 11.06.2015, 39°.188'.46" N, 40°.488'.74" E, 1422 m,
124. Düşlüce mah. bahçe kenarı, 11.06.2015, 39°.234'.89" N, 40°.464'.47" E, 1361 m,
125. Karababa tepesi, step, 03.07.2015, 39°.144'.23" N, 40°.453'.67" E, 2137 m,
126. Sülük gölü, göl içi, 03.07.2015, 39°.255'.79" N, 40°.458'.79" E, 1627 m,
127. Sülük gölü, göl çevresi, 03.07.2015, 39°.255'.79" N, 40°.458'.79" E, 1627 m,
128. Hiro yaylası güneyi, Arıcan mah., çayır, 03.07.2015, 39°.251'.73" N, 40°.527'.66" E, 1816 m,
129. Hiro yaylası, step, 03.07.2015, 39°.263'.60" N, 40°.553'.37" E, 2015 m,
130. Hiro yaylası güneyi, kayalık, 03.07.2015, 39°.235'.11" N, 40°.512'.46" E, 1581 m,
131. Karababa tepesi kuzeydoğusu, step, 25.10.2015, 39°.145'.71" N, 40°.462'.64" E, 2085 m,
132. Karacubuk köyü güneyi köprü, step, 25.10.2015, 39°.188'.46" N, 40°.488'.74" E, 1422 m,
133. Danatepe mah. girişi, çayır, 09.04.2016, 39°.213'.15" N, 40°.469'.75" E, 1303 m,
134. Karaçubuk köyü, kayalık, 09.04.2016, , 39°.182'.29" N, 40°.496'.12" E, 1607 m,
135. Topağaçlar köyü, yol kenarları, 09.04.2016, 39°.209'.00" N, 40°.360'.73" E, 1300 m,
136. Çanakçı mezrası, step, 09.04.2016, 39°.219'.00" N, 40°.364'.73" E, 1314 m,
137. Kozlu köyü yol ayrımı, step, 09.04.2016, 39°.157'.84" N, 40°.497'.75" E, 1790 m,
138. Karaçubuk köyüne 1-2 km kala, kayalık, 09.04.2016, 39°.182'.29" N, 40°.496'.12" E, 1607 m,
139. Karaçubuk köyüne 1-2 km kala, step, 09.04.2016, 39°.182'.29" N, 40°.496'.12" E, 1607 m,
140. Kozlu yol ayrımı, step, 09.04.2016, 39°.157'.84" N, 40°.497'.75" E, 1790 m,
141. Karacubuk köyü çıkışı, orman açıkları, 21.04.2016, 39°.192'.18" N, 40°.480'.15" E, 1429 m,
142. Sülük gölü kuzeyi, çayır, 21.04.2016, 39°.241'.61" N, 40°.457'.24" E, 1518 m,
143. Karababa tepesi güneydoğusu, step, 21.04.2016, 39°.132'.96" N, 40°.459'.15" E, 1911 m,
144. Karababa tepesi, step, 21.04.2016, 39°.145'.71" N, 40°.462'.64" E, 2085 m,
145. Kört gölü güneyi, kayalık, 21.04.2016, 39°.255'.79" N, 40°.458'.79" E, 1627 m, ,
146. Kört gölü güneyi, step, 21.04.2016, 39°.255'.79" N, 40°.458'.79" E, 1627 m,
147. Erbaşlar köyü yol ayrımı, step, 15.05.2016, 39°.199'.45" N, 40°.480'.21" E, 1304 m,
148. Güngörsün köyü, yol kenarları, 15.05.2016, 39°.262'.70" N, 40°.474'.74" E, 1563 m,
149. Güngörsün köyü, bahçe, 15.05.2016, 39°.276'.79" N, 40°.473'.93" E, 1539 m,
150. Karaçubuk köyü, çayır, 15.05.2016, 39°.203'.90" N, 40°.463'.78" E, 1352 m,
151. Karaçubuk köyü, yol kenarı, 15.05.2016, 39°.205'.10" N, 40°.462'.37" E, 1337 m, Silene
152. Adaklı merkez, bahçe kenarları, 15.05.2015, 39°.228'.77" N, 40°.487'.76" E, 1508 m
153. Karababa tepesi, step, 15.05.2016, 39°.143'.66" N, 40°.453'.03" E, 2128 m,
154. Karababa tepesi, step, 15.05.2016, 39°.145'.60" N, 40°.455'.73" E, 2105 m,
155. Güngörsün köyü kuzeyi, step, 15.05.2016, 39°.283'.60" N, 40°.474'.22" E, 1644 m,
156. Güngörsün köyü kuzeyi, step yamaçlar, 15.05.2016, 39°.284'.67" N, 40°.471'.32" E, 1778 m,
157. Karaçubuk köyü, yol kenarı, 20.05.2016, 39°.205'.10" N, 40°.462'.37" E, 1337 m,
158. Danatepe mah. güneyi, çayır, 26.05.2016, 39°.209'.64" N, 40°.463'.93" E, 1254 m,
159. Danatepe mah. güneyi, dere kenarı, 26.05.2016, 39°.209'.64" N, 40°.463'.93" E, 1254 m,
160. Karaçubuk köyü, orman açıkları, 26.05.2016, 39°.192'.18" N, 40°.480'.15" E, 1429 m,
161. Karaçubuk köyü, step, 26.05.2016, 39°.197'.37" N, 40°.469'.23" E, 1450 m,

162. Düşlüce köyü çevresi, step, 26.05.2016, 39°.234'.89" N, 40°.464'.47" E, 1361 m,
163. Karaçubuk köyü kuzeyi, orman, 26.05.2016, 39°.202'.07" N, 40°.458'.27" E, 1433 m,
164. Güngörsün köyü, yol kenarları, 18.07.2016, 39°.271'.00" N, 40°.473'.18" E, 1520 m,
165. Güngörsün köyü batısı, step, 24.07.2016, 39°.282'.49" N, 40°.474'.16" E, 1633 m,
166. Güngörsün köyü kuzeyi, step, 18.07.2016, 39°.284'.76" N, 40°.489'.17" E, 1623 m,
167. Güngörsün köyü kuzeybatısı, step, 18.07.2016, 39°.283'.00" N, 40°.476'.66" E, 1560 m,
168. Sülük gölü çevresi, step, 18.07.2016, 39°.253'.12" N, 40°.454'.18" E, 1640 m,
169. Güngörsün köyü kuzeyi, bahçe, 18.07.2016, 39°.285'.40" N, 40°.482'.95" E, 1605 m,
170. Kört gölü, göl içi, 23.07.2016, 39°.190'.30" N, 40°.489'.93" E, 1434 m,
171. Kuru mezrası güneydoğusu, orman, 23.07.2016, 39°.182'.29" N, 40°.496'.12" E, 1607 m,
172. Karaçubuk köyü yayla yolu, orman içi, 23.07.2016, 39°.166'.56" N, 40°.484'.72" E, 1830 m,
173. Karaçubuk köyü yaylası, step, 23.07.2016, 39°.149'.21" N, 40°.468'.94" E, 1972 m,
174. Hasbağlar köyü girişi, step, 11.09.2016, 39°.194'.54" N, 40°.372'.71" E, 1558 m,
175. Kozlu yol ayrımı, step, 23.07.2016, 39°.157'.84" N, 40°.497'.75" E, 1790 m,

4.2. Araştırma Alanının Florası

Division: PTERIDOPHYTA

1. EQUICETACEAE / ATKUYRUĞUGİLLER

1. Equisetum arvense L. / atkuyruğu; 17, YY131, Cr.
2. E. palustre L. / kırkbacak; 27, YY214; 68, YY800b, Cr.

2. CYSTOPTERIDACEAE/ GEVREKEĞRELTİGİLLER

3. Cystopteris fragilis (L.) Bernh. / gevrek eğrelti; 109, YY1102, Hc.

Division: SPHERMATOPHYTA

Sundivision: GYMNOSPERMAE

3. CUPRESSACEAE / SERVİGİLLER

4. Juniperus excelsa M.Bieb. subsp. ***exelsa*** / boz ardıç; 65, YY779; 141, YY1606; 144, YY1666; 174, YY2196, Fh.

Subdivisio: ANGIOSPARMAE

Classis: DICOTYLEDONES

4. ACANTHACEAE / AYIPENÇESİGİLLER

5. Acanthus dioscoridis L. var. ***dioscoridis*** / lokman ayıpençesi; 169, YY2082, Hc.

5. ADOXACEAE / MÜRVERGİLLER

6. Sambucus ebulus L. / mürver otu; 52, YY563, Eu.-Sib. elm., Fh.,
7. S. nigra L. / ağaç mürver; 51, YY564; 104, YY1058; Eu.-Sib. elm., Fh.

6. ALISMATACEAE / KURBAĞAKAŞIĞIGİLLER

8. Alisma lanceolatum With. / kurbağakaşığı; 127, YY1471, 171, YY2129, Cr.(Hd.)

7. AMARANTHACEAE / HOROZİBİĞİGİLLER

9. Amaranthus albus L. / kömüş mancarı; 52, YY605, Th.
10. Atriplex lasiantha Boiss. / deli unluca; 72, YY834, Th.
11. Chenopodium album L. subsp. ***album*** var. ***album*** / aksirkan; 52, YY602, Th.
12. C. botrys L. / kızılbacak; 52, YY566, Th.
13. C. foliosum Asch. / cülek; 52, YY583, Th.
14. C. vulvaria L. / kokar sirken, 47, YY457, Th., (▲)
15. Noaea tournefortii (Jaub.& Spach) Moq. / tuz hölmezi; 65, YY772, Ir.-Tur. elm., Hc.

8. AMARYLLIDACEAE / NERGİSGİLLER

16. A. cardiostemon Fisch. & C.A.Mey. / yamaç körmeni; 18, YY125a; 119, YY1319a; 164, YY1970, Ir.-Tur. elm., Cr.
17. A. nevsehirense Koyuncu & Kollmann / nevşehir soğanı; 117, YY1270a; 131, YY1544, END., LC., Ir.-Tur. elm., Cr.,
18. A. nigrum L. / kara soğan; 21, YY162; 102, YY1018, Medit. elm., Cr., (▲)
19. A. pictistamineum O.Schwarz / izmir soğanı; 117, YY1285a; 126, YY1442, YY1446, END., NT., E. Medit. elm., Cr.,
20. A. pustulosum Boiss. & Hausskn. / bey soğanı; 116,YY1208a, Ir.-Tur. elm., Cr.
21. A. scorodoprasum L.subsp. ***rotundum*** (L.) Stearn / deli pırasa; 122, YY1366; 164, YY1971; 174, 2176, Medit. elm., Cr.,
22. A. tauricola Boiss. / toros soğanı; 52, YY597, END., LC., Ir.-Tur. elm., Cr.
23. A. trachycoleum Wendelbo / boz sarımsak; 32, YY260; 117, YY1273a, 126, YY1447, Ir.-Tur. elm., Cr.,
24. A. vineale L. /sirmo; 114, YY1187, Cr.,
25. Sternbergia clusiana (Ker Gawl.) Ker Gawl. ex Spreng. / vargetgülü; 175, YY2233, Ir.-Tur. elm., Cr., (▲)

9. ANACARDIACEAE / MENENGİÇGİLLER

26. Pistacia eurycarpa Yalt. / bendek;161, YY1865, Ir.-Tur. elm., Fh.

10. APIACEAE / MAYDANOZGİLLER

27. Actinolema macrolema Boiss. / koca aklema; 46, YY430, Ir.-Tur. elm., Th.,
28. Angelica purpurascens (Avé-Lall.) Gilli / melekotu; 56, YY642, Hc.,
29. Anthriscus cerefolium (L.) Hoffm. / mendik; 104, YY1057, YY1059; Hc.,
30. A. nemorosa (M.Bieb.) Spreng. / peçek, 100, YY978; 107, YY1074, Hc.,
31. Artedia squamata L. / karabenek; 30,YY252; 125,YY1386; 170, YY2114, Th.,
32. Astrodaucus orientalis (L.) Drude / havyıldız; 45, YY385; 131, YY1531, Ir.-Tur. elm.,? Th.,
33. Berula erecta (Huds.) Coville / gendeme; 61, YY695, Cr.,
34. Bunium elegans (Fenzl) Freyn var. ***involucratum*** Ö.Saya / hoş aksar; 52, YY567; 171, YY2147; 174, YY2205, END., LC., Cr.,
35. B. paucifolium DC. / koçkuzu; 109, YY1119, Ir.-Tur. elm., Cr.
36. Bupleurum gerardii All. / çalı şeytanı; 142, YY1852, Th.
37. Cahaerophllum bulbosum L. / handok; 48, YY473; 48, YY485; 52, YY585; 112, YY1172, Eu.-Sib. elm., Cr.
38. C. crinitum Boiss. / saçılakotu; 15, YY100; 109, YY1112, Ir.-Tur. elm., Cr.
39. C. macrospermum (Willd. ex Spreng.) Fisch. & C.A.Mey. ex Hohen. / iri handokotu, 55, YY641; 62, YY741, Ir.-Tur. elm., Hc.,
40. Eryngium billardieri Delile / hıyarok; 169, YY2101, Ir.-Tur. elm., Hc.
41. Falcaria vulgaris Bernh. / orakotu; 11,YY52; 64,YY758; 167, YY2039, Hc.
42. Gasparrinia peucedanoides Thell. / göbek aksar; 173, YY2152, Eu.-Sib. elm., Hc.
43. Grammosciadium daucoides DC. / kami; 110, YY1133, Ir.-Tur. elm., Hc.
44. G. pterocarpum Boiss. / ayaklı kami; 164, YY1964, Ir.-Tur. elm., Hc.,
45. Heptaptera anisoptera (DC.) Tutin. / kanatlı çakşır; 48, YY472, Hc.
46. Heracleum trachyloma Fisch. & C.A.Mey. / poğluk; 112, YY1170, **VU.**, Hc., (▲)
47. Lecokia cretica (Lam.) DC. / eşek baldıranı; 88, YY902, Cr.
48. Lisaea strigosa (Banks & Sol.) Eig / dik gelinpıtrağı; 46, YY407, Ir.-Tur. elm., Th.
49. Malabaila lasiocarpa Boiss. / şabulgan; 16, YY119; 47, YY470; 48, YY474; 110, YY1125; 116, YY1237, END., LC., Ir.-Tur. elm., Hc.
50. Oenanthe silaifolia M.Bieb. / attohumu; 111, YY1144, Cr.
51. Ormosciadium aucheri Boiss. / ayıeli; 50, YY532; 131, YY1545, Th.
52. Physocaulis nodosus (L.) W. Koch / hacıkuş; 102, YY1041, Th.
53. Pimpinella cappadocica Boiss. & Balansa var. ***cappadocica*** / peri anasonu; 55, YY640; 126, YY1430, END., LC., Ir.-Tur. elm., Hc.,
54. P. corymbosa Boiss. / salkım anason; 130, YY1513; 131, YY1533; 168, YY2059, Ir.-Tur. elm., Hc.,
55. P. peregrina L. / el anasonu; 166, YY2009; 169, YY2109, Hc.,
56. P. tragium Vill. subsp. ***lithophila*** (Schischk.) Tutin / teke anasonu, 162, YY1897; 166, YY1990, Hc.,
57. Prangos ferulacea (L.) Lindl. / eşek çakşırı, 43, YY355, Hc.,
58. P. platychlaena Boiss. subsp. ***platychlaena*** / korkor; 63, YY751; 166, YY1987, END., LC., Ir.-Tur. elm., Hc.,
59. Scandix iberica M.Bieb. / atkişnekotu; 27, YY210; 142, YY1630, Th.
60. S. pecten-veneris L. / zühretarağı; 102, YY1023, Th.,
61. S. stellata Banks & Sol. / dağ kişkişi; 102, YY1022; 142, YY1631, Th.
62. Sium sisarum L. var. ***lancifolium*** (M.Bieb.) Thell. / dere kerevizi; 58,YY646, Cr.
63. Torilis arvensis (Huds.) Link subsp. ***neglecta*** (Schult.) Thell. / şeytanhavucu; 44, YY370, 174, YY2189, Th.
64. T. leptophylla (L.) Rchb.f. / ince dercikotu; 15, YY99; 161, YY1864; Th.
65. Turgenia latifolia (L.) Hoffm. / karaheci; 32, YY263; 47, YY446; 148, YY1688, Th.,

11. APOCYNACEAE / ZAKKUMGİLLER

66. Vincetoxicum tmoleum Boiss. / hyaluk; 42, YY340; 174, YY2185, Ir.-Tur. elm., Hc.

12. ARACEAE / YILANYASTIĞIGİLLER

67. Arum rupicola Boiss. var. ***rupicola*** / dağsorsalı; 164, YY1919, END., LC., Cr.
68. A. rupicola Boiss. var. ***virescens*** (Stapf) Bornm. & Gauba. / dağsorsalı; 15, YY65; 113, YY1178, Ir.-Tur. elm., Cr.
69. Biarum carduchorum (Schott) Engl. / kardi; 73, YY835, Ir.-Tur. elm., Cr.
70. Lemna turionifera Landolt / sivri sumercimeği; 171, YY2134, Cr.(Hd.).

13. ARISTOLOCHIACEAE / LOHUSAOTUGİLLER

71. Aristolochia bottae Jaub & Spach / köpektaşağı; 8, YY35; 143, YY1651, Ir.-Tur. elm., Hc.

14. ASPARAGACEAE / KUŞKONMAZGİLLER

72. Bellevalia gracilis Feinbrun / aktepeli; 143, YY1649, END., LC., Ir.-Tur. elm., Cr.
73. B. paradoxa (K.Koch) Losinsk. / aşpenceri; 98, YY952, Ir.-Tur. elm., Cr.
74. B. speciosa Woronow ex Gross. / saplı sümbül; 10, YY48; 22, YY172; 143, YY1653, Cr.,
75. Muscari armeniacum Leichtlin ex Baker / gavurbaşı; 80, YY865; 83, YY881; 86, YY889; 90, YY916; 137, YY1590, Cr.,
76. M. comosum (L.) Mill. / morbaş; 28, YY219; 157 YY1075; 157, YY1776, Medit. elm., Cr.,
77. Ornithogalum arcuatum Steven / kurtkirişi; 161, YY1871, Ir.-Tur. elm., Cr.
78. O. montanum Cirillo / dağ akyıldızı; 28, YY217, E. Medit. elm., Cr.
79. O. narbonense L. / akbaldır; 6, YY21; 23, YY178, Medit. elm., Cr.,
80. O. oligophyllum E.D.Clarke / kurt soğanı; 144, YY1660; 146, YY1681, Cr.
81. O. sphaerocarpum A.Kern. / salkım sakarca; 116, YY1200, Cr. (▲)
82. O. wiedemannii Boiss. var. ***wiedemannii*** / engin yıldız; 2, YY878; 89, YY912; 97, YY942; 155, YY1734, Cr., (▲)
83. Puschkinia scilloides Adams. / serhişing; 88, YY903; 89, YY907a; 97, YY943; 98, YY951; 145, YY1669a, Ir.-Tur. elm., Cr.,
84. Scilla siberica Haw. subsp. ***armena*** (Grossh.) Mordak / camışkıran; 74, YY845; 75, YY846; 78, YY861; 82, YY873, 85, YY885, 87, YY900; 89,YY905; 97, YY947; 141, YY1607, Ir.-Tur. elm., Cr.,

15. ASTERACEAE / PAPATYAGİLLER

85. Achillea arabica Kotschy / hanzabel; 164, YY1953, Ir.-Tur. elm., Hc.,
86. A. millefolium L. subsp. ***millefolium*** var. ***millefolium*** / civanperçemi; 46, YY433; 62, YY739; 130, YY1528; 167, YY2015, Eu.-Sib. elm., Hc.,
87. A. nobilis L. subsp. ***neilreichii*** (A.Kern.) Velen. / binbiryaprak; 52, YY584; 111, YY1152, Eu.-Sib. elm., Hc.
88. A. schischkinii Sosn. / deli civanperçemi; 116, YY1195; END., LC., Ir.-Tur. elm., Hc.
89. A. vermicularis Trin. / püşan; 45, YY397, Ir.-Tur. elm., Ch.,
90. Anacyclus anatolicus Behçet & Almanar / dağındest; 4, YY187; 43, YY364, END., CR., Th., (▲).
91. Anthemis kotschyana Boiss. var. ***discoidea*** (Bornm.) Grierson / koç papatyası; 42, YY345; 119, YY1332, Hc.,
92. Arctium minus (Hill) Bernh. / löşlek; 165, YY1982, Eu.-Sib. elm., Hc.
93. Bidens tripartita L. / üç suketeni; 64, YY759; 72, YY832, Th.,
94. Carduus nutans L. subsp. ***leiophyllus*** (Petrovič) Stoj. & Stef. / kerbeş; 42, YY335; 47, YY449; 60, YY668; 116, YY1257, Hc.,
95. C. pycnocephalus L. subsp. ***albidus*** (M.Bieb.) Kazmi / arap soymacı, 47, YY448, Hc.,
96. Carlina oligocephala Boiss. & Kotschy subsp. ***oligocephala*** / domuz dikeni; 60, YY 670, Hc.,
97. Centaurea aggregata Fisch. & C.A. Mey. ex DC. subsp. ***aggregata*** / kümedüğme; 50, YY531, Hc.,
98. C. aucheri (DC.) Wagenitz / güdük sarıbaş, 62, YY750, Ir.-Tur. elm., Hc., (▲)
99. C. bingoelensis Behçet & İlçim, 62, YY748, YY749, END., CR., Hc.,
100. C. consanguinea DC. / tezdüğme; 130,YY1527,END.,LC.,Ir.-Tur. elm.,? Hc.,
101. C. fenzlii Reichardt / battalbaş; 23, YY 177, 165, YY1976, END., LC., Ir.-Tur. elm., Hc.,
102. C. iberica Trev. ex Spreng. / deligözdikeni, 51, YY560; 53, YY624, Hc.,
103. C. polypodiifolia Boiss. var. ***szovitsiana*** (Boiss.) Wagenitz / akbehmen, 52, YY614, Hc., (▲)
104. C. pseudoscabiosa Boiss. & Buhse subsp. ***pseudoscabiosa*** / yaman kavgaluz; 166, YY1994; 167, YY2040, Hc.,
105. C. saligna (K.Koch) Wagenitz / hol; 61, YY691, END., LC., Ir.-Tur. elm., Hc.,
106. C. solstitialis L.subsp. ***solsitialis*** / çakırdikeni; 43, YY357; 52, YY573; 169, YY2081, Hc.,
107. C. spectabilis (DC..) Sch.Bip. var. ***microlopha*** (Boiss.) Wagenitz / turanbaşı; 54, YY628; 59, YY650, Ir.-Tur. elm., Hc.,
108. C. virgata Lam. / acı süpürge; 60, YY682; 169, YY2107, Ir.-Tur. elm., Hc.,
109. Chardinia orientalis (L.) Kuntze, 20, YY139; 28, YY216; 29, YY220; 102, YY1014, Ir.-Tur. elm., Th.,
110. Chondrilla juncea L. / karakavuk; 61, YY688a; 60, YY675, Hc.
111. Cichorium intybus L. / hindiba; 52, YY571; 53, YY620, Hc.
112. Cirsium arvense L. / köygöçüren; 55, YY637; 61, YY707, Hc.
113. C. ciliatum (Murray) Moench subsp. ***szovitsii*** (K.Koch) Petr. / kazandelen; 176, YY2232, Ir.-Tur. elm., Hc.,
114. C. sommieri Petr. / kaznkulpu; 169, YY2099, END., LC., Ir.-Tur. elm., Hc.,
115. C. subinerme Fisch. & C.A.Mey. / su kangalı; 166, YY1986, Ir.-Tur. elm., Hc.,
116. Cnicus benedictus L. / topdiken; 11, YY51, 111, YY1160, Hc.,
117. Cota austriaca (Jacq.) Sch.Bip. / babuçça; 121, YY1356, Th.,
118. C. coelopoda (Boiss.)Boiss. var. ***bourgaei*** (Boiss.) U. Özberk & Vural / çiçekçi papatyası; 16, YY114; 40, YY323; 112, YY1174; 160, YY1824, Hc.,
119. C. tinctoria (L.) J. Gay ex Guss. var. ***tinctoria*** / boyacı papatyası; 30, YY245; 34, YY282; 125, YY1398; 126, YY1416; 131, YY1529, Hc.,
120. C. wiedemanniana (Fisch. & C.A.Mey.)Holub / bodur babuçça; 30, YY241a; 161, YY1846; 161, YY1868, Th.,
121. Crepis alpina L. / yürekotu; 24, YY 192; 50, YY547; 111, YY1166; 148, YY1698; 161, YY1867, Th.,
122. C. commutata (Spreng.) Greuter / delidışkısı: 8, YY41a; 167, YY2047, Th.,
123. C. foetida L. subsp. ***rhoeadifolia*** (M.Bieb.) Čelak. / sakarkanak; 45, YY384a; 65, YY776; 66, YY791; 166, YY1998, Th.,
124. C. pulchra L. subsp. ***pulchra,*** / zarif kıskıs; 46, YY413, Th.,
125. C. sancta (L.) Bornm. / yaban kıskısı; 50, YY524; 86, YY886, Th.,
126. Crupina crupinastrum (Moris) Vis. / gelindöndüren; 50, YY519, Hc.,
127. C. vulgaris Pers. ex Cass. / kır gelindöndüreni; 17, YY 129; 164, YY1928, Hc.,
128. Cyanus depressus (M.Bieb.) Soják / gökbaş; 95, YY931, Th.
129. C. segetum Hill / gelintacı; 16, YY118; 20, YY150, Th.,
130. C. triumfettii All. subsp. ***triumfetti,*** / delikapele; 35, YY289; 99, YY959; 116, YY1210; 117, YY1281a, Hc.,
131. Echinops orientalis Trautv / dağşekeri; 52, YY611, Ir.-Tur. elm., Hc.,
132. Erigeron acris L. subsp. ***pycnotrichus*** (Vierh.) Grierson / yünlü şifaotu; 170, YY2113, Eu.-Sib. elm., Hc.
133. Filago arvensis L. / keçeotu, 47, YY465; 144, YY1338, Th.,
134. Garhadiolus hamosus Boiss. & Hausskn. / sarı kıskıs; 27, YY215, Ir.-Tur. elm., Th.,
135. G. hedypnois Jaub. & Spach / bostan kıskısı; 118, YY1288; 164, YY1944, Ir.-Tur. elm., Th.
136. Gundelia tournefortii L. var. ***tournefortii,*** / kenger; 15, YY101; 164, YY1937, Ir.-Tur. elm., Hc.,
137. Helichrysum arenarium (L.) Moench subsp. ***aucheri*** (Boiss.) P.H.Davis. & Kupicha / ölmez çiçek; 169, YY2080a, END., LC., Ir.-Tur. elm., Ch.
138. H. armenium DC. subsp. ***armenum*** / altınotu; 45, YY402; 126, YY1426, Ir.-Tur. elm., Ch.
139. H. plicatum DC. subsp. ***plicatum*** / mantuvar; 130, YY1502, Ch.,
140. H. plicatum DC. subsp. ***pseudoplicatum*** (Nábělek) P.H.Davis & Kupicha / bozoğlan; 166, YY1995; 169, YY2105, Ch.
141. Inula discoidea Boiss. / dilsiz andızotu; 169, YY2108, END., DD., Ir.-Tur. elm., Cr.,
142. I. montbretiana DC. / kökçayı; 126, YY1434, Ir.-Tur. elm., Cr.,
143. I. oculus-christi L. / yolotu; 126, YY1454; 128, YY1480; 129, YY1497; 130, YY1500; 167, YY2024, Eu.-Sib. elm., Cr.,
144. I. salicina L. / su andızotu; 170, YY2120, Eu.-Sib. elm., Cr.
145. Klasea serratuloides Takht. / etli topbaş; 157, YY1755; 168, YY2062, Ir.-Tur. elm., Hc.,
146. Lactuca hispida DC. / kıllı marul; 161, YY1870, Cr.
147. L. mulgedioides (Vis. & Pančić) Boiss. & Kotschy ex Boiss. / muş marulu; 55, YY634; 129,YY1496, Hc.,
148. L. orientalis (Boiss.) Boiss. / sızıkamışkan; 62, YY732, Ir.-Tur. elm., Hc.,
149. L. tuberosus (Jacq.) Grossh. / topar marul; 43, YY361, Cr.
150. L. viminea (L.) J.Presl & C.Presl / çukurçıtlığı; 59, YY656, 60, YY674, Hc.,
151. Lapsana communis L. subsp. ***intermedia*** (M.Bieb.) Hayek / şebrek; 62, YY742; 125, YY1385; 161, YY1906, Hc.,
152. Leontodon asperrimus (Willd.) Endl. / aşyemliği; 42, YY346; 49, YY502, Ir.-Tur. elm., Hc.
153. L. crispus DC. ex Nyman subsp. ***asper*** (Waldst. & Kit.) Rohl. var. ***asper*** / aslandişi;3, YY358, Hc.
154. Onopordum acanthium L. / galagan; 165, YY1981, Hc.,
155. Picnomon acarna (L.) Cass. / kılçıkdiken; 61, YY688; 65, YY78; 165, YY1979, Medit. elm., Hc.
156. Picris hieracioides L. subsp. ***hieracioides,*** / deli şiro; 64, YY756, Eu.-Sib. elm., Hc.,
157. P. kotschyi Boiss. / arap şirosu; 46, YY435, Th.,
158. P. cf. ***olympica*** Boiss. / ulu şiro; 31 , YY256, END., LC., Medit.(mt) elm., Hc., (▲)
159. P. strigosa M.Bieb. subsp. ***strigosa,*** / acışiro; 65, YY767, Ir.-Tur. elm., Hc.,
160. Pilosella hoppeana (Schult.) F.W.Schultz & Sch.Bip. subsp. ***troica*** (Zahn) P.D.Sell & C.West / er trnakotu; 126, YY1420, Hc.,
161. P. procera (Fr.) F.W.Schultz & Sch.Bip. / uzun trnakotu; 47, YY439; 126, YY1403; 164, YY1942, Hc.,
162. P. verruculata (Link) Soják / kınalı trnakotu; 167, YY2013, Hc.,
163. Pulicaria vulgaris Gaertn. / ak yaraotu; 169, YY2091, Eu.-Sib. elm.,? Th.,
164. Reichardia dichotoma (Vahl.) Freyn / karasakız; 67, YY796, Ir.-Tur. elm., Hc.,
165. Scorzonera cana (C.A.Mey.) Grossh. var. ***jacquiniana*** (W.Koch) D.F.Chamb. / tekesakalı; 33, YY272; 102, YY1039; 159, YY1819, Hc.,
166. S. incisa DC. / kanık; 15, YY 102; 32, YY268, Ir.-Tur. elm., Hc.,
167. S. latifolia (Fisch. & C.A.Mey.) DC. var. ***angustifolia*** Prilipko / dağsakızı; 168, YY2049, Hc.,
168. S. mollis M.Bieb. subsp. ***mollis*** /iskorçina; 10, YY 47; 15, YY103; 108, YY1083, 109, YY1113; 164, YY1916, Hc.
169. S. mollis M.Bieb. subsp. ***szowitzii*** (DC.) D.F.Chamb. / goftigoda; 13, YY60; 99, YY968, Ir.-Tur. elm., Hc.
170. S. semicana DC. / kıvrım; 18, YY125, END., LC., Ir.-Tur. elm., Hc.,
171. Senecio mollis Willd. / saz kanaryaotu; 165, YY1983, Ir.-Tur. elm.,? Hc.,
172. S. vernalis Waldst. & Kit. / kanaryaotu; 8, YY 42; 60, YY684, Th.,
173. Tanacetum abrotanifolium (L.) Druce / kose pireotu; 55, YY639; 164, YY1921; 167, YY2018, Ir.-Tur. elm., Hc.,
174. T. aucheri DC. / acı preotu; 119, YY1311, E. Medit. elm., Hc., (▲)
175. T. aureum (Lam.) Greuter var. ***aureum,*** / ekşi pireotu; 119, YY1312, Hc.,
176. T. balsamitoides Sch.Bip. / marsuvanotu; 130, YY1517; 167, YY2016; 173, YY2167, Hc.,
177. T. cilicium (Boiss.) Grierson / kaba pireotu; 167, YY2017, E. Medit. elm., Cr.,
178. T. parthenium (L.) Sch.Bip. / beyaz papatya; 42, YY352; 129, YY1485, Hc.,
179. Taraxacum montanum (C.A.Mey.) DC. / dağ hindibası; 61, YY692, Ir.-Tur. elm., Hc.,
180. Tragopogon dubius Scop. / at yemliği; 32, YY266; 164,YY1926, Hc.
181. T. porrifolius L. var. ***longirostris*** (Sch.Bip.)Greuter / helevan; 21, YY 161; 33, YY273; 116,YY1219, YY1229; 118, YY1295, Hc..
182. Tripleurospermum disciforme (C.A.Mey.) Sch.Bip. / kel beybunik; 30, YY238; 110, YY1126; 159, YY1813; 162, YY1882, Ir.-Tur. elm.,? Hc.,
183. T. oreades (Boiss.) Rech.f. var. ***oreades*** / hoşhoş; 6, YY22; 12, YY61; 19, YY134; 110, YY1136; 117, YY1280, Hc.,
184. T. oreades (Boiss.) Rech.f. var. ***tchihathewii*** (Boiss.) H.Hausskn. / hoşhoş; 15, YY104, Hc., (▲)
185. Turanecio eriospermus (DC.) Hamzaoğlu / boz turanotu; 119, YY1307; 166, YY2003, Ir.-Tur. elm., Hc.,
186. Tussilago farfara L. / öksürükotu; 144, YY1654, Eu.-Sib. elm., Hc.,
187. Xanthium spinosum L. / pıtrak; 120 1535a, Th.
188. X. strumarium L. subsp. ***strumarium,*** / koca pıtrak; 125, YY1380a, Th.
189. Xeranthemum annuum L. / kağıt çiçeği; 52, YY590; 130, YY1515; 169, YY2098, Th.

16. BERBERIDACEAE / KARAMUKGİLLER

190. Bongardia chrysogonum (L.) Spach / çatlakotu; 1, YY 09; 93, YY929, 143, YY1643, Ir.-Tur. elm., Cr.,

17. BORAGINACEAE/ HODANGİLLER

191. Alkanna froedinii Rech. f. / gedik havacivaotu; 13, YY63; 106, YY1069; 156, YY1751, END., LC., Ir.-Tur. elm., Hc.,
192. Anchusa azurea Mill. var. ***azurea*** / sığırdili; 29, YY222, Hc.,
193. Asperugo procumbens L. / nevazilotu; 14, YY73, Eu.-Sib. elm., Th.,
194. Brunnera orientalis I.M.Johnst. / minik göğce; 99, YY967; 150, YY1708, Eux. elm., Hc.,
195. Buglossoides arvensis (L.) I.M.Johnst. subsp. ***sibthorpiana*** (Griseb.) R.Fern. / tarla taşkeseni; 1, YY06; 4, YY17; 14, YY74, Th.,
196. Cerinthe minor L. subsp. ***auriculata*** (Ten.) Domac / livarotu; 156, YY1745,Hc.
197. Cynoglossum montanum L. / dağ köpekdili; 164, YY1929, Eu.-Sib. elm., Hc.
198. Echium italicum L. / kurtkuyruğu; 169, YY2096, Medit. elm., Hc.,
199. Heliotropium circinatum Griseb. / deli bambulotu; 53, YY625, Ir.-Tur. elm., Th.,
200. H.europaeum L. / akrep otu; 50, YY467, Ir.-Tur. elm., Th.
201. Lappula barbata (M.Bieb.) Gürke / gürke; 119, YY1306; 157, YY1765, Ir.-Tur. elm., Hc.,
202. Macrotomia densiflora (Ledeb.) McBride / koca eğnik; 157, YY1766, Ir.-Tur. elm., Hc., (▲)
203. Myosotis arvensis (L.) Hill subsp. ***arvensis,*** / kardeşboncuğu; 106; 163**,** YY1949, Eu.-Sib. elm., Th.,
204. M. olympica Boiss. / ulu boncukotu; 101, YY998; 154, YY1727, Eux. elm.?, Hc.,
205. M. platyphylla Boiss. / cilo boncuğu; 174,YY2230, END.,VU., Ir.-Tur. elm., Hc.,
206. M. propinqua Fisch. & C.A.Mey. / ayaklı kuşgözü; 13, YY70; 144, YY1664, Eux. elm.,? Th.,
207. M. stricta Link ex Roem. & Schult. / yitik unutmabeni; 41, YY334; 142, YY1629, Eu.-Sib. elm., Th.,
208. Nonea monticola (Rech. f.) Selvi & Bigazzi / dağ sormuğu; 89, YY908b; 97, YY941, END., LC., Hc., (▲)
209. N. stenosolen Boiss. & Balansa / sormuk otu; 89**,** YY1115; 154, YY1729, END., LC., Ir.-Tur. elm., Hc.,
210. Onosma bourgaei Boiss. / uzun emcek; 163, YY1914, Ir.-Tur. elm., Hc. (▲)
211. O. polioxantha Rech.f. / yoz emzikotu; 41, YY331, END., LC., Ir.-Tur. elm., Hc.
212. O. proballanthera Rech.f. / yayla emziği; 60, YY680, END., NT**.,** Ir.-Tur. elm., Hc.,
213. O. sericea Willd. / kağıt emcek; 29, YY227; 144, YY1341, Ir.-Tur. elm., Hc.,
214. Paracaryum cristatum Boiss. subsp. ***carduchorum*** R.R.Mill / zap çarşakotu; 41, YY328; 126, YY1456, Ir.-Tur. elm., Hc.
215. Phyllocara aucheri **(**A.DC.) Guşul / karadindik; 99, YY975a; 160, YY1829a, Th.,
216. Rindera lanata (Lam.) Bunge var. ***canescens*** (A.DC.) Kusn. / yünlügelin; 99, YY971, Ir.-Tur. elm., Hc.
217. Solenanthus stamineus (Desf.) Wettst. / yayla tütünü; 101, YY985; 109, YY1104, Hc.,

18. BRASSICACEAE / TURPGİLLER

218. Aethionema arabicum (L.) Andrz. ex DC. / arap taşçantası; 6, YY 24; 44, YY376; 111, YY1167, Th.,
219. Ae. carneum (Banks & Sol.) B.Fedtsch. / al kayagülü; 86, YY887; 90, YY915; 134, YY1570; 148, YY1695, Ir.-Tur. elm., Th.,
220. Ae. cordatum (Desf.) Boiss. / kalp çantası; 117, YY1285; 126, YY1436; 156, YY1749, Ch.,
221. Ae. membranaceum DC. / etekli kayagülü; 39, YY313, Ir.-Tur. elm., Ch.,
222. Ae. speciosum Boiss. & A.Huet subsp. ***speciosum,*** / som kayagülü; 126, YY1432; 157, YY1775, Ir.-Tur. elm., Ch., .
223. Alliaria petiolata (M.Bieb.) Cavara & Grande / sarımsak; 8, YY43; 96, YY938; 142, YY1637, Th.,
224. Alyssum armenum Boiss. / arı kevkesi; 126, YY1410, Hc.
225. A. desertorum Stapf / dumanotu; 1, YY11; 142, YY1635, Th.,
226. A. filiforme Nyár. / telli kevke; 121, YY1359; 166, YY2008; 174, YY2213, END., LC., Ir.-Tur. elm., Hc.,
227. A. hirsutum M.Bieb. subsp. ***hirsutum*** / kıllı kuduzotu; 162, YY1900, Th.,
228. A.linifolium Stephan ex Willd. var. ***linifolium,*** / çıplak kuduzotu; 80, YY864; 86, YY896; 137, YY1591, Th.,
229. A. longistylum Grossh. / öbek kuduzotu; 117, YY1283, Hc.
230. A. pateri Nyár. subsp. ***prostratum*** (Nyár.) Dudley / yatık kevke; 108, YY1087, 109, YY1106; 126, YY1406, END., LC., Ir.-Tur. elm., Hc.,
231. A. praecox Boiss. & Balansa / güzel kuduzotu; 144, YY1344, END., LC., Hc.,
232. A. simplex Rudolph / sade kuduzotu; 118, YY1286; 134, YY1578, Th.,
233. A. strictum Willd. / dik kuduzotu; 116, YY1239, Ir.-Tur. elm., Th.,
234. A. strigosum subsp. ***cedrorum*** (Schott & Kotschy) T.R.Dudley / kaya kuduzotu; 105, YY1067, Th. (▲)
235. A. strigosum Banks & Sol. subsp. ***strigosum*** / dökük kuduzotu; 86, YY895; 96, YY937; 102, YY1031, YY1034, Th.,
236. Arabis alpina L. subsp. ***alpina*** / kazteresi; 89, YY914; 139, YY1599, Hc.
237. A. alpina L. subsp. ***brevifolia*** (DC.) Cullen / düz kazteresi; 1, YY05b, E. Medit.(mt) elm., Hc.
238. A. montbretiana Boiss. / ova kazteresi; 20, YY145, Ir.-Tur. elm., Th.
239. A. nova Vill. / tıfıl kazteresi; 142, YY1628, Th.
240. Barbarea brachycarpa Boiss. K.Koch subsp. ***minor*** var. ***minor*** / nicarcık; 101, YY997, Hc.,
241. B. plantaginea DC. / götlezgötü; 3, YY67, 109; 160, YY1840, Hc.
242. Bunias orientalis L. / çırşalgamı; 156, YY1753, Hc.,
243. Camelina hispida Boiss. / kıllı ketentere; 7, YY 224, Th
244. C.rumelica Velen. / ketentere; 42, YY343; 109, YY1108, Th.
245. Capsella bursa-pastoris (L.) Medik. / çobançantası; 134, YY1575, Th.,
246. Cardamine uliginosa M.Bieb. / , 27, YY212; 101, YY1009, Cr.
247. Clypeola aspera (Grauer) Turrill / kıllı akçaotu; 158, YY1784, Ir.-Tur. elm., Th.,
248. Coluteocarpus vesicaria (L.) Holmboe subsp. ***vesicaria*** / patarıkotu; 126, YY1437, Ir.-Tur. elm., Hc.,
249. Conringia clavata Boiss. / topuztelkari; 92, YY925; 157, YY1761, Th.
250. C. orientalis (L.) Dumort. / kocatelkari; 30, YY243, Th.,
251. Descurainia sophia (L.) Webb ex Prantl subsp. ***sophia*** / sadırotu; 15, YY75, Th.
252. Draba nemorosa L. / orman dolaması; 99, YY958; 104, YY1061, Th.,
253. D. nuda (Belanger) Al-Shehbaz & M. Koch / cıbıl dolama; 82, YY870; 99, YY965, Th.,
254. D. verna L. / çırçırotu; 76, YY849; 82, YY872; 138, YY1597, Th.,
255. Eruca vesicaria (L.) Cav. / roka; 123, YY1368, Th., (▲)
256. Erysimum crassipes Fisch. & C.A.Mey. / zarifeotu; 116, YY1260, Hc.,
257. E. leucanthemum (Stephan ex Willd.) B.Fedtsch. / bayır zarifesi; 24, YY190; 60, YY672; 126, YY1464; 157, YY1771; 162, YY1898, Hc.,
258. E. repandum L. / çatal zarife; 1, YY12; 92, YY928; 134, YY1572, Th.,
259. E. smyrnaeum Boiss. & Balansa / zeybek zarifesi; 33, YY269, Hc.,
260. Euclidium syriacum (L.) R.Br. / fındık hardalı; 124, YY1371, Th.,
261. Fibigia clypeata (L.) Medik. subsp. ***clypeata*** var. ***clypeata*** / sikkeotu; 157, YY1762, Hc.
262. F. clypeata (L.) Medik. subsp. ***clypeata*** var. ***eriocarpa*** (DC.) Post. / sikkeotu; 31, YY255; 39, YY311, 111, YY1149, Hc.,
263. F. macrocarpa (Boiss.) Boiss. / koca sikkeotu; 11, YY50; 162, YY1889, Hc.,
264. Hesperis matronalis L. subsp. ***matronalis*** / akşamyıldızı; 15, YY 87, Hc.,
265. Isatis buschiana Schischk. / ağrı çivitotu; 117, YY1281, Ir.-Tur. elm., Hc.,
266. Lepidium chalepense L. / kormik; 164, YY1945, Hc.
267. L. draba L. / diğnik; 14, YY 78, Hc.
268. Microthlaspi perfoliatum L. / giyle; 101, YY1008, Th.,
269. Nasturtium officinale R.Br. / suteresi; 160, YY1835, Cr.,
270. Neslia paniculata (L.) Desv. subsp. ***paniculata*** / tophardal; 9, YY38, Th.,
271. N. paniculata (L.) Desv. subsp. ***thracica*** (Velen) Bornm. / göçmen hardalı; 102, YY1029; 161, YY1849, Th.,
272. Ptilotrichum angustifolium Hausskn. ex Bornm. / seyyahotu; 117, YY1261; 118, YY1303, END., CR., Ir.-Tur. elm., Hc.,
273. Sisymbrium altissimum L. / ergelenotu; 15, YY76; 161, YY1874, Th.
274. S. loeselii L. / bülbülotu; 112, YY1173; 115, YY1191, Th.
275. Tchihatchewia isatidea Boiss. / allıgelin; 111, YY1140; 157, YY1780, END., VU., Ir.-Tur. elm., Hc.,
276. Thlaspi arvense L. / ekin dağarcığı; 113, YY1185, Th.
277. T. bornmuelleri (Rchb.f.) Hedge / firenk dağarcığı; 116, YY1212, END., VU., Ir.-Tur. elm., Th., (▲)
278. T. oxyceras (Boiss.) Hedge / sivri dağarcık; 101, YY986, YY996, Hc.,

19. BUTOMACEAE / BATAKLIKGÜLÜGİLLER

279. Butomus umbellatus L. / bataklıkgülü; 171, YY2135, Eu.-Sib. elm., Cr.(Hd.),

20. CAMPANULACEAE / ÇANÇİÇEĞİGİLLER

280. Asyneuma amplexicaule (Willd.) Hand.-Mazz. subsp. ***amplexicaule*** var. ***amplexicaule*** / hoşdeğnek; 174, YY2203, Hc.,
281. A. amplexicaule (Willd.) Hand.-Mazz. subsp. ***aucheri*** (A.DC.) Bornm. / süslü değnek; 167, YY2021, Ir.-Tur. elm., Hc.,
282. A. eximium Rech.f. /düldüldeğneği; 65, YY763, END., NT., E. Medit.(mt) elm., Hc., (▲)
283. A. filipes (Nábelek) Damboldt / yayladeğneği; 65, YY769; 130, YY1516, Ir.-Tur. elm., Hc.,
284. A. linifolium (Boiss. & Heldr.) Bornm. subsp. ***linifolium*** / tavşanekmeği;126, YY1455, 130, YY1509, END., LC., E. Medit.(mt) elm., Hc.,
285. A. rigidum (Willd.) Grossh. subsp. ***rigidum*** / nujdan; 171, YY2140, Ir.-Tur. elm., Hc.,
286. Campanula glomerata L. subsp. ***hispida*** (Witasek) Hayek / yumak çanı; 167, YY2020; 174, YY2215, Hc.,
287. C. involucrata Aucher ex A.DC. / sarım çanı; 43, YY362; 122, YY1364, Hc.,
288. C. propinqua Fisch. & C.A.Mey. / kum çanı; 131, YY1535, Th.
289. C. rapunculoides L. / elmacık; 55, YY636; 167, YY2019, Hc., (▲)
290. C. saxonorum Gand. / ince çıngırak; 30, YY246; 50, YY540, END., LC., Th.
291. C. sclerotricha Boiss. / dere çıngırağı; S61, YY709, Ir.-Tur. elm., Hc.
292. C. stevenii M.Bieb. subsp. ***beauverdiana*** (Fomin) Rech.f. & Schiman-Czeika / benli çan; 110, YY1135; 162, YY1902, Ir.-Tur. elm., Hc.,
293. C. stricta L. var. ***stricta,*** / gül çançiçeği; 65, YY777; 174, YY2212, Hc.
294. Legousia falcata (Ten.) Fritsch ex Janch. / eğri kadıaynası; 122, YY1365, Medit. elm., Th.,
295. L. pentagonia (L.) Thell. / kadınaynası, 41, YY330, E. Medit. elm., Th.,

21. CANNABACEAE / KENEVİRGİLLER

296. Celtis tournefortii Lam. / dardağan; 121, YY1361, Fh.,

22. CAPRIFOLIACEAE / HANIMELİGİLLER

297. Centranthus longiflorus Steven subsp. ***longiflorus*** / mahmuzçiçeği; 34, YY276; 45, YY396; 131, YY1536, Ir.-Tur. elm., Cr.,
298. Cephalaria anatolica Shkhiyan / ana pelemir; 65, YY762; 174, END., CR., Ir.-Tur. elm., Hc.,
299. C. procera Fisch. & Avé-Lall. / ganteper; 167, YY2041, Ir.-Tur. elm., Hc.,
300. C. speciosa Boiss. & Kotschy / yıldız pelemiri; 59, YY660; 62, YY744; 166, YY1993, END., LC., Ir.-Tur. elm., Hc.,
301. C. taurica Szabó / kırım pelemiri; 52 , YY575, 64, YY755, END., VU., E. Medit. elm., Hc., (▲)
302. Dipsacus laciniatus L. / fesçitarağı; 165, YY1977, Hc.
303. Lonicera iberica M.Bieb. / dadaş hanımeli; 164, YY1930, YY1931, Hyrcano-Eux. elm., Fh., (▲)
304. L. nummulariifolia Jaub. & Spach subsp. ***nummulariifolia*** / tavşançili; 70, YY813, Fh., (▲)
305. L. orientalis Lam. / has çakkana; 20, YY148, END., LC., Fh.,
306. Pterocephalus plumosus (L.) Coult. / gök cücükotu; 44, YY367, Hc.,
307. Scabiosa argentea L. / yazı süpürgesi; 103, YY2069, Hc.,
308. S. persica Boiss. / acem zivanı; 120 YY1334, Ir.-Tur. elm., Th.,
309. S. rotata M.Bieb. / top uyuzotu; 116, YY1259, Ir.-Tur. elm., Th.,
310. Valeriana discoridis Sm. / çobanzurnası; 11, YY49; 32, YY262; 102, YY1028; 157, YY1773, E. Medit. elm., Cr.,
311. Valerianella coronata (L.) DC. / taçlı kuzugevreği; 50, YY523; 142, YY1860, Th.,
312. V. dactylophylla Boiss. & Hohen. / el kuzugevreği; 24, YY189, 113, YY1184; 119, YY1327, Ir.-Tur. elm., Th.
313. V. turgida (Steven) Betcke / yar kuzugevreği; 6, YY25a, Th.
314. V. uncinata (M.Bieb.) Dufr. / ender kuzugevreği; 159, YY1806, Ir.-Tur. elm., Th.,
315. V. vesicaria (L.) Moench / kuzugevreği; 24, YY183; 41, YY333; 43, YY354; 111, YY1169; 125, YY1384, Th.,

23. CARYOPHYLLACEAE / KARANFİLGİLLER

316. Agrostemma githago L. / buğday karamuğu; 30, YY237; 164, YY1920, Th.
317. Arenaria serpyllifolia L. subsp. ***serpyllifolia*** / tarla kumotu; 41, YY332; 45, YY387; 160, YY1838, Th.
318. Bufonia oliveriana Ser. / dicle hatunotu; 65, YY761, Th.,
319. B. tenuifolia L. / hatunotu; 53, YY627, Th.,
320. B. virgata Boiss. / tel hatunotu; 73, YY840; 131, YY1537; 133, YY1565, Th.,
321. Cerastium cerastoides (L.) Britton / yumak boynuzotu; 1, YY 04, Th.,
322. C. dichotomum L. subsp. ***dichotomum*** / çatal boynuzotu; 6, YY29, Th.
323. C. dubium (Bastard) O.Schwarz / mızrak boynuzotu; 99, YY956, 143, YY1650, Th.,
324. C. glomeratum Thuill. / boynuzotu; 13, YY64, Th.
325. C. perfoliatum L. / ekin boynuzotu; 134, YY1569, Th.
326. Dianthus crinitus Sm. var. ***crinitus*** / uzunçanak; 62, YY738, Hc.,
327. D. floribundus Boiss. / kırk karanfil; 174, YY2201, Ir.-Tur. elm., Hc.,
328. D. masmenaeus Boiss. var. ***masmenaeus*** / etek karanfili; 59, YY 661; 62, YY737, END., LC., Ir.-Tur. elm., Hc.,
329. D. masmenaeus Boiss. var. ***glabrescens*** Boiss. / etek karanfili; 130, YY1518; 173, YY2168, END., LC., Ir.-Tur. elm., Hc.,
330. D. orientalis Adams / yar karanfili; 71, YY824; 124, YY1370, Hc.,
331. Eremogone acutisepala Hausskn. ex F.N.Williams / eğin kumotu; 166, YY1997, END., LC., Ir.-Tur. elm., Hc., (▲)
332. E. cucubaloides Sm. / çayır kumotu; 157, YY1775, Ir.-Tur. elm., Hc.
333. E. gypsophiloides (L.) Fenzl / çöven kumotu; 117, YY1278; 162, YY1886, Ir.-Tur. elm., Hc.
334. Gypsophila elegans M.Bieb. / hoş çöven; 49, YY497; 121, YY1351, Ir.-Tur. elm., Th.,
335. G. hispida Boiss. / kıllı çöven; 167, YY2048, Ir.-Tur. elm., Hc.,
336. G. pallida Stapf / şark çöveni; 168, YY2056, Ir.-Tur. elm., Hc.,
337. G. ruscifolia Boiss. / acem çöveni; 131, YY1540, Ir.-Tur. elm., Hc.
338. Herniaria glabra L. / atyaran; 42, YY344; 174, YY2171, Th.,
339. H. incana Lam. / kabayaran; 126, YY1437a; 174, YY2172, Hc.,
340. Holosteum umbellatum L. subsp. ***umbellatum*** / şeytan küpesi; 14, YY68, Th.,
341. Minuartia hamata (Hausskn.) Mattf. / koruotu; 6, YY25b; Th.
342. M. juniperina (L.) Maire & Petitm. / hanım şiltesi; 144, YY1343; Ch.
343. M. meyeri (Boiss.) Bornm. / koza tıstısı; 119, YY1318; Ir.-Tur. elm., Th.
344. Moenchia mantica (L.) Bartl. subsp. ***mantica*** / dördüz otu; 25, YY 193a, Th.,
345. Paronychia kurdica Boiss. subsp. ***kurdica*** var. ***kurdica*** / boz kepekotu; 133, YY1564, Hc.,
346. Petrorhagia alpina (Hablitz) P.W.Ball & Heywood subsp. ***olympica*** (Boiss.) P.W.Ball & Heywood / yaylaferacesi, 174, YY2180, Th.,
347. P. cretica (L.) P.W.Ball & Heywood / ada zarçiçeği; 45, YY386, Th.,
348. Saponaria viscosa C.A.Mey. / şenak; 61, YY689, Ir.-Tur. elm., Th.,
349. Scleranthus perennis L. subsp. ***marginatus*** (Guss.) Nyman / kaz kınavel; 133, YY1563, Hc.,
350. S. uncinatus Schur, 124, YY1372, Th.,
351. Silene ampullata Boiss. / hoş kıyışak;118, YY1299, Ir.-Tur. elm., Hc.,
352. S. capitellata Boiss. / kavuklu nakıl; 119, YY1309, END., LC., Ir.-Tur. elm., Hc.,
353. S. chlorifolia Sm. / puşkullu; 48, YY488, Ir.-Tur. elm., Hc.
354. S. compacta Fisch. ex Hornem. / kanlıbasıra otu; 129, YY1495, Hc.
355. S. conoidea L. / şıvananotu; 150, YY1710, Th.,
356. S. hamzaoglui Budak. / yağız nakıl; 110, YY1138; 116, YY1202;152, YY1781, END., CR., Hc.
357. S. latifolia Poir. subsp. ***alba*** (Miller) Greuter & Burdet / gıcıgıcı; 55, YY632; 144, YY1339; 126, YY1458, Hc.
358. S. latifolia Poir. subsp. ***ericalicyna*** (Boiss.) Greuter & Burdet / gıcıme; 171, YY2145, Hc.
359. S. longipetala Vent. / ballı süpürge; 25, YY193; 162, YY1890, Ir.-Tur. elm., Hc.
360. S. spergulifolia (Desf.) M.Bieb. / ana nakıl; 11, YY53, 109, YY1109, Ir.-Tur. elm., Hc.
361. S. vulgaris (Moench) Garcke var. ***vulgaris*** / ecibücü; 15, YY92; 48, YY484; 158, YY1791, Hc.
362. Stellaria holostea L. / urgancık; 164, YY1924, Eu.-Sib. elm., Hc.
363. S. kotschyana Fenzl ex Boiss. / zarif kuşotu; 126, YY1433, Hc.
364. S. media (L.) Vill. / kuşotu; 14, YY81; 124, YY1375, Th.
365. S. neglecta (Weihe) Gremli / yavşu; 134, YY1579a, Th.
366. S. pallida (Dumort.) Pire. / kuşmak; 134, YY1580, Th.
367. Telephium oligospermum Steud. ex Boiss. / kaya zulzulası; 126, YY1427, Ir.-Tur. elm., Hc.
368. Vaccaria hispanica (Mill.) Rauschert / ekin ebesi; 116, YY1222, Th.
369. Velezia rigida L. / tığotu; 46, YY417; 47, YY432, Th.

24. CERATOPHYLLACEAE / SUBOYNUZUGİLLER

370. Ceratophyllum submersum L. / suboynuzu; 171, YY2131 Eu.-Sib. elm., Cr.(Hd.), (▲)

25. CISTACEAE / LADENGİLLER

371. Helianthemum ledifolium (L.) Mill. / kuru güngülü; 35, YY289, Th.
372. H. microcarpum Coss. ex Boiss. / çalı güngülü; 50, YY550; 116, YY1235, Th.

26. COLCHICACEAE / ACIÇİĞDEMGİLLER

373. Colchicum falcifolium Stapf, 77, YY855; 79, YY863; 139, YY1600, Ir.-Tur. elm., Cr.
374. C. szovitsii Fisch. & C.A.Mey. subsp. ***szovitsii*** / katır çiğdemi; 98, YY844; 141, YY1611, Ir.-Tur. elm., Cr.

27. CONVOLVULACEAE / TARLASARMAŞIĞIGİLLER

375. Convolvulus arvensis L. / tarla sarmaşığı; 50, YY462; 52, YY587, Th.
376. C. betonicifolius Mill. subsp. ***peduncularis*** (Boiss.) Parris / büyük yayılgan; 92, YY411, 50, YY539, Ir.-Tur. elm., Hc.,
377. C. carduchorum P.H.Davis / yapıkotu; 126, YY1421; 174, YY2189a, END., LC., Ir.-Tur. elm., Hc.,
378. C. galaticus Rost. ex Choisy / boz sarmaşık; 92, YY434, Ir.-Tur. elm., Hc.,
379. C. lineatus L. / top yayılgan; 116, YY1243, Hc.,
380. Cuscuta campestris Yunck. / kafirsaçı; 64, YY760a, Th.,

28. CORNACEAE / KIZILCIKGİLLER

381. Cornus sanguinea L. subsp. ***australis*** (C.A.Mey.) Jáv. / kansiğdiren; 163, YY1910, Eu.-Sib. elm., Fh., (▲)

29. CRASSULACEAE / DAMKORUĞUGİLLER

382. Hylotelephium telephium (L.) H.Ohba / mandakulağı; 69, YY801, Eu.-Sib. elm., Hc.,
383. Rosularia radiciflora (Steud.) Boriss. subsp. ***glabra*** (Boiss.) Chamberlain & Muirhead / bodur kayakoruğu; 124, YY1377, Ir.-Tur. elm., Hc.
384. Sedum album L. / çobankavurgası; 110, YY1127, Hc.
385. S. pallidum M.Bieb. / koyunörmece; 47, YY464, Eux. elm., Th.,
386. S. tenellum M. Bieb. / narin damkoruğu; 109, YY1123, Hc.
387. Umbilicus luteus (Huds.) Webb & Berthel. / sarı göbekotu; 109, YY1111, 110, YY1128, Cr.

30. CYPERACEAE / HASIROTUGİLLER

388. Bolboschoenus laticarpus Marhold / çapılotu; 159, YY1799, Hc.(Hd.).
389. B. maritimus (L.) Palla subsp. ***maritimus*** / sandalyesazı; 37, YY301; 127, YY1473, Hc.(Hd.)
390. Carex distachya Desf. var. ***distachya*** / ikiz ayakotu; 142, YY1621, Medit. elm., Hc.
391. C. divulsa Stokes / ayakotu; 32, YY267, Hc.
392. C. filiformis L. / dalsaparna; 142, YY1624, Eu.-Sib. elm., Hc.,
393. C. hordeistichos Vill., 160, YY1841, Hc.,
394. C. melanostachya M.Bieb. ex Willd. / benli ayakotu; 48, YY475; 151, YY1716; 159, YY1793; 164, YY1934, Hc.,
395. C. pseudocyperus L. var. ***pseudocyperus*** / üçsazotu; 66, YY795, Eu.-Sib. elm., Hc., (▲)
396. C. stenophylla Wahlenb. subsp. ***stenophylloides*** (V.I.Krecz.) T.V.Egorova / çol ayakotu; 1, YY01;142, YY1617, Ir.-Tur. elm., Hc.,
397. Cyperus longus L. subsp. ***longus*** / karatopalak; 61, YY710, Hc.(Hd.),
398. Eleocharis mitracarpa Steud. / feslisaz; 159, YY1802, Hc.(Hd.),
399. Schoenoplectus lacustris (L.) Palla subsp. ***lacustris*** / semerotu; 37, YY297; 127, YY1472, Hc.,

31. ELAEAGNACEAE / İĞDEGİLLER

400. Elaeagnus angustifolia L. var. ***angustifolia*** / iğde; 125, YY1387, Fh.

32. EUPHORBIACEAE / SÜTLEĞENGİLLER

401. Euphorbia cheiradenia Boiss. & Hohen. / şirker; 42, YY349; 119, YY1316; 144, YY1345; 126, YY1460, Ir.-Tur. elm., Hc.
402. E. esula L. subsp. ***tommasiniana*** (Bertol.) Kuzmanov / eşek sütleğeni; 70, YY797; 96, YY934, Hc.
403. E. falcata L. subsp. ***falcata*** var. ***falcata*** / eğri sütleğen; 52, YY604, Th.
404. E. falcata L.subsp. ***macrostegia*** (Bornm.) O.Schwartz / eğri sütleğen; 24, YY186; 53, YY626, E. Medit. elm., Th.
405. E. macroclada Boiss. / neblul; 66, YY789, Ir.-Tur. elm., Hc.,

406. E. orientalis L. / gezer sütleğen; 161, YY1865; 166, YY1991, Ir.-Tur. elm., Hc.
407. E. szovitsii Fisch. & C.A.Mey. var. ***kharputensis*** Aznav. ex M.S. Khan / urus sütleğeni; 44, YY380; 50, YY526, Ir.-Tur. elm., Th.

33. FABACEAE / BAKLAGİLLER

408. Astragalus aduncus Willd. / çengel geven; 15, YY96; 157, YY1756, Ch.
409. A. amblolepis Fisch. / küt geven; 167, YY2046, Ir.-Tur. elm., Ch.,
410. A. anthylloides Pall. / torbalı geven; 108, YY1094; Ir.-Tur. elm., Hc., (▲)
411. A. cf. ***caspicus*** M.Bieb. subsp. ***caspicus*** / hazar geveni; 174, YY2183, Ir.-Tur. elm., Ch., (▲)
412. A. cephalotes Pall. var. ***sintenisianus*** (Eig) Chamb. & Matthews / başlı geven; 126, YY1444, Ch., (▲)
413. A. chamaephaca Freyn / özgeven; 147, YY1684, Ir.-Tur. elm., Hc.,
414. A. christianus L. subsp. ***christianus*** / dallı geven; 143, YY1646, Ch.,
415. A. compactus Lam. subsp. ***compactus*** / guni; 18, YY1298, Ir.-Tur. elm., Ch.,
416. A. diphtherites Fenzl var. ***diphtherites*** / yamaç geveni; 22, YY167, Ir.-Tur. elm., Ch.,
417. A. elongatus (Phil.) Reiche subsp. ***nucleiferus*** (Boiss.) D.F. Chamb. / düğmeli geven; 21, YY165, Hc., (▲).
418. A. fragrans Willd. / mis geven; 117, YY1262; 141, YY1612, Hc.,
419. A. fraxinifolius DC. / batak geveni; 59, YY652, Ir.-Tur. elm., Hc.
420. A. gummifer Labill. / sakızlı geven; 130, YY1521, Ir.-Tur. elm., Ch.
421. A. halicacabus Lam. / sepet geveni; 16, YY115, Ir.-Tur. elm., Hc.
422. A. hamosus L. / koçboynuzu; 102, YY1020; 159, YY1795, Th., (▲)
423. A. lagopoides Lam. / somgeven; 65, YY780; 174, YY2184, Ch.,
424. A. longifolius Lam. / taze geven; 62, YY747, Ir.-Tur. elm., Ch.,
425. A. macrocephalus Willd. subsp. ***finitimus*** (Bunge) D.F.Chamb. / topaç geven; 166, YY2010, Ir.-Tur. elm., Ch.,
426. A. muschianus Kotschy & Boiss. ex Boiss. / muş geveni; 60, YY662, YY665, YY666, YY667; 65, YY782; 126, YY1440, YY1451, 130, YY1522; 160, YY1823; 168, YY2052; 174, YY2209, Ir.-Tur. elm., Ch.,
427. A. oleifolius DC. / deligeven; 60, YY662a, Ir.-Tur. elm., Ch.,
428. A. pendulus DC. / sırık geveni; 108, YY1095; 111, YY1147, 149, YY1704; 156, YY1747, Ir.-Tur. elm., Hc.,
429. A. pinetorum Boiss. subsp. ***pinetorum*** / babadağ geveni; 119, YY1318a, Ch.,
430. A. psoraloides Lam. / Bayburt geveni; 108, YY1082, Ch.,
431. Cicer anatolicum Alef. / nakaçe; 162, YY1885, Ir.-Tur. elm., Hc.
432. C. pinnatifidum Jaub. & Spach / çakıl nohutu; 31, YY258; 163, YY1915, Th.
433. Colutea cilicica Boiss. & Balansa / patlangaç; 169, YY2092, Fh.
434. Genista albida Willd. / ak borcak; 126, YY1422, Ch.
435. Hedysarum varium Willd. subsp. ***syriacum*** (Boiss.) Townsend / şam batalağı; 148, YY1689; 168,YY2061, Ir.-Tur. elm., Hc.,
436. Lathyrus cicera L. / colban; 50, YY544; 102, YY1043, Medit. elm., Th.
437. L. roseus Steven subsp. ***roseus*** / gül mürdümüğü; 27, YY 209, Hyrcano-Eux. elm., Hc.,
438. L. rotundifolius Willd. subsp. ***minuatus*** (M.Bieb. ex Steven) P.H.Davis / hırıgürü; 20, YY152; 23, YY175; 116, YY1224; 149, YY1705, Hc.,
439. L. setifolius L. / büllü baklası; 121, YY1354, Medit. elm., Th.
440. L. sphaericus Retz. / çam burçağı; 106, YY1072, Medit. elm., Th.
441. Lens culinaris Medik. subsp. ***orientalis*** (Boiss.) Hand.-Mazz. / yasmık; 29, YY221; 50, YY543; 102, YY1013, Th.
442. Lotus corniculatus L. var. ***corniculatus*** / gazalboynuzu; 65, YY774; 126, YY1413; 129, YY1487, Hc.,
443. L. gebelia Vent. var. ***gebelia*** / gül gazalboynuzu; 30, YY248; 40, YY325a; 49, YY501; 108, YY1089, Ir.-Tur. elm., Hc., .
444. Medicago brachycarpa M.Bieb. / küme yonca; 111, YY1158; 116, YY1199, Ir.-Tur. elm., Th.,
445. M. crassipes (Boiss.)E.Small / hançer yoncası; 45, YY388, Ir.-Tur. elm., Th.,
446. M. lupulina L. / bitçikotu; 52, YY606, Hc.,
447. M. minima (L.) Bertal. var. ***minima*** / gurnik; 16, YY117; 47, YY459; 102, YY1011, YY1021, 1044; 159, YY1808; 159, YY1821, Th.,
448. M. monantha (C.A.Mey.) Trautv. / dağ gurniği; 38, YY298; 39, YY312; 40, YY325; YY468, 108, YY1080; 159, YY1811, Ir.-Tur. elm., Th.
449. M. noeana Boiss. / çevrince; 45, YY389, Ir.-Tur. elm., Th.
450. M. orbicularis (L.) Bartal. / paralık; 159, YY1805, Th., (▲)
451. M. radiata L. / hilal yonca; 39, YY310; Ir.-Tur. elm., Th.,
452. M. rigidula (L.) All. subsp. ***cinerascens*** (Jord.) Ponert / kaba yonca; 39, YY315, 111, YY1145; 159, YY1807, Th.
453. M. sativa L. subsp. ***sativa*** / karayonca; 44, YY368; 168, YY2054, Hc.
454. Melilotus albus Desr. / ak taşyoncası; 46, YY429; 170, YY2123, Hc.,
455. M. officinalis (L.) Desr. / kokulu yonca; 125, YY1379, Hc.
456. Onobrychis fallax Freyn & Sint. var. ***fallax*** / yalancı korunga; 49, YY491; 166, YY2009a, END., LC., Ir.-Tur. elm., Hc., (▲)
457. O. vaciifolia Scop. / korunga; 170, YY2126, Hc.
458. Ononis spinosa L. subsp. ***leiosperma*** (Boiss.) Širj. / kayışkıran; 120 YY1336a, Hc.
459. Pisum sativum L. subsp. ***elatius*** (M.Bieb.) Asch. & Graebn. var. ***pumilio*** Meikle / bezelye; 17, YY130; 49, YY490, Th.
460. Securigera orientalis (Mill.) Lassen var. ***orientalis*** /ala körigen; 15, YY95; 62, YY734; 111, YY1155; 126, YY1461, Hc.,
461. S. varia (L.) Lassen / körigen; 48, YY482; 50, YY548; 62, YY735, Hc.,
462. Trifolium angustifolium L. / nefel; 25, YY195, Th.,
463. T. arvense L. var. ***arvense*** / tavşanayağı; 47, YY471; 121, YY1350; 161, YY1854, Th.
464. T. campestre Schreb. subsp. ***campestre*** var. ***campestre*** / üçgül; 48, YY478b; 129, YY1499; 161, YY1873, Th.,
465. T. diffusum Ehrh. / koru yoncası; 108, YY1090; 121, YY1348, 148, YY1691; 161, YY1872, Th.,
466. T. hirtum All. / deli yonca; 50, YY535, Medit. elm., Th.,
467. T. nigrescens Viv. subsp. ***petrisavii*** (Clementi) Holmboe / yel üçgülü; 125, YY1389, 129, YY1486; 159, YY1812; 174, YY2229, Th.,
468. T. pauciflorum d'Urv. / sülün üçgülü; 48, YY480; E. Medit. elm., Th.,
469. T. phleoides Willd. / çayır yoncası; 164, YY1963; 164, YY1965, Th.,
470. T. physodes M.Bieb. var. ***physodes*** / meşe üçgülü; 116, YY1223; 164,YY1967, Medit. elm., Hc.,
471. T. pilulare Boiss. / boncuk üçgül; 47, YY469, Th.,
472. T. pratense L. var. ***pratense*** / çayır üçgülü; 15, YY94; 16, YY120; 23, YY179; 61, YY719; 64, YY755a; 125, YY1388, Hc.,
473. T. purpureum Loisel. var. ***purpureum*** / mor üçgül; 162; 163, YY1905, YY1878, E. Medit. elm., Th.,
474. T. repens L.var. ***repens*** / ak üçgül; 160, YY1833, Hc.
475. T. resupinatum L. var. ***resupinatum*** / Anadolu üçgülü; 16, YY116, Th.,
476. T. retusum L. / küçük üçgül; 47, YY458, Th.,
477. T. trichocephalum M.Bieb. / Hemşin üçgülü; 48, YY476, 116, YY1213, Hc.,
478. Trigonella macrorrhyncha Boiss. / boyotu; 116, YY1193, END., LC., Th., (▲)
479. T. spicata Sm. / başak boyotu; 116, YY1198, Th., (▲)
480. T. spruneriana Boiss. / koç boyotu; 116, YY1197, Th.,
481. Vicia anatolica Turrill / yılan fiği; 27, YY207, Ir. -Tur. el.,Th.,
482. V. cracca L. subsp. ***cracca*** / kuş fiği; 30, YY257, Eu.-Sib. elm., Hc.,
483. V. cuspidata Boiss. / ege baklası; 11, YY58; 99, YY962, E. Medit. elm., Th.,
484. V. galilaea Plitmann & Zohary / deli culban; 32, YY264; 102, YY1042, Th.,
485. V. lathyroides L. / çamfiği; 142, YY1622; Th.,
486. V. noeana Boiss. var. ***noeana*** / salkım bakla; 102, YY1030b, Ir.-Tur. elm., Th.,
487. V. peregrina L. / kavli; 148, YY1692, Th., (▲)
488. V. sativa L. subsp. ***nigra*** (L.) Ehrh. var. ***nigra*** / eşek gürülü; 164, YY1927, Th.,
489. V. sativa L. subsp. ***nigra*** (L.) Ehrh. var. ***segetalis*** (Thuill.) Ser. ex DC. eşek gürülü; 27, YY208; 49, YY500, Th.,
490. V. sericocarpa Fenzl var. ***sericocarpa*** / çitfiği; 102, YY1030a, Th.,

34. FAGACEAE / KAYINGİLLER

491. Quercus libani G.Olivier / Lübnan meşesi; S61, YY690; 65, YY784; 131, YY1539; 132, YY1558; 158, YY1782; Ir.-Tur. elm., Fh.,
492. Q. petraea (Matt.) Liebl. subsp. ***pinnatiloba*** (K.Koch) Menitsky / koca pelit; S61, YY713, YY714; 70, YY812; 131, YY1538; 132, YY1559; 158, YY1783; 166, YY2001, END., LC., Fh.,
493. Q. robur L. subsp. ***pedunculiflora*** (K.Koch) Menitsky / Akmeşe; 61, YY715, YY716, Ir.-Tur. elm., Fh.,

35. GENTIANACEAE / GENTİANGİLLER

494. Centaurium erythraea Rafn subsp. ***turcicum*** (Velen.) Melderis / tukulotu; S61, YY704, Th.,

36. GERANIACEAE / TURNAGAGASIGİLLER

495. Erodium cicutarium (L.) L'Hér. subsp. ***cicutarium*** / iğnelik; 6, YY26; 134, YY1573, Th.,
496. Geranium divaricatum Ehrh. / çatal ıtır; 153, YY1726, Th.,
497. G. libanoticum Schenk / pelgizer; 90, YY917; 92, YY923; 98, YY950, Cr.,
498. G. molle L. / yumuşak ıtır; 70, YY815, Th.
499. G. pyrenaicum Burm.f. / gelin çarşafı; 15, YY90; 52, YY589, Hc.,
500. G. rotundifolium L. / helilok; 20, YY144, Th.,

37. HYPERICACEAE / KANTARONGİLLER

501. Hypericum amblysepalum Hochst. / kantülçiçeği; 172, YY2143, Ir.-Tur. elm., Hc.
502. H. armenum Jaub. & Spach subsp. ***armenum*** / güneşotu; 117, YY1270; 126, YY1441; 173, YY2165, Ir.-Tur. elm., Hc.,
503. H. lydium Boiss. / cayesanciyan; 36, YY291, Hc.
504. H. lysimachioides Boiss. & Noë subsp. ***lysimachioides*** / eğin kantaronu; 48, YY483; 164, YY1947; 167, YY2045a, Ir.-Tur. elm., Hc.
505. H. perforatum L. subsp. ***veronense*** (Schrank) H. Linb. / sarı kantaron; 170, YY2124, Hc.,
506. H. scabrum L. / karahasançayı; 34, YY279; 117, YY1273, Ir.-Tur. elm., Hc.,
507. H. tetrapterum Fr. var. ***tetrapterum*** / çizgili kantaron; 61, YY702, Hc.,

38. IRIDACEAE / SÜSENGİLLER

508. Crocus biflorus Mill. subsp. ***tauri*** (Maw) B.Mathew berfan; 74, YY843; 75, YY848; 77, YY856; 78, YY860; 79, YY862; 82, YY871; 85, YY883, 87, YY899; 89, YY910; 141, YY1610, Ir.-Tur. elm., Cr.,
509. C. pallasii Goldb. subsp. ***turcicus*** B.Mathew / çitvan; 73, YY836; 175, YY2234, Cr.,
510. Gladiolus illyricus W.D.J.Koch / osman çiçeği; 24, YY185; 25, YY196; 108, YY1098; 119, YY1304, Medit. elm., Cr., (▲)
511. Iris caucasica Hoffm. subsp. ***turcica*** B.Mathew / türk navrozu; 18, YY126; 28; 103, YY1048, 109, YY1114; 154, YY1731, Ir.-Tur. elm., Cr.,
512. I. persica L. / buzala; 82, YY879, Ir.-Tur. elm., Cr.,

513. I. reticulata M.Bieb. var. ***reticulata*** / kara körpeze; 81, YY868; 89, YY911; 140, YY1604, Ir.-Tur. elm., Cr.,

39. IXIOLIRIACEAE / KÖPEKOTUGİLLER

514. Ixiolirion tataricum (Pall.) Schult. & Schult f. var. ***tataricum*** / köpekotu; 16, YY122, **VU.**, Ir.-Tur. elm., Cr.

40. JUGLANDACEAE / CEVİZGİLLER

515. Juglans regia L. / ceviz; 61, YY724, Fh.

41. JUNCACEAE / HOFAGİLLER

516. Juncus articulatus L. subsp. ***articulatus*** / camışotu; 62, YY736, Eu.-Sib. elm., Hc.,

517. J. bufonius L. / kamır; 160, YY1837, Hc.,

518. J. inflexus L. subsp. ***inflexus*** / sazak;129, YY1489, Hc.,

42. LAMIACEAE / BALLIBABAGİLLER

519. Acinos rotundifolius Pers., 29, YY231; 43, YY365; 116, YY1245, Th., .

520. Ajuga chamaepitys (L.) Schreb. subsp. ***chia*** (Schreb.) Arcang. / acıgıcı; 156, YY1743, Hc.

521. A. chamaepitys (L.) Schreb. subsp. ***laevigata*** (Boiss.) P.H.Davis / kelmayasıl; 30, YY239; 118, YY1284, Ir.-Tur. elm., Hc.

522. A. salicifolia (L.) Schreb. / sivrimayasıl; 22, YY170, 116, YY1203; 156, YY1746, Ir.-Tur. elm., Hc.,

523. Ballota nigra L. subsp. ***kurdica*** P.H.Davis / mor nemnem; 174, YY2173, Ir.-Tur. elm., Hc.,

524. Clinopodium vulgare L. subsp. ***arundanum*** (Boiss.) Nyman / kamış fesleğen; 52, YY580; 55, YY638; 60, YY673; 129, YY1488, Hc.,

525. Lallemantia iberica (M.Bieb.) Fisch. & C.A.Mey. /ajdarbaşı; 7, YY30; 24, YY191, 144, YY1340; 148, YY1694, Ir.-Tur. elm., Th.,

526. L. peltata (L.) Fisch. & C.A.Mey. / kalkanbaşı; 119, YY1305; 164, YY1925, Ir.-Tur. elm., Th.,

527. Lamium album L. subsp. ***albüm*** / balıcak; 8, YY34, Eu.-Sib. elm., Hc.

528. L. amplexicaule L. var. ***amplexicaule*** / baltutan; 15, YY71; 78, YY858; 80, YY866; 101, YY1006; 138, YY1593, Th.

529. L. garganicum L.subsp. ***striatum*** (Sm.) Hayek var. ***striatum*** / tel balıcak; 19, YY137; 109, YY1101, Medit. elm., Hc.,

530. L. purpureum L. var. ***purpureum*** / ballıbaba; 15, YY72, Eu.-Sib. elm., Th.,

531. Marrubium astracanicum Jacq. subsp. ***astracanicum*** / mor yayotu; 117, YY1263, 144, YY1347, Hc.

532. M. parviflorum Fisch. & C.A.Mey. subsp. ***parviflorum*** / bozotu; 30, YY247, Ir.-Tur. elm., Hc.

533. Melissa officinalis L.subsp. ***inodora*** Born. / anababakokusu; 52, YY568; 167, YY2022, Medit. elm., Hc.,

534. Mentha longifolia (L.) L. subsp. ***typhoides*** (Briq.) Harley / dere nanesi; 52, YY572; S61, YY701, Hc.,

535. Nepeta nuda L. subsp. ***albiflora*** (Boiss.) Gam / karaküncü; 122, YY1363; 124, YY1373; 167, YY2028, Hc.

536. N. stenantha Kotschy & Boiss. / nezleotu; 110, YY1129, Ir.-Tur. elm., Hc.

537. N. trachonitica Post / kızıl pisikotu; 46, YY437, Ir.-Tur. elm., Hc., (▲)

538. Phlomis armeniaca Willd. / boz şavlak; 130, YY1520, Ir.-Tur. elm., Hc.,

539. P. kurdica Rech.f. / gubel; 174, YY2188, Ir.-Tur. elm., Hc.,

540. P. pungens Willd. var. ***hirta*** Velen. / silvanok; 167, YY2035, Hc.,

541. P. rigida Labill. diri çalba; 165, YY1973; 173, YY2169, Ir.-Tur. elm., Hc.,

542. Prunella vulgaris L. / gelinciklemeotu; 170, YY2115, Eu.-Sib. elm., Hc.,

543. Salvia brachyantha (Bordz.) Pobed. subsp. ***brachyantha*** / kazan şalbası; 61, YY718; 108, YY1084; 168, YY2051, Ir.-Tur. elm., Hc.,

544. S. frigida Boiss. / sağır şalba; 128, YY1479; 170, YY2127, Ir.-Tur. elm., Hc.

545. S. microstegia Boiss. & Balansa / yağlambaç; 29, YY228; 121, YY1355; 148, YY1701, Ir.-Tur. elm., Hc.,

546. S. multicaulis Vahl / kürt reyhanı; 20, YY157; 22, YY169; 99, YY964; 108, YY1088, 109, YY1105, 119, YY1321, Ir.-Tur. elm., Ch.,

547. S. nemorosa L. / gehareş; 49, YY498, Ir.-Tur. elm., Hc.

548. S. poculata Nábelek / küllü şalba; 109, YY1110; 118, Ir.-Tur. elm., Hc.

549. S. sclarea L. / paskulak; 50, YY514; 167, YY2026, Hc.,

550. S. staminea Montbret & Aucher ex Benth. / erkek şalba; 60, YY685; 126, YY1419; 173, YY2163, Ir.-Tur. elm., Hc.,

551. S. suffruticosa Montbret & Aucher ex Benth. / kalın şalba; 21, YY160; 35, YY285, 108, YY1099, Ir.-Tur. elm., Hc.,

552. S. syriaca L. / çevlikotu; 22, YY173, Ir.-Tur. elm., Hc.,

553. S. trichoclada Benth. / meşe şalbası; 19,YY138; 116, YY1242; 148, YY1702, Ir.-Tur. elm., Hc.,

554. S. verticillata L. subsp. ***verticillata*** / dadırak; 45, YY395; 46, YY427; 59, YY659; 129, YY1493; 131, YY1534, Eu.-Sib. elm., Hc.,

555. Satureja hortensis L. / çibriska; 45, YY391; 47, YY466; 71, YY831, Th.,

556. Scutellaria megalaspis Rech.f. / koca kaside; 60, YY686, Ir.-Tur. elm., Hc., (▲)

557. S. orientalis L.subsp. ***orientalis*** / sarı kaside; 131, YY1541, Ir.-Tur. elm., Ch.

558. S. orientalis L.subsp. ***alpina*** (Boiss.) O.Schwarz var. ***alpina*** / dağ kasidesi; 157, YY1760, Ch., (▲)

559. S. salviifolia Benth. / has kaside; 39, YY318; 116, YY1230; 163, YY1904, END., LC., Hc., (▲)

560. Sideritis montana L. subsp. ***montana*** / karaçay; 151, YY1722, E. Medit. elm., Th.

561. Stachys annua (L.) L. subsp. ***annua*** var. ***annua*** / hacıosmanotu; 29, YY223; 52, YY586; 52, YY593; 110, YY1132, Hc.

562. S. burgsdorffioides (Benth.) Boiss. subsp. ***burgsdorffioides*** / ekin karabaşı; 46, YY409, Ir.-Tur. elm., Th., (▲)

563. S. iberica M.Bieb. subsp. ***stenostachya*** (Boiss.) Rech f. / benli deliçay; 47, YY453; 126, YY1453; 167, YY2037, Ir.-Tur. elm., Hc.

564. S. kurdica Boiss. & Hohen. var. ***kurdica*** / kara deliçay; 157, YY1757, Ir.-Tur. elm., Hc.,

565. S. lavandulifolia Vahl / tüylü çay; 109, YY1116; 117, YY1272; 119, YY1313, Ch.

566. S. macrostachys (Wender.) Briq. / soğulcan; 174, YY2174, Eux. elm., Hc.,

567. S. mardinensis (Post) R.R.Mill / kaya pungu; 34, YY283; 40, YY324; 124, YY1374, Ir.-Tur. elm., Hc.,

568. Teucrium chamaedrys L. subsp. ***sinuatum*** (Celak.) Rech.f. / sancıotu; 60, YY679; 65, YY770; 126, YY1412; 166, YY2006, Ir.-Tur. elm., Ch.,

569. T. orientale L. var. ***orientale*** / kirveotu; 42, YY350; 50, YY517a; 126, YY1409; 131, YY1532; 131, YY1547, Ir.-Tur. elm., Hc.

570. T. orientale L. var. ***puberulens*** Ekim / kirveotu; 63, YY752, 130, YY1513a; 169, YY2084, Ir.-Tur. elm., Hc.

571. T. polium L. subsp. ***polium*** / acıyavşan; 50, YY534; 131, YY1546, Hc.,

572. Thymus kotschyanus Boiss. & Hohen. var. ***kotschyanus*** / kekik;34, YY277, 126, YY1417; 169, YY2086; 126, YY1399; 126, YY1405, Ir.-Tur. elm., Ch.

573. T. transcaucasicus Ronniger / kır kekiği; 48, YY481; 52, YY570, **VU.**, Ch.,

574. Ziziphora capitata L. anuk;, 157, YY1759a, Th.

575. Z. clinopodioides Lam. / dağ reyhanı; 130, YY1526, Ir.-Tur. elm., Hc.,

43. LENTIBULARIACEAE / SUMİĞFERİGİLLER

576. Utricularia australis R.Br. / durgun sumiğferi; 171, YY2132, Eu.-Sib. elm., Cr.(Hd.), (▲)

44. LILIACEAE / ZAMBAKGİLLER

577. Fritillaria assyriaca Baker subsp. ***melananthera*** Rix / mut lalesi; 145, YY1673, END., EN., E. Medit. elm., Cr., (▲)

578. F. pinardii Boiss. / mahcup lale; 97, YY946, 99, YY976, 101, YY1000, Ir.-Tur. elm., Cr.,

579. Gagea bulbifera (Pall.) Salisb. / düğmeli yıldız; 146, YY1674, Eu.-Sib. elm., Cr.

580. G. chanae Grossh. / çan yıldızı; 84, YY882, DD., Ir.-Tur. elm., Cr., (▲)

581. G. fibrosa (Desf.) Schult. & Schult.f. / tellisarı; 142, YY1625, Cr., (▲)

582. G. luteoides Stapf / altınyıldız; 1, YY03; 5 YY18; 87, YY901; 91, YY922; 138, YY1595; 140, YY1601, Cr.,

583. G. peduncularis (C.Presl) Pascher / karga sarımsağı; 134, YY850,Medit. elm., Cr.,

584. G. reticulata (Pall.) Schult. & Schult.f. / ağ yıldızı; 89, YY907b; 101, YY1007, Ir.-Tur. elm., Cr.,

585. G. villosa (M.Bieb.) Sweet var. ***villosa*** / tüylü yıldız; 134, YY847; Medit. elm., Cr.,

586. Tulipa armena Boiss. var. ***armena*** / dağ lalesi; 6, YY20; 30, YY250, YY939, 98, YY953, Ir.-Tur. elm., Cr.,

45. LINACEAE / KETENGİLLER

587. Linum mucronatum Bertol. subsp. ***mucronatum*** / sarı keten; 34, YY284; 116, YY1258, 117, YY1271; 121,YY1358, Ir.-Tur. elm., Hc.

588. L. mucronatum Bertol. subsp. ***armenum*** (Bordz.) P.H.Davis / sarıkamış keteni; 49, YY510, 168, YY2057, Ir.-Tur. elm., Hc.

589. L. nodiflorum L. / yaban keten; 22, YY171; 148, YY1690; 159, YY1804, Medit. elm., Th.,

590. L. triflorum P.H.Davis / üç keten; 117, YY1264, END., VU., Ir.-Tur. elm., Hc.,

46. MALVACEAE / EBEGÜMECİGİLLER

591. Alcea apterocarpa Boiss. / gülfatma; 65, YY768, 130, YY15011; 169, YY2076, Ir.-Tur. elm., Hc.,

592. A. calvertii (Boiss.) Boiss. / hıraçiçeği; 53, YY619, Ir.-Tur. elm., Hc.,

593. Malva neglecta Wallr. / çoban çöreği; 26, YY198; 169, YY2074, Th.,

47. OLEACEAE / ZEYTİNGİLLER

594. Fraxinus angustifolia Vehl subsp. ***angustifolia*** / sivri dişbudak; 61, YY687, YY717, YY721, 173, YY2161, Fh.,

595. F. angustifolia Vehl subsp. ***oxycarpa*** (Willd.) Franco & Rocha Afonso Anadolu dişbudağı; 61, YY727, Eu.-Sib. elm., Fh., (▲)

48. ONAGRACEAE / YAKIOTUGİLLER

596. Epilobium angustifolium L. / yakıotu; 59, YY657, Hc.,

597. E. montanum L. / dağ yakısı; 61, YY706, Eu.-Sib. elm., Hc., (▲)

598. E. roseum (Schreb.) Schreb. subsp. ***subsessile*** (Boiss.) P.H.Raven / üç eşekgülü; 56, YY643, Cr., (▲)

49. ORCHIDACEAE / SALEPGİLLER

599. Cephalantera damasonium (Mill.) Druce / ormankuşçuğu; 156, YY1753a, Eu.-Sib. elm., Cr.,

600. C. kotschyana Renz & Taubenheim / koç salebi; 116, YY1196; 157, YY1779; 164, YY1918, END., LC., Cr.,

601. C. rubra (L.) Rich. / çamçiçeği; 116, YY1192, Cr., (▲)

602. Dactylorhiza osmanica (Klinge) P.F.Hunt & Summerh. var. ***anatolica*** (E.Nelson) Renz & Taubenheim / osmanlı salebi; 61, YY696, END., NT., Ir.-Tur. elm., Cr.

603. D. osmanica (Klinge) P.F.Hunt & Summerh. var. ***osmanica*** / osmanlı salebi; 113, YY1182; 118, YY1297, END., LC.,Ir.-Tur. elm.,? Cr.

604. Ophrys oestrifera M.Bieb subsp. ***oestifera*** / sinek salebi; 21, YY166; 116, YY1201, Cr.,

605. O. reinholdii Spruner ex Fleischm. subsp. ***straussii*** (H.Fleischm.) E.Nelson / sidikli salep; 35, YY288, Ir.-Tur. elm., Cr.

606. Orchis coriophora L. subsp. ***coriophora*** / pirinççiçeği; 116, YY1252; 118; 161, YY1855, Cr.
607. O. palustris Jacq. subsp. ***palustris*** / çayır salebi; 31, YY253; 111, YY1142; 151, YY1717, Cr.
608. O. punctulata Steven ex Lindl. / selef; 92, YY927, 116, YY1205, E. Medit. elm.,? Cr.,

50. OROBANCHACEAE /CANAVAROTUGİLLER

609. Bungea trifida (Vahl) C.A.Mey. / üç kernekotu; 156, YY1739, Ir.-Tur. elm., Hc.
610. Melampyrum arvense L. var. ***arvense*** / inek buğdayi; 156, YY1740, Eu.-Sib. elm., Th.,
611. M. arvense L.var. ***elatius*** Boiss. / inek buğdayi; 52, YY616, END., LC., Eux. elm., Th.,
612. Orobanche aegyptiaca Pers. / dinlendiren; 25, YY194; 50, YY549, Th.,
613. O. kurdica Boiss. & Hausskn. / şark baklakıranı; 102, YY1017, Ir.-Tur. elm., Th.
614. O. minor Sm. / güveotu; 174, YY2208, Th., (▲)
615. Parentucellia latifolia Caruel subsp. ***flaviflora*** (Boiss.) Hand.-Mazz. sarı üçdilotu; 157, YY1763, Th.
616. Pedicularis comosa L. var. ***acmodonta*** (Boiss.) Boiss. / hotozlu bitotu; 36, YY293, Hc.
617. Phelypaea tournefortii Desf. / ayıparmağı; 20, YY155; 110 m, YY1137, Ir.-Tur. elm., Hc.

51. PAEONIACEAE / AYIGÜLÜGİLLER

618. Paeonia arietina G.Anderson / şakayık; 174, YY2219, Hc.

52. PAPAVERACEAE / HAŞHAŞGİLLER

619. Corydalis oppositifolia DC. subsp. ***oppositifolia*** / ipar kazgası; 82, YY874; 87, YY898; 89, YY906; 101, YY1003; 141, YY1605, END., LC., Cr.,
620. Fumaria asepala Boiss. ak şahtere; 11, YY 55, Ir.-Tur. elm., Th.
621. F. officinalis L. subsp. ***officinalis*** / şahtere; 15, YY 89; 27, YY 206; 134, YY1576, Th.
622. Papaver dubium L. subsp. ***dubium*** / köpekyağı; 111, YY1148, Th.,
623. P. fugax Poir. var. ***fugax*** / gelingülü; 44, YY379, Hc.,
624. P. macrostomum Boiss. & A.Huet. / minimitçe; 26, YY 202; 49, YY493; 116, YY1249; 125, YY1381; 162, YY1899, Ir.-Tur. elm., Th.,
625. Roemeria hybrida (L.) DC. subsp. ***hybrida*** / pıtpıtotu; 108, YY1096, Th.,

53. PLANTAGINACEAE / SİNİROTUGİLLER

626. Anarrhinum orientale Benth. süpürgeotu; 121, YY1353, Ir.-Tur. elm., Hc.,
627. Globularia trichosantha Fisch. & C.A.Mey. subsp. ***trichosantha*** / köse yaylımı; 97, 145, YY1668, Ir.-Tur. elm.,? Hc.,
628. Linaria chalepensis (L.) Mill. var. ***chalepensis*** / halep nevruzotu; 161, YY1875, E. Medit. elm., Th.,
629. L. corifolia Desf. / tarla nevruzotu; 116, YY1194, END., LC., Ir.-Tur. elm., Hc.,
630. L. genistifolia (L.) Mill. subsp. ***genistifolia*** / som nevruzotu; 62, YY730, Eu.-Sib. elm., Hc.,
631. L. kurdica Boiss. & Hohen. subsp. ***kurdica*** / sarı nevruzotu; 29, YY232; 49, YY513, Ir.-Tur. elm., Hc.,
632. L. kurdica Boiss. & Hohen. subsp. ***pycnophylla*** (Boiss. & Bal.) P.H.Davis / körpe nevruzotu; 65, YY764, Ir.-Tur. elm., Hc.,
633. L. pelisseriana (L.) Mill. mor nevruzotu; 20, YY141, Medit. elm., Th.,
634. Plantago lanceolata L. / damarlıca; 15, YY109; 102, YY1027, Hc.,
635. P. major L. subsp. ***intermedia*** (Gilib.) Lange / yedidamarotu; 127, YY1470, Hc.,
636. Veronica anagallis-aquatica L. / sugedemesi; 159, YY1820, Hc.,
637. V. anagalloides Guss. subsp. ***heureka*** M.A.Fisch. / su camağı; 38, YY309, YY308, Ir.-Tur. elm., Th.,
638. V. arvensis L. / ekinmavişi; 38, YY303, Eu.-Sib. elm., Th.,
639. V. arguteserrata Regel &Schmalh. / kırmavişi;15,YY107, Ir.-Tur. elm., Th.,
640. V. beccabunga L. subsp. ***abscondita*** M.A.Fisch. / camış teresi; 61, YY703, YY705, Ir.-Tur. elm., Th.,
641. V. bozakmanii M.A.Fisch. / bozakman mavişi; 21, YY158, Ir.-Tur. elm., Th.,
642. V. hederifolia L. / baharmavisi; 1, YY02; 14, YY79, Th.
643. V. macrostachya Vahl subsp. ***mardinensis*** (Bornm.) M.A.Fisceh. mardin mavisi; 39, YY314, END., VU., Ir.-Tur. elm., Th.,
644. V. orientalis Mill. var. ***orientalis*** / gözmumcuğu; 144, YY1657, Ch.,
645. V. oxycarpa Boiss. / dere mavişi; 61, YY693, YY700, Ir.-Tur. elm., Hc.,
646. V. polita Fr. / mavişotu; 104, YY1054, Th.,
647. V. poljensis Murb. / acem mavişi; 127, YY1469, Ir.-Tur. elm., Hc.,

54. PLUMBAGINACEAE / KARDİKENİGİLLER

648. Acantholimon acerosum (Willd.) Boiss. subsp. ***brachystachyum*** (Boiss.) Doğan & Akaydın / fızık; 60, YY664, END., LC., Ir.-Tur. elm., Ch.,
649. A. glumaceum (Jaub. & Spach) Boiss. / kavuzlu geven; 65, YY765, Ir.-Tur. elm., Ch.,
650. A. venustum Boiss. var. ***venustum*** / kınalı kirpiotu; 126, YY1463, Ir.-Tur. elm., Ch.,
651. Plumbago europaea L. / kara kına; 53, YY623, Eu.-Sib. elm., Hc.,

55. POACEAE / BUĞDAYGİLLER

652. Aegilops columnaris Zhukovsky / kıl buğday; 30, YY242, Ir.-Tur. elm., Th.
653. A. cylindrica Host / kirpikli ot; 45, YY382, Ir.-Tur. elm., Th.,
654. A. speltoides Tausch subsp. ***ligustica*** (Savign.) Bornm. / ak buğdayaynası; 169, YY2102, Th., (▲)
655. A. triuncialis L. subsp. ***triuncialis*** / üçkılçık; 50, YY527; 50, YY527; 50, YY530, Th.,
656. A. umbellata Zhuk. / hanım buğdayı; 49, YY492, Ir.-Tur. elm., Th.,
657. Alopecurus aequalis Sobol. / kınalı tilkikuyruğu; 66, YY786, 171, YY2136, Eu.-Sib. elm., Th.,
658. A. arundinaceus Poir. / kamış tilkikuyruğu; 26, YY201; 100, YY984, 116, YY1221, Eu.-Sib. elm., Cr.,
659. A. myosuroides Huds. var. ***myosuroides*** / tarla tilkikuyruğu; 14, YY83; 24, YY184; 46, YY422; 134, YY1577, Eu.-Sib. elm., Th.,
660. A. vaginatus (Willd.) Kunth / benekli tilkikuyruğu; 117, YY1265, Cr., (▲)
661. Apera intermedia Hack. / puslu ipekçimi; 47, YY461, Ir.-Tur. elm., Th.,
662. Arrhenatherum palaestinum Boiss. / kırk çayıryulafı; 164, YY1959, E. Medit. elm., Hc.,
663. Brachypodium sylvaticum (Huds.) P.Beauv. / koru kılcanı; 170, YY2110, Eu.-Sib. elm., Hc.,
664. Briza humilis M. Bieb. / kadıdili; 46, YY436; 48, YY487; 116, YY1209, YY1216, YY1218; 158, YY1788, Th.,
665. Bromus danthoniae Trin. subsp. ***danthoniae*** / ibubukotu; 47, YY450; 50, YY546; 126, YY1467, Th.
666. B. danthoniae Trin. subsp. ***pseudodanthoniae*** (Drobow) H.Scholz / yalancı ibubuk; 160, YY1822, Th.
667. B. erectus Huds. / dik brom; 119, YY1308; 150, YY1711, Th.,
668. B. japonicus Thunb. subsp. ***anatolicus*** (Boiss. & Heldr.) Pénzes / aniyeotu; 45, YY384, Th.
669. B. japonicus Thunb. subsp. ***japonicus*** / iyeotu; 46, YY426; 50, YY552; 116, YY1226; 151, YY1720, Th.
670. B. lanceolatus Roth. / kılıç bromu; 46, YY423, Th.,
671. B. scoparius L. / ibibuk ekini; 104, YY1060; 116, YY1208, Th.,
672. B. sterilis L., 49, YY494, 112, YY1171; 164, YY1950, Th.,
673. B. tectorum L. / kır bromu; 151, YY1721, Th.,
674. Calamagrostis pseudophragmites (Haller) Koeler / sazçimi; 18, YY133; 42, YY341; 44, YY366; 45, YY393; 160, YY1832, Eu.-Sib. elm., Hc.,
675. Catabrosa aquatica (L.) P.Beauv. / çipil; 112, YY1176; Cr.
676. Crypsis acuminata Trin. subsp. ***acuminata*** / sivri bakakotu; 68, YY799, Th.,
677. C. alopecuroides (Piller & Mitterp.) Schrad. / dere bakakotu; 66, YY787, Th.,
678. Dactylis glomerata L. subsp. ***hispanica*** (Roth) Nyman / kıllı domuzayrığı; 34, YY280; 49, YY512, Hc.,
679. Echinaria capitata (L.) Desf. / dikenbaşotu; 30, YY235; 102, YY1019, Th.,
680. Echinochloa crus-galli (L.) P.Beauv. / darıcan; 64, YY760b, Th.,
681. Elymus elongatus (Host) Runemark subsp. ***turcicus*** (McGuire) Melderis / puslu putaotu; 43, YY363, Hc.,
682. E. hispidus (Opiz) Melderis subsp. ***hispidus*** / elimotu; 166, YY1989; YY2027, Hc.,
683. E. hispidus (Opiz) Melderis subsp***. barbulatus*** (Schur) Melderis / ılamuk; 47, YY443; 50, YY551; 171, YY2149, Hc.
684. E. panormitanus (Parl.) Tzvelev / koru buğdayı; 172, YY2151, Medit. elm., Hc.,
685. Eragrostis barrelieri Daveau / salkım yulaf; 68, YY800, Th.,
686. Eremopoa multiradiata (Trautv.) Roshev. / dere salkımı; 160, YY1826, Ir.-Tur. elm., Th.,
687. E. altaica (Trin.) Roshev. / dağ salkımı; 42, YY347; 144, YY1337; 160, YY1827; 164, YY1957, Ir.-Tur. elm., Th.,
688. Gaudiniopsis macra (M.Bieb.) Eig subsp. ***macra*** / som yulaf; 116, YY1232, Ir.-Tur. elm., Th.,
689. Glyceria notata Chevall. / kıvrık tatlıçim; 159, YY1800, Hc.,
690. Hordeum bulbosum L. / boncuk arpa; 50, YY555; 164, YY1938, Cr.,
691. Hordeum murinum L. subsp. ***leporinum*** (Link) Arcang. / kılçık arpa; 45, YY400; 50, YY545; 50, YY554; 160, YY1825, Ir.-Tur. elm., Th.,
692. Koeleria macrantha (Ledeb.) Schult. / koca kırnal; 34, YY281; 116, YY1241; 162, YY1894, Hc.,
693. K. nitidula Velen. / köse kırnal; 116, YY1225; 117, YY1269, Hc., (▲)
694. Lolium rigidum Gaudin var. ***rigidum*** / sert çim; 123, YY1367, Th.,
695. Melica persica Kunth subsp. ***inaequiglumis*** (Boiss.) Bor. / kireç inciotu; 49, YY489; 130, YY1504; 161, YY1856, Hc.,
696. Oryzopsis holciformis (M.Bieb.) Hack. var. ***holciformis*** / kadife pirinçotu; 126, YY1425; 116, YY1211, Hc.,
697. Phleum boissieri Bornm. / yayla itkuyruğu; 51, YY562; 116, YY1206; 120 YY1335; 125, YY1392, Ir.-Tur. elm., Th.,
698. P. exaratum Griseb. subsp. ***exaratum*** / meşe itkuyruğu; 33, YY270, YY274, Th.,
699. P. montanum K.Koch subsp. ***montanum*** / dağ itkuyruğu; 55, YY630; 161, YY1847, Hc.,
700. P. montanum C.Koch. subsp. ***serrulatum*** (Boiss.) Dogan / dişlek itkuyruğu; 44, YY372; 174, YY2170, E. Medit. elm., Hc.,
701. Poa araratica Trautv. / ağrı salkımı; 117, YY1275; 162, YY1877, Ir.-Tur. elm., Ch.,
702. P. bulbosa L. / yumrulu salkım; 16, YY108a;117, YY1276, Cr.,
703. P. longifolia Trin. / ipek salkımotu; 153, 1508 m, YY1725, Eux. elm., Cr.,
704. P. pratensis L. / çayır salkımotu; 153, YY1724, Cr.,
705. P. trivialis L. / kaba salkımotu; 111, YY1163; 116, YY1227; 125, YY1382; 151, YY1718; 163, YY1912, Th.,
706. Psathyrostachys fragilis (Boiss.) Nevski / narin arpa; 157, YY1764, Ir.-Tur. elm., Hc.

707. Psilurus incurvus (Gouan) Schinz & Thell. / eğri kuyrukotu; 161, YY1862; 164, YY1943, Th.,
708. Sclerochloa dura (L.) P.Beauv. / mıcırotu; 51, YY563, Eu.-Sib. elm., Th.,
709. Secale cereale L. var. ***ancestrale*** (Zhuk.) Kit Tan / tüylü çavdar; 125, YY1391, END., VU., Hc.,
710. Secale montanum Guss. / dağ çavdarı; 45, YY403; 50, YY521; Hc.,
711. Setaria viridis (L.) P.Beauv. / yeşil sıçansaçı; 73, YY837, Th.
712. Stipa ehrenbergiana Trin. & Rupr. / surguçotu; 119, YY1331, Ir.-Tur. elm., Hc.,
713. Stipa holosericea Trin. / dirgen kılaç; 126, YY1465, Ir.-Tur. elm., Hc.,
714. Taeniatherum caput-medusae (L.) Nevski subsp. ***crinitum*** (Schreb.) Melderis / kılçık arpası; 47, YY445; 50, YY556; Ir.-Tur. elm., Th.
715. Triticum dicoccoides (Körn. ex Asch. & Graebn.) Schweinf / yabani gernik; 165, YY1984, VU., Ir.-Tur. elm., Th., (▲)
716. Ventenata dubia (Leers) Coss. & Durieu / venten otu; 46, YY408; 46, YY415, Th.,
717. Vulpia myuros (L.) C.C.Gmel. / arsız kirpikli çim; 160, YY1839, Th.,
718. V. unilateralis (L.) Stace / yamuk kirpikliçim; 102, YY1047, Th.,

56. POLYGALACEAE / SÜTOTUGİLLER

719. Polygala papilionacea Boiss. / mor sütotu; 35, YY287, Ir.-Tur. elm., Hc.,
720. P. vulgaris L. / sütotu; 116, YY 1204, Eu.-Sib. elm., Hc.

57. POLYGONACEAE / MADIMAKGİLLER

721. Polygonum amphibium L. / yerdeğiştire; 127, YY1468, Cr.,
722. P. arenastrum Boreau / bezmece otu; 68, YY806; 73, YY841, Th.,
723. P. aviculare L. / köyotu; 160, YY1829, Th.,
724. P. cognatum Meisn. / madımak; 14, YY84, Hc.,
725. P. convolvulus L. / yayılgan; 173, YY2153, Hc.,
726. P. polycnemoides C.A.Mey. / harmanotu; 65, YY775, Ir.-Tur. elm., Th.,
727. P. persicaria L. / söğütotu; 51, YY565; 52, YY588, Th.,
728. P. setosum Jacq. subsp. ***setosum*** / ebem ekmeği; 71, YY830, Ir.-Tur. elm., Hc.,
729. Rheum ribes L. / ışgın; 113, YY1177, Ir.-Tur. elm., Cr.,
730. Rumex acetosella L. / kuzukulağı; 7, YY229; 47, YY441; 130, YY1505, Hc.,
731. R. alpinus L. / şortah; 44, YY357; 129, YY1492, Cr.,
732. R. angustifolius Compd. subsp. ***angustifolius*** / taşturşusu; 119, YY1310, Hc.,
733. R. conglsomeratus Murray / ekşikulak; 51, YY559; 165, YY1978, Hc.,
734. R. crispus L. / labada; 162, YY1901; 169, YY2104, Hc.,
735. R. scutatus L. / ekşime; 11, YY54; 62, YY740, Hc.,
736. R. tuberosus L. subsp. ***horizontalis*** (Koch) Rech. / kömeturşusu; 30, YY249; 48, YY486; 52, YY579, Cr.,

58. PORTULACACEAE / SEMİZOTUGİLLER

737. Portulaca oleracea L. / semizotu; 40, YY327a, Th.

59. POTAMOGETONACEAE / SUSÜMBÜLÜGİLLER

738. Potamogeton natans L. / suotu; 171, YY2130, Cr.(Hd.),
739. Stuckenia pectinata (L.) Börner / sutarağı; 171, YY2133, Cr.(Hd.),

60. PRIMULACEAE / ÇUHAÇİÇEĞİGİLLER

740. Anagallis arvensis L. var. ***arvensis*** / farekulağı; 48, YY478a, Th.
741. Androsace maxima L. / tavukkursağı; 1, YY07; 3, YY16; 86, YY894, Th.,
742. Lysimachia vulgaris L. / kargaotu; 56, YY644, Hc.,

61. RANUNCULACEAE / DÜĞÜNÇİÇEĞİGİLLER

743. Adonis aestivalis L. subsp. ***aestivalis*** / kandamlası; 150, YY1713, Th.,
744. A. aestivalis L. subsp. ***parviflora*** (Fisch. ex DC.) N.Busch / kuşlalesi; 161, YY1844,Th.,
745. A. flammea Jacq. cinlalesi; 46, YY420, 148; 150, YY1709, Th.,
746. Ceratocephala falcata (L.) Pers. Yelotu; 5, YY 19; 80, YY867, 138, YY1598, 140, YY1602, Th.,
747. Consolida scleroclada (Boiss.) Schrödinger var***. rigida*** (Freyn & Sint.) P.H.Davis / sertmahmuz; 58, YY648, Ir.-Tur. elm., Th.,
748. Delphinium albiflorum DC. / ak hezaren; 173, YY2166, Hc.,
749. Nigella latisecta P.H. Davis / ekin çörekotu; 46, YY431, Ir.-Tur. elm., Th.
750. N. oxypetala Boiss. / fırat çörekotu; 50, YY537, Ir.-Tur. elm.,Th.
751. Ranunculus arvensis L./ mustafaçiçeği; 105, YY1068, Th.,
752. R. bingoeldaghensis Engin / karaz; 91, YY921; 97, YY945; 99, YY963; 101,YY993, YY994, Ir.-Tur. elm., END., EN., Cr.,
753. R. cuneatus Boiss. / körükotu; 10, YY 46; 92, YY926; 142, YY1616, Hc.,
754. R. illyricus L. subsp. ***illyricus*** / gümüş düğünçiçeği; 158, YY1790, Cr.,
755. R. isthmicus Boiss. subsp. ***stepporum*** P.H.Davis / kır köstebekotu; 9, YY44; 103, YY1049, Cr.,
756. R. kochii Ledeb. / karçiçeği; 82, Y876; 85, YY884, Ir.-Tur. elm., Cr.,
757. R. kotschyi Boiss. / grit lalesi; 1, YY 14; 100, YY980; 143, YY1652, Hc.,
758. R. myosuroides Boiss. & Kotschy / kar yağlıçanağı; 91, YY920; 97, YY944, 141, YY1613, Ir.-Tur. elm., Cr.,
759. R. repens L. / tiktakdana; 94, YY930, Cr.,
760. R. sericeus Banks & Sol. / çınarcık; 159, YY1797, Ir.-Tur. elm., Cr.,
761. R. trichophyllus Chaix ex Vill. / suluçanak; 127, YY1482, Cr.(Hd.),

62. RESEDACEAE / GERDANLIKGİLLER

762. Reseda lutea L. var. ***lutea*** / muhabbetçiçeği; 26, YY204; 111, YY1151; 156, YY1742; 166, YY1985, Hc.

63. ROSACEAE / GÜLGİLLER

763. Alchemilla crinita Buser / yivli keltat; 62, YY733, Hc., (▲)
764. Amygdalus communis L. / badem; 135, YY1584, Fh.
765. Armeniaca vulgaris Lam / kaysı; 170, YY2112, Fh.
766. Cerasus mahaleb (L.) Mill. var. ***mahaleb*** / mahlep; 61, YY722, YY725; 65, YY783; 71, YY825; 142, YY1636; 146, YY1677, Fh.,
767. C. microcarpa (C.A.Mey.) Boiss. subsp. ***tortuosa*** (Boiss. & Hausskn.) Browicz / sarıdağ kieazı; 101, YY988, Ir.-Tur. elm., Fh.,
768. Cotoneaster nummularia Fisch. & C.A.Mey / dağ muşmulası; 71, YY826; 132,YY1557; 162, YY1883; 174, YY2218, Fh.,
769. Crataegus monogyna Jacq. subsp. ***monogyna*** / yemişen; 23, YY180; 132, YY1555; 166, YY2000; 132, YY1556; 171, YY2144, Fh.,
770. C. orientalis Pall. ex M.Bieb. subsp. ***orientalis*** / alıç; 69, YY803; 73, YY838; 167, YY2030, Fh.,
771. C. orientalis Pall. ex M.Bieb. subsp. ***szovitsii*** (Pojark.) K.I.Chr. / koyun alıcı; 73, YY839, Ir.-Tur. elm.,? Fh., (▲)
772. Geum urbanum L. / meryemotu; 23, YY182, Eu.-Sib. elm., Hc.
773. Malus pumila Mill. / elma; 70, YY809; 143, YY1648, Fh.,
774. Potentilla anatolica Peşmen / sarıtabusluk; 23, YY181; 52, YY569, END., LC., Ir.-Tur. elm., Hc.,
775. P. argentea L. / gümüş parmakotu; 70, YY814, Hc.
776. P. inclinata Vill. / eğri parmakotu; 126, YY1411; 174, YY2222, Hc.
777. P. recta L. / su parmakotu; 167, YY2041, Hc.
778. P. reptans L. / reşatıotu; 38, YY302, Cr.
779. Prunus cocomilia Ten. / dağ eriği; 170, YY2122, Ir.-Tur. elm., Fh.,
780. Pyrus elaeagnifolia Pall. subsp. ***elaeagnifolia*** / ahlat; 62, YY743; 70, YY808; 161, YY1848, Fh.,
781. Rosa boisieri Crép. / has gül; 69, YY806, 170, YY2118; 21, YY163; 51, YY561; 116, YY1238; 126, YY1462; 132, YY1560, Fh.,
782. R. canina L. / kuşburnu; 61, YY698; 66, YY790; 71, YY827, Fh.,
783. R. mollis Sm. / cazı gülü; 174, YY2226, Fh.,
784. R. vanheurckiana Crép. var. ***vanheurckiana*** / muş gülü; 26, YY200, Ir.-Tur. elm., Fh.,
785. Rubus caesius L. / büküzümü; 167, YY2034, Fh.
786. Sanguisorba minor L. subsp. ***minor*** / çayırdüğmesi; 111, YY1150, Hc.
787. Sorbus torminalis (L.) Crantz var. ***torminalis*** / pitlicen; 149, YY1707; 164, YY1952; 167, YY2038, Fh.,
788. S. umbellata Desf. / geyik elması; 69, YY802; 174, YY2179, Fh.,

64. RUBIACEAE / KÖKBOYAGİLLER

789. Asperula arvensis L. / tarla belumotu; 111, YY1156a, Medit. elm., Th.
790. A. orientalis Boiss. & Hohen. / gökçe belumotu; 24, YY188, Ir.-Tur. elm., Th.,
791. A. prostrata (Adams) K.Koch / yayvan belumotu; 174, YY2190; 126, YY1407, Eux. (mt) elm., Ch.,
792. A. setosa Jaub. & Spach / acem belumotu; 20, YY146, Ir.-Tur. elm., Th.,
793. A. stricta Boiss. subsp. ***latibracteata*** (Boiss.) Ehrend. / berit belumotu; 166, YY2004, 170, YY2117, END., LC., Ir.-Tur. elm., Hc.,
794. A. suavis Fisch. / pak belumotu; 169, YY2103; 148, YY1696, END., LC., Ir.-Tur. elm., Hc., (▲)
795. A. xylorrhiza Nábelek / Siirt belumotu; 30, YY240; 119, YY1330, 126, YY1466; 162, YY1896, Ir.-Tur. elm., Hc.
796. Callipeltis cucullaris (L.) Steven / nermik; 33; YY275, 50, YY528; 50, YY556; 116, YY1234; 121, YY1348a, Ir.-Tur. elm., Th.,
797. Crucianella exasperata Fisch. & C.A.Mey. / yayla haçotu; 46, YY424, Ir.-Tur. elm., Th.
798. Cruciata taurica (Pall. ex Willd.) Ehrend. / kırım güzeli; 7, YY31; 86, YY892, Ir.-Tur. elm., Ch.,
799. Galium consanguineum Boiss. / altın iplikçik; 135, YY2146, Ir.-Tur. elm., Ch.,
800. G. incanum Sm. subsp. ***elatius*** (Boiss.) Ehrend. / gür iplikçik; 20, YY156, Ir.-Tur. elm., Ch.,
801. G. nigricans Boiss. / karaiplikçik; 50, YY553, Ir.-Tur. elm., Th.,
802. G. runcinatum Ehrend. & Schönb.-Tem. / dişlek iplikçik; 142, YY1857a, END., VU., Ir.-Tur. elm., Th., (▲)
803. G. tenuissimum M.Bieb. subsp. ***tenuissimum*** / yoz iplikçik; 18, YY1301, Th., (▲)
804. G. tenuissimum M.Bieb. subsp. ***trichophorum*** (Kar. & Kir.) Ehrend. & Schönb.-Tem. / yoz iplikçik; 111, YY1156, Ir.-Tur. elm., Th.,
805. G. tricornutum Dandy / havotu; 102, YY1040, Ir.-Tur. elm., Th.,
806. G. verum L. subsp. ***verum*** / boyalık; 46, YY410; 46, YY421; 126, YY1450; 130, YY1507, Eu.-Sib. elm., Ch.,
807. Rubia tinctorum L. / kökboyası; 163, YY1383, Ir.-Tur. elm., Hc.,

65. SALICACEAE / SÖĞÜTGİLLER

808. Populus alba L. var. ***alba*** / akkavak; 170, YY2111, Eu.-Sib. elm., Fh.
809. P. tremula L. subsp. ***tremula*** / titrek kavak; 117, YY1277, YY1279; 119, YY1328; 126, YY1424; 174, YY2186, Eu.-Sib. elm., Fh.
810. Salix aegyptiaca L. / halef; 61, YY711, Ir.-Tur. elm., Fh., (▲)
811. S. alba L. subsp. ***alba*** / aksöğüt; 160, YY1834, Eu.-Sib. elm., Fh.
812. S. armeno-rossica A.K.Skvortsov / kars söğüdü; 156, YY1748, Fh.,
813. S. bornmuelleri Hausskn / köy söğüdü; 18, YY132; Ir.-Tur. elm., Fh.,
814. S. caprea L. / sorgun; 61, YY708; 136, YY1589, Eu.-Sib. elm., Fh.,

66. SANTALACEAE / GÜVELEKGİLLER

815. Chrysothesium cilicicum Hausskn. & Bornm. / Toros güveleği; 117, YY1268; 126, YY1438, END., NT., E. Medit.(mt) elm., Hc., (▲)
816. Thesium billardieri Boiss. / meşe güveleği; 16, YY124; 111, YY1146; 116, YY1256; 157, YY1758; 157 YY1778, Hc.,

67. SAPINDACEAE / AKÇAAĞAÇGİLLER

817. Acer hyrcanum Fisch. & C.A.Mey. subsp. ***hyrcanum*** / taraklık ağacı; 70, YY807, Eu.-Sib. elm., Fh., (▲)
818. A. platanoides L. / çınar akçaağacı; 20, YY140; 69, YY805; 146, YY1680; 155, YY1735; 174, YY2206, Eu.-Sib. elm., Fh.,

68. SCROPHULARIACEAE / SIRACAOTUGİLLER

819. Scrophularia cinerascens Boiss. / gümüş sıracaotu; 117, YY1267; Hc.
820. S. ilwensis K.Koch / meşe sıracası; 100, YY979, Ir.-Tur. elm., Th.,
821. S. libanotica Boiss. subsp. ***libanotica*** var. ***sivasica*** R.R.Mill. denekutnu; 42, YY348; 148, YY1687, END., NT., Ir.-Tur. elm., Hc., (▲)
822. S. libanotica Boiss. subsp. ***libanotica*** var. ***urartuensis*** R.R. Mill. / denekutnu; 13, YY59; END., LC., Ir.-Tur. elm., Hc.,
823. S. pegaea Hand.-Mazz. / peşmen sıracası; 61, YY699, Ir.-Tur. elm., Hc.,
824. S. umbrosa Dumort. / su kestereotu; 165, YY1975, Eu.-Sib. elm., Hc.,
825. S. xanthoglossa Boiss. var. ***decipiens*** (Boiss. & Kotschy) Boiss. / serkele; 7, YY33; 157, YY1774, Ir.-Tur. elm., Hc.,
826. Verbascum cymigerum Hub.-Mor. / demet sığırkuyruğu; 52, YY618, END., EN., E. Medit. elm., Hc., (▲)
827. V. heterodontum Hub.-Mor. / dişlek sığırkuyruğu; 108, YY1076, END., VU., Ir.-Tur. elm., Hc.,
828. V. lysiosepalum Hub.-Mor. / meşe sığırkuyruğu; 121, YY1349, END., LC., Ir.-Tur. elm., Hc.,
829. V. oreophilum K. Koch var. ***johannis*** (Bordz) Hub.-Mor. / dağcı sığırkuyruğu; 126, YY1452, Ir.-Tur. elm., Hc.,
830. V. songaricum Schrenk ex Fisch. subsp. ***songaricum*** / erciş sığırkuyruğu; 124, YY1378, Ir.-Tur. elm., Hc., (▲)
831. V. songaricum Schrenk ex Fisch. subsp. ***subdecurrens*** Hub.-Mor. / ırаz sığırkuyruğu; 126, YY1435, END., LC., Ir.-Tur. elm., Hc.,

69. SOLANACEAE / PATLICANGİLLER

847. Datura stramonium L. / boru çiçeği; 52, YY578; 165, YY1980, Th.
833. Hyoscyamus niger L. / banotu; 26, YY203, Hc.,
834. Solanum americanum Mill. / itüzümü; 47, YY456, Th.,

70. TAMARICACEAE

835. Tamarix smyrnensis Bunge, 61, YY726, Fh.,
836. T. tetrandra Pall. ex M.Bieb.,110, YY1131; 160, YY1837a, Fh.,
837. Myricaria germanica (L.) Desv., 45, YY405, Fh.,

71. TYPHACEAE / SAZGİLLER

838. Sparganium erectum L. subsp. ***erectum*** / kındıra; 127, YY1474, Cr.(Hd.), (▲)
839. Typha latifolia L. / çil; 57, YY645, Hc.,
840. T. laxmannii Lepech. / papur; 72, YY833, Eu.-Sib. elm., Hc.,

72. URTICACEAE / ISIRGANGİLLER

841. Parietaria judaica L. / duvar fesleğeni; 42, YY351; 71, YY828; 135, YY1583, Hc.,
842. Urtica dioica L. subsp. ***dioica*** / ısırgan; 15, YY111, Eu.-Sib. elm., Hc.,

73. VIOLACEAE / MENEKŞEGİLLER

843. Viola occulta Lehm. / saklı menekşe; 15, YY 80; 77, YY854; 111, YY1162; 134, YY1567; 142, YY1619, Th.,
844. Viola odorata L. / kokulu menekşe; 1, YY08; 2, YY15; 142, YY1620, Cr.,
845. V. parvula Tineo / tüylü menekşe; 138, YY1596; 144, YY1658, Th.,

74. ZYGOPHYLLACEAE / ÇOBANÇÖKERTENGİLLER

846. Tribulus terrestris L. / çobançökerten; 167, YY2043a, Th.

4. Sonuçlar ve tartışma

2013-2016 yılları arasında vejetasyon dönemlerinde araştırma alanına gidilerek 2250 bitki örneği toplandı. Bu örneklerin değerlendirilmesi sonucunda 846 (74 familya 361cins'e ait 548 tür, 200 alttür ve 98 varyete) takson tespit edildi. 846 taksonun 3'ü *Pteridophyta* 843'ü *Spermatophyta* divizyoları içersinde yer almaktadır. *Spermatophyta* üyelerinin 1'i *Gymnospermae* 842'si *Angiospermae* altdivizyonuna aittir. *Angiospermae*'lerin 701'i *Dicotyledones*, 145'sı *Monocotyledones* sınıflarına dahildir. Taksonların 68 tanesinin B8 karesindeki yayılışı ilk defa kaydedildi.

İran-Turan fitocoğrafik bölgesinde yer alan çalışma alanında tespit edilen taksonların fitocoğrafik bölgelere göre dağılımı şöyledir; İran-Turan 290 (%34,75), Akdeniz 45 (%5,31), Avrupa-Sibirya 67(%7,91) ve çok bölgeli veya fitocoğrafik bölgesi bilinmeyen 444 (%52,48)'dir (Tablo 3.).

Alanımız İran-Turan fitocoğrafik bölgesinde yer aldığından dolayı bu bölge elementleri alanımızda birinci sırada yer almışlardır. İran-Turan fitocoğrafik bölgesi içerisinde *Astragalus*, *Centaurea*, *Acantholimon* ve *Onobrychis* cinslerinin çeşitlenme merkezidir (Zohary 1971). Karlıova (Bingöl) ve Çat (Erzurum) ilçelerine yakın yüksek yerlerde karla örtülü gün sayısının fazla olması Avrupa-Sibirya fitocoğrafik bölge elementinin 2. sırada olmasında etkili olmuştur. Alanımızın düşük rakımlı, güneye bakan ve Akdeniz ikliminin tipik özelliği olan ılıman ve yaz kuraklık etkisinin nispeten fazla olduğu bazı habitatlarda (Adaklı-Hasbağlar arasında) Akdeniz fitocoğrafik bölge elementleri sınırlı ölçüde gelişme imkânı bulmuşlardır.

Tablo 3. Çalışma sahamız ile ona yakın alanlarda yapılmış çalışmalarda belirlenen taksonların fitocoğrafik bölge ve endemizm dağılımlarının karşılaştırılması

*Çalışma alanı	Toplam takson sayısı	İran-Turan %	Akdeniz %	Avrupa-Sibirya %	Fitocoğrafik bölgesi belli olmayan veya çok bölgeli yayılış gösterenler %	Endemizm oranı %
1. Hiro Yaylası	846	34,23	5,31	7,91	52,53	8,50
2. Altıkardeş Dağı	535	25,98	8,41	8,03	57,58	3,92
3. Dikme yaylası	707	35,6	4,2	6,5	52,6	10,60
4. Bingöl Dağı	980	43,30	1,40	10,80	44,50	13,20
5. Munzur	1518	45,70	4,40	8,00	49,10	19,90
6. Bitlis Çayı	925	31,80	8,70	4,10	54,60	6,80
7. Pirreşit Dağı	828	38,40	9,50	2,60	49,50	9,00
8. Kırmızı Tuzla	1052	30,84	2,27	8,42	58,46	9,73
9. Aşağıçakmak köyü	820	39,20	5,50	4,20	51,10	11,30
10. Tekevler-Maden	506	34,20	4,50	4,30	56.00	8,90
11. Zilan vadisi	1156	36,41	2,42	10,01	51,16	7,95
12. Çayırlı	591	39,59	3,55	11,99	45,85	23,52
13. Kambos	650	37,84	5,38	5,38	49,23	8,30

* Yukarda kısaltılmış olarak verilen çalışma alanlarının isimleri ve numaraları aşağıdaki gibidir:

1. **Hiro yaylası:** Hiro Yaylası ve Çevresinin (Adaklı-Bingöl) Florası 2. **Altıkardeş Dağı:** Altıkardeş Dağı ve Çevresinin (Genç, Bingöl) Florası (Sinan ve Behçet, 2014), 3. **Dikme:** Dikme (Kür) Yaylası (Merkez-Bingöl) ve Çevresinin Florası (Kılıç ve Yıldırımlı, 2015), 4. **Bingöl Dağı:** Bingöl Dağı ve Çevresindeki İlçelerin (Hınıs, Tekman, Çat, Varto, Karlıova) Bitkilerinin Floristik Araştırılması (Engin, 1990), 5. **Munzur:** Munzur Dağları Florası Üzerinde Bir Araştırma (Yıldırımlı, 1982), 6. **Bitlis Çayı:** Bitlis Çayı Havzası Florası (Altıok ve Behçet, 2005), 7. **Pirreşit Dağı:** Pirreşit Dağı (Muradiye–Van) Florası (Ünal ve Behçet, 2007), 8. **Kırmızı Tuzla:** Kırmızı Tuzla (Bulanık-Muş), Bahçe Tuzlası (Malazgirt-Muş) ve Çevrelerinin Florası (Behçet vd., 2009), 9. **Aşağıçakmak Köyü:** Aşağıçakmak Köyü ile Keban Baraj Gölü (Elazığ) Arasındaki Sahanın Florası (Kılıç ve Bağcı, 2011), 10. **Tekevler-Maden:** Tekevler-Maden (Elazığ) Arası Sahanın Florası (Çakılcıoğlu ve Civelek, 2011), 11. **Zilan Vadisi:** Zilan Vadisi (Erciş-Van) Florası (Karabacak ve Behçet, 2014), 12. **Çayırlı:** Çayırlı ilçesinin (Erzincan, Türkiye) floristik çeşitliliği ve endemik bitkileri (Korkmaz, 2015), 13. **Kambos Dağı:** Kambos Dağı'nın Florası (Bitlis) (Kurşat ve Karataş, 2017)

Çalışma alanındaki endemik takson sayısı 72 ve endemizm oranı %8,50'dir. Endemik (72 takson) ve endemik olmayıp risk altında (5 takson) olan taksonların tehlike kategorilerine dağılımları şu şekildedir: 5'i "**CR**", 3'ü "**EN**", 9'u "**VU**", 48'i "**LC**", 6'si "**NT**" ve 1'i "**DD**" kategorisinde yer almaktadır. Alanda bulunan endemik olmayan nadir bitkilerin 4'ü "**VU**" ve 1'i "**DD**" kategorisinde yer almaktadır. (Ekim vd., 1989; 2000, Vural, 2006; IUCN, 2013)

Tür ve türaltı takson sayısına göre alanda ilk 10 familya sırasıyla; ; *Asteraceae* (105), *Fabaceae* (83), *Poaceae* (67), *Brassicaceae* (61), *Lamiaceae* (57), *Caryophyllaceae* (54), *Apiaceae* (39), *Boraginaceae* (27), *Rosaceae* (26) ve *Plantaginaceae* (22)

şeklindedir. Asteraceae üyelerinin çok farklı ortamlarda gelişebilmesi ve bu familya üyelerinin tohumlarının uzak mesafelere taşınmasını kolaylaştıran yapıları sayesinde geniş alanlara yayılmasını kolaylaştırmaktadır. Araştırma alanımıza yakın çalışmalarda da Asteraceae familyası ilk sırada yer almaktadır. Dolayısıyla yaptığımız çalışma, alanımıza yakın alanlarda yapılan çalışmalara benzerlik göstermektedir. Alanımızda ikinci sırada en çok takson içeren familya Fabaceae'dir. Dünya üzerinde 700 cins ve 17000 türe sahip bu familya; tropik ve sıcak bölgelerde yayılış alanı oldukça geniştir (Heywood, 1985). Alanımızda, hayvancılık için üretilen ürünlerin step vejetasyonunu iyi bir şekilde temsil etmesinden dolayı takson sayısına göre ikinci sırada yer almaktadır. Çalışma sahamıza yakın çalışmalardan; Bingöl Dağı ve Çevresindeki İlçeler (Engin, 1990), Kambos dağı (Bitlis) (Kurşat ve Karataş, 2017) flora çalışmaları dışında diğer çalışmalarda Fabaceae familyası ilk üç familya içerisinde yer almaktadır. Araştırma alanımızda üçüncü sırada Poaceae familyası bulunmaktadır. Bu durum farklı habitatlarda geniş yayılışlı çeşitli taksonların yayılışına uygun habitat değişikliğinin alanımızda bulunması ile açıklanabilir. Çalışma sahamıza yakın alanlardaki çalışmalarda; Pirreşit Dağı (Muradiye-Van) (Ünal ve Behçet, 2007), Altıkardeş Dağı (Genç, Bingöl) (Sinan ve Behçet, 2014), Zilan Vadisi (Erciş-Van) (Karabacak ve Behçet, 2014), flora çalışmalarında da Poaceae familyası ilk 3 familya içerisinde yer almaktadır. En çok takson içeren cinsler sırasıyla; *Astragalus* (23), *Trifolium* (16), *Centaurea* (12), *Salvia* (12), *Veronica* (12), *Alyssum* (12), *Ranunculus* (11), *Silene* (11), *Vicia* (10),and *Medicago* (10)'dur. Türkiye Florası'nda en çok takson içeren cinsler *Astragalus*, *Verbascum*, *Allium*, *Centaurea* ve *Silene*'dir. *Astragalus* araştırma alanımızda da en çok takson içeren cinstir. ikinci sırada yer alan *Trifolium* cinsidir. Bu cinsin alanımızda fazla taksonla temsil edilmesi Akdeniz fitocoğrafik bölgesi ekolojisinin etkisini göstermektedir. Alanımız her ne kadar İran-Turan fitocoğrafik bölgesinde yer alsa da alanın düşük rakımlı yerlerine ve Kığı barajına yakın alanlarda Akdeniz ikliminin etkisi görülmektedir. Üçüncü sırada yer alan *Centaurea* cinsi *Astragalus* cinsi ile benzer habitatlarda yayılış göstermekte ve İran-Turan fitocoğrafik bölgesinde iyi temsil edilmektedirler. Çalışma alanımıza yakın alanlarda yapılmış çalışmaların büyük çoğunluğunda *Astragalus* cinsi ilk 3 sırada yer almaktadır. Alanımıza yakın çalışmalardan; Kambos dağı (Bitlis) (Kurşat ve Karataş, 2017) flora çalışmaları hariç diğer tüm çalışmalarda *Astragalus* cinsi en çok takson içeren ilk 3 cins arasında yer almaktadır. Karşılaştırdığımız çalışmalarda cinslerin sıralanmasındaki farklılık, habitat özellikleri ve çalışma tarzı farklılıkları ile açıklamak mümkündür.

Sonuç olarak bu çalışma ile belirlenen 846 taksonun endemizim durumları ve fitocoğrafik bölge element dağılımları ortaya konmuştur. B8 karesi için ikez yayılışı olan taksonlar belirlenmiştir. Böylece Türkiye florasına katkıda bulunulmuştur.

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Kaynaklar

Akman, Y. (1990). İklim ve Biyoiklim, Palme Yayınları, Ankara.

Altıok, A., Behçet, L. (2005). The flora of Bitlis River valley, Turk. J. Bot., 29: 355-387.

Anonim, (1984). Bingöl ili Toprak ve Su Kaynakları Geliştirme Projesi, Başbakanlık Tarım Orman ve Köyişleri Bakanlığı Topraksu Genel Müdürlüğü I. Daire Başkanlığı, Yayın No: 772.

Avcı, V. (2016). Adaklı ilçesi'nde (Bingöl) görülen heyelanların jeomorfolojik faktörlere göre dağılışı, Bingöl Araştırmaları Dergisi, 2(2): 31-60.

Behçet, L., Almanar, S. (2004). *Anacyclus anatolicus* (*Asteraceae*), a new species from Turkey, Ann. Bot. Fennici, 41(4): 299-303.

Behçet, L., Özgökçe, F., Ünal, M., Karabacak, O. (2009). The flora of Kırmızı Tuzla (Karaçoban, Erzurum/Turkey) and Bahçe Tuzlası (Malazgirt, Muş/Turkey) and their environment, BioDiCon, 2(3): 122-155.

Behçet, L., Yapar, Y., Sinan, A. (2014). Contribution to the flora of Turkey from B8 square (Bingöl, Elazığ/ Turkey), BioDiCon, 7(3): 87-97.

Behçet, L., İlçim, A., Yapar, Y. (2017). *Centaurea bingoelensis* (Asteraceae), a new species from Turkey" Turkish Journal of Botany, 41: 180-188.

Boissieri, E., (1867-1888). Flora Orientalis", Vol. 1-5, Genova.

Çakılcıoğlu, U., Civelek, Ş. (2011). Tekevler-Maden (Elazığ) arası sahanın florası, BioDiCon, 4(1): 54-66.

Davis, P.H., (ed.). **(**1965-1985). Flora of Turkey and the east aegean islands. Vol. 1-9, Edinburgh Univ. Press, Edinburgh.

Davis, P.H., Mill, R.R., Tan, K., (eds.). (1988). Flora of Turkey and the east aegean islands, Vol.10, Edinburgh Univ. Press, Edinburgh, 1988.

DMİ. (2013). Meteroloji bülteni, Devlet Meteoroloji İşleri Genel Müdürlüğü, Ankara,

Donner, J. (1990). Distribution maps to P.H. Davis, flora of Turkey, Vol. 1-10 Linzer Biol. Beitr., 22(2): 381-515.

Ekim, T., Koyuncu, M., Erik, S., İlarslan, R. (1989). Türkiye'nin tehlike altındaki nadir ve endemik bitki türleri, Seri no: 18, Ankara.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgü zel, N. (2000). Türkiye bitkileri kırmızı kitabı, Türkiye Tabiatını Koruma Derneği ve Yüzüncü Yıl Üniv., Ankara.

Ekim, T., (2014). Damarlı Bitkiler: Şu eserde: Güner, A. ve Ekim, T., (edlr). Resimli Türkiye florası, cilt 1. Ali Nihat Gökyiğit Vakfı, Flora Araştırmaları Derneği ve Türkiye İş Bankası Kültür Yayınları yayını, İstanbul.

Emberger, L. (1955). Une classification biogeographique des climats, Rec. Trav. Lab. Bot. Fac. Sc., 7: 3-43.

Engin, A., "Bingöl Dağı ve çevresindeki ilçelerin (Hınıs, Tekman, Çat, Varto, Karlıova) bitkilerinin floristik araştırılması", Doçentlik Tezi, Ondokuz Mayıs Üniv., Egitim Fak., Biyoloji Anabilim Dalı, 1990.

Gaussen, H., (1955). Determination des climats par la methode des courbes ambrothermiques, C. R. Ac, Sc. E.

Güner, A., Özhatay, N., Ekim, T., Başer, K.H.C. (eds). (2000). Flora of Turkey and the east aegean islands, Vol. 11, Edinburgh Univ. Press, Edinburgh.

Güner, A., Aslan, S., Ekim, T., Vural, M., Babaç, MT., (edlr.).(2012). Türkiye bitkileri listesi (Damarlı bitkiler), Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul.

Heywood, V.H. (1985). Flowering plants of the world, Oxford University Press, England, s. 335.

IUCN, (2013). Red list categories: Version 3.1. Prepared by the IUCN Species Survival Commission. Gland", Switzerland and Cambridge.

Haston, E., Richardson, J.E., Stevens, P.F., Chase, M.W. ve Harris, D.J. (2009). The linear angiosperm phylogeny group (LAPG) III: A linear sequence of the families in APG III. Botanical Journal of Linnean Society 161: 128- 131.

Kandemir, A., Korkmaz, M., Karacan, S. (2014). Bilim dünyası için yeni sinonimler ve yeni kombinasyon, Bağbahçe Bilim Dergisi, 1(3): 82-94.

Karabacak, O., Behçet, L. (2014). The flora of Zilan valley (Erciş-Van/Turkey), BioDiCon, 7(3): 20-41.

Kurşat M., Karataş M. (2017). Kambos dağının florası (Bitlis), BioDiCon, 10(2): 93-112.

Kılıç, Ö., Bağcı, E. (2011). Aşağıçakmak Köyü ile Keban Baraj Gölü (Elazığ) arasındaki sahanın florası, Ot Sistmatik Botanik Dergisi, 18(2): 79-130.

Kılıç, Ö., Yıldırımlı, Ş. (2014). Dikme (Kür) (Bingöl merkez) ve çevresinin florası, Ot Sistmatik Botanik Dergisi, 21(1): 69-125.

Komarov, V.L., (ed.). (1933-1964). Flora of the USSR. (English translation), Vol. 1-30, Moscow and Leningrad: Akademiya Nauk SSSR.

Korkmaz, M. (2015). Floristical diversity and endemic plants of Çayırlı district (Erzincan/Turkey), BioDiCon, 8(3): 223-247.

Podlech, D., Zarre, S.H. (2013). A taxonomic revision of the genus *Astragalus* L. (*Leguminosae*) in the old world, (with collaboration of M. Ekici, A.A. Maassoumi & A. Sytin), Koenigstein, Germany.
Raunkiaer, C., (1934). The life forms of plants and statistical plant geography, Oxford: Clarendon Press.
Rechinger, K.H. (1965-1977). Flora of Iranica. Graz. Academisch Druck u Cerlangsanstalt, Graz-Austria, 1965-1977.
Reveal, J.L., Chase M.W. (2011). APG III: Bibliographical information and synonymy of Magnoliidae. Phytotaxa 19: 71-134.
Saya, Ö. (1992). *Bunium pauciflorum* DC. ve *Bunium elegans* (Fenzl) Freyn (*Apiaceae*) hakkında" Doğa-Tr.J.of Botany, 16: 417-428.
Sinan, A., Behçet, L. (2014). Altıkardeş Dağı (Genç-Bingöl) ve çevresinin florası, BioDiCon, 7(3): 98-116.
Scholz, H. (1998). Notes on *Bromus danthoinae* and relatives (*Gramineae*), Willdenowia, 28: 143-150.
Towsend, C.C., Guest, E. (1960-1985). Flora of Iraq. Vol. 1;2;4-6;8;9", Ministry of Agriculture Repplic of Iraq. Baghdad.
Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M., Webb, D.B. (1964-1981). Flora Europaea, Vol. 1-5, Unv. Press, Cambridge.
Ünal, M., Behçet L. (2007). The Flora of Pirreşit Mountain (Van,Turkey), T. J. of Botany, 31(3): 193-223.
Vural, M. http://portal.milliparklar.gov.tr. Türkiye'nin Kırmızı Liste Taslağı, anasayfa, 2006.
Yıldırımlı, Ş. (1995). Munzur Dağları (Erzincan–Tunceli) florası, Ot Sistematik Botanik Dergisi, 2(1): 1-78.
Yıldırımlı, Ş. (2014). Miscellaneous nomenclatural and taxonomic corrections on Turkish plants", Ot Sistematik Botanik Dergisi, 21(1): 29-38.
Zohary, M. (1971). Geobotanical foundations of the Middle East., Vol. 1-2: Gustav Fischer Verlag, Amsterdam.
Zohary, M. (1966-1986). Flora Palaestina, Vol. 1-4., Jerusalem Academic Press. Israel.

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Research article/Araştırma makalesi

Some additional notes on fruit fly (Diptera: Tephritidae) fauna and a new genera and species record from Turkey

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Abstract

The study was based on the fruit fly samples which were obtained different regions in Turkey between years of 2003 and 2016. Materials collected using insect net and killed in the jar. In the study, *Ictericodes zelleri* (Loew 1844) was recorded for the first time from Turkey. New localities reported for 12 species of fruit fly for fauna of Turkey. Also, wing figures and zoogeographic distribution of each species were presented in the paper.

Key words: *Ictericoides zelleri*, Fruit flies, Tephritidae, Fauna, Turkey

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Türkiye'den yeni bir cins ve tür kaydı ve meyve sinekleri (Diptera: Tephritidae) faunası üzerine bazı ilave notlar

Özet

Bu çalışma Türkiye'nin farklı bölgelerinden 2003 ve 2016 yılları arasında elde edilen meyve sineği örneklerine dayanmaktadır. Örnekler atrap kullanılarak toplandı ve öldürme şişesinde öldürüldü. Çalışmada, *Ictericodes zelleri* (Loew 1844) Türkiye'den ilk kez kaydedilmiştir. Türkiye meyve sineği faunası için 12 türün yeni lokaliteleri bildirildi. Ayrıca, makalede her bir türün zoocoğrafik yayılışları ve kanat resimleri sunulmuştur.

Anahtar kelimeler: *Ictericoides zelleri*, Meyve sinekleri, Tephritidae, Fauna, Türkiye

1. Introduction

The family Tephritidae, includes about 4792 described species in 497 genera. The larvae of most species develop in the seed-bearing organs of plants, including many commercially grown soft fruits and fruit-vegetables (*e.g.* cucumber, tomato) (White, 2006; Pape et al., 2011). According to Freidberg and Kugler (1989), species of subfamily Tephritinae larvae develop in family Asteraceae and some species cause serious damages on plants. Genus *Centaurea* L. is one of the largest genera of the family Asteraceae (Ranjbar et al., 2012). Some larvae of fruit flies develop in species of *Centaurea* and damage the plants.

Giray (1979) presented first checklist of fruit flies in Turkey. According to this checklist, 51 fruit flies species were distributed in our country. Up to date, many researchers described a lot of new species or new records from Turkey. Finally, Yaran and Kütük (2016) reported 160 species of fruit fly are distributed in Turkey.

Main purpose of this study is to provide new contributions to the fruit flies fauna of Turkey. Wing figures and zoogeographic distribution of each species presented in this paper.

2. Materials and methods

Samples of fruit flies were collected randomly from host plants using insect net. After the collection, materials killed in ethyl acetate killing jars in various locations of Turkey between 2003 and 2016. The obtained fruit flies were brought to the laboratory and preaparated standard museum methods. Thus all the specimens were made ready for the

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identification of the species. Samples were identified by using the keys of Freidberg and Kugler (1989), Hendel (1927), Merz (1994), Korneyev and White (1993 and 1999), Korneyev (2003, 2006), Kütük (2006) and White (1988). Species were stored in the insect laboratory of Gaziantep University.

3. Results

In the paper, 12 species of fruit flies have been given which were collected different region of Turkey. *Ictericodes zelleri* (Loew 1844) was recorded for the first time from Turkey. Species were given alphabetically order in the below.

3.1. *Acinia biflexa* (Loew 1844)

Specimens Examined: Iğdır, Tuzluca, 40° 03' N, 43° 39' E, 1122 m, 06.7.2009, 1 ♀, 2 ♂♂, (M. Kütük & M. Yaran).
Distribution : Albania, Austria, Czech Republic, Belgium, French mainland, Hungary, Germany, Moldova, Poland, Slovakia, Russia, Ukraine and East Palearctic (www.faunaeur.org).

3.2. *Ceratitis capitata* (Wiedemann 1824)

Specimens Examined: Gazianep, Şehitkamil, İbrahimli Village, 37° 07' N, 36° 62' E, 870 m, 07.05.2014, 2 ♀♀, 1 ♂; İslahiye, Türkbahçe Village, 37° 04' N, 36° 37' E, 519 m, 20.09.2016, 12 ♀♀, 15 ♂, (M. Kütük & M. Yaran).
Distribution: Most of Europe, Australian Region, Afro-Tropical Region, Near East, Neotropical Region, Nearctic Region, North Africa and Oriental Region (www.faunaeur.org).

3.3. *Heringina guttata* (Fallen 1814)

Specimens Examined: Gümüşhane, Centrum, 40° 21' N, 39° 23' E, 1857 m, 18.06.2003, 1 ♂; Trabzon, Çaykara, 40° 35' N, 40° 17' E, 2000 m, 17.06.2003, 1 ♀; Giresun, Şebinkarahisar, 40° 26' N, 38° 23' E, 2000 m, 18.06.2003, 1 ♀, (M. Kütük).
Distribution: Czech Republic, Danish mainland, Germany, Finland, Hungary, Sweden, Lithuania, Netherlands, Poland, The Ukraine, East Palearctic and Near East (www.faunaeur.org).

3.4. *Ictericoides zelleri* (Loew 1844)

Specimens Examined: Dissected material; Bayburt, Kop Mountain, 40° 01' N, 40° 30' E, 2400 m, 08.07.2009, 1 ♀; Bayburt, Kop Mountain, 40° 01' N, 40° 30' E, 2400 m, 08.07.2009, 1 ♂ (M. Kütük & M. Yaran).
Distribution: Austria, Czech Republic, Danish mainland, Germany, Hungary, French mainland, Italian mainland, Lithuania, Poland, Slovakia, Switzerland and Near East (www.faunaeur.org).

- The genus *Ictericoides* and *Icterioides zelleri* recorded from Turkey for the first time.

3.5. *Oxyna nebulosa* (Wiedemann 1817)

Specimens Examined: Gümüşhane, Centrum, 40° 23' N, 39° 38' E, 1311 m, 18.06.2003, 1 ♂, (M. Kütük).
Distribution: Most of Europe and Near East (www.faunaeur.org).

3.6. *Terellia* (*Cerajocera*) *ceratocera* (Hendel 1913)

Specimens Examined: Çankırı, Korgun, 40° 41' N, 33° 33' E, 835 m, 12.06.2003, 1 ♂, (M. Kütük).
Distribution: Most of Europe and East Palearctic (www.faunaeur.org).

3.7. *Terellia* (*Terellia*) *longicauda* (Meigen 1838)

Specimens Examined: Sivas, Koyulhisar, 40° 21' N, 37° 45' E, 1616 m, 12.06.2003, 2 ♂♂, (M. Kütük).
Distribution: Middle and West Europe, Near East (www.faunaeur.org).

3.8. *Terellia (Terellia) quadratula* (Loew 1869)

Specimens Examined: Giresun, Şebinkarahisar, 40° 20' N, 38° 26' E, 1280 m, 18.06.2003, 2 ♀♀, 3 ♂♂, (M. Kütük).
Distribution: Armenia, Azerbaijan, Iran, Israel, Jordan, Lebanon and Turkey (Korneyev, 2006).

3.9. *Terellia* (*Cerajocera*) *tussilaginis* (Fabricius 1775)

Specimens Examined: Bayburt, Kop Mountain, 40° 01' N, 40° 30' E, 2400 m, 08.07.2009, 1 ♀, 1 ♂; Erzurum, Narman, 40° 20' N, 41° 54' E, 1571 m, 07.07.2009, 1 ♀, 1 ♂, (M. Kütük & M. Yaran).
Distribution: Most of Europe, East Palearctic and Near East (www.faunaeur.org).

3.10. *Urophora stylata* (Fabricius 1775)

Specimens Examined: Artvin, Borçka, 41° 15' N, 41° 46' E, 223 m, 08.06.2009, 2 ♀♀, 3 ♂♂, (M. Kütük & M. Yaran).
Distribution: Most of Europe, Australian Region, East Palearctic and Near East (www.faunaeur.org).

3.11. *Urophora tenuis* Becker 1908

Specimens Examined: Artvin, Yusufeli, 40° 43' N, 41° 40' E, 700 m, 07.07.2009, 1 ♀, 1 ♂, (M. Kütük & M. Yaran).
Distribution: East Palearctic and South European Russia (www.faunaeur.org).

3.12. *Xyphosia miliaria* (Schrank 1781)

Specimens Examined: Kastamonu, Çatalzeytin, 41° 54' N, 34° 09' E, 635 m, 13.06.2003, 2 ♀♀, 3 ♂♂; Samsun, Vezirköprü, 41° 06' N, 35° 30' E, 500 m, 14.06.2003, 1 ♀, 2 ♂♂, (M. Kütük & M. Yaran).
Distribution: Most of Europe and East Palearctic (www.faunaeur.org).

4. Conclusions and discussion

Most of fruit flies distributed in Turkey feed flowerhead of the Asteraceae (Except a few species). As a result of this study, we determined 12 species of fruit flies from different region of Turkey. Obtained fruit flies in the study are common in Turkey and Palearctic region. *Ictericodes zelleri* (Loew 1844) was recorded for the first time from Turkey. Yaran and Kütük (2016) reported 160 species of fruit flies distributed in Turkey. Thus number of fruit flies species increases to 161 in Turkey. Present study gives new information to distribution of fruit fly fauna in Turkey.

References

Freidberg, A., Kugler, J. (1989). Fauna Palaestina Insecta IV. Diptera: Tephritidae. Israel at Keterpress Enterprises, Jerusalem.

Giray, H. 1979. Türkiye Trypetidae (Diptera) faunasına ait ilk liste. Türk. Bit. Kor. Derg. 3(1): 35–46.

Hendel, F. (1927). 49. Trypetidae die Fliegen der Palaerktischen Region, Stuttgard.

Korneyev, V. A., White, I. M. (1993). Fruit flies of the genus *Urophora* R.-D. (Diptera. Tephritidae) of East Palaearctic. II. Review of species of the subgenus *Urophora* s. str. (Commınication 2). Entomologicheskoe Obozrenie, 72, 232-247. (In Russian, English Translation in Entomological Review 1993: 72, 82-98.)

Korneyev, V. A., White, I. M. (1999). Fruit flies of the genus *Urophora* R.-D. (Diptera, Tephritidae) of East Palaearctic. III. Key to Palaearctic Species. Entomologicheskoe Obozrenie. 78, 464-482. (In Russian, English Translation in Entomological Review 79, 296-309.)

Korneyev, V. A. (2003). New and little known Tephritidae (Diptera, Cyclorrhapha) from Europe. Vestnik Zoologii, 37, 3-12.

Korneyev, V. A. (2006). A revision of the *quadratula* group of the genus *Terellia* Robineau-Desvoidy (Diptera: Tephritidae). Isr. J. Zool., 35-36, 341-366.

Korneyev, V. A., Evstigneev, D. A., Karimpour, Y., Kütük, M., Namin, M. S., Koyuncu, M. Ö., Yaran, M. (2013). Revision of the *Terellia virens* group (Diptera, Tephritidae) with description of three species. Vestnik Zoologii, 47, 3-25.

Kütük, M. (2006). The fauna and systematics of the genus Tephritis Latreille, 1804 (Diptera: Tephritidae) with a key to the species of *Tephritis* in Turkey. Turk. J. Zool., 30, 345-356.

Merz, B. (1994). Diptera, Tephritidae. Insecta Helvetica Fauna, HGE press, Geneva.

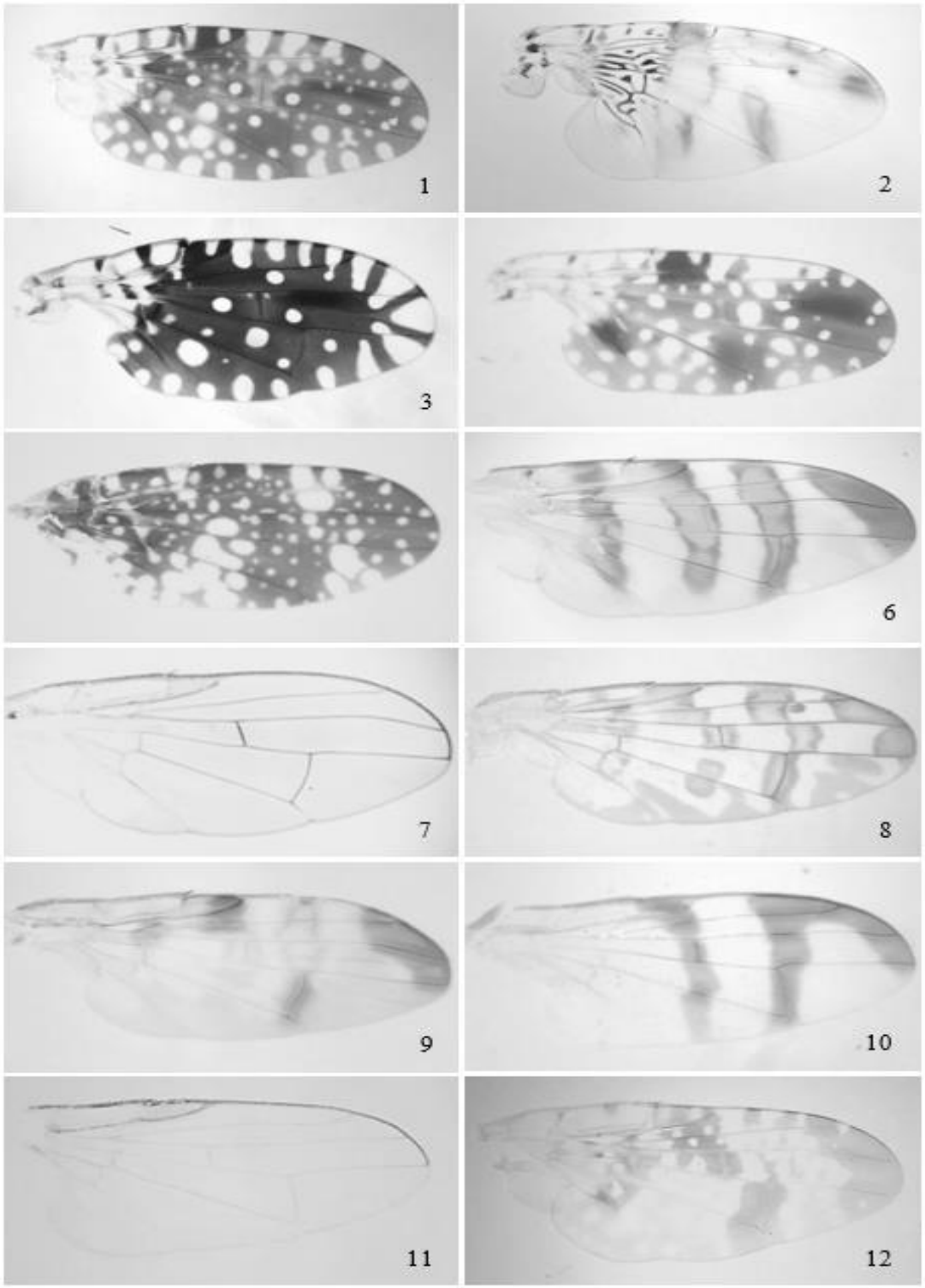
Pape, T., Blagoderov V., Mostovski, M. B., 2011. Order Diptera Linnaeus, 1758. In: Zhang Z-Q (Ed) Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. Zootaxa, 3148: 222-229.

Ranjbar, M., Negaresh, K., Karamian, R. (2012). *Centaurea regia* subsp. *javanroudense*, a new subspecies of *Centaurea* sect. *Cynaroides* (Asteraceae), from flora of Iran. Biological Diversity and Conservation, 5, 5-10.

White, I. M. (1988). Tephritid flies (Diptera: Tephritidae). Handbook for the identification of British insects. Dorset Press, London.

White, I. M. (2006). Taxonomy of the Dacina (Diptera: Tephritidae) of the Africa and the Middle East. African Entomology Memoir No: 2. 156 pp.

Yaran, M., Kütük, M. (2016). Fruit flies (Diptera: Tephritidae) fauna in Nevşehir and Niğde provinces with a new record from Turkey. Turkish Journal of Zoology, 40, 785-800.



Figures: Wing figures of fruit flies; 1) *Acinia biflexa,* 2) *Ceratitis capitata*, 3) *Heringina guttata*, 4) *Ictericoides zelleri*, 5) *Oxyna nebulosa,* 6) *Terellia ceratocera,* 7) *Terellia longicauda*, 8) *Terellia quadratula,* 9) *Terellia tussialginis*, 10) *Urophora stylata*, 11) *Urophora tenuis*, 12) *Xyphosia miliaria*

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Research note/Araştırma notu

Two lichenized fungi (*Bactrospora corticola, Pycnora sorophora*) from Bursa province new to Turkey

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Abstract

Two species of lichenized fungi from Bursa province, *Bactrospora corticola* and *Pycnora sorophora*, are new to Turkey. *Cliostomum griffithii* is new for Bursa province. For each species, a short description, ecology, associated species, and distribution are presented.

Key words: Ascomycota, biodiversity, lichens, Bursa, Turkey

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Bursa ilinden Türkiye için yeni iki likenleşmiş mantar (*Bactrospora corticola, Pycnora sorophora*)

Özet

Bu çalışmada Bursa ilinden Türkiye için yeni olan iki likenleşmiş mantar türünün (*Bactrospora corticola* ve *Pycnora sorophora*) kaydı yer almaktadır. *Cliostomum griffithii* ise Bursa ili için yeni kayıttır. Her türün kısa bir açıklaması, ekolojisi, habitatında bir arada bulunduğu türler ve dağılımı sunulmaktadır.

Anahtar kelimeler: Ascomycota, biyoçeşitlilik liken, Bursa, Turkey

1. Introduction

Bursa province is one of the Turkish provinces where the lichen diversity has been well studied. The first 14 lichen records from Bursa province were reported by Steiner (1916), and subsequent studies were reported by Szatala (1927, 1940, 1960). More recent reports of lichenized and lichenicolous fungi from Bursa province have been increased taxa number (Doğru and Güvenç, 2007; Yazıcı, 2007; Yazıcı et al., 2007; Oran and Öztürk, 2010; Arslan et al., 2011). Recently, the studies on species diversity (Oran and Öztürk, 2011) and community structure of epiphytic lichens (Güvenç and Öztürk, 2017) on oaks from Bursa province have been done. Bursa province is one of the best known of the lichen diversity in Turkey and so far, 657 lichen taxa have been reported from Bursa (Doğru and Güvenç, 2016). In this study, the records of three additional species from Bursa province were presented. Two of which are new to Turkey.

2. Materials and methods

The specimens were examined with a Leica EZ4 model stereomicroscope, and an Olympus CH-2 light microscope for external morphology and anatomical observations. Ascospore measurements were carried out in water. Ascospores measured (n = 10) and the results were given as: (min.) mean ± standard deviation (max.), where min. and max. are the extreme values. Identifications were determined according to the literature (Nash III et al., 2007; Smith et al., 2009; Wirth et al., 2013) and papers (Egea and Torrente, 1993; Gowan, 1990). The specimens were stored in Herbarium of Faculty of Sciences and Arts, Uludag University, Bursa, Turkey (BULU).

3. Results

From three lichenized fungi given in this study, *Bactrospora corticola* and *Pycnora sorophora* are new records for Turkey. Another species, *Cliostomum griffithii*, is new to Bursa province (Figure 1).

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Bactrospora corticola (Fr.) Almq.

Thallus crustose, immersed or superficial, grey-white, scurfy, diffuse or weakly rimose, not sorediate. Apothecia 0.2 –0.5 (–0.6) mm diameter, round, brown-black, deep red-brown when wet, at first flat, becoming ± convex, epruinose; true exciple pale within, dark red-brown, particularly towards the outher edge; epithecium dark brown, of congealed granules, K+ blackish olive, not dissolving; hymenium 70–100 µm high, I+ reddish; hypothecium I+ pale blue. Asci 60–90 × 9–11 µm. Ascospores 50–100 × (1.5–) 2 (–2.5) µm, at first indistinctly long and very narrow, faintly spiralled, soon fragmenting into numerous, rounded or cuboid. Pycnidia 0.1–0.2(–0.3) mm diameter. Conidia 3.5–4 × 1–1.5 µm, simple, bacilliform or long ellipsoid, straight or slightly curved. Ascospores in the examined sample (55–) 62.27 ± 5.48 (–75) × (1.5–) 2.23 ± 0.55 (–3.3) µm.

Examined sample — Bursa: Karacabey district; Bayramdere village, near to Picnic place, 40°23′35″N 28°22′31″E, alt. 40 m, north-facing slopes, forested areas, on *Quercus cerris*, 14.08.2014, leg. & det. Ş. Güvenç (BULU 16445).

It was found usually together with *Amandinea punctata* (Hoffm.) Coppins & Scheid., *Lecanora chlarotera* Nyl., *Lecidella elaeochroma* (Ach.) M. Choisy, *Lepraria lobificans* Nyl., *Opegrapha herbarum* Mont., and *Scoliciosporum umbrinum* (Ach.) Arnold on old oak trees in coastal areas (Güvenç and Öztürk, 2017).

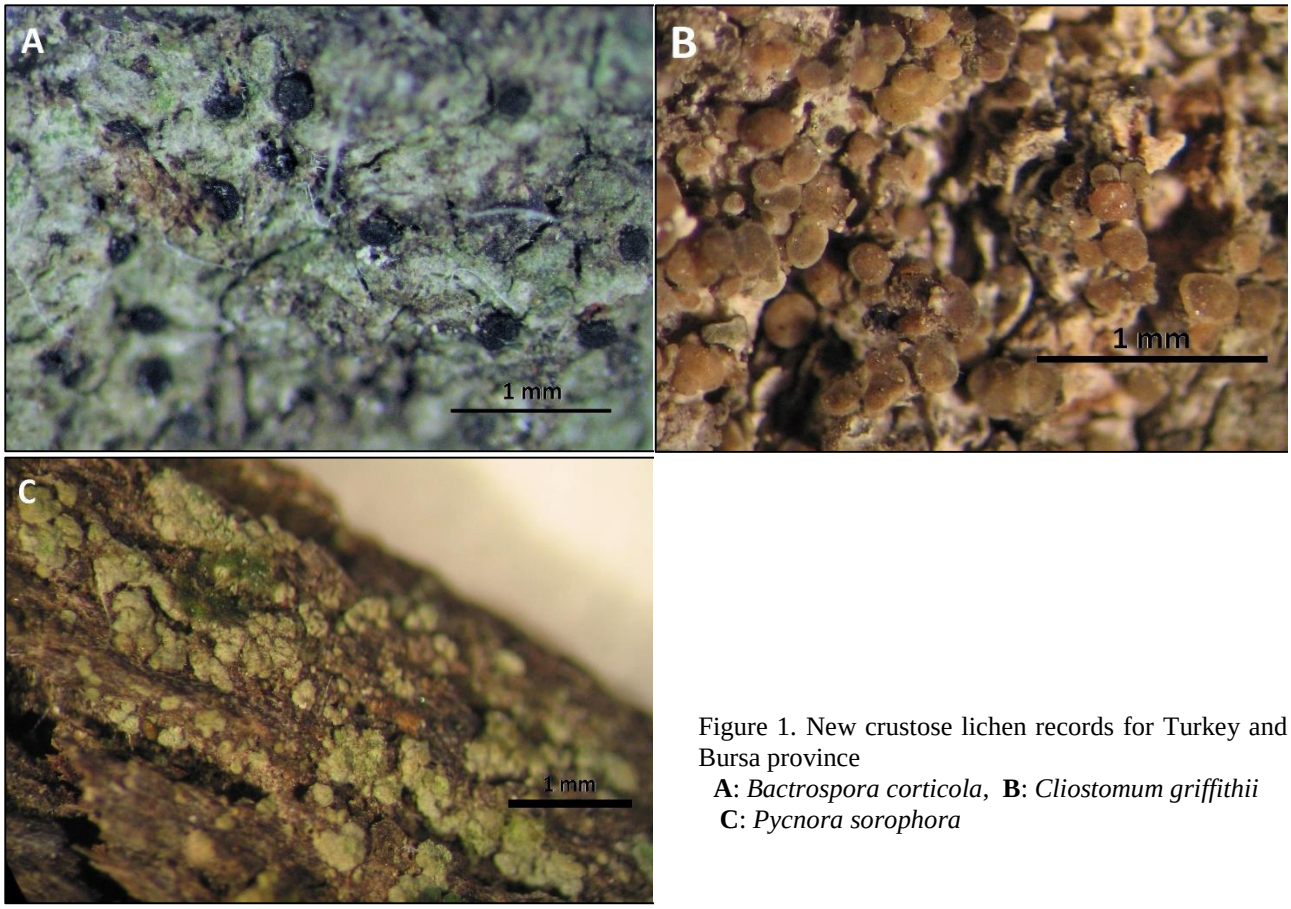

Figure 1. New crustose lichen records for Turkey and Bursa province
A: *Bactrospora corticola*, **B**: *Cliostomum griffithii*
C: *Pycnora sorophora*

Cliostomum griffithii (Sm.) Coppins

Thallus crustose, whitish to pale grey or blue-grey, matt or slightly glossy, continuous, smooth to warted-areolat. Apothecia 0.2–0.6(–0.8) mm diameter; disc concave-flat or slightly convex, often thinly white-pruinose, pink-brown to dark brown-grey or blackish, sometimes ± piebald; true exciple thin, pale or concolorous, in section colourless or brown (K+ purplish tinge) at the upper outer edge, ± densely granular internally; hymenium 55–60 µm high. Ascospores 8–16 × 2.5–3.5 µm, (0–) 1 (–3) septate; conidia 3.5–4.5 × 1.5–2 µm, oval to ellipsoid. Ascospores in the examined sample (8–) 9.58 ± 0.99 (–11) × (3–) 3.06 ± 0.16 (–3.5) µm, (0–) 1 septate. Thallus K+ yellow.

Examined sample — Bursa: Büyükorhan district; north-facing slopes in the west of Büyükorhan dam, 39°47′27″N 28°54′45″E, alt. 717 m, roadside, on *Quercus cerris*, 20.04.2015, leg. & det. Ş. Güvenç (BULU 16444).

Cliostomum griffithii is easily recognized by its whitish, slightly granulose or warted thallus bearing a multitude of black pycnidia, brownish flat to concave, slightly grey-pruinose apothecia with a grey pinkish or blackish tinge and a distinct margin and 1-septate spores. It occurs most frequently on dry sides of the bark of mature trees including conifers and wood, often in rather dry, well-lit situations, more rarely on sheltered, ± vertical rock faces or walls (Holien and

Hilmo, 1991). So far, this species has been recorded only from the oak and spruce mixed forest at 1200-1500 meters in Artvin and Rize provinces (John and Türk, 2017). Its previous world distribution was Europe, North America, and Australasia (Gowan, 1990).

Our specimen of *Cliostomum griffithii* was found associated with *Buellia disciformis* (Fr.) Mudd, *Evernia prunastri* (L.) Ach., *Hypogymnia physodes* (L.) Nyl., *H. tubulosa* (Schaer.) Hav., *Lecanora chlarotera* Nyl., *L. subcarpinea* Szatala, *Parmelia sulcata* Taylor, *Platismatia glauca* (L.) W.L. Culb. & C.F. Culb., *Pleurosticta acetabulum* (Neck.) Elix & Lumbsch, *Pseudevernia furfuracea* (L.) Zopf, and *Ramalina farinacea* (L.) Ach. on the old oaks around the dam lake (Güvenç and Öztürk, 2017).

Pycnora sorophora (Vain.) Hafellner

Thallus crustose, areoles up to 0.5(–1) mm diameter, weakly convex; upper surface dull, light grey or yellowish brown; soralia bursting from apices or more rarely, from margins of the areoles, yellowish brown; soredia farinose, 20–30(–50) µm diameter. Apothecia up to 0.6(–0.8) mm diameter, marginal or laminal, plane; disc black, epruinose; exciple of closely conglutinated hyphae, brown in inner part, brownish black in the rim, not containing crystals, K+ violet, N–; epithecium dark brown, not containing crystals, K+ violet, N–; hypothecium dark brown. Asci with a well-developed tholus containing an amyloid flank. Ascospores 6–9 × 2.5–4.5 µm, broadly to narrowly ellipsoid, simple. Pycnidia sessile, black, attached to the areole or apparently directly to the substratum. Conidia 3.5–5 × 1.5–2.5 µm, ellipsoid to bacilliform. Apothecia were not found in the examined sample. Soralia C+ red, K+ yellow, KC+ red, P+ yellow, UV+ yellow.

Examined sample — Bursa: Karacabey district; Örencik village, within valleys 4 km north of Örencik village, 40°19'12″N 28°17'29″E, alt. 257 m, mixed forest of oak, sycamore, linden, and chestnut trees, on *Erica* sp., 08.05.2012, leg. M. Gül, det. Ş. Güvenç (BULU 15934).

Pycnora sorophora is lignicolous, very rarely corticolous. It occurs mainly on old, erect, decorticated, dry trunks in open situations. It also occurs on wooden fences and buildings in agricultural areas, especially on the north-facing side of old log-houses in fields (Timdal, 1984). *Pycnora sorophora* is a sterile crustose lichen, and widely distributed in boreal and temperate Europe (Tsurykau et al., 2012).

Our specimen of *Pycnora sorophora* was found associated with *Parmelia sulcata* on dead bark of *Erica* sp.; in the same locality, other species collected on *Erica* sp. were *Hypogymnia physodes*, *Melanelixia glabratula* (Lamy) Sandler & Arup, *Parmelia sulcata*, and *Parmelina carporrhizans* (Taylor) Hale. (Gül and Güvenç, 2016).

References

Arslan, B., Öztürk, Ş., Oran, S. (2011). *Lecanora*, *Phaeophyscia* and *Rinodina* species new to Turkey. Mycotaxon, 116, 49-52.

Doğru, Z., Güvenç, Ş. (2007). Lichenized and lichenicolous fungi from Bursa province new to Turkey. Mycotaxon, 102, 389-394.

Dogru, Z., Güvenç, Ş. (2016). Lichenized and lichenicolous fungi of Katırlı mountain in Bursa province. Biological Diversity and Conservation, 9(3), 40-51.

Egea, J.M., Torrente, P. (1993). The lichen genus *Bactrospora*. Lichenologist, 25(3), 211-255.

Gowan, S.P. (1990). *Cliostomum* (lichen-forming *Ascomycotina*) in North America and Europe. Mycologia, 82(6), 766-771.

Gül, M., Güvenç, Ş. (2016). Lichenized fungi of Karadağ Mountain (Karacabey-Bursa). J. Biol. Environ. Sci., 10(29), 89-99.

Güvenç, Ş., Öztürk, Ş. (2017). Difference in Epiphytic Lichen Communities On *Quercus cerris* From Urban and Rural Areas in Bursa (Turkey). Pakistan Journal Of Botany 49, 631-637.

Holien, H., Hilmo, O. (1991). Contributions to the lichen flora of Norway, primarily from the central and northern counties. Gunneria, 65, 1-38.

John, V., Türk, A. (2017). Türkiye likenleri listesi (A Checklist of the Lichens of Turkey). İstanbul: Nezahat Gökyiğit Botanik Bahcesi Yayını.

Nash III, T.H., Gries, C., Bungartz, F (eds). (2007). Lichen flora of the Greater Sonoran Desert Region. Vol. 3. Tempe: Arizona State University Lichen Herbarium.

Oran, S., Öztürk, Ş. (2010). Three lichenized fungi new to Turkey. Mycotaxon, 112, 389-392.

Oran, S., Öztürk, Ş. (2011). The diversity of lichen and lichenicolous fungi on *Quercus* taxa found in the Marmara region (Turkey), Biological Diversity and Conservation, 4(2), 204-223.

Smith, C.W., Aptroot, A., Coppins, B.J., Fletcher, A., Gilbert, O.L., James, P.W., Wolseley, P.A. (eds). (2009). The lichens of Great Britain and Ireland. London: The British Lichen Society.

Steiner, J. (1916). Aufzälung der von J. Bornmülller in Oriente gesammelten Flechten. Ann. Naturhist. Mus. Wien, 30, 24-39.

Szatala, Ö. (1927). Lichenes Turciae asiaticae a Patre Prof. Stefano Selinka in insula Burgaz Adassi (Antigoni) lecti. Magy. Bot. Lapok., 26, 18-22.

Szatala, Ö. (1940). Contribitions à la connaisance de la flore lichenologique de la Peninsule des Balkans et de l'Asie mineure. Borbasia, 2, 33-50.
Szatala, Ö. (1960). Lichenes Turcicae asiaticae ab Victor Pietscmann collecti. Sydowia, 14, 312-325.
Timdal, E. (1984). The genus *Hypocenomyce* (*Lecanorales*, *Lecideaceae*) with special emphasis on the Norwegian and Swedish species. Nord. J. Bot., 4, 83-108.
Tsurykau, A., Khramchankova, V., Motiejünaite, J. (2012). *Pycnora sorophora* (Lecanoraceae) – Lichen species new to Belarus. Botanica Lithuanica, 18(1), 80-82.
Wirth, V., Hauck, M., Schultz, M. (2013). Die Flechten Deutschlands. Teil 1–2. Stuttgart: Ulmer.
Yazıcı, K. (2007). Five lichens new to Turkey. Mycotaxon, 100, 21-26.
Yazıcı, K., Aptroot, A., Aslan, A. (2007). Six lichenized and non–lichenized fungi new to Turkey. Mycotaxon, 102, 307-313.

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Research article/Araştırma makalesi

Presence of *Dianthus glutinosus* in Turkey and new variety of this species

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Abstract

Marmara, Ege ve Akdeniz bölgelerinden toplanmış örneklerin teşhisi ve ilgili literatürlerin incelenmesi sonucu *Flora of Turkey and the East Aegean Islands* (Türkiye Florası) adlı eserde verilen *Dianthus corymbosus* Sibth. & Sm. ve *D. pubescens* Sibth. & Sm. ile *Flora Hellenica*'da verilen *D. glutinosus* Boiss. & Heldr. arasındaki taksonomik ve korolojik ilişkiler belirlendi. İnceleme sonucu, *D. corymbosus*'un bir Yunanistan endemiği, *D. pubescens*'in ise yine bir Yunanistan endemiği olan *D. diffusus* Sm. altında sinonim olduğu anlaşılmıştır. Türkiye Florası'nda *D. corymbosus* ve *D. pubescens* olarak verilen örneklerin ise *D. glutinosus* Boiss. & Heldr. olduğu tespit edilmiştir. Ayrıca, Çanakkale Gökçeada'dan toplanmış bazı örneklerde çiçek durumunun salgı tüylü, alt kısmın ise tamamen tüysüz olduğu tespit edildi. Diğer karakterler bakımından benzer olduğu için, bu örneklerin *D. glutinosus* altında "var. *gokceadaensis* Hamzaoğlu & Koç" olarak adlandırılmasına karar verildi.

Key words: *Dianthus glutinosus, Dentati,* Flora Hellenica, yeni varyete, Türkiye

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Presence of *Dianthus glutinosus* in Turkey and new variety of this species

Özet

The taxonomic and corologic relations between *Dianthus corymbosus* and *D. pubescens,* which are mentioned in *Flora of Turkey and the East Aegean Islands* (Flora of Turkey)*,* and *D. glutinosus,* which *is* mentioned in *Flora Hellenica,* were diagnosed with identification of plant specimens collected from Marmara, Ege and Akdeniz Regions and review of related literature data. As a result of observations and evaluations, it is understood that *D. corymbosus* is endemic to Greece and *D. pubescens* is synonymous with *D. diffusus* which is also endemic to Greece. In addition, it is determined that the species which are named as *D. corymbosus* and *D. pubescens* in Flora of Turkey are *D. glutinosus.* Moreover, it is identified that inflorescence is glandular hairy and lower part is glabrous of some samples collected from Gökçeada (Çanakkale). Accordingly, these samples are decided to be named as "var. *gokceadaensis*" under *D. glutinosus* since having similarities in terms of other characters.

Anahtar kelimeler: *Dianthus glutinosus, Dentati,* Flora Hellenica, new variety, Turkey

1. Giriş

Yazılan her yeni flora, sadece konu edindiği ülke için değil aynı zamanda komşu ülkeler içinde taksonomik ve korolojik katkılar sağlar. *Flora Hellenica* (Yunanistan Florası)'nın yayınlanmasının ardından, Türkiye *Dianthus* L. cinsine ait bazı taksonlar hakkında daha detaylı bilgilere ulaşılmıştır. *Dentati* Boiss., Türkiye *Dianthus* cinsinin en fazla takson içeren seksiyonudur (Reeve, 1967; Hamzaoğlu et al., 2014; Hamzaoğlu & Koç, 2018). Seksiyonun bazı türleri Türkiye ve Yunanistan için ortaktır. Burada, *Flora of Turkey and the East Aegean Islands* (Türkiye Florası) adlı eserde *Dentati* seksiyonu altında verilen *Dianthus corymbosus* Sibth. & Sm. ve *D. pubescens* Sibth. & Sm. ile Yunanistan

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Florası'nda verilen *D. glutinosus* Boiss. & Heldr. arasındaki taksonomik ve korolojik ilişkiler açıklanmıştır (Reeve, 1967; Strid, 1997).

2. Materyal ve yöntem

Marmara, Ege ve Akdeniz bölgelerinden toplanmış örnekler teşhis edilmiş, taksonomik ve korolojik açıdan değerlendirilmiştir. Örneklerin teşhisinde, taksonomik durumlarının belirlenmesinde ve korolojilerinin tespitinde Türkiye Florası, komşu ülke floraları ve ilgili literatürlerden faydalanılmıştır (Reeve, 1967; Tutin & Walters, 1993; Strid, 1997). İncelenen ve/veya yeni takson olarak tanımlanan örnekler GAZI, ANK, HUB, ISTE, ISTF, EGE ve KNYA herbaryumlarında muhafaza altına alınmıştır.

3. Bulgular

Dianthus corymbosus Sibth. & Sm. ve *D. pubescens* Sibth. & Sm. Türkiye Florası'nda Marmara, Ege ve Akdeniz bölgelerinden çok sayıda adresten bilinir (Reeve, 1967). Marmara, Ege ve Akdeniz bölgelerinden toplanmış ve herbaryumlarda muhafaza altına alınmış Türkiye örnekleri Yunanistan ve Avrupa Florası dikkate alınarak incelenmiştir (Tutin & Walters, 1993; Strid, 1997). Yapılan inceleme sonucu *D. corymbosus*'un bir Yunanistan endemiği olduğu, *D. pubescens*'in ise yine Yunanistan endemiği olan *D. diffusus* Sm. altında sinonim olduğu anlaşılmıştır. Kısaca bu iki takson Türkiye'de yetişmez. Türkiye Florası'nda *D. corymbosus* ve *D. pubescens* olarak tanıtılan örneklerin gerçekte *D. glutinosus* Boiss. & Heldr. olduğu tespit edilmiştir.

Dianthus glutinosus; çiçeklerin gövde uçlarında tek (2-6 çiçekli kümeler halinde değil) ve pedisellerinin görünür olmasıyla (brakteler tarafından örtülmüş değil) *D. corymbosus*'tan, tüm bitkinin yoğun salgı tüylü (üst kısmı tüysüz-gibi değil), kaliks pullarının kılçıklı (mukrolu veya kısa-küspitli değil) ve kaliksinin salgı tüylü (tüysüz değil) olmasıyla da *D. diffusus*'tan ayrılır (Şekil 1). *Dianthus glutinosus* Türkiye'de Marmara ve Akdeniz Bölgelerinde otlu yamaçlarda, orman veya maki açıklığında yaklaşık 50-1500 metreler arasında yetişir. Türkiye'den başka Doğu Ege Adalarından Midilli ve Limni'de de yetiştiği bilinen takson, bu yayılışı nedeniyle Akdeniz elementi olarak değerlendirilmiştir (Reeve, 1967; Takhtajan, 1986; Strid, 1997).

3.1. *Dianthus glutinosus* Boiss. & Heldr. (Boissier in Diagn. Pl. Orient. 2(1): 61 (1854)!

Holotypus: [Yunanistan] "Constantinople", *Aucher-Eloy* 503 (K, K000725245-foto!).
= *D. corymbosus* Sm. subsp. *tenuiflorus* (Griseb.) Trinajstic, Fl. Anal. Jugosl. 1: 746 (1979).

Betimleme: Kısa ömürlü çok yıllık, tek veya seyrek demetsi otlar. Gövdeler eğik veya dik, 12-45 cm boyunda, alttan, ortadan veya üstten dallanmış, tamamen salgı tüylü-havlı veya alt kısım tüysüz, 7-15-düğümlü. Çiçeklenme zamanında kısır sürgün yaprakları yok. Alt yapraklar çiçeklenmede genellikle kuruyucu ve/veya dökülücü; orta yapraklar şeritsi, 15-70 × 1.3-3 mm, enine kesitte yassı, gövdeden ayrık, düğümarasından kısa veya uzun, salgı tüylü-havlı veya tüysüz, 3-5-damarlı, kenarlar pürtüklü ve/veya salgı tüylü -havlı, uç sipsivri, kın boyu ± enine eşit; üst yapraklar şeritsi, enine kesitte yassı, taban yeşil veya bazen morumsu, genellikle şişkin. Çiçekdurumu rasem, gövdeler çok çiçekli, çiçekler dal ucunda tek; yandallar gövdeye 45-60 derece açılı, salgı tüylü-havlı, en fazla 20 cm boyunda; pediseller 5-35 mm, salgı tüylü-havlı, yeşilimsi. Kaliks pulları 2 adet; otsu-zarsı, yeşilimsi veya samanrengi, 5-7-damarlı, salgı tüylü-havlı, uç genellikle kalikse basık, kaliksin 1/2-3/4'ü kadar, mızraksı, 8-15 × 2.5-4 mm, kenar 0.4-0.8 mm eninde zarsı, uç sivri-küt veya küt-kesik, kılçıklı, kılçık tüm pulun 1/2-2/3'ü kadar. Kaliks eliptik-mızraksı, 17-23 × 2.5-4 mm, tabandan uca doğru belirgin 35-40-damarlı, salgı tüylü-havlı, yeşilimsi veya morumsu; dişler dar üçgensi, 6-9 × 1-1.5 mm, salgı tüylü-havlı, 5-7-damarlı, kenar silli ve belirgin zarsı, uç sipsivri. Petal 18-28 mm boyunda; aya kuneat, 6-10 × 5-7 mm, tüm petalin c. 1/3'ü kadar, c. 1/2'si kaliksin dışında, beyaz benekli, sakallı, üst pembemsi, alt sarımsı-yeşil, kenar yandan uca kadar düzensiz 3-7-dişli, dişler geniş üçgensi, ayanın 1/7'sinden daha kısa; kılav 12-18 × 1.3-1.8 mm, yaka eni kılav eninin c. 1/2'si kadar. Meyve kaliksten kısa. Tohumlar eliptik, siyah, 1.2-1.5 × 0.7-1 mm. *Çiçeklenme ve habitat: Haziran-Temmuz, otlu yamaçlar, orman veya maki açıklığı, 50-1500 m.*

Yayılış ve incelenen örnekler: Akdeniz elementi. Doğu Ege Adaları (Midilli, Limni), Türkiye. **Türkiye**. **A1 Edirne**: 12 miles from Keşan to Enez, at Kızkapan, 100 m, dry grazed land, 1.7.1965, *M.J.E.Coode* et al. 2889 (E-foto); **Çanakkale**: Gökçeada, Eşelek köyü doğusu, 35T 0410493-4445737, 60 m, garik içi, 30.5.2015, *Hamzaoğlu* & *Koç* 1925 (ANK, EGE, GAZI, HUB, ISTO, KNYA); **A2 İstanbul**: Kartal, Aydos Dağı, verici yolu, 40º56'11″K-29º15'18″D, 410

m, 28.6.2012, orman açıklığı, *Hamzaoğlu* 6382, *Aksoy* & *Koç* (ANK, HUB, VANF); Yakacık, Aydos Dağı güney eteği, Asiltürk Caddesi, Poligon yakınları, 295 m, 40°55′36″K-29°14′52″D, meşe açıklığı, 14.6.2013, *Hamzaoğlu* 6708 & *Koç* (ANK, EGE, GAZI, HUB, KNYA, VANF); **B1 İzmir**: Yamanlar köyü üstü, Karagöl'e gidiş, 38º32'31″K-27º07'42″D, 530 m, 11.6.2012, orman açıklığı, *Hamzaoğlu* 6329, *Aksoy* & *Koç* (ANK, GAZI, ISTO, KNYA, VANF); aynı yer, 9.6.1966, *R.Alava* & *G.Bocquet* 5069 (E-foto); Bergama, Kozak, Demircidelen köyü, 400 m, Fıstık Çamı ormanı, 17.6.1993, *A.Güner* 11158 (HUB); **Balıkesir**: Ayvalık Balıkevi, 5.6.1956, *Pohl* s.n. (ISTF-15513); Ayvalık-Gömeç arası, Kozak yolu, Demircidere köyü civarı, 39º15'36″K-26º56'40″D, 405 m, 25.6.2012, orman açıklığı, *Hamzaoğlu* 6358, *Aksoy* & *Koç* (ANK, GAZI, KNYA, VANF); **B2 Balıkesir**: Susurluk, Seyyitler (İrşadiye) köyü, Keltepe mermer ocağı üstü, 800 m, 28.7.1994, *Y.Altan* 5826 (GAZI); **C3 Isparta**: Sütçüler, Belence-İbişler arası, serpenatin şistli akarsu vadisi, 980-1100 m, 27.5.1974, *H.Peşmen* & *A.Güner* 1228 (HUB); **C4 Konya**: Bozkır, Sorkun üstü, c. 1300 m, 16.6.1968, *R.Çetik* & *T.Ekim* 223 (ANK).

Şekil 1. *D. glutinosus* var. *glutinosus* – A. Habit, B. Çiçekdurumu, C. Çiçek, D. Petal, E. Meyve.

Çanakkale Gökçeada'da *Sarcopoterium spinosum* (L.) Spachn topluluğu arasında yetişen *D. glutinosus*'a benzeyen bazı örnekler toplanmıştır. İnceleme sonucu bu örneklerde çiçek durumunun salgı tüylü-havlı, alt kısmın ise tamamen tüysüz olduğu tespit edilmiştir. Diğer karakterler bakımından benzer olduğu için, Gökçeada örneklerinin *D. glutinosus* altında bir varyete olarak adlandırılmasına karar verilmiştir (Reeve, 1967; Strid, 1997).

3.2. *Dianthus glutinosus* Boiss. & Heldr. var. *gokceadaensis* Hamzaoğlu & Koç var. nova

Holotypus: Türkiye. **A1 Çanakkale**: Gökçeada, Eşelek köyü doğusu, 35T 0410493-4445737, 60 m, garik içi, 30.5.2015, *Hamzaoğlu* & *Koç* 1925 (GAZI, **isotypus**: ANK, EGE, GAZI, HUB, ISTO, KNYA).

Diagnosis: *Dianthus glutinosus* var. *gokceadaensis* differs from *D. glutinosus* var. *glutinosus* in its stem completely glabrous below the inflorescence (vs. glandular-pubescent).

Betimleme: Gövdeler tabandan çiçekdurumuna kadar tamamen tüysüzdür. Diğer özellikleri *Dianthus glutinosus* (var. *glutinosus*)'a benzerdir.

4. Sonuçlar ve tartışma

Herbaryum örneklerinin ve ilgili literatürün incelenmesi sonucu *Dianthus corymbosus* ve *D. pubescens* (*D. diffusus* sinonimi)'in Yunanistan'ın doğu ve güneydoğusunda yayılış gösteren iki endemik takson olduğu anlaşılmıştır. Türkiye Florası'nda *D. corymbosus* ve *D. pubescens* olarak tanıtılan örneklerin ise *D. glutinosus* olduğu anlaşılmıştır. *D. glutinosus* (var. *glutinosus*); Türkiye'de Marmara, Ege ve Akdeniz bölgeleri ile Doğu Ege Adalarından Midilli (Lesvos) ve Limni'de (Limnos) yetişir (Reeve, 1967; Strid, 1997). Burada tanımlanan *D. glutinosus* var. *gokceadaensis* ise şimdilik sadece Gökçeada'dan bilinen bir dar endemik taksondur. *Dianthus glutinosus* (var. *glutinosus*) ile tanımlanan yeni varyetenin ayırım anahtarı aşağıda verilmiştir.

1. Gövdeler tabandan çiçekdurumuna kadar salgı tüylü-havlı ……. **var. *glutinosus***
1. Gövdeler tabandan çiçekdurumuna kadar tamamen tüysüz……..…...……..……. **var. *gokceadaensis***.

Teşekkür

Dianthus örneklerinin incelenmesine izin veren GAZI, ANK, HUB ve ISTF herbaryum sorumlularına teşekkür ederiz..

Kaynaklar

Boissier, E. (1854). **Diagnoses Plantarum Orientalium Novarum**. Vol. 2(1), pp. 61-68, Lipsiae [Leipzig]: Apud B. Herrmann.

Hamzaoğlu, E., Koç, M., Aksoy, A. (2014). A new pricking Carnation (Caryophyllaceae) grows on tuff from Turkey: Dianthus aculeatus sp. nov. Biological Diversity and Conservation, 7(2), 159-162.

Hamzaoğlu, E., Koç, M. (2018). *Dianthus sancarii* (Caryophyllaceae), a new species from eastern Turkey. Biological Diversity and Conservation, 11(1), 30-34.

Reeve, H. (1967). ***Dianthus* L.** In: Davis, P.H. (Ed.). **Flora of Turkey and the East Aegean Islands**. Vol. 2, pp. 99-131, Edinburgh: Edinburgh University Press.

Strid, A. (1997). *Dianthus* L. In: Strid, A., Tan, K. (Eds.). **Flora Hellenica**. Vol. 1, pp. 343-372, Königstein: Koeltz Scientific Books.

Takhtajan, A. (1986). **Floristic regions of the world**. Berkley, Los Angeles, London: University of California Press.

Tutin, T.G., Walters, S.M. (1993). ***Dianthus* L.** In: Tutin, T.G., Burges, N.A., Chater, A.O., Edmondson, J.R., Heywood, V.H., Moore, D.M., Valentine, D.H., Walters, S.M., Webb, D.A. (Eds.). **Flora Europaea**. Vol. 1, Edition 2, pp. 227-246, Cambridge: Cambridge University Press.

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Research article/Araştırma makalesi

An anatomical ınvestigation on *Sideritis ozturkii* Aytaç & Aksoy and *Sideritis rubriflora* Hub.- Mor. (Lamiaceae) from Turkey

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Abstract

In this study, the anatomical features of the taxa *Sideritis ozturkii* Aytaç & Aksoy and *Sideritis rubriflora* Hub. - Mor., which belong to the genus *Sideritis* L. of Lamiaceae family, were investigated. The results were obtained by taking samples from the cross sections of the vegetative organs of the taxa being the subject of the anatomical study. Based on the cross sections taken from the taxon *Sideritis ozturkii*, the cells present in the root, stem and leaves of subjected taxon were observed to be greater than those in *Sideritis rubriflora* in terms of the number of layers as well as the size. In addition, the anatomic measurements carried out on the taxa *Sideritis ozturkii* and *Sideritis rubriflora* were presented in a table and the similarities and differences between the taxa in terms of anatomical traits were discussed.

Key words: anatomy, endemic, Lamiaceae, *Sideritis*, Turkey

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Türkiye'den *Sideritis ozturkii* Aytaç & Aksoy ve *Sideritis rubriflora* Hub.- Mor. (Lamiaceae) üzerine anatomik bir araştırma

Özet

Bu araştırmada, Lamiaceae familyasında yer alan *Sideritis* L. cinsine ait *Sideritis ozturkii* Aytaç & Aksoy ve *Sideritis rubriflora* Hub.- Mor. taksonlarının anatomik özellikleri çalışılmıştır. Anatomik çalışması yapılan taksonların vejetatif organlarının enine kesitlerinden numuneler alınmak suretiyle bulgular elde edilmiştir. *Sideritis ozturkii* taksonundan alınan enine kesitler sonucunda kök, gövde ve yapraklarda bulunan hücrelerin hem katman sayısı hem de büyüklük bakımından *Sideritis rubriflora'*dan daha büyük oldukları gözlenmiştir. Ayrıca, *Sideritis ozturkii* ve *Sideritis rubriflora* taksonları üzerine yapılan anatomik ölçümler tablo halinde verilmiş olup taksonlar arasındaki anatomik yönden benzerlikler ve farklılıklar tartışılmıştır.

Anahtar kelimeler: anatomi, endemik, Lamiaceae, *Sideritis*, Türkiye

1. Giriş

Türkiye zengin florasıyla uzun yıllardır pek çok araştırmacının dikkatini çekmektedir. Ülkemizin florasının bu kadar zengin olması; Avrupa-Sibirya, İran-Turan ve Akdeniz fitocoğrafik bölgelerinin kesiştiği konumda olması, Asya ve Avrupa kıtaları arasında köprü görevi görmesi, iklim ve topoğrafya çeşitliliği, topraksal faktörlerin çok çeşitlilik göstermesi gibi faktörlerden kaynaklanmaktadır. Avrupa kıtasının florası ile kıyaslandığında; Türkiye' de yayılış gösteren bitki türlerinin sayısı ile Avrupa kıtasında yayılış gösteren bitki türlerinin sayısı birbirlerine yakındır (Erik ve Tarıkahya, 2004; Avci, 2005).

Türkiye Bitkileri Listesine göre ; Ülkemiz, 167 familya ve 1320 cinse ait; toplamda 11707 takson içermektedir. 3649 takson endemik olup, endemizm oranı % 31.82' dir (Güner vd., 2012). Ülkemizde *Sideritis* cinsine ait türler halk arasında farklı isimlerle bilinir. Bunlar; dağ çayı, ada çayı, yayla çayı, kuyruk çayı, sarı kız çayı gibi değişik yöresel isimlerdir. Antioksidan etkisinden dolayı halk arasında yaygın olarak tüketilmektedir (Arabacı vd., 2014). *Sideritis* cinsi dünyada geniş bir yayılış alanına sahip olup başlıca yayılış bölgesi olan Akdeniz Bölgesi 150' den fazla tür içermektedir.

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Türkiye'de *Empedoclia* ve *Hesiodia* seksiyonuyla temsil edilen cinsin, *Sideritis ozturkii* ve *Sideritis rubriflora* taksonları *Empedoclia* seksiyonunda yer almaktadır. *Sideritis* cinsi toplam 46 tür ve 53 takson içermekte olup bu taksonların 39 tanesi endemik ve cinsin endemizm oranı yaklaşık % 80'dir. (Aytaç ve Aksoy, 2000; Güvenç ve Duman, 2010).

Sideritis cinsine ait yapılan çalışmaların büyük çoğunluğunu farmakolojik çalışmalar oluşturmakta ve anatomik çalışmaların oldukça sınırlı olduğu yapılan literatür araştırmaları ile tespit edilmiştir. Bu çalışma ile aromatik ve tıbbi özelliği bulunan endemik iki takson *Sideritis ozturkii* ve *Sideritis rubriflora* ilk kez anatomik açıdan incelenmiş ve taksonların benzerlik ve farklılıkları ortaya konulmuştur.

2. Materyal ve yöntem

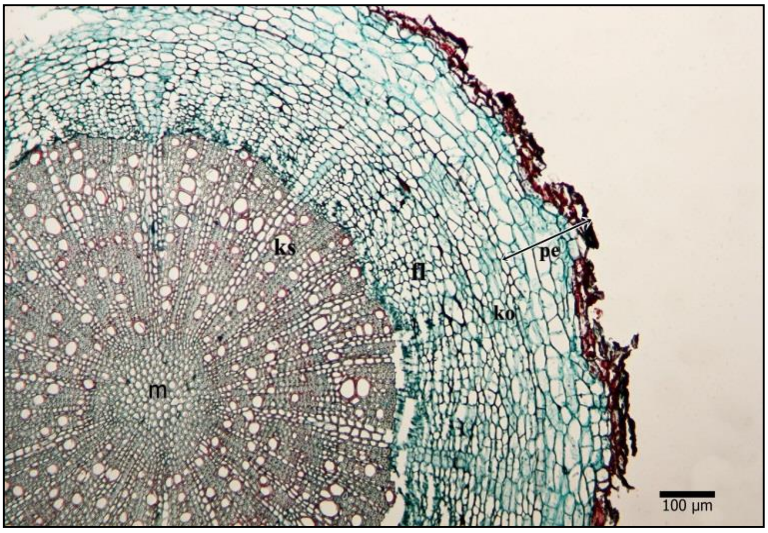
Sideritis rubriflora taksonu Antalya ilinin Gazipaşa ilçesinden, *Sideritis ozturkii* taksonu ise Konya ilinin Derebucak ilçesinden toplanmıştır. Anatomik çalışmalarda kullanmak için *Sideritis ozturkii* ve *Sideritis rubriflora* taksonlarının kök, gövde ve yaprak kısımları arazi koşullarında % 70'lik alkol dolu kapların içine konulmuş ve depolanmıştır. Anatomik çalışmalar esnasında (Algan,1981)'ın yöntemleri izlenmiştir. Anatomik çalışmalar beş kademede tamamlanmıştır. Bu kademeler sırasıyla dehidrasyon (suyun uzaklaştırılması), parafine doyurma, parafine gömme, kesit alma ve boyamadır. Boyanan kesitler entellan ile üstü kapatılarak daimi preparat haline getirilmiştir. Daimi preparatlar Leica DM 1000 marka mikroskoba entegre edilmiş Canon EOS 450D marka kamera ile fotoğraflanmış ve Kameram 21 programı yardımıyla ölçümleri gerçekleşmiştir. Elde edilen ölçümlerle minimum, maksimum, ortalama ve standart sapma değerleri belirlenmiştir.

3. Bulgular

3.1. *Sideritis ozturkii*

3.1.1 Kök

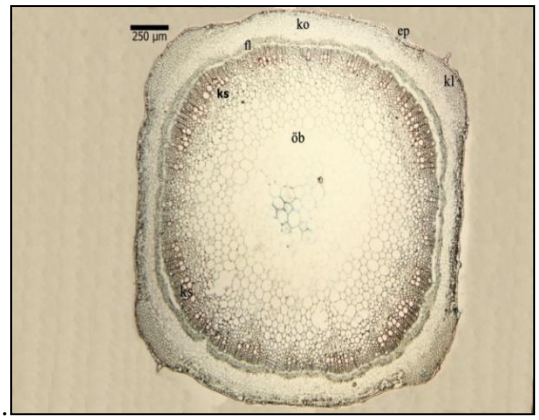
Köklerden alınan enine kesitler incelendiğinde dıştan içe doğru; peridermis, korteks, iletim dokusu ve merkez bölgesinden meydana geldiği gözlemlenmiştir. Peridermisin en dış tabakasında yer alan fellem hücreleri parçalanmış, ezilmiş veya dökülmüştür. Hücreler kalın çeperlidir. Peridermis tabakasının kalınlığı 92.66 - 204.31 µm 'dir. Korteks, hücreler 5-7 sıralı, dikdörtgen şekillidir. Hücrelerin boyutları 5.66-25.66 × 11.36-45.11 µm' dir. İletim dokusu, hücreler yuvarlak veya ovalimsidir. Ksilem elemanlarından trakelerin çapı 7.11-46.99 µm' dir. Özden dışa doğru uzanan 1-3 sıralı parankimatik öz ışınları bulunmaktadır. Merkez bölge, merkezde çok dar bir alanda sklerenkimatik öz gözlenmiştir (Şekil 3.1).



Şekil 3.1. *S. ozturkii* kök enine kesiti genel görüntüsü; pe: Peridermis, ko: Korteks, fl: Floem, ks: Ksilem, m: Merkez bölgesi

3.1.2. Gövde

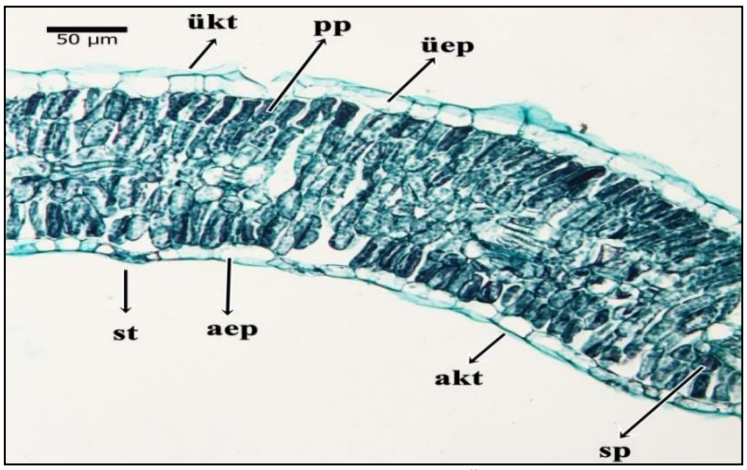
Gövde enine kesitleri incelendiğinde Lamiaceae familyasının karakteristik özelliği olan 4 köşeli gövde yapısı görülmüştür. Gövde dıştan içe doğru; epidermis, korteks, iletim demetleri ve öz kısımlarından meydana gelmektedir. Epidermis hücreleri düzgün, tek sıralı, kare, dikdörtgen veya oval şekillidir. Epidermis hücrelerinin boyutları 5.41-19.11 × 7.28-27.76 µm'dir. Korteks parankiması gövdeyi tamamen çevrelemiş olup 8-11 sıralıdır. Hücreler yuvarlak, oval veya çokgen şekillidir. Hücrelerin boyutları 9.31 - 38.7 µm'dir. Korteks parankiması ile iletim demetleri arasında 1-2 hücre halinde endodermis tabakası bulunur. Endodermis hücrelerinin boyutları 4.85 - 18.37 × 8.18 - 30.4 µm'dir. İletim demetleri elemanlarından olan floem 5-6 sıra farklı büyüklükte hücrelerden meydana gelir. Ksilem elemanlarından trake hücrelerinin boyutları 11.43-53.61 µm'dir. Öz bölgesi oval veya çok köşeli parankima hücrelerinden oluşur. Ksileme yakın olan hücreler küçük, merkeze yakın olan hücreler büyüktür. Parankima hücrelerinin kalınlığı 6.58- 95.55 µm'dir (Şekil 3.2).



Şekil 3.2. *S. ozturkii* gövde enine kesiti genel görünüşü; ep: epidermis, kl: kollenkima, ko: korteks, fl: floem, ks: ksilem, öb: öz bölgesi

3.1.3. Yaprak

Yaprak enine kesitleri incelendiğinde epidermis, mezofil ve iletim demetleri gözlenmiştir. Yaprak ekvifasiyaldir. Epidermis hücreleri ince bir kutikula ile kaplıdır. Epidermis hücreleri tek sıralı, sık dizilmiş, dikdörtgen veya ovalimsidir. Üst epidermis hücreleri alt epidermis hücrelerine nazaran daha büyüktür. Üst epidermis hücrelerinin boyutları 6.81-28.75 × 8.09-44.51 µm, alt epidermis hücrelerinin boyutları 6.98-17.88 × 5.06-27 µm' dir. Üst ve alt epidermis dalgalı çeperlidir. Stoma her iki yüzeyde de gözlendiği için yaprak amfistomatiktir. Mezofil tabakasının kalınlığı 111.04-183.72 µm' dir. Üst epidermisin altında 1-2(-3) sıralı, alt epidermisin altında 1(-2) sıralı palizat parankiması bulunur. Bazı bölgelerde palizat parankiması alt epidermise kadar kesintisiz devam etmektedir. Hücreleri silindirik şekillidir. Palizat parankiması sık dizilmiş hücrelerden meydana gelir. Palizat parankiması hücrelerinin boyutu 19.2-45.85 × 7.71-19.52 µm' dir. Üst epidermisin altındaki palizat parankiması ile alt epidermisin altında bulunan palizat parankiması arasında 2-3 sıralı sünger parankiması bulunur. Sünger parankiması iletim demetleri arasında, az ve yer yer görülmektedir. Sünger parankiması hücrelerinin çapı 8.14-20.52 µm' dir. İletim demeti floem ve ksilemden meydana gelmektedir. İletim demetinin etrafı demet kınıyla çevrilmiş olup, hücreler yuvarlak veya oval şekillidir (Şekil 3.3).

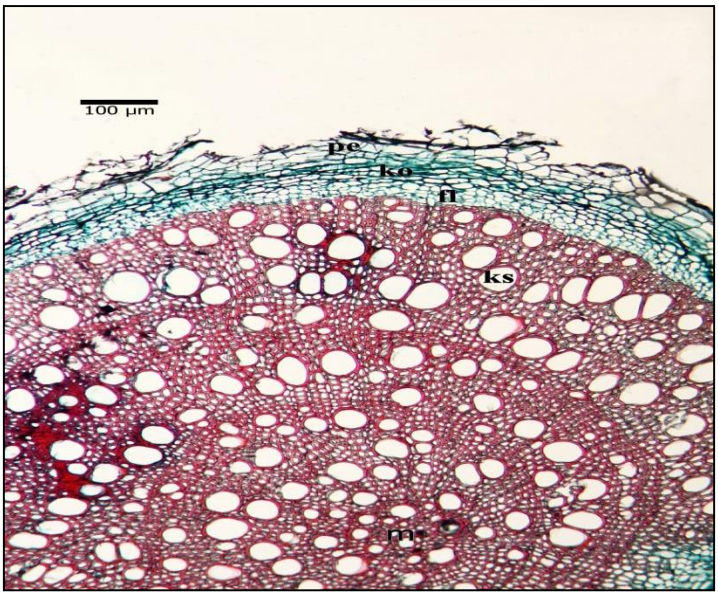


Şekil 3.3. *S. ozturkii* gövde yaprak enine kesit; üep: Üst Epidermis, aep: Alt Epidermis, pp: PalizatParankiması, sp: Sünger Parankiması, st: Stoma, ükt: Üst Kutikula, kt: Alt Kutikula

3.2. *Sideritis rubriflora*

3.2.1. Kök

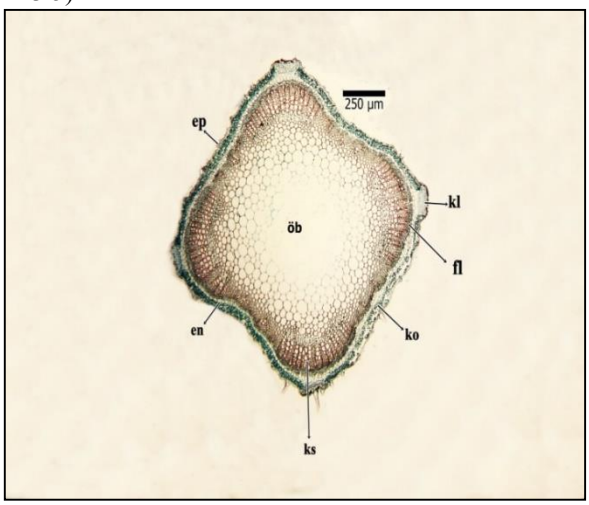
Köklerden alınan enine kesitler incelendiğinde dıştan içe doğru peridermis, korteks, iletim dokusu ve merkez bölgesinden meydana geldiği gözlemlenmiştir. Peridermisin en dış tabakasında yer alan fellem hücreleri parçalanmış, ezilmiş veya dökülmüştür. Hücreler kalın çeperlidir. Peridermis tabakasının kalınlığı 57.65 - 151.68 µm 'dir. Korteks, Parankimatik hücrelerden meydana gelir. Hücreler 3-5 sıralı, dikdörtgen şekillidir. Hücrelerin boyutları 5.68-16.4× 8.01-34.39 µm 'dir.İletim dokusu elemanlarından, floem korteksin altındadır. Ksilem elemanı olan trake hücreleri öze kadar geniş bir alan kaplamaktadır. Hücreler yuvarlak veya ovalimsidir. Ksilem elemanlarından trake hücrelerinin çapı 8.48-66.65 µm' dir. Özden dışa doğru uzanan 1-2 sıralı parankimatik öz ışınları bulunmaktadır. Merkezde çok dar bir alanda sklerenkimatik öz gözlenmiştir (Şekil 3.4).



Şekil 3.4. *S. rubriflora* kök enine kesiti genel görünüş; Pe: Periderma, ko: Korteks, fl: Floem, ks: Ksilem, m: Merkez bölgesi

3.2.2. Gövde

Gövde enine kesiti incelendiğinde Lamiaceae familyasının karakteristik özelliği olan 4 köşeli gövde yapısı görülmüştür. Gövde dıştan içe doğru; epidermis, korteks, iletim demeti ve öz kısımlarından meydana gelmektedir. Epidermis hücreleri düzgün, tek sıralı, dikdörtgen, oval veya kare şekillidir. Hücrelerin üzeri ince bir kutikula ile kaplıdır. Kutikula kalınlığı 1.48-3.31 µm'dir. Epidermis hücrelerinin boyutu 6.31-17.54 × 4.32-17.78 µm'dir. Köşelerde 9-11 sıralı kollenkima dokusu bulunur. Korteks, Korteks parankiması kenarlarda bulunur ve 4-5 sıralıdır. Yuvarlak, çokgen veya oval şekillidir. Hücrelerin boyutu 5.94-22.71 µm'dir. Korteks parankiması ile iletim demetleri arasında 1 hücreli, belirgin, halka şeklinde endodermis tabakası bulunur. Hücreler iri ve dikdörtgen şekillidir. Endodermis hücrelerinin boyu 5.67-20.91 × 6.32-29.28 µm'dir. İletim demetleri elemanlarından floem 4-5 sıra farklı büyüklükteki hücrelerden meydana gelir. Ksilem elemanlarından trake hücrelerinin boyutu 6.47-29.53 µm'dir. Öz bölgesi yuvarlak veya çokgen şekilli parankima hücrelerinden oluşur. Ksileme yakın olan hücreler küçük, merkeze yakın olan hücreler büyüktür. Parankima hücrelerinin boyutu 18.27-103.69 µm'dir (Şekil 3.5).

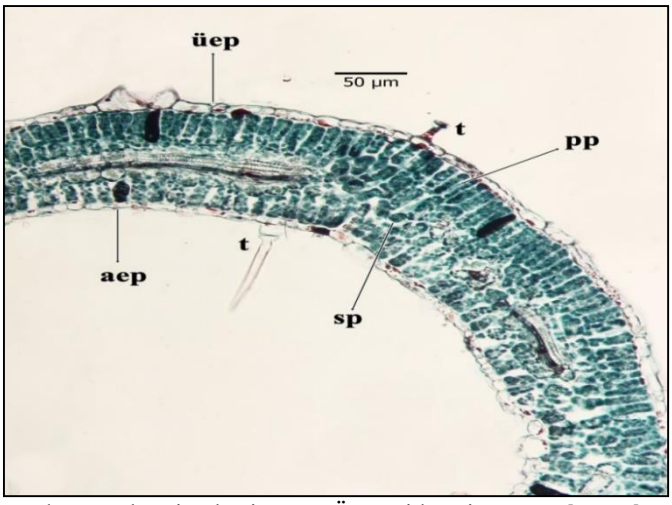


Şekil 3.5 *S. rubriflora* gövde enine kesiti genel görünüş; ep: Epidermis, kl: Kollenkima, ko: Korteks, fl: Floem, ks: Ksilem, öb: Öz Bölgesi en: Endodermis

3.2.3. Yaprak

Yaprak enine kesitleri incelendiğinde epidermis, mezofil ve iletim demeti gözlenmiştir. Yaprak ekvifasiyaldir. Epidermis hücreleri ince bir kutikula ile kaplı, tek sıralı, sık dizilmiş, dikdörtgen veya oval şekillidir. Üst epidermis hücreleri alt epidermis hücrelerine nazaran daha büyüktür. Üst epidermis hücrelerinin boyutları 5-17.05 × 4.17-20.34 µm, alt epidermis hücrelerinin boyutları 4.12-11.8 × 3.16-12.34 µm' dir. Üst ve alt epidermis dalgalı çeperlidir. Stoma her iki yüzeyde de gözlendiği için yaprak amfistomatiktir. Mezofil tabakasının kalınlığı 46.5-160.94 µm' dir. Üst epidermisin altında 1-2 sıralı, alt epidermisin altında 1 sıralı palizat parankiması bulunur. Bazı bölgelerde palizat parankiması alt epidermise kadar kesintisiz devam etmektedir. Hücreleri silindirik şekillidir. Palizat parankiması sık dizilmiş hücrelerden meydana gelir. Palizat parankiması hücrelerinin boyutu 15.2-40 × 5.12-15.01 µm' dir. Üst epidermisin altındaki palizat parankiması ile alt epidermisin

altında bulunan palizat parankiması arasında 1-2 sıralı sünger parankiması bulunur. Sünger parankiması iletim demetleri arasında, az ve yer yer görülmektedir. Demetlere yakın bölgelerde ve yaprak uçlarında yoğunlaşmıştır. Hücreler yuvarlaktır. Hücreler arasında boşluk bulunmaktadır. Sünger parankiması hücrelerinin çapı 5.96-14.72 µm' dir. İletim demeti floem ve ksilemden meydana gelmektedir. İletim demetinin etrafı demet kınıyla çevrilmiş olup, hücreler yuvarlak veya oval şekillidir (Şekil 3.6).



Şekil 3.6. *S. rubriflora* gövde yaprak enine kesit; üep: Üst Epidermis, aep: Alt Epidermis, pp: Palizat Parankiması, sp: Sünger Parankiması, t: Tüy

Tablo 1. *S. ozturkii* ve *S. rubriflora* taksonlarına ait anatomik hücre ölçümleri

			Genişlik (µm)			Uzunluk (µm)		
			Min	Max	Ort±SD	Min	Max	Ort±SD
Sideritis ozturkii	Kök	Peridermis	92.66	204.31	151.58±27.44			
		Korteks	11.36	45.11	27.3±6.84	5.66	25.56	14.59±3.40
		Trake	7.11	46.99	22.4±8.32			
		Öz Işın	3.52	15.59	7.91±2.56	3.63	28.28	14.22±4.24
	Gövde	Epidermis	7.28	27.76	15.14±3.74	5.41	19.11	11.03±2.69
		Korteks	9.31	38.70	21.38±5.58			
		Trake	11.43	53.61	27.17±7.58			
		Öz hücresi	6.58	95.55	42.30±20.30			
		Kollenkima	7.04	25.57	14.55±3.76			
		Endodermis	8.18	30.4	16.09±3.77	4.85	18.37	8.92±2.28
		Kutikula	0.89	3.11	2.25±0.47			
	Yaprak	Üst epidermis	8.90	44.51	14.01±8.37	6.81	28.75	17.08±4.55
		Alt epidermis	5.06	27.00	12.92±4.54	6.98	17.88	11.87±2.78
		Mezofil	111.04	183.72	148.5±14.89			
		Üst kutikula	1.19	2.98	2.07±0.35			
		Alt kutikula	0.83	2.42	1.45±0.34			
		Sünger parankima	8.14	20.52	13.95±2.53			
Sideritis rubriflora	Kök	Epidermis	57.65	151.68	106.54±22.92			
		Korteks	8.01	34.39	23.26±5.50	5.68	16.4	10.6±2.49
		Trake	8.48	66.65	37.36±11.50			
		Öz hücresi	3.37	11.86	7.17±1.90	7.29	32.36	18.85±5.38
	Gövde	Epidermis	4.32	17.78	9.99±2.91	6.31	17.54	9.63±1.71
		Korteks	5.94	22.71	11.05±2.61			
		Trake	6.47	29.53	17.34±5.20			
		Öz hücresi	18.27	103.69	46.73±15.98			
		Kollenkima	4.21	14.96	9.05±1.89			
		Endodermis	6.32	29.28	17.65±4.56	5.67	20.91	11.82±2.96
		Kutikula	1.48	3.31	2.41±0.37			
	Yaprak	Üst epidermis	4.17	20.34	11.29±3.02	5.00	17.05	8.5±1.91
		Alt epidermis	3.16	12.34	7.72±1.92	4.12	11.08	6.88±1.30
		Mezofil	46.5	160.94	93.80±17.83			
		Üst kutikula	0.76	2.31	1.45±0.39			
		Alt kutikula	0.49	1.21	0.78±0.15			
		Sünger parankima	5.96	14.72	9.99±1.77			

Min: minimum, max: maksimum, ort: ortalama, SD: standart sapma

4. Sonuçlar ve tartışma

Sideritis L. cinsine ait türler üzerine anatomik çalışmaların çok sınırlı olduğu gözlemlenmektedir (Uysal, 1991; Güvenç ve Duman, 2010). Araştırmamıza konu teşkil eden *S. rubriflora* ve *S. ozturkii* taksonlarının her ikisi de cinsin anatomik özelliklerini taşımaktadır.

Kök anatomik yapısı üzerine yapılan anatomik çalışmalarda *S. ozturkii'* nin peridermis tabakasının daha kalın, korteks parankiması, öz ışın hücrelerinin sıra ve boyut yönünden ortalama değerler açısından *S. rubriflora*'dan daha büyük olduğu tespit edilmiştir. İletim dokusu her iki takson için karşılaştırıldığı zaman *S. rubriflora*' nın trakelerinin daha geniş olduğu belirlenmiştir (Tablo 1).

Sideritis cinsine ait taksonların anatomik yapılarında tipik dikdörtgen şekli hemen göze çarpmaktadır (Uysal, 1991; Güvenç ve Duman, 2010). İncelenen taksonlarda da bu yapı aynı şekilde gözlemlenmiştir. Gövde enine kesitlerinin köşelerinde kollenkima hücreleri yer almaktadır. Epidermisde yer alan salgı ve örtü tüyleri mevcuttur. Kutikula kalınlığı her iki takson için ortalama olarak benzer kalınlıkta ölçülmüştür. *S. ozturkii'*nin epidermis, korteks parankiması, trake hücreleri ve öz bölgesinde bulunan hücrelerin boyutlarının ortalama olarak daha büyük olduğu, endodermis hücrelerinin ise daha küçük olduğu gözlemlenmiştir (Tablo 1).

Yaprak anatomisine dair yapılan araştırmalar, *Sideritis* cinsinde tüylerin yoğun bir şekilde bulunmasını ve ekvifasiyal tip mezofilin varlığını ortaya koymaktadır (Uysal, 1991; Güvenç ve Duman, 2010). *S. ozturkii* ve *S. rubriflora* taksonlarının her ikisi de bol miktarda salgı ve örtü tüyü ihtiva etmektedir. İncelenen taksonlarda, yapraklarda ekvifasiyal yapının varlığını ortaya çıkarmıştır. Üst ve alt epidermis hücrelerinin tek sıralı olduğu tespit edilmiş olup, taksonlar tipik kserofitik bitki yapısı göstermektedir. *S. ozturkii'ye ait* anatomik ölçümlere göre; alt ve üst epidermis hücrelerinin boyutlarının *S. rubriflora*'dan daha büyük olduğu, kutikula kalınlığı ile sünger parankiması hücreleri boyutlarının *S. rubriflora* ile benzer olduğu, palizat parankiması hücrelerinin ise *S. rubriflora* 'dan daha küçük olduğu tespit edilmiştir (Tablo 1).

Sideritis ozturkii ve *Sideritis rubriflora* taksonları Lamiaceae familyasına ait *Sideritis* cinsi içinde yer alan iki endemik takson olup taksonomik olarak birbirine çok benzerlik gösterir. Yaptığımız çalışma sonucunda iki taksonun da anatomik farklılıkları ve benzerlikleri belirlenmiştir. Yapılan literatür araştırmalarında *Sideritis* cinsi üzerine farmakolojik çalışmaların çok fazla olduğu fakat anatomik çalışmaların yetersiz olduğu görülmüştür. Bu çalışma ile *Sideritis* cinsi ve taksonları üzerinde yapılacak olan anatomik çalışmalara ışık tutacağı kanaatindeyiz..

Teşekkür

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Kaynaklar

Algan, G. (1981). Bitkisel dokular için mikroteknik, Fırat Üniversitesi Fen Fakültesi Yayınları.

Arabacı, O., Öğretmen, N. G., Tan, U., Yaşar, F. (2014). "Bazı Tohum Uygulmalarının *Sideritis perfoliata* L.'da Çimlenmeye Etkisi." Traya Üniversity Journal of Natural Sciences15(2): 83-87.

Avci, M. (2005). "Çeşitlilik ve endemizm açısından Türkiye'nin bitki örtüsü." İstanbul İ.Ü. Edb. Fak. Coğrafya Dergisi13: 27-55.

Aytaç, Z., Aksoy, A. (2000). "A new *Sideritis* species (Labiatae) from Turkey." Flora Mediterranea10: 181-184.

Davis, P.H. (1982). Flora of Turkey and the East Aegean Island, Edinburgh University Press. Vol. 7, 178-199.

Erik, S., Tarıkahya, B. (2004). "Türkiye florası üzerine." Kebikeç17: 139-163.

Güner, A., Aslan, S., Ekim,T., Vural, M., Babaç, M. T. (Eds) (2012). Türkiye bitkileri listesi (Damarlı bitkiler).

Güvenç, A. , Duman, H. (2010). "Morphological and anatomical studies of annual taxa of *Sideritis* L. (Lamiaceae), with notes on chorology in Turkey." Turkish Journal of Botany34(2): 83-104.

Uysal, İ. (1991). "*Sideritis trojana* Bornm. Endemik Türünün Morfolojisi, Anatomisi ve Ekolojisi " Doğa - Tr. J. of Botany 15: 371-379.

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Research article/Araştırma makalesi

Studies on Scoliidae (Hymenoptera: Vespoidea) of Adana province, Turkey

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Abstract

The present study is based on the Scoliidae samples collected from Adana province between June-October 2017. 6 species and 3 subspecies of Scoliinae are recorded from the study area; *Colpa klugii* (Vander Linden, 1827); *Colpa sexmaculata* (Fabricius, 1782); *Megascolia maculata maculata* (Drury, 1773); *Scolia anatolia* Osten, 2004; *Scolia fallax* Eversmann, 1849; *Scoliafuciformis* Scopoli, 1786; *Scolia galbula* (Pallas, 1771); *Scolia hirta hirta* (Schrank, 1781); *Scolia sexmaculata sexmaculata* (Müller, 1766). *Colpa klugii* (Vander Linden, 1827) and *Scolia galbula* (Pallas, 1771) are new records for Scoliidae fauna in Adana province. The systematic, faunistic, ecological, biological and phenological informations of the species were given.

Key words: Scoliidae, systematic, fauna, Adana

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Adana ili Scoliidae (Hymenoptera: Vespoidea) türleri

Özet

Bu çalışma 2017 yılı Haziran- Ekim ayları arasında Adana ilinden toplanan Scoliidae örneğine dayanmaktadır. Araştırma bölgesinde; Scoliinae alt familyasına ait 9 tür ve alttür: *Colpa klugii* (Vander Linden, 1827); *Colpa sexmaculata* (Fabricius, 1782); *Megascolia maculata maculata* (Drury, 1773); *Scolia anatolia* Osten, 2004; *Scolia* (*Scolia*) *fallax* Eversmann, 1849; *Scolia* (*Scolia*) *fuciformis* Scopoli, 1786; *Scolia* (*Scolia*) *galbula* (Pallas, 1771); *Scolia* (*Discolia*) *hirta hirta* (Schrank, 1781); *Scolia* (*Scolia*) *sexmaculata sexmaculata* (Müller, 1766) tespit edilmiştir. *Colpa* (*Colpa*) *klugii* (Vander Linden, 1827) ve *Scolia* (*Scolia*) *galbula* (Pallas, 1771) Adana ili Scoliidae faunası için yeni kayıttır. Türler hakkında sistematik, faunistik, ekolojik, biyolojik ve fenolojik bilgiler verilmiştir.

Anahtar kelimeler: Scoliidae, sistematik, fauna, Adana

1. Introduction

Hymenoptera species, which are members of the class insecta, are referred to also as membranous-winged animals as a result of having two pairs of wings of membranous nature. The order Hymenoptera is divided into two suborders, namely Symphyta and Apocrita. Apocrita suborder is further divided into two infraorders, namely Tenebrantia (gall wasps, parasitic wasps) and Aculeata (stinging wasps). The group Aculeata comprises three superfamilies, namely Apoidae, Chrysidoidea and Vespoidea, and the superfamily Vespoidea comprises 10 families, namely Bradynobaenidae, Formicidae, Mutillidae, Pompilidae, Rhopalosomatidae, Sapygidae, Scoliidae, Sierolomorphidae, Tiphiidae and Vespidae (Goulet and Huber, 1993).

The bodies of Scoliidae, known also as spurred bees, have thick hair and yellow, orange and red patterns on a black surface. The wings are black, yellow and brownish color (Goulet and Huber, 1993; Osten, 2000), and these color differences attract the attention of other bees during food intake and mating, and facilitate communication (Osten, 1999a). Unlike wasps, they do not attack human, although females will on rare occasions pierce human skin with the spur-shaped stings on their legs. They can live in different biotopes, from tropical forests to warm savannas, and can reside in same habitats as Scarabeidae, which are their ectoparasites (Osten et al., 2003). Adult Scoliidae, which are solitary, feed on the

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nectar and pollen of flowers while their larvae feed on other insects (Goulet and Huber, 1993). The female of the species rest after mating and mature their eggs by taking nectar from flowers. Their reproductive capacities are very low. They are bees that can fly fast into the wind, but break flight when they want to feed on flowers. The male s are active at night while the females spend nighttime under the soil. The lifespan of the maleis three to four times shorter than that of the female (Osten, 1999a). Since the body hair is not capable of retaining pollen, their contribution to pollination is limited, although male Scoliidae ensure pollination through their pseudocopulation behavior (Ciotek et al. 2005). They are economically important. The females are ectoparasites of Scarabaeidae and Curculionidae (Coleoptera) larvae, which are pests to agriculture and forestry (Goulet and Huber, 1993). Scoliidae larvae feed on Coleoptera, thus preventing damage to pasture and crops, and serve as biological control agents. A parasitic relationship has also been identified between Scoliidae and some Diptera of the family Conopidae. Sexual dimorphism is apparent in the tribus Campsomerini, while the morphologies of the sexes are homogeneous in other genera (Osten, 1999a, 2000).

The Scoliidae family is divided into two subfamilies: Proscoliinae and Scoliinae, and is composed of approximately 560 species, 220 subspecies, 43 genera, 28 subgenera and two subfamilies (Osten, 2005b). The Proscoliinae family, of which there are only two species in the world, is prevalent in the Palearctic region.

There are 24 species and subspecies of the Scoliidae family in Turkey (Tüzün and Bağrıaçık, 2000; Osten and Özbek, 1999; Japoshvili and Karaca, 2010). Özbek and Anlaş (2011) reported 22 Scoliidae species in our country, although only the species *Proscolia spectator* of the Proscoliinae subfamily have been reported in our country. A female sample of the *Proscolia spectator* species was reported in Ankara in 1939. *Proscolia archarica*, as another species of the subfamily, was detected in Aras River, close to the border between Turkey and Iran, according to which the species can be considered to have a wide distribution in our country (Osten and Özbek, 1999).

A literature review uncovered only a few studies related to Scoliidae fauna in Turkey, and there are obvious deficiencies in the determination of the geographical distribution of the species. The present study makes both a systematic and faunistic analysis of the Scoliidae species that inhabit the Adana province. Some ecological, biological and phenological observations of the analyzed species are discussed, and the distribution of the species in Turkey and in the rest of the world is detailed. This study is important in determining the geographical distribution and ecological properties of the Scoliidae family.

2. Materials and methods

Samples were collected between June and October 2017 from the Adana and its adjacent areas, as the selected area of research. Insect nets were used for the collection of samples, which were removed from the nets and placed in killing jars containing KCN. The samples were then removed from the jars using forceps and placed in cardboard boxes with labels detailing the collector, location, date, altitude and coordinates. The plants on which the insects fed and rested were collected and identified, in addition to the samples collected from the field. The studies of Betrem (1935) and Osten (2000) were also taken into account in the detection of samples, and the studies of Osten (2000, 2005a,b) were also taken into account in the scientific nomenclature of the species. A Leica EZ4 stereo microscope was used for the determination of the species.

3. Results

Subfamily Scoliinae Latreille, 1802

Tribus Campsomerini Osten, 2001

Genus *Colpa* Dufour, 1841

Colpa klugii (Vander Linden, 1827)

Material Examined: Adana: Kozan, 342 m, 15.VII.2017, 1 ♂; Ceyhan, 78 m, 2.IX.2017, 1 ♀ (Totally 2 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Amasya, Antalya, Artvin, Balıkesir, Bilecik, Burdur, Çanakkale, Elazığ, Erzurum, Gaziantep, Isparta, İstanbul, İzmir, Malatya, Manisa, Mersin, Muş, Niğde, Osmaniye, Samsun, Tekirdağ (Osten and Özbek, 1999; Anlaş and Çevik, 2004; Özbek and Anlaş, 2011, Elçin and Bağrıaçık, 2015).

World distribution: Portugal, Albania, Balkan peninsula, Ukraine, Iran (Osten, 2000; Özbek and Anlaş, 2007).

Phenology: July-September.

Remarks: This species is new record for Adana province.

Colpa sexmaculata (Fabricius, 1782)

Material Examined: Adana: Ceyhan, 32 m, 12.VI.2017, 1 ♀, 1 ♂; Yumurtalık, 24 m, 13.VI.2017, 2 ♀♀, 2 ♂♂; Karataş, 13 m, 14.VI.2017, 1 ♂; Karaisalı, 317 m, 15.VI.2017, 2 ♀♀, 1 ♂; Seyhan, 312 m, 18.VI.2017, 1 ♂; Çukurova, 27 m, 19.VI.2017, 3 ♀♀, 2 ♂♂; Kozan, 284 m, 20.VI.2017, 2 ♂♂; İmamoğlu, 85 m, 21.VI.2017, 2 ♀♀, 1 ♂; Ceyhan, 33 m, 22.VI.2017, 3 ♂♂; Kozan, 316 m, 10.VII.2017, 3 ♂♂; Feke, 364 m, 11.VII.2017, 2 ♀♀, 3 ♂♂; Saimbeyli, 950 m, 12.VII.2017, 1 ♂; Kozan, 304 m, 13.VII.2017, 3 ♀♀, 2 ♂♂; Feke, 557 m, 14.VII.2017, 2 ♂♂; Feke, 603 m, 15.VII.2017, 2 ♀♀, 1 ♂; Kozan, 356 m, 16.VII.2017, 2 ♂♂; Tufanbeyli, 1470m, 17.VII.2017, 1 ♂; İmamoğlu, 86 m, 18.VII.2017, 2 ♂♂; Sarıçam, 312 m, 19.VII.2017, 3 ♀♀, 1 ♂; Seyhan, 33 m, 20.VII.2017, 2 ♀♀, 1 ♂; Çukurova, 30 m, 21.VII.2017, 2 ♂♂; Ceyhan, 156 m, 22.VII.2017, 4 ♀♀, 2 ♂♂; Ceyhan, 212 m, 23.VII.2017, 1 ♂; Yüreğir, 42 m, 24.VII.2017, 2 ♀♀, 1 ♂; Yumurtalık, 17 m, 25.VII.2017, 1 ♂; Yumurtalık, 20 m, 26.VII.2017, 3 ♀♀, 1 ♂; Karataş, 8 m, 27.VII.2017, 3 ♂♂; Ceyhan, 43 m, 28.VII.2017, 1 ♂; Feke, 580 m, 14.VIII.2017, 2 ♀♀, 1 ♂; Kozan, 342 m, 15.VIII.2017, 2 ♂♂; Kozan, 371 m, 16.VIII.2017, 3 ♀♀, 1 ♂; İmamoğlu, 94 m, 17.VIII.2017, 1 ♀, 1 ♂; Feke, 364 m, 18.VIII.2017, 1 ♂; Saimbeyli, 884 m, 19.VIII.2017, 1 ♂; Sarıçam, 337 m, 24.VIII.2017, 2 ♂♂; Yumurtalık, 14 m, 25.VIII.2017, 2 ♂♂; Ceyhan, 72 m, 26.VIII.2017, 3 ♂♂; Yumurtalık, 20 m, 27.VIII.2017, 1 ♀, 4 ♂♂; Karataş, 42 m, 28.VIII.2017, 1 ♂; Ceyhan, 38 m, 29.VIII.2017, 1 ♂; Çukurova, 48 m, 30.VIII.2017, 1 ♂; Seyhan, 58 m, 31.VIII.2017, 1 ♂; Ceyhan, 37 m, 3.IX.2017, 1 ♀, 1 ♂; Kozan, 371m, 18.IX.2017, 2 ♂♂; Feke, 364 m, 19.IX.2017, 1 ♂; Saimbeyli, 570 m, 20.IX.2017, 1 ♂; Seyhan, 326 m, 21.IX.2017, 1 ♂; Karataş, 24 m, 22.IX.2017, 2 ♂♂; Aladağ, 225 m, 23.IX.2017, 1 ♂; İmamoğlu, 278 m, 23.IX.2017, 3 ♂♂; Pozantı, 1036 m, 24.IX.2017, 1 ♂; Karaisalı, 306 m, 24.IX.2017, 2 ♂♂ (Totally 121 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Ankara, Antalya, Artvin, Aydın, Balıkesir, Çanakkale, Diyarbakır, Edirne, Elazığ, Erzincan, Erzurum, Iğdır, İzmir, Kars, Kırıkkale, Konya, Malatya, Manisa, Mersin, Muğla, Muş, Nevşehir, Tokat, Tunceli, Uşak (Madl, 1997; Osten and Özbek, 1999; Tüzün and Bağrıaçık, 2000; Tüzün, 2004; Anlaş and Çevik, 2004; Tezcan et al., 2004; Özbek and Anlaş, 2007; Özbek and Anlaş, 2011; Bağrıaçık, 2016).

Distribution in the world: Crete, Rhodes, from Turkey through Uzbekistan (Osten, 2000).

Phenology: June-September.

Tribus Scoliini Osten, 2001

Genus *Megascolia* Betrem, 1928

Megascolia maculata maculata (Drury, 1773)

Material Examined: Adana: Kozan, 284 m, 20.VI.2017, 1 ♀; Feke, 364 m, 11.VII.2017, 1 ♀, 1 ♂; İmamoğlu, 86 m, 18.VII.2017, 1 ♀; Seyhan, 33 m, 20.VII.2017, 1 ♀; Yüreğir, Camuzcu, 42 m, 24.VII.2017, 1 ♀; Ceyhan, 154 m, 1.IX.2017, 1 ♀; Ceyhan, 37 m, 3.IX.2017, 2 ♀♀; İmamoğlu, 278 m, 23.IX.2017, 1 ♀, 1 ♂ (Totally 12 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Adıyaman, Ankara, Antalya, Aydın, Balıkesir, Bilecik, Bingöl, Bitlis, Çanakkale, Denizli, Edirne, Elazığ, Erzincan, Erzurum, Gaziantep, Gümüşhane, Hatay, Iğdır, Isparta, İstanbul, İzmir, Kahramanmaraş, Konya, Kütahya, Malatya, Manisa, Mardin, Mersin, Muğla, Niğde, Şırnak, Tokat, Tunceli, Uşak, Van, Yalova (Tkalcu, 1987; Madl, 1997; Osten and Özbek, 1999; Anlaş and Çevik, 2004; Tezcan et al., 2004; Özbek and Anlaş, 2007; Elçin and Bağrıaçık, 2015; Bağrıaçık, 2016).

World distribution: Mediterranean, France, Greece, Caucassus, Albania, Austria, Bosnia and Herzegovina, Bulgaria, Crete, Croatia, Cyclades Islands, Dodecanese Islands, Iraq, Hungary, Macedonia, North Africa, Romania, southern Russia, Turkmenistan, Slovenia (Osten, 2000; Fallahzadeh and Saghaei, 2010).

Phenology: June-September.

Genus *Scolia* Fabricius, 1775

Scolia anatolia Osten, 2004

Material Examined: Adana: Ceyhan, 32 m, 12.VI.2017, 4 ♂♂; Kozan, 284 m, 20.VI.2017, 2 ♀♀, 1 ♂; İmamoğlu, 85 m, 21.VI.2017, 3 ♂♂; Ceyhan, 33 m, 22.VI.2017, 4 ♀♀, 3 ♂♂; Kozan, 316 m, 10.VII.2017, 5 ♂♂; İmamoğlu, 86 m, 18.VII.2017, 3 ♂♂; Sarıçam, 312 m, 19.VII.2017, 3 ♂♂; Seyhan, 33 m, 20.VII.2017, 4 ♀♀, 1 ♂; Çukurova, 30 m,

21.VII.2017, 1 ♂; Seyhan, 58 m, 31.VII.2017, 2 ♂♂; Feke, 364 m, 18.VIII.2017, 2 ♂♂; Yumurtalık, 14 m, 25.VIII.2017, 4 ♀♀, 1 ♂; Ceyhan, 72 m, 26.VII.2017, 6 ♂♂; Karataş, 42 m, 28.VII.2017, 3 ♂♂; Ceyhan, 38 m, 29.VIII.2017, 5 ♂♂; Çukurova, 48 m, 30.VIII.2017, 5 ♂♂; Ceyhan, 37 m, 3.IX.2017, 2 ♀♀, 4 ♂♂; Kozan, 371 m, 18.IX.2017, 2 ♂♂; Feke, 364 m, 19.IX.2017, 3 ♂♂; Karataş, 24 m, 22.IX.2017, 2 ♀♀, 1 ♂; İmamoğlu, 278 m, 23.IX.2017, 2 ♂♂ (Totally 78 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Antalya, Artvin, Aydın, Erzurum, Iğdır, Kars, Kilis, Konya, Mersin, Muğla, Niğde, Osmaniye, Rize (Osten and Özbek, 1999; Osten, 2004; Özbek and Anlaş, 2007, Özbek and Anlaş, 2011; Elçin and Bağrıaçık, 2015; Bağrıaçık, 2016).

Distribution in the world: Crete, Dodecanese Islands, Iran, Turkey, Turkmenistan, Uzbekistan, Syria (Fallahzadeh and Saghaei, 2010).

Phenology: June-September.

Scolia fallax Eversmann, 1849

Material Examined: Adana: Kozan, 371 m, 16.VIII.2017, 1 ♀ (Totally 1 specimen, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Ankara, Artvin, Elazığ, Erzurum, Gaziantep, Hatay, İstanbul, İzmir, Kars, Kütahya, Manisa, Muğla, Niğde, Tokat (Madl, 1997; Osten and Özbek, 1999; Tüzün, 2004; Anlaş and Çevik, 2004; Tezcan et al., 2004; Özbek and Anlaş, 2004; Özbek and Anlaş, 2011; Elçin and Bağrıaçık, 2015; Bağrıaçık, 2016).

World distribution: Spain, Italy, France, Greece, Caucasus, Armenia, Azerbaijan, Dodecanese Islands, Iran, Turkmenistan, Turkey, Ukraine (Osten, 2000; Fallahzadeh and Saghaei, 2010).

Phenology: August.

Scolia fuciformis Scopoli, 1786

Mateial Examined: Adana: Ceyhan, 32 m, 12.VI.2017, 1 ♂; Yumurtalık, 24 m, 13.VI.2017, 1 ♂; Feke, 364 m, 11.VII.2017, 1 ♀, 1 ♂; Saimbeyli, 950 m, 12.VII.2017, 1 ♂; İmamoğlu, 86 m, 18.07.2017, 1 ♂; Sarıçam, 312 m, 19.VII.2017, 1 ♂; Ceyhan, 156 m, 22.VII.2017, 1 ♂; Yumurtalık, 20 m, 26.VII.2017, 1 ♂; Karataş, 8 m, 27.VII.2017, 1 ♂; Ceyhan, 38 m, 29.VII.2017, 1 ♂; İmamoğlu, 94 m, 17.VIII.2017, 1 ♂; Saimbeyli, 903 m, 22.VIII.2017, 1 ♂; Karataş, 42 m, 28.VIII.2017, 1 ♂; Ceyhan, 37 m, 3.IX.2017, 1 ♀, 2 ♂♂ (Totally 17 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bitlis, Diyarbakır, Erzincan, Erzurum, Hatay, İzmir, Kars, Konya, Manisa, Muş, Niğde, Osmaniye, Tunceli, Yozgat (Osten and Özbek, 1999; Tüzün, 2004; Tezcan et al., 2004; Özbek and Anlaş, 2007; Özbek and Anlaş, 2011; Elçin and Bağrıaçık, 2015; Bağrıaçık, 2016).

Distribution in the world: Balkan peninsula, Egypt, Italy, Iran (Osten, 2003).

Phenology: June-September.

Scolia galbula (Pallas, 1771)

Material Examined: Adana: Karataş, 13 m, 14.VI.2017, 1 ♀, 1 ♂; Kozan, 284 m, 20.VI.2017, 2 ♀, 1 ♂; Feke, 364 m, 11.VII.2017, 1 ♂; Kozan, 304 m, 13.VII.2017, 1 ♀; İmamoğlu, 86 m, 18.VII.2017, 2 ♂♂; Ceyhan, 156 m, 22.VII.2017, 1 ♂; Yüreğir, 42 m, 24.VII.2017, 1 ♂; Yumurtalık, 20 m, 26.VII.2017, 1 ♀; Feke, 364 m, 18.VIII.2017, 1 ♂; Yumurtalık, 20 m, 27.VIII.2017, 1 ♀; Kozan, 371 m, 18.IX.2017, 1 ♂; İmamoğlu, 278 m, 23.IX.2017, 1 ♀ (Totally 16 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Afyonkarahisar, Ankara, Antalya, Artvin, Aydın, Denizli, Erzincan, Erzurum, Hakkari, Hatay, İzmir, Kars, Konya, Manisa, Mersin, Muğla, Trabzon (Osten and Özbek, 1999; Tüzün, 2004; Anlaş and Çevik, 2004; Tezcan et al., 2004; Özbek and Anlaş, 2007; Özbek and Anlaş, 2011).

Distribution in the world: Azerbaijan, Georgia, Transcaucasia, France, Italy, Balkan peninsula, Hungary, Ukraine, Bulgaria, Cyprus, Caucasus, Egypt, Greece, Israel (Osten, 1999a, 2002, 2005a; Tüzün, 2004).

Phenology: June-September.

Remarks: This species is new record for Adana province.

Scolia hirta hirta (Schrank, 1781)

Material Examined: Adana: Yumurtalık, 24 m, 13.VI.2017, 1 ♂; Karataş, 13 m, 14.VI.2017, 1 ♂; Karaisalı, 317 m, 15.VI.2017, 1 ♂; Kozan, 284 m, 20.VI.2017, 1 ♂; Ceyhan, 33 m, 22.VI.2017, 1 ♂; Kozan, 316 m, 10.VII.2017, 1 ♀, 1 ♂; Feke, 364 m, 11.VII.2017, 2 ♀♀, 1 ♂; Feke, 603 m, 15.VII.2017, 2 ♂♂; Kozan, 356 m, 16.VII.2017, 1 ♂; İmamoğlu, 86 m, 18.VII.2017, 1 ♂; Sarıçam, 312 m, 19.VII.2017, 1 ♂; Ceyhan, 212 m, 23.VII.2017, 2 ♂♂; Yüreğir, 42 m, 24.VII.2017, 2 ♀♀, 2 ♂♂; Yumurtalık, 20 m, 26.VII.2017, 1 ♂; Karataş, 8 m, 27.VII.2017, 1 ♂; Kozan, 371 m, 16.VIII.2017, 1 ♂; Saimbeyli, 884 m, 19.VIII.2017, 1 ♀, 1 ♂; Yumurtalık, 14 m, 25.VIII.2017, 1 ♂; Seyhan, 58 m, 31.VIII.2017, 1 ♂; Ceyhan, 78 m, 2.IX.2017, 2 ♀♀, 1 ♂; Feke, 364 m, 19.IX.2017, 1 ♂; Seyhan, 326 m, 21.IX.2017, 1 ♀; Aladağ, 225 m, 23.IX.2017 1 ♀, 1 ♂, Karaisalı, 306 m, 24.IX.2017, 1 ♂ (Totally 36 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Ankara, Antalya, Artvin, Aydın, Burdur, Denizli, Elazığ, Erzincan, Erzurum, Hakkari, Hatay, Isparta, İçel, İzmir, Karabük, Kars, Kayseri, Konya, Muğla, Niğde, Osmaniye, Tokat, Rize (Osten and Özbek, 1999; Tüzün and Bağrıaçık, 2000; Tüzün, 2004; Anlaş and Çevik, 2004; Tezcan et al., 2004; Özbek and Anlaş, 2007; Japoshvili and Karaca, 2010; Özbek and Anlaş, 2011; Elçin and Bağrıaçık, 2015; Bağrıaçık, 2016).

Distribution in the world: Southern and eastern Europe, central Europe, north Africa, Israel, Lebanon, Iran, southern Russia (Osten, 2000).

Phenology: June-September.

Scolia sexmaculata sexmaculata (Müller, 1766)

Material Examined: Adana: Ceyhan, 32 m, 12.VI.2017, 1 ♂; Yumurtalık, 24 m, 13.VI.2017, 1 ♀, 1 ♂; Karataş, 13 m, 14.VI.2017, 2 ♀♀, 1 ♂; Karaisalı, 317 m, 15.VI.2017, 1 ♂; Seyhan, 312 m, 18.VI.2017, 1 ♂; Çukurova, 27 m, 19.VI.2017, 1 ♂; Kozan, 284 m, 20.VI.2017, 2 ♂♂; İmamoğlu, 85 m, 21.VI.2017, 1 ♂; Ceyhan, 33 m, 22.VI.2017, 3 ♂♂; Kozan, 316 m, 10.VII.2017, 2 ♀♀, 1 ♂; Feke, 364 m, 11.VII.2017, 3 ♂♂; Saimbeyli, 950 m, 12.VII.2017, 1 ♂; Kozan, 304 m, 13.VII.2017, 1 ♀, 2 ♂♂; Feke, 557 m, 14.VII.2017, 1 ♂; Feke, 603 m, 15.VII.2017, 1 ♂; Kozan, 356 m, 16.VII.2017, 1 ♂; Tufanbeyli, 1470m, 17.VII.2017, 1 ♂; İmamoğlu, 86 m, 18.VII.2017, 1 ♂; Sarıçam, 312 m, 19.VII.2017, 1 ♂; Seyhan, 33 m, 20.VII.2017, 1 ♂; Çukurova, 30 m, 21.VII.2017, 2 ♂♂; Ceyhan, 156 m, 22.VII.2017, 1 ♀, 2 ♂♂; Ceyhan, 212 m, 23.VII.2017, 1 ♂; Yüreğir, 42 m, 24.VII.2017, 1 ♂; Yumurtalık, 17 m, 25.VII.2017, 1 ♂; Yumurtalık, 20 m, 26.VII.2017, 2 ♀♀, 1 ♂; Karataş, 8 m, 27.VII.2017, 1 ♂; Ceyhan, 43 m, 28.VII.2017, 1 ♂; Feke, 580 m, 14.VIII.2017, 1 ♂; Kozan, 342 m, 15.VIII.2017, 2 ♂♂; Kozan, 371 m, 16.VIII.2017, 1 ♂; İmamoğlu, 94 m, 17.VIII.2017, 1 ♂; Feke, 364 m, 18.VIII.2017, 1 ♂; Saimbeyli, 884 m, 19.VIII.2017, 1 ♂; Sarıçam, 337 m, 24.VIII.2017, 1 ♂; Yumurtalık, 14 m, 25.VIII.2017, 1 ♀, 2 ♂♂; Ceyhan, 72 m, 26.VIII.2017, 2 ♀♀, 3 ♂♂; Yumurtalık, 20 m, 27.VIII.2017, 1 ♂; Karataş, 42 m, 28.VIII.2017, 1 ♂; Ceyhan, 38 m, 29.VIII.2017, 1 ♂; Çukurova, 48 m, 30.VIII.2017, 1 ♂; Seyhan, 58 m, 31.VIII.2017, 1 ♂; Ceyhan, 37 m, 3.IX.2017, 1 ♂; Kozan, 371m, 18.IX.2017, 1 ♀, 1 ♂; Feke, 364 m, 19.IX.2017, 2 ♀♀, 1 ♂; Saimbeyli, 570 m, 20.IX.2017, 1 ♂; Seyhan, 326 m, 21.IX.2017, 1 ♂; Karataş, 24 m, 22.IX.2017, 2 ♂♂; Aladağ, 225 m, 23.IX.2017, 1 ♂; İmamoğlu, 278 m, 23.IX.2017, 1 ♂; Pozantı, 1036 m, 24.IX.2017, 1 ♂; Karaisalı, 306 m, 24.IX.2017, 1 ♂ (Totally 80 specimens, leg. S. E. Yalnız).

Distribution in Turkey: Adana, Adıyaman, Ankara, Antalya, Aydın, Bitlis, Burdur, Bursa, Diyarbakır, Erzincan, Erzurum, Gaziantep, Isparta, İçel, İstanbul, İzmir, Kars, Kayseri, Konya, Manisa, Muğla, Muş, Nevşehir, Niğde, Osmaniye, Van (Madl, 1997; Osten and Özbek, 1999; Tüzün and Bağrıaçık, 2000; Tüzün, 2004; Anlaş and Çevik, 2004; Tezcan et al. 2004; Japoshvili and Karaca, 2010; Özbek and Anlaş, 2011; Elçin and Bağrıaçık, 2015; Bağrıaçık, 2016).

Distribution in the world: North Africa, England, Germany, southern and eastern Europe, Balkan peninsula, Israel, Iran (Osten, 2000).

Phenology: June-September.

4. Conclusions and discussion

This is the first comprehensive study of its kind to be carried out in the Adana province, involving 363 Scoliidae samples. As a result of the study, nine Scoliidae species of three genera were determined, and were evaluated systematically, faunistically and ecologically. *Colpa klugii* (Vander Linden, 1827); *Colpa sexmaculata* (Fabricius, 1782); *Megascolia maculata maculata* (Drury, 1773); *Scolia anatolia* Osten, 2004; *Scolia fallax* Eversmann, 1849; *Scolia fuciformis* Scopoli, 1786; *Scolia galbula* (Pallas, 1771); *Scolia hirta hirta* (Schrank, 1781); *Scolia sexmaculata sexmaculata* (Müller, 1766) were collected from study areas, and among these, *Colpa klugii* (Vander Linden, 1827 and

Scolia galbula (Pallas, 1771) were firstly recorded from Adana with this study. The population density was the highest in the *Colpa sexmaculata* (33%) and *Scolia sexmaculata sexmaculata* (22%) species, and lowest in the *Colpa klugii* and *Scolia fallax* (1%) species. Scoliidae species were found at altitudes of between 8 and 1740 meters, but mostly at altitudes between 212 and 980 meters. The *Colpa sexmaculata* species was found to have a wide tolerance of altitudes, being found at altitudes of between 960 meters and 1470 meters in Tufanbeyli. Phenologically, *Scolia fallax* species was found only in August. Other species were abundant between June and September, with the highest species diversity and population density observed in July and August. The flight activities of the male samples were higher than the females, as female Scoliidae were generally observed to hide beneath the soil. Turkey is very rich as regards to ophiolitic rock and endemism.

Except for the eastern and south eastern part of the country the ultramaphic rocks are present all over Turkey. They are frequently observed in Kütahya, Balıkesir, Antalya, Muğla, Hatay and Adana regions in Amanos Mountains, in Eastern Taurus, north and northeast of Mersin and between Niğde and Adana, in Aladağ massive and thousands of kilometer square land from Adana to Erzincan. Also they are locally present between Ankara and Çanakkale regions (Kurt et al., 2013). Scoliidae were generally reported to feed on red, purple and blue flowers, such as *Alhagi*, *Carthamus* and *Mentha*, and during the field studies, the Scoliidae species were mostly seen to feed together on the same plants. *Colpa klugii* and *Megascolia maculata maculata* species were most often collected from *Echinops* plants, while the *Scolia hirta hirta* was collected from *Origanum* plants.

This study has identified nine taxa of the Scoliidae family in the Adana province, while *Colpa klugii* (Vander Linden, 1827) and *Scolia galbula* (Pallas, 1771) from the Hymenoptera fauna were reported for the new records in the Adana province. The present study has detailed the distribution of the Scoliidae species in the Adana province, and has identified their contribution to Turkey's biological diversity.

References

Anlaş, S., Çevik, E. İ. (2004). Manisa ilindeki Scoliidae (Hymenoptera) familyası türleri üzerinde faunistik araştırmalar. Turkish Journal of Entomology, 28, 221-228.

Bağrıaçık, N. (2016). The Situation of the Scoliidae (Hymenoptera: Vespoidea) in the Çukurova Region. Hacettepe Journal of Biology and Chemistry, 44(2), 149-153.

Betrem, J.G. (1935). Beitrag zur Kenntnis der palaarktischen Arten des Genus *Scolia*. Tijdschrift Voor Entomologie, 78, 1-78.

Ciotek, L., Giorgis, P., Benitez-Vieyra, S., Cocucci, A.A. (2005). First confirmed case of pseudocopulation in terrestrial orchids of South America: Pollination of *Geoblasta pennicillata* (Orchidaceae) by *Campsomeris bistrimacula* (Hymenoptera, Scoliidae). Flora, 201, 365-369.

Elçin, G.B., Bağrıaçık, N. (2015). A study on Turkish Scoliidae (Hymenoptera). Entomofauna, 36(3), 49-52.

Fallahzadeh, M., Saghaie, N.A. (2010). A Brief Study on The Scoliidae in Iran (Insecta: Hymenoptera). Munis Entomology and Zoology, 5, 792-795.

Japoshvili, G., Karaca, İ. (2010). List of Vespidae, Scoliidae and Tiphiidae (Hymenoptera) of Gölcük Natural Park in Isparta Province, Turkey. Süleyman Demirel University Journal of Science, 5, 194-199.

Goulet, H., Huber, J.T. (1993). Hymenoptera of the world: An identification guide to families. Research Branch Agriculture Canada Press, Canada, 668p.

Kurt, L., Özbey, B.G., Kurt, F., Özdeniz, E., Bölükbaşı, A. (2013). Serpentine Flora of Turkey. Biological Diversity and Conversation, 6(1), 134-152.

Madl, M. (1997). Über Vespiden, Pompiliden, Scoliiden und Tiphiiden der Türkei (Hymenoptera). Linzer biologischen Beiträge, 29, 823-827.

Osten, T. (1999a). Beobachtungen an Scoliiden (Hymenoptera) in der Türkei. Linzer biologischen Beiträge, 31, 449-457.

Osten, T., Özbek, H. (1999). Beitrag zur Kenntnis der Scoliiden-Fauna der Türkei (ohne Zypren) mit Anmerkungen zur Systematik und Taxonomie (Hymenoptera, Scoliidae). Entomofauna, 31, 429-444.

Osten, T. (2000). Die Scoliiden des Mittelmeer-Gebietes und angrenzender Regionen (Hymenoptera) Ein Bestimmungsschlüssel. Linzer biologischen Beiträge, 32, 557-593.

Osten, T. (2002). Beitrag zur Kenntnis der Scoliidenfauna von Israel (Hymenoptera, Scoliidae). Zeitschrift für entomologie, 28, 337-352.

Osten, T., Ebrahimi, E., Chahartaghi, A.M. (2003). Die Scoliiden des Iran und angrenzender Regionen mit Anmerkungen zu ihrer Lebensweise (Hymenoptera, Scoliidae). Entomofauna, 26, 353-380.

Osten, T. (2004). Beitrag zur Kenntnis der Scoliiden-Fauna Griechenlands (ohne Zypren) (Hymenoptera, Scoliidae). Zeitschrift für entomologie, 20, 305-320.

Osten, T. (2005a). Die Scoliiden-Fauna Mittelasiens (Hymenoptera, Scoliidae) (Kazakhstan, Turkmenistan, Uzbekistan, Tadzhikistan, Kirgistan) Ein Bestimmungschlüssel. Linzer biologischen Beiträge, 37, 1451-1479.

Osten, T. (2005b). Checkliste der Dolchwespen der Welt (Insecta: Hymenoptera: Scoliidae). Bericht der Naturforshenden Gesselschaft Augsburg, 1-62.

Özbek, H., Anlaş, S. (2007). New records for some Turkish Scoliidae (Hymenoptera). Zoology in the Middle East, 41, 112-114.

Özbek, H., Anlaş, S. (2011). Distribution of Scoliidae (Hymenoptera: Aculeata) of Turkey with their zoogeographic characterization. Turkish Journal of Entomology, 35, 627-639.

Tezcan, S., Karsavuran, Y., Pehlivan, E., Anlaş, S. (2004). Contribution to the knowledge of Scoliidae (Hymenoptera) fauna of Turkey. Turkish Journal of Entomology, 28, 247-252.

Tkalcu, B. (1987). Ergebnisse der Tschechoslowakisch-Iranischen Entomologischen Expedition nach dem Iran 1970, 1973 und 1977 (Mit Angaben über einige Sammelresultate in Anatolien) Hymenoptera: Scoloidea, Scoliidae. Acta Entomology Museum Natural Prague, 42, 287-291.

Tüzün, A., Bağrıaçık, N. (2000). Some Faunistic Records on The Scoliidae (Insecta: Hymenoptera) Species in Balıkesir, İzmir, Manisa and Muğla Provinces. Selçuk Üniversitesi Fen-Edebiyat Fakültesi Fen Dergisi, 17, 1-13.

Tüzün, A. (2004). Studies on Scoliidae (Insecta: Hymenoptera) Fauna of Ankara Province. Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 16, 25-29.

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Research article/Araştırma makalesi

Determination of phenolic compounds and antibacterial activity of *Juglans regia*

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Abstract

Treatment with plants has gained more importance because of reaching critical limits to antibiotic resistant. In this study phenolic compounds of walnut membrane was analyzed using by HPLC. Antibacterial activity of methanol and ethanol extracts of juglans fruit membranes were evaluated against Gram-positive and Gram-negative strains (*Bacillus cereus* ATCC 11778, *Enterecoccus faecalis* ATCC 29212, *Staphylococcus aureus* ATCC 25923, *Methicillin-Resistant Staphylococcus aureus* ATCC 43300, *Chromobacterium violaceum* ATCC 12472, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Pseudomonas aeruginosa* PAO1 and clinical *Staphylococcus spp*. As a results; it was observed that all extracts had antibacterial activity on Gram-positive strains different rate (12 mm to 19 mm). The lowest minimum inhibitory concentration (MIC) value was detected 1,01 mg/ml for reference strains. HPLC analysis showed walnut membrane extracts have some phenolic acids and flavonoids such as gallic acid, epicatechin, catechin, rutin, p-hydroxy benzoic acid, p-coumaric acid, rosmarinic acid.

Key words: Walnut membrane, phenolic, HPLC, antibacterial

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Juglans regia fenolik bileşen içeriklerinin ve antibakteriyel aktivitesinin belirlenmesi

Özet

Antibiyotik direncinin kritik seviyelere ulaşması neticesinde enfeksiyon hastalıklarının tedavisinde bitkilerin kullanımı giderek önem kazanmıştır. Yapılan bu çalışmada ceviz ara kabuğunun içerdiği bazı fenolik bileşikler HPLC ile analiz edilmiştir. Ayrıca antibakteriyel etkisi bazı Gram-pozitif ve Gram-negatif (*Bacillus cereus* ATCC 11778, *Enterecoccus faecalis* ATCC 29212, *Staphylococcus aureus* ATCC 25923, *Methicillin-Resistant Staphylococcus aureus* ATCC 43300, *Chromobacterium violecium* ATCC 12472, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Pseudomonas aeruginosa* PAO1) suşlar ile klinik Stafilokok izolatları üzerinde antibakteriyel etkisi araştırılmıştır. Sonuçta ekstraktların Gram-pozitif bakterilere karşı farklı oranlarda antibakteriyel etkiye sahip olduğu gözlenmiştir (12 mm-19 mm). Gram-negatif bakterilerden ise sadece *C. violaceum* ATCC 12472 üzerinde antibakteriyel etkisi olduğu gözlenmiştir. Minumum inhibisyon konsantrasyon değeri ise en düşük 1,01 mg/ml olarak tespit edilmiştir. HPLC analiz sonuçlarına göre de farklı oranlarda fenolik asit ve flavonoid (gallik asit, epikateşin, kateşin, rutin, p-hidroksi benzoik asit, p-kumarik asit, rosmarik asit) içerdiği tespit edilmiştir.

Anahtar kelimeler: Ceviz ara kabuk, fenolik, HPLC, antibakteriyel

1. Giriş

Bakterilerde artan antibiyotik direnci, enfeksiyon hastalıkları ile mücadelede başarısızlığın başlıca nedenlerinden biridir. Özellikle bağışıklık sistemi baskılanmış hastaların önemli bir kısmında mortalite ve morbiditenin en önemli nedeni enfeksiyonlardır (Taşova, 2003). İnsanlık tarihi boyunca birçok hastalığın bitkiler kullanılarak tedavi edilmesi mikroorganizmalarla mücadelede de sıklıkla başvurulan bir çözüm yolu olmuş ve günümüzde artan antibiyotik direnci bitkilerle tedavi seçeneğinin umut vaat eden bir strateji olarak görülmesine neden olmuştur. Dünyanın her yerinde yetişen

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birçok bitkinin kök, gövde, yaprak, çiçek, kabuk, meyve gibi dokuları antimikrobiyal aktivite çalışmalarında kullanılmış ve halen kullanılmaya devam etmektedir. Ceviz (*Juglans regia* L.), de *Juglans* cinsine ait bir bitki olup, başta Çin, ABD ve İran olmak üzere dünya genelinde yaygın olarak yetişmekte ve bu ülkelerden sonra en fazla ceviz üretimi ülkemizde gerçekleşmektedir (Bayazit vd., 2016; Kadiroğlu ve Ekici, 2018). Ceviz çoğunlukla meyve olarak tüketilmekte olup, yeşil kabukları, yaprakları kozmetik ve ilaç sanayide etken madde, tekstilde ise boyar madde olarak kullanılmaktadır (Beiki et al., 2017). Geleneksel tedavide ise yeşil kabukları ya da yapraklarının özellikle venöz yetmezlik ve hemoroit semptomlarının giderilmesinde antidiaretik, antihelmintik özelliklerinden yararlanıldığı bilinmektedir (Pereira et al., 2007). Ceviz bitkisinin farklı dokuları ile yapılmış birçok antibakteriyel aktivite çalışması olup, yapılan bir çalışmada ceviz ekstraktlarının kozmetik ürünler içerisinde kimyasal bazlı koruyucular yerine potansiyel doğal koruyu olarak kullanılabileceği gösterilmiştir (Beiki et al., 2017). Bitkilerin tedavi edici özellikleri yapılarında bulunan fitokimyasallar sayesinde olup, bu bileşenler ile antibakteriyel, antioksidan, antikanser ya da insan sağlığı için önem arz eden birçok özellik göstermektedirler. Bütün bitkiler sekonder metabolit olarak fenolik madde oluşturmaktadırlar (Karadeniz ve Ekşi, 2001). Fenolik bileşik terimi, fonksiyonel türevleri de dahil olmak üzere hidroksil grubu taşıyan aromatik halkaya sahip 8000'den fazla türü bulunduğu bilinen bir gruptur (Shi et al., 2003; Ignat et al., 2011; Özaydın, 2013). Bitkilerde bulunan en önemli bileşenler arasında yer alan fenolik bileşenlerin makromoleküllerin oksidasyonunu inhibe ederek ya da oksidatif stresi azaltarak dejeneratif hastalık riskini azalttığı da bilinmektedir (Silva et al., 2004). Gram-pozitif bakteriler hem toplum hem de hastane kökenli infeksiyonların önemli nedenlerinden olup, dünya genelinde Gram-pozitif patojenlerde direnç hızı alarm verici ölçüde artmaktadır (Özkaya Şahin, 2003). Nozokomiyal enfeksiyonlarda özellikle *Staplococcus aureus* ve *Staplococcus epidermidis* önemli olup, yapılan bu çalışmada ceviz ara kabuğunun metanol, etanol ekstraktlarının klinik Stafilokok izolatları ve referans Gram-pozitif, Gram-negatif suşlar üzerindeki antibakteriyel etkisi araştırılmıştır. Yapılan literatür taramasında ceviz bitkisi ile yapılan antibakteriyel aktivite çalışmalarının genellikle ceviz yeşil kabuğunun kurutulması ve yaprak ekstraktları ile olduğu görülmüş, ceviz ara kabuğu ile yapılan bir çalışmaya rastlanmamıştır.

2. Materyal ve yöntem

1.1. Bitki örnekleri ve ekstraksiyon

Çalışmada kullanılan cevizler Isparta yöresine ait olup ticari olarak temin edilmiştir. Kuru olan cevizlerin iki ceviz parçasını birbirinden ayıran iç kabukları çıkartılmış ve blender (Waring 8011 EB) yardımı ile toz haline getirilmiştir. Toz materyalden 5 gr tartılarak 50 ml çözücü (Metanol, Etanol) eklenmiştir. Çözücü-toz karışımı ultrasonik banyoda 30 dakika ekstrakte edilmiş ve kaba filtre kâğıdı ile süzüldükten sonra 40-45ºC'de rotary evaporatör (Heıdolph Hei-Vap Rotary Evaporator) kullanılarak çözücüler uzaklaştırılmıştır. İşlem sonunda balon içerisinde kalan bitki özütü tartılarak kaydedilmiş ve Dimetilsülfoksit (DMSO) ile çözülerek alınmıştır.

2.2. HPLC-DAD analizi

Ceviz iç kabuğu ile hazırlanan ekstraktlar HPLC analizinde Gomes vd. (1999)'nin kullandığı metot üzerinde bazı modifikasyonlar yapılarak kullanılmıştır. Literatürdeki mobil faz A'da % 2 asetik asit kullanılmış olup, bu çalışmada % 3 asetik asit kullanılmıştır. Ayrıca literatürde 1 mL/dk olan akış hızını 0.8 ml/dk'ya düşürülmüştür. Çalışmada 23 adet fenolik bileşeni 90 dakikalık bir gradiyent program ile ayırım yapılmıştır. Çalışmaya dahil edilen meyvelerin fenolik bileşiklerinin tespiti Photo Diode Array dedektörde 278 nm dalga boyunda gerçekleştirilmiştir. Kolon olarak Agilent Eclipse XDB C-18 (250 x 4.6 mm) 5 µm kolon kullanılmıştır.

Tablo 1. HPLC çalışma koşulları

	Süre (dk)	**A (%)**	**B (%)**
Dedektör: Photo Diode Array dedektör (λmax=278nm)	0	93	7
Auto sampler: SIL–10AD vp	20	72	28
Sistem kontrol: SCL-10Avp	28	75	25
Pompa: LC-10ADvp	35	70	30
Degaser: DGU- 14A	50	70	30
Kolon fırını: CTO-10Avp	60	67	33
Kolon: Agilent Eclipse XDB C-18 (250x4,6 mm) 5 µm	62	58	42
Kolon sıcaklığı: 30 °C	70	50	50
Mobil faz: A = Su / asetik asit (97/3: v/v) pH:2,2	73	30	70
B = Metanol	75	20	80
Akış hızı: 0,8 mL/dak	80	0	100
Enjeksiyon hacmi: 20 µL	81	93	7

Ters faz kolonu olarak Agilent Eclipse XDB C-18 (250 x 4.6 mm) 5 µm kolon kullanılmış; ayırım, ikili çözücü sistemiyle gradient program uygulanarak yapılmıştır. Çözeltiler hazırlandıktan sonra bir süre ultrasonik banyoda bekletilerek içlerindeki hava kabarcıklarının uzaklaşması sağlanmış, gradient program bittikten sonra kolonu dengeye getirmek amacıyla kolondan 10 dakika mobil faz geçirilmiştir.

2.3. Bakteriyel suşlar ve antibakteriyel aktivite

Çalışmada farklı servislerden kan, balgam, yara, kulak örneklerinden izole edilen ve daha önce konvensiyonel yöntemlerle tiplendirilmiş, Eczacılık Fakültesi bakteri stoğunda yer alan *S. aureus* (6), *S. epidermidis* (3) ve *S. hominis* (5) suşları ile standart *B. cereus* ATCC 11778, *E. faecalis* ATCC 29212, *S. aureus* ATCC 25923, *MRSA* ATCC 43300, *C.violecium* ATCC 12472, *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853, *P. aeruginosa* PAO1 suşları kullanılmıştır. Ceviz ara kabuk ekstraktlarının antibakteriyel etkileri agar kuyucuk yöntemi kullanılarak test edilmiştir (Holder and Boyce, 1994). Luria-Bertani besiyerinde 37 ºC'de bir gece süreyle üretilen bakteriler, ertesi gün 0,5 McFarland bulanık değerine göre süspansiyonlar hazırlanmıştır. 5 ml soft agar (%0,5 agar) içerisine 100 µl 0,5 McFarland bulanıklıkta hazırlanmış olan bakteri süspansiyonundan eklenerek petrilerde hazırlanmış olan Müller-Hinton agar besiyeri üzerine dökülmüştür. Bir süre kurumaya bırakılan besiyerleri üzerinde 6 mm çapında cam pipet yardımı ile kuyucuklar açılmış ve kuyucuklar içerisine 100 µl bitki ekstraktları eklenmiştir. 35ºC'de 24 saat inkübasyon sonunda oluşan zon çapları ölçülerek antibakteriyel aktivite belirlenmiştir.

2.4. İstatistiksel analiz

Deneyler tesadüf parselleri deneme desenine göre üç tekrarlı yürütülmüş olup, elde edilen veriler JMP 8 paket istatistik programı kullanılarak varyans analizine tabi tutulmuştur. İstatistiksel farklılıklar LSD çoklu karşılaştırma testi ile harflendirilmiştir.

3. Bulgular

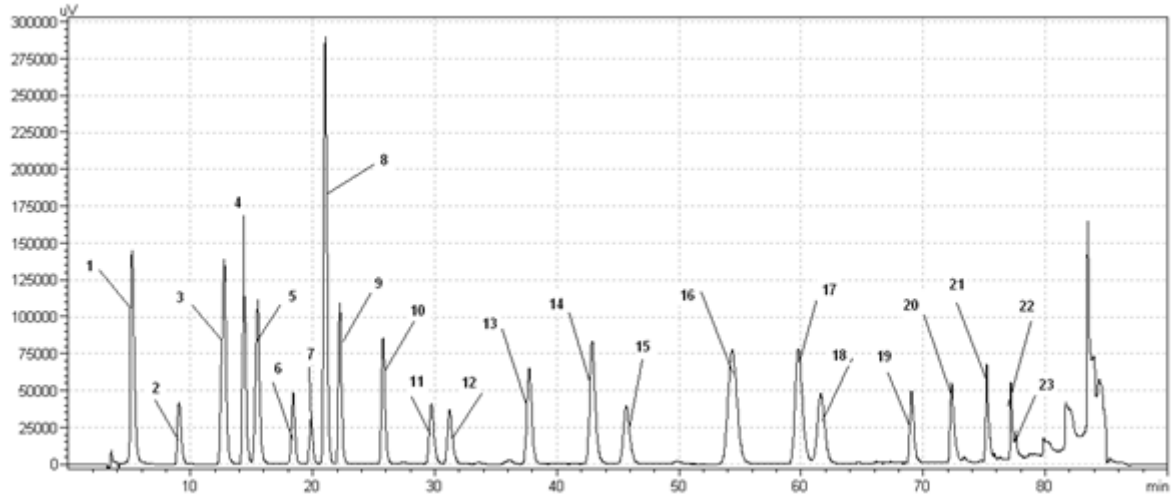
3.1. Fenolik bileşen

Metanol ve etanol ile hazırlanan ceviz ara kabuk ekstraktlarında HPLC analizi sonuçlarına göre varlığı araştırılan 23 fenolik bileşen Tablo 2'de verilmiş olup, tespit edilen fenolik asit (gallik asit, protokateşik asit, p-hidroksi benzoik asit, p-kumarik asit, rosmarinik asit) ve flavonol (kateşin, epikateşin, rutin) bileşenlerinin tamamının metanol ekstraktında daha fazla oranda olduğu saptanmıştır. Ayrıca fenolik asit standart kromatogramı ile ekstraktlara ait fenolik bileşen profilleri Şekil 1, Şekil 2 ve Şekil 3 de verilmiştir.

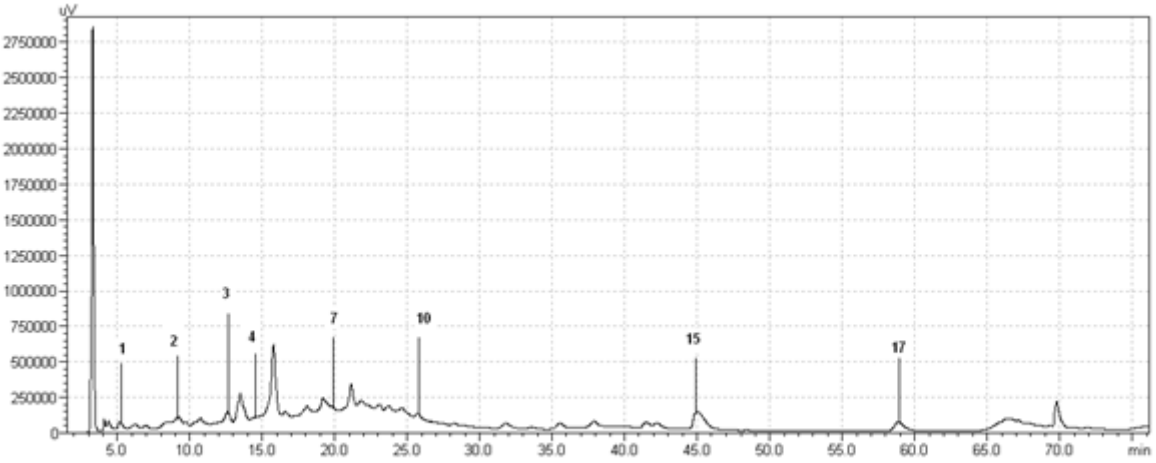
Tablo 2. Ceviz ara kabuk ekstraktları fenolik bileşen içerikleri

İçerik	**Etanol (µg.g^{-1})**	**Metanol (µg.g^{-1})**
Fenolik asitler		
gallik asit	5,2	16,1
protokateşik asit	29,6	56,4
p-hidroksi benzoik asit	19,9	27,3
klorojenik asit	*	*
kafeik asit	*	*
şiringikasit	*	*
vanilin	*	*
p-kumarik asit	5,5	10,7
ferulik asit	*	*
sinapinik asit	*	*
benzoik asit	*	*
o-kumarik asit	*	*
rosmarinik asit	193,3	339,2
sinnamik asit	*	*
Flavonoller		
kateşin	94,4	201,4
epikateşin	98,1	181,2
rutin	88,3	158,7
hesperidin	*	*
eriodiktiol	*	*
quercetin.2H2O	*	*
luteolin	*	*
kamferol	*	*
apigenin	*	*

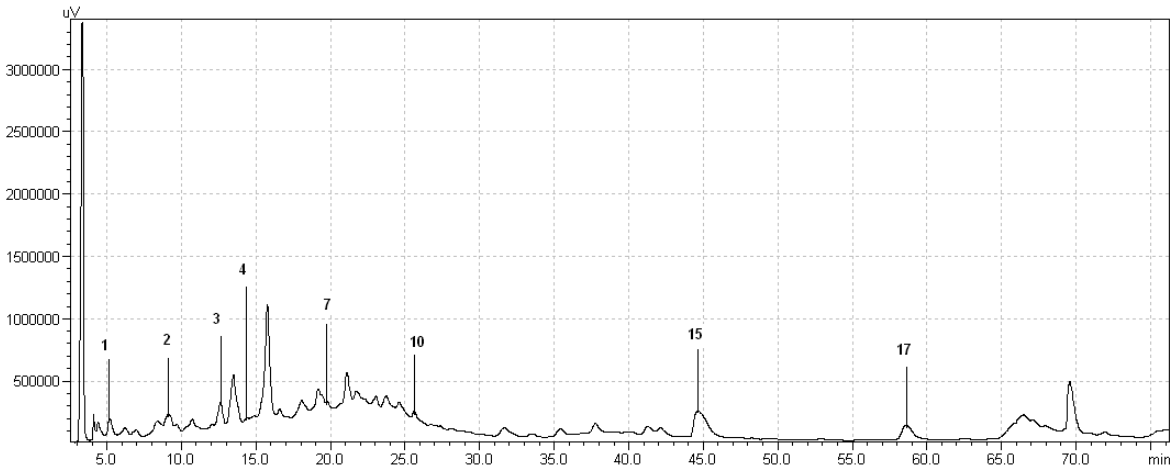
* tespit edilmedi



Şekil 1. Fenolik bileşen standart kromatogramı. Standartlar: 1. Gallik asit 2. Protokateşik asit 3. Kateşin 4. p-hidroksi benzoik asit 5. Klorojenik asit 6. Kafeik asit 7. Epikateşin 8. Şiringiç asit 9. Vanilin 10. p-Kumarik asit 11. Ferulik asit 12. Sinapinik asit 13. Benzoik asit 14. o- kumarik asit 15. Rutin 16. Hesperidin 17. Rosmarinik asit 18. Eriodiktiol 19. Sinnamik asit 20. Quersetin 21. Luteolin 22. Kamferol 23. Apigenin.



Şekil 2. Ceviz ara kabuk etanol ekstraktına ait fenolik bileşen kromotogramı.1.Gallik asit 2. Protokateşik asit 3. Kateşin 4. p-hidroksi benzoik asit 7. Epikateşin 10. p-Kumarik asit 15. Rutin 17. Rosmarinik asit.



Şekil 3. Ceviz ara kabuk etanol ekstraktına ait fenolik bileşen kromatogramı. 1. Gallik asit 2. Protokateşik asit 3. Kateşin 4. p-hidroksi benzoik asit 7. Epikateşin 10. p-Kumarik asit 15. Rutin 17. Rosmarinik asit.

3.2. Antibakteriyel aktivite

Ceviz ekstraktlarının antibakteriyel etkileri agar kuyucuk yöntemi ile üç tekrarlı olarak test edilmiştir. Elde edilen verilere göre referans suşlar üzerinde her iki ekstrakt farklı oranlarda antibakteriyel etki gösterirken Gram-negatif suşlardan ise sadece *C. violaceum* ATCC 12472 antibakteriyel etki gözlenmiştir (Tablo 3). Ekstraktların bakteriler üzerindeki MIC değerleri Tablo 4 de verilmiş olup, en düşük MIC değeri etanol ekstraktında 1,01 mg/ml olarak tespit edilmiş ve MRSA ve *B. cereus* suşları üzerinde etkili olmuştur.

Tablo 3. Ekstraktların referans suşlar üzerinde antibakteriyel etkisi

	***S. aureus* (G+) ATCC 25923**	**MRSA (G+) ATCC 43300**	***B. cereus* (G+) ATCC 11778**	***E. faecalis* (G+) ATCC 29212**
CN (100 µg/ml)	15,3 c**	15,3 b**	19,7 a**	15,0 a**
EtOH	17,3 b	17,0 a	16,7 b	12,0 b
MeOH	19,7 a	16,0 b	16,7 b	12,3 b
	***C. violeceum* (G-) ATCC 12472**	***E. coli* (G-) ATCC 25922**	***P. aeruginosa* (G-) ATCC 27853**	***P. aeruginosa* (G-) PAO1**
CN (100 µg/ml)	13,7 *öd*	*Ed*	*Ed*	*Ed*
EtOH	13,7	*Ed*	*Ed*	*Ed*
MeOH	15,0	*Ed*	*Ed*	*Ed*

CN: gentamisin. Aynı harfi alan ortalamalar arasındaki farklılık istatistiksel olarak önemsizdir (**p<0,01). *Öd*; önemli olmayan istatistiksel farklılığı göstermektedir. *Ed*; etkili değil.

Tablo 4. MIC değerleri (mg/ml)

	***S. aureus* (G+) ATCC 25923**	**MRSA (G+) ATCC 43300**	***B. cereus* (G+) ATCC 11778**	***E. faecalis* (G+) ATCC 29212**	***C. violaceum* (G-) ATCC 12472**
EtOH	2,125	1,01	1,22	2,125	2,125
MeOH	1,22	1,22	1,22	1,22	1,22

Tablo 5. Ceviz ara kabuk etanol ve metanol ekstraktlarının *S. epidermis* klinik izolatları üzerine antibakteriyel etkisi

	Örnek yeri	**Klinik İzolat**	**İnhibisyon zon çapı (mm)**
	kan	5196	16,3 ab*
CN (100 µg/ml)	kan	7445	17,0 a
	kan	8461	15,3 b
	kan	5196	13,0 c
EtOH	kan	7445	16,3 ab
	kan	8461	13,7 c
	kan	5196	13,0 c
MeOH	kan	7445	17,0 a
	kan	8461	13,0 c

CN: gentamisin. Aynı harfi alan ortalamalar arasındaki farklılık istatistiksel olarak önemsizdir (*p<0,05). Harflendirme çözücü*klinik izolat interaksiyonu karşılaştırmasını göstermektedir.

Metanol ve etanol ekstraktlarının klinik izolatlar üzerindeki antibakteriyel etkilerine bakıldığında *S. epidermis* izolatları üzerinde pozitif kontrol ile kıyaslandığında aynı oranda antibakteriyel etki gösterdikleri bazı suşlarda ise kontrole göre etkinliklerinin daha az olduğu görülmüştür (Tablo 5).

Metanol ceviz ekstraktının farklı dokulardan izole edilen *S. hominis* izolatları üzerine etkisi sonucu oluşan zon çapları 16 mm ile 19 mm arasında değişkenlik göstermiş olup, benzer sonuçlar etanol ile de elde edilmiş ve bulunan bu sonuçların pozitif kontrol ile kıyaslandığında istatistiksel açıdan da anlamlı olduğu tespit edilmiştir (Tablo 6). Benzer sonuçlar *S. aureus* izolatları üzerinde elde edilmiş olup her iki ekstraktın klinik izolatlar üzerinde gösterdiği antibakteriyel etki istatistiksel olarak anlamlı bulunmuştur (Tablo 7).

Tablo 6. Ceviz ara kabuk metanol etanol ekstraktlarının *S. hominis* klinik izolatları üzerine antibakteriyel etkisi

	Örnek yeri	**Klinik İzolat**	**İnhibisyon zon çapı (mm)**
CN (100 µg/ml)	kan	801	17,3 c-e**
	kan	6858	14,7 gh
	kan	7524	14,3 h
	kan	8460	15,7 f-h
	kan	9558	15,7 f-h
EtOH	kan	801	19,0 ab
	kan	6858	17,3 c-e
	kan	7524	19,0 ab
	kan	8460	18,3 a-c
	kan	9558	16,3 d-f
MeOH	kan	801	19,0 ab
	kan	6858	17,7 b-d
	kan	7524	19,7 a
	kan	8460	19,0 ab
	kan	9558	16,0 e-g

CN: gentamisin. Aynı harfi alan ortalamalar arasındaki farklılık istatistiksel olarak önemsizdir (**p<0,01). Harflendirme çözücü*klinik izolat interaksiyonu karşılaştırmasını göstermektedir.

Tablo 7. Ceviz ara kabuk metanol etanol ekstraktlarının *S. aureus* klinik izolatları üzerine antibakteriyel etkisi

	Örnek yeri	**Klinik İzolat**	**İnhibisyon zon çapı (mm)**
CN (100 µg/ml)	yara	1277	14,3 de**
	balgam	5366	17,3 ab
	kan	5914	15,3 c-e
	kan	5916	15,0 de
	kulak	7095	14,3 de
	yara	9428	16,0 a-d
EtOH	yara	1277	15,0 de
	balgam	5366	15,3 c-e
	kan	5914	17,7 a
	kan	5916	17,0 a-c
	kulak	7095	16,0 a-d
	yara	9428	14,0 e
MeOH	yara	1277	15,7 b-e
	balgam	5366	15,7 b-e
	kan	5914	17,3 ab
	kan	5916	17,0 a-c
	kulak	7095	15,7 b-e
	yara	9428	14,0 e

CN: gentamisin. Aynı harfi alan ortalamalar arasındaki farklılık istatistiksel olarak önemsizdir (**p<0,01). Harflendirme çözücü*klinik izolat interaksiyonu karşılaştırmasını göstermektedir..

4. Sonuçlar ve tartışma

Bitkiler geleneksel tedavi yöntemlerinde sıklıkla kullanılmakta olup, bunun yanı sıra içerdikleri etken maddeler ile kozmetik ve ilaç sektöründe de aktif olarak kullanılmaktadır. Antimikrobiyal aktivite çalışmalarında yoğun olarak kullanılan bitkilerin içerdikleri fitokimyasalların tespiti de bu çalışmalara eşlik etmektedir. Yapılan bu çalışma ile ceviz ara kabukları farklı çözücüler kullanılarak ekstrakte edilmiş ve Gram-pozitif, Gram-negatif bakteriler üzerinde antibakteriyel etkileri araştırılmıştır. Ayrıca metanol ve etanol ekstraktlarında HPLC analizi ile 23 farklı fenolik bileşenin varlığı araştırılmıştır (Tablo 1). Etanol ekstraktının fenolik madde içeriğine bakıldığında, gallik asit, protokateşik asit, kateşin, p-hidroksi benzoik asit, klorojenik asit, kafeik asit, epikateşin, şiringic asit, vanilin ve p-kumarik asit içerdiği görülmüştür. En yüksek bileşen rosmarinik asit olup 193,3µg/ml olarak tespit edilmiş bunu sırasıyla epikateşin (98,1 µg/ml), kateşin (94,4 µg/ml) ve rutin (88,3 µg/ml) izlemiştir. Metanol ekstraktında ise aynı bileşenler tespit edilmiş olup oranlarının daha yüksek olduğu gözlenmiştir. Rosmarinik asit en yüksek oranda tespit edilirken kateşin, epikateşin, rutin sırasıyla 339,2 µg/ml, 201,4 µg/ml, 181,2 µg/ml, 158,7 µg/ml olarak bulunmuştur (Tablo 2). Ceviz bitkisi zengin fenolik içeriğe sahip olup, yeşil ceviz meyvesi ile yapılan bir çalışmada, etanol-su ekstraktında farklı miktarlarda 17 fenolik

bileşen tespit edilmiş, bu bileşenler içerisinde kateşin oranının çok yüksek (530.80 mgGAE/L) olduğu tespit edilmiştir (Cosmulesco et al., 2014).

Ceviz yaprak ekstraktı ile yapılan bir çalışmada ise kuersetin türevleri hisperosit, isokuersitrin, avikularin, kaffeik asit türevleri (klorojenik ve neoklorojenik asit, ayrıca apigenin türevleri isoviteksin ve juglanin tespit edilmiştir (Pirvu et al., 2011). Bitki materyallerinden fenolik bileşenlerin etkili ekstraksiyonu doğru yöntem, bileşenlerin yapısı ve kullanılan çözücüye de bağlıdır. Bitkilerdeki polifenoller genellikle polar çözücülerde daha etkin elde edilmekte olup bu amaçla etanol, metanol, aseton ya da etil asetatın sulu çözeltileri tercih edilmektedir (Do et al., 2014). Ceviz ara kabuğunun metanol ve etanol ekstraktlarının fenolik içeriğine bakılan bu çalışmada, metanol ile hazırlanan ekstraktta tespit edilen fenolik madde miktarının daha fazla olduğu fakat her iki çözücü ile elde edilen bileşenlerin aynı olduğu gözlenmiştir. Yeşil ceviz meyvesi fenolik madde içeriğinin araştırıldığı bir çalışmada ise iki farklı tür ceviz de metanol ve etanol ile hazırlanan ekstraktlarda gallik asit, klorojenik asit, protokateşik asit ve kateşin tespit edilmiş olup, fenolik madde miktarları bu çalışma ile paralel sonuç göstermiş ve metanol ekstraktında elde edilen fenolik içeriğin daha fazla olduğu gözlenmiştir (Jakopič et al., 2009).

Oral enfeksiyon etkeni bakterilerle yapılan bir çalışmada ceviz kabuğu etanol ve su ekstraktının antibakteriyel etkisi araştırılmış, çalışılan *S. sanguis, S. mutans, S. salivarius* ve *S. aureus* bakterileri üzerinde etanol ekstraktının antibakteriyel etkisinin suya göre daha fazla olduğu bulunmuştur (Zakavi et al.,2013). Ceviz yapraklarının etanol ekstraktı ile yapılan bir çalışmada en fazla antibakteriyel etki Gram-pozitif *S. epidermidis* üzerinde gözlenirken Gram negatif *P. aeruginosa* ATCC 9027 üzerinde de antibakteriyel etki gözlenmiş, *S. aureus* ATCC 6538 üzerinde ise antibakteriyel etki görülmemiştir (Nicu et al., 2018). Bitkilerin bakteriler üzerinde gösterdikleri bakterisit etkileri içerdikleri flavonoidler sayesinde birçok etki mekanizması ile olup bunlardan birinin nükleik asit biyosentezini inhibe ederek ya da farklı moleküler proseslerle gerçekleştiği bilinmektedir (Baba and Malik, 2015; Cushnie and Lamb, 2005). Fenolik bileşenler antimikrobiyal etkilerini genellikle membran seviyesinde göstermektedirler. Örneğin fenol, hücre zarı fonksiyonlarını değiştirerek, protein yağ oranını etki etmekte ve potasyum iyonlarının dışarı akışını teşvik etmektedir. Yine kateşinler ve epigallokateşin gallat, lipid tabakasını etkileyerek membranın parçalanmasına neden olmakta ve hücre bütünlüğü bozulan hücrenin ölümle sonuçlanmasına neden olmaktadır (Keweloh et al., 1990; Heipieper et al., 1991; Hashimoto et al., 1999; Yücel Şengün and Yücel, 2015).

İdrar yolu enfeksiyonu etkeni farklı türler ile yapılan bir çalışmada ceviz hekzan ekstraktının Gram-negatif *E. coli* (22 mm) ve *P. aeruginosa* (12 mm), *K. pneumonia* (16 mm) bakterileri üzerinde de antibakteriyel etkisinin olduğu tespit edilmiştir (Allaie et al., 2018). Ceviz yapraklarının etanol-su ile hazırlanan ekstraktı ile yapılan bir başka çalışmada ise *S. aureus* üzerinde antibakteriyel etkiye sahip olduğu rapor edilmiştir. Ayrıca Gram-negatif *E. coli* üzerinde de aynı etkiyi görmüşlerdir (Saltan Çitoğlu and Altanlar, 2003). Ceviz yeşil kabuk ve yapraklarının metanol ve su ekstraktları ile yapılan bir çalışmada ise her iki bitki kısmının metanol ekstraktının su ekstraktına oranla *S. aureus* üzerinde daha fazla antibakteriyel etkiye sahip olduğu gözlenmiştir (Yiğit vd., 2009). İran'da yetişen bir ceviz türünün endokarp ve ekzokarp dokularının ekstraksiyonu ile yapılan bir çalışmada ise *S. aureus* üzerinde metanol ekstraktının sırasıyla 25 mg/ml ve 50 mg/ml MIC değerleri ile antibakteriyel etki gösterdiği bulunmuştur (Moghaddam et al., 2017). Yapılan bu çalışmada ise metanol ekstraktı MIC değeri antibakteriyel etki görülen tüm bakteriler için 1,22 mg/ml olarak bulunmuştur. Bitki ekstraktları ile yapılan birçok çalışmada Gram-pozitif bakterilerin Gram-negatif bakterilere oranla daha hassas oldukları, bitki bileşenlerinin Gram-pozitif bakteriler üzerinde antibakteriyel etkinliğinin daha fazla olduğu görülmüştür. Bu durumun bakteriler arasındaki hücre duvar yapısındaki farklılıklardan kaynaklandığı ve Gram negatif bakterilerin dış membranının hidrofobik bileşiklere karşı koruyucu bir bariyer geliştirmesinden kaynaklandığı tespit edilmiştir (Puupponen-Pimia et al.,2001; Erdoğan, ve Everest, 2013).

Ceviz kabuklarının etanol ekstraktı ile yapılan bir çalışmada ise *S. aureus* ATCC 6538, üzerine antibakteriyel etkisinin çok düşük olduğu gözlenmiştir (Kale et al., 2011). Antibakteriyel aktivite çalışmalarında aynı bitkilerle yapılan çalışma sonuçları arasındaki farklılık kullanılan çözücülerden başka bitkinin yetiştirildiği coğrafya ve iklim koşullarına bağlı olarak yapılarında bulunan sekonder metabolitlerin çeşit ve miktarının farklı olmasında kaynaklanmaktadır (Koohsari et al., 2015)

Yapılan bu çalışma ile ceviz ara kabuğunun fitokimyasal içeriği ve bazı bakteriler üzerindeki antibakteriyel özelliği araştırılmış olup, ceviz yaprak, yeşil dış kabuk, kuru iç kabuk ve meyvesinde olduğu gibi ara kabuğunda da birçok faydalı bileşenin olduğu tespit edilmiştir. Metanol ve etanol çözücüleri ile ekstrakte edilen ara kabukların farklı servislerden izole edilen klinik stafilokok izolatları ile referans suşlar üzerinde de antibakteriyel etkinliğe sahip olduğu gözlenmiştir. Bundan sonraki çalışmalarda besin olarak tüketilmeyen bu kısımların sahip oldukları diğer bileşenlerin varlığı aydınlatılmaya çalışılabilir ve farklı mikroorganizma türleri ile de antimikrobiyal etkinlikleri araştırılabilir. Ayrıca bundan sonraki çalışmalarda in vivo etkinlikleri araştırılarak bazı sentetik antibiyotiklere alternatif olarak kullanılması düşünülebilir.

Kaynaklar

Allaie, A.H., Mishra, R.P., Ganaie, A. A., Ali, S., Singh, R. (2018). Antibacterial activity of hexane extract of Juglans regia against some clinical isolates of urinary tract infection. International Journal of Biology Research, 3(2), 64-67

Baba, S.A., Malik, S.A. (2015). Determination of total phenolic and flavonoid content, antimicrobial and antioxidant activity of a root extract of Arisaema jacquemontii Blume. J Taibah Univ Sci., 9,449–454.

Bayazit, S., Tefek, H., Çalışkan, O. (2016). Türkiye'de ceviz (*Juglans regia* L.) araştırmaları. Süleyman Demirel Üniversitesi Ziraat Fakültesi Dergisi, 11(1), 169-179.

Beiki, T., Ghasem D. Najafpour, G.D., Hosseini, M. (2017). Evaluation of antimicrobial and dyeing properties of walnut (*Juglans regia* L.) green husk extract for cosmetics. Society of Dyers and Colourists, Color. Technol., 134, 71–81.

Cosmulescu, S., Trandafır, I., Nour, V., Ionıca, M , Tutulescu, F. Phenolics Content, Antioxidant Activity and Color of Green Walnut Extracts for Preparing Walnut Liquor. Not Bot Horti Agrobo, 2014, 42(2):551-555.

Cushnie, T.P.T., Lamb, A.J. (2005). Antimicrobial activity of flavonoids. Int. J. Antimicrob. Agents, 26, 343-356. 17. Jakopıč, J., Veberıč, R., Štampar, F. (2009). Extraction of phenolic compounds from green walnut fruitsin different solvents. Acta agriculturae Slovenica, 93(1), 11 – 15.

Do, Q. D., Angkawijaya, A. E., Tran-Nguyen, P. L., Huynh, L. H., Soetaredjo, F. E., Ismadji, S., Ju, Y. H. (2014). Effect of extraction solvent on total phenol content, total flavonoid content, and antioxidant activity of Limnophila aromatica. Journal of Food and Drug Analysis, 22, 296–302.

Erdoğan, E., Everest, A. (2013). Antimikrobiyal Ajan Olarak Bitki Bileşenleri. Türk Bilimsel Derlemeler Dergisi. 6 (2), 27-32.

Gomes, T., Caponio, F., Alloggio, V. (1999). Phenolic compounds of virgin olive oil: influence of paste preperation techniques. Food Chemistry, 64, 203-209.

Hashimoto, T., Kumazawa, S., Nanjo, F., Hara, Y., Nakayama, T. (1999). Interaction of tea catechins with lipid bilayers investigated with liposome systems. Bioscience, Biotechnology, and Biochemistry, 63, 2252-2255.

Heipieper, H.J., Keweloh, H., Rehm, H.J. (1991). Influence of phenols on growth and membrane permeability of free and immobilized *Escherichia coli*. Applied and Environmental Microbiology, 57, 1213-1217.

Holder I.A., Boyce S.T. (1994). Agar well diffusion assay testing of bacterial susceptibility to various antimicrobials in concentrations non-toxic for human cells in culture. Burns, 20 (5), 426-429.

Ignat, I., Volf, I., Popa, V.I. (2011). A critical review of methods for characterisation of polyphenolic compounds in fruits and vegetables. Food Chemistry, 126(4), 1821–1835.

Jakopıč, J ., Veberıč, R., Štampar, F. (2009). Extraction of phenolic compounds from green walnut fruits in different solvents. Acta agriculturae Slovenica, 93(1), 11 – 15.

Kadiroğlu, P., Ekici, H. (2018). Yeşil Ceviz Kabuklarının biyoaktif özelliklerinin FT-IR spektroskopi yöntemiyle tahmin edilmesi. Akademik Gıda, 16(1), 20-26.

Kale, A. A., Pawar, A. B., Deshpande, N. R., Salvekar, J. P. (2011). Antimicrobial activity study of *Juglans regia* L. Journal of Pharmacy Research, 4(2),331-332.

Karadeniz, F., Ekşi, A. (2001). Elma suyunda fenolik madde dağılımı üzerine araştırma. Tarım Bilimleri Dergisi, 7(4),102-105.

Keweloh, H., Weyrauch, G., Rehm, H.N. (1990). Phenol-induced membrane changes in free and immobilized Escherichia coli. Applied Microbiology and Biotechnology, 33, 66-71.

Koohsari, H., Ghaemi, E.A., Sadegh Sheshpoli, M., Jahedi, M., Zahiri, M. (2015). The investigation of antibacterial activity of selected native plants from North of Iran. J Med Life., 8(Spec Iss 2), 38–42.

Moghaddam, P.Z., Mohammadi, A., Feyzi, P., Alesheikh, P. (2017). *In vitro* antioxidant and antibacterial activity of various extracts from exocarps and endocarps of walnut. Pak. J. Pharm. Sci., 30(5), 1725-1731

Nicu, A.I., Pîrvu, L., Stoian, G., Vamanu, A. (2018). Antibacterial activity of ethanolic extracts from *Fagus sylvatica* L. and *Juglans regia* L. leaves. Farmacia, 66(3), 483-486.

Özaydın A, 2013. Farklı kurutma koşullarının bazı önemli armut çeşitlerinin aroma, fenolik madde ve diğer kalite bileşenleri üzerine etkilerinin araştırılması. Süleyman Demirel Üniversitesi, Fen Bilimleri Enstitüsü, Doktora Tezi, 181s, Isparta.

Özkaya Şahin, G. (2003). Gram pozitif kok enfeksiyonları: Sorunlar ve Çözümler. 11-21, Güneş Kitabevi, Ankara.

Pereira, J.A., Oliveira, I., Sousa, A., Valenta˜o, P., Andrade, P.B., Ferreira, I.C.F.R., Ferreres, F., Bento, A., Seabra, R., Estevinho, L. (2007). Walnut (*Juglans regia* L.) leaves: Phenolic compounds, antibacterial activity and antioxidant potential of different cultivars. Food and Chemical Toxicology, 45, 2287–2295.

Pirvu, L., Barbulescu, D., Nichita, C., Nita, S., Colceru Mihul, S. (2011). Obtaining and chemical characterization of some vegetal extracts with corrosion-scaling inhibition properties. Part II. Juglandis folium and Agrimoniae herba extracts. Rom Biotechnol Lett., 6(1), 5937-5944.

Puupponen-Pimia, R., Nohynek, L., Meier, C., Kahkönen, M., Heinonen, M., Hopia, A., Oksman-Caldentey, K.M. (2001). Antimicrobial Properties of Phenolic Compounds From Berries. Journal Of Applied Microbiology. 90, 494-507.

Saltan Çitoğlu, G., Altanlar, N. (2003). Antimicrobial activity of some plants used in folk medicine. Ankara Ecz. Fak. Derg., 32 (3), 159-163.

Shi, J., Yu, J., Pohorly, J.E., Kakuda, Y. (2003). Polyphenolics in grape seeds-biochemistry and functionality. Journal of Medicinal Food, 6(4), 291-299.

Silva, B.M., Andrade, P.B., Valenta˜o, P., Ferreres, F., Seabra, R.M., Ferreira, M.A. (2004). Quince (*Cydonia oblonga* Miller) fruit (pulp, peel, and seed) and jam: antioxidant activity. Journal of Agricultural and Food Chemistry, 52, 4705–4712.

Taşova, Y. (2003). İmmunosupresif Hastalarda Gelişen İnfeksiyonlar: Sık Rsatlanan Gram-pozitif Kok Enfeksiyonları. 27-43, Güneş Kitabevi, Ankara.

Yiğit, D., Yiğit, N., Aktaş, E., Özgen, U. (2009). Ceviz (*Juglans regia* L.)'in antimikrobiyal aktivitesi. Türk Mikrobiyoloji Cem Derg., 39(1-2),7-11.

Yücel Şengün, İ., Yücel, E. (2015). Antimicrobial properties of wild fruits. Biological Diversity and Conservation, 8(1), 69-77.

Zakavi, F., Golpasand Hagh, L., Daraeighadikolaei, A., Farajzadeh Sheikh, A., Daraeighadikolaei, A., Leilavi Shooshtari, Z. (2013). Antibacterial effect of *Juglans regia* bark against oral pathologic bacteria. Int J Dent. 2013; 2013:854765; doi:10.1155/2013/854765.

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Research article/Araştırma makalesi

Determination of Epipelic, Epiphytic and Epilitic Indicator Algae; Sarısu Creek (Antalya) sampling area

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Abstract

In this study, it is aimed to determine and compare the varieties of indicator algae that may be of economic importance in Sarısu Creek which is born from Olympos Mountains and poured into Antalya Bay. Samples from 3 stations from epirhitral region to potamal area in Sarısu Creek samples were collected from different habitats including epilithic, epiphytic and epipelic. In the Sarisu Creek, a total of 72 algal taxa are identified. It is observed that Bacillariophyta division with 54,1%, is the most represented group, while Chlorophyta 25,2%, Cyanobacteria 14,2%, Euglenophyta 2,8% and Dinophyta 2,8% are also recorded, respectively. Species belonging to Cymbella, Gomphonema, Nitzschia, Oscillatoria, Phormidium and Euglema species were determined as pollution indicators.

Key words: Sarısu Stream, algae, pollution, indicator species

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Epipelik, Epifitik ve Epilitik İndikatör Alg Türlerinin belirlenmesi; Sarısu Çayı (Antalya) örnekleme alanı

Özet

Bu çalışmada, Olimpos dağlarından doğan ve Antalya körfezine dökülen Sarısu Çayındaki kirlilik indikatörü ve ekonomik önemi olabilecek alg türlerini belirlemek ve karşılaştırma yapmak amacıyla yapılmıştır. Sarısu çayında epirhitral bölgeden potamal bölgeye kadar 3 istasyondan örnekler Numuneler epipelik, epifitik, epilitik olmak üzere farklı habitatlardan toplanmıştır. Sarısu çayında beş divisio ya ait toplam 72 alg taksonu tespit edilmiştir. Belirlenen divisiolarından en yaygın ve dominat olanı %54,1 ile Bacillariophytadır. Diğer divisyolar ise sırasıyla, Chlorphyta %25,2 Cyanobacteria %14,2 Euglenophyta 2,8 ve Dinophyta %2,8 olarak bulunmuştur. Kirlilik indikatörü olarak Cymbella, Gomphonema, Nitzschia, Oscillatoria, Phormidium ve Euglema cinslerine ait türler tespit edilmiştir.

Anahtar kelimeler: Sarısu Çayı, algler, kirlilik, indikatör tür

1. Giriş

Canlılığın devamı için hayati önemi olan su, bütün canlıların yapısına girmesi, metabolik olaylar için en başta gelen bir hayat maddesi özelliğini taşıması ve ayrıca bir hayat ortamı olması nedeniyle yüzyıllardır insanoğlunun dikkatini çekmiştir. Canlılar için bu kadar önemli olan suyun özellikleri ve su ortamına adapte olmuş, bütün fizyolojik olaylarını su içerisinde gerçekleştiren canlıların bilinmesi de son derece önemlidir (Atıcı ve Akıska, 2005). Algler, besin zincirinin ilk halkasını oluşturmaları ve akarsulardaki heterotrof organizmaların besin ve oksijen kaynağı olmaları bakımından biyolojik açıdan önemli organizmalardır. Alglerin önemi bununla da sınırlı kalmamaktadır. Bu organizmalardan tıp, boya, kozmetik, ilaç, tekstil, gübre, gıda sanayinde ve biyoteknolojide de yararlanılmaktadır. Ayrıca günümüzde hızla artan nüfus ve bunun beraberinde getirdiği beslenme, sanayi gelişimi ve çevre kirliliği gibi sorunlara algler üzerine araştırmalar yapılarak çözümler aranmaktadır. Alglerin sulardaki tür çeşitliliği ve dağılımları o ortamdaki heterotrof organizmaların konumuyla ve besin tuzları ile ilgilidir. Su kirliliğinin belirlenmesinde de, kirlilik indikatörü olarak bilinen türlerden yararlanılmaktadır (Solak ve Acs 2011, Rimet 2012; Atıcı ve Udoh, 2016).

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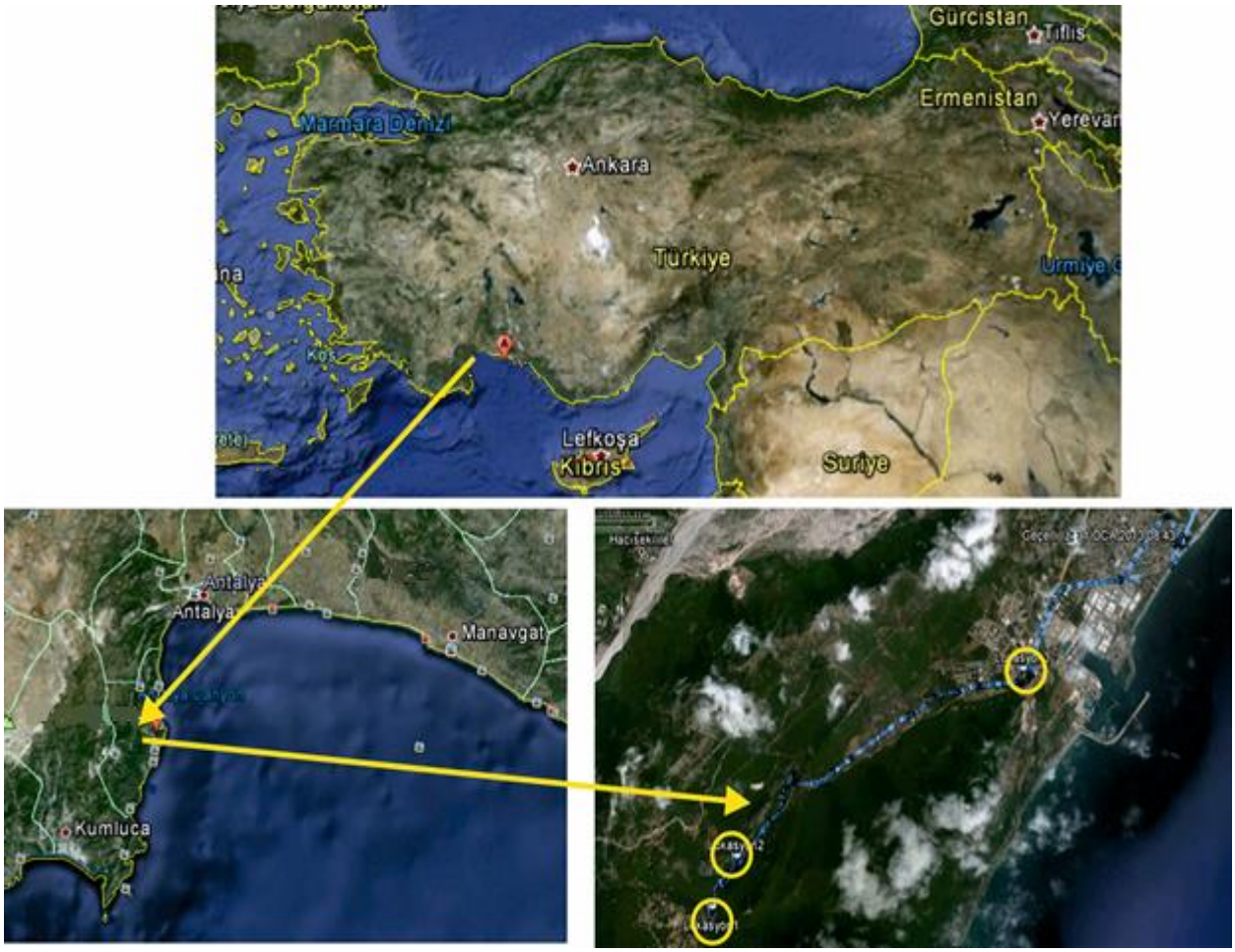
İki kıtayı birbirine bağlayan bir yarımada niteliğinde olan ülkemiz, iç su kaynakları yönünden de son derece zengindir. 906118 ha. doğal göl, 18000 ha. baraj gölü ve 145000 km. uzunluğundaki akarsu ağına sahiptir (Yavuz ve Çetin, 2000). Bu kadar zengin iç su kaynaklarına sahip ülkemizde, primer prodüktiviteye direkt etkisi olan diyatomelerin tespiti, ülkemiz için büyük önem taşımaktadır. Çağımızın en büyük problemlerinden biri olan çevre ve su kirliliği, tüm dünyada olduğu gibi ülkemizde de gün geçtikçe artmaktadır. Su kaynakları, yoğun ve çarpık endüstrileşme ile hızlı nüfus artışı sonucu gittikçe kirlenmekte ve böylece yararlanılabilir temiz su kaynakları azalmaktadır. Sucul ekosistemlerdeki alglerin sayı ve zenginlikleri, bulundukları su ortamının verimliliği hakkında bilgi verirken kirlilik indikatörü olan bazı alg türleri de, yine bu ortamlardaki kirlilik derecesinin belirlenmesinde önemli ölçüt olmaktadır.

Silisli algler olarak bilinen diyatomeler ise tatlı su ve denizlerde bol olarak bulunan önemli bir alg grubudur. Diyatomelerin hücre duvarı (kabuk) silisli yapıdadır. Hücre duvarı, bir kutunun birbiri üzerine kapanan iki kapağı şeklindedir. Diyatomelerin hücre duvarı parçalanmaya karşı dirençli olduğundan, göllerin geçmiş yıllardaki durumlarını inceleme amacıyla kullanılırlar. Algler fotosentetik organizmalar olarak sucul ekosistemin en önemli grubunu temsil eder. Alglerle ilgili olarak Biyoindikatör tür belirleme çalışmaları; bir türdeki ekolojik etkinin ne derece de olduğunu, yada etkinin var olup olmadığını tanımlamak için yapılmaktadır. Tek hücreli veya koloni oluşturmuş mikroskobik formlardan ipliksi, tallus yapısı gösteren veya yabancı parankimatik dokulu makroskobik formlara kadar birçok şekilde olabilirler. Su içerisinde planktonik olarak serbest halde bulunabildikleri gibi, bentik olarakta bulunabilirler. Bu habitatlar; epilitik (taşlar üzerinde), epifitik (sucul bitkiler üzerinde) ve epipelik (sediment üzerinde) olarak bilinir (Round, 1984).

Sarısu çayı Antalya ili Konyaaltı bölgesinin güney batısında yer alır. Sarısu çayı Olimpos dağlarının yüksek kesimlerdeki eriyen kar suları ile beslenerek birkaç küçük yan kolların birleşmesi ile oluşarak kısa bir akıştan sonra denize dökülür. Bahar aylarında 500-600 l/s civarında akımı olan çayın yaz ve sonbahar dönemlerinde kuruduğu gözlenmektedir (Şekil 1) (www.googleearth.com).

Bölgede şimdiye kadar alglerle ilgili bilimsel bir çalışma yapılmamıştır. Bu nedenle Sarısu Çayı'n da biyoindikatör türlerin belirlenmesi bölge için önem arz etmektedir. İndikatör olarak kullanılabilen çok farklı organizmalar vardır. İndikatör alg türlerinin araştırıldığı bu çalışmada, tatlı su kaynaklarındaki alglerin tespiti ve Türkiye tatlı su indikatör alglerinin belirlenmesi açısından da önemlidir.



Şekil 1. Çalışma alanı genel görünümü (www.googleearth.com)

2. Materyal ve yöntem

Sarısu Çayı kirlilik indikatörü algleri belirlemek ve karşılaştırma yapmak amacıyla, Sarısu Çayından epirhitral bölgeden potarnal bölgeye kadar üç istasyon belirlenmiştir. Şubat 2013 ve Haziran 2013 tarihlerinde yapılan örnekleme çalışmasında, farklı habitatlardan (epilitik, epifitik ve epipelik) alınan örnekler tür teşhisleri için laboratuara getirilmiştir (APHA, AWWA, WEF, 2005). Olimpus CX41RF model mikroskop ile incelenip, çeşitli kaynaklardan (Gerrath ve Denny, 1980; Smol ve Stoermer, 2010; Huber, 1982; Korshikov, 1987: Prescott, 1987; Wehr vd., 2003; John vd., 2002; Graham vd., 2009; Lee, 2008 ve http://turkiyealgleri.omu.edu.tr) faydalanılarak tür tayinleri tamamlanmıştır.

Belirlenen istasyonlardan alınan numunelerden teşhis edilen türler bulundukları habitatlara göre listelenmiş ve kaynak bölge ile antropojen kirliliğe maruz kalmış bölge algleri karşılaştırılmıştır. Kirliliğe adapte olmuş ve besin tuzlarından yeteri kadar faydalanan dolayısı ile diğer türlere göre sayıca bol olan indikatör algler belirlenmiştir. Dünyada ve Ülkemizde yapılmış olan benzer çalışmalardan faydalanılarak belirlenmiş olan kirlilik indikatörü türler ile de karşılaştırılması yapılmıştır.

3. Bulgular

Sarısu çayında toplam 72 farklı taksona ait alg türleri tespit edilmiştir. Sarısu çayında yapılan çalışmada Bacillariophyta divisiosu %54,7 ile en fazla temsil edilen gurup olmuştur, diğer divisyolar ise sırasıyla, Chlorphyta %25,2 Cyanobacteria %14,2 Euglenophyta 2,8 ve Dinophyta %2,8 olarak bulunmuştur. Tespit edilen türler aşağıda Tablo 1'de alfabetik olarak listelenmiştir (www.algaebase.org). Suya ait sıcaklık, yükselti ve koordinatlar ise Tablo 2'de verilmiştir.

Tablo 1. Sarısu Çayı Alglerinin İstasyonlara Göre Dağılımı (El:Epilitik; Ef: Epifitik; Ep: Epipelik)

Taxon	**Sarısu Çayı**								
	1. St.			**2. St.**			**3. St.**		
	El	**Ef**	**Ep**	**El**	**Ef**	**Ep**	**El**	**Ef**	**Ep**
BACILLARIOPHYTA									
Achnanthes sp.	+			+		+	+		+
Achnanthidium minutissimum (Kützing) Czarnecki		+			+	+			+
Aulacoseira granulata var. Valida (Husted) Simonsen		+			+	+	+	+	
Cocconeis linearis (W.Smith) Schonfeldt		+		+		+	+		+
Cocconeis pediculus Ehrenberg		+			+	+			+
Cyclotella meneghiniana Kützing				+		+	+	+	
Cyclotella sp.	+			+	+	+			+
Cymbella cymbiformis C.Agardh	+				+	+			+
Cymbella helvetica Kützing				+		+	+		
Cymbella linearis Østrup	+	+			+	+	+	+	+
Cymbella neocistula Krammer		+		+	+	+			+
Cymbella neolanceolata (C.Agardh) Kirchner		+		+	+	+			+
Cymbella sp.	+	+			+	+			+
Diatoma vulgare Bory	+	+			+	+		+	+
Diatoma elongatum var. *minor* Grunow		+		+		+	+		+
Fragilaria acus (Küting) Lange Bertalot	+	+			+	+		+	+
Fragilaria capucina Desmazieres		+			+	+			+
Fragilaria sp.	+			+		+	+		
Gomphonema olivaccum (Hornemann) Brébisson		+			+	+	+	+	+
Gomphonema parvulum (Kützing) Kützing	+			+	+	+		+	+
Gyrosigma acuminatum (Kützing) Rabenhorst		+		+	+	+			+
Melosira varians C.Agardh	+	+			+	+		+	+
Melosira italica var. *valida* Grunow				+		+	+		
Meridion circulare (Greville) C.Agardh	+				+	+	+	+	+
Navicula oblonga (Kützing) Kützing	+				+	+			+
Navicula splendida Van Landingham		+		+		+	+		+
Navicula sp.		+		+	+	+			+
Nitzschia truncatum (Kützing) W.Smith	+	+			+	+		+	+
Nitzschia linearis W.Smith	+	+			+	+			+
Nitzschia tryblonella Hantzsch	+			+		+	+		
Nitzschia sp.		+			+	+	+	+	+
Pantocsekiella ocellata (Pantocsek) K.T. Kiss & E. Ács	+	+			+	+	+		+

Tablo 1. Devam ediyor

Pinnularia brebissonii (Kützing) Rabenhorst	+	+		+	+	+		+	+
Rhiocosphaenia abbreviata (C.Agardh) Lange-Bertalot		+			+	+	+		
Sellaphora pupula (Kützing) Mereschkovsky	+	+			+	+		+	+
Surirella ovata Kützing	+				+	+	+		+
Surirella ovalis Brébisson	+	+		+	+	+	+		+
Tryblionella hungarica (Grunow) Frenguelli		+		+		+	+		+
Ulnaria ulna (Nitzsch) Compère				+		+	+		
CHLOROPHYTA									
Chlorella vulgaris Beyerinck		+			+	+	+		
Cladophora fracta (O.F.Müller ex Vahl) Kützing				+			+		+
Cladophora glomerata (Linnaeus) Kützing		+			+	+		+	+
Closterium sp.				+	+		+		+
Cosmarium botrytis Meneghini ex Ralfs				+		+	+		
Cosmarium speciosum P.Lundell	+				+	+	+		+
Cosmarium sp.		+				+	+		
Enteromorpha sp.	+	+			+	+		+	+
Oedigonium sp.				+		+	+		
Oocystis sp.	+				+	+	+	+	+
Pediastrum boryanum (Turphin) Meneghini		+			+	+	+		+
Pediastrum tetras (Ehrenberg) Ralfs							+	+	+
Scenedesmus accuminatus (Lagerheim) Chodat	+	+			+	+		+	+
Scenedesmus sp.				+			+	+	+
Spirogyra gratiana Transeau	+	+			+	+	+		+
Spirogyra princeps (Vaucher) Link ex Meyen		+			+		+	+	+
Spirogyra sp.	+				+	+			+
Ulothrix sp.	+			+		+			+
Zygnema sp.					+		+	+	
CYANOBACTERIA									
Lyngbya wollei (Farlow ex Gomont) Speziale & Dyck		+			+	+		+	+
Lyngbya sp.				+		+	+		+
Merismopedia elegans A.Braun ex Kützing		+			+		+	+	+
Nostoc commune Vaucher ex Bornet & Flahault	+					+	+		+
Oscilatoria princeps Vaucher ex Gomont		+				+		+	+
Oscilatoria splendida Gravilla ex Gomont		+			+				+
Oscilatoria sp.				+		+	+		+
Phornmidium tenue Gomont		+			+	+		+	+
Spirulina subsalsa Oersted ex Gomont							+	+	+
Spirulina sp.		+			+	+			+
DINOPHYTA									
Peridinium cinctum (O.F.Müller) Ehrenberg		+			+	+		+	+
Gymnodinium sp.				+		+	+	+	+
EUGLENOPHYTA									
Euglena sp.		+			+	+			+
Trachelomonas sp.					+		+		+

Tablo 2. Sarısu Çayı istasyonlara ait sıcaklık, yükseklik ve koordinatları

İstasyon	**Sıcaklık (^{0}C)**		**Rakım (m)**	**Koordinat**	
	Şubat	**Haziran**			
1.	5	25	170	N36 48 33.4	E30 32 19.6
2.	6	26	50	N36 48 54.1	E30 32 35.0
3.	10	30	5	N36 50 10.9	E30 35 39.9

4. Sonuçlar ve tartışma

Günümüzde yapılan çeşitli çalışmalarda (Guiry and Guiry, 2016; Cox, 1996; Van Dam, Mertens, Sinkeldam, 1994; Rimet, Cauchie, Hoffmann and Ector, 2005: Sládeček, 1973; Sládeček, 1986; Atıcı, 1997: Bellinger and Sigee, 2015; Hellawell, 1986) farklı su kalitesinde bulunan karakteristik indikatör algler aşağıdaki şekilde zonlara ayrılmıştır;

Polysabrobic zonda *Euglena, Oscillatoria, Phormidium*
α -Mesosabrobic zonda *Ulothrix, Oscillatoria, Stigeoclonium*
β -Mesosabrobic zonda *Cladophora, Phormidium, Scenedesmus, Pediastrum, Ulothrix, Voucheria*
Oligosabrobic zonda ise *Meridion, Lemanea, Batrachospermum* cinsleridir.

Yukarıdaki zonasyonda belirtilen alg türleri gibi benzer türler Sarısu çayında da tespit edilmiştir (Tablo 3). Bunlar *Pediastrum, Oscilatoria, Ulothrix* ve *Phormidium* cinslerine ait türlerdir. Tespit edilen alg türleri içerisinde bazı cinsler sayıca daha fazla görülmektedir. Bunlar sırasıyla *Cymbella* 6, *Nitzschia* 5, Navicula 5, *Oscilatoria* 3, Pediastrum 3 ve Spirogyra 3 adet olarak belirlenmiştir.

Özellikle 3. İstasyon bölgesinde organik madde yoğunluğunun ve fosfat miktarının arttığı zamanlarda Cyanophyta ve Euglenophyta üyelerinin tür çeşitliliğinin ve yoğunluğunun arttığı görülmüştür. Kirlenmenin olduğu alanlarda kirlilik indikatörü olarak bilinen *Euglena* ve *Oscillatoria* iyi gelişme göstermiştir. Akarsularımızda nadiren görülen *Gymnodinium* ve *Peridinium* türleri ise Sarı su çayında yaygın olarak bulunmuştur. Bu bölgede akarsuyun taşıdığı organik yük artmaktadır. Ekili tarım alanlarında kullanılan gübre ve çeşitli antropojenik etkilerde bu durumu tetiklemektedir. Çalışma alanında istasyon bazında yapılan karşılaştırmada tür yoğunluğu bakımından 3. İstasyon diğer istasyonlara göre daha fazla sayıda tür yoğunluğuna sahip olmuş bunu sırasıyla 2. İstasyon ve 1. İstasyon takip etmiştir.

Tablo 3. Sarısu Çayı Polysabrobic zon, α -Mesosabrobic zon, β -Mesosabrobic zon ve Oligosabrobic zonlardaki Algleri

İndikatör türler	**Zonlar**
BACILLARIOPHYTA	
Cymbella cymbiformis	Oligotrofik seviye
Cymbella neocistula	Ötrofik seviye
Cymbella neolanceolata	Oligotrofik seviye
Gomphonema olivaceum	Ötrofik seviye
Nitzschia linearis	Ötrofik seviye
CHOLOROPHYTA	
Cladophora fracta	β -Mesosabrobik seviye
Pediastrum boryanum	β -Mesosabrobik seviye
Pediastrum dubium	β -Mesosabrobik seviye
Scenedesmus accuminatus	β -Mesosabrobik seviye
Scenedesmus sp.	β -Mesosabrobik seviye
Ulotrix sp.	β –Mesosabrobik seviye
CYANOBAKTERIA	
Oscilatoria princeps	Polysabrobik seviye, α Mesosabrobik seviye
Oscilatoria splendida	Polysabrobik seviye, *α* Mesosabrobik seviye
Oscilatoria sp.	Polysabrobik seviye, α Mesosabrobik seviye
Phormidium tenium	Polysabrobik seviye, α Mesosabrobik seviye
EUGLENOPHYTA	
Euglena sp.	Polysabrobik seviye

Algler su kalitesi belirlemede uzun vadede kullanılan temel organizma guruplarındandır (Dixit SS, Smoll and Kingson, 1992; Round, 1993). Sakarya Nehrinde (Atıcı ve Yıldız, 1996) yapılan bir çalışmada epilitik alglerden; *Melosira varians, Nitzschia dissipata, Navicula exigua, Navicula cuspidata, Cymbella, Gomphonema minutum, Gomphonema olivaceum* ve *Surirella* en baskın türler olarak rapor edilmiştir. Kızılırmak nehrinde (Yıldız ve Özkıran 1991) yapılan bir çalışmada *Navicula, Nitcschia, Cymbella, Surirella,* ve *Pinnularia* ya ait taksonların yoğun olduğu rapor edilmiştir. Aksu çayında yapılan bir çalışmada (Kalyoncu , Barlas ve Yorulmaz, 2008) *Nitcschia, Navicula, Cymbella* ve *Gomphonema* cinslerinin baskın olduğu görülmüştür. Yine Köprüçay Nehrinde (Çiçek ve Ertan, 2012) yapılan bir çalışmada fiziksel kimyasal verilerle alg çeşitliliği arasındaki bağ kurulmaya çalışılmış ve Köprüçay Nehrinde *Nitzschia* en çok taksonla temsil edilmiş, bunu *Navicula, Gomphonema* ve *Cymbella* türleri takip etmiştir. Yukarıda belirlenen türlerden; *Melosira, Nitzschia, Navicula, Cymbella, Gomphonema* ve *Surirella* Sarısu çayında da görülmüştür. Çalışma alanında 1. İstasyon erimiş karsuları tarafından beslenen ve antropojenik etki görülmeyen bölge olduğundan burada *Cyclotella meneghiniana, Cymbella helvetica, Melosira italica, Ulnaria ulna, Cladophora fracta, Chrococcus* sp., *Closterium* sp., *Oedogonium* sp. *Pediastrum dubium, Scenedesmus* sp., *Zygnema* sp, *Lyngbya* sp., *Spirulina subsalsa, Gymnodium* sp. ve *Trachelomonas* sp. taksonları belirlenmemistir. Buna karşın deniz seviyesine çok yakın olan, yerleşim yeri içinden geçen ve arıtma tesisi çıkış suyunu alan üçüncü istasyonda ise *Pediastrum dubium, Spirulina subsalsa* ve *Trachelomonas* sp. taksonları görülmüştür.

Tablo 1 de belirlenen *Oscillatoria* türleri, *Pediastrum* türleri, *Cyclotella* türleri, *Diatome* türleri, *Synedra* türleri, *Achnanthes* türleri, *Cymbella* türleri, *Pinnularia* türleri, *Gomphonema* türleri, ve *Nitzschia* türleri Ankara Çayında (Atıcı ve Akıska, 2005) kirliliğe adapte olmuş türler olarak belirlenmiş organizmalardır.

Antropojen kaynaklı kirlilik ile organik ve inorganik artıklar tatlısu kaynaklarına karışır. Organik atıkların anaerob veya aerob olarak parçalanması sonucu açığa çıkan fosfat ve azot bileşikleri algler için önemli bir besin kaynağı oluşturmaktadırlar (Hellawell, 1986; Zhuzbayeva ve Atıcı, 2016). Bu durum tatlı sularda bazı türlerin hızla çoğalmasına neden olur. Kirlilik toleransı olan türler hem temiz sularda hem de organik ve inorganik kirliliğe maruz kalmış sularda yaşamını sürdürebilirler. Temiz ortam tercihli türler ise yalnızca temiz kaynak sularında yaşamlarını sürdürebilirler. Bu çalışma ile tatlı su indikatör algleri Sarısu çayında belirlenmeye çalışılmış ve kirliliğe toleranslı algler belirlenmiştir. Ancak ileride bu su kaynaklarının fiziksel ve kimyasal özellikleri de belirlenerek çalışma desteklenirse daha verimli sonuçlara ulaşılabilir.

Kaynaklar

APHA, AWWA, WEF (2005). Standard methods for the examination of water and waste water (21st 411 ed.). American Water Works Association and Water Environment Federation New York, Washington DC.

Atıcı, T. and Akıska, S. (2005). Pollution and Algae of Ankara Stream. G.U. Journal of Science, 18 (1):51-59.

Atıcı, T., (1997). Sakarya Nehri Kirliliği ve Algler, Ekoloji Çevre Dergisi, 24, pp. 28-32.

Atıcı, T. and U. Abel, U. (2016). Indicator Algae of Adrasan Stream (Antalya) Turkey, Sinop Uni J Nat Sci 1(2): 135 - 149.

Atıcı, T. ve Yıldız, K. (1996). Diatoms of Sakarya River, Tr. J. of Botany, 20, 119-134.

Bellinger, EG. and Sigee, DC. (2015). Freshwater Algae: Identification, Enumeration and Use as Bioindicators, 2st ed. Wiley-Blackwell, UK.

Cox, EJ. (1996). Identification of freshwater diatoms from live material. Chapman & Hall, London.

Çiçek, N.L. ve Ertan, Ö.O. (2012). Köprüçay Nehri Epilitik Alg Çeşitliliğinin Bazı Fizikokimyasal Değişkenlerle İlişkisi. Eğirdir Su Ürünleri Fakültesi Dergisi, 8(1): 22-41.

Dixit, SS., Smoll, JP. and Kingson, JC. (1992). Diatomes: Powerful indicators of environmetal change, Environment Science Tecnology, 26, 23- 32.

Gerrath, JF. and Denny, P. (1980). Freshwater Algae of Siera leone III. Cyanopyta, Chrysophyta, Xantophyta, Chloromonadophyta, Cryptophyta, Dinophyta, Nova Hedwigia, 33: 933-947.

Graham, LE., Graham JM. and Wilcox LW. (2009). Algae, Benjamin Cummings Press. California University.

Guiry, MD. and Guiry, GM. (2016). AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. http://www.algaebase.org; (Erişim Tarihi: 08.12.2016).

Hellawell, JM. (1986). Biological indicators of freshwater pollution and environmental management, Elsevier Applied Science Publishers.

Huber, PG. (1982). Das Phytoplankton des Süsswasers 8.Teil, 1.Halfte, Conjugatophyceae, Zygnematales and Desmidiales, E.Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

John, DM., Whitton, BA. and Brook, AJ. (2002). The freshwater Algal Flora of the British Isles, 2th ed, Cambridge University Press.

Kalyoncu, H., Barlas, M. and Yorulmaz, B. (2008). Aksu Çayı'nda (Isparta-Antalya) Epilitik Alg Çeşitliliği ve Akarsuyun Fizikokimyasal Yapısı Arasındaki İlişki, Ekoloji, 17, 66, 15-22.

Korshikov, OA. (1987). The Freshwater Algae of the Ukrainian S.S.R, V. Bishen Singh Mahendra Pal Singh and Koeltz, Scýentific Books.

Lee, RE. (2008). Phycology, 4 th.ed. Cambridge, UK.

Prescott, GW. (1987). Algae of Western Greats Lakes Area, Brown company publisher. ISBN 0-697-04522-8.

Rimet, F., Cauchie, HM., Hoffmann, L. and Ector, L. (2005). Response of diatom indices to simulated water quality improvements in a river. J Appl Phycol, 17, 119-128.

Rimet,, F. (2012). Recent views on river pollution and diatoms. Hydrobiologia. 683:1–24.

Round, FE. (1984). The Ecology of Algae. Cambridge: Cambridge University Press.

Round, FE. (1993). A Reviev and Methods for the Use of Epilitic Diatoms for the Detecting and Monitoring Changes in River Water Quality, HMSO, London.

Sládeček, V. (1973). System of water quality from the biological point of view. Arch Hydrobiol Beih Ergebn Limnol, vol. 7, no. I-IV, p. 1-218.

Sládeček, V. (1986). Diatoms as indicators of organic pollution. Acta Hydrochim Hydrobiol, 14, 555-566.

Smol, JP. and Stoermer, EF. (2010). The Diatoms: Applications for the Environmental and Earth Sciences, 2th ed, Cambridge University Press.

Solak, CN. and Ács, É. (2011). Water qualıty monıtorıng in European and Turkish rivers using diatoms. Turkish Journal of Fisheries and Aquatic Sciences 11(2): 329-337.

Tütkiye Algleri, http://turkiyealgleri.omu.edu.tr/; searched on 09.12.2016.

Van Dam H, Mertens, A. and Sinkeldam JA, (1994). A coded checklist ve ecological indicator values of freshwater diatoms from the Netherlands. Neth J Aquat Ecol, 28, 117-133.

Wehr JD, Sheath RG and Kociolek JP, 2003. Freshwater Algae of North America: Ecology and Classification, Michigan, Elsevier.

www.googleearth.com (Erişim tarihi: 18.11.2016)

Yavuz, O. Çetin, K. (2000). Cip Çayı (Elazığ - Türkiye) Pelajik Bölge Algleri ve Mevsimsel Değişimleri. F. Ü. Fen ve Müh. Dergisi 12 (2), 25 – 39.

Yıldız, K. and Özkıran, Ü. (1991). Kızılırmak Nehri Diatomeleri. Doğa TR. J. of Botany 15, 166-188.

Zhuzbayeva, A. and Atıcı, T. (2016). Algae and water qualities of Badam Dam Reservoir (Kazakhstan). Biological Diversity and Conservation, 9(2), (34-43).

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Research article/Araştırma makalesi

Antenna and mouthpart defect in *Chironomus (Camptochironomus) tentans* larvae (Chironomidae) and their relevance with habitat characteristics

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Abstract

A shallow, eutroph and metal contaminated lake (one of the Ramsar sites in Turkey, Lake Uluabat) was investigated from August 2004 to July 2005 to determine the defects at some mouthparts (mentum, mandible and epipharyngis) and antenna of *Chironomus (Camptochrinomus) tentans* larvae. Although a total of 1800 chironomid larvae belonging twelve taxa were found in Lake Uluabat, it was dominated by *Chironomus* (*Camptochironomus*) *tentans* Fabricius, 1805. A total of 327 *C.* (*C.*) *tentans* were examined, 55.04% of which possessed defects. A total of 12 stations were sampled but all samples of *C.* (*C.*) *tentans*, collected from two stations where water circulation is reduced, demonstrated the highest incidence of deformities during the study. Defects were found in all mouthparts and antenna in *C.* (*C.*) *tentans* but mentum and epipharyngis defects were the most frequent.

In each sample station, dissolved oxygen, temperature, pH and depth of the lake water were measured as in situ. In addition, concentrations of eight metals (Pb, Zn, Cd, Cu, Ag, Cr, Fe and Ni) were measured monthly in lake water (for all samples at each sampling station, n = 9) and sediment (n) monthly. = 9). Analyses of water and sediment from Lake Uluabat showed the presence of metal pollutants such as zinc, nickel, lead and copper.

The relationship between defect and water-sediment toxicity relationship was analyzed by Correspondence Analysis. According to the results, the total rate of defect were largely correlated with high amounts of Ni, Zn, Pb and Cd in sediment and PO_4, pH in water. In mouthpart; the mentum defects positively correlated with Ag and Zn in sediment, SO_4 and COD in water and negatively correlated with Cd in water and Cu in sediment; epipharyngis defect positively correlated with Zn in water and with Ag in sediment. Antenna defects showed a statistically correlation with Cr in sediment and COD, NO_3–N, SO_4 in water.

Key words: Defects in Chironomidae larvae, Lake Uluabat

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Chironomus (Camptochironomus) tentans (Chironomidae) larvaları anten ve ağız parçalarındaki şekil bozuklukları ve habitat özellikleri ile ilişkileri

Özet

Türkiye'deki önemli Ramsar alanlarından biri olan Uluabat Gölü sığ, ötrof ve metal ile kontamine olmuş bir göldür. *Chironomus (Camptochrinomus) tentans* larvalarının anten ve ağıız parçalarındaki (mentum, anten, mandibul ve epifarinks) şekil bozukluklarını incelemek amacıyla Ağustos 2004-Temmuz 2005 tarihleri arasında örnekler toplanmıştır. Araştırmada toplam 1800 chironomid larvası incelenmiş, Uluabat Gölü'nün 12 Chironomid taxonu içerdiği ve *Chironomus* (*Camptochironomus*) *tentans* Fabricius, 1805 türünün baskın olduğu tespit edilmiştir. Toplamda 327 *C.* (*C.*) *tentans* incelenerek bunların %55.04'ünde anten ve ağız parçalarında şekil bozukluklarının olduğu saptanmıştır. Su sirkülâsyonunun azaldığı iki istasyondan toplanan tüm *C.* (*C.*) *tentans* örnekleri çalışma süresince en yüksek oranda şekil bozukluğunun tespit edildiği örneklerdir. *C.* (*C.*) *tentans* larvaları tüm ağız parçalarında şekil bozuklukları tespit edilmiş olup, bu normalden sapmaların mentum ve epifarinkste daha yaygın olduğu belirlenmiştir.

Her bir örnekleme noktasında, su ölçümleri (derinlik, pH, çözünmüş oksijen ve sıcaklık) *in situ* olarak yapılmıştır. Ek olarak, sekiz metalin (Cd, Cr, Pb, Cu, Ni, Fe, Zn ve Ag) göl suyunda (her bir istasyonda bütün örnekler için, n=9) ve sedimentteki (n=9) konsantrasyonları aylık olarak analiz edilmiştir. Uluabat Gölü'nden sediment ve su analizleri nikel, çinko, bakır ve kurşun gibi metal kirleticilerin varlığına işaret etmektedir.

Anten ve ağız parçalarındaki şekil bozuklukları ile su-sediment toksisitesi arasındaki ilişki Correspondence Analysis (Uyum Analizi) ile incelenmiştir. Sonuçlarımıza göre anten ve ağız parçalarındaki toplam şekil bozukluğu oranı

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sedimentte nikel, çinko, kadmiyum ve kurşun, suda ise pH ve fosforun yüksek içerikleri ile pozitif korelasyon göstermektedir. Mentumdaki şekil bzuklukları ise sedimentteki Ag ve Zn, suda SO_4 ve COD ile positif korelasyon gösterirken, sudaki Cd ve sedimentteki Cu ile negatif korelasyon göstermektedir. Anten şekil bozuklukları sedimentte krom, suda kimyasal oksijen ihtiyacı, nitrat, sülfat ile pozitif korelasyon göstermektedir. Epifarinks şekil bozuklukları ise suda çinko, sedimentte gümüş ile pozitif korelasyon göstermektedir. Epifarinksteki şekil bozulmaları sudaki Zn ve sedimentteki Ag ile pozitif korelasyon gösterirken, anten yapısındaki bozulmaların sedimentteki Cr ve sudaki COD, NO_3–N, SO_4 içeriği ile pozitif korelasyon gösterdiği tespit edilmiştir.

Anahtar kelimeler: Uluabat Gölü, Chironomidae larvalarında şekil bozuklukları

1. Introduction

Chironomidae larvae are approved as bioassay organisms by reason of spending most of their lifetime in the surface of sediments where these organisms are subject of different toxicants. Given the ecological importance of the Chironomidae in the dynamics of aquatic ecosystems, they were often used as bioindicators in studies monitoring water quality (Vermeulen, 1995; Warwick, 1985). The existence of deformed individuals among chironomid larvae shows toxic stress (Janssens de Bisthoven, 1999). Therefore, their inclusion in community assessment adds inferring power to assess ecosystem health (Diggins & Stewart, 1998). Chironomidae larvae, as *apneustic aquatic insects*, often represent an important part of the benthic fauna in polluted aquatic systems. However, difficulties in identification often force the researcher to examine them at the tribe, subfamily or family level (Armitage & Blackburn, 1985).

In Europe and America, many studies have showed the existence of defect (or deformities) in the larvae of several chironomid genera (e.g. *Procladius*, *Chironomus* and *Cryptochironomus* spp.), and results strongly indicate that abnormalities are associated with polluted sediments (Vermeulen, 1995). In Turkey, great efforts have been realized in the last three decades to testing pollution in many lakes and rivers (including Lake Uluabat) (Dalkıran et al., 2006; Kökmen et al., 2007; Filik-İşçen et al., 2008; Emiroğlu et al., 2010; Çamur-Elipek et al., 2010; Arslan et al., 2010a; Arslan et al., 2010b). However, much less relevance is gave to the using of aquatic organisms for environmental bioassessments. Although determination of trace metals in benthic invertebrates started several decades ago in Turkey, our knowledge of mouthpart and antenna defects in chironomidae species is still limited.

The objectives of this paper are: (1) to elucidate and illustrate mouthpart and antenna defects (epipharyngis, antennae, mentum, and mandibles) in larval *C.* (*C.*) *tentans* for the first time in Turkey, (2) to compare deformation severity in *C.* (*C.*) *tentans* collected at different sites in the contaminated Lake Uluabat, and (3) to evaluate the effects of pollution on mouthpart defects.

2. Materials and methods

Cd, Cr, Pb, Cu, Ni, Zn, Fe and Ag concentrations were examined monthly in lake water (for all samples at each sampling station, (n=9), sediment (n=9)) between August 2004 and July 2005 from 12 sites in Lake Uluabat.

2.1. Study Area

Lake Uluabat (Lake Apolyont) is respected as one of the most important Bird Areas (IBA), both of in Turkey and in the Palearctic region (Magnin and Yarar, 1997). It is situated between 62º 00' and 65º 00' E longitude and 44º 40' and 44º 60' N latitude in Bursa, Turkey, to the south of the Marmara Sea (Figure 1). The lake is currently evaluated as showing a typical eutrophication character (Magnin and Yarar, 1997) and protected by the Ramsar Convention, 1998. The Uluabat Lake is a shallow (maximally 3 m deep), but large freshwater lake, which encompass an area of between 135 and 160 km^2, depending on the water level. An expanding and large delta has been constituted by silt deposition around the mouth of Mustafakemalpaşa River in the southwest part and its single outlet is in the northwest part where it drains into the Kocaçay River. Heavy metal concentrations and water quality in Uluabat Lake were investigated in different studies and levels of metal accumulation were reported (Turgut, 2005; Kazancı et al, 2010).

2.2. Sampling

C. (*C.*) *tentans* larvae were collected monthly (except during the winter season because of extreme weather conditions) from twelve stations in Lake Uluabat. A variety of defects on the head capsule were observed and the same scoring system as Lenat, 1993 was used. At each sampling site some parameters of water, dissolved oxygen, pH, depth and temperature were measured *in situ* with a DOK-TAO mark portable water quality checker (WQC-22A). At the same time, 1 L in volume of water samples were taken into plastic bottles at each sampling point and pH was adjusted to 2 by adding HNO_3, kept cool for metal analysis in the laboratory. Sample bottles were washing with detergent and then keeping them in 50% HCl for 24 hours before sampling. At the end, the bottles were washed with distilled water. Bottles were soaking in 1% nitric acid before their use. In addition, at each sampling site sediment was collected from three random sites and mixed. The upper layers of sediment were collected for metal analysis at all stations by using an Ekman-dredge (surface area 225 cm^2), taking small parts from the center of the dredge by using a polyethylene spoon to beware contamination by metallic parts of the dredge.

Maximum, minimum and average values of the environmental parameters determined in the lake water and sediment are given in Table 1. At each sampling site, Chironomid larvae were collected by using an Ekman-dredge and sieving *in situ* using a 200-µm mesh size. They were fixed in 4% formalin in the field. All collected samples were identified to species level.

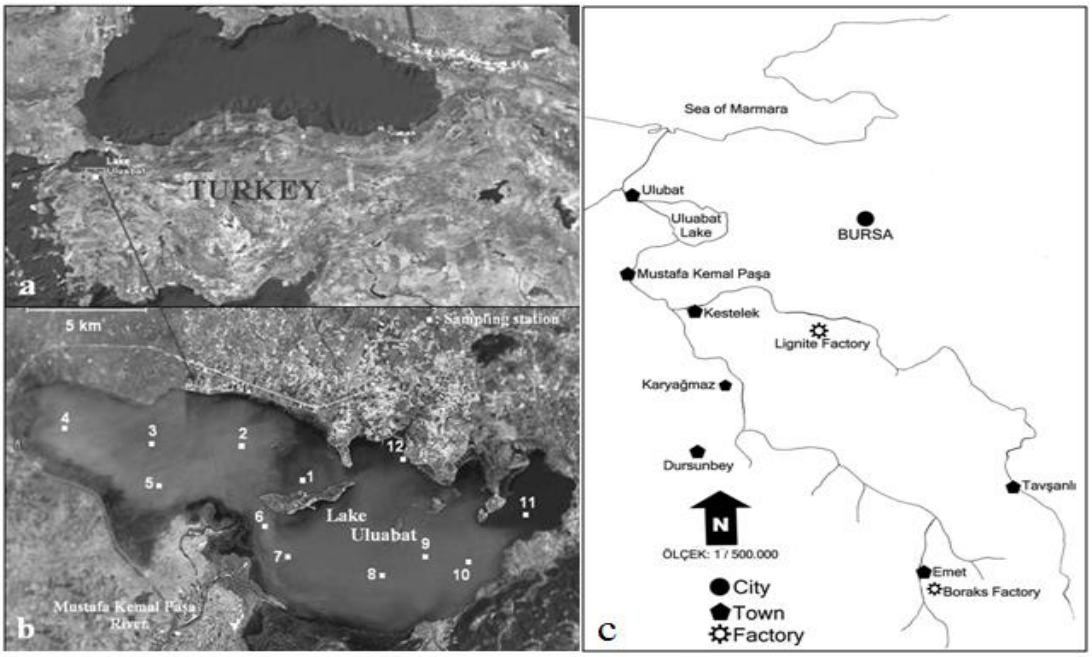

Figure 1. a- Geographical situation of Lake Uluabat; b- Sampling stations; c- Lake Uluabat basin

2.3. Evaluation of metal concentrations

Cr, Cd, Pb, Cu, Ni, Zn, Ag and Fe were analyzed in sediments and the lake water. Bottom sediment which are air-dried samples were dried for 3 hours at 105ºC to use in metal analysis. After whole samples had been sieved by a nylon (0.5 mm), 0.5 g of each sample was sited in pyrex reactors of a CEM Star 2 microwave digestion unit. $HClO_4$:HNO_3 acids of 1:3 proportions for samples were placed in the reactors. Samples were mineralized for 30 minutes at 200°C later. The samples were filtered by means of making their volumes up to 100 ml with ultrapure distilled water. Metals were identified by the flame atomic absorption spectrophotometric (Varian Spectra A 250 Plus model) method (EPA, 1998; APHA, 1992; ASTM, 1985; EPA, 2001). The metal analyses in bottom sediment and water were recorded as means triplicate measurements. In the FAAS analysis, the following wavelength lines were used: Cr 357.9 nm, Pb 217.0/283.3 nm, Cu 324.8 nm, Ni 232.0 nm, Cd 228.8 nm and Zn 213.9 nm. The analytical quality phase was also controlled by standard reference material NIST-SRM 1573a and certified reference biological material of NCS DC73350.

2.4. Evaluation of defects in the larvae

The preserved larvae were moved to a petri dish including 10% KOH solution and kept in the solution to digest the larval muscles for 24-48 hours. After then, the permanent slide mounts of the larvae were prepared following the method of Epler (2001). The slide mounted larvae were defined to species level using available taxonomic keys (Şahin, 1991; Epler, 2001) and some mouthparts (epipharyngis, mentum, mandibles) and antennae were examined for defect existence. The percentage of defect was calculated with the following formula: % defect= (number of deformed larvae/total number of larvae examined) x100. The severity of deformities was used as a standard to estimate the influences of pollution and was scored using the TSI of Janssens de Bisthoven et al. (1998); Class 1 (CL.1–individuals without any morphological deformity); Class 2 (CL.2–individuals with weak deformity): one or two round teeth, one additional or missing tooth, two joined teeth, one bifid tooth, weak asymmetry,; Class 3 (CL. 3–individuals with strong deformity). Toxic Score = No.of Class I + 2. (No.of Class II) + 3.(No.of Class III) * 100/ Total Number of Larvae.

2.5. Statistical analyses

The relationship between defect and water-sediment toxicity was analyzed by Correspondence (Greenacre and Blasiusi, 1994; Özdamar, 1999; Yıldız, 2004). Measurements were performed on samples obtained from Lake Uluabat on which deformation on the some mouthpart and antenna of *C.* (*C.*) *tentans* was observed. Similarly, the analysis of metals in sediment and water and the analysis of environmental parameters of water were also carried out. All these variables were normalized by taking the average station based values; and then, by labeling non-deformed larvae as 1, deformed larvae as 2, and for the other data, lower than average values as 1 and higher values as 2, they were categorized. The correspondence analysis was performed with categorical variables. Later, the levels of the variables' locations were given in a coordinate system. The relationship between the levels of the variables was interpreted by using the cosine value (Cos(α)) of the angle between the lines that are drawn from the levels to origin (Uzgören and Uzgören, 2007).

3. Results

3.1. Elemental Analyses

Environmental parameters measured monthly at the sampling sites from August 2004 to July 2005 are given in Table 1. According to the results, the concentrations of copper, lead, zinc and nickel in the water samples were observed higher than the limits of Regulation on Management of Surface Water Quality (2015). In addition, metals in the sediment of Lake Uluabat were found at generally 100–200 times higher than in lake water (Table 1). Zinc was found in the highest concentrations in the lake water at all sampling sites (except sites 5, 7, 8 and 9), while lead was measured in the highest concentrations at sites 5, 7, and 8 (Fig. 2). These two metal concentrations in lake water were higher than the criteria maximum concentration (CMC) limits given by the EPA (2006) (0.120 and 0.065 mg L^{-1}, respectively) (US EPA, 2006). According to average values, the metal levels were as follows for the water in Lake Uluabat: Zn > Ag > Cu > Fe > Pb > Ni > Cr > Cd.

The metal concentrations were measured in the upper layer of the sediments of the 12 sampling sites varied significantly. Except the essential metals (such as nickel and zinc), lead and copper were found in the highest concentrations at 3, 5 and 11 sampling sites. In addition, all the concentrations amounts of the eight investigated metals of the lake's sediment were found to be higher than those of lake water.

Table 1: Environmental parameters of Lake Uluabat in the investigated period from August 2004 to July 2005 (WT: water temperature; BOD: Biological oxygen demand; DO: dissolved oxygen; COD: Chemical oxygen demand; DW; dry weight).

Limnological Parameters									
Months	**DO** (mg L^{-1})	**BOD** (mg L^{-1})	**COD** (mg L^{-1})	**WT** (ºC)	**pH**	**NO_2 – N** (mg L^{-1})	**NO_3-N** (mg L^{-1})	**NH_3-N** (mg L^{-1})	**PO_4^{-3}** (mg L^{-1})
Aug.04	6.5	16.3	41.2	23.9	8.5	0.051	0.298	0.623	0.951
Sep. 04	5.4	13	39.1	23.1	8.2	0.075	0.788	0.153	0.493
Oct. 04	7.4	5.5	27.4	18.3	8.3	0.018	1.838	0.026	0.477
Nov. 04	9.3	3.5	27.7	12	8	0.041	1.533	0.138	0.466
Mar.05	6.4	10.8	45.6	13.4	8.8	0.036	1.147	0.128	0.323
Apr. 05	7.5	6.6	73.4	19.1	8.3	0.048	0.833	0.114	0.331
May. 05	7	7.1	70.8	22.5	8.3	0.028	0.708	0.083	0.148
Jun. 05	7.5	7.6	78.3	23	8.4	0.045	1.167	0.285	0.331
Jul. 05	6.3	18.2	66.4	25.7	8.8	0.044	0.617	0.463	0.302
Stations									
1st	8.5	15.4	62.3	20.4	8.5	0.036	0.531	0.400	0.369
2nd	8.6	7.6	48.5	20	8.5	0.046	0.762	0.174	0.302
3rd	9.3	7.4	47.8	19.5	8.4	0.068	1.077	0.157	0.570
4th	7.7	7.7	60.6	19.5	8.4	0.027	1.111	0.239	0.378
5th	9.2	7.8	56.3	19.7	8.5	0.052	1.012	0.128	0.281
6th	8.3	7.6	34.6	19.6	8.3	0.053	0.944	0.182	0.527
7th	7.5	8.1	51.6	20	8.3	0.036	1.103	0.202	0.314
8th	7.4	7.1	51.9	19.8	8.4	0.038	1.238	0.302	0.355
9th	7.7	14.6	41.6	21	8.4	0.051	0.749	0.222	0.532
10th	7.4	11.9	63	20.4	8.4	0.039	1.199	0.201	0.475
11nd	6.1	15.2	47.2	21.5	8.5	0.040	1.139	0.311	0.574
12th	5.4	6	73.6	18.8	8.4	0.021	1.074	0.114	0.306

Average concentration of metals (min.-max value±SD) in lake water and sediment								
	Cd	**Cr**	**Pb**	**Cu**	**Ni**	**Zn**	**Fe**	**Ag**
Water ($mg\ L^{-1}$)	0.003 (n.d.-0.018)	0.017 (n.d.-0.132)	0.105 (n.d.-0.401)	0.118 (0.007-0.337)	0.056 (n.d.-0.245)	0.284 (0.363-3.85)	0.107 (0.09-1.56)	0.1375 (0.048-0.059)
Sediment (DW,$mgkg^{-1}$)	0.699 (n.d.-7.4)	57.9 (n.d.-132.7)	110.7 (n.d.-372.5)	119.226 (38.6-289.8)	209.4 (75.6-303.7)	171 (17.2-395.73)	65.10 (58.6±154.89)	21.6 (7.35±78.13)

3.2. Defects in *Chironomus (Camptochironomus) tentans*

A total of 1800 chironomid larvae were examined from the twelve sampling sites. Chironomid larvae were abundant in the sediments of Lake Uluabat, representing on average 12.3% of the benthic fauna. *C.* (*C.*) *tentans* was the dominant chironomid species consisting 66.2% of the total chironomid limnofauna. Among the identified chironomid species the highest frequencies of defects were found in *C.* (*C.*) *tentans.* A total of 327 *C.* (*C.*) *tentans* were examined, 55.04% of which possessed defects (Table 2). 4th instar *C.* (*C.*) *tentans* larvae which were deformed for some mouthparts (mentum, mandibles, epipharyngis) and antenna are illustrated in Figure 2. Although defects were found in the mentum, mandibles, epipharyngis and antennae in *C.* (*C.*) *tentans*, mentum and epipharyngis defects were the most frequent (Table 2 and Figure 2).

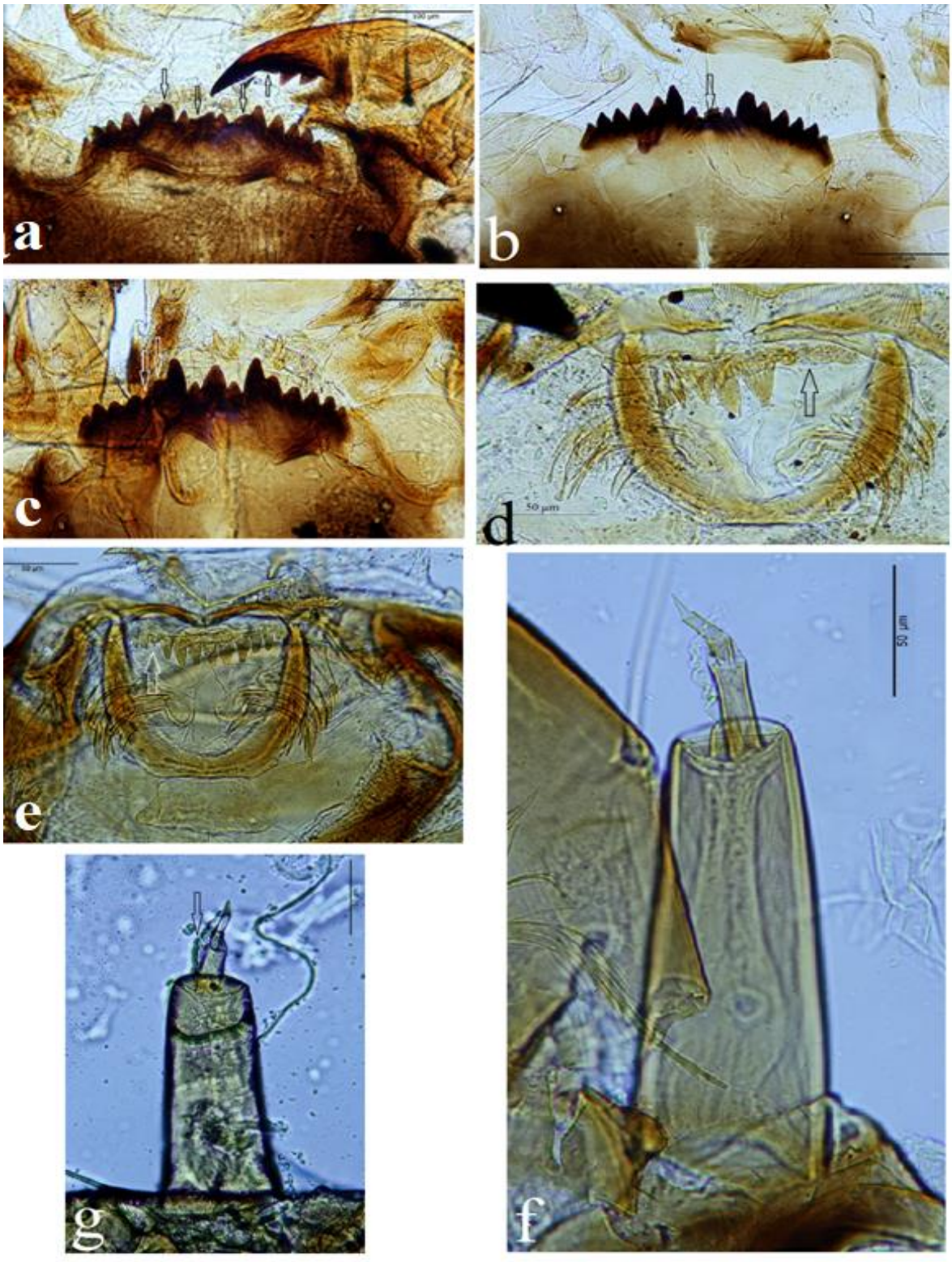

Figure 2. Defects in *Chironomus* (*Camptochironomus*) *tentans* larvae collected from Lake Uluabat: Mouthpart deformities; a-c: mentum deformities, d-e: epipharyngis deformities; and antenna deformities f-g: antenna

3.3. Statistical analyses

The most common type of mentum defect observed was the loss or strong reduction of median teeth, and asymmetry in the number of lateral teeth and gaps in the mentum were very common. Epipharyngis defects were characterized into two general types, ranging from the absence of the lateral teeth and asymmetry in the number of lateral teeth as demonstrated in Figure 2a-c. Existence of extra lateral teeth was another deformity but it was very rare.

Table 2. Defect frequencies (%) in larvae (n=327) of *C.* (*C.*) *tentans* collected from Lake Uluabat (Ss: Sampling stations; TS: Toxic score)

Ss	Total larvae	*C.* (*C.*) *tentans*	Class I	Class II	Class III	Non-defect Larvae	Defect Rate (%)	Mentum defect rates (%)	TS (%)
1	172	54	26	27	1	26	16	39.3	48.2
2	202	50	21	27	2	21	14	37.9	40
3	132	42	24	18	-	24	14	55.6	45.4
4	75	3	-	3	-	-	4	33.3	8
5	84	2	1	1	-	1	1	0	3,6
6	110	6	2	3	1	2	4	25	10
7	133	7	2	5	-	2	4	20	9,02
8	384	75	32	41	2	32	11	20.9	31.2
9	265	49	22	24	3	22	10	48.1	30
10	168	36	17	18	1	17	11	26.3	33.3
11	14	3	-	3	-	-	21	66.7	43
12	61	-	-	-	-	-	-	0	0

Correspondence analysis showed significant correlations between the deformed mouthpart (mentum, epipharyngis) and antennae of *C.* (*C.*) *tentans* larvae and the environmental parameters of water and sediment. Mouthpart defect incidence did not equally correspond to the environmental parameters of the water and sediment (Figures 3, 4 and 5). According to our results, the deformity rate showed a significant relation with high contents of Ni, Pb, Cd and Zn in sediment and pH, PO_4 in water.

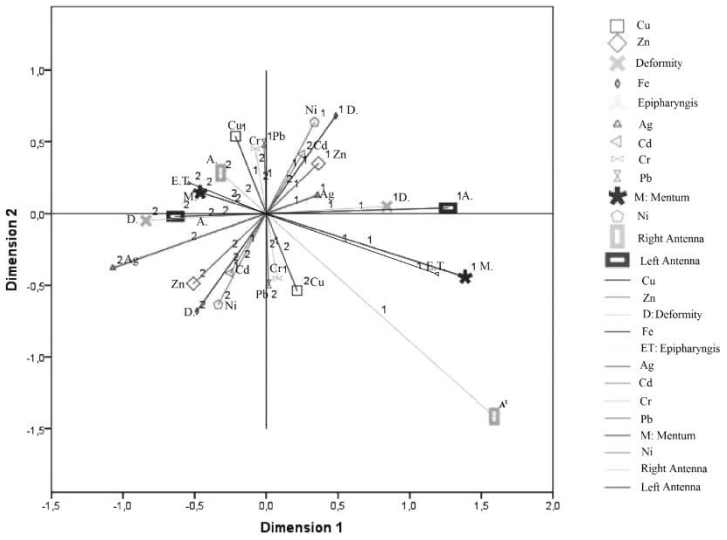

Figure 3. Correlation coefficients between mouthpart defects and sediment metal concentrations

With regard to Correspondence analysis, Zn in water, Ag in sediment showed a significant positive relationship with epipharyngis deformities, whereas Cu in sediment showed a significant negative relationship. In addition, it was found that the relation between NO_3–N, PO_4, temperature, SO_4 and epipharyngis deformities were significantly directly proportional. The mentum deformities positively correlated with Ag and Zn in sediment, SO_4 and COD in water and negatively correlated with Cd in water and Cu in sediment. Antenna deformities positively correlated with Cr in sediment and COD, NO_3–N, SO_4 in water.

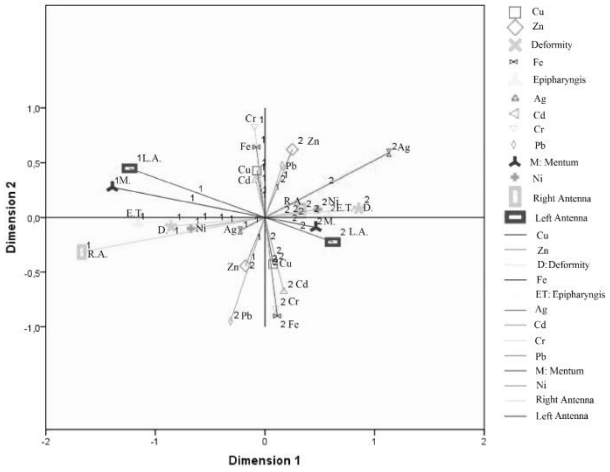

Figure 4. Correlation coefficients between mouthpart defects and water metal concentrations

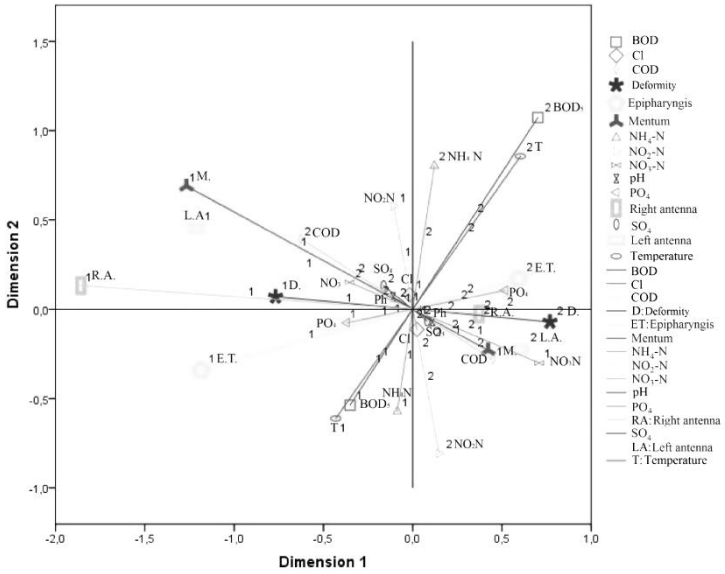

Figure 5. Correlation coefficients between water parameters and mouthpart defects

4. Conclusions and discussion

It is known that Lake Uluabat is dominated by pollution-tolerant invertebrate taxa, like Nematoda, Oligochaeta, Chironomidae spp. (Kökmen et al., 2007; Arslan et al., 2010a). Lake Uluabat is most likely contaminated with domestic and waste agricultural chemicals and it also receives industrial discharges from surrounding areas (Filik-İşçen et al., 2008). The larvae of the subfamily Chironomini are considered as filter or sediment feeders (Armitage and Blackburn, 1985). *C.* (*C.*) *tentans* belonging to the subfamily Chironominae was the most abundant chironomid in Lake Uluabat, showing a higher rate of mouthpart defects. All samples of *C.* (*C.*) *tentans*, collected from stations 4th and 11th where water circulation is reduced (Figure 1a) demonstrated the highest effects of defects throughout the study.

As is known, heavy metal contamination is a main cause of defects in the chironomid larvae (Martinez et al., 2004; Bhattacharyay et al., 2005; Al-Shami et al., 2010). The metal concentrations were measured in the upper layer of the sediments in the 12 sampling sites varied significantly. Except the essential metals (nickel and zinc), lead and copper were measured in the highest concentrations at 3, 5 and 11 sampling sites. In addition, all the concentrations values of the eight investigated metals of the sediment of the lake proved to be higher than those of lake water. Almost all deformed *C.* (*C.*) *tentans* samples pertain to instar IV exposed to toxic sediment substances for the longest period. This indicates that the high frequency of defects is related to high levels of sediment contamination. High lead and copper concentrations were measured in the Uluabat Lake sediments (Table 1). The relationship between sediment metals (especially Ag, Zn, Cr, Pb and Cd) and chironomid mouthpart defects was significantly positive. These results were in agreement with others (Madden et al., 1992 and 1995; Bird, 1994; van Urk et al., 1992; Thornberg, 1995) who recorded an almost linear relationship between increasing levels of heavy metals and deformity rates. In addition, our results show that the relation

between deformity rates strongly correlated with pH, PO_4, SO_4, NO_3–N and COD in water. Janssens de Bisthoven et al. (1994) were reported that the relationship between pollutants and defects is not always linear and depends greatly on the pollutant involved. They found that defects in the mandibles correlated with exposure to heavy metals whereas the menta and antennae were more sensitive to organic xenobiotic exposure.

The results of the present study are different from the results of Janssens de Bisthoven et al. (1994) because we found that defects in the antennae and menta also correlated with metals Cr and Ag-Zn in sediment respectively.

As we mentioned before, zinc was found in the highest concentrations in the lake water at all sampling sites (except sites 5, 7, 8, and 9), while lead was measured in the highest concentrations at sites 5, 7, and 8. Zinc in water showed a significant positive relationship with epipharyngis defects and, in addition, mentum defects positively correlated with Zn and Ag in sediment. Furthermore, the present study found a positive correlation between Cd and Pb in deformity rates and sediments. Although zinc is known as an essential metal and cofactor of many enzyme systems among the elements analyzed, it is clear that the high concentration of this metal, as well as Pb and Cd in water and sediment (either alone or in combination), may be the agents inducing the mouthpart deformities.

Many contaminants have been recommended as causal agents for the deformities in chironomid larvae. However, overview of the literature finds out that heavy metals generally are the only common factor. However, Simkiss and Taylor (1989) reported that as with other metals, the uptake or toxicity of zinc in aquatic organisms is modified by environmental conditions such as temperature, salinity and pH. In addition, lead and cadmium are very toxic to aquatic organisms and pH, temperature, and water hardness are factors that affect its toxicity (Hellawell, 1998). In Lake Uluabat, the temperature did not diverse along the lake, and a normal seasonal change was observed (Table 2). pH values were high and slightly alkaline. The present study found a positive relationship between pH and epipharyngis deformity.

Janssens de Bisthoven et al. (1994) reported that a possible relationship between specific defect types and specific contaminants, supposing that defect type can be used as a potential indication of the responsible contaminant. He showed that Pb was most likely to be related to mentum defects while there was no certain relationship between Zn and Cu and specific defects. However, Martinez et al. (2001) found that Pb and Zn set off defects in the mentum at a higher rate than in the mandibles. They also reported that Zn was associated with higher rates of missing and fused mentum teeth. Deformities exposed to Pb in chironomids were most likely to be Kohn gaps and missing mentum teeth (Martinez et al., 2001).

In this study it was found that the percentage of deformation in the mentum is higher that of the other mouthparts. This reveals that the Zn, Cu and Pb contents in the water and sediment is of very high concentration and that they affect the mentum more than the mouthparts. However, contrastly to the results of the study by Martinez et al. (2001), the percentage of deformation in the mandibula is not very high.

Nickel, zinc, copper and lead concentrations in both sediment and water appear to set off defects in the mentum at a higher proportion than in mandibles, with Kohn gaps and missing or fused mentum teeth the most common deformity types. As can be seen in Table 2, the metal with the second highest concentration in water is silver (0.137 mg/L). The average concentration in the sediment was established to be 0.21 mg/kg and the highest concentration to be 78.35 mg/kg. It is known that concentrations of Ag in sediment from highly industrialised areas range from 1 to 150 mg/kg, whereas background concentrations in nonurban areas are usually <0.1 mg/kg (Eisler, 1996). There are many industrial plants located in Lake Uluabat's catchment area. This shows that silver was carried from the river basin to the lake and that it was accumulated in the lake water and the sediment.

According to the mean value of lake water parameters, NO_2 –N was generally determined at three-fourths quality, NO_3 –N was determined at first quality level, and NH_3 –N was determined at second quality level and phosphate was determined at third quality level (Regulation on Management of Surface Water Quality, 2015). The maximum value of ammonium concentrations were found at stations 1, 4, 6, 8 and 11. All samples of *C.* (*C.*) *tentans*, collected from stations 1st, 8th and 11th showed the highest defect rate throughout the study (16%, 11% and 21% respectively). This result shows that mouthpart deformities not only correlated with metals but also correlated with water parameters such as NO_3–N, NO_2–N, NH_3–N and PO_4.

In *C.* (*C.*) *tentans* (Table 2) defect, analysis of the mentum showed a deformity incidence of 55.04% (CL.2+CL.3; 180 of 327 specimens). CL.2 deformity affected 51.98% of specimens whereas strong deformity (CL.3) affected 3.05% of specimens. Lenat (1993) suggested that toxic score = 25 should be taken as the threshold value above which a watercourse should be considered as toxically contaminated. TS values calculated for our *C. (C.) tentans* samples are shown in Table 2. Samples in which TS is over 25 were found in sampling sites 1, 2, 3, 8, 9, 10 and 11 (TS>30). In addition, Lenat (1993) also suggests that the frequency of severe deformities (especially Class II and Class III deformities) is generally greater than 6% at toxic sites. In most of our samples, the frequency of severe deformities was higher than 6%. In addition, Diggins and Stewart (1998), search the heavily industrialized Buffalo River, reported a 15% deformity rate for the predator *Procladius* and a 22–66% deformity proportion for the deposit-feeder *Chironomus*. The current study also found that deformities were most prevalent in *C.* (*C.*) *tentans*, although our highest (21%) deformity proportion was less than their lowest deformity rate. The results of our study show that the water and sediment of Lake Uluabat, which is a Ramsar zone, are heavily contaminated. Furthermore, taking the literature data into account, the high proportions of TS, Class II and Class III deformities show that the effects of past pollution are extreme. Warwick and Tisdale (1988), and Bird (1994) reported that deformities of the mentum are a common developmental anomaly in *Chironomus* spp.

larvae, and our result supports this knowledge. In addition, *Chironomus* spp. larvae are known as organisms which are highly susceptible to morphological deformation. *Chironomus* spp. are, therefore, one of the important indicators of the effects of sediment and water bound contaminants (Vermeulen, 1995; Hudson and Ciborowski, 1996). Kosalwat and Knight (1987) and van de Guchte and Urk (1989) have reported experiments with various *Chironomus* species that show direct relationships between deformities and heavy metal levels. Our data are in agreement with the studies mentioned above. In summary, our results show that not only high metal concentrations (especially Ni, Zn, Pb, Cu and patially Ag) in water and sediment but also NO_3–N, NO_2–N, NH_3–N and PO_4 concentrations can set off deformities in chironomid larvae subjected to these metals during their lifetime. The surveyed deformity induction in the current study supports the potential for use of chironomid deformity rates for bioassay applications.

Consequantly, larvae of *C.* (*C.*) *tentans* in Lake Uluabat have a high effect of mouthpart defects. *C.* (*C.*) *tentans* is the best bioindicator because it closely reflects the condition of the sediment influenced by the hydrological regime of the lake.

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References

Al-Shami, S., Rawi, C. S. M., Nor, S. A. M., Ahmad, A. H., Ali, A. (2010). Morphological deformities in *Chironomus* spp. (Diptera: Chironomidae) larvae as a tool for impact assessment of anthropogenic and environmental stresses on three rivers in the Juru River System, Penang, Malaysia. Journal of Environmental Entomology, 39, 210–222.

APHA, American Public Health Association. (1992). Standard methods for the examination of water and wastewater. CSS (Complete Statistica System): Statistica. References for Statistical Procedures (DOS and Windows version), Release 3.1. StatSoft Inc., Tulsa (OK): Washington StatSoft Inc.

Armitage, P. D., Blackburn, J. H. (1985). Chironomidae in a pennine stream system receiving mine drainage and organic enrichment. Hydrobiologia, 121, 165–172.

Arslan, N., Ayık, O., Sahin, Y. (2010a). Diversity and structure of Chironomidae (Diptera) limnofauna of Lake Uluabat, a Ramsar site of Turkey, and their relation to environmental variables. Turkish Journal Fisheries and Aquatic Sciences, 10(3), 235-243.

Arslan, N., Koç, B., Cicek, A. (2010b). Metal contents of macroinvertebrates (Oligochaeta - Chironomidae), in water, and bottom sediments of Lake Uluabat, a Ramsar site of Turkey. The Scientific World Journal Environment, 10, 1269-1281.

ASTM, American Society for Testing and Materials. (1985). Preparation of biological samples for inorganic chemical analysis. 1. Annual Book of ASTM Standards, D-19: 740–747.

Bhattacharyay, G., Sadhu, A. K., Mazumdar, A., Chaudhuri, P. K. (2005). Antennal deformities of chironomid larvae and their use in biomonitoring of heavy metal pollutants in the River Damodar of West Bengal, India. Environmental Monitoring and Assessment, 108, 67–84.

Bird, G. A. (1994). Use of chironomid deformities to assess environmental degradation in the Yamaska River, Quebec. Environmental Monitoring and Assessment, 30, 163–175.

Camur Elipek, B., Arslan, N., Kırgız, T., Oterler, B., Guher, H., Ozkan, N. (2010). Analysis of benthic macroinvertebrates in relation to environmental variables of Lake Gala (Edirne / Turkey). Turkish Journal of Fisheries and Aquatic Sciences, 10, 315-322.

Dalkıran, N., Karacaoglu, D., Dere, S., Senturk, E., Torunoglu, T. (2006). Factors affecting the current status of a eutrophic shallow lake (Lake Uluabat, Turkey): Relationships between water physical and chemical variables. Chemistry and Ecology, 22(4), 279–298.

Diggins, T. P., Stewart, K. M. (1998). Chironomid deformities, benthic community composition, and trace elements in the Buffalo River (New York) area of concern. Journal of the North American Benthological Society, 17(3), 311–323.

Eisler R. (1996). Silver hazards to fish, wildlife and invertebrates: A synoptic review. Contaminant Hazard Reviews. Laurel, MD (US): Department of the Interior Patuxent Wildlife Research Center. Report No.:32.

Emiroglu, O., Cicek, A., Arslan, N., Aksan, S., Ruzgar, M. (2010). Boron concentration in water, sediment and different organisms around large borate deposits of Turkey. Bulletin of Environmental Contamination and Toxicology, 84(4), 427-431.

EPA Method 2007. (2001). Determination of metals and trace elements in water and wastes by inductively coupled plasma-atomic emission spectrometry.

EPA Method 3051. (1998). Microwave assisted acid digestion of sediments, sludges, soils, and oils.

EPA, Environmental Protection Agency (US). (2006). National recommended water quality criteria-correction. Office of Water. 822-z-99-001.

Epler, J. H. (2001). Identification manual for the larval Chironomidae (Diptera) of North and South Carolina. A guide to the taxonomy of the midges of the Southeastern United States, including Florida. North Carolina, Special Publication, SJ2001-SP13.

Fılık Iscen C., Emiroglu, O., Ilhan, S., Arslan, N., Yılmaz, V. (2008). Application of multivariate statistical techniques in the assessment of surface water quality in Uluabat Lake, Turkey. Environmental Monitoring and Assessment, 144, 269-276.

Greenacre, M., Blasius, J. editors. (1994). Correspondence analysis in the social science. San Diego: Academic Press.

Hellawell M. J., 1998. Toxic substances in rivers and streams. Environmental Pollution, 50, 61–85.

Hudson, L. A., Ciborowski, J. J. (1996). Spatial and taxonomic variation in incidence of mouthpart deformities in midge larvae (Diptera: Chironomidae, Chironomini). Canadian Journal of Fisheries and Aquatic Sciences, 53, 297-304.

Janssens de Bisthoven, L. (1999). Biomonitoring with deformities in aquatic organisms. In: Gerhardt A editor. Biomonitoring of Polluted Water. Zürich: Transtech Publications. Environmental Science Forum, 9, 65–94.

Janssens de Bisthoven, L., Huysmans, C., Ollevier, F. (1994). The *in situ* relationships between sediment concentrations of micropollutants and morphological deformities in *Chironomus* gr. *thummi* larvae (Diptera, Chironomidae) from lowland rivers (Belgium): a spatial comparison. In: Cranston PA editor. Chironomids: from genus to ecosystems. CSIRO, Melbourne. p. 63-80.

Janssens de Bisthoven, L., Nuyts, P., Goddeeris, B., Ollevier, F. (1998). Sublethal parameters in morphologically deformed *Chironomus* larvae: clues to understanding their bioindicator value. Freshwater Biology, 39, 179-191.

Kazancı, N., Leroy, S. A. G., Öncel, S., İleri, Ö., Toprak, Ö., Costa, P., Sayılı, S., Turgut, C., Kibar, M. (2010). Wind control on the accumulation of heavy metals in sediment of Lake Uluabat, Anatolia, Turkey. Project supported by Technical and Scientific Research Council of Turkey (YDABCAG 103Y102), and by NATO (EST.CLG.978645). https://bura.brunel.ac.uk/bitstream/2438/4190/1/JOPL1528R3.pdf.

Kokmen, S., Arslan, N., Filik, C., Yılmaz, V. (2007). Zoobenthos of Lake Uluabat, a Ramsar site in Turkey, and their relationship with environmental variables. Clean, 35(3), 266-274.

Kosalwat, P., Knight, A. W. (1987). Chronic toxicity of copper to a partial life cycle of the midge *Chironomus decorus*. Archives of Environmental Contamination and Toxicology, 16, 283–290.

Lenat, D. R. (1993). Using mentum deformities of *Chironomus* larvae to evaluate the effects of toxicity and organic loading in streams. Journal of the North American Benthological Society, 12(3), 265–269.

Madden, C. P., Austin, A. D., Suter, P. J. (1995). Pollution monitoring using chironomid larvae: what is a deformity? In: Cranston P editor. Chironomids: from genes to ecosystems. CSIRO Pub East Melbourne, Australia. p. 89–100.

Madden, C. P., Suter, P. J., Nicholas, B. C., Austin, A. D. (1992). Deformities in chironomid larvae as indicator of pollution (pesticide) stress. Netherland Journal of Aquatic Ecology, 26, 551–557.

Magnin, G., Yarar, M. (1997). Important bird breeding areas in Turkey, İstanbul.

Martinez, E. A., Moore, B. C., Schaumloffel, J., Dasgupta, N. (2001). Induction of morphological deformities in *Chironomus tentans* exposed to zinc- and lead-spiked sediments. Environmental Toxicology and Chemistry, 20(11), 2475–2481.

Martinez, E. A., Moore, B. C., Schaumloffel, J., Dasgupta, N. (2004). Teratogenic versus mutagenic abnormalities in chironomid larvae exposed to Zinc and Lead. Archives of Environmental Contamination and Toxicology, 47, 193–198.

Ozdamar, K. (1999). Paket programlarla istatistiksel veri analizi "çok değişkenli analizler". Eskişehir: Kaan Kitabevi.

Republic of Turkey Ministry of Environment and Forest. (2015). Regulation on Management of Surface Water Quality.

Sahin, Y. (1991). Türkiye Chironomidae Potamofaunası. Project No.:TBAG-869.

Simkiss, K., Taylor, M. G. (1989). Metal fluxes across the membranes of aquatic organisms. Critical Reviews in Aquatic Sciences, 1, 173–188.

Thornberg, A. E. (1995). Mouthpart deformities in chironomids from heavy metal contaminated sediments of the Coeur d' Alene region [master's thesis]. [Pullman (WA)]: Washington State University.

Turgut, C. (2005). Ulubat Gölü çökellerinde ve göl suyunda metal konsantrasyonlarının incelenmesi. Yüksek Lisans Tezi, Gebze Yuksek Teknoloji Enstitüsü, Gebze, Kocaeli, 92 p.

Uzgoren, N., Uzgoren, E. (2007). Dumlupınar Üniversitesi lisans öğrencilerinin memnuniyetini etkileyen bireysel özelliklerin istatistiksel analizi-hipotez testi, ki-kare testi ve doğrusal olasılık modeli. Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 17, 173-192.

van de Guchte, C., van Urk, G. (1989). Discrepancies in the effects of field and artificially heavy metal contaminated aquatic sediments upon midge larvae. In: Vernet JP editor Heavy metals in the environment. 7th International Conference; Geneva.

van Urk, G., Kerkum, F. C. M., Smit, H. (1992). Life cycle patterns, density and frequency of deformities in *Chironomus* larvae (Diptera: Chironomidae) over a contaminated sediment gradient. Canadian Journal of Fisheries and Aquatic Sciences, 49, 2291–2299.

Vermeulen, V. C. (1995). Elaborating chironomid deformities as bioindication of toxic sediment stress: the potential application of mixture toxicity concepts. Annales Zoologici Fennici, 32, 265-285.

Warwick, W. F. (1985). Morphological abnormalities in Chironomidae (Diptera) larvae as measures of toxic stress in freshwater ecosystem: indicating antennal deformities in *Chironomus meigen*. Canadian Journal of Fisheries and Aquatic Sciences, 42, 1881-1914.

Warwick, W. F., Tisdale, N. A. (1988). Morphological deformities in *Chironomus*, Cryptochironomus, and *Procladius* (Diptera: Chironomidae) from two differentially stressed sites in Tobin Lakes, Saskatchewan. Canadian Journal of Fisheries and Aquatic Sciences, 45, 1123–1144.

Yıldız, Z. (2004). Eğitim düzeyi ile suç türü arasındaki ilişkinin araştırılması. Kuram ve Uygulamada Eğitim Yönetimi Dergisi, 38, 278-291.

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Research article/Araştırma makalesi

Current evaluation of the Cinereous vulture (*Aegypius monachus* L.) population in Türkmenbaba mountain (Turkey)

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Abstract

Cinereous vulture is a threatened species. The second largest population of species in Western Palearctic region is found in Anatolia. Türkmenbaba mountain has one of the largest breeding colonies in Turkey. Detailed studies on Cinereous vulture colony in Türkmenbaba mountain was conducted between 2001-2005. Since then, there is no updated information on the population in the region. The aim of this study is to present current data regarding the population of the species in the area. Data on breeding pairs and fledglings number of Cinereous vulture were determined in the region. It was found that 28 pairs breed in Türkmenbaba mountain in 2016. Four nests out of the 28 which were detected as active in the beginning of breeding season were deserted (three of them in the incubation and one of them in the nestling period). Breeding success ratio of Cinereous vulture colony was 85%. Additionally, it was determined that, 10 nests which were initially found during the 2001-2005 monitoring period, used by individuals in 2016 breeding season. The breeding pair numbers that were detected in this study was the highest ever recorded for the Türkmenbaba mountain vulture breeding colony. In order to obtain more detailed information on the population of species in the region, monitoring studies for a longer period should be conducted.

Key words: Anatolia, breeding success, *Cinereous vulture*, Eskişehir, population

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Türkiye'nin en büyük Kara akbaba (*Aegypius monachus* L.) üreme alanlarından birine sahip olan Türkmenbaba populasyonuna yönelik güncel bir değerlendirme

Özet

Kara akbaba tehlike altında olan bir türdür. Türün Batı Palearktik bölgede en büyük ikinci populasyonu Anadolu'da bulunmaktadır. Türkmenbaba dağı türün en büyük üreme kolonisinden birine sahiptir. Türkmenbaba dağı Kara akbaba kolonisine yönelik olarak 2001-2005 yılları arasında detaylı çalışmalar gerçekleştirilmiştir. Ancak türün populasyonunun bölgedeki durumu ile ilgili güncel veriler bulunmamaktadır. Bu çalışmanın amacı, Türkmenbaba dağında üreyen Kara akbaba kolonisi hakkında veri toplamaktır. Bu amaçla üreyen çift sayısı ve uçma başarısına ulaşan yavru sayısını belirlemeye yönelik olarak çalışmalar gerçekleştirilmiştir. Elde edilen verilere göre bölgede 28 çiftin ürediği tespit edilmiştir. Üreme dönemi başlangıcında aktif olarak belirlenen yuvalardan 4 tanesi terk edilmiştir (3 yuva kuluçka döneminde, 1 yuva ise yavru yumurtadan çıktıktan sonraki dönemde). Koloninin 2016 yılı için üreme başarısı %85'dir. Ayrıca 2001-2005 yılları arasında tespit edilen yuvalardan 10 tanesinin 2016 üreme döneminde de kullanıldığı görülmüştür. Bu çalışmada elde edilen Kara akbaba üreyen çift sayısı Türkmenbaba dağı için tespit edilen en yüksek sayıdır. Ancak populasyonun durumu hakkında kesin verilere ulaşmak için uzun yılları kapsayan takip çalışmalarının yapılması zorunludur.

Anahtar kelimeler: Anadolu, üreme başarısı, Kara akbaba Eskişehir, populasyon

1. Introduction

Vultures are among the birds that are most severely affected by anthropogenic activities (Ogada et al., 2012). In many regions where they have spread, the reduction of their numbers as a result of the increasing pressure of the

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threatening factors has created the consequences named as the vulture crisis, and populations of numerous vulture species have gone into extinction process (Green et al., 2004; Virani et al. 2011). The main factors that threaten the vulture populations are poisoning, electrocution, collisions with wind power farms, persecution and decline in food supply (Barov and Derhé, 2011; Ogada et al., 2016; Vasilakis et al., 2017; Parvanov et al., 2018).

Increased threatened factors on the vulture species has accelerated the processes of establishing action plans for the conservation of these species by researchers, NGOs and governments extending their conservation efforts (Bowden, 2017; Botha et al., 2017). Individual numbers have increased in the population of certain vulture species which shows the importance of the studies on conservation (Moreno-Opo and Margalida, 2014; Skartsi et al., 2010b; Vlachos et al., 1999).

Studies on conserving the species can be done by monitoring the population and determining the conditions that threaten these populations (Kovács et al., 2008). From this point of view, breeding pairs and the annual number of nestlings are very important in terms of providing information about the trends of the population (Dahl et al., 2012; Di Vittorio et al., 2017). Thus, the trend and threats of the populations of endangered species can be determined and conservation efforts can be carried out.

Four vulture species are distributed in Turkey. *Aegypius monachus* (Cinereous vulture) is a species that forms loose colonies. Species, often make their nests on the tops of pine trees in Turkey, and breed once every year (Yamaç 2006; Özcan and Yamaç, 2015). Breeding period begins at the end of February. After the incubation period that lasts 50-55 days, the nestling becomes fledgling about three months later (Cramp and Simmons, 1980).

Cinereous vulture is a threatened species and qualified as "Near-threatened" according to IUCN criteria (BirdLife International, 2017). The breeding areas of species in Turkey until the present day are mostly located in the northwest part of Central Anatolia and in the southern part of the Western Black Sea Region (Yamaç, 2006; Kirazlı and Yamaç, 2013; Özcan and Yamaç, 2015). Due to the lack of detailed monitoring scheme covering the entire Turkey it is not possible to reach the clear figures regarding the entire population number, the number of breeding pairs and the distribution of the species. In this regard, the number of breeding pairs according to different sources range from 200 to 500 (Heredia, 1996; Barov and Derhé, 2011).

One of the best studied regions (Yamaç, 2006), with the second highest number of breeding pairs of Cinereous vulture in Turkey is known to be Türkmenbaba Mountain after the recently discovered colony in Middle Sakarya Region (Kirazlı and Yamaç, 2013). The Türkmenbaba Mountain Cinereous vulture population had a maximum of 26 breeding pairs known by an inventory conducted during the years 2001 and 2005 (Yamaç, 2006). However, there is no data on the status of the population in recent years. The purpose of this study is to present current data regarding the breeding parameters of the population in the area and compare them with data obtained in previous studied periods (2001-2005). For this purpose, the number of Cinereous vulture pairs breeding in Türkmenbaba mountain, the number of fledgling, the use of previously determined nests, the coordinates of new nests and the nearest neighbour distance of all used nests, were investigated. The data will provide information on the population status and the level of the threat on the Türkmenbaba Cinereous vulture population.

2. Materials and methods

The study was performed in the Türkmenbaba Mountain which is situated between Eskişehir and Kütahya in northwest Turkey (39º24’ N- 30º18’ E) (see Figure 1). Floristic, faunistic, geographic and climatic characteristics of the region were presented by Yamaç and Günyel (2010) and Güner and Yücel (2015).

Within the scope of this study, the investigations regarding the Cinereous vulture population were carried out in 2016. A total of 12 field surveys were conducted at least once a month, starting from March, the beginning of the breeding period, until the end of August. In study period, it was attempted to check all previously known nests (Yamaç, 2006) to determine occupancy, describe nesting activities and also searched for new nests within the study area. Nests were located using historical descriptions of traditional nesting site and extensive exploratory surveys on foot. Occupied (active) nests were monitored with telescope (20-45x/25-56x) and binoculars (8–20 x 40) at a safe distance to avoid disturbing the vultures. Nests were determined as occupied when, either the incubation was confirmed or the nestling was present in the nest. Otherwise the nest was deemed unoccupied. A pair that succeeded to rear a fledgling was determined as successful. Percentage of successful pairs was based on the ratio of successful nests to the total number of occupied nests. The nests that were initially confirmed to be active but in the breeding season the presence of an egg or nestling was not confirmed, were signified as unsuccessful.

After the breeding period, the coordinates of the active nests were recorded using GPS and data about the closest distances between the nests and their distributions within the region were obtained measuring the distances on Google map. In addition, evaluations were made on whether each nest was used in previous periods.

3. Results

The breeding parameters of 2016 were compared with those obtained in the previous periods (Table 1). The data from the year 2001 were not included in the comparisons, due to the fact that the surveys did not cover the whole area this particular year.

Table 1. Breeding parameters of Cinereous vulture population in Türkmenbaba Mountain according to years.

Parameters	**Year**				
	2002	2003	2004	2005	2016
Active nest number	26	26	21	23	28
Successful nest number	21	20	17	21	24
Unsuccessful nest number	5	6	4	2	4
Breeding success (%)	80	76	80	91	85

We found that the nearest neighbour distance of the active nests ranges from 137 to 2802 m, while the mean value of this parameter was found to be 693.6±551.0. The distribution of the active nests used by the population in 2016 and in the first monitoring periods (2002-2005) are shown in Figure1-5. We discover 18 new active nests in 2016. Ten nests detected to be active in the breeding period of 2016 were among the nests used between 2001-2005. Accordingly, for the 2016 breeding period, using rate of previously used nests was 35.7%. In addition, the ratio of the previously used active nests (10) in 2016 to the once active nests for at least one year between 2001 and 2005 (n = 46) was determined as 21.7%. In the 24 out of 28 nests, which were detected to be active, nestlings reached the fledgling stage. Although four nests were found to be active in the beginning of the breeding season, they were determined as empty in latter field surveys (three of them in the incubation and one of them in the nestling period). The breeding success ratio determined in the entire population was 85% (Table 1). Besides, breeding success was confirmed for 9 of the previously used 10 nests in 2016.

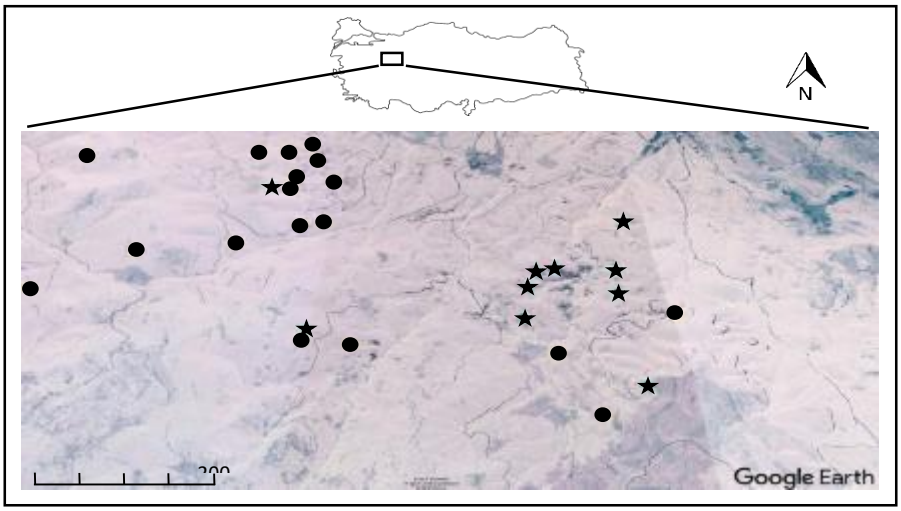

Figure 1. Active nests (28) of Cinereous vulture in 2016 in Türkmenbaba Mountain
● Nests (18) which were detected for the first time in 2016
★ Nests (10) which were detected active in the first monitoring period (2001- 2005)

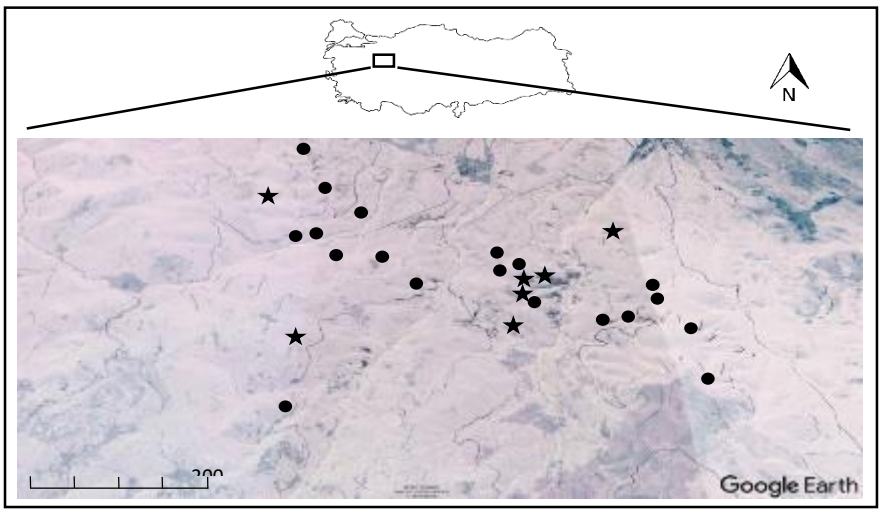

Figure 2. Active nests (26) of Cinereous vulture in 2002 in Türkmenbaba Mountain
● Nests (19) which were not used by Cinereous vulture in 2016
★ Nests (7) which were detected active in 2016

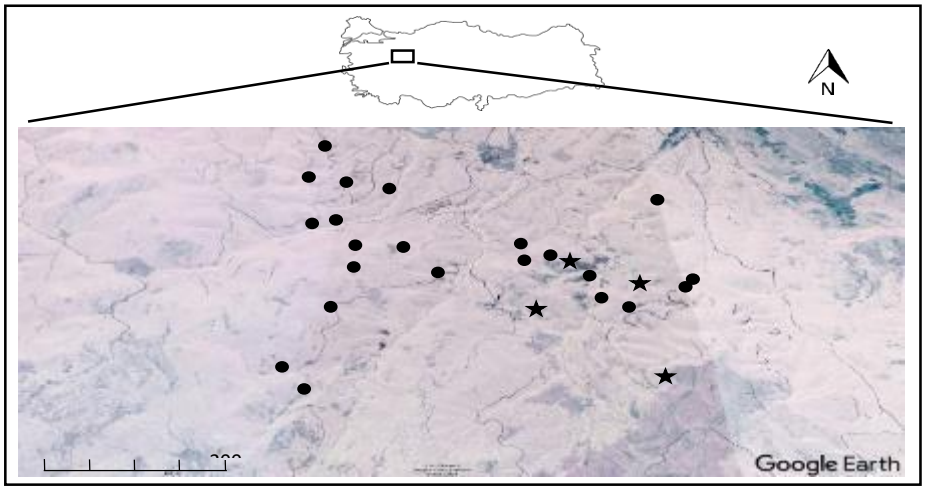

Figure 3. Active nests (26) of Cinereous vulture in 2003 in Türkmenbaba Mountain
- ● Nests (22) which were not used by Cinereous vulture in 2016
- ★ Nests (4) which were detected active in 2016

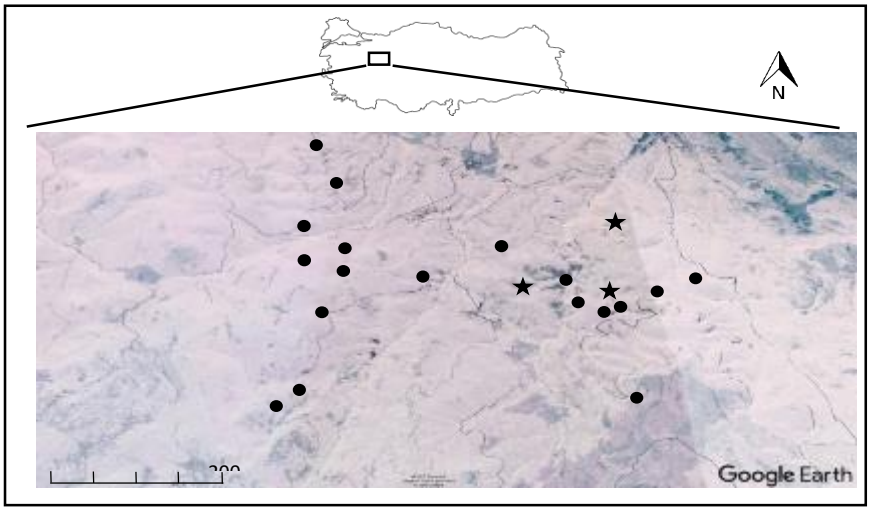

Figure 4. Active nests (21) of Cinereous vulture in 2004 in Türkmenbaba Mountain
- ● Nests (18) which were not used by Cinereous vulture in 2016
- ★ Nests (3) which were detected active in 2016

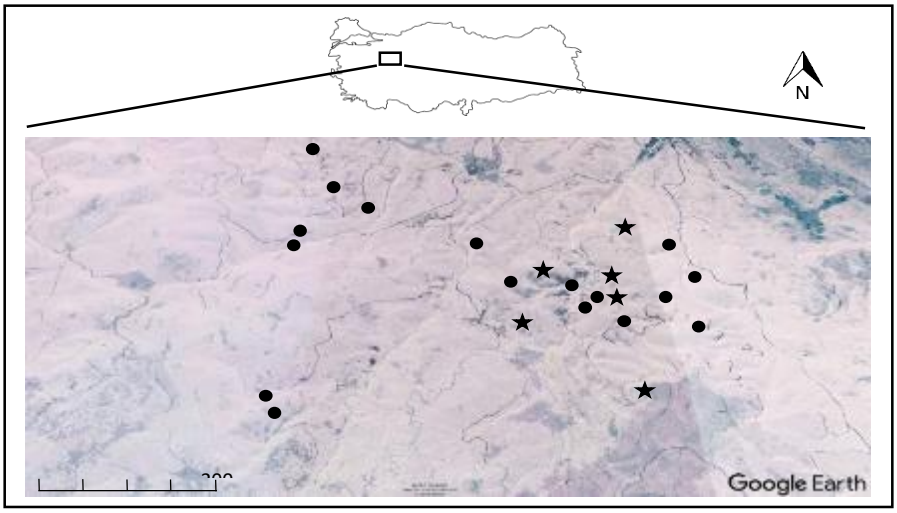

Figure 5. Active nests (23) of Cinereous vulture in 2005 in Türkmenbaba Mountain
- ● Nests (17) which were not used by Cinereous vulture in 2016
- ★ Nests (6) which were detected active in 2016

4. Conclusions and discussion

In this study, current data on the Cinereous vulture population in Türkmenbaba Mountain, which has one of the largest breeding population, has been presented. Thus, it is possible to compare resent information on the breeding parameters with the data obtained between the years 2001 - 2005, when a population monitoring in this region were carried out for first time.

A significant number (28) of active Cinereous vulture pairs have bred during the breeding period of 2016. Although this figure is close to the number of pairs reported for the first monitoring period (26), it is the highest number of breeding pairs reported for the region up to now. However, this data should not be interpreted as "positive population trends". It is known that the number of breeding pairs in the bird populations fluctuates under the influence of factors such as climate and food availability, depending on years (Väli, 2015; Clouet, 2017). In addition, in the first monitoring periods, although the whole area had been covered, the possibility that some of the areas have been overlooked due to improper terrain conditions should be considered. To make a definite assessment a long term population monitoring should be initiated.

The breeding success of the population for 2016 breeding period was 85%. When compared it with the previous monitoring period, this value is higher than the breeding success of the years 2002-2004 and lower than the breeding success of 2005. When compared to Turkey's largest Cinereous vulture breeding colony in Sündiken Mountain breeding success (78% for 2010, 73% for 2011 and 54% for 2012) (Kirazlı and Yamaç, 2013) these value have indicated to be higher for the studied colony.

Forestry activities is conducted extensively in Türkmenbaba Mountain. Roads in the forest to reach the logging areas affect negatively the wildlife, not only by fragmentation of the habitats but also by increasing uncontrolled human entrances into the region. There is an intensive human entrance to the region for recreational purposes, apart from forestry activities. The negative effects of anthropogenic activities on the Cinereous vulture populations have been emphasized in many studies (Donazar et al., 2002; Morán-López et al., 2006a; Moreno-Opo et al., 2013). However, in populations where there is no human pressure, decline in breeding success can also be reported (Reading et al., 2010). In such cases, limiting factors of natural conditions have been determined.

It is known that in breeding areas where there are no human activities, the breeding success for Cinereous vultures can be over 90% (Heredia, 1996). It has been reported that the breeding success of the Cinereous vulture colony in Dadia (Greece) is up to 95% as a result of intensive conservation activities such as strict logging control out of the breeding period (Vlachos et al., 1999). Also, it was reported that the breeding success for a colony was 100%, while the breeding success rate for the whole region was 69.2% in Extremadura (Spain) (Morán-López et al., 2006b). On the other hand, in spite of conservation efforts in breeding area, factors out of the conservation area such as poisoning and illegal hunting can affect breeding success negatively (Skartsi et al. 2008, Skartsi et al., 2010a, Skartsi et al., 2010b).

Although the breeding success of Türkmenbaba colony in 2016 compared to the studies mentioned above, is higher than the most Cinereous vulture colonies under human pressure, it can be concluded that, in case of establishing strict conservation plan for this species in our study region, the breeding success can be much higher. The spatial (out of the breeding areas) and temporal regulation (out of the breeding season) logging and recreational activates can severe to the direction of increasing the breeding success.

The nearest nest neighbour distance we found is similar to that obtained in Türkmenbaba colony the first monitoring period (min = 140, max = 1730, mean = 580 m). In another Cinereous vulture colony in the region, it was stated that the nearest active nest distance was 50 m and the mean distance varies between 346 and 398 m depending on years (Kirazlı, 2013). It was also reported that the nearest distance between the active nests in Greece was 646 m (Poirazidis et al., 2004**)**. In Spain, it was stated that the mean distance was 556.6 m for all the colonies, and the average distance varied between 490.6 and 1605.9 m for different colonies (Morán-López et al., 2006a). Moreover, the mean distance was indicated as 1104 m in Georgia (Gavashelishvili et al., 2006). It can be concluded that the nest distances of the Cinereous vultures are within a wide scale and species forms loose colonies. From this point of view, our findings are consistent with studies conducted in the region in the past and studies conducted in other regions over the world.

It was determined that 10 nests detected during the breeding period of 2016 were also used in the previous periods by the Cinereous vulture. Some of the nests detected as active in the past periods have been destroyed due to unfavourable climatic conditions, and some of them were not used in 2016. It is known that birds of prey tend to use the same nest every year (Jiménez-Franco et al., 2014). Also, Cinereous vultures prefer the same nests for nesting when there is no adverse effect of human or other ecological conditions (Cramp and Simmons, 1980). The use of the same nests in the following years shows that the nesting sites are of high quality (Sergio and Newton, 2003). The fact that only 21.7% of the nests, which were used at least once the years from 2001 to 2005, have been preferred in 2016 indicates that there may be problems with the quality of the nesting areas that are not active today, although they have been used in the past. On the other hand, according to the distribution of the nests by the years, different nests were used by individuals although they are in the same areas. Therefore, reason of abandonment should be evaluated for each nest separately and more detailed studies should be conducted to reach a conclusion on unoccupied nests.

For Cinereous vulture, the most negative effect on breeding success is human activities (Morán-López et al., 2006b; Moreno-Opo et al., 2013), which shows that the breeding area needs to be evaluated using this point of view and

serious measures must be taken. In the Türkmenbaba Mountain, which has one of the biggest breeding colonies of the Cinereous vulture in Turkey, the initiation of a strict management and conservation plan for species is considered to be of outmost importance, not only for the Turkish population but also for the world endangered population of the species.

References

Barov, B., Derhé, M. (2011). Review of the implementation of species action plans of threatened birds in the European Union (2004–2010). Final report. BirdLife International for the European Commission.

BirdLife International. (2017). *Aegypius monachus* (amended version of assessment). The IUCN Red List of Threatened Species 2017: e.T22695231A118573298. http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22695231A118573298.en. (Downloaded on 31 March 2018).

Botha, A.J., Andevski, J., Bowden, C.G.R., Gudka, M., Tavares, J., Safford, R. J., Williams, N. P. (2017). Multi-species action plan to conserve African-Eurasian vultures. Raptors MoU Technical Publication No. 4. CMS Technical Series No. 33. Coordinating Unit of the CMS Raptors MoU, Abu Dhabi

Bowden, C. H. R. I. S. (2017). Asian vulture crisis: Some positive signs. Birding ASIA, 27, 94-95.

Clouet, M., Gerard, J. F., Goar, J. L., Goulard, M., González, L., Rebours, I., Faure, C. (2017). Diet and breeding performance of the golden eagle *Aquila chrysaetos* at the eastern and western extremities of the Pyrénées: an example of intra-population variability. Ardeola, 64(2), 347-361.

Cramp, S., K. E. L. Simmons. (1980). Handbook of the birds of Europe, the Middle East and north Africa. The birds of the western Palearctic. Volume 2: Hawks to bustards. Oxford, London, UK & New York: Oxford University Press.

Dahl, E. L., Bevanger, K., Nygård, T., Røskaft, E., Stokke, B. G. (2012). Reduced breeding success in white-tailed eagles at Smøla windfarm, western Norway, is caused by mortality and displacement. Biological Conservation, 145(1), 79-85.

Di Vittorio, M., Di Trapani, E., Cacopardi, S., Rannisi, G., Falci, A., Ciaccio, A., Salvo, G. (2017). Population size and breeding performance of the Lanner Falcon *Falco biarmicus* in Sicily: conservation implications. Bird Study, 64(3), 339-343.

Donázar, J. A., Blanco, G., Hiraldo, F., Soto-Largo, E., Oria, J. (2002). Effects of forestry and other land-use practices on the conservation of cinereous vultures. Ecological Applications, 12(5), 1445-1456.

Gavashelishvili, A., McGrady, M. J., Javakhishvili, Z. (2006). Planning the conservation of the breeding population of cinereous vultures *Aegypius monachus* in the Republic of Georgia. Oryx, 40(1), 76-83.

Green, R. E., Newton, I. A. N., Shultz, S., Cunningham, A. A., Gilbert, M., Pain, D. J., Prakash, V. (2004). Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent. Journal of Applied Ecology, 41(5), 793-800.

Güner, Ş. T., Yücel, E. (2015). The relationships between growth of *Pinus sylvestris* ssp. hamata forests with ecological factors in Central Anatolia. Biological Diversity and Conservation, 8(3), 06-19.

Heredia, B. (1996). Action plan for the Cinereous Vulture in Europe, (Compiled by: Heredia, B., with Contrubutors), Bird Life International (on behalf of the European Commission), U.K.

Jiménez-Franco, M. V., Martínez, J. E., Calvo, J. F. (2014). Patterns of nest reuse in forest raptors and their effects on reproductive output. Journal of Zoology, 292(1), 64-70.

Kirazlı, C., Yamaç, E. (2013). Population size and breeding success of the Cinereous Vulture, *Aegypius monachus*, in a newly found breeding area in western Anatolia (Aves: Falconiformes). Zoology in the Middle East, 59(4), 289-296.

Kovács, A., Mammen, U.C.C., Wernham, C.V. (2008). European monitoring for raptors and owls: state of the art and future needs. Ambio, 37(6): 408–412.

Morán-López, R., Sánchez Guzmán, J. M., Borrego, E. C., Sanchez, A. V. (2006a). Nest-site selection of endangered cinereous vulture (*Aegypius monachus*) populations affected by anthropogenic disturbance: present and future conservation implications. Animal Conservation, 9(1), 29-37.

Morán-López, R., Sánchez, J. M., Costillo, E., Corbacho, C., Villegas, A. (2006b). Spatial variation in anthropic and natural factors regulating the breeding success of the cinereous vulture (*Aegypius monachus*) in the SW Iberian Peninsula. Biological Conservation, 130(2), 169-182.

Moreno-Opo, R., Fernández-Olalla, M., Margalida, A., Arredondo, Á., Guil, F. (2013). Influence of environmental factors on the breeding success of Cinereous Vultures *Aegypius monachus*. Acta Ornithologica, 48(2), 187-193.

Moreno-Opo, R., Margalida, A. (2014). Conservation of the Cinereous Vulture *Aegypius monachus* in Spain (1966–2011): a bibliometric review of threats, research and adaptive management. Bird Conservation International, 24(2), 178-191.

Ogada, D. L., Keesing, F., Virani, M. Z. (2012). Dropping dead: causes and consequences of vulture population declines worldwide. Annals of the New York Academy of Sciences, 1249(1), 57-71.

Ogada, D., Shaw, P., Beyers, R. L., Buij, R., Murn, C., Thiollay, J. M., Krüger, S. C. (2016). Another continental vulture crisis: Africa's vultures collapsing toward extinction. Conservation Letters, 9(2), 89-97.

Özcan A.U., Yamaç, E. (2015). Kara akbaba (*Aegypius monachus* L. 1766)'nın Kuzey İç Anadolu Bölgesi'ndeki yaşama alanları ve populasyon büyüklüğünün tespiti. 2023'e Doğru 3. Doğa ve Ormancılık Sempozyumu, Antalya.

Parvanov, D., Stoynov, E., Vangelova, N., Peshev, H., Grozdanov, A., Delov, V., Iliev, Y. (2018). Vulture mortality resulting from illegal poisoning in the southern Balkan Peninsula. Environmental Science and Pollution Research, 25(2), 1706-1712.

Poirazidis, K., Goutner, V., Skartsi, T., Stamou, G. (2004). Modelling nesting habitat as a conservation tool for the Eurasian black vulture (*Aegypius monachus*) in Dadia Nature Reserve, northeastern Greece. Biological conservation, 118(2), 235-248.

Reading, R. P., Kenny, D., Azua, J., Garrett, T., Willis, M. J., Purevsuren, T. (2010). Ecology of Eurasian black vultures (*Aegypius monachus*) in Ikh Nart nature reserve, Mongolia. Exploration into the Biological Resources of Mongolia, 11, 177-188.

Sergio, F., Newton, I. A. N. (2003). Occupancy as a measure of territory quality. Journal of Animal Ecology, 72(5), 857-865.

Skartsi, T., Elorriaga, J. N., Vasilakis, D. P., Poirazidis, K. (2008). Population size, breeding rates and conservation status of Eurasian black vulture in the Dadia National Park. Journal of Natural History, 42 (5-8), 345-353.

Skartsi, T., Elorriaga, J. N., Vasilakis, D. P. (2010a). Eurasian Black Vulture: the focal species of the Dadia–Lefkimi–
Soufli Forest National Park. G. Catsadorakis, and H. Källander, (eds). The Dadia–Lefkimi–Soufli Forest National Park, Greece: Biodiversity, Management and Conservation. WWF Greece, Athens, pp. 195-206.

Skartsi, T, Vasilakis, D. P., Elorriaga, J. N. (2010b). Population trends and conservation of vultures in the Dadia–Lefkimi–Soufli Forest National Park. G. Catsadorakis, and H. Källander, (eds). The Dadia–Lefkimi–Soufli Forest National Park, Greece: Biodiversity, Management and Conservation. WWF Greece, Athens, pp. 183-193.

Väli, Ü. (2015). Monitoring of spotted eagles in Estonia in 1994–2014: Stability of the lesser spotted eagle (*Aquila pomarina*) and decline of the greater spotted eagle (*A. clanga*). Slovak Raptor Journal, 9(1), 55-64.

Vasilakis, D. P., Whitfield, D. P., Kati, V. (2017). A balanced solution to the cumulative threat of industrialized wind farm development on cinereous vultures (*Aegypius monachus*) in south-eastern Europe. PloS one, 12(2), e0172685.

Virani, M. Z., Kendall, C., Njoroge, P., Thomsett, S. (2011). Major declines in the abundance of vultures and other scavenging raptors in and around the Masai Mara ecosystem, Kenya. Biological Conservation, 144(2), 746-752.

Vlachos, C. G., Bakaloudis, D. E., Holloway, G. J. (1999). Population trends of Black Vulture *Aegypius monachus* in Dadia Forest, north-eastern Greece following the establishment of a feeding station. Bird Conservation International, 9(2), 113-118.

Yamaç, E. (2006). Studies on Black Vulture (*Aegypius monachus* L.) population in Eskişehir, Northwest Turkey. International Congress on the Zoogeography and Ecology of Greece and Adjacent Regions., Patra, Greece.

Yamaç, E., Günyel, E. (2010). Diet of the Eurasian Black Vulture, *Aegypius monachus* Linnaeus, 1766, in Turkey and implications for its conservation: (Aves: Falconiformes). Zoology in the Middle East, 51(1), 15-22.

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Research article/Araştırma makalesi

A new lichen record for the Asia: *Parmelia barrenoae* Divakar, M.C. Molina & A. Crespo, Supported by Molecular Data from Turkey

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Abstract

Parmelia barrenoae is reported from Turkey and Asia for the first time. Comments on its habitats, substrata, distributional data and macrophoto are provided. In addition, a phylogenetic tree was constructed by comparing the sequence data of the ITS region of closely related species.

Key words: Ascomycetes, Molecular phylogeny, *Parmelia*

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Asya için yeni bir liken kaydı: Türkiye'den moleküler veri ile desteklenen *Parmelia barrenoae* Divakar, M.C. Molina & A. Crespo

Özet

Parmelia barrenoae türü Türkiye ve Asya'dan ilk kez rapor edilmektedir. Türe ait habitat, substrat, dağılış ve makro fotoğraf verilmiştir. Buna ek olarak, yakın ilişkili türlerin ITS bölgelerine ait dizi analizleri ile karşılaştırılarak bir filogenetik ağaç oluşturulmuştur.

Anahtar kelimeler: Ascomycetes, Moleküler filogeni, *Parmelia*

1. Introduction

About 1800 lichen and lichenicolous fungi species are known from Turkey (John ve Türk, 2017). In this work done by John ve Türk (2017) all the floristic articles made up to date are collected in a book. Besides lichenological research in Turkey has improved in the last thirty years with many floristic studies published recently about several regions of Turkey (e.g., John, 1992, 1995, 2007; Şenkardeşler, 2011; Halıcı and Aksoy, 2009; Kocakaya et al., 2014; Özdemir Türk et al., 2015).

The lichenized fungal genus *Parmelia* (Parmeliaceae, Lecanorales) foliose thallus, upper surface grey to grey-green or brownish grey, with or without soredia, pustules or isidia. Lower surface black, uniformly rhizinate to margins; rhizines mostly simple or sometimes squarrosely branched, black. Species formerly included in this genus are now placed in *Arctoparmelia, Flavoparmelia, Hypotrachyna, Melanelia, Melanelixia, Melanohalea, Parmelina, Parmelinopsis, Parmotrema, Pleurosticta, Punctelia* and *Xanthoparmelia* (Purvis, 1992). Only six species are known belonging to the genus *Parmelia* from Turkey ; *P. discordans* Nyl., *P. omphalodes* (L.) Ach., *P. saxatilis* (L.) Ach., *P. squarrosa* Hale, *P. submontana* Nadv. ex Hale, Smiths and *P. sulcata* Taylor (John ve Türk, 2017).

2. Materials and methods

Thallus loosely adnate, 6 cm diam., lobes overlapping and imbricate, short, 2–5 mm wide, older lobes revolute. Upper surface glaucous whitish grey, becoming reticulately cracked. Pseudocyphellae laminal and marginal effigurate, numerous, soralia sparse, granular, medulla white. Rhizines on black lower surface moderately abundant, simple, not squarrose, 1–2 mm long (Figure 1). Specimen Examined: Turkey, Çorum, Laçin district, on *Quercus* sp., 40° 45' 692" N, 34° 52' 169" E., 1020 m., M. Kocakaya, MK-6795.

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Figure 1. Thallus of *Parmelia barrenoae*; MK-6795

Samples prepared from freshly collected were ground with sterile pestles. Total genomic DNA was used extracting the DNA using DNeasy Plant Mini Kit (Qiagen) following the manufacturer's protocols with minor modifications. ITS4 (TCCTCCGCTTATTGATATGC) (White et al., 1990) and ITS1-F (CTTGGTCATTTAGAGGAAGTAA), (Gardes and Bruns, 1993) were used to amplify the ITS sequence. The same regions have been successfully used by Divakar et. al., (2005) in the molecular phylogenetic analysis of the *Parmelia*. PCR-amplification was carried out, following Divakar et. al. (2005). The PCR products were visualized on 1% agarose gel as a band of approx. 500 or 600 bp. The PCR products were subsequently purified using the "ExoSAP-IT™ PCR Product Cleanup Reagent" (ThermoFisher Scientific, USA) according to the manufacturer's instructions. Sequences of PCR products obtained from *Parmelia* samples were performed using the Big Dye Terminator Cycle Sequencing v3.1 (Applied Biosystems, Foster City, CA) following the manufacturer's protocol and analysed on an ABI 3730XL Genetic Analyzer (Applied Biosystems, Foster City, CA).

ITS sequence results were analyzed automatically and manually using samples from Genbank using the Clustal W option in the BioEdit program. Compared with the nuITS rDNA sequence data of the genus-belonging species given in the previous article, which describes the *Parmelia barrenoae*. Out groups *Platismatia glauca*, *Parmelia laevior* and *P. signifera* were used. These out groups were previously described by Molina et al., (2004). Details of the samples and the GenBank accession numbers are listed in Table 1. For phylogenetic tree, MEGA 7 (Molecular Evolutionary Genetics Analysis) program was used (Kumar et al., 2016). Phylogenetic tree was constructed by Maximum Likelihood analysis using Tamura-Nei model (Figure 2) (Tamura and Nei, 1993). Pairwise deletion was performed for deleting data gaps and checking. The tree reliability was tested with 1000 bootstrap replications. Specimen is deposited in Bozok University Lichen Herbarium.

3. Results and discussion

Parmelia barrenoae was described on *Quercus* sp. from Spain (Divakar et al., 2005). These species resembles *P. sulcata*. *Parmelia sulcata* differs in having richly branched, squarrose rhizines and older lobes of *P. barrenoae* are revolute, soralia are only laminar and less developed than those of *P. sulcata* (Divakar et al., 2005). The Turkish population of *P. barrenoae* that we have examined in oak forest at 1020 m in the Central Anatolia Region.

P. barrenoae species was examined in terms of its morphological, anatomical and ecological characters. The ITS sequence of the species was successfully obtained. It was evaluated together with the sequence results from the genBank. The analysis involved 32 nucleotide sequences with outgroups. All positions containing gaps and missing data were eliminated. There were a total of 389 positions in the final dataset. The ITS sequences of *P. barrenoae* collected from the Turkey were blasted with sequences of species from Japan, Portugal and Spain. It is seen that the phylogenetic tree matches with other *P. barrenoae* species (Figure 2).

P. barrenoae is known from North America, Afrika and Poland (Hodkinson et al., 2010; Ossowska and Kukwa, 2016).

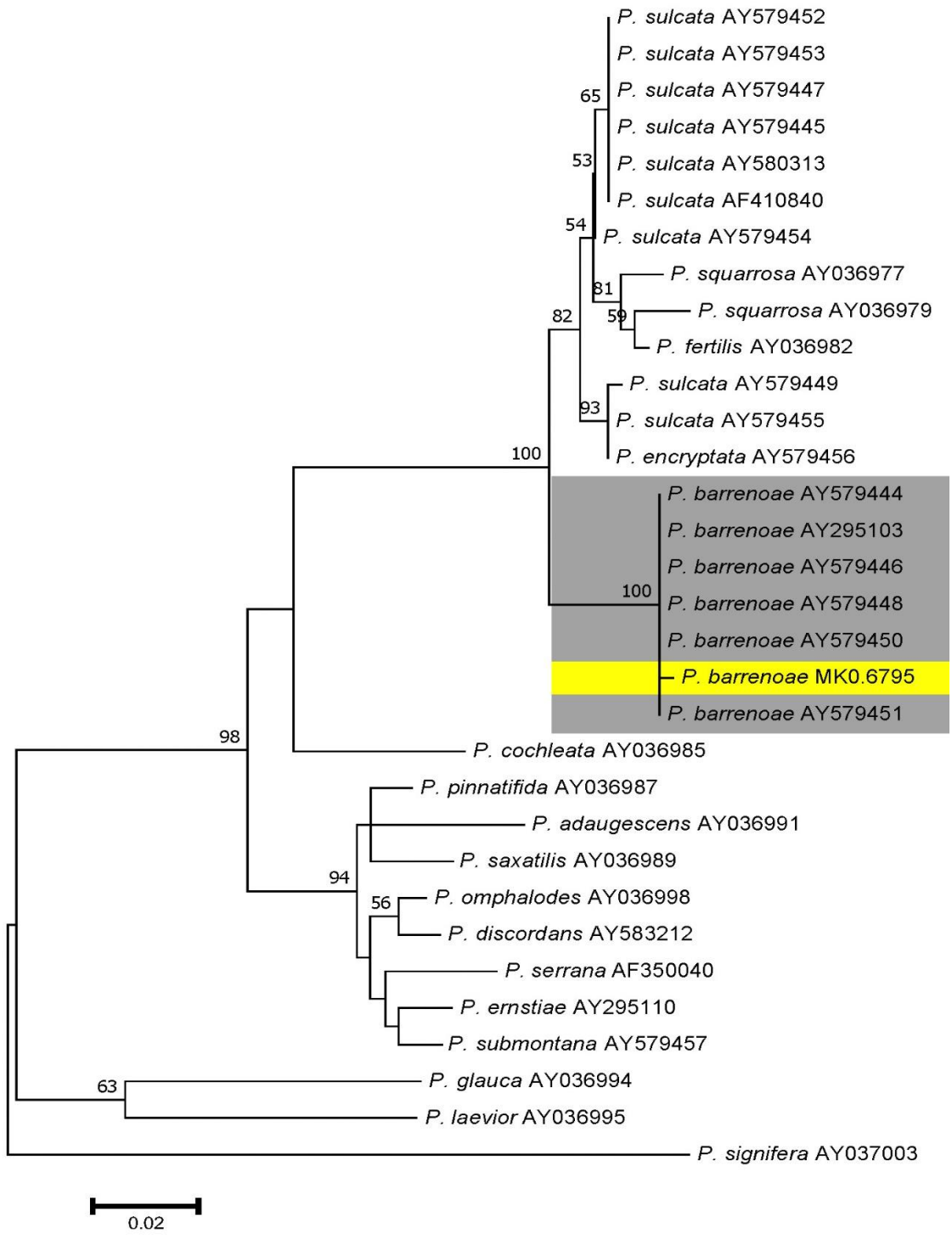

Figure 2. Maximum Likelihood (ML) analysis of the ITS region of *Parmelia barrenoae* and related species. Numbers at tree nodes indicate bootstrap values of ML (only values ≥50%).

Acknowledgements

Thanks to Arif Ömer Çubukçu for their help in the field.

Table 1. The sequences used in this study were downloaded from the gene bank and the new product was indicated by bold. (The genbank number will be received after the accepted the publication)

Taxa	Locality/Source	GenBank no. (ITS)
P. adaugescens	Japan/GenBank	AY036991
P. barrenoae	Spain/GenBank	AY579444
P. barrenoae	Spain/GenBank	AY295103
P. barrenoae	Spain/GenBank	AY579446
P. barrenoae	Spain/GenBank	AY579448
P. barrenoae	Portugal/GenBank	AY579450
P. barrenoae	**Turkey**	**MK0.6795**
P. barrenoae	Spain/GenBank	AY579451
P. cochleata	Japan/GenBank	AY036985
P. discordans	UK/GenBank	AY583212
P. encryptata	Spain/GenBank	AY579456
P. ernstiae	Spain/GenBank	AY295110
P. fertilis	Japan/GenBank	AY036982
P. omphalodes	Spain/GenBank	AY036998
P. pinnatifida	Russia/GenBank	AY036987
P. saxatilis	Russia/GenBank	AY036989
P. serrana	Spain/GenBank	AF350040
P. squarrosa	USA/GenBank	AY036977
P. squarrosa	USA/GenBank	AY036979
P. submontana	Spain/GenBank	AY579457
P. sulcata	Spain/GenBank	AY579452
P. sulcata	Germany/GenBank	AY579453
P. sulcata	Spain/GenBank	AY579447
P. sulcata	Spain/GenBank	AY579445
P. sulcata	Spain/GenBank	AY580313
P. sulcata	Sweden/GenBank	AF410840
P. sulcata	Germany/GenBank	AY579454
P. sulcata	Spain/GenBank	AY579449
P. sulcata	Spain/GenBank	AY579455
P. glauca	Japan/GenBank	AY036994
P. laevior	Japan/GenBank	AY036995
P. signifera	Australia/GenBank	AY037003

References

Divakar, P. K., Molina, M. C., Lumbsch, H. T., Crespo, A. (2005). *Parmelia barrenoae*, a new lichen species related to Parmelia sulcata (Parmeliaceae) based on molecular and morphological data. The Lichenologist, 37(1), 37–46.

Gardes, M., Bruns, T. D. (1993). ITS primers with enhanced specificity for basidiomycetes - application to the identification of mycorrhizae and rusts. Molecular Ecology, 2, 113–118.

Halıcı, M. G., Aksoy, A. (2009). Lichenised and Lichenicolous Fungi of Aladağlar National Park (Niğde, Kayseri and Adana Provinces) in Turkey. Turkish Journal of Botany, 33, 169–89.

Hodkinson, B. P., Lendemer, J. C., Esslinger T. L. (2010). *Parmelia barrenoae*, a macrolichen new to North America and Africa. North Amercian Fungi, 5, 1-5.

John, V. (1992). Flechten der Türkei I. Das die Türkei betreffende lichenologische Schrifttum. Pollichia, Bad Dürkheim, 1–14.

John, V. (1995). Flechten der Türkei IV. Erganzungen zum die Türkei betreffende lichenologische Schrifttum. Pollichia, Bad Dürkheim, 1–10.

John, V. (2007). Lichenological studies in Turkey and their relevance to environmental interpretation. Bocconea, 21, 85–93.

John, V., Türk, A. (2017). Türkiye Likenleri Listesi. İstanbul: Nezahat Gökyiğit Botanik Bahçesi Yayını.

Kocakaya, M., Halıcı, M. G., Aksoy, A. (2014). Lichenized and lichenicolous fungi of Gevne Valley (Konya, Antalya). Turkish Journal of Botany, 38, 358–369.

Kumar, S., Stecher, G., Tamura, K. (2016). MEGA7: Molecular Evolutionary Genetics Analysis version 7.0 for bigger datasets. Molecular Biology and Evolution, 33, 1870-1874.

Molina, M. C., Crespo, A., Blanco, O., Lumbsch, H. T., Hawksworth, D. L. (2004). Phylogenetic relationships and species concepts in *Parmelia* s. str. (Parmeliaceae) inferred from nuclear ITS rDNA and B-tubulin sequences. Lichenologist, 36, 37–54.

Ossowska, E., Kukwa, M. (2016). *Parmelia barrenoae* and *P. pinnatifida*, two lichen species new to Poland. Herzogia, 29, 198-203.

Özdemir Türk, A., Halıcı, M. G., Candan, M., Yavuz, Y. (2015). The lichenized fungus genus *Peltigera* in Turkey. Biological Diversity and Conservation, 8, 146-156.

Purvis, O. W. (1992). Lichen Flora of Great Britain and Ireland. Natural History Museum Publications in association with the British Lichen Society.

Şenkardeşler, A. (2011). Das die Türkei betreffende lichenologische Schrittum için ek kayıtlar. Türk Liken Topluluğu Bülteni, 9, 9–10.

Tamura, K., Nei, M. (1993). Estimation of the number of nucleotide substitutions in the control region of mitochondrial DNA in humans and chimpanzees. Molecular Biology and Evolution, 10, 512-526.

White, T. J., Bruns, T., Lee, S., Taylor, J. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: PCR Protocols: a guide to methods and applications (eds. Innis, M.A., Gelfand, D.H., Sninsky, J.J., White, T.J.). New York: Academic Press. 18(1), 315-322.

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Research article/Araştırma makalesi

Karyological studies of four *Lathyrus* (Fabaceae) taxa belonging to section *Pratensis* from Turkey

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Abstract

The karyological analysis of 4 taxa from section *Pratensis* (*Lathyrus*, Fabaceae) growing in Turkey, have been determined. These taxa are *L. pratensis*, *L. layardii* (end), L. *laxiflorus* subsp. *angustifolius* (end) and *L. czeczottianus* (end). Karyotype analysis was made in for the first time for 2 of these taxa including 3 endemic species. The chromosome numbers of all taxa was found to be 2n = 14. Short arm, long arm, and total length of the chromosomes were measured and relative lengths, centromeric index were calculated and shown in tables. The photographs showing metaphase chromosomes of the taxa and ideograms are included to the study.

Key words: Chromosome, *Lathyrus*, *Section Pratensis*, Turkey

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Lathyrus (Fabaceae) cinsinin *Pratensis* eksiyonunda bulunan 4 taksonun karyolojik çalışmaları

Özet

Türkiye'de yetişen *Pratensis* seksiyonunda (*Lathyrus*, Fabaceae) yer alan 4 taksonun karyolojik analizleri tanımlanmıştır. Bu taksonlar *L. pratensis*, *L. layardii* (end), L. *laxiflorus* subsp. *angustifolius* (end) ve *L. czeczottianus* (end)'dur. Endemik olan üç taksondan ikisinin karyolojik analizleri ilk defa yapılmıştır. Bütün taksonların kromozom sayıları 2n=14 olarak bulundu. Kromozom kısa kol, uzun kol, toplam uzunluğu ölçülmüş, sentromerik indeks, bağıl uzunluk hesaplanmış ve tabloda gösterilmiştir. Taksonların metefaz kromozomlarını gösteren fotoğraflar ve idiogramlar çalışmaya eklenmiştir.

Anahtar kelimeler: Kromozom, *Lathyrus*, *Pratensis* seksiyonu, Türkiye

1. Introduction

The genus *Lathyrus* L. (Fabaceae) is comprised of approximately 200 species, and includes annual and perennial plants, generally centred in the Mediterranean region (Kupicha, 1983). *Lathyrus* is represented by 80 species, 25 of which are endemic to Turkey (Davis, 1970; 1988; Güneş and Özhatay, 2000; Güner et al., 2012). The section *Pratensis* Bässler contains 5 wild taxa including 3 endemic species in Turkey.

Cytological studies (Darlington and Wylie, 1955; Roy and Singh, 1967; Ball, 1968; Ress and Hazarika, 1969; Fouzdar and Tandon, 1975; Narayan, 1983; Yamamoto et al., 1984; Kuruyan and Narayan, 1988; Gutiérrez et al., 1994; Seijo and Fernández, 2003; Özcan et al., 2006; Badr, 2006; Güneş and Çırpıcı, 2008; Güneş, 2011; Güneş and Meriç 2017) showed that *Lathyrus* L. generally has a diploid chromosome of 2n=14. Meanwhile, tetraploids of 2n=28 have been reported in *L. pratensis* L. (Darlington and Wylie, 1955), *L. venosus* Sweet. (Başaran, 2007), *L. brachypterus* Čel (Güneş, 2011) and hexaploids of 2n=42 have been reported in *L. palustris* L. subsp. *palustris* (Ball, 1968; Güneş and Çırpıcı, 2008).

Yamamoto et al. (1984) also examined morphological and karyotypical properties of 24 species belonging to *Pratensis*, *Lathyrus*, *Orobastrum*, *Cicercula*, *Clymenum*, *Nissolia* and *Aphaca* sections of *Lathyrus.* The number of chromosomes of these species was 2n=14 except for *L. pratensis* that was found to be tetraploid (2n=28). Yamamoto et

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al. (1984), and Güneş and Çırpıcı (2008) noted that *L. ochrus* (L.) DC. and *L. clymenum* L. species had very different karyotypical properties, although they are included in the same section. However, despite the significant difference in their karyotypes, these two species display a substantial morphological similarity. Because of this, they concluded that chromosome properties have not much importance for separating genus *Lathyrus* into sections. However, they also emphasized that karyotypical properties are important for distinguishing controversial species with very similar morphological properties, such as *L. annuus* L. and *L. hierosolymitanus* Boiss.

Seijo and Fernández (2003) investigated karyotype analysis and chromosome evolution in South American species (16 taxa) of *Lathyrus*. All of the species had a chromosome number of 2n=14, but their karyotype formulas were different. Badr (2006) investigated karyotype analysis and chromosome evolution in some species (13 taxa) of *Lathyrus*, all with a chromosome number of 2n=14.

Various karyological studies were performed on *Lathyrus* species present in the flora of Turkey. Evren et al. (1994) reported the same number. Güneş and Çırpıcı (1996) counted the same number in the three *Lathyrus* species growing around Istanbul. More counts of the same number were reported by Şahin et al. (1998; 2000) in fifteen species, and the same diploid number of 2n=14 was also found in eight taxa growing in East Black Sea Region Özcan et al. (2006) and Ayaz and Ertekın (2008) on two species. On the other hand, Güneş and Çırpıcı (2008) surveyed the chromosomes of sixteen taxa and encountered a hexaploid number (2n=42) for *L. palustris* subsp. *palustris* but the other fifteen species were diploid. Güneş (2011) determined karyotype analysis and chromosome number for section *Platystylis* (Lathyrostylis) Turkish species (16 taxa) of *Lathyrus*. She reported that all of the species were 2n=14 except *L. bracypterus* that was found tetraploid (2n=28).

The purpose is to determine the number of chromosomes of the taxa (*L. pratensis* L., *L. laxiflorus* (Desf.) O. Kuntze subsp. *angustifolius* (Post ex Dinsm.) Davis, *L. czeczottianus* Bässler and *L. layardii* Ball ex Boiss.) included in this section, to perform karyotype analyses and propound the systematic availability of the findings obtained.

2. Materials and methods

2.1. Plant materials

Four taxa were collected from their natural habitats between 2007 and 2009 (Table 1; Figure 1-2). All collected specimens were identified by using Flora of Turkey (Davis, 1970; 1988; Güneş and Özhatay, 2000) and deposited in the herbarium of the Faculty of Pharmacy, Trakya University.

Table 1. Examined specimens, distribution in the world and locality

Taxa	**Distribution in the world**	**Locality**
L. pratensis	Most of Europe, N. W. Africa, Abyssinia, Lebanon, N. Iraq. Caucasia, east-wards to C. Asia and Himalayas. Turkey-in-Europe, N., Inner (mainly E.) & S. W. Anatolia, Islands.	**A8 Artvin:** Ardanuç-Bulanık, 1349 m, 24.07.2007, F. Güneş, 1289; **A9 Kars:** Kars – Sarıkamış, forest area, 2100 m, 08.08.2007, F. Güneş, 36; **B9 Ağrı:** Eleşkirt-Horasan road, Tahir village 5 km, 2128 m, 15.07.2007, F. Güneş, 1029.
L. layardii (end)	E. Anatolia, rare.	**B8 Erzurum:** Horasan-Eleşkirt road, Saçlı passage, meadows, 19.07.2008, F. Güneş 1981; **B10 Ağrı:** Hamur-Tutak road, 10. km, 2571 m, 26.08.2007, F. Güneş, 1518.
L. laxiflorus subsp. *angustifolius* (end)	S. Anatolia	**C6 Hatay:** Hatay-Belen, Soğukoluk plateau, 655 m, 07.07.2008, F. Güneş, 1956; **C6 Kahramanmaraş:** Başkonuşlar National Park, 680 m, 08.06.2009, F. Güneş 2272.
L. czecczottianus (end)	Inner Anatolia and adjasent parts of N. Anatolia, local.	**A4 Kastamonu:** Ilgaz-Kastamonu old road, Ilgaz Mountain passage, 918 m, 17.07.2009, F. Güneş, 2485; **A7 Gümüşhane:** Vavuk Mountain, Vavuk passage, 1865 m, 26.07.2007, F. Güneş, 1310; **B6 Kayseri:** Erciyes Mountain around, scrubs, 1170 m, 26.07.2008, F. Güneş, 1995. C5 Niğde: Aladağlar.

2.2. Cytogenetics

Seeds were soaked for 3-30 days on petri dishes with moist filter paper at room temperature. Germinating root tips, pre-treated in a saturated solution of α-Bromonaphthalene for 24 hours at 4 °C, were fixed in Carnoy's solution. The root tips were hydrolysed in 1 N HCL for 10-20 min at 60 °C and stained with Feulgen solution. Semipermanent slides were examined by light microscopy. Mitotic chromosomes were photographed by Nikon E600 trinocular photomicroscope with a 100 immersion objective. Chromosomal measurements were made using x4000 magnified photographs of 5 well-spread metaphase plates per plant. Short arm length (S) and long arm length (L) were measured, total length of the chromosomes (C), arm ratio (R=L/S), centromeric index (I) and relative lengths (R) were calculated. The classification of chromosomes by centromeric indices followed Levan et al. (1964).

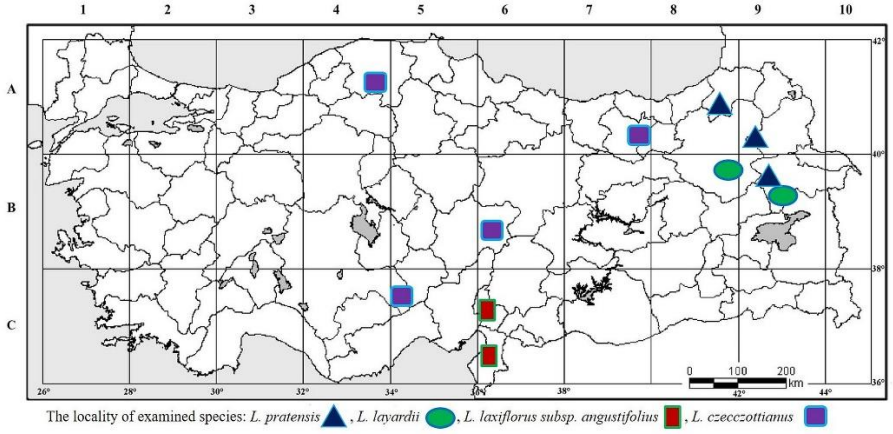

Figure 1. The locality of examined species in Turkey.

3. Results

The karyotype analysis was made in detail for the first time for 2 of these taxa, including 3 endemic. The chromosomes of 4 studied taxa were counted, karyological properties and ideograms were determined. The number of chromosomes were identified as 2n=14 for 4 species. All of the species studied are perennial and have large chromosomes. The largest chromosome was measured for *L. layardii* (5.50 µm) species and the smallest for *L. laxiflorus* subsp. *angustifolius* (2.94 µm). Satellites were only observed on the short arm of the fifth chromosome of *L. layardii*. The photographs of the nature, metaphase chromosomes and ideograms are included (Table 2-5, Figure 2-6).

Figure 2. The photos of examined taxa; A. *L. pratensis*, B. *L. layardii*, C. *L. laxiflorus* subsp. *angustiflorus*, D. *L. czeczottianus*

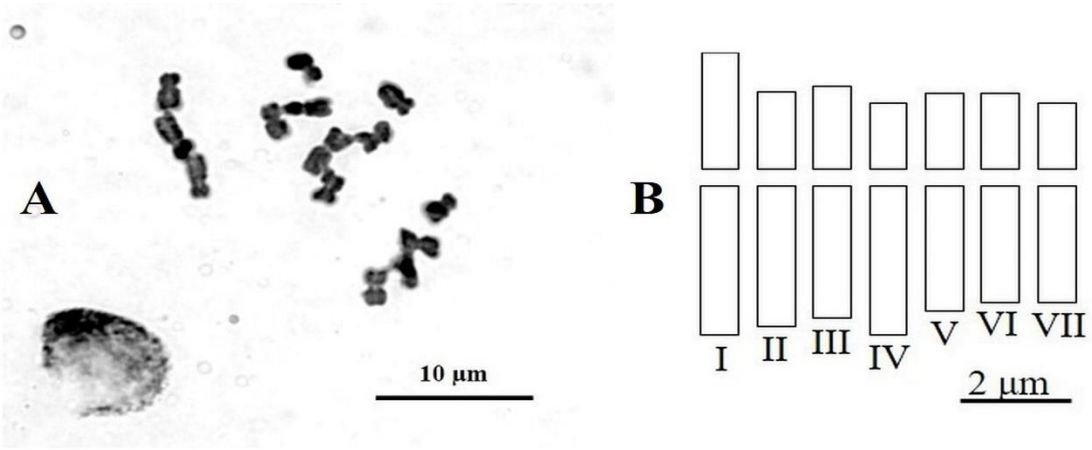

Table 2. Chromosome types, chromosome lenght and ratio of *L. pratensis*

Chromosome pairs	Total lenght (C, µm)	Long arm (L, µm)	Short arm (S, µm)	Arm ratio R=L/S	Centromeric index (I)	Relative length (R)	Chrom. type
I	4.13	2.29	1.83	1.23	44.44	8.32	m
II	3.67	2.25	1.42	1.59	38.64	7.39	m
III	3.63	2.17	1.46	1.49	40.23	7.31	m
IV	3.54	2.29	1.25	1.83	35.29	7.14	sm
V	3.42	2.00	1.42	1.41	41.46	6.89	m
VI	3.33	1.92	1.42	1.35	52.50	6.72	m
VII	3.17	1.92	1.25	1.53	39.47	6.39	m
Average	MC=3.55			MR=1.49			

Figure 3. A. Mitotic metaphase chromosomes, B. Idiogram of *L. pratensis* and Table 2. Chromosome types, chromosome lenght and ratio of *L. pratensis*

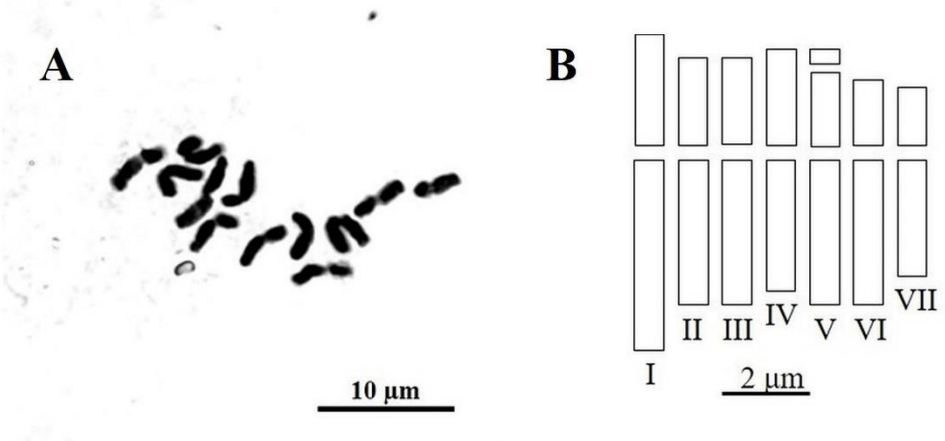

Table 3. Chromosome types, chromosome lenght and ratio of *L. layardii*

Chromosome pairs	Total lenght (C, µm)	Long arm (L, µm)	Short arm (S, µm)	Satellite (SAT)	Arm ratio R=L/S	Centromeric index (I)	Relative length (R)	Chrom. type
I	5.50	3.50	2.00	---	1.75	36.36	8.87	sm
II	4.50	2.88	1.63	---	1.77	36.11	7.26	sm
III	4.50	2.75	1.75	---	1.57	38.88	7.26	m
IV	4.50	2.63	1.88	---	1.40	41.67	7.26	m
V	4.25	2.75	1.50	0.63	1.83	35.29	6.85	sm
VI	4.13	2.88	1.25	---	2.30	30.30	6.65	sm
VII	3.63	2.50	1.13	---	2.22	31.03	5.85	sm
Average	MC=4.43				MR=1.83			

Figure 4. A. Mitotic metaphase chromosomes, B. Idiogram of *L. layardii* and Table 3. Chromosome types, chromosome lenght and ratio of *L. layardii*

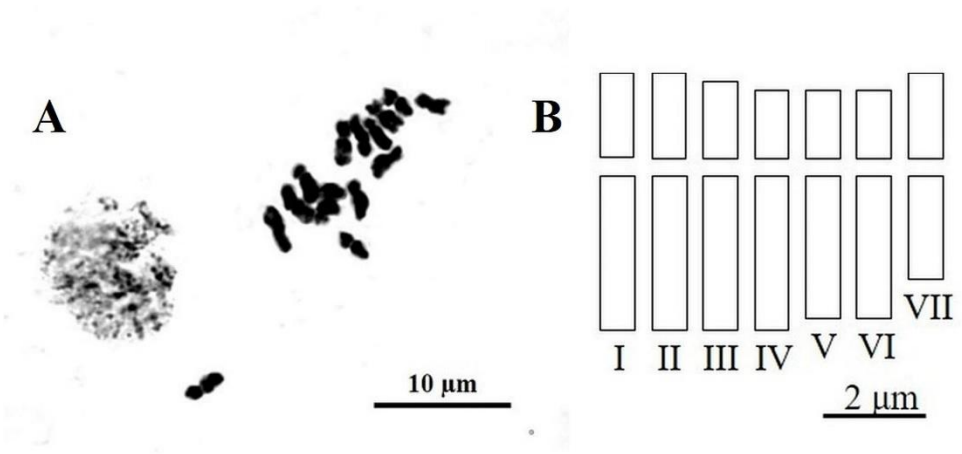

Table 4. Chromosome types, chromosome lenght and ratio of *L. laxiflorus* subsp. *angustifolius*

Chromosome pairs	Total lenght (C, µm)	Long arm (L, µm)	Short arm (S, µm)	Arm ratio R=L/S	Centromeric index (I)	Relative length (R)	Chrom. type
I	3.44	2.19	1.25	1.75	36.36	7.49	sm
II	3.38	2.13	1.25	1.70	37.04	7.36	sm
III	3.38	2.38	1.00	2.38	29.63	7.36	sm
IV	3.31	2.13	1.19	1.79	35.85	7.22	sm
V	3.25	2.06	1.19	1.74	36.54	7.08	sm
VI	3.25	2.06	1.19	1.74	36.54	7.08	sm
VII	2.94	1.50	1.44	1.04	48.94	6.40	M
Average	MC=3.28			MR=1.73			

Figure 5. A. Mitotic metaphase chromosomes, B. Idiogram of *L. laxiflorus* subsp. *angustiflorus* and Table 4. Chromosome types, chromosome lenght and ratio of *L. laxiflorus* subsp. *angustifolius*.

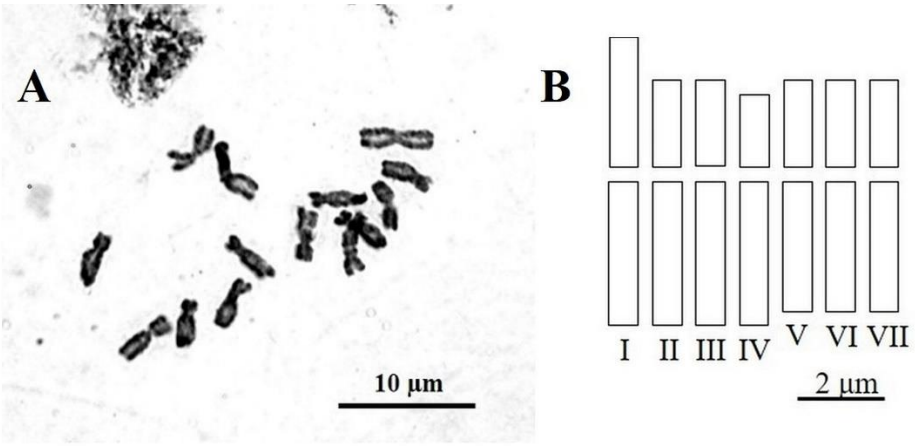

Table 5. Chromosome types, chromosome lenght and ratio of *L. czeczottianus*

Chromosome pairs	Total lenght (C, µm)	Long arm (L, µm)	Short arm (S, µm)	Arm ratio R=L/S	Centromeric index (I)	Relative length (R)	Chrom. type
I	5.26	2.73	2.55	1.07	48.34	9.48	M
II	4.25	2.75	1.50	1.83	35.29	7.64	sm
III	4.15	2.60	1.55	1.68	37.35	7.46	m
IV	4.08	2.70	1.36	1.96	33.74	7.33	sm
V	4.00	2.52	1.48	1.71	36.88	7.19	sm
VI	4.00	2.46	1.53	1.62	38.13	7.19	m
VII	3.86	2.40	1.48	1.63	38.06	6.97	m
Average	MC=4.54			MR=1.64			

Figure 6. A. Mitotic metaphase chromosomes, B. Idiogram of *L. czeczottianus* and Table 5. Chromosome types, chromosome lenght and ratio of *L. czeczottianus*.

4. Conclusions and discussion

This section is separated from the *Lathyrus* sections morphologically, according to their angled but not winged stem, broad sagittate stipules and raceme flowers. Studied taxa collected from Turkey displayed 2n=14 chromosome numbers. All of the taxa are perennial and the sizes of their chromosomes ranged between 2.94–5.50 µm.

In sections examined earlier, these values were observed to be *Pratensis* 2.94–7.25 µm, *Lathyrus* 3.70–10.25 µm, *Orobus* 3.00–7.00 µm, *Cicercula* 2.54–5.75 µm, *Nissolia* 2.89–3.78 µm and *Aphaca* 2.03–3.22 µm (Güneş and Çırpıcı, 2008; Güneş, 2011). Ress and Hazarika (1969) indicated that total chromosome length in perennial *Lathyrus* species is generally greater than that of annual species. Our results confirm the previous studies. Özcan et al. (2006) and Şahin et al. (1988) determined the chromosome types of *L. laxiflorus* subsp. *laxiflorus* as metacentric (m) and submetacentric (sm) and observed satellites as shown in Table 6. Morphologically, *L. laxiflorus* subsp. *laxiflorus* and *L. laxiflorus* subsp. *angustifolius* are very similar and their chromosome types are very similar too. *L. czeczottianus*, subsp.*laxiflorus* and subsp. *angustifolius* have medianpoint (M) chromosome (Table 6; Fig. 5-6).

L. pratensis is different from other species of the section with yellow flowers. In some countries or in some regions, *L. pratensis* can have different numbers of chromosomes. Therefore we needed to study this species more closely. We have collected specimens from Turkey's Caucasus region. This region is both high and cold but the number of chromosomes we detected was the same (2n=14), like other researchers in Turkey (Table 6). Earlier investigators observed that the chromosome numbers in the somatic cells of *L. pratensis* were 2n=14 (Darlington and Wylie, 1955, London; Yamomato et al., 1984, London and Czechoslovakia; Şahin et al., 1988, Centre of Turkey; Gutiérrez, 1994, France-Germany, Switzerland; Klamt and Wittmann, 2000; Özcan et al., 2006, North of Turkey) and 2n=28 (Darlington and Wylie, 1955, London; Yamomato et al., 1984; Gutiérrez, 1994, Spain-Geneva). As shown in Table 6, the chromosome numbers of the section *Pratensis* species in the present study were also in accordance with previous findings (Darlington and Wylie, 1955; Yamomato et al. 1984; Gutiérrez, 1994; Şahin et al., 1998; Güneş and Çırpıcı, 2008; Özcan et al., 2006).

Table 6. Chromosome number and chromosome type of examined taxa and references

Taxa	Chromosome number (2n)	Chromosome type	Reference chromosome number (2n)	Reference chromosome type
L. pratensis	14	m,m,m,sm,m,m,m	**14** 1. Darlington and Wylie 1955, London) 2. (Yamomato et al. 1984, London and Czechoslovakia) 3. (Şahin et al. 1988, Turkey) 4. (Gutiérrez 1994, France-Germany, Switzerland**).** 5. Klamt and Wittmann 2000 6. (Ozcan et al. 2006, Türkiye)	1. Unspecified 2. Unspecified 3. m^{sat}sm,sm,sm,sm,sm,m 4. Unspecified 5. 2m + 12 sm 6. m,sm,sm,sm,sm^{sat},m,m,
			28 1. Darlington and Wylie 1955, London) 2. (Yamomato et al. 1984) 3. (Gutiérrez 1994, Spain-Geneva).	1. Unspecified 2. Unspecified 3. Unspecified
L. layardii (End)	14	sm,sm,m,m,sm^{sat}sm, sm	**new**	**new**
L. laxiflorus subsp. *laxiflorus*			**14** 1. (Ozcan et al. 2006, Turkey), 2. (Şahin et al. 1988, Turkey) 3. (Güneş and Çırpıcı 2008, Turkey)	1. sm,m,sm,sm,m^{sat},m,m 2. m,sm^{sat}sm,sm,sm,sm,m 3. m,sm,sm,sm,sm,sm,M
L. laxiflorus subsp. *angustifolius* (End)	14	sm,sm,sm,sm,sm,sm ,M	**new**	**new**
L. czeczottianus (End)	14	M,sm,m,sm,sm,m,m	14 (Ozcan et al. 2006, Turkey)	m,sm,m,sm,m^{sat}sm,m

L. czeczottianus is an endemic plant that is wide spread in Anatolia. Özcan et al. (2006) collected it in the Eastern Black Sea region (north of Turkey). In this study, we compared the localities of the most western, eastern and southern regions of the province where the plant has spread (Table 1 and 6). The studies that have been performed before were of *L. pratensis* and *L. czeczottianus* (end) taxa. It has been suggested that the different chromosome types determined in these taxa were because of the different methods used by the researchers. The karyological findings obtained in this study and their systematic availability show parallelism with the determinations of previous researchers (Darlington and Wylie, 1955; Yamomato et al., 1984; Şahin et al., 1988; Gutiérrez, 1994; Klamt and Wittmann, 2000; Özcan et al., 2006; Güneş and Çırpıcı, 2008) (Table 6).

The satellites were only observed in the fifth chromosome of *L. layardii,* and are large and with a width equal to the chromosome width (Table 3; Figure 4). Güneş (2011) showed that karyological characteristics could be referred to for distinguishing some morphologically very similar taxa, specifically *L. atropatanus*, *L. spatulatus*, *L. karsianus* and *L. cyaneus* var. *cyaneus*. Güneş and previous authors (Martin et al. 2011; Özcan, 2013; Altınordu et al. 2013; Güneş and Meriç 2017)

believed that this important data concluded from the study of karyotype analysis would lead to a better understanding of the taxa and provide a contribution to any future studies.

The karyotype analysis of two taxa, all of them endemic (*L. layardii* and *L. laxiflorus* subsp. *angustiflorus*), and included in the section *Pratensis* growing in Turkey were determined in detail for the first time in this study.

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References

Altınordu, F., Kandemir, A., Martin, E. (2013). Karyological study on endemic Sonchus erzincanicus Matthew (Asteraceae) in Turkey. Biological Diversity and Conservation, 6/3: 128-134.

Ayaz, E., Ertekin, S.A. (2008). Karyotype Analysis of two species of Genus Lathyrus from South eastern Anatolia, Turkey. Int. J. Agric. Biol., 5: 569-572 .

Badr, S.F. (2006). Karyotype analysis and chromosome evolution in species of Lathyrus (Fabaceae). Cytologia, 71(4): 447-455.

Ball, P.W. (1968). Lathyrus L. in Tutin et all.: "Flora Europaea", Vol. 2, Cambridge Univ. Press, pp.136-143.

Başaran, U., Acar, Z., Aşçı, Ö.Ö., Mut, H., Ayan, I. (2007). Agricultural importances, using possibilities and toxic substances of Lathyrus species. Anadolu Journal of Agricultural Sciences (Turkey).

Davis, P.H. (1970). Lathyrus L. In: Davis, P.H. (ed), "Flora of Turkey and East Aegean Islands" University Press, Edinburgh, Vol. 3: 328-369.

Davis, P.H. (1988). Flora of Turkey and East Aegean Islands. University Press, Edinburgh. Vol. 10: 125-126,

Darlington, C.D., Wylie, A.P. (1955). Chromosome Atlas of Flowering Plants, George Allen and Unwin, London, 155-156

Evren, H., Şahin, A., Çobanoğlu, D. (1994). Morphological and sytological features of Lathyrus nissolia L. (Fabaceae), Tr. J. of Botany, 18: 367-374.

Fatma, G. (2011). Karyotype analysis of Lathyrus taxa belonging to Platystylis (= Lathyrostylis) section (Fabaceae) from Turkey. Caryologia, 64(4): 464-477.

Fouzdar, A., Tandon, S.L. (1975). Cytotaxonomıc Investigations in the Genus Lathyrus. The Nucleus,18:24-33.

Gutiérrez, J.F., Vaquero, F., Vences, F.J. (1994). Allopolyploid vs. autopolyploid origins in the genus *Lathyrus* (Leguminosae). Heredity, 73(1):29.

Güneş, F. (2012). Lathyrus L. In: Güner, A., Aslan, S., Ekim, T., Vura,l M., Babaç, M.T. (edlr.). Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği yayını. İstanbul. 466-470.

Güneş, F., Çırpıcı, A. (1996). The morphological and cytological investigations on some *Lathyrus* growing in Istanbul vicinity. XII. The National Biology Congress, 17-20 September, İstanbul. Proceedings Book, 501-509.

Güneş, F., Özhatay, N. (2000). *Lathyrus* L. In: A. Güner, N. Özhatay, T. Ekim and K.H.C. Baser (eds). Flora of Turkey and East Aegean Islands. University Press, Edinburgh. Vol. 11 (supplement 2): 92-94.

Gunes, F., Ali, C. (2008). Karyotype analysis of some *Lathyrus* L. species (Fabaceae) from the Thrace region (Turkey-in-Europe). Caryologia, 61 (3): 269-282.

Güneş, F., Meriç, Ç. (2017). Morphological, anatomical and karyological investigations of the Turkish endemic species Lathyrus woronowii Bornm.(Fabaceae). Acta Botanica Croatica, 76 (2): 132-137.

Khawaja, H.I.T., Sybenga, J., Ellis, J.R. (1997). Chromosome pairing and chiasma formation in autopolyploids of different Lathyrus species. Genome, 40 (6): 937-944.

Klamt, A., Schifino-Wittmann, M.T. (2000). Karyotype morphology and evolution in some Lathyrus (Fabaceae) species of southern Brazil. Genetics and Molecular Biology, 23 (2): 463-467.

Kupicha, F.K. (1983). The infrageneric structure of *Lathyrus*. Notes from the Royal Botanic Garden. Edinburgh. 41: 209-244.

Kurıyan, P.N., Narayan, R.K.J. (1988). The Distribution and Divergence during Evolution of Families of Repetitive DNA Sequences in Lathyrus Species. Journal of Molecular Evolution, 27: 303-310.

Levan, A., Fredga, K., Sandberg, A.A. (1964). Nomenclature for Centromeric Position on Chromosomes, Hereditas, 52: 201-220.

Martin, E., Çetin, Ö., Akgül, G., Ay, H. (2011). New chromosome numbers in the genus Marrubium(Horehound) from Turkey. Biological Diversity and Conservation, 4 (2): 185-188.

Narayan, R.K., Durrant, J.A. (1983). DNA distribution in chromosomes of Lathyrus species, Genetica, 61: 47-53.

Özcan, M., Hayirlioğlu-Ayaz, S., İnceer, H. (2006). Karyotype analysis of some *Lathyrus* L. taxa (Fabaceae) from north-eastern Anatolia. Acta Bot. Gallica, 153 (3): 375-385

Özcan, T. (2013). Presence of Teucrium microphyllum in Turkey: Morpho-anatomical, karyological and ecological studies. Biological Diversity and Conservation, 6 (3): 79-87.

Ress, H., Hazarıka, M.H. (1969). Chromosome evolution in Lathyrus. Chromosome Today Vol. II. 6: 131-139.

Roy, A.P., Sıngh, M.K. (1967). Cytological studies in the genus Lathyrus Linn. Indian. J. Cytol. Genet., 2: 128.

Şahin, A., Babac, M.T. (1995). Cytotaxonomic investigations on some Lathyrus L. species growing in eastern and southern-eastern Anatolia regions in Turkey. Tr. J. of Botany, 19: 293-297.

Şahin, A., Genç, H., Bağcı, E. (1998). Cytotaxonomic investigations on some Lathyrus L. species growing in western Mediteranean and southern Aegean regions in Turkey, Acta Bot. Hung., 41(1- 4): 229-241.

Şahin, A., Genç, H., Bağcı, E. (2000). Cytotaxonomic investigations on some Lathyrus L. species growing in eastern Mediteranean and southern Aegean regions – II. Acta Bot. Gallica, 147 (3): 243-256.

Seijo, J.G., Fernández, A. (2003). Karyotype analysis and chromosome evolution in South American species of Lathyrus (Leguminosae). American Journal of Botany, 90 (7): 980-987.

Yamamoto, K., Fujıwara, T. 1984. Karyotypes and morphological characteristics of some species in the genus Lathyrus L. Japan. J. Breed., 34: 273- 284.

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Research article/Araştırma makalesi

Pollen analysis of honeys from Hatay/Turkey

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Abstract

This study presents pollen analysis of natural honey produced in Hatay province in Turkey. Honey samples were collected from 15 different localities in 2013 around Hatay and its environs. The pollen analysis was carried out using microscopical analysis. In all 100 taxa belonging to 40 different families were determined. Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae, Poaceae, Rosaceae and *Trifolium* were the most represented taxa. In honey samples, dominant pollen types were from Fabaceae and *Petroselinum crispum* while Apiaceae, Asteraceae, Brassicaeae, Fabaceae, Rosaceae, Lamiacea, *Lathyrus* sp., *Erica manipuliflora*, *Arbutus andrachne*, *Olea europaea* and *Citrus aurantium* were recorded as secondary taxa. Among the 15 honey samples, only three samples collected from Üçgüllük (H01 honey sample), Kale (H02 honey sample), and Bektaşlı villages (H07 honey sample) were unifloral, because of having only one dominant and trace pollen, others were determined as multifloral honeys. The highest number of pollen was observed in the samples from Üçgüllük Village (96113 pollen grain).

Key words: melissopalynology, honey, pollen analysis, Hatay, Turkey

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Hatay/Türkiye ballarının polen analizi

Özet

Bu çalışma Türkiye'de Hatay ilinde üretilen doğal balların polen analizini sunmaktadır. 2013 yılında Hatay ve çevresinde 15 farklı lokaliteden bal örnekleri toplanmıştır. Polen analizi mikroskopik analiz kullanılarak gerçekleştirilmiştir. 40 farklı aileye ait toplam 100 takson belirlendi. Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae, Poaceae, Rosaceae ve *Trifolium* en çok temsil edilen taksonlardır. Bal numunelerinde dominant polen tipleri Fabaceae ve *Petroselinum crispum* iken, Apiaceae, Asteraceae, Brassicaeae, Fabaceae, Rosaceae, Lamiaceae, *Lathyrus* sp., *Erica manipuliflora*, *Arbutus andrachne*, *Olea europaea* ve *Citrus aurantium* sekonder takson olarak kaydedilmiştir. 15 adet bal örneğinden sadece Üçgüllük (H01 bal örneği), Kale (H02 bal örneği) ve Bektaşlı köylerinden (H07 bal örneği) toplanan üç bal örneği dominant ve iz polenine sahip olduğundan unifloral, diğerleri ise multifloral baldır. Üçgüllük Köyü (96113 polen tanesi)'nden toplanan bal örneğinde en fazla polen tanesi gözlenmiştir.

Anahtar kelimeler: melisapalinoloji, bal, polen analiz, Hatay, Turkiye

1. Introduction

Honey is consumed all over the world, but adulteration and the false labelling are the problems we face globally (Song et al., 2012). Composition of honey is varies and from region and climatic features of the area. Therefore the evaluation of the chemical composition of honeys is necessary. The composition and physicochemical properties of honeys can be used to verify the botanical origin and microscopic characteristics (Bogdanov et al., 2004, 2007). Melissopalynology plays a great role in this connection, as it helps to find out the botanical and geographical origin of honey with the help of their pollen composition (Anklam, 1998, Song et al., 2012). Floral composition of a honey sample can be determined by characterization of pollen content and diversity.

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In order to determine the origin, above other properties as bitterness, aroma and flavor, color, and rapid crystallization status of honeys, pollen analysis is reported to be the best approach (Sorkun, 1985). Many countries all over the world have strict import and export laws that requires three types of certification. These are verification of the honey's floral type, quality, and precise place of origin. As a result of these obligations countries impose strict rules governing the importation and exportation of honey products. This situation makes these certifications very important. People use pollen analyses to determine these certifications (Jones and Bryant, 2004). Many investigations have been undertaken during the last few decades in this connection all over the world notable among these being; Terrab et al. (2004, 2005), Khan et al. (2006), Mandić et al. (2006), Sabo et al. (2011), Upadhyay and Bera (2012), Song et al. (2012) from Spain, Morocco, Pakistan, Croatia, India, and China.

In Turkey first scientific report on pollen analysis of honey was published by Qustrani in 1976 (Erdoğan et al., 2006). There are several reports from Turkey on the pollen spectrum of honeys (Silici and Gökçeoğlu, 2007; Ozturk et al., 2012). All melissopalinological studies have been carried out in different phytogeographical regions of Turkey as reviwed by Ozturk et al. (2012). In this study, pollen types belonging to total 244 plant taxa have been reported, listed as dominant and secondary pollen (Ozturk et al., 2012).

Our major aim here is to provide information on the type and plant sources in the honey collected from the Hatay (Turkey) and put forward a guide for beekeeping in the province.

2. Materials and methods

2.1. Study area

A determination of the floral diversity, flowering and nectar accumulation times are very important for an effective and conscious beekeeping. The province of Hatay in Turkey has a great potential due to the its varying geographical, topographical and ecological features (Genç, 1990). The State of Antakya (Antiochia) in the upper mesopotamian part of Turkey is located between 35˚48' N and 37˚00' N and between 35˚46' E and 36˚41' E in the most southern region of Turkey. The altitude varies from sea level to 2240 m. The Mediterranean Sea lies in its west, Syria in the south and east and Adana, Osmaniye and Gaziantep provinces in the North. The province is spread over an area of 5.559 km^2 and 46.1 percent of the land is mountain, 33.5 percent plain and 20.4 percent plateau and hillside (Korkmaz et al., 2012; Altay et al., 2011). The area is under the influence of the Mediterranean climate, annual average temperature varies between 15.1-20 ˚C and average annual rainfall between 562.2-1216.3 mm, most of which falls in winter months (Altay et al., 2011).

Shrubs are encountered between 0-500 m in the area and consist of species like *Quercus coccifera*, *Phillyrea latifolia*, *Pistacia terebinthus* ssp. *palestina*, *Myrtus communis*, *Paliurus spina-christi*, *Calicotome villosa*, *Nerium oleander*, *Cistus creticus*, *Spartium junceum* and *Cotinus coteneaster*. At higher altitudes (500-1000 m) we find plant taxa such as: *Pinus brutia*, *Laurus nobilis* and *Arbutus andrachne*; between 1000-1500 m the dominant cover is compposed of *Quercus* sp. and *Ostraya carpinifolia*, and between 1500-2000 m *Pinus nigra*, *Cedrus libani*, *Abies cilicica* forests are dominant representatives (Akman, 1973; Altay, 2015). The mountains run parallel to the coast line in the region and moisture values around Iskenderun are higher. We come across many woody plant taxa here such as *Laurocerasus officinalis*, *Fagus orientalis*, *Corylus avellana*, *Tilia argentea*, *Acer platanoides* and *Ilex colchica* in the east of Dörtyol, which are specific to the Black Sea region (Akman, 1973). The plant diversity of Hatay with about 250 endemic taxa (rate of endemism 12.5%) is composed of approximately 2000 natural vascular plant taxa (Altay, 2015).

2.2. Data analysis

A total of 15 natural honey samples (Appendix 1), were collected from nonmigratory beekeepers (members of the Hatay Beekeepers Association) in the Hatay province during 2013 and 2014. The preparation of honey samples was carried out according to the standardized method of Louveaux (1970), Pendleton (2006), Silici and Gökçeoğlu (2007). To analysis the pollen content of the honey samples methods outlined in detail by Ozturk et al. (1989, 2012), and Sorkun (2008) were followed. Honey samples (300 g) were collected from different locations was put into sterile jars. Samples were incubated at 65-70 ˚C in water baths to prevent crystallization and stirred to get homogeneous suspensions. From these suspensions, 10 g samples were mixed with 20 mL distilled water, incubated at 45 ˚C in water bath and continuously shaken to dissolve honey in water. The mixture was centrifuged at 6000-6500 rpm, upper water phase was discarded and pre-prepared glycerol-gelatin mixture (1:1.5) was added to the tubes. They were transferred to a slide, covered with coverslip and prepared, then analyzed by using Leica DM2500 light microscope (1000×) to determine and the pollen content (Şık et al., 2017).

Percentage of every pollen type in the pollen sediment was calculated for all honey samples. Pollen types were allocated to one of four frequency classes: (i) predominant pollen types (>45% of the total pollen content); (ii) secondary pollen types (16-45%); (iii) important minor pollen types (3-15%); and (iv) minor pollen types (<3%) (Song et al., 2012) (Appendix 2). The total amount of pollen grains in a honey sample was determined and the results were compared with the classification proposed by Louveaux et al. (1978). The five classes according to the pollen content in 10 g of honey

were: **I**: less than 20.000 pollen grains; **II**: 20.000 to 100.000 pollen grains; **III**: 100.000 to 500.000 pollen grains; **IV**: 500.000 to 1.000.000 pollen grains; **V**: over 1.000.000 pollen grains.

3. Results

During this study, a total of 100 pollen types belonging to 40 families were identified from 15 honey samples. The number of plant taxa (pollen types) present in each honey sample studied varied between 18 to 46 (Appendix 1).

The dominant families are **Fabaceae** (Fabaceae type, *Astragalus, Calicotome villosa, Ceratonia siliqua, Cicer arietinum, Glycyrrhiza glabra, Lathyrus, Medicago, Pisum sativum, Sophora, Trifolium* and *Vicia*), **Asteraceae** (Asteraceae type, *Anthemis, Aster, Carduus, Centaurea, Cichorium intybus, Helianthus annus, Lactuca, Tanacetum, Xeranthemum* and *Taraxacum*), **Lamiaceae** (Lamiaceae type, *Lavandula stoechas, Prunella, Rosmarinus officinalis, Salvia, Teucrium, Thymbra* and *Thymus*), **Brassicaceae** (Brassicaceae type, *Brassica, Isatis, Rapistrum rugosum, Raphanus raphanistrum* and *Sinapis*), **Rutaceae** (*Citrus* type, *Citrus aurantium, Citrus limon, Citrus nobilis, Citrus parasidi* and *Citrus sinensis*) and **Cucurbitaceae** (Cucurbitaceae type, *Citrullus lanatus, Cucumis sativus, Cucumis melo* and *Ecballium elaterium*) (Appendix 1).

Families that occurred in more than 50 percent of the honey samples included Cistaceae and Boraginaceae (60%, n=9), Rutaceae and Oleaceae (73.33%, n=11), Liliaceae (80%, n=12), Myrtaceae (86.67%, n=13); Rosaceae, Poaceae, Lamiaceae and Apiaceae (93.33%, n=14), and Fabaceae, Brassicaceae and Asteraceae (100%, n=15).

17 pollen types were found in more than one-half of the honey samples in the study area. These pollen types included *Citrus aurantium, Cistus salviifolius, Raphanus raphanistrum* and Boraginaceae type (53.33%, n=8), *Olea europaea, Myrtus communis, Eucalyptus camaldulensis* and *Centaurea* (66.67%, n=10), Liliaceae type (80%, n=12), Poaceae type (86.67%, n=13), Rosaceae type, Lamiaceae type, *Trifolium*, Asteraceae type and Apiaceae type (93.33%, n=14), and Brassicaceae type and Fabaceae type (100%, n=15).

Of the 15 honey samples, 12 were classified as multifloral and 3 as unifloral, represented by 2 predominant pollen types: *Petroselinum crispum* (n=2) and Fabaceae type (n=1) (Appendix 2).

Based on the absolute pollen content per 10 g of the honey samples, 73.33% (n=11) of the samples were found to belong to **Group I** (<20.000 pollen grains per 10 g honey) and 26.67% (n=4) to **Group II** (20.000-100.000) (Appendix 2).

The number of pollen grains per 10 g of honey, extended from the 'very poor' (<20.000) to the 'very rich' category (500.000-1.000.000) (Feller-Demalsy et al., 1989). In our study, honey samples generally "very poor" in grains represented 73.33% of all the samples (Appendix 2).

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4. Conclusions and discussion

Pollen content and the diversity is most important factor to determine the quality level of honey (Yan et al., 2001). Pollen present in the dominant and secondary group are primary contributors to the formation of honey while pollen content in quantities less than other pollen are added to the honey generally by external factors such as wind (Moar, 1985). The dominant and secondary groups determine the honey content and quality. According to Lieux (1972), the diversity of trace and minor groups has always been higher than diversity of dominant group pollen taxa. Our result show parallalelity with these findings.

The pollen composition of the honey samples revealed important information on the floral structure of the study area. Of the dominant pollen taxa group (>45%) *Petroselinum crispum* was present in two of the 15 samples, ranging from 77.2 to 93.62 percent (H01 and H02 honey samples). These honey samples are named locally as "**Maydanoz balı**" (honey name in turkish). It was present as secondary pollen in one sample (H08 honey sample) (Appendix 2). *Petroselinum crispum* is commonly cultivated in the study area. The honey samples were taken from the honey hives located near the parsley cultural fields. Similarly, it is reported for other species of the Apiaceae family in Turkey. Silici and Gökçeoğlu (2007) reported that *Pimpinella anisum* pollen were dominant in two honey samples from Antalya Province. It has also been reported similar to other countries in the Mediterranean basin. According to Tsigouri et al. (2004), *Pimpinella anisum* pollen were dominant in two honey samples from Greece and Apiaceae pollen were most frequently found in Algerian honeys (Ouchemoukh et al., 2005).

Fabaceae type was predominant in only one sample (H07 honey sample). It was also the secondary pollen in four samples (Appendix 2). Fabaceae type pollen has already been reported in the different phytogeographical regions in Turkey honeys by Ozturk et al. (2012). Twelve pollen types belonged to the secondary pollen group (16-45%): Apiaceae type (H03, H04 and H10), *Petroselinum crispum* (H08), Fabaceae type (H11, H12, H14 and H15), *Lathyrus* (H06), *Erica manipuliflora* (H09), *Arbutus andrachne* (H09), Lamiaceae type (H10, H11 and H12), Asteraceae type (H11), Brassicaceae type (H12, H13, H14 and H15), Rosaceae type (H06), *Citrus aurantium* (H04 and H05) and *Olea europaea* (H13) (Appendix 2).

The pollen types of Apiaceae, Asteraceae, Brassicaceae, Fabaceae, Lamiaceae and Rosaceae are present in almost all honey samples in the study area (Appendix 1) and these are considered as secondary pollen groups. Similarly,

these pollen types have also been reported as secondary pollen in other regions of Turkey (Ozturk et al., 2012). Ouchemoukh et al. (2005) reported that Apiaceae pollen is most frequently found in Algerian honeys. Atanassova et al. (2009) reported that Fabaceae, Lamiaceae, Brassicaceae and Rosaceae are the most represented families in honey from the Kazanlak region (Central Bulgaria). In addition, Atanassova et al. (2016) reported that Fabaceae, Rosaceae and Brassicaceae families were important for honey production from serpentine and nonserpentine areas in the Eastern Rhodopes Mt. (Bulgaria).

Asteraceae is one of the the richest families in terms of plant species and pollen types in the world. Similarly, pollen of this family have been most frequently found in honeys from Turkey (Ozturk et al., 2012). Brassicaceae is a cosmopolite family and it contains many natural and cultivated plant species in Turkey. Many members of the Brassicaceae are economically important for medicinal, ornamental, and economic purposes (Gugel and Falk, 2006; Warwick et al., 2007). Brassicaceae family members are common plants along the roads and highways and they are important bee plants not only for honeybees but also for the bumbles (Silici and Gökçeoğlu, 2007). Pollen grains of this family are very commonly present in honey samples. Previous studies have reported that pollen of this family is usually present in honey samples from Turkey (Sorkun and İnceoğlu, 1984b, c; Kaplan and İnceoğlu, 2002; Ozturk et al., 2012).

The number of honey plants belonging to Fabaceae family is less than other families, because the flowering period of the family is between April-September. Fabaceae plants have a long flowering period and are used as sources of pollen and nectar by bees, and are also frequently observed in honey (Silici and Gökçeoğlu, 2007). Many previous melissopalynological studies report that Fabaceae type pollen are frequently found in Turkey's different regions and neighboring countries with similar climate (Sorkun and İnceoğlu, 1984a; Sorkun and Yuluğ, 1985a, b; Göçmen and Gökçeoğlu, 1992; Kaplan and İnceoğlu, 2002).

The Lamiaceae family has more nectar bearing plants than other families in Turkey. It is one of the most important families as pollen and nectar source because it has long flowering period and very nice smell (Sorkun and Yuluğ, 1985b; Silici, 2004).

Rosaceae family has a large number of pollen and it is preferred by honeybees due to nectar and pollen source (Sorkun, 1988). The presence in our many honey samples could possibly be attributed to the fruit trees also in urban area (*Malus sylvestris, Prunus* spp., *Cerasus* sp.) to common (Taşkın and İnce, 2009).

Citrus aurantium pollen grains are present in eight samples and as secondary in two samples. Silici and Gökçeoğlu (2007) reported that there was no correlation between the percentage of *Citrus* pollen and the area of production. Likewise, Tsigouri et al. (2004) reported similar results. Although different *Citrus* varieties (*C. aurantium, C. limon, C. paradisi, C. nobilis* and *C. sinensis*) are cultivated throughout the study area, the pollen percentage was not high in our honey samples. This is due to the fact that *Citrus* pollen grains are underrepresented in honey. Silici and Gökçeoğlu (2007) have found similar results in Antalya Province (Turkey). Similarly, melissopalinological studies by different researchers especially Italy, Spain and Greece as well as other countries in the Mediterranean Basin are consistent with ours (Persano-Oddo et al., 1995, 1998, 2004a, b; Serra Bonvehi and Ventura Coll, 1995; Tsigouri et al., 2004). D'Albore (1997) has reported that percentage of pollen in Italian *Citrus* honeys is greater than 5 percent. *Olea europaea*, the most typical Mediterranean plant, is cultivated in coastal areas and its pollen was observed as secondary in one sample in the research area. Pollen from *O. europaea* has also been reported in variable frequencies in Spanish and Moroccan honeys (Debbagh, 1987; Muñuera-Giner and Carrion-Garcia, 1994; Cabreara-Ruiz et al., 1997; Terrab et al., 2003).

In Turkey, *Erica manipuliflora, Arbutus andrachne* (Ericaceae) and *Lathyrus* (Fabaceae) taxa growing along the coastal area are very important for honey bees as pollen and nectar source (Sorkun, 2008; Ozturk et al., 2012). *E. manipuliflora* and *A. andrachne* pollen were observed as secondary in one honey sample (H09), and *Lathyrus* pollen also was observed as secondary in one honey sample (H06) in the study area.

Twenty three pollen types belonged to the 'important minor' class. The pollen of Apiaceae, Asteraceae, Brassicaceae, Boraginaceae, Cucurbitaceae, Fabaceae, Lamiaceae, Poaceae, Polygonaceae, Rosaceae, *Anthemis, Arbutus andrachne, Cistus salviifolius, Citrus aurantium, Citrus sinensis, Erica manipuliflora, Eucalyptus camaldulensis, Lathyrus, Myrtus communis, Olea europaea, Raphanus raphanistrum, Trifolium* and *Vicia* are present in almost all honey samples in the study area (Appendix 2) and they can be considered as the important minor pollen.

The low number of the pollen in the honey samples is because of the short flowering period (Moar, 1985). However, nectars with lower sugar content are not preferred by honey bees. Small number of pollen grains affect the quality of honey. This is because of increase in the pollen species diversity. Taxa from 15 honey samples belong to "minor pollen" class except *Petroselinum crispum* (Appendix 2).

A total of 24 non-melliferous plant taxa found in our honey samples are: *Cedrus libani, Chenopodium album, Cistus, Cistus salviifolius, Cupressus sempervirens, Helianthemum nummularium, Hypericum, Juglans regia, Linum, Lycopersicon esculentum, Morus, Quercus* sp., *Quercus coccifera, Olea europaea, Phillyrea latifolia, Pinus brutia, Pistacia terebinthus, Poaceae, Populus, Rumex* sp., *Rumex acetosella* and *Typha* sp., *Vitis vinifera* and *Zea mays*. The presence of these pollen types is most likely from contamination by the bees from mainly wind-pollinates plants.

Honey is a local product so its botanical and geographical origin and many environmental factors have important effects on its quality (physical and chemical characteristics) (Bogdanov et al., 2007; Atanassova et al., 2016).

Melissopalynological analysis is still considered as a suitable method for honey evaluation. Many workers think that acidity and humidity are not the only significant parameters for honey quality; in addition pollen analysis gives important knowledge about the geographical and botanical origin (Persano Oddo and Piro, 2004a, b; Kaya et al., 2005; Silici and Gökçeoğlu, 2007), especially -if the plant is an endemic plant (Anklam, 1998). As emphasised by Mandić et al. (2006) Europe has more than 100 unifloral honeys but the honeys have local importance and people produce them periodically. Geographical and botanical properties play critical roles about their quality (Sabo et al., 2011). About 500 plants in Turkey are important nectar and pollen offering beekeeping plants. It is reported that all of this plants are important for beekeeping also 50-60 of them are economically dominant nectar and pollen yields (Sorkun, 2008; Ozturk et al., 2012).

In this study, two predominant pollen types (*Petroselinum crispum* and Fabaceae type) were recorded in three unifloral honeys. Local beekeepers designate honey samples as *Citrus, Eucalyptus, Petroselinum crispum, Calluna, Pinus, Capparis spinosa* and *Gossypium*" without melissapalynologycal analysis according to their botanical origins. They are considered as unifloral by the name, but our pollen analysis revealed that honey in some sites is multifloral and should be named as "Blossom".

Hatay province has a great potential in apiculture in terms of climate and vegetation. Cultivation of cash crops, garden plants and forage plants is intensive in the province. The vegetation of the province has a capacity which will serve for more than the number of existing bee colonies. However, the current potential of the province has not been adequately evaluated (Şahinler and Şahinler, 1996; Şahinler and Gül, 2005). Şahinler and Gül (2005) have reported that in different regions of Hatay, apiarists use big amounts of Mavrik, Kenaz, Perizin and Rulamit VA etc. to cure various diseases such as (varroa parasite, foulbrood). They have also reported that the reason of the situation was the fact that apiarists were uneducated, they lack experince and information, and they usually use unlicensed chemicals. Gül (2014) has also reported that such factors are of significiance as the most critical contributing causes diminution of bee populations in Turkey. In addition, the urbanization and industrialization, destruction of forests, coastal tourism, and greenhouse gases affect the beekeeping in Turkey. This situation is considered as the reason of the low quantities of pollen and taxa in samples. The lack of clean water supply also effects the spread of bee diseases (Yücel, 2008). In 3 km radius of the hive ecological vegetable production should be done and natural plant cover should exist for good honey production. Hives, should be placed away from industrial area, highways and from conventional agriculture using pesticides (Yücel, 2008). The beekeepers should produce honey in places that have plants with a lot of pollen and nectar and places which are suitable for bees. Orientation of beekeeper in this regard will play important role of mapping of appropriate pollen and nectar area for honey production and will provide food security (Yücel, 2008). Also helping pollination plays an active role in ensuring the diversity and continuity of generations (Kumova et al., 2001; Kambur and Kekeçoğlu, 2018).

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References

Akman, Y. (1973). Apercu preliminaire sur les conditions phytosocioloqiques de la chaine de l'Amanous dans la region du Hatay (I-II-III). Com de la Fac-Des Sicid'Ank. Serie C Tome, 17.

Altay, V. (2015). Hatay Bitki Örtüsü. In: 81 İlde Kültür ve Şehir - Hatay. M. Eriş ve H. Çoruh (eds.), Hatay Valiliği Neşriyatı, p. 57-64, Hatay.

Altay, V., Çelik, O., Kayıkçı, S. (2011). Hatay'ın vasküler duvar florası. Ot Sistematik Botanik Dergisi, 18(2), 131- 144.

Anklam, E. (1998). A review of the analytical methods to determine the geographical and botanical origin of honey. Food Chem., 63, 549-562.

Atanassova, J. R., Yurukova, L. D., Lazarova, M. A. (2009). Palynological, physical, and chemical data on honey from the Kazanlak region (Central Bulgaria). Phytologia Balcanica, 15(1), 107-114.

Atanassova, J. R., Pavlova, D., Lazarova, M., Yurukova, L. (2016). Characteristics of honey from serpentine area in the Eastern Rhodopes Mt., Bulgaria. Biol. Trace Elem. Res., Springer Science+Business Media New York.

Bogdanov, S., Ruoff, K., Persano-Oddo, L. (2004). Pyysico-chemical methods for the characterisation on unifloral honeys: a rewiew. Apidologie, 35, 4-17.

Bogdanov, S., Haldimann, M., Luginbuhl, W., Gallmann, P. (2007). Minerals in honey: environmental, geographical and botanical aspects. J. Apic. Res. Bee World, 46(4), 269-275.

Cabreara-Ruiz, C., Montilla-Gomez, J., Guerra-Hernandez, E., Molins-Marin, J. L. (1997). Physico-chemical analysis of orange honeys sold in Spain. Bull. Techn. Apic., 24, 63-70.

D'Albore, G. R. (1997). Textbook of melissopalynology. Bucharest: Apimondia.

Debbagh, S. (1987). Relationships between species foraged by the honeybee, *Apis mellifera intermissa*, and plant-association surveys in south Morocco. Trav. Doc. Geogr. Tropic., 59, 44.

Erdoğan, N., Pehlivan, S., Doğan, C. (2006). Adapazarı ili Hendek-Akyazı ve Kocaeli ilçeleri ballarında polen analizi. Mellifera, 6, 20-27.

Feller-Demalsy, M. J., Parent, L., Strachan, A. A. (1989). Microscopic analysis of honeys from Manitoba, Canada. J. Apic. Res., 28, 41-49.

Genç, F. (1990). Bal arılarında koloni performansını etkileyen faktörler. Teknik Arıcılık Dergisi, 27, 18-26.
Göçmen, S. ve Gökçeoğlu, M. (1992). Bursa yöresi ballarında polen analizi. Doğa Türk. J. Bot., 16, 373-381.
Gugel, R. K. and Falk, K. C. (2006). Agronomic and seed quality evaluation of *Camelina sativa* in western Canada. Can. J. Plant Sci., 86, 1047-1058.
Gül, A. (2014). Arı ölümleri, sebepleri ve alınması gereken tedbirler. Arıcılık Araştırma Dergisi, 11, 2-5.
Jones, G. D., Bryant, J. R. V. M. (2004). The use of ETOH for the dilution of honey. Grana, 43, 174-182.
Kambur, M. ve Kekeçoğlu, M. (2018). The current situation of Turkey honey bee (*Apis mellifera* L.) biodiversity and conservations studies. Biological Diversity and Conservation, 11(1), 105-119.
Kaplan, A. ve İnceoğlu, Ö. (2002). Konya yöresi ballarının polen analizi. Ot Sistematik Botanik Dergisi, 9(1), 101-109.
Kaya, Z., Binzet, R., Orcan, N. (2005). Pollen analysis of honeys from some regions in Turkey. Apiacta, 40, 10-15.
Khan, M. N., Qaiser, M., Raza, S. M., Rehman, M. (2006). Physicochemical properties and pollen spectrum of imported and local samples of blossom honey from the Pakistani market. International Journal of Food Science and Technology, 41, 775-781.
Korkmaz, H., Çetin, B., Özşahin, E., Karataş, A., Bom, A. (2012). Hatay İl Yıllığı, Hatay Coğrafyası. Hatay Valiliği Yayınları, p. 20-38, Hatay.
Kumova, U., Sağlamtimur, T., Korkmaz, A. (2001). Fazelya (*Phacelia tanacetifolia* Bentham) çeşitlerinde bal arısının (*Apis mellifera* L.) tarlacılık tercihinin araştırılması. Mellifera, 1(1), 27-32.
Lieux, M. H. (1972). A melissopalynological study of 54 Louisiana (USA) honeys. Rev. Palaeobot. Palynol., 13, 95-124.
Louveaux, J. (1970). Atlas photographique d'analyse pollinique des miels. Paris: Serv. Repress. Fraud. Contr. Qualite, Min. Agric.
Louveaux, J., Maurizio, A., Vorwohl, G. (1978). International Commission for Bee Botany of IUBS, Methods of Melissopalynology. Bee World, 59, 139-157.
Mandić, M. L., Primorac, L. J., Kenjerić, D., Bubalo, D., Perl, A., Flanjak, I. (2006). Characterization of oak mistletoe and common thistle honeys by physicochemical, sensory and melissopalynology parameters. Deut Lebensm Rundsch., 102, 245-249.
Moar, N. T. (1985). Pollen Analysis of New Zealand Honey. New Zealand Journal of Agricultural Resaerch, 28, 39-70.
Munuera-Giner, M. and Carrion-Garcia, J. S. (1994). Pollen analysis of *Citrus* honeys of the Segura basin (Alicante and Murcia). Alimentaria, 31(258), 37-42.
Ouchemoukh, S., Louaileche, H., Schweitzer, P. (2005). Physicochemical characteristics and pollen spectrum of some Algerian honeys. Food Control, 18, 52-58.
Ozturk, M., Dalgıç, R., Gemici, Y. (1989). Türkiye'nin Ege Bölgesi ballarının polen ve kimyasal analizi. Journal of Faculty of Science Ege University Series B, 11(2).
Ozturk, M., Dalgıç, R., Güvensen, A., Altay, V., Gücel, S. (2012). Honey-Pollen-Health: palinochemical analysis of honey from Turkey. Acta Horticulturae, 1, 83-92.
Pendleton, M. (2006). Descriptions of melissoplaynological methods involving centrifugation should include data for calculating Relative Centrifugal Force (RCF) or should express data in units of RCF or gravities (g). Grana, 45, 71-72.
Persano-Oddo, L., Piazza, M. G., Sabatini, A. G., Accorti, M. (1995). Characterization of unifloral honeys. Apidologie, 26, 453-465.
Persano-Oddo, L., Festuccia, N., Quaranta, M. (1998). Italian rosemary honey (*Rosmarinus officinalis* L.) melissopalynological and organoleptic features. Ape-Nostra America, 20, 6-20.
Persano-Oddo, L. and Piro, R. (2004a). Botanical species giving unifl oral honey in Europe. Apidologie, 35, 82-93.
Persano-Oddo, L. and Piro, R. (2004b). Main European unifloral honeys: descriptive sheets. Apidologie, 35, 38-81.
Sabo, M., Potočnjak, M., Banjari, I., Petrović, D. (2011). Pollen analysis of honeys from Varaždin County, Croatia. Turk. J. Bot., 35, 581-587.
Serra Bonvehi, J. and Ventura Coll, F. (1995). Characterization of Citrus honey (*Citrus* spp.) produced in Spain. J. Agric. Food Chem., 43, 2053-2057.
Silici, S. (2004). Türkiye'nin farklı bölgelerine ait bal örneklerinin kimyasal ve palinolojik özellikleri. Mellifera, 4(7), 12-18.
Silici, S. and Gökçeoğlu, M. (2007). Pollen analysis of honeys from Mediterranean region of Anatolia. Grana, 46, 57-64.
Song, X. Y., Yao, Y. F., Yang, W. D. (2012). Pollen analysis of natural honeys from the Central Region of Shanxi, North China. Plos One, 7(11), 1-11.
Sorkun, K. (1985). Balda Polen Analizi. Teknik Arıcılık Dergisi, 1, 28-30.
Sorkun, K. (1988). Ballı Bitkiler. Teknik Arıcılık, 15, 28-29.
Sorkun, K. (2008). Türkiye'nin nektarlı bitkileri, polenleri ve balları. Palme Yayıncılık, Ankara.
Sorkun, K. and Inceoglu, O. (1984a). Pollen analysis of honey from Central Anatolia. Doga Bilim Dergisi A2, 8(2), 222-228.
Sorkun, K. and İnceoglu, O. (1984b). Secondary pollens in honey of the Central Anatolia region. Doga Bilim Dergisi, 8, 382-384.
Sorkun, K. and Inceoglu, O. (1984c). Dominant pollens in honey of the Central Anatolia Regions. Doga Bilim Dergisi A2, 8, 377-381.
Sorkun, K. ve Yuluğ, N. (1985a). Erzurum yöresi ballarının polen analizi ve antimikrobiyal özellikleri. Türk Mikrobiyoloji Cemiyeti Dergisi, 15, 93-100.
Sorkun, K. ve Yuluğ, N. (1985b). Rize-İkizdere Yöresi ballarının polen analizi ve antimikrobiyal özellikleri. Doğa Bilim Dergisi A2, 9, 118-123.
Şahinler, N. ve Gül, A. (2005). Hatay Yöresinde bulunan arıcılık işletmelerinde arı hastalıklarının araştırılması. Uludag Bee Journal, 5, 27-31.
Şahinler, N. ve Şahinler, S. (1996). Hatay İlinde arıcılığın genel durumu sorunları ve çözüm yolları. M.K.Ü. Ziraat Fakültesi Dergisi, 1(1), 17-28.
Şık, L., Güvensen, A., Durmuşkahya, C., Erol, O. (2017). Pollen analysis of honeys from Ardahan/Turkey. Biological Diversity and Conservation, 10(2), 12-19.
Taşkın, D. ve İnce, A. (2009). Burdur yöresi ballarının polen analizi. Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 13, 10-19.
Terrab, A., Diez, M. J., Heredia, F. J. (2003). Palynological, physico-chemical and colour characterization of Moroccan honeys: I. River red gum (*Eucalyptus camaldulensis* Dehnh) honey. Int. J. Food Sci. Technol., 38, 379-386.

Terrab, A., Pontes, A., Heredia, F. J., Diez, M. J. (2004). A preliminary palynological characterization of Spanish thyme honeys. Bot. J. Linn. Soc., 146(3), 323-330.

Terrab, A., Valdes, B., Diez, M. J. (2005). Study of plants visited by honeybees (*Apis mellifera* L.) in the Central Rif Region (N. Morocco) using polen analysis. Grana, 44, 209-215.

Tsigouri, A., Passaloglu-Katrali, M., Sabatakou, O. (2004). Palynological characteristics of different unifloral honeys from Greece. Grana, 43, 122-128.

Upadhyay, D. and Bera, S. (2012). Pollen spectra of natural honey samples from a coastal District of Orissa, India. J. Apicult. Res., 51(1), 10-22.

Warwick, S. I., Gugel, R. K., Gómez-Campo, C. (2007). Genetic variation in the *Eruca vesicaria* (L.) Cav. Plant Genet. Resour. Charact. Util., 5, 142-153.

Yan, W. Y., Li, L., Zhou, L. H. (2001). Using the pollen in honey for distinguishing the quality of honey. Apicult. Sci. Technol., 3: 4-5.

Yücel, B. (2008). Ekolojik Arıcılık. In: Ekolojik/Organik Tarım ve Çevre, (ed.) Ak, I., Ekolojik Yaşam Derneği Yayın No: 1, Chapter 18, p. 238-246, Bursa. .

Appendix 1. Pollen taxa recovered from the honey samples and their frequency percentages

Pollen taxa	Sample no														
	H01	H02	H03	H04	H05	H06	H07	H08	H09	H10	H11	H12	H13	H14	H15
Anacardiaceae															
Pistacia terebinthus									**0.23**	**0.12**					
Apiaceae															
Apiaceae type	**0.73**	**2.22**	**34.53**	**23.2**	**10.18**	**2.33**	**2.51**	**3.67**	**3.41**	**20.11**	**9.58**	**4.6**	**7.32**		**6.63**
Petroselinum crispum	**93.62**	**77.2**						**36.05**							
Asteraceae															
Asteraceae type	**0.06**	**0.32**	**6**	**11.14**	**2.26**	**6.22**	**3.14**	**2.65**	**9.78**	**2.1**	**24.64**		**1.98**	**4.6**	**2.94**
Anthemis		**0.19**	**12.01**	**0.93**				**0.076**	**1.14**	**2.4**					
Aster											**0.07**				
Carduus	**0.001**														
Centaurea	**0.002**	**0.017**				**0.54**	**0.03**	**0.007**	**0.02**	**0.075**	**0.07**	**0.006**		**0.04**	
Cichorium intybus		**0.017**													
Helianthus annus									**0.01**	**0.06**	**0.14**		**0.05**	**0.19**	
Lactuca		**0.001**													
Tanacetum							**0.015**	**0.003**							
Xeranthemum										**0.03**					
Taraxacum				**0.025**			**0.06**								
Boraginaceae															
Boraginaceae type		**0.032**	**3**	**0.93**		**2.33**		**0.45**		**3.3**		**0.06**	**0.2**		
Anchusa								**0.003**							
Echium					**0.06**					**0.06**					
Brassicaceae															
Brassicaceae type	**0.12**	**7.13**	**3**	**3.71**	**13.58**	**3.9**	**3.77**	**5.98**	**8.42**	**10.5**	**12.32**	**35.66**	**20.76**	**16.86**	**24.3**
Rapistrum rugosum		**0.004**								**0.015**					
Raphanus raphanistrum		**2.29**			**2.26**			**3.56**		**1.8**	**2.74**	**0.29**		**10.73**	**5.15**
Sinapis														**0.04**	**0.04**
Brassica								**0.007**							
Isatis								**0.011**							
Capparaceae															
Capparis spinosa	**0.001**	**0.003**		**0.025**		**0.06**				**0.06**		**0.004**			
Chenopodiaceae															
Chenopodium album													**0.02**		**0.26**
Cistaceae															
Cistus							**0.03**			**0.13**					

Cistus salviifolius	**0.042**	**1.03**			**1.13**			**3.18**		**2.4**	**1.37**	**2.59**	**0.99**		
Helianthemum nummularium		**0.006**													
Cucurbitaceae															
Cucurbitaceae type												**0.35**		**3.06**	**5.15**
Citrullus lanatus								**0.02**							
Cucumis sativus								**0.003**				**0.03**			**0.29**
Cucumis melo															**0.26**
Ecballium elaterium		**0.017**					**0.06**								
Cupressaceae															
Cupressus sempervirens												**0.007**			
Ebenaceae															
Diospyros								**0.11**		**0.045**			**0.03**		
Elaeagnaceae															
Elaeagnus angustifolia															**0.04**
Ericaceae															
Erica manipuliflora		**0.064**							**42.09**	**3**		**0.09**		**1.53**	
Arbutus andrachne		**0.16**						**0.076**	**17.52**	**3.3**					
Fabaceae															
Fabaceae type	**0.83**	**0.84**	**15.01**	**9.28**	**9.05**	**14.01**	**47.8**	**4.54**	**7.96**	**2.7**	**16.43**	**23.13**	**15.82**	**30.65**	**24.3**
Astragalus		**0.009**	**0.04**			**0.43**		**0.038**							
Trifolium	**3.79**	**0.45**	**1.5**	**1.85**	**4.53**	**2.33**	**0.63**	**1.89**	**0.68**	**4.8**		**3.18**	**0.4**	**3.06**	**2.21**
Calicotome villosa							**0.047**	**0.015**		**0.21**	**0.14**			**0.11**	
Glycyrrhiza glabra															**0.07**
Sophora						**0.04**				**0.03**					
Lathyrus			**3**	**2.78**		**24.13**		**0.83**					**0.6**		
Medicago						**0.02**									
Vicia				**0.93**				**0.45**		**0.6**				**9.19**	**8.1**
Ceratonia siliqua										**0.34**					
Cicer arietinum															**0.11**
Pisum sativum															**0.15**
Fagaceae															
Quercus		**0.001**													
Quercus coccifera									**0.11**	**0.015**					**0.11**
Hypericaceae															
Hypericum						**0.02**									
Juglandaceae															
Juglans regia		**0.001**						**0.011**							
Lamiaceae															
Lamiaceae type	**0.042**	**3.38**	**4.5**	**4.64**	**4.53**	**9.34**	**9.43**	**2.34**		**18.31**	**21.9**	**28.29**	**9.1**	**7.66**	**8.84**
Lavandula stoechas	**0.001**	**0.003**						**0.003**							
Prunella						**0.02**							**0.04**		
Rosmarinus officinalis															**0.26**
Salvia		**0.001**													
Teucrium		**0.001**				**0.02**						**0.003**			
Thymus						**0.29**	**0.015**								
Thymbra											**0.14**				
Lauraceae															
Laurus nobilis		**0.001**			**0.11**			**0.003**	**0.93**		**0.14**	**0.001**			
Liliaceae															
Liliaceae type	**0.006**	**0.003**		**0.07**		**0.15**	**0.015**	**0.019**	**0.02**	**0.015**	**0.07**	**0.006**	**0.03**		**0.18**
Linaceae															
Linum								**0.011**							
Malvaceae															
Malvaceae type												**0.001**			
Gossypium															**0.11**
Moraceae															
Morus								**0.003**			**0.07**	**0.003**			

Myrtaceae															
Eucalyptus camaldulensis	**0.48**	**0.19**	**3**				**6.29**	**9.24**		**3.6**		**0.26**	**0.6**	**4.6**	**2.21**
Myrtus communis		**1.42**	**1.5**	**10.21**	**1.13**		**3.77**	**5.38**	**1.36**	**2.4**		**0.26**	**13.25**		
Oleaceae															
Olea europaea			**7.5**	**2.78**	**3.39**	**0.78**	**10.7**	**9.39**		**3**	**1.37**		**20.76**		**0.74**
Phillyrea latifolia									**0.4**						
Onagraceae															
Epilopium angustifolium		**0.001**													
Pinaceae															
Pinus brutia	**0.002**							**0.003**							
Cedrus libani						**0.02**									
Poaceae															
Poaceae type	**0.23**	**1.61**			**10.18**	**6.22**	**1.26**	**1.21**	**0.45**	**3.6**	**4.11**	**0.12**	**2.37**	**1.53**	**5.88**
Zea mays			**0.11**					**0.003**			**0.07**		**0.03**		**0.04**
Polygonaceae															
Polygonaceae type		**0.064**				**0.78**		**6.21**	**2.5**			**0.03**		**1.53**	
Rumex								**0.003**					**0.02**		
Rumex acetosella		**0.003**													
Polygonum						**0.04**		**0.1**	**0.09**						
Portulacaceae															
Portulaca oleracea	**0.001**	**0.001**													
Punicaceae															
Punica granatum						**0.02**	**0.03**	**0.003**		**0.015**					
Ranunculaceae															
Ranunculaceae type					**0.03**				**0.06**						
Ranunculus														**0.04**	
Rhamnaceae															
Paliurus spina-christii			**0.19**	**0.07**				**0.24**		**0.16**		**0.003**	**0.02**	**0.04**	
Rosaceae															
Rosaceae type	**0.021**	**0.93**	**1.5**	**3.71**	**6.79**	**25.69**	**10.07**	**0.98**	**0.91**	**5.4**	**4.11**	**0.32**	**4.94**	**3.06**	
Rutaceae															
Citrus							**0.03**			**0.39**		**0.004**		**0.34**	
Citrus aurantium		**0.096**	**3**	**23.2**	**20.37**			**0.83**	**1.82**	**3**		**0.06**			
Citrus limon		**0.001**			**0.06**					**0.015**		**0.003**			
Citrus paradisi								**0.003**					**0.01**		
Citrus nobilis												**0.001**			
Citrus sinensis		**0.032**			**10.18**					**1.5**		**0.59**	**0.4**		
Salicaceae															
Populus		**0.004**													
Solanaceae															
Nicotiana								**0.003**							
Solanum														**1.07**	**1.29**
Lycopersicon esculentum															**0.15**
Thypaceae															
Typha	**0.002**									**0.045**					
Verbenaceae															
Vitex agnus-castus			**0.04**	**0.05**				**0.019**				**0.001**			
Vitaceae															
Vitis vinifera											**0.07**				

Appendix 2. Pollen analytical data of honey samples from the study area

*Samples	Predominant pollen (>45%)	Secondary pollen (16-45%)	Important minor pollen (3-15%)	Minor pollen (<3%)	The total pollen number	Nature of Honey	Maurizio's classes	Feller-Demalsy et al. (1989)
H01	*Petroselinum crispum* (93.62%)		*Trifolium* (3.79%)	Fabaceae type, Apiaceae type, *Eucalyptus camaldulensis*, Poaceae type, Brassicaceae type, Asteraceae type, *Cistus salviifolius*, Lamiaceae type, Rosaceae type, Liliaceae type, *Centaurea*, *Pinus brutia*, *Typha*, *Capparis spinosa*, *Carduus*, *Lavandula stoechas*, *Portulaca oleracea*	**96113**	**Unifloral**	**II**	**normal**
H02	*Petroselinum crispum* (77.2%)		Brassicaceae type (7.13%), Lamiaceae type (3.38%)	*Raphanus raphanistrum*, Apiaceae type, Poaceae type, *Myrtus communis*, *Cistus salviifolius*, Rosaceae type, Fabaceae type, *Trifolium*, Asteraceae type, *Anthemis*, *Eucalyptus camaldulensis*, *Arbutus andrachne*, *Citrus aurantium*, *Erica manipuliflora*, Polygonaceae type, Boraginaceae type, *Citrus sinensis*, *Centaurea*, *Cichorium intybus*, *Ecballium elaterium*, *Astragalus*, *Helianthemum nummularium*, *Populus*, *Rapistrum rugosum*, *Capparis spinosa*, *Lavandula stoechas*, Liliaceae type, *Rumex acetocella*, *Epilobium angustifolium*, *Citrus limon*, *Lactuca*, *Laurus nobilis*, *Portulaca oleracea*, *Salvia*, *Juglans regia*, *Quercus*, *Teucrium*	**62040**	**Unifloral**	**II**	**normal**
H03		Apiaceae type (34.53%)	Fabaceae type (15.01%), *Anthemis* (12.01%), *Olea europaea* (7.5%), Asteraceae type (6%), Lamiaceae type (4.5%), Boraginaceae type (3%), Brassicaceae	*Myrtus communis*, Rosaceae type, *Trifolium*, *Paliurus spina-christii*, *Zea mays*, *Astragalus*, *Vites agnus-castus*	**2664**	**Multifloral**	**I**	**very poor**

			type (3%), *Eucalyptus camaldulensis* (3%), *Citrus aurantium* (3%), *Lathyrus* (3%)					
H04		Apiaceae type (23.2%), *Citrus aurantium* (23.2%)	Asteraceae type (11.14%), *Myrtus communis* (10.21%), Fabaceae type (9.28%), Lamiaceae type (4.64%), Brassicaceae type (3.71%), Rosaceae type (3.71%)	*Lathyrus, Olea europaea, Trifolium, Anthemis*, Boraginaceae type, *Vicia*, Liliaceae type, *Paliurus spina-christii, Vitex agnus-castus, Capparis spinosa, Taraxacum*	**4310**	**Multifloral**	**I**	**very poor**
H05		*Citrus aurantium* (20.37%)	Brassicaceae type (13.58%), Apiaceae type (10.18), *Citrus sinensis* (10.18%), Poaceae type (10.18%), Fabaceae type (9.05%), Rosaceae type (6.79%), Lamiaceae type (4.53%), *Trifolium* (4.53%), *Olea europaea* (3.39%)	Asteraceae type, *Raphanus raphanistrum, Cistus salviifolius, Myrtus communis, Laurus nobilis, Citrus limon, Echium*, Ranunculaceae type	**3535**	**Multifloral**	**I**	**very poor**
H06		Rosaceae type (25.69%), *Lathyrus* (24.13%)	Fabaceae type (14.01%), Lamiaceae type, (9.34%), Asteraceae type (6.22%), Poaceae type (6.22%), Brassicaceae type (3.9%)	Apiaceae type, Boraginaceae type, *Trifolium, Olea europaea*, Polygonaceae type, *Centaurea, Astragalus, Thymus*, Liliaceae type, *Capparis spinosa, Polygonum, Sophora, Cedrus libani, Hypericum, Medicago, Prunella, Punica granatum, Teucrium*	**5138**	**Multifloral**	**I**	**very poor**
H07	Fabaceae type (47.8%)		*Olea europaea* (10.7%), Rosaceae type (10.07%), Lamiaceae (9.43%), *Eucalyptus*	Apiaceae type, Poaceae type, *Trifolium, Ecballium elaterium, Taraxacum, Calicotome villosa, Centaurea, Cistus, Citrus, Punica granatum,* Liliaceae type, *Tanacetum, Thymus*	**6360**	**Unifloral**	**I**	**very poor**

		camaldulensis (6.29%), Brassicaceae type (3.77%), *Myrtus communis* (3.77%), Asteraceae type (3.14%)					
H08	*Petroselinum crispum* (36.05%)	*Olea europaea* (9.39%), *Eucalyptus camaldulensis* (9.24%), Polygonaceae type (6.21%), Brassicaceae type (5.98%), *Myrtus communis* (5.38%), Fabaceae type (4.54%), Apiaceae type (3.67%), *Raphanus raphanistrum* (3.56%), *Cistus salviifolius* (3.18%)	Asteraceae type, Lamiaceae type, *Trifolium*, Poaceae type, Rosaceae type, *Citrus aurantium*, *Lathyrus*, Boraginaceae type, *Vicia*, *Paliurus spina-christii*, *Diospyros*, *Polygonum*, *Anthemis*, *Arbutus andrachne*, *Astragalus*, *Citrullus lanatus*, Liliaceae type, *Vitex agnus-castus*, *Calicotome villosa*, *Isatis*, *Juglans regia*, *Linum*, *Brassica*, *Centaurea*, *Anchusa*, *Citrus paradisi*, *Cucumis sativus*, *Laurus nobilis*, *Lavandula stoechas*, *Morus*, *Nicotiana*, *Pinus brutia*, *Punica granatum*, *Rumex*, *Tanacetum*, *Zea mays*	**26406**	**Multifloral**	**II**	**normal**
H09	*Erica manipuliflora* (42.09%), *Arbutus andrachne* (17.52%)	Asteraceae type (9.78%), Brassicaceae type (8.42%), Fabaceae type (7.96%), Apiaceae type (3.41%)	Polygonaceae type, *Citrus aurantium*, *Myrtus communis*, *Anthemis*, *Laurus nobilis*, Rosaceae type, *Trifolium*, Poaceae type, *Phillyrea latifolia*, *Pistacia terebinthus*, *Quercus coccifera*, *Polygonum*, Ranunculaceae, *Centaurea*, Liliaceae type, *Helianthus annus*	**8791**	**Multifloral**	**I**	**very poor**

H10	Apiaceae type (20.11%), Lamiaceae type (18.31%)	Brassicaceae type (10.5%), Rosaceae type (5.4%), *Trifolium* (4.8%), *Eucalyptus camaldulensis* (3.6%), Poaceae type (3.6%), *Arbutus andrachne* (3.3%), Boraginaceae type (3.3%), *Citrus aurantium* (3%), *Erica manipuliflora* (3%), *Olea europaea* (3%)	Fabaceae type, *Anthemis*, *Cistus salviifolius*, *Myrtus communis*, Asteraceae, *Raphanus raphanistrum*, *Citrus sinensis*, *Vicia*, *Citrus*, *Ceratonia siliqua*, *Calicotome villosa*, *Paliurus spina-christii*, *Cistus*, *Pistacia terebinthus*, *Centaurea*, *Capparis spinosa*, *Echium*, *Helianthus annus*, *Diospyros*, *Typha*, *Sophora*, *Xeranthemum*, *Citrus limon*, Liliaceae type, *Quercus coccifera*, *Rapistrum rugosum*	**6664**	**Multifloral**	**I**	**very poor**
H11	Asteraceae type (24.64%), Lamiaceae type (21.9%), Fabaceae type (16.43%)	Brassicaceae type (12.32%), Apiaceae type (9.58%), Poaceae type (4.11%), Rosaceae type (4.11%)	*Raphanus raphanistrum*, *Cistus salviifolius*, *Olea europaea*, *Calicotome villosa*, *Helianthus annus*, *Laurus nobilis*, *Thymbra*, *Aster*, *Centaurea*, Liliaceae type, *Morus*, *Vitis vinifera*, *Zea mays*	**1461**	**Multifloral**	**I**	**very poor**
H12	Brassicaceae type (35.66%), Lamiaceae type (28.29%), Fabaceae type (23.13%)	Apiaceae type (4.6%), *Trifolium* (3.18%)	*Cistus salviifolius*, *Citrus sinensis*, Cucurbitaceae type, Rosaceae type, *Raphanus raphanistrum*, *Eucalyptus camaldulensis*, *Myrtus communis*, Poaceae type, *Erica manipuliflora*, Boraginaceae type, *Citrus aurantium*, *Cucumis sativus*, Polygonaceae type, *Cupressus sempervirens*, *Centaurea*, Liliaceae type, *Capparis spinosa*, *Citrus*, *Citrus limon*, *Morus*, *Paliurus spina-christii*, *Teucrium*, *Citrus nobilis*, *Laurus nobilis*, Malvaceae type, *Vitex agnus-castus*	**67864**	**Multifloral**	**II**	**normal**
H13	Brassicaceae type (20.76%), *Olea europaea* (20.76%)	Fabaceae type (15.82%), *Myrtus communis* (13.25%), Lamiaceae type (9.1%), Apiaceae type (7.32%),	Poaceae type, Asteraceae, *Cistus salviifolius*, *Eucalyptus camaldulensis*, *Lathyrus*, *Citrus sinensis*, *Trifolium*, Boraginaceae type, *Helianthus annus*, *Prunella*, *Diospyros*, Liliaceae type, *Zea mays*, *Chenopodium album*, *Paliurus*	**10114**	**Multifloral**	**I**	**very poor**

		Rosaceae type (4.94%)	*spina-christii, Rumex, Citrus paradisi*				
H14	Fabaceae type (30.65%), Brassicaceae type (16.86%)	*Raphanus raphanistrum* (10.73%), *Vicia* (9.19%), Lamiaceae type (7.66%), Asteraceae type (4.6%), *Eucalyptus camaldulensis* (4.6%), Cucurbitaceae type (3.06%), Rosaceae type (3.06%), *Trifolium* (3.06%)	*Erica manipuliflora*, Poaceae type, Polygonaceae type, *Solanum, Helianthus annus, Calicotome villosa, Centaurea, Paliurus spina-christii, Ranunculus, Sinapis*	**2610**	**Multifloral**	**I**	**very poor**
H15	Brassicaceae type (24.3%), Fabaceae type (24.3%)	Lamiaceae type (8.84%), *Vicia* (8.1%), Apiaceae (6.63%), Poaceae type (5.88%), Cucurbitaceae type (5.15%), *Raphanus raphanistrum* (5.15%)	Asteraceae type, *Eucalyptus camaldulensis, Trifolium, Solanum, Olea europaea, Cucumis sativus, Chenopodium album, Cucumis melo, Rosmarinus officinalis*, Liliaceae type, *Lycopersicon esculentum, Pisum sativum, Cicer, Gossypium, Quercus coccifera, Glycyrrhiza glabra, Elaeagnus angustifolia, Sinapis, Zea mays*	**2716**	**Multifloral**	**I**	**very poor**

*__**The localities of honey sample collection**__:
H01: Üçgüllük village-Arsuz, 28.05.2013; **H02**: Kale village-İskenderun, 29.06.2013; **H03**: Turunçlu village-Erzin, 30.06.2013; **H04**: Gökdere village-Erzin, 30.06.2013; **H05**: Dörtyol (Center), 30.06.2013; **H06**: Katranlı village-Hassa, 30.06.2013; **H07**: Bektaşlı village-Kırıkhan, 01.07.2013; **H08**: Gözlüce village-Yayladağı, 01.07.2013; **H09**: Keldağ-Yayladağı, 01.07.2013; **H10**: Meydan village-Samandağ, 02.07.2013; **H11**: Uzunalıç village-Serinyol, 06.07.2013; **H12**: Karlısu-Antakya, 17.08.2013; **H13**: Babatorun village-Altınözü, 15.07.2013; **H14**: Davutpaşa village-Reyhanlı, 03.07.2013; **H15**: Konuk village-Reyhanlı, 03.07.2013

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Research article/Araştırma makalesi

Karyotype of the Black Sea Turbot, *Scophthalmus maeoticus* (Pallas 1814) (Pisces: Pleuronectiformes)

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Abstract

In this study, using conventional staining method, chromosome structures and numbers of Black Sea turbot *Scophthalmus maeoticus* (Pallas 1814), a species of flatfish living in the Black Sea, have been examined. The specimens of the fish were obtained through fishing in regions between the coasts of West and Middle Black Sea of Turkey. It was determined that *S. maeoticus* had a diploid number chromosomes of 2n= 44 and a fundamental number of NF= 48. The karyotpe of turbot contained 2 pairs of metacentric, 7 pairs of subtelocentric and 13 pairs of acrocentric chromosomes.

Key words: *Scophthalmus maeoticus*, turbot, The Black Sea, chromosome, cytotaxonomy

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Karadeniz Kalkan Balığının, *Scophthalmus maeoticus* (Pallas 1814) (Pisces: Pleuronectiformes) Karyotipi

Özet

Bu çalışmada geleneksel boyama metou kullanılarak Karadeniz'de yaşayan yassı balıkların bir türü olan Karadeniz Kalkanı *Scophthalmus maeoticus* (Pallas 1814)'un kromozom yapıları ve sayıları incelenmiştir. Balık örnekleri Türkiye'nin Batı ve Orta Karadeniz kıyıları arasında kalan bölgeden avcılık yoluyla elde edilmiştir. *S. maeoticus*'un 2n=44 diploid kromozoma sahip olduğu ve kromozom kol sayısının da NF=48 olduğu tespit edilmiştir. Kalkan balığının karyotipinin 2 çift metasentrik, 7 çift subtelosentrik ve 13 çift akrosentrik kromozom içerdiği belirlenmiştir.

Anahtar kelimeler: *Scophthalmus maeoticus*, kalkan balığı, Karadeniz, kromozom,sitotaksonomi

1. Introduction

Fish species are classified in many ways including the use of morphometric measurements and ratios, meristic counts, anatomical characteristics, color, reproductive isolation tests as well as the karyotype and DNA analyses. Karyotype analysis is one of the methods that has been used in ichthyology since the mid-20th century that is especially applied for the classification of the taxon but this may lead to some identical problems, confused with the other turbot species, especially Atlantic turbot (*Scophthalmus maximus*) due to some morphological similarities. Karyotype of species represents the physical demonstration of the genetic system. The number and morphology of chromosomes are conserved to a further and better extent relative to such other traits (Watson et al., 2013).

Traditionally, flatfish are classified as halibut and flounder with a right and left eye. It is argued hypothetically that halibut and scald fish evolved from ancestors analogous to Psettods and the form of a right and left eye emerged from a rather primitive ancestor (Berendzen and Dimmick, 2002). As knowledge on this subject grows, the process of understanding the inter-relation of flatfish becomes more complicated. The side with the eye stands as a significant characteristic in terms of classification. The first scientist to claim the alternative hypothesis was Chapleau (1993) who stated the side with the eye is mostly determinative for flatfish but the condition of the eye is not an exact determinative of the inter-relations within the group. As a result of a molecular study conducted by Berendzen and Dimmick (2002) the conclusion was reached that the knowledge or the determination of the side with the eye does not suffice to derive phylogenic knowledge.

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In the world, about 772 alive species are identified in approximately 129 genera and 14 families within the Pleuronectiformes order (Nelson et al., 2016). Turbot were classified as part of the Bothidae family until the 1970s; however they are currently classified in Scophthalmidae (turbot) (Nelson et al., 2016). While four genera, these being *Lepidorhombus*, *Phrynorhombus*, *Scophthalmus* and *Zeugopterus* are represented in eight or nine species worldwide (Nelson et al., 2016; Froese and Pauly, 2017), 5 species of them in 3 genera were reported to be in Turkey's seas (Akşıray, 1987; Bilecenoğlu et al., 2014). There are twelve studies known to be on chromosomes of three species of the Scophthalmidae family (Klinkhardt, 1995; Arai, 2011). As a result of the taxonomic, morphological and phylogenic analysis conducted (Froese and Pauly, 2017; Borsa, and Quignard, 2001), it was reported that the Black Sea turbot, which is systematically recognized and classified as *Psetta maxima* (Suzuki et al., 2004), was, in fact, *Scophthalmus maeoticus* (Pallas 1814) because this taxon name is used to as usual synonymous of *S. maeoticus* (Froese and Pauly, 2017; GBIF, 2017). However, it was used *Rhombus maeoticus*, one of old synonymous of *S. maeoticus*, in previous two old studies conducted by Ivanov (1969) and Vasiliev (1985).

Since the 1980s cytogenetic studies, which have been carried out intensively in human-beings and other organisms, have also been carried out at the same rapidity in fishes. Of these, approximately twelve studies related to flatfish were focused to determine chromosomes of species belonging to the Scophthalmidae family. Some of them are not only related directly as karyotype purpose but also used to determine the ploidy of fishes in aquaculture because of reporting only chromosome number of experimented species in these studies.

This study intends to determine the karyotype of the turbot, *Scophthalmus maeoticus* (Pallas 1814) of the Scophthalmidae family, and to reveal the species-specific differences in the chromosome structures.

2. Materials and methods

The study was conducted along the coastline between Cape Çam, Ordu in the East (41°06′998N–37°47′169E) and Cape Ölüce, Zonguldak (41°18′826N–31°23′833E). The specimens were collected in Zonguldak, Bartın, Ayancık and Sinop from fishermen (Figure 1). Six turbot specimens obtained from the hatchery of the Trabzon Central Fishery Research Institute (CFRI) were also used in the study.

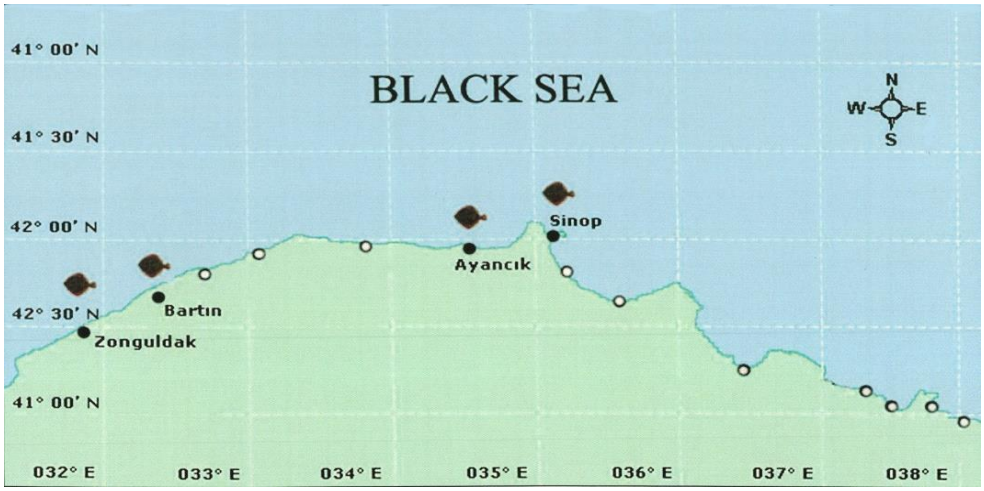

Figure 1. In the study, the map shows the sampling stations of Black Sea turbot

The mitotic chromosomes were analyzed in total 26 turbot specimens of various sizes. The specimens were transferred to laboratories alive and kept in well-aired containers. Figures 2 a, b and c demonstrate the thorn-like bone structures on both sides, which are specific to the *S. maeoticus* species sampled as a part of this study. Bony tubercles generally developed on both sides, which are always larger than eye as shown in Figure 2. d, e, f and g, as defined in some references (Nielsen, 1986; Samsun et al., 2005). By modifying the method followed by Denton (1973), we undertook our preliminary trials in research, mitotic inhibition, dissection and the hypotonic application process. Kligerman and Bloom's (1977) method was used for chromosome preparation of the solid tissues(gills and fins) ; the dried preparations were stained with 6% Giemsa solution (pH 6.8 phosphate buffer) for 15 minutes. After this process, a microscopic examination of the Giemsa stained slides was carried out. With the aim of counting and determining type of chromosomes, the Nikon Eclipse™ EC600 phase contrast microscope was used for the observations of at least the best ten metaphase on the slides prepared from each specimen. The suitable metaphase plates in the preparations were identified in 10× magnification and then in 100× magnification with immersion oil and metaphase chromosomes were observed (Denton, 1973).

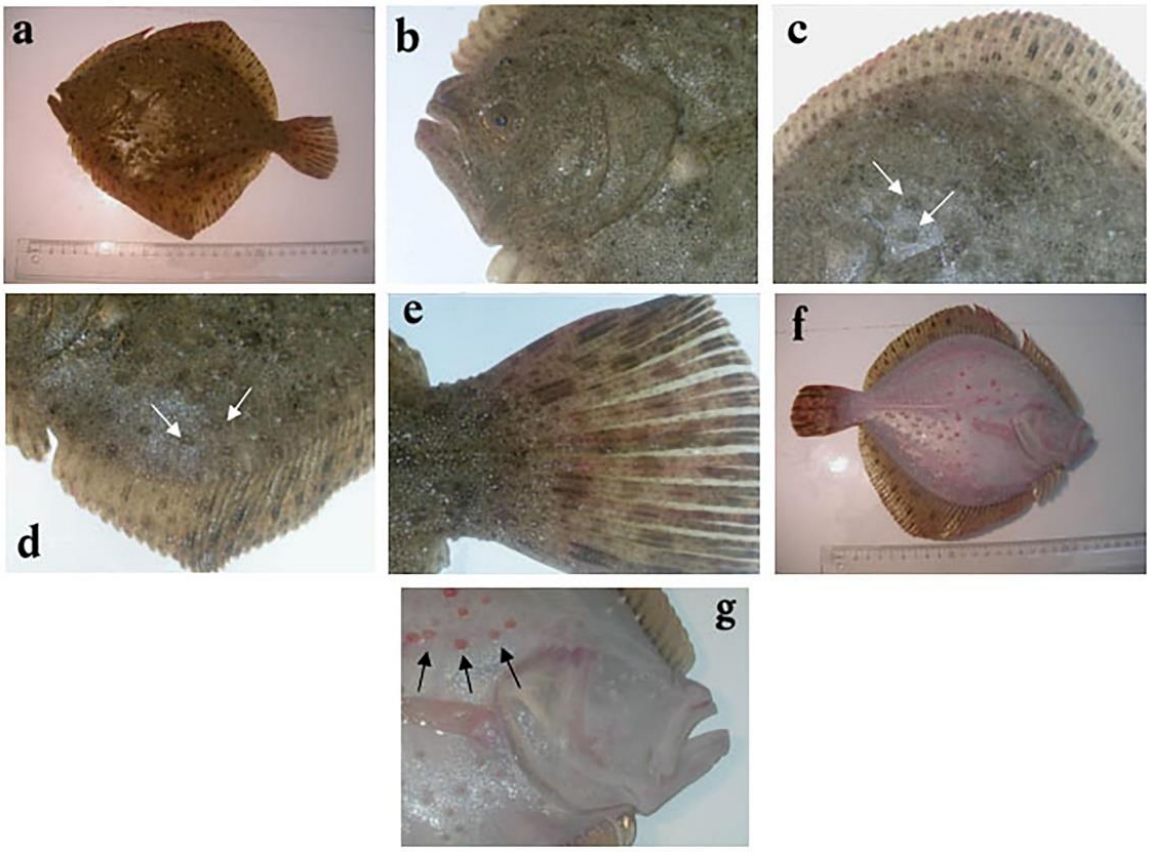

Figure 2. Morphology of the turbot sampled in the study: a- The upper left side (eyed side); b- Head and eyes; c-, d-, e- (respectively) Dorsal, anal and caudal side and fins; f- The lower right side (eyeless side); g- Gills (eyeless side) (species specific thorns-bony scales located on both sides of the fish were indicated by arrows)

Photographs of each sample were taken at a minimum 100 metaphase (Thorgaard and Disney, 1990) via a CCD camera (Pixelink™ Megapixel FireWire Camera, Vitana Corp.), which was connected to a microscope and then transferred to a computer during the microscopic investigation. The chromosomes were counted on the best metaphase images, with the data converted into graphic expressions; and the numbers of diploid chromosomes of the turbot samples at each sampling stations were determined (Denton, 1973; Thorgaard and Disney, 1990).

Among the photographs taken with the microscope, the relative arm lengths of the most available metaphase chromosomes were measured using MicroMeasure© (Version 3.3 PC Software) (Reeves, 2001; Jankun et al. 2003, Karahan, 2016). Chromosome morphology was ascertained on the basis of arm ratio as suggested by Levan et al. (1964) and the chromosomes were classified as metacentrics (m), submetacentrics (sm) and acrocentrics (a) or telocentrics (t). NF (chromosome arm number) was determined considering m/sm chromosomes to have two arms and t/a chromosomes to have one arm (Denton, 1973; Thorgaard and Disney, 1990; Oliveira and Gosztonyi, 2000). Adobe Photoshop® was used for the preparation of the karyograms and ideograms (Çetin et al., 2010).

3. Results

In this study, the number and shape of the diploid chromosomes of turbot, *Scophthalmus maeoticus* (Pallas 1814), which is the only Scophthalmidae species among the flatfish (Pleuronectiformes) species inhabiting in the Black Sea were determined.

A total of 727 metaphase plates obtained from twenty six turbot specimens collected from study area and reared in Institute of CFR were examined in this study. The karyotype of *S. maeoticus* had a diploid chromosome number of 2n= 44 chromosomes, and a fundamental number of NF =48. It consisted of 2 pairs of metacentric (m), 7 pairs of subtelocentric (st) and 13 pairs of acrocentric (a) chromosomes. Metaphase plate and karyogram of the species are given in Figures 3 and 4.

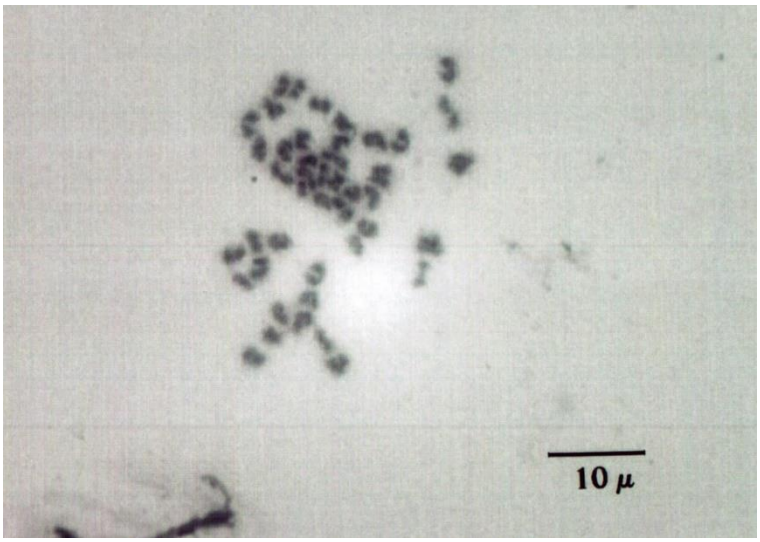

Figure 3. The metaphase plate of *Scophthalmus maeoticus*

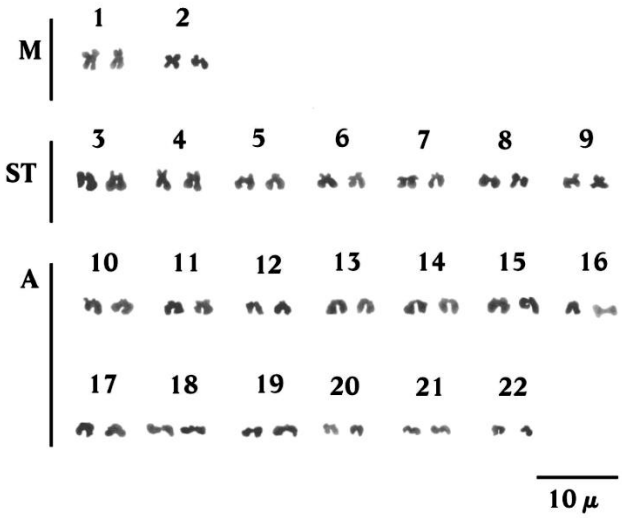

Figure 4. Karyotype of *Scophthalmus maeoticus*

The ideogram of *S. maeoticus* was created by the relative arm length ratios of chromosomes. Figure 5 shows the ideogram drawn up with respect to the relative short arm (p) and relative long arm (q) lengths of the chromosomes

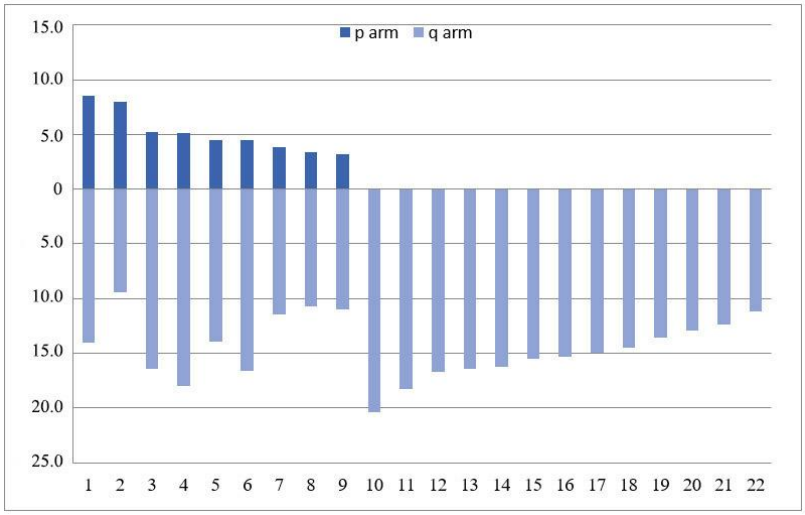

Figure 5. The ideogram of *Scophthalmus maeoticus*

4. Conclusions and discussion

It has been known to be some taxonomic problems in the solution of the relationships within the Pleuronectiformes order which has a structure that makes it difficult to work morphologically and in making a classification that reflect their affinities (Berendzen and Dimmick, 2002). However, it has been understood that the studies enabled the determination of cytotaxonomic information will make a significant contribution to the taxonomy, in addition to the systematic and molecular genetic information of the Scophthalmidae family. As a result of the cytogenetic studies, important and uncertain differences among the species of the family were detected, as can be seen in Table 1. This study, conducted on the Black Sea turbot, determined; the number of diploid chromosomes of the studied species was 2n= 44, while the karyotype consists of four metacentric, fourteen subtelocentric and twenty six acrocentric chromosomes, and the number of arms was determined as NF= 48.

Only three turbot species out of the Scophthalmidae family were studied cytogenetically (Table 1). One of these studies was reported *Rhombus maeoticus* as synonymous of the species belonging to *Scophthalmus* genus inhabit in the Black Sea and determined the number of diploid chromosomes as 2n= 40 - 48, and indefinitely determined the number of chromosome arms as NF= 60 (Ivanov, 1969), another study determined the same as 2n= 40 NF= 48 (Vasiliev, 1985). While results were observed for *Scophthalmus maximus*, which is the most intensively studied species, as 2n= 44, K= 4m+ 2sm-st+ 10st+ 28a (NF= 48) (Bouza et al., 1994; Piferrer et al., 2000); 2n= 44, K= 4m+ 22st+ 38a (27), 2n= 44, K= 4m+ 12st+ 28a (Chen et al., 2005) and 2n= 44 diploid (Castro et al., 200; Wang et al., 2010); the values found as 2n= 44, K= 4m+ 12st+ 28a and NF= 48 (Pardo et al., 2001) for *S. rhombus*. The results were reported by Fan et al. (2010) as a consequence of the cytogenetic study carried out on the basis of cell culture on *S. maximus* and were reported as 2n= 44 chromosomes and the karyotype as 4m+ 2sm+ 10st+ 28t. However, Taboada et al. (2014) explained the number of diploid chromosomes as 2n= 44 and the karyotype as 3 pairs of m/sm and 19 pairs of st/a of *S. maximus* as a result of the study conducted by the latest and most advanced cytogenetic analysis method available (FISH with BAC clones) for the mapping of the chromosomes. The study results are similar to the diploid chromosome numbers yielded through both studies and are consistent with the karyotype determined (Table 1).

Table 1. An outline of some cytogenetic and karyological studies reported in Scophthalmidae family (2n: Diploid chromosome number, NF: Number of Fundamental= Total arm number)

Species	**Location**	**2n**	**NF**	**Karyotype**	**References**
Rhombus (*Scophthalmus*) *maeoticus*	Black Sea - Russia	40-48	60?		Ivanov (1969)
Rhombus (*Scophthalmus*) *maeoticus*	Black Sea - Russia	44	48		Vasiliev (1985)
Scophthalmus maeoticus	Black Sea-Turkey	44	48	4m+ 14st+ 26a	In this study
Scophthalmus rhombus	Spain	44	48	4m+ 2sm+ 38a	Pardo et al. (2001)
Scophthalmus maximus	Spain	44	48	4m+ 2sm/st+ 10st+ 28a	Bouza et al. (1994)
Scophthalmus maximus	Spain	44	48	4m+ 2sm/st+ 10st+ 28a	Piferrer et al. (2000)
Scophthalmus maximus	Spain	44	48	4m+ 22st+ 18a	Cunado et al. (2001)
Scophthalmus maximus	China	44	48	4m+ 12st+ 28a	Chen et al. (2005)
Scophthalmus maximus	Spain	44			Castro et al. (2003)
Scophthalmus maximus	China	44			Wang et al. (2010)
Scophthalmus maximus	China	44	60	4m+ 2sm+ 10st+ 28t	Fan et al. (2010)
Scophthalmus maximus	Spain	44		6m/sm+ 38st/a	Taboada et al. (2014)

This study showed a similarity in the results as those conducted on turbot in terms of the diploid chromosome number and fundamental number except the study carried out by Ivanov (1969) in the Black Sea (Russia). It also showed

similar results in regards to the number of metacentric chromosomes (4m) as all of the other studies with *S. maximus* except for the study carried out by Taboada et al. (2014). Differences were also seen in regards to the number of subtelocentric and acrocentric chromosomes compared to the studies undertaken by Cunado et al. (2001) and Chen et al. (2005). However, the karyotype derived from this study was determined to be different with those determined by Bouza et al. (1994), Piferrer et al. (2000) and Pardo et al. (2001) in terms of 1 pair of submeta-subtelocentric (sm/st) and acrocentric (a) chromosomes even though it is fairly similar to the same (Table 1). The results of the study reveal that the Black Sea turbot, *Scophthalmus maeoticus*, is a separated species from the Atlantic turbot (*S. maximus*).

In terms of the number of diploid chromosomes, this study showed similar results as those submitted by Ivanov (1969) and Vasiliev (1985), however, as they failed to definitively determine the karyotypes in their studies a precise comparison could not be made. It was stated within both studies, conducted in the Black Sea, that the species *R. maeoticus* could, taxonomically a synonym, be *Psetta maxima maeotica* or *P maxima*, being a sub-species of *Scophthalmus maeoticus* (Froese and Pauly, 2017).

Suzuki et al. (2004) stated within their study that the results of the genetic analysis (mitochondrial DNA analysis) conducted on the individuals of *Psetta maxima*, commonly known as the Mediterranean Sea turbot, exist in the Atlantic Ocean, the Mediterranean Sea, the Aegean Sea, the Marmara Sea and the Black Sea (the Sea of Azov, Turkish coasts and Romanian coasts) indicate a separated species. They also state that the genetic distance between separate *P. maxima* populations was fairly slight despite the geographic differences, and that the species live in the Black Sea was *P. maxima*, and that the molecular analysis conducted did not support the assumption about a local species or a sub-species, the assumption of which is based on the taxonomic studies (on the basis of the diameter and number of the osteoid apophysis) that have been conducted so far. On the other hand, it is currently reported by taxonomists that the Black Sea turbot is classified into the *Scophthalmus* genus, and is an individual and separated species, referred to as *Scophthalmus maeoticus* (Pallas 1814) (Whitehead 1986; Evseenko, 1996; Eschemeyer, 1998; Froese and Pauly, 2017; GBIF, 2017).

In light of the information above, we believe that the polymorphism in the chromosome numbers and shapes observed in the turbot might have arisen out of the fact that the populations studied were different, the intraspecific and interspecific variations and the fact that there were technical differences as well as differences among the methods and tools used for the purpose of analysis. Since the chromosome sizes are fairly small and issues are encountered in serial banding or staining (Cunado et al., 2001) there are several challenges that occur with the cytogenetic analysis of the flatfish chromosomes (Pleuronectiformes). It was stated that, therefore, it was natural to experience difficulties in the classification of chromosomes, which leads to an expectable outcome of yielding different karyotypes even in the case of the same species (Denton, 1973, Thorgaard and Disney, 1990; Cunado et al., 2001).

In conclusion, there has been a vast plurality of the cytotaxonomic assertions and studies involving chromosome analysis conducted to date in Turkey on freshwater fish species. However, there have been an insignificant number of studies carried out on saltwater fish. This is due to the fact that it is relatively easier to acquire and collect freshwater fish species and to keep them alive compared to saltwater fish species. This study is the first to determine the number of diploid chromosomes of and define the karyotype for the Black Sea turbot, *Scophthalmus maeoticus*, which is a saltwater fish.

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References

Akşıray, F. (1987). Türkiye Deniz Balıkları ve Tayin Anahtarı. İstanbul: İstanbul Üniversitesi Yayınları No: 3490.

Arai, R. (2011). Fish Karyotypes: A Check List. Japan: Springer Publication.

Berendzen, P.B., Dimmick, W.W. (2002). Phylogenetic relationships of Pleuronectiformes based on molecular evidence. Copeia, 3, 642-652.

Bilecenoğlu, M., Kaya, M., Cihangir, B., Çiçek, E. (2014). An updated checklist of the marine fishes of Turkey. Turkish Journal of Zoology, 38, 901-929.

Borsa, P., Quignard, J.P. (2001). Systematics of the Atlantic-Mediterranean soles *Pegusa impar*, *P. lascaris*, *Solea aegyptiaca*, *S. senegalensis*, and *S. solea* and *S. solea* (Pleuronectiformes: Soleidae). Canadian Journal of Zoology, 79, 2297-2302.

Bouza, C., Sanchez, L., Martinez, P. (1994). Karyotypic characterization of turbot (*Scophthalmus maximus*) with conventional fluorochrome and restriction endonuclease banding techniques. Marine Biology, 120, 609-613.

Castro, J., Bouza, C., Sanchez, L., Cal, R.M., Piferrer, F., Martinez, P. (2003). Gynogenesis Assessment Using Microsatellite Genetic Markers in Turbot (*Scophthalmus maximus*). Marine Biotechnology, 5, 584–592.

Çetin, Ö., Martin, E., Duran, A., Özdemir, A. (2010). Karyological study on endemic *Astragalus stereocalyx* Bornm. (Milk-vetch) in Turkey. Biological Diversity and Conservation, 3(3), 153-157.

Chapleau, F., (1993). Pleuronectiform relationships: a cladistic reassessment. Bulletin of Marine Science, 52, 516-540.

Chen, S.L., Ren, G.C., Sha, Z.X., Hong, Y. (2005). Development and characterization of a continuous embryonic cell line from turbot (*Scophthalmus maximus*). Aquaculture, 249, 63-68.

Cunado, N., Terrones, J., Sanchez, L., Martinez, P., Santos, J.L. (2001). Synaptomeal complex analysis in spermatocytes and oocytes of turbot, *Scophthalmus maximus* (Pisces, Scophthalmidae). Genome, 44, 1143-1147.

Denton, T.E. (1973). Fish Chromosome Methodology. NewYork: Charles C. Thomas Publisher.

Eschemeyer, W.N. (1998). Catalog of Fishes, Volume I, II and III. San Francisco: California Academy of Sciences.

Evseenko, S.A. (1996). Ontogeny and relationships of the flatfishes of the Southern Ocean (Achiropsettidae, Pleuronectoidei). Journal of Ichthyology, 36, 687-712.

Fan, T.J., Ren, B.X., Geng, X.F., Yu, Q.T., Wang, L.Y. (2010). Establishment of a turbot fin cell line and its susceptibility to turbot reddish body iridovirus. Cytotechnology, 62, 217-223.

Froese, R., Pauly, D. (2016). Fishbase. http://www.fishbase.org version. (Accessed: 06 Aug 2017)

GBIF (2017). GBIF Backbone Taxonomy. World Wide Web Electronic Publication http://www.gbif.org/species/2409419. doi:10.15468/39omei (Accessed 06 Aug 2017)

Ivanov, B.N. (1969). The chromosomes of the Black Sea flatfish *Rhombus maeoticus* Pallas. Doklady Biological Sciences, USSR, 187, 1397-1399.

Jankun, M.K., Ocalewicz, B.G., Pardo, P., Martinez, P., Woznicki, P., Sanchez, L. (2003). Chromosomal characteristics of rDNA in European grayling *Thymallus thymallus* (Salmonidae). Genetica, 119, 219-224.

Karahan, A. (2016). Karyotype analysis and chromosome banding of Upeneus moluccensis (Bleeker, 1855) from the north-eastern Mediterranean. Caryologia, 69(2), 141-146.

Kligerman, A.D., Bloom, S.E. (1977). Rapid chromosome preparations from solid tissues of fishes. Journal of the Fisheries Research Board of Canada, 34, 266-269.

Klinkhardt, M.B.,Tesche, M., Greven, H. (1995). Database of Fish Chromosomes. Magdeburg: Westarp Wissenchaften Verlag Wolf Graf von Westarp.

Levan, A., Fredga, K., Sandberg, A.A. (1964). Nomenclature for centromeric position on chromosomes. Hereditas, 52, 201-220.

Nelson, J.S., Grande, T., Wilson, M.V.H. (2016). Fishes of the World. 2nd ed. Hoboken, New Jersey: John Wiley and Sons Inc.

Nielsen, J.G. (1986). Scophthalmidae. In: Fishes of the North-eastern Atlantic and the Mediterranean, Vol. III, pp. 1287-1293. Paris: UNESCO publ.

Oliveira, C., Gosztonyi, A.E. (2000). A cytogenetic study of *Diplotnystes mesembrinus* (Teleostei, Siluriformes, Diplomystidae) with a discussion of chromosome evolution in siluriforms. Caryologia, 53(1), 31-37.

Pardo, B.G., Bouza, C., Castro, J., Martinez, P., Sanchez, L. (2001). Localization of ribosomal genes in Pleuronectiformes using Ag-, CMA_3-banding and *in situ* hybridization. Heredity, 86, 531-536.

Piferrer, F., MªCal, R., Álvarez-Blázquez, B., Sánchez, L., Martinez, P. (2000). Induction of triploidy in turbot (*Scophthalmus maximus*) I. Ploidy determination and the effects of cold shocks. Aquaculture, 188, 79-90.

Reeves, A. (2001). MicroMeasure: A new computer program for the collection and analysis of cytogenetic data. Genome, 44, 439-443.

Samsun, N., Kalaycı, F., Samsun, S. (2005). The Determination of Biologic and Morphologic Characteristics of Turbot (*Scophthalmus maeoticus* Palas, 1811) Caught in The Sinop Region. Turkish Journal of Aquatic Life, 3(4), 57-64.

Suzuki, N., Nishida, M.K., Yoseda, K., Üstündağ, C., Şahin, T., Amaoka, K. (2004). Phylogeographic relationships within the Mediterranean turbot inferred by mitochondrial DNA haplotype variation. Journal of Fish Biology, 65, 580-585.

Taboada, X., Pansonato-Alves, J.C., Foresti, F., Martínez, P., Viñas, A., Pardo, B.G., Bouza, C. (2014). Consolidation of the genetic and cytogenetic maps of turbot (*Scophthalmus maximus*) using FISH with BAC clones. Chromosoma, 123, 281-291.

Thorgaard, G.H., Disney, J.E. (1990). Chromosome Preparation and Analysis. In: Methods for Fish Biology, pp. 171-190. Bethesda, Maryland: American Fisheries Society.

Vasiliev, V.P. (1985). Evolutionary karyology of fishes. Moscow: Publishing House Nauka.

Wang, N., Wang, X.I., Sha, Z.X., Tian, Y.S., Chen, S.I. (2010). Development and characterization of a new marine fish cell line from turbot (*Scophthalmus maximus*). Fish Physiology and Biochemistry, 36, 1227-1234.

Watson, J.D., Gann, A., Baker, T.A., Levine, M., Bell, S.P., Losick, R., Harrison, S.C. (2013). Molecular biology of the gene. Cold Spring Harbor, New York: Cold Spring Harbor Laboratory Press.

Whitehead, P.J.P. (1986). Fishes of the NE Atlantic and the Mediterranean, Vol. 1. Rome: UNESCO Publ.

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Brown, L. F., Yeo, K., Berse, B., Yeo, T. K., Senger, D. R., Dvorak, H. F., Van De Water, L. (1992). **Expression of vascular permeability factor**. The Journal of Experimental Medicine, 176(5), 1375-1379.

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Eroğlu, G., Kaşik, G., Öztürk, C. (2015). **Three new myxomycete records from Turkey**. Biological Diversity and Conservation, 8(1), 16-18.

Brown, L. F., Yeo, K., Berse, B., Yeo, T. K., Senger, D. R., Dvorak, H. F., Van De Water, L. (1992). **Expression of vascular permeability factor**. The Journal of Experimental Medicine, 176(5), 1375-1379.

Kitaptan kaynak gösterimi/ Books

Berkes, F. ve Kışlalıoğlu, M. (1990). **Ekoloji ve çevre bilimleri**. İstanbul: Remzi Kitabevi.

Langlais, B., Reckhow, D. A., Brink, D. R. (1991). **Ozone in water treatment**. London: CRC Press.

Çeviri kitaptan kaynak gösterimi/ Translation books

Graham, L., Graham, J. M., Wilcox, L. (2004). **Bitki biyolojisi** (Işık, K., Yıldız, M.). Ankara: Palme Yayınları.
Keeton, W. T., Gould, J. L., Gould, C. G. (2004). **Genel biyoloji** (Demirsoy, A., Türkan, İ., Gündüz, E.). Ankara: Palme Yayıncılık.

Yazarı belli olmayan kaynaktan kaynak gösterimi/The authors are not certain references

Anonim (1998). **Biyoloji terimleri sözlüğü**. Ankara: Türk Dil Kurumu Yayınları.

İnternetten kaynak gösterimi/ Internet

Environment Canada. (2004). **The peregrine falcon survey in Canada**. U. Banasch and G. Holroyd (Eds). (Occasional Paper no. 110). http://www.cws-scf.ec.gc.ca/publications (Erişim tarihi: 26.06.2016).
Browning, T. (1993). **A brief historical survey of women writers of science fiction**. http://www.cwrl.utexas.edu/~tonya/Tonya/sf/history.html (Erişim tarihi: 26.06.2016).
Anonim (2011). **Ulusal hububat konseyi çeltik raporu**. http://uhk.org.tr/ (Erişim tarihi: 26.06.2016).

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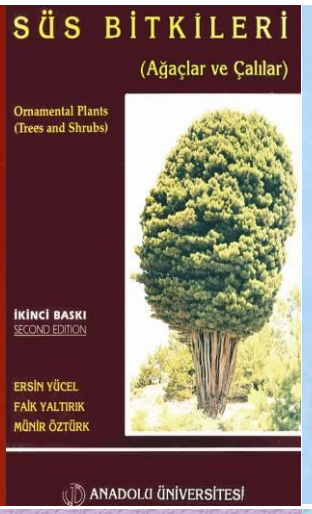

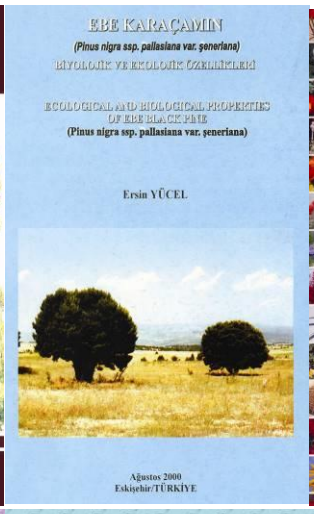

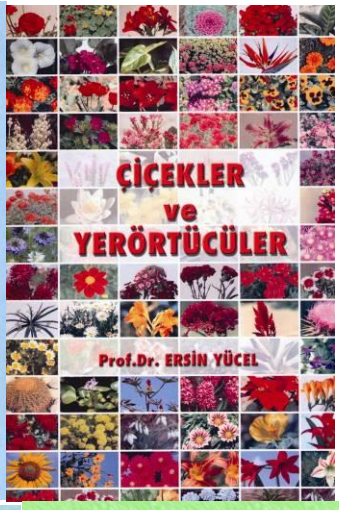

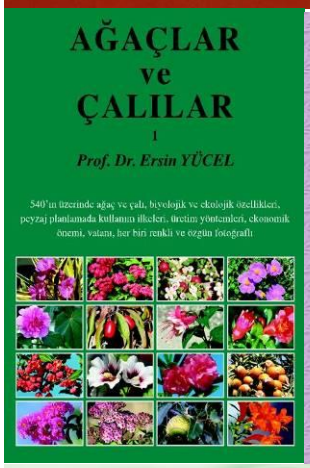

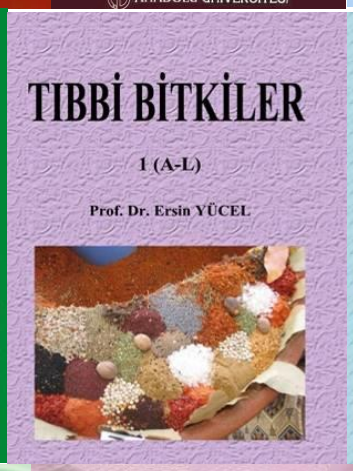

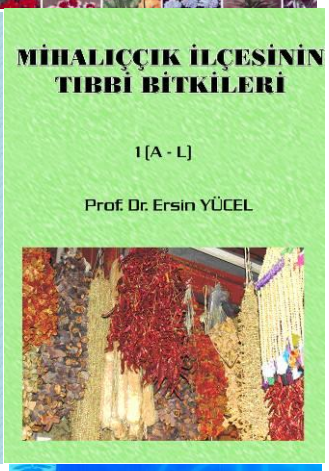

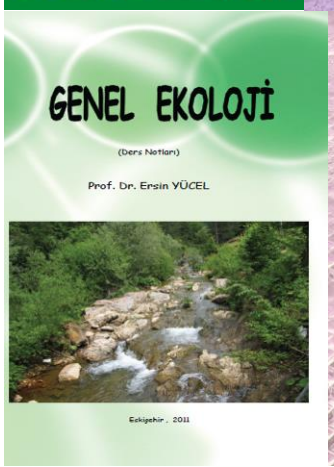

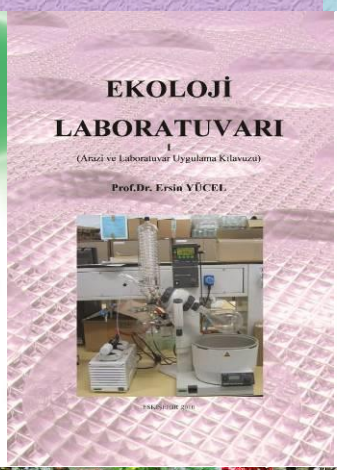

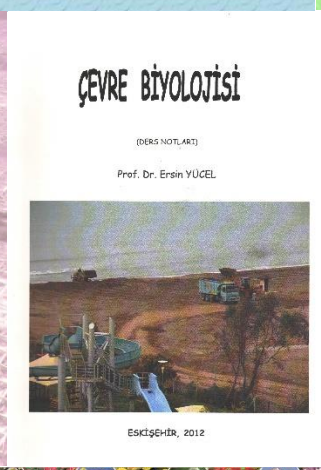

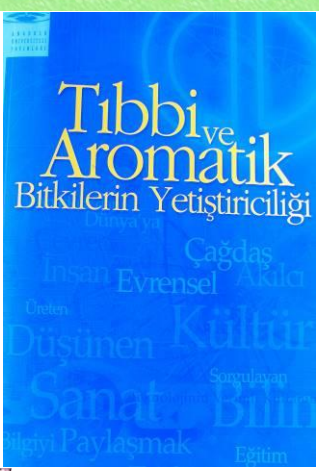

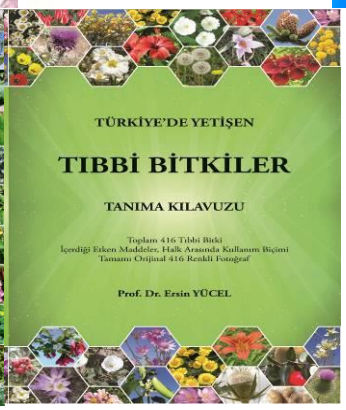

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