

# PLANT DIVERSITY AND CONSERVATION OF THE NORTH-EAST PHRYGIA REGION UNDER THE IMPACT OF LAND DEGRADATION AND DESERTIFICATION (CENTRAL ANATOLIA, TURKEY)

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## Abstract

Plant diversity and ecological structure of an area which is in critical level in terms of land degradation and erosion are quite important. North-east part of the Phrygia Region has densely been under natural and anthropogenic effects since 3000 B.C. In the area, primary vegetation was destroyed in low and high parts around steppe plains and replaced by a secondary vegetation with anthropogenic characteristics. These anthropogenic effects have still continued in the region. In the course of the present study, vascular plant specimens were collected from the area and 589 species belonging to 314 genera classified within 67 families were identified. Seventy seven (13.1%) taxa are endemic to Turkey. When the risk situations of the plant taxa determined in the research area are checked according to IUCN, it can be seen that 56 taxa are in Least Concern, 9 in Near Threatened, 4 in Vulnerable risk categories. The largest family is Asteraceae (72) and the richest genus is *Centaurea* L. (13) in the area. Distributions of the plant taxa in terms of phytogeographical regions are as follows: Irano-Turanian elements: 123 (20.9%), Euro-Siberian elements: 36 (6.1%), Mediterranean elements: 33 (5.6%). Dominant biological types in the area are Hemicryptophytes (37%) and Therophytes (29.9%). A long term unsystematic use of mountain pastures leads a serious degradation. Therefore, determining the variation in the floristic composition of plant communities gives monitoring opportunity of land degradation in the region.

## Introduction

Land degradation and desertification are both a natural and man-induced phenomenon, widely occurring within the Mediterranean basin. Therefore, projects related to monitoring of land degradation, erosion and desertification specifically in the Mediterranean countries including Turkey and determining bioindicator plants are of great importance (Anon., 2005; Dregne, 2002; Geist & Lambin, 2004). Central Anatolia is the far-west part of steppe and desert zones of Middle Asia and also Irano-Turanian phytogeographical region (Abahussain *et al.*, 2002; Amin, 2004).

Turkey, located at the temperate region of the World, has quite rich habitat diversity because of its geomorphologic, topographic and climatic characteristics. However, natural structure of Anatolia, connected with three continents (Europe, Asia and Africa) and located at the intersection of three phytogeographical regions (Euro-Siberian, Irano-Turanian and Mediterranean), has been changed under long term natural and anthropogenic effects (Harris *et al.*, 2003; Özgül & Öztaş, 2002). When the civilizations and their life spans in Anatolia are considered, it can easily be seen that plant diversity of Turkey has been under permanent effects of uncontrolled land use, overgrazing and mining activities (Küçüködük & Çetik, 1984; Uslu, 1959; Zaady *et al.*, 2001). Grazing and land use are generally considered to be the most economical way of utilizing rangeland vegetation (Manzano *et al.*, 2000). However, these effects always reduce plant

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cover that protects the soil and generally result in soil erosion and compaction (Blanca *et al.*, 1998; Ghazanfar, 1998; Logakanthi *et al.*, 2000; Bouchard *et al.*, 2003; Victor & Dold, 2003). Soil properties and vegetation can also be altered over time under different land uses, management systems and soil erosion (Branson *et al.*, 1981; Villamil *et al.*, 2001; Harris *et al.*, 2003; Rowntree *et al.*, 2004; Villamil *et al.*, 2001). For instance, due to the soil erosion, which is a serious problem in many countries, over 500 million tons of productive soil and large amounts of plant nutrients remove every year in Turkey (Öztaş *et al.*, 2003).

Unsystematical use of an area leads to its degradation (Le Houerou, 2002). On measure of the pressure, increasing following three stages are consecutively changed: destruction of plant cover, soil cover and the lithosphere. This requires the differentiated approach to the performance of plant cover and soil-ecological monitoring of these degregation processes (Li *et al.*, 2004). The set of such monitoring indices could include the most following important indicators: Floristic composition, stocks and structure of the biomass (Jauffret & Lavorel, 2003; Logakanthi *et al.*, 2000; Mamytov, 1985; Teague *et al.*, 2004; Vladychenskiy, 2002).

For sustainable land use, it is necessary to control the state of soil and plant cover to prevent their irreversible degradation by special monitoring systems. The main objects of monitoring are the consequences of the negative processes in ecosystem, connected with plant and soil covers. Analysis of plant diversity and ecological structure of an area which is in critical level in terms of land degradagation and erosion are quite important (Macdougall *et al.*, 1998; Skapetas *et al.*, 2004; Vladychenskiy, 2002).

In the research area, it is quite difficult to determine the changes in plant diversity because there is no detailed study carried out before. Therefore, it is thought that the present study, aimed to determine structural components of the plant diversity of the region, will serve as a database to monitor the changes in positive or negative way and monitoring opportunity of the plant species will be able to help to know characteristics of plant diversity and preserve the gene sources.

**General characteristics of the study area:** North-east part of the Phrygia Valley, the study area, is located at the city borders of Eskişehir and Ankara in Central Anatolia region (Sevin, 2001), (Fig. 1). The highest points of the region belong to Sivrihisar and Arayıt mountains. Ankara-Eskişehir road and railway are also located at the region. The altitudinal range of the area changes between 950 and 1800 m. The region lies in B3 square according to Davis's Grid System (1965).

**Climate:** Annual precipitation (mm) and precipitation regime types of city Eskişehir and county Sivrihisar are given in Table 1. Both of these areas are in semi-arid Mediterranean bioclimate zone. Table 2 summarizes the results of bioclimatic analysis based on meteorological data of Eskişehir and Sivrihisar according to Emberger method (1952).

Ombrothermic diagrams of Eskişehir and Sivrihisar are given in Figs. 2, 3 (Cireli *et al.*, 1983). Dry period covers the beginning of June to October in Eskişehir and the end of May to middle of September in Sivrihisar.

**Geology:** Geological evolution of the region started in Paleosoic age and has still been continued. So, there are Paleosoic, Mesozoic and Quaternary aged rocks in the region (Atalay, 1987; Kulaksız, 1981).

**Table 1. Annual precipitation (mm) and precipitation regime types of city Eskişehir and county Sivrihisar according to data obtained from Eskişehir and Sivrihisar meteorology stations.**

Station	Spring (Sp)	Summer (S)	Fall (F)	Winter (W)	Annual	Precipitation regime
Eskişehir	120,7	54,2	71,8	127,1	373,8	W.Sp.F.S.
Sivrihisar	134,3	55,3	74,3	129,7	393,6	Sp.W.F.S.

**Table 2. Bioclimatic zones of the study area according to Emberger method (1952).**

Station	Altitude (m)	P (mm)	PE (mm)	M	m	S (PE/M)	Q	Bioclimate zone
Eskişehir	801	373,8	54,2	28,9	-3,7	1,8	51,9	Semi-dry mediterranean
Sivrihisar	1070	393,6	55,3	28,2	-3,3	1,9	55,3	Semi-dry mediterranean

(P: Annual average precipitation (mm/m<sup>2</sup>), PE: Annual summer precipitation mm/m<sup>2</sup>, M: Average temperature of the hottest month (°C), m: Average temperature of the coldest month (°C), S: Value of dry season (PE/M), Q: Comparison of temperature-precipitation (2000.P.(M+m+546,4) . (M-m))

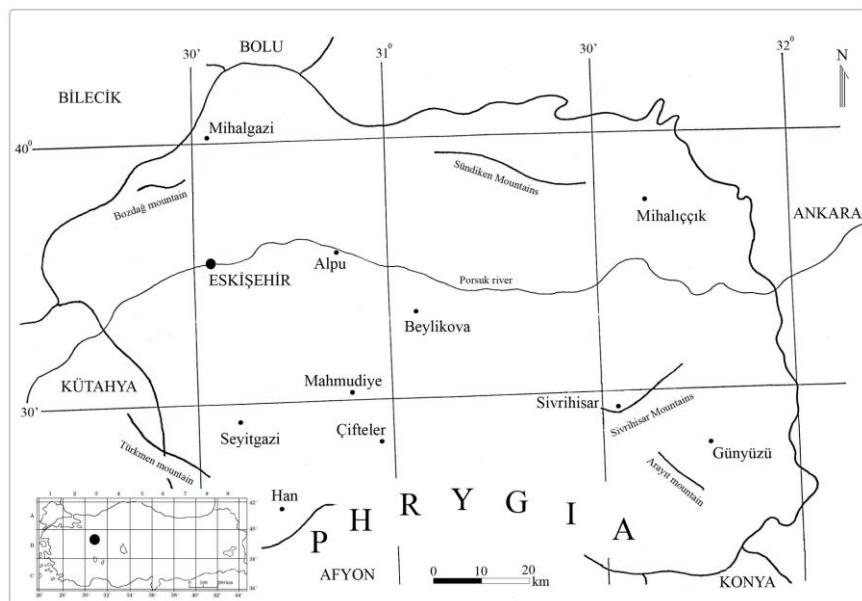


Fig. 1. Location of the study area.

Metamorphic rocks of Paleosoic age are represented as northern units, southern units and a faulted area in between these units. Albite, muscovite, chlorite quartz schist, metaconglomerate recrystallized limestone in the northern whereas talc, chlorite serpentized schist, micaschist are present in the southern units. All these rock groups belong to Paleozoic age. Mesozoic rock groups overlie Paleosoic basement rocks with an unconformity. Triassic marbles and metadiabases are present in the lower courses. Generally, massive and partially recrystallized, less fossiliferous limestone units of Jurassic-Cretaceous age unconformably overlie Triassic units.

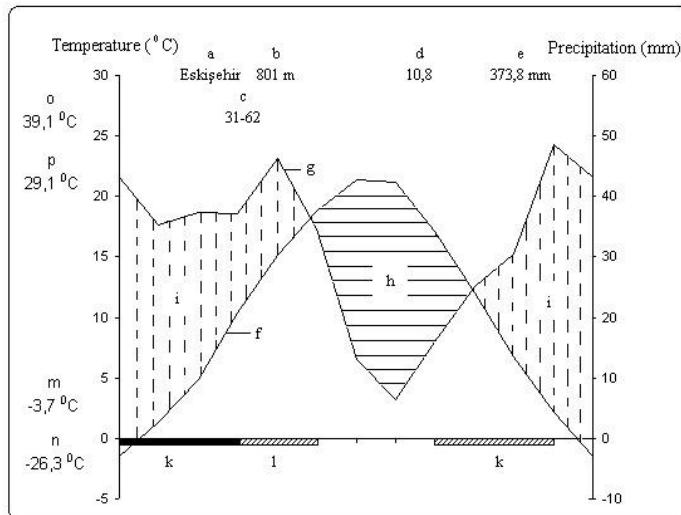


Fig. 2. Ombrothermic diagram of Eskişehir region.

(**a:** City name, **b:** Altitude, **c:** Temperature and observation year number **d:** Mean annual temperature, **e:** Mean annual precipitation, **f:** Mean monthly temperature curve, **g:** Mean monthly precipitation curve, **h:** Dry period, **i:** Rainy period, **k:** Minimum temperature of the coldest month, **l:** Annual absolute minimum temperature, **m:** Absolute maximum temperature, **n:** Maximum temperature of the hottest month)

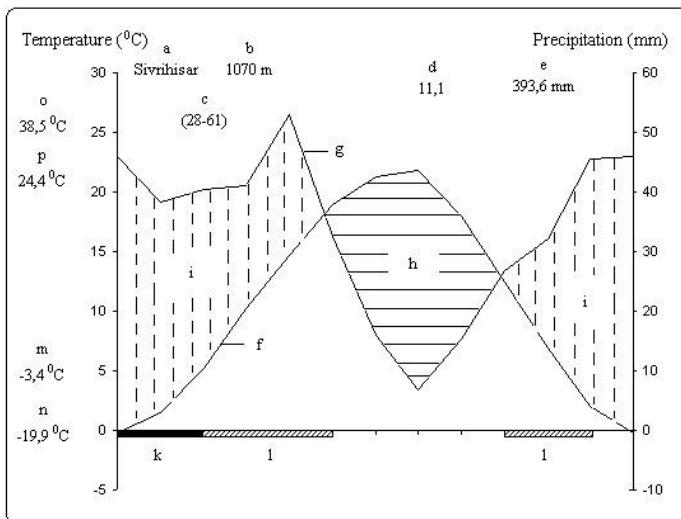


Fig. 3. Ombrothermic diagram of county Sivrihisar (Eskişehir, Turkey).

(**a:** City name, **b:** Altitude, **c:** Temperature and observation year number **d:** Mean annual temperature, **e:** Mean annual precipitation, **f:** Mean monthly temperature curve, **g:** Mean monthly precipitation curve, **h:** Dry period, **i:** Rainy period, **k:** Minimum temperature of the coldest month, **l:** Annual absolute minimum temperature, **m:** Absolute maximum temperature, **n:** Maximum temperature of the hottest month)

Cenozoic units are present over the Mesozoic units with an unconformity. Unconsolidated red green, blue sand and conglomerates of Paleogene age are at the basement; these are followed by lower Neogene aged tuff and metamorphosed volcanics. Clay, sand, unconsolidated conglomerates, volcanic tuff and lacustrine limestone are present in the upper courses of the Neogene. Quaternary units of alluvium, debris flow and their deposits are observable everywhere in the region. Metamorphic rocks in the area separated by faults from the northern and southern units are in the form of dikes and series of dikes their locations are N 80 E/70-80 NW, N 80 W/89 NE. Alterations are common in the form of extensive serpentisation. Studies of metamorphic rocks reveal that the grade of metamorphism is at transitional stage from lawsonite-glaucophane schist facies to glaucophanitic greenschist facies.

**Major soil types:** When the major soil types in the research area are examined, it is understood that a great many of the types consist of red brown, alluvial and hidromorphic soils (Anon., 1984). Red brown soil types have undergone erosion as a result of the disappearance of vegetation cover in the study area. Their horizon A's are generally washed, rich in skeleton items and consist of shallow soil. They are on steep slopes and flat areas which have bushes belonging to *Quercus* and *Juniperus* taxa.

They exist over the flat areas which we can call plain that contain mechanical combinations of red brown clay and sticky mud with clay and they are Zonal (mature) soil types. Calcification plays a role in their formation. Their natural drainage is good. Because of the oxidation of the iron in the soil, their colour seems to be red. The upper soil contains low quantities of organic substance. Horizon A is typically reddish brown or red and soft. Horizon B is red or reddish brown, heavier and quite tight. It has horizon C which gradually penetrates to the main material. The area, both on the surface and underneath consists of 10-15% stone and pebble. The main material is marn, chist with clay and chalk. Alluvial soils cover quite a narrow area along small streams in and around the research area. Generally there are no horizons. But there are mineral layers of different characters. They are always or seasonally wet. Hidromorphic alluvial soils are wet and marshy for most of the year because of surface flows. There are generally plants in shallow water.

Mean values of physical and chemical analysis results of the soil samples taken from different vegetation types of the research area are given in Table 3. Soils in the area where shrub vegetation is dominant are heavy textured. pH levels of the soils changes between low and medium basic levels. Soils can be considered as rich in terms of lime and as low in terms of organic matter. Total nitrogen amount is related to total organic matter amount in the soils. Phosphorus is in middle level.

It is determined that the soils taken from the areas where meadow vegetation is dominant are light textured. Soil pH is in middle basic level. Soil solution shows low calcerous characteristics. The soils in the research area which are poor in respect of organic matter and total nitrogen concentration shows difference based on the organic matter concentration. Phosphorus is in middle level.

The soil samples taken from the areas dominated by steppe vegetation are light textured. Soil pH is in middle basic level. Soil solution belonging to shrub is low calcerous. Organic matter is more than in the steppic areas and is in medium level. Total nitrogen amount also shows similarity to organic matter amount.



## Materials and Methods

This paper is mainly based on the vascular plant specimens collected from Sivrihisar Mountains and their environs (Eskişehir-Ankara) during the period 2000-2002 (Böcük, 2002) and other related researches carried out in the north-east Phrygia region (Davis, 1965; Davis *et al.*, 1988; Türe *et al.*, 1996; Güner *et al.*, 2000; Türe, 2000). The specimens were identified mainly by using the Flora of Turkey and the East Aegean Islands (Davis, 1965; Davis *et al.*, 1988; Güner *et al.*, 2000), some other sources (Altınayır, 1987; Baytop, 1997; Baytop, 1998; Heywood & Tutin, 1963-1980; Ketenoglu *et al.*, 1999; Polunin, 1972; Seçmen *et al.*, 2000; Stearn, 1972; Tokur, 1992; Yaltırık & Efe, 1996; Yücel *et al.*, 1995). Some of the plant taxa were checked in the herbaria of Anadolu University (ANES), Ankara University (ANKA) and Gazi University (GAZİ). Threatened categories are proposed according to IUCN risk categories (Ekim *et al.*, 2000; Anon., 2001). Phytogeographical regions of the taxa were evaluated according to Flora of Turkey and the East Aegean Islands (Davis, 1965; Davis *et al.*, 1988; Güner *et al.*, 2000). All plant samples collected from the research area were stored in the herbarium of Science Faculty, Anadolu University (ANES) (Holmgren & Holmgren, 2002).

The analysis techniques for soils were as follows: total organic matter was determined by using the Walkley-Black method; total N by Kjeldahl method; calcium carbonate by Scheibler calcimeter; actual acidity with pure water (1/2.5) by Beckman expanded scale pH meter ( $\pm 0,01$  sensitivity), phosphorus by Olsen method by using spectronic 20D. Physical analysis of soil by Bouyoucos hidrometer method, and classified according to American soil classification triangle (Anon., 1994; Baver, 1956; Black, 1965; Bouyoucos, 1955; Gülçür, 1974; Türe & Bell, 2004).

## Results and Discussion

In this study, vascular plant specimens were collected from the research area and 589 plant taxa belonging to 314 genera classified within 67 families were determined. One species belongs to *Pteridophyta*, 4 species to *Gymnospermae* while the other 584 taxa belong to *Angiospermae*. Seventy seven taxa (13.1%) are endemic for Turkey. When the risk situations of the plant taxa determined in the study area are checked according to the IUCN categories, it can be seen that 56 taxa (51 endemic, 5 non-endemic) are in Least Concern (LC), 9 (endemic) in Near Threatened (NT), 4 (3 endemic, 1 non-endemic) in Vulnerable (VU) risk categories (Ekim *et al.*, 2000; Anon., 2001), (Table 4, Fig. 4).

The largest families according to taxa numbers are as follows: Asteraceae 72, Fabaceae 54, Lamiaceae 46, Poaceae 45, Brassicaceae 41 (Table 5). It matches to the family sequence in the Flora of Turkey. Asteraceae is the largest and most widespread family of flowering plants in the World. Most members of this family protect themselves with their spiny structures. They can distribute their seeds easily and also have a wide ecological tolerance (Türe, 2003). In addition, steppe characteristics of the area and most abundant presence of *Astragalus* (Fabaceae) in steppe areas may contribute to the results cited above. The richest genera in the area are *Centaurea* L. (13), *Alyssum* L. (12), *Salvia* L. (11), *Silene* L. (9), *Galium* L. (9) *Astragalus* L. (7) (Davis, 1985; Davis *et al.*, 1988), (Table 6).

Table 4. Risk situations of the plant species.

Plant species	Risk category
<b>Endemic species</b>	
<i>Achillea aleppica</i> DC. subsp. <i>zederbaueri</i> (Hayek) Hub.-Mor.	LC
<i>Alyssum pateri</i> Nyâr. subsp. <i>pateri</i>	LC
<i>Amblyopyrum muticum</i> (Boiss.) Eig var. <i>loliaceum</i> (Jaub. & Spach) Eig	LC
<i>Astragalus micropterus</i> Fischer	LC
<i>Astragalus vulnerariae</i> DC.	LC
<i>Asyneuma limonifolium</i> (L.) Janchen subsp. <i>pestalozzae</i> (Boiss.) Damboldt	LC
<i>Asyneuma virgatum</i> (Labill.) Bornm. subsp. <i>cichoriforme</i> (Boiss.) Damboldt.	LC
<i>Bolanthus minuartioides</i> (Jaub. & Spach) Hub.-Mor.	LC
<i>Bupleurum heldreichii</i> Boiss. & Bal.	LC
<i>Campanula lyrata</i> Lam. subsp. <i>lyrata</i>	LC
<i>Centaurea drabifolia</i> Sm. subsp. <i>detonsa</i> (Bornm.) Wagenitz	LC
<i>Consolida raveyi</i> (Boiss.) Schröd.	LC
<i>Convolvulus galaticus</i> Rostan ex Choisy	LC
<i>Crataegus tanacetifolia</i> (Lam.) Pers.	LC
<i>Crepis macropus</i> Boiss. & Heldr.	LC
<i>Digitalis lamarckii</i> Ivan.	LC
<i>Ebenus hirsuta</i> Jaub. & Spach	LC
<i>Erodium absinthoides</i> Willd. subsp. <i>absinthoides</i>	LC
<i>Eryngium bithynicum</i> Boiss.	LC
<i>Genista aucheri</i> Boiss.	LC
<i>Gysophylla eriocalyx</i> Boiss.	LC
<i>Haplophyllum mrytifolium</i> Boiss.	LC
<i>Hedysarum cappadocicum</i> Boiss.	LC
<i>Helichrysum arenarium</i> (L.) Moench subsp. <i>aucheri</i> (Boiss.) Davis & Kupicha	LC
<i>Hieracium paphlagonicum</i> Freyn & Sint.	LC
<i>Hyacinthella lineata</i> (Steudel) Chouard	LC
<i>Iris schachtii</i> Markgraf	LC
<i>Jurinea pontica</i> Hausskn. & Freyn ex Hausskn	LC
<i>Linaria corifolia</i> Desf.	LC
<i>Linaria genistifolia</i> (L.) Miller subsp. <i>confertiflora</i> (Boiss.) Davis	LC
<i>Linaria iconia</i> Boiss. & Heldr.	LC
<i>Linum hirsutum</i> L. subsp. <i>anatolicum</i> (Bois.) Hayek var. <i>anatolicum</i>	LC
<i>Minuartia anatolica</i> (Boiss.) Woron. var. <i>arachnoidea</i> McNeill	LC
<i>Minuartia erythrosepala</i> (Boiss.) Handz.-Mazz. var. <i>cappadocica</i> (Boiss.) McNeill	LC
<i>Nonea macrosperma</i> Boiss. & Heldr.	LC
<i>Onobrychis armena</i> Boiss. & Huet	LC

Table 4. (Cont'd.).

Plant species	Risk category
<i>Onobrychis tournefortii</i> (Willd.) Desv.	LC
<i>Onosma bornmuelleri</i> Hausskn.	LC
<i>Onosma bracteosum</i> Hausskn. & Bornm.	LC
<i>Onosma isauricum</i> Boiss. & Heldr.	LC
<i>Oxytropis argyleuca</i> Bornm.	LC
<i>Paracaryum ancyritanum</i> Boiss.	LC
<i>Phlomis armeniaca</i> Willd. Ir.-Tur.	LC
<i>Rhamnus thymifolius</i> Bornm.	LC
<i>Salvia cadmica</i> Boiss.	LC
<i>Salvia cryptantha</i> Montbret & Aucher ex Bentham	LC
<i>Salvia wiedemannii</i> Boiss.	LC
<i>Stachys cretica</i> L. subsp. <i>anatolica</i> Rech. fil.	LC
<i>Tragopogon aureus</i> Boiss.	LC
<i>Verbascum cherianthifolium</i> Boiss. var. <i>asperulum</i> (Boiss.) Murb.	LC
<i>Veronica multifida</i> L.	LC
<i>Aethionema turcica</i> H. Duman & Aytaç	NT
<i>Alkanna orientalis</i> (L.) Boiss. var. <i>leucantha</i> (Bornm.) Hub.-Mor.	NT
<i>Alyssum blepharocarpum</i> Dudley & Hub.-Mor.	NT
<i>Astragalus macrocephalus</i> Willd. subsp. <i>macrocephalus</i>	NT
<i>Astragalus melanophrurius</i> Boiss.	NT
<i>Centaurea bornmuelleri</i> Hausskn. ex. Bornm.	NT
<i>Paronychia argyroloba</i> Stapf	NT
<i>Paronychia dudleyi</i> Chaudhri	NT
<i>Sideritis galatica</i> Bornm.	NT
<i>Minuartia anatolica</i> (Boiss.) Woron. var. <i>phrygia</i> (Bornm.) McNeill	VU
<i>Paronychia angorensis</i> Chaudhri	VU
<i>Secale cereale</i> L. var. <i>ancestrale</i> (Zhuk.) Kit Tan	VU
<b>Non-endemic species</b>	
<i>Acanthus hirsutus</i> Boiss.	LC
<i>Consolida thirkeana</i> (Boiss.) Schröd.	LC
<i>Crocus ancyrensis</i> (Herbert) Maw	LC
<i>Helianthemum nummularium</i> (L.) Miller subsp. <i>lycaonicum</i> Coode & Cullen	LC
<i>Salvia cyanescens</i> Boiss. & Bal.	LC
<i>Thymus leucostomus</i> Hausskn. & Velen. var. <i>argillaceus</i> Jalas	VU

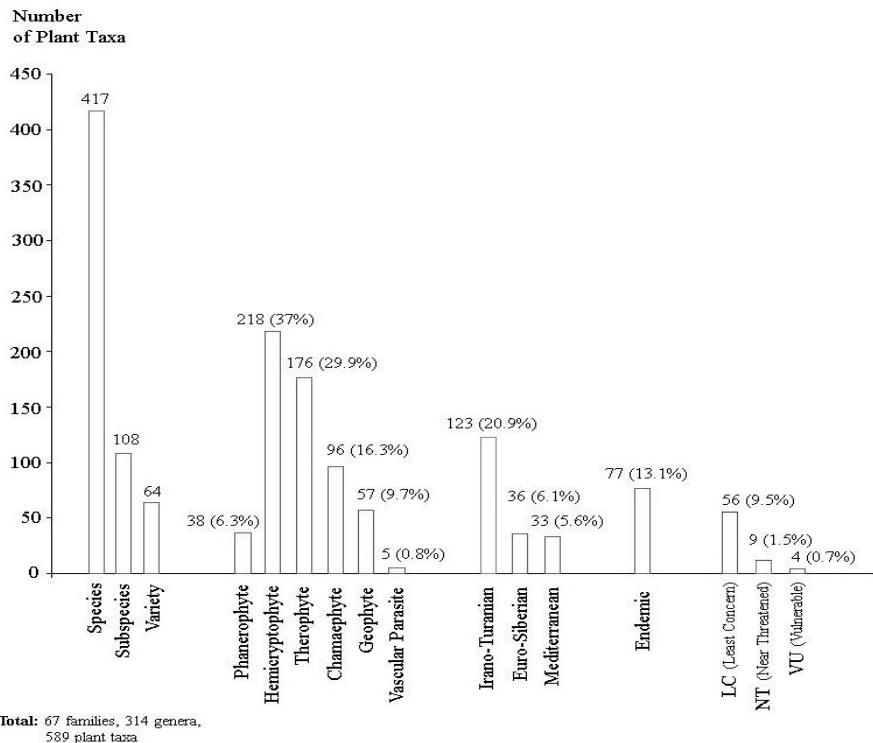


Fig. 4. Some information about the number of plant taxa, life forms, phytogeographical regions, endemism, risk categories of the plant taxa determined in the research area.

**Table 5. The largest families in the research area.**

Family	Genera	Taxa	Percent
Asteraceae	37	72	12.2
Fabaceae	23	54	9.1
Lamiaceae	20	46	7.8
Poaceae	31	45	7.7
Brassicaceae	24	41	6.9
Caryophyllaceae	13	35	5.9
Boraginaceae	16	29	4.9
Apiaceae	14	20	3.3
Scrophulariaceae	6	18	3.0
Ranunculaceae	8	18	3.0
Rosaceae	14	18	3.0
Liliaceae	9	17	2.9
Other families	99	176	30.3
<b>Total</b>	<b>314</b>	<b>589</b>	<b>100</b>

**Table 6. The largest genera in the research area.**

Genus	Number of taxa	Percent
<i>Centaurea</i>	13	4.1
<i>Alyssum</i>	12	3.8
<i>Salvia</i>	11	3.5
<i>Galium</i>	9	2.8
<i>Silene</i>	9	2.8
<i>Astragalus</i>	7	2.2
<i>Anchusa</i>	6	1.9
<i>Minuartia</i>	6	1.9
<i>Ranunculus</i>	6	1.9
<i>Verbascum</i>	6	1.9
Others	229	73.2
<b>Total</b>	<b>314</b>	<b>100</b>

Distributions of the plant taxa determined in the study area in terms of phytogeographical regions are as follows: Irano-Turanian elements: 123 (20.9%), Euro-Siberian elements: 36 (6.1%), Mediterranean elements: 33 (5.6%). The remaining species are either multiregional or of unknown phytogeographical origin (Fig. 4). Location of the area is in the far-west part of steppe and desert border in Central Asia, extending to the west as Irano-Turanian floristic region, Central Anatolia exhibits dominancy of Anatolian endemics and Irano-Turanian elements.

Sylvatic vegetation in the area extends on the mountain and hills formed by volcanic and sedimentary rocks. In some transition zones, it can be seen that the contribution of Mediterranean and Euro-Siberian elements were quite high. Irano-Turanian and Mediterranean elements are generally distributed in open and steppe areas whereas Euro-Siberian elements are found in humid and shady areas, around damp springs and in meadows at high altitudes.

Endemism ratio of the study area (13.1%) is quite high when it is compared with the average endemism ratio of the flora of Turkey (over 30%), (Fig. 4). It is known that the regions which have high endemism ratios are Central Anatolia, East and South Anatolia. However, it is about 5% in Black Sea region as a result of having more homogeneous environmental factors when compared with the Central, Eastern and South Anatolia regions of Turkey (Türe & Tokur, 2000).

Soil and climate are key factors for the vegetation of an area. Actually, the most important indicator of bioclimate in a region are plants and animals (Cioaca & Dinu, 2002). Besides, life forms, floristic elements and various formations are the best indicators of general climate types. Therefore, when life forms of the plant taxa determined in the research area are checked, it can be seen in the following ratios: Therophytes 29.9%, Hemicryptophytes 37.0%, Phanerophytes 6.3%, Geophytes 9.7%, Chameophytes 16.3% and vascular parasites 0.8% (Fig. 4). In these areas, because of the heavy destruction, the ratio of phanerophytes is low but hemicryptophytes and therophytes are quite high. Because therophytes are more resistant to summer drought than the hemicryptophytes, phanerophytes and geophytes, since the former spend the summer in seed form and the latter in the form of vegetative structures. And also, hemicryptophytes protect their productive vegetative parts under ground during difficult conditions (Çetik, 1985; Floret *et al.*, 1990; Keshet *et al.*, 1990; Türe, 2003).

Xerophytic plants, most common and arid elements, can also be seen in the region and these are surrounded by relatively xerophytic shrub and forest vegetations. These forests are called as "steppe forests" (Podwojewski *et al.*, 2002). Low mountain steppes were formed as a result of steppe forest degregation (Kay, 1997; Manzano *et al.*, 2000; Peer *et al.*, 2001). Tournefort, among the first scientists studied about the flora of Turkey, reported that there were healthy and dense forests between Eskişehir and Ankara nearly 280 years ago (Kuniholm, 1977). According to Zohary (1973), it is thought that real steppe borders widened during a few thousand years under the effects of a climatic variations and changed into low and high mountain steppes. Semi-arid north-east part of Frig Valley under antropogenic pressure are defined as "Xero-Euxinian". Central Anatolia plain and mountain steppe consist of antropogenic flora and vegetation, so they show secondary characteristics (Harris *et al.*, 2003). Here, primer vegetation has a restricted area or no distribution in the important part of low and high mountain zones around plain steppe.

In the region, step forests are dominantly represented by the associations of *Juniperus oxycedrus* L. subsp. *oxycedrus*, *Juniperus excelsa* Bieb. (Harris *et al.*, 2003) and *Quercus pubescens* L. Some plant taxa like *Rosa canina* L., *Rhamnus rhodopeus* Velenovsky, *Paliurus spina-christi* Miller are also available in these areas.

Dominant plant taxon of steppe is *Artemisia santonicum* in the region. Dominancy of Poaceae (Gramineae) taxa growing in arid environments of steppe vegetation calls attention (Jauffret & Lavorel, 2003; Skapetas *et al.*, 2004; Türe & Böcük, 2007). Besides the Gramineae (Poaceae) members like *Aegilops triuncialis* L., *Bromus tectorum* L., *Poa pratensis* L. and *Stipa lessingiana* Trin & Rupr., some associations forming by some plant taxa like *Astragalus vulnerariae* DC., *Ononis spinosa* L. subsp. *leiosperma* (Boiss.) Širj., *Peganum harmala* L., *Alyssum sibiricum* Willd., *Globularia orientalis* L., *Eryngium campestre* L. var. *virens* Link, *Teucrium polium* L., *Acantolimon acerosum* L. var. *acerosum* are quite dominant in steppe vegetation. It is seen that wind erosion is very effective on the sandy soils in the region. In the studies, it is reported that *Artemisia santonicum* shows secondary characteristic and replaced after damaging of *Bromus-Stipa* steppe because of uncontrolled land use and overgrazing activities (Peer *et al.*, 2001). *A. santonicum* is resistant to the climate of Central Anatolia and grazing because of its hard structure. But, the population of the plant has been decreased by antropogenic effects for the last three or four decades. So, the unpalatable species, *Peganum harmala* and *Alhagi pseudoalhagi* populations have been dominant day by day.

Uncontrolled land usage pressure change the floristic composition of plant communities and decrease the biomass stock (Jauffret & Lavorel, 2003; Logakanthi *et al.*, 2000; Shikhotov, 1974; Vladychenskiy, 2002; Vuren & Coblenz, 1987). Antropogenic steppes occurred in many areas where arid steppe forests and high mountain forests were destroyed. Agricultural activities are carried out in certain areas like plain and low mountain steppe. Main agricultural plants are barley, wheat, lentil and chickpea. In the region, there are also weeds in important number. Most of these belong to Asteraceae. These are followed by the plant taxa belonging to *Brassicaceae*, *Poaceae*, *Lamiaceae*, *Boraginaceae* families (Türe & Köse, 2000, Türe and Böcük, 2008).

Characteristic plants of meadow vegetation have been destroyed because of overgrazing activities on the areas with relatively higher ground water level. Populations formed by *Hordeum murinum* L. subsp. *leporinum* (Link) Arc. var. *leporinum*, *Cynodon dactylon* (L.) Pers. var. *dactylon*, *Potentilla recta* L., *Turgenia latifolia* (L.) Hoffm., *Trifolium pratense* L. var. *pratense*, *Lamium purpureum* L. var. *purpureum* call attention

in the floristic composition of the meadows. Besides some phanerophytic taxa like *Salix alba* L. are seen in some limited wetlands, some other plant taxa like *Typha angustifolia* L., *Phragmites australis* (Cav.) Trin .ex Steudel, *Veronica anagallis-aquatica* L., *Thalictrum lucidum* L., *Lythrum salicaria* L., *Epilobium hirsutum* L., *Scirpoides holoschoenus* (L.) Sojak are distributed in these areas.

General conventional peculiarity of agriculture and overgrazing including pasturage in mountain ecosystems, indicate a prevalence of extensive forms of land use. This is the reason that great quantities of natural resources are involved into agriculture sphere. Limited natural resources in the mountains are under the impacts the high level of anthropogenic pressure (Manzano *et al.*, 2000). Landscape is a spatial and temporal result of interacting ecosystems and socio-cultural environment and has a certain structure, function and change trend. Landscape is a dynamic system and it inherently contains "change". However, the acceleration and change of direction of such change by the human influence cause certain negative impacts upon the landscape components and the entire landscape itself (Abahussain *et al.*, 2002; Geist & Lambin, 2004).

Although there are no detailed floristic studies carried out in the region, change on vegetation and soil characteristics of the region due to the antropogenic effects in terms of the criterions mentioned above can easily be seen when compared with the vegetation structure and plant diversity of the research area by macro observations of some researchers and protected natural areas around the research area (Harris *et al.*, 2003; Li *et al.*, 2004).

Plant cover is the most sensitive component to grazing in an ecosystem. Permanent unsystematical use of mountain pastures leads to their degradation seriously. Floristic composition of plant communities is strongly changed. This effect greatly reduces stability of soils because it becomes thinner and less durable (Vladychenskiy, 2002).

If it is thought that nearly half of the people in the region live in rural areas and their main economic sources are pasture, segregated steppe forests and agricultural areas formed by destroying of natural areas (Macleod *et al.*, 2004), it can easily be seen the reality that negative antropogenic effects will continue in the region in future.

In order to establish the regain of natural equilibrium in steppe areas, some important measures may be taken as follows: Early and heavy grazing system continuing on the natural pasture areas in the upper part of the mountains must be prevented, the rotational grazing plan should be applied based on herb productivity (Kondoh, 2003). In addition to these, the poisonous and spiny weeds should be removed by the natural competition of the herb species in the protected area. Cutting of oak branches must be prohibited in order to maintain the natural regeneration and the increase of biomass productivity of the steppe forests. The eroded areas must be reforested and afforested. In the reforestation activities, the oak has to be selected as climax species for the region (Atalay, 2002).

The sustainable use of the natural resources, in broad sense including the protection of environment, is dependent on the economic and social development of the rural people (Shelton, 2003). For this reason, some measurements, relating to the education, settlement rehabilitation, innovation in the animal husbandry, marketing, economic aids, various extension etc. should be taken into consideration.

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