

## FLORISTIC DIVERSITY IN BAŞHEMŞİN VALLEY OF KAÇKAR MOUNTAINS NATIONAL PARK OF RİZE, TURKEY

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### Abstract

The floristical structure of Başhemşin and its environs as a protected and isolated area within Kaçkar Mountains National Park, situated in Rize, a province in the Blacksea region of Turkey, is studied. 1830 plant specimens were collected and 503 taxa were identified in 234 genera and 75 families. Sixteen *Pteridophytes* and 487 *Spermatophytes* were determined. Two of *Spermatophytes* are *Gymnospermae* while 485 of them are *Angiospermae* (98 *Monocotyledones* and 389 *Dicotyledones*). The richest families in taxa are *Asteraceae*, *Poaceae*, *Brassicaceae*, and *Fabaceae* (55 *Asteraceae*, 49 *Poaceae*, 28 *Brassicaceae*, and 27 *Fabaceae*). Phytogeographic elements are listed in order as: Euro-Siberian 247 (49.1%), Irano-Turanian 17 (3.4%), Mediterranean 6 (1.2%), multiregional-unknown phytogeographic root 233 (46.3%). Hemicryptophytes are the richest with 224 (44.5%) taxa and it is followed by cryptophytes 144 (28.6%), therophytes 53 (10.5%), chamaephytes 59 (11.7%), phanerophytes 19 (3.8%), vasicular parasites 2 (0.4%), nanophanerophytes/chamaephytes 1 (0.2%) and hydrophytes 1 (0.2%). 34 endemic taxa were determined (6.7%). 13 threatened taxa were detected in the research area and we determined that *Sorbus caucasica* Zinserl. var. *yaltırnkii* Gökşin population has fallen into CR endangered category with only 2 individuals in the study area.

**Key words:** Başhemşin, Çamlıhemşin, Flora, Rize, Turkey.

### Introduction

Even though a lot of studies have been done to determine the world flora, there are still numerous fields which have not been studied yet (Shaheen *et al.*, 2014). Having a temperate climate, Turkey is one of the important countries in terms of plant diversity (Özhatay *et al.*, 2013). Turkey has a rich flora, and Turkish vascular flora has been documented as eleven volumes (Davis, 1965-1985; Davis *et al.*, 1988; Güner *et al.*, 2000). In these 11 volumes, a total of 8796 species reported in Turkey (Özhatay *et al.*, 2013). In December 2013 about 945 new species were described in the Turkish vascular flora, and these were published as check list series by Özhatay *et al.* (2013). Currently, Turkish vascular plant taxa is over 12.000; it continuous to increase day by day and it still needs further floristical studies.

Some studies have been carried out on the flora of Rize, neighbouring areas to Rize and the study area (Güner, 1984; Güner *et al.*, 1987; Vural, 1996; Terzioğlu, 1998; Eminağaoğlu & Anşin, 2003, 2004; Palabaş-Uzun, 2009; Uzun, 2009; Çobanoğlu, 2012; Demir, 2013). Limited literature survey is available on the floristical aspects of Başhemşin, (Güner (1984), Davis (1965-1985), Güner (2000)). We chose Başhemşin and its environs for following reasons:

1. No floristic study is reported on this area which records all plant coverings of all seasonal variations.
2. The study area is in the borders of protected area of Kaçkar Mountains National Park.
3. The study area is located at the Fırtına Valley hotspot, which remains as a mountainous isolated area.
4. The study area covers Verçenik Mountain, the second highest peak of Kaçkar Mountains.

The objective of the research is to ascertain the floristic diversity in Başhemşin valley, an isolated and protected area within Kaçkar Mountains National Park.

### Material and Methods

Başhemşin is in Çamlıhemşin district, located 75 km away from south-east of Rize, Turkey (Fig. 1). It lies between the latitudes 40° 40' 303 and 40° 49' 540 and the longitudes 40° 51' 505 and 40° 56' 416. The research area is at A8 square (Davis, 1965-1985), in Colchic floristic sector (Davis, 1965-1985; Zohary, 1973). Başhemşin is the southeastern border of the Kaçkar Mountains National Park. The southern, southwestern, southeastern and western borders of the area are Tatos (Dilek), Verçenik (Verşembek) and Cimil Mountains and the northern border is Tapfur upland. The lowest part of the study area, which is in the borders of the Fırtına Valley hotspot, is 1650 m below Aşağıköy and the top point is 3709 m on the peak of Verçenik, which is the second highest peak level of Kaçkar mountain chain. The streams from the subalpine and alpine parts of the study area support the flow rate of the hotspot Fırtına Valley (Fig. 1).

Başhemşin and its environs are geologically composed of Palaeozoic aged Kaçkar granite and middle Jurassic aged basalt, andasite lava, dasite and pyroclast of Hamurkesen formations (Anon., 2000). The vast majority of the study area is at the alpine and subalpine zone, and thus, the significant part of the area consists of scars and rifts; the rest of the area has two main soil types, namely grey-brown podzolic soils and high mountain meadows (Anon., 2005). The study area has a very-humid, mesothermal climate without any dry season. The precipitation regime is as autumn, winter, spring and summer (Au.Wi.Su.Si.). The average annual precipitation is 2039 mm while temperature is 13.54°C. August is the maximum average temperatured (M) month with 25.3°C while January is the minimum average temperatured (m) month with 3.2°C (Anon., 2011). We also interpolated the climatological values of Pazar station for the altitude of 1850 m. According to the interpolated values, January, February, March and December are the frosty months while April and November are the probable frosty months (Fig. 2).

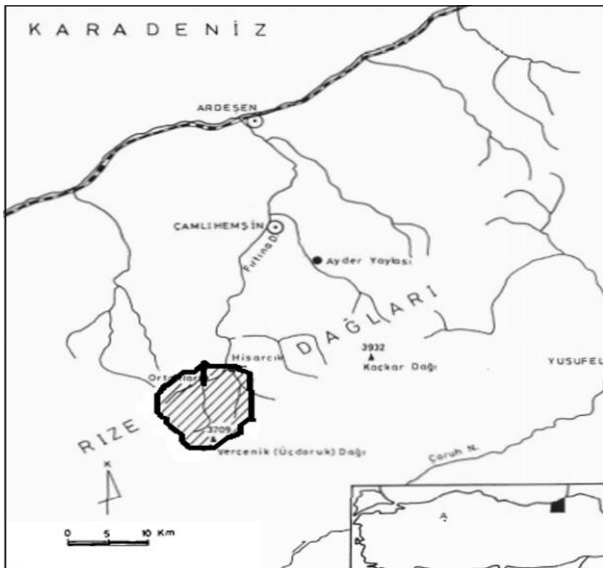


Fig. 1. Map of study area.

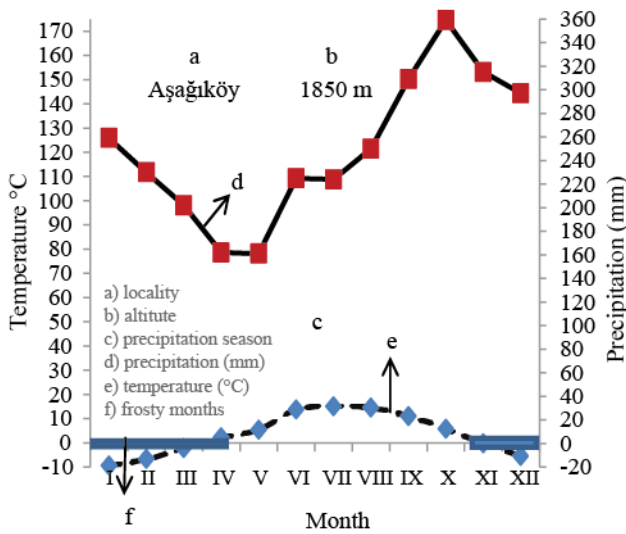


Fig. 2. Interpolated climate diagram study area.

Fig. 3. CR categorized taxon *Sorbus caucasica* Zinslerl. var. *Yaltirikii* Gökşin.

The study materials of selected plant taxa from Başhemşin were collected during the vegetation seasons between the years of 2011-2014. The samples for each taxon were allowed to dry and stuck on carton papers with standard herbarium rules (Erik *et al.*, 1996) and deposited in the herbarium of Biology Department, Faculty of Arts and Sciences, Recep Tayyip Erdoğan University. The taxa were identified using the 11 volumed Turkish flora (Davis, 1965-1985; Davis *et al.*, 1988; Güner *et al.*, 2000) and checked with European flora (Tutin *et al.*, 1964-1980), Russian flora (Komarov & Shishkin, 1933-1964; Ketzkhoveli & Gagnidze, 1971-2001) and some other studies (Lelebici, 1990; Makbul, 2006; Agar *et al.*, 2010; Khan *et al.*, 2011, 2013, 2014, 2015). The herbarium of Hacettepe University was used to check the taxa. For each taxon, the family name, taxon name, author (Brummitt *et al.*, 1992) and locations are given correspondingly. Furthermore, life forms (Raunkiaer, 1934; Ellenberg & Mueller-Dombois, 1967; Khan *et al.*, 2013), threatened categories (Ekim *et al.*, 2000), phytogeographical regions (Davis, 1965-1985) and endemism status were also given.

## Results and Discussion

The data about the floristic features of Başhemşin and environs are given below. These obtained data such as total number of taxa, genus, family, endemism ratio, threatened categories, phytogeographical region elements, life spectra, floristic richness and taxonomic diversity were compared with 8 studies carried out in other areas (AC., GC., KOB., SF., KS., UF., HAT. and RF.) close to the present research area.

Three to five specimens for each taxon were collected from Başhemşin between the years of 2011-14 during different vegetation seasons. After detailed identifications and verifications, it has been proved that the vascular flora of Başhemşin is represented by 503 taxa, 75 families, 244 genera, 357 species, 108 subspecies and 38 varieties. 487 taxa belong to the *Spermatophyta* while 16 remainders belong to *Pteridophyta*. Subdivision *Gymnospermae* has only 2 taxa and *Angiospermae* has 485 taxa (Table 1). 387 of *Angiospermae* are *Dicotyledones* while 98 of these are *Monocotyledones*. The floristic diversity of the area in terms of the total number of taxa (503) is richer than the total taxa determined in the studies AC (228) and SF (479), closer to GC (517) and smaller than that of KOB. (656), KS. (853), UF. (1024), HAT. (769), RF. (1430) (Table 3). As total taxa number in a study is connected with geographical size, topography, edaphic factors etc., this can explain the differences of total taxa number in the studies we compared above. The phytogeographical element status of the identified taxa are shown in Table 2: Euro-Siberian 247 (49.12%), Irano-Turanian 17 (3.4%), Mediterranean 6 (1.2%) and multi regional-unknown phytogeographic root 233 (46.3%). As it is mentioned above, Başhemşin and environs are located at the Eastern Blacksea region in Turkey and this part of Turkey is in the borderlines of Euro-Siberian floristic province, which clarifies the Euro-Siberian element dominance. The southern part of the study area is in the borderlines of Irano-Turanian floristic region, and thus, these elements follow Euro-Siberian elements. Microclimates in Başhemşin and environs may be the reason for the presence of Mediterranean elements. 23 (4.6%) endemics are Euro-Siberian and 3 (0.6%) endemics are Irano-Turanian elements (Table 2). The order of the floristic region elements obtained are compatible with the studies of AC., KOB., SF., KS., UF., HAT., and RF (Table 3). This is an expected result for the reason mentioned above. Only the data from GC. differ from the other data given (Table 3).

**Table 1. The taxa into higher taxonomical categories.**

	Family	Genus	Species	Subspecies	Variety	Taxa	Endemics
Pteridophyta	9	10	13	3	-	16	-
Spermatophyta	66	234	344	105	38	487	34
Gymnospermae	2	2	2	-	-	2	-
Angiospermae	64	232	342	105	38	485	34
Dicotyledones	54	186	268	85	34	387	29
Monocotyledones	10	46	74	20	4	98	5
Total	75	244	357	108	38	503	34

**Table 2. Phytogeographic, endemic, nonendemic, and threat status of taxa.**

Regions	End.		Nonend.		Sum	
	No	Ratio	No	Ratio	No	Ratio
Euro-Siberian	23	4.6	224	44.5	247	49.1
Irano-Turanian	3	0.6	14	2.8	17	3.4
Mediterranean	-	0	6	1.2	6	1.2
Cosmopolite and others	8	1.6	225	44.7	233	46.3
Total	34	6.8	469	93.2	503	100
CR	1	0.2			1	0.2
EN	1	0.2			1	0.2
VU	2	0.4	4	0.8	6	1.2
NT	2	0.4			2	0.4
LC	3	0.6			3	0.6
Sum	9	1.8	4	0.8	13	2.6

End.: Endemic; Nonend.: Nonendemic; No: Number; CR: Critically endangered; EN: Endangered; VU: Vulnerable; NT: Near threatened; LC: Least concern

**Table 3. Phytogeographic elemental comparison of Başhemşin and environs with studies in the adjoining areas.**

Studies	Taxa	Euro Siberian	Irano Turanian	Mediterranean	Cosmopolite and other	Endemic
FEB.	503	49.1	3.4	1.2	46.3	6.7
AC.	228	67.5	2.2	0	29.3	5.3
GC.	517	47.2	2.1	3.3	47.4	4.3
KOB.	656	43.9	4.0	3.4	48.8	5.2
SF.	479	49.5	2.3	1.3	46.9	4.2
KS.	853	39.4	10.3	1.2	49.1	6.3
UF.	1024	41.1	4.6	2.0	5.3	7.1
HAT.	769	35.6	6.9	2.2	55.3	7.4
RF.	1430	48.2	5.7	3.0	43.0	18.5

FEB.: Flora Vegetation and Ethnobotany of Başhemşin (Çamlıhemşin, Rize); AC.: Flora Chemical and Palynological Analysis of Ayder-Ceymakçur provinces (Çamlıhemşin, Rize), 2013; GC.: Flora and Vegetation of Güneysu-Çağrankaya (Güneysu, Rize), 2012; KOB.: Mapping and Determination of plant biodiversity of KTU University Research Forest (Trabzon), 2009; SF.: Flora, Vegetation and Succession of Sıdşağı (Trabzon), 2009; HAT.: Flora of Hatila Valley National Park (Artvin) and its Close Environs, 2003; KS.: Flora of the Karagol-Sahara National Park (Artvin) and Its Environs, 2004; UF.: Flora and Vegetation of Uzungöl (Çaykara, Trabzon), 1998; RF.: Flora, Vegetation and Polen Analysis of Rize, 1987

According to IUCN risk categories, there are 13 threatened taxa in the selected study area; 9 of them are endemics, and 4 of them are nonendemics; 1 endemic is listed in EN, 2 endemic and 4 nonendemic are given in VU, 2 endemics are in NT, 3 endemics are in LC and 1 endemic is given in CR (Ekim *et al.*, 2000) (Table 2). We determined that *Sorbus caucasica* Zinslerl. var. *yaltırıkii* Gökşin population has changed as CR category with only 2 individuals in the selected study area (Fig. 3). The total threatened taxa number in nearby studies are as follow; AC. 12, GC. 22, SF. 30, KOB. 42 and KS. 30. In the other 3 studies (UF, HAT. and RF.) there is no information

available related to the threatened taxa. 34 of total taxa are endemics in the study area (Table 1). In Table 3 the ratio of endemism in Başhemşin and their comparison with the data of neighbouring areas are given. The highest endemism ratio (18.5%) was found in the RF data. It is 2.5 or 4 times higher than the other studies. The endemism ratio of 4 studies (FEB., KS., UF. and HAT.) were around 7% while 3 of them (AC., GC. and KOB.) were around 5%. The main reason for low endemism ratio in Başhemşin and Blacksea region can be listed as follows; 1. Homogeneous climate, 2. High similarities in the environment, 3. The presence of tree species from sea level to the higher parts of the region.

**Table 4. 10 families containing the maximum genus.**

Family	Genus	Ratio (%)
<i>Asteraceae</i>	32	6.4
<i>Poaceae</i>	24	4.8
<i>Brassicaceae</i>	16	3.2
<i>Rosaceae</i>	14	2.8
<i>Lamiaceae</i>	11	2.2
<i>Apiaceae</i>	11	2.2
<i>Fabaceae</i>	8	1.6
<i>Caryophyllaceae</i>	8	1.6
<i>Liliaceae</i>	8	1.6
<i>Boraginaceae</i>	8	1.6
Total	140	28.0

**Table 5. The richest families in taxa.**

Families	Taxa	Ratio (%)
<i>Asteraceae</i>	55	10.9
<i>Poaceae</i>	49	9.7
<i>Brassicaceae</i>	28	5.6
<i>Fabaceae</i>	27	5.4
<i>Rosaceae</i>	26	5.2
<i>Caryophyllaceae</i>	21	4.2
<i>Lamiaceae</i>	21	4.2
<i>Cyperaceae</i>	17	3.4
<i>Ranunculaceae</i>	15	3.0
<i>Apiaceae</i>	14	2.8
Total	273	54.2

**Table 6. The richest genera in taxa.**

Genera	Taxa	Ratio (%)
<i>Carex</i>	16	3.1
<i>Poa</i>	9	1.8
<i>Veronica</i>	9	1.8
<i>Geranium</i>	9	1.8
<i>Campanula</i>	8	1.6
<i>Ranunculus</i>	7	1.4
<i>Myosotis</i>	7	1.4
<i>Vicia</i>	6	1.2
<i>Epilobium</i>	6	1.2
<i>Primula</i>	6	1.2
Total	83	16.5

The richest families regarding taxa are *Asteraceae* (55), *Poaceae* (49), *Brassicaceae* (28), *Fabaceae* (27), *Rosaceae* (26), *Lamiaceae* (21), *Caryophyllaceae* (21), *Cyperaceae* (17), *Ranunculaceae* (15), and *Apiaceae* (14) (Table 5). *Asteraceae* is the largest family in all studies except HAT (Table 7). *Asteraceae* is also the

largest family in Turkish flora regarding taxa number; therefore, the results of current study and the other studies AC., GC., KOB., SF., KS., UF., and RF. are compatible. *Poaceae* is the second largest family in the studies FEB., GC., KOB. and RF., which have large meadows within the boundaries (Table 7). Even though there are small differences in the order of the other families shown in table 7, there is a general concordance in the results due to the local microclimates and microhabitats.

The richest families of genera can be listed as: *Asteraceae* (32), *Poaceae* (24), *Brassicaceae* (16), *Rosaceae* (14), *Lamiaceae* (11), *Apiaceae* (11), *Fabaceae* (8), *Caryophyllaceae* (8), *Liliaceae* (8) and *Boraginaceae* (8) (Table 4).

Listing the genera in terms of taxa number, we have *Carex* (16), *Poa* (9), *Veronica* (9), *Geranium* (9), *Campanula* (8), *Ranunculus* (7), *Myosotis* (7), *Vicia* (6), *Epilobium* (6) and *Primula* (6). Besides these genera, *Silene*, *Sedum* and *Pedicularis* also have 6 taxa (Table 6). It is hard to find a correlation among the families and genera based on taxa number in the compared studies. In this study, top three genera are *Carex* (16), *Poa* (9) and *Veronica* (9) (Table 6), which is different compared with reported data such as; *Carex* (7), *Allium* (6) and *Campanula* (4) in GC., *Campanula* (14), *Carex* (10), and *Alchemilla* (9) in KOB., *Alchemilla* (10), *Campanula* (10), and *Ranunculus* (9) in SF., *Astragalus* (22), *Campanula* (15), and *Veronica* (14) in KS., *Trifolium* (13), *Acer* (8), and *Geranium* (8) in HAT., *Alchemilla* (22), *Trifolium* (17), and *Silene* (14) in UF. and *Geranium* (19), *Trifolium* (19), and *Alchemilla* (18) in RF.

In Table 9 the life spectra of vascular plants in Başhemşin and environs are given: hemicryptophytes 224 (44.5%), cryptophytes 144 (28.6%), chamaephytes 59 (11.7%), therophytes 53 (10.5%), phanerophytes 19 (3.8%), vascular parasites 2 (0.4%), nanophanerophytes/chamaephyte 1 (0.2%), and hydrophyte 1 (0.2%). Hemicryptophytes are the richest life-form in the studies of FEB. (224), GC. (252) and AC. (143). This is reasonable due to the large amount of subalpine and alpine vegetation in these study areas. The size of subalpine and alpine vegetation in this study is larger than the studies of GC. and AC. Therefore, in this study, phanerophytes (19), which consist of tree, shrub and lians, are found less compared to those found in the studies of GC. (83) and AC. (31). The hydrophyte in the study area can be explained with the presence of lakes. We could not compare the life forms of this study with the other 6 reported studies because there is no information available in those studies about the life-form of the taxa.

According to Table 8, the floristic richness and taxonomic diversity of this study has a very close concordance with the other studies conducted nearby. This study has a richer T/G (2.1%) than the other studies of AC. (1.7%), GC. (1.8%), KOB. (1.8%) and SF. (1.8%). G/F (3.1%) values of this study are higher than that of AC. (2.7%), equal to SF. (3.1%) and lower than the others.

**Table 7. Analogy of families which are rich about taxa with previous studies carried out at adjoining regions.**

Family	Compared studies (%)								
	FEB.	AC.	GC.	KOB.	SF.	KS.	UF.	HAT.	RF.
<i>Asteraceae</i>	10.9	10.5	10.1	11.4	10.9	11.4	13.8	9.8	12.5
<i>Poaceae</i>	9.7	3.5	6.8	7.3	6.1	7.5	5.5	2.5	10.7
<i>Brassicaceae</i>	5.6	3.9	6.0	3.5	2.5	5.3	3.6	5.5	4.4
<i>Fabaceae</i>	5.4	3.9	4.8	6.3	6.3	9.4	6.5	10.2	4.8
<i>Rosaceae</i>	5.2	6.6	4.6	6.1	7.9	6.7	6.0	5.9	5.0
<i>Caryophyllaceae</i>	4.2	3.1	3.7	3.4	1.5	4.8	4.9	2.6	3.9
<i>Lamiaceae</i>	4.2	5.3	4.6	5.0	5.4	5.8	4.8	5.9	4.7
<i>Cyperaceae</i>	3.4	1.3	2.7	1.5	1.7	1.0	1.8	0.2	3.8
<i>Ranunculaceae</i>	3.0	6.1	3.1	2.0	2.9	3.2	2.6	2.4	2.5
<i>Apiaceae</i>	2.8	2.7	2.9	3.5	3.8	2.11	3.2	0.8	3.3

**Table 8. Comparative floristic richness and taxonomic diversity.**

	Compared studies								
	FEB.	AC.	GC.	KOB.	SF.	KS.	UF.	HAT.	RF.
(T)	503	228	517	656	479	863	1024	769	1430
(G)	234	131	352	354	259	364	435	374	555
(F)	75	48	104	95	82	91	117	95	130
T/G	2.1	1.7	1.8	1.8	1.8	2.4	2.4	2.1	2.6
G/F	3.1	2.7	3.9	3.7	3.1	4.0	3.7	3.9	4.3

(T): Species; (G): Genus; (F): Family; T/G: Species/Genus; G/F: Genus/Family

**Table 9. Life-form of taxa in the compared studies.**

Studies	Hcrp.	Crp.	Chp.	Thp.	Php.	Vp.	Hd.	NanoPh.
FEB.	224	144	59	53	19	2	1	1
GC.	252	47	54	81	83	-	-	-
AC.	143	31	16	16	31	-	-	-

Hcrp.: Hemicryptophytes; Crp.: Cryptophytes; Chp.: Chamaephytes; Thp.: Therophytes; Php.: Phanerophytes; Vp.: Vascular parasite; Hd.: Hydrophytes; NanoPh.: Nanophanerophytes

**References**

- Agar, G., A. Adıgüzel, O. Barıs, M. Güllüce, F. Şahin and M. Şengül. 2010. Phenotypic and Genotypic Diversity among *Astragalus* species Growing In Eastern Anatolia Region of Turkey. *Bangladesh J. Bot.*, 39(1): 1-7.
- Anonymous, 2000. *1/500000 Ölçekli Türkiye Jeoloji Haritaları*. Maden Tetkik ve Arama Genel Müdürlüğü Press., Ankara.
- Anonymous, 2005. *Rize İli Arazi Varlığı*. T.C. Tarım ve Köyişleri Bakanlığı, Köy Hizmetleri Genel Müdürlüğü, İl Rapor No: 53, Ankara.
- Anonymous, 2011. *1975-2010 Dönemi Pazar Meteoroloji İstasyonuna Ait Rasat Değerleri*. Devlet Meteoroloji İşleri Genel Müdürlüğü Press., Ankara.
- Brummitt, R.K. and C.E. Powell (Eds.). 1992. Authors of Plant Names. *Royal Botanic Gardens*, 732 pp., Kew.
- Çobanoğlu, M. 2012. *Flora and Vegetation of Güneysu-Çağrankaya (Güneysu, Rize)*. Master thesis. Recep Tayyip Erdoğan Üniversitesi Fen Bilimleri Enstitüsü, Rize.
- Davis, P.H. (Eds.). 1965-1985. *Flora of Turkey and the East Aegean Islands*. Vols. 1-9, Edinburgh University Press., Edinburgh.
- Davis. P.H., R.R. Mill and K. Tan (Eds.). 1988. *Flora of Turkey and the East Aegean Islands*. Vol. 10, Edinburgh University Press., Edinburgh.
- Demir, E. 2013. *Flora Chemical and Palynological Analysis of Ayder-Ceymakçur provinces (Çamlıhemşin, Rize)*. Master thesis. Recep Tayyip Erdoğan Üniversitesi Fen Bilimleri Enstitüsü, Rize.
- Ekim, T., M. Koyuncu, M. Vural, H. Duman, Z. Aytaç and N. Adıgüzel. 2000. *Türkiye Bitkileri Kırmızı Kitabı, Eğrelti ve Tohumlu Bitkiler (Red Data Book of Turkish Plants, Pteridophyta and Spermatophyta)*. TTKD Van Yüzüncüyıl Üniversitesi Press., Ankara.
- Ellenberg, H. and D. Mueller-Dombois. 1967. A key to Raunkiaer plant life forms with revised subdivisions. *Ber. Geobot. Inst ETH Stifg Rubel Zurich*37: 56-73.
- Eminağaoğlu, O. and R. Anşin. 2004. Flora of the Karagol-Sahara National Park (Artvin) and its environs. *Turk. J. Bot.* 28: 557-590.
- Eminağaoğlu, O. and R. Anşin. 2003. The flora of Hatila Valley National Park and its close environs (Artvin). *Turk. J. Bot.*27: 1-27.

- Erik, S., A. Güner, Ş. Yıldırım and H. Sumbul. 1996. *Tohumlu Bitkiler Sistematigi Laboratuvar Kılavuzu*. Literature Yayınevi Press., Ankara.
- Güner, A. 1984. Rize Florasına Hazırlık I Rize'den bitki toplananların listesi. *Doğa Turk. J. Bot.*, 8 (2): 278-281.
- Güner, A., M. Vural and K. Sorkun. 1987. Rize Florası, Vegetasyonu ve Yöre Ballarının Polen Analizi. Tübitak Matematik, Fizik ve Biyolojik Bilimler Araştırma Grubu, Proje No: TBAG-650, Ankara, Türkiye.
- Güner, A., N. Özhatay, T. Ekim and K.H.C. Başer (Eds.). 2000. *Flora of Turkey and the East Aegean Islands*. Vol. 11. Edinburgh University Press., Edinburgh.
- Ketzkhoveli, N.N. and R.I. Gagnidze (Eds.). 1971-2001. *Georgian Flora (Flora of Georgia)*. Vols. 1-13. Metsniereba, Tbilisi, Georgia.
- Khan, S. M., D. M. Harper, S. Page and H. Ahmad, 2011. Species and Community Diversity of Vascular Flora along Environmental Gradient in Naran Valley: A Multivariate approach through Indicator Species Analysis. *Pak. J. Bot.* 43 (5): 2337-2346.
- Khan, S. M., S. Page, H. Ahmad and D. M. Harper, 2013. Sustainable Utilization and Conservation of Plant Biodiversity in Montane Ecosystems; using the Western Himalayas as a Case Study. *Ann. Bot.*, 112(3): 479-501
- Khan, S. M., S. Page, H. Ahmad and D. M. Harper, 2014. Ethno-ecological importance of plant biodiversity in mountain ecosystems with special emphasis on indicator species; a case study of the Naran Valley in the Northern Pakistan. *J. of Eco. Ind.* 37 (Part A); 175-185.
- Khan, S. M., S. Page, H. Ahmad, Z. Ullah, H. Shaheen, M. Ahmad and D. M. Harper, 2013. Phyto-climatic gradient of vegetation and habitat specificity in the high elevation Western Himalayas. *Pak. J. Bot.* 45(SI):223-230.
- Khan, W., S. M. Khan and H. Ahmad, 2015. Altitudinal variation in plant species richness and diversity at thandiani sub forests division, Abbottabad, Pakistan. *J. of Biod. & Env. Sc.* 7(1): 46-53.
- Komarov, V.L. and B.K. Shishkin (Eds.). 1933-1964. *Flora of USSR (English translation)* Vols. 1-30, Akademiya Nauk SSSR., Moscow and Leningrad.
- Leblebici, E. 1990. The genus *Polygonum* L. in Turkey. *Doğa Turk. J. Bot.*, 14: 203-214.
- Makbul, S. 2006. *Doğu Karadeniz Bölgesi Scorzonera L. (Asteraceae) taksonlarının Morfolojik, Anatomiik Yönden İncelenmesi*. Phd. Thesis. Fen Bilimleri Enstitüsü, Trabzon.
- Özhatay, N., Ş. Kültür and B. Gürdal. 2013. Check List of Additional Taxa to the Supplement Flora of Turkey VI. *İstanbul Ecz. Fak. Derg.* 43(1): 33-82.
- Palabaş-Uzun, 2009. *Flora, Vegetation and Succession of Sisdağı (Trabzon)*. Phd. Thesis, Fen Bilimleri Enstitüsü, Trabzon.
- Raunkiaer, C.1934. *The Life Form of Plants and Statistical Plant Geography*. Oxford University Press., London.
- Shaheen, H., Q. Rahmatullah, Z. Iram, M. Munir and M. Ilyas. 2014. Floristic Diversity of Santh Saroola, Kotli Sattia, Rawalpindi, Pakistan. *Pak. J. Bot.* 46(6): 1945-1954.
- Terzioğlu, S. 1998. *Flora and Vegetation of Uzungöl (Çaykara, Trabzon)*. KTU Fen Bilimleri Enstitüsü, Trabzon.
- Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S. Walters and B.A. Webb (eds.). 1964-1980. *Flora Europaea*. Vols. 1-5. Cambridge University Press., Cambridge.
- Uzun, A. 2009. *Mapping and Determination of plant biodiversity of KTU Universty Research Forest (Trabzon)*. Phd. Thesis. Fen Bilimleri Enstitüsü, Trabzon.
- Vural, M. 1996. Rize'nin Yüksek Dağ Vegetasyonu. *Doğa Turk. J. Bot.*, Ek Sayı: 83-102.
- Zohary, M. 1973. *Geobotanical Foundations of the Middle East*. Vols.1-2. Gustav Fischer Verlag., Amsterdam.

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