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Research article/Araştırma makalesi

An overview of the floristical, phytosociological and phytoecological structure of Turkish Eastern Beech (*Fagus orientalis*) forests

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Abstract

Fagus orientalis Lipsky (eastern / oriental beech) is the most common species of the genus *Fagus* L. in Turkey. *F. orientalis* formation is widespread especially in Black Sea and Marmara Regions. Furthermore, this species is locally seen in the Pos Forests (Adana), on the Amanos Mountains and Kahramanmaraş-Andırın district (in East Mediterranean Region); on the Murat and Türkmen Mountains (Aegean Region). *F. orientalis* is represented by 17 associations in Turkey. These associations include 515 taxa (111 tree and shrub habit, 414 herbaceus) floristically. The life form spectrum of *F. orientalis* forests includes 298 hemicryptophytes, 83 phanerophytes, 79 therophytes, 31 geophytes, 27 chamaephytes, 5 vascular parasites. Phytogeographically a major part of the taxa in *F. orientalis* forests are Euro-Siberian elements (23%) followed by the Irano-Turanian (6%) and Mediterranean (6%). There are 32 endemic taxa in *F. orientalis* forest (6 shrub/tree habit-26 herbaceus) (6.21%). *F. orientalis* associations are found in different altitudes (between 10-1740 m.), on different bedrocks (limestone, andesite, schist, mica schist, flaser gneiss, granite) and in brown forest soils commonly in Turkey. The distribution of associations numerically evaluated on the *F. orientalis* vegetation distributed in Turkey is related to the climatic and geographic factors. Similar associations in the same climate zones show resemble ordination and cluster results.

Key words: *Fagus orientalis*, Turkey, Floristical Structure, Phytosociology, Phytoecology

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Türkiye'nin Doğu Kayını (*Fagus orientalis*) ormanlarına floristik, fitososyolojik ve fitoekolojik açıdan genel bir bakış

Özet

Fagus orientalis Lipsky (doğu kayını)" *Fagus* cinsinin Türkiye'deki en yaygın türüdür. *F. orientalis* formasyonları özellikle Karadeniz ve Marmara Bölgeleri'nde geniş yayılış göstermektedir. Ayrıca bu türe Doğu Akdeniz'de, Adana'nın Pos ormanlarında, Amanos dağlarında ve Kahramanmaraş-Andırın yöresinde; Ege Bölgesi'nde de Murat ve Türkmen Dağları'nda lokal olarak rastlanmaktadır. *F. orientalis* Türkiye'de 17 birlik ile temsil edilmektedir. *F. orientalis* birlikleri floristik açıdan 111'i ağaç ve çalı, 414'ü de ot formunda olmak üzere 515 takson ihtiva etmektedir. *F. orientalis* ormanlarında hayat formları bakımından; 298 hemikriptofit, 83 fanerofit, 79 terofit, 31 geofit, 27 kamefit ve 5 vasküler parazit takson göze çarpmaktadır. Fitocoğrafik olarak Avrupa-Sibirya kökenli bitkiler bu ormanlarda çoğunluktadır (%23). İran-Turan ve Akdeniz fitocoğrafik bölgesi bitkileri ise ikinci sırada gelmektedir (%6). *F. orientalis* ormanlarında 32 endemik takson (6'sı ağaç/çalı-26'sı otsu) (%6.28) belirlenmiştir. *F. orientalis* birlikleri Türkiye'de 10-1740 metreler arasında, değişik anakayalar (kireçtaşı, andezit, şist, mikaşist, gnays, granit) üzerinde ve çoğunlukla kahverengi orman topraklarında yayılış göstermektedir. Türkiye'de yayılış gösteren *F. orientalis* vejetasyonu üzerinde yapılan nümerik değerlendirmede birliklerin dağılımı iklimsel ve coğrafik faktörlere göre gerçekleşmiştir. Aynı iklim bölgelerinde benzer birlikler, ordinasyon ve cluster sonuçlarında görülmektedir.

Anahtar kelimeler: *Fagus orientalis*, Türkiye, Floristik Yapı, Fitososyoloji, Fitoekoloji

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1. Introduction

Turkey is situated in the temperate zone and it has the richest flora among the west palearctic countries. It also attracts attention with its high endemism rate in the Turkish flora (34.4%). Nearly one third of the flowering plants and ferns grown naturally in Turkey (10.765) are endemic (3022). In the temperate zone, except the isolated islands and tropical countries, the high rate of endemism is not seen in any other countries (Özhatay et al., 2003). Because, Turkey contains a great variety of natural habitats, ranging from Mediterranean, Aegean, and Black Sea beaches to towering coastal and interior mountains, from deeply incised valleys to expansive steppes, from fertile alluvial plains to arid, rocky hillslopes (Kaya and Raynal, 2001). Turkey is one of the oldest inhabited regions in the world and embodies a rich biodiversity and plant formations distributed on different landscapes (Gücel et al., 2008).

In Turkey, forest lands constitute 20.7 million ha or 26.8% of the area of the country. Of these forests, 10.5 million ha (51% of total forest land) are considered to be productive while the remaining 10.2 million ha of forests are unproductive or highly degraded due to excessive exploitation (Boydak, 1999). Most forest lands are located in the Black Sea, the Mediterranean Sea and Aegean geographic regions (Kaya and Raynal, 2001).

Turkish forestry focuses mainly have focused on timber production. The Black Sea region contains most of the country's forestland (Kaya and Raynal, 2001). Productive deciduous tree species occupy only 7% (1 414 000 ha) of the country's total forestland, of which "eastern / oriental beech (*Fagus orientalis*)" has the greatest share (42%). About 80% of beech forests are classified as highly productive, producing more than 3 million m^3 annually (Anonymous, 1987).

More than 450 species of trees and shrubs are distributed naturally in the forests of Turkey (Colak and Rotherham, 2006). Turkish forests consist of pure and sometimes mixed communities formed by deciduous and evergreen tree types (Anonymous, 2005). 42% of the forests in Turkey are composed of coniferous species (30% *Pinus sp*., 4.6% *Juniperus sp*., 0.9% *Abies sp*., 0.7% *Picea orientalis* (L.) Link, 0.5% *Cedrus libani* A. Rich, and 5.5% mixed coniferous forests), 53.3% of broad-leaved species (22.7% *Quercus sp*., 3.3% *F. orientalis*, 0.2% *Alnus sp*., 0.1% *Castanea sativa* Miller, 0.1% other broad-leaved species, 18.5% mixed broad-leaved forests and 8.4% maquis) and 4.5% mixed coniferous and broadleaved forests (Mayer and Aksoy, 1986). As seen, more than the half of Turkish forests are composed of broadleaved tree types and among these species *Fagus sp.* comes in the second range after *Quercus sp.*

Fagaceae family, which is the most important leaved tree types in Turkey and Europe regarding to the forestry, contains more than 600 taxa (belong to 6 genera: *Castanea sp., Fagus sp., Quercus sp., Nothofagus sp., Castanopsis sp. ve Lithocarpus sp*.) spreaded on booth hemispheres. 39.25% of the total forest area 21.2 million ha in Turkey is covered with tree types including *Fagaceae* family (Anonymous, 2006).

Fagus (beech) is among the most abundant and economically important genera of broadleaved trees in northern hemisphere temperate forests (Denk et al., 2002). The genus *Fagus* Tourn. ex L. (Fagaceae) comprises about ten monoecious broad-leaved deciduous tree species that are at present disjunctly distributed in temperate areas of the Northern Hemisphere (Denk, 2003). *F. orientalis* is a forest tree which grows up to 35-50 m. The geographical areas on Earth are Turkey, Bulgaria, Caucasus and Iran (Davis, 1965-1985). As for "*F. sylvatica* L. (European beech)" is the most abundant broad-leaved forest tree in Central Europe and in many mountains of southern Europe. It is highly competitive in many types of zonal forest as it is shade-tolerant as juvenile and casts deep shade as canopy tree (Peters, 1997).

There are 1.751.484 ha beech (*F. orientalis* and *F. sylvatica*) forests in Turkey (www.ogm.gov.tr). *F. orientalis* which has a high economical value occupies 614.615 ha. of the country's total forestland with the ratio 17.8% and 40.8% of the broadleaved high forest (Anonymous, 1987). The eastern beech wood is hard and heavy. It is processed and cleaved easily and the declination resistance of its wood and its flexibility module is high. It is used for making furniture, car, parquet, toy, boat and oven oars, carpenter frames and producing fuel (Anonymous, 1987; Yaltırık 1993).

F. orientalis is the most common species of *Fagus* distributed in Turkey (Davis, 1965-1985) (Figure 1). *F. orientalis* formation is widespread especially in the Pontic Province of Euro-Siberian floristic region of Turkey (in Black Sea and Marmara Regions). From the phytosociological point of view that is very interesting *F. orientalis* enclave in the Pos Forests (Adana / Anti –Taurus) (Yurdakulol, 1981). In addition Quezel and Pamukçuoğlu (1970) in the Kaz Mountain and Akman (1973) in the Amanos Mountains have been pointed out the relicts of the *F. orientalis* outside of the Pontic Province of Turkey.

Moreover this species is grown on Murat and Türkmen Mountains in Aegean Region (Anonymous, 2005; Göl et al., 2008). It is also seen locally Maraş-Andırın (North-East Mediterranean) (Yaltırık and Efe, 2000; Güler and Bektaş, 2000; Bektaş et al., 2002). *F. orientalis* forms pure communities and sometimes mixed as well. The other species *F. sylvatica* is widespread in Europe and locally seen on some mountains in Thrace and Aegean Regions (Anonymous, 2005). In this study the floristical, phytosociological and phytoecological structure of some Turkish *F. orientalis* forests were investigated.

F. orientalis associations occur especially around İnegöl Mountain (Gümüşhacıköy-Amasya) Yıldırım and Kılınç (2011); Sakarat Mountain (Amasya) Bingöl et al. (2007); Istranca (İstanbul-Bulgaristan) Yarcı (2000), Yarcı (2002), Nebyan Mountain (Bafra-Samsun) Kutbay and Kılınç (1995);

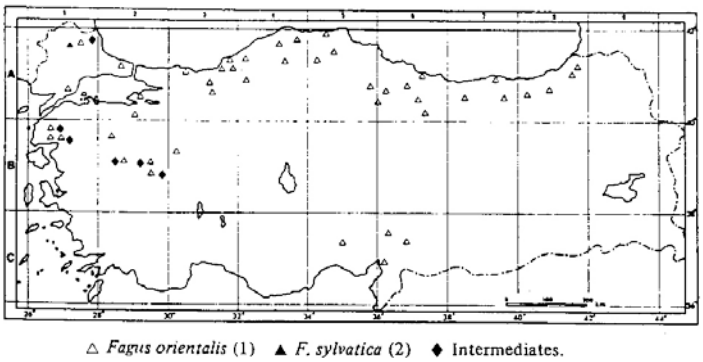

Figure 1. The distribution of *Fagus* species in Turkey (Davis, 1965-1985)

Çam Mountains (Düzce-Akçakoca) Aydoğdu (1982); Simav Mountain (Simav-Kütahya) Yayıntaş (1982); Gümüş Mountain (Kütahya) Tatlı et al. (2005); Bolu Mountains (Bolu) Akman and Yurdakulol (1980); Uzungöl and surroundings (Trabzon) Terzioğlu (1998); Kunduz Forest (Vezirköprü-Samsun) Özen and Kılınç (2002); between Alaçam-Gerze and Boyabat-Durağan (Sinop) Özen and Kılınç (1995); Sinop Peninsula Kılınç and Karaer (1995); Bilecik-Bursa (Bithynia) Türe et al. (2005) and vicinity of Kastamonu-İnebolu-Cide Ketenoğlu (1981). Their altitudinal distribution area ranges between 10-1740 m. In Sinop Peninsula the altitude falls down to 10-50 m. In Kunduz Forest (Vezirköprü-Samsun) they are found at 1150-1740 m.

2. Materials and methods

In this study the following phytosociological studies, Yıldırım and Kılınç (2011), Bingöl et al. (2007), Tatlı et al. (2005), Özen and Kılınç (2002), Yarcı (2002), Yarcı (2000), Kutbay and Kılınç (1995), Özen and Kılınç (1995), Kılınç and Karaer (1995), Aydoğdu (1982), Yayıntaş (1982), Ketenoğlu (1981), Akman and Yurdakulol (1980) were evaluated. In evaluated studies, vegetation analysis was performed according to traditional Braun-Blanquet approach (1964) and the cover abundance scale of Barkman et al. (Barkman et al., 1964) used. The names and classifications of all earlier described syntaxa were checked and necessary corrections made in accordance with the "International Code of Phytosociological Nomenclature" (ICPN) (Quézel et al., 1992; Weber et al. 2000).

In this research, the nomenclature, taxonomy and chorology of the taxa in the associations were taken from Davis et al. (1965-1988) and Zohary (1973). The life forms were determined according to Raunkier (Kılınç et al., 2006). The floristical, phytosociological and phytoecological characters of *F. orientalis* associations were determined. The distribution map of *F. orientalis* associations in Turkey was drawn. The syntaxonomic categories of *F. orientalis* associations described in different areas were compared. Furthermore, *F. orientalis* associations mentioned in different research were compared regarding to their spreading altitude, bedrock, soil, inclination, direction and the height and coverage of the tree layer.

17 association tables obtained from the 15 different studies relating to the *Fagus orientalis* vegetation in Turkey are combined in a pre-table. The coverage-abundance values belonging to the taxa in quadrats were converted into the scala suggested by Van der Maarel (Van der Maarel, 1979). For the pre-table designed in this format cluster analysis was applied with the Detrended Correspondence Analysis (DCA) Hill and Gauch (1980) and Ward (1963) by using Community Analysis Package version 1.50 Henderson and Seaby (1999) packet program. Shannon-Wiener diversity index Magurran (2004) was used for biological diversities. Index values were calculated using Biodiversity version 2.0 McAlleece (1997) packet programme.

3. Results and discussion

According to Mayer and Aksoy (1986) and Colak and Odabası (2004), in terms of the forest regions of Turkey (distinctive forest communities are adapted to the different climatic conditions) *F. orientalis* forests are included the “Euxin-Subeuxin Forest Regions of North Anatolia (cool winters, humid to sub-humid summers)”.

17 plant associations were determined in 15 various researches carried on *F. orientalis* forests in Turkey (Figure 2). 12 of these associations were found in Black Sea Region, 3 of them in Marmara Region and 2 of them are in Aegean Region. As *F. orientalis* is widely spreaded and the best grown up on the medium and high parts of the mountains lying parallel to the Black Sea coasts from Demirköy to Hopa and formed pure and mixed forests in the north sides Yaltırık (1993), it is quite natural to have such a table regarding to the spreading of the associations.

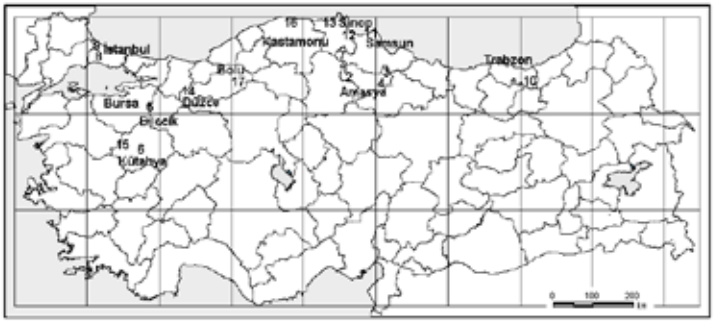

Figure 2. The distribution of *F. orientalis* associations in Turkey

F. orientalis is represented by the following associations in Turkey (Figure 2):

1.*Cardamino bulbiferae-Fagetum orientalis* (Yıldırım and Kılınç, 2011): İnegöl Mountain (Gümüşhacıköy-Amasya), 1350-1600 m, Andesite bedrock, Brown Forest Soils.

2. *Carpino betuli-Fagetum orientalis* (Yıldırım and Kılınç, 2011): İnegöl Mountain (Gümüşhacıköy-Amasya), 1350-1650 m, Andesite bedrock, Brown Forest Soils.

3. *Pino sylvestri-Fagetum orientalis* (Bingöl et al., 2007): Sakarat Mountain (Amasya), 1074-1575 m, Limestone-Volcanic bedrock, Brown Forest Soils.

4. *Rhododendro lutei-Fagetum orientalis* (Bingöl et al., 2007): Sakarat Mountain (Amasya), 800-1520 m, Limestone bedrock, Brown Forest Soil – Chestnut Soils.

5. *Trachystemo orientalis-Fagetum orientalis* (Türe et al., 2005): Bilecik-Bursa (Bithynia), 550-940, Calcite – Schist bedrock.

6. *Pino sylvestri-Fagetum orientalis* (Tatlı et al., 2005): Gümüş Mountain (Kütahya), 1630-1710 m, Limestone bedrock, Brown Forest Soils.

7. *Galio-Fagetum orientalis* (Özen and Kılınç, 2002): Kunduz Forest (Vezirköprü-Samsun), 1150-1740 m, Grayish Brown Podzolic Soils.

8. *Carpino betuli-Fagetum orientalis* (Yarcı, 2002): Istranca Mountains (İstanbul-Bulgaristan), 670-710 m, Flaser Gneiss –Granite bedrock, Brown Forest Soil - Podzolic Soils.

9. *Rhododendro ponticum-Fagetum orientalis* (Yarcı, 2000): Istranca Mountains (İstanbul-Bulgaristan), 200-400 m, Granite bedrock, Brown Forest Soil - Podzolic Soils.

10. *Piceo orientalis-Fagetum orientalis* (Terzioğlu, 1998): Uzungöl and Surroundings (Trabzon), 940-1650 m, Grayish Brown Podzolic Soils.

11. *Carpino-Fagetum orientalis* (Kutbay and Kılınç, 1995): Nebyan Mountain (Bafra-Samsun), 150-650 m, Grayish Brown Podzolic Soils.

12. *Carpino-Fagetum orientalis* (Özen and Kılınç, 1995): Alaçam-Gerze and Boyabat-Durağan (Sinop), 300-900 m.

13. *Carpino betuli-Fagetum orientalis* (Kılınç and Karaer, 1995): Sinop Peninsula, 10-50 m.

14. *Rhododendro ponticum-Fagetum orientalis* (Aydoğdu, 1982): Çam Mountains (Düzce-Akçakoca), 400-1200 m, Andesite - Schist –Limestone bedrock.

15. *Fagetum orientalis* (Yayıntaş, 1982): Simav Mountain (Simav-Kütahya), 1300-1700 m, Mica Schist - Flaser Gneiss bedrock, Organic Soils.

16. *Rhododendro ponticum-Fagetum orientalis* (Ketenoğlu, 1981): Kastamonu-İnebolu-Cide, 800-1100, Limestone – Schist bedrock, Brown Forest Soils.

17. *Rhododendro ponticum-Fagetum orientalis* (Akman and Yurdakulol, 1980): Bolu Mountains, 500-1600 m, Brown Forest Soils.

The taxa of *F. orientalis* associations are in 111 tree/shrub and 414 herb forms. Especially in the associations formed by eastern beech the floristic structure is quite poor depending on coverage of crown diameter. 32 endemic taxa composed of the floristical composition of the *F. orientalis* associations according to threatened categories are as follows (Ekim et al., 2000) (Table 1).

The distribution ratio of plant species in *F. orientalis* forests according to the Raunkier Life Forms are given in Figure 3. As seen in the figure hemicryptophytes are dominant in *F. orientalis* forests (298-57%). Phanerophytes place in the second in biological spectrum (83-16%) and terophytes in the third as their ratio is close to phanerophytes (79-15%). As the *F. orientalis* associations are mostly distributed in Euro-Siberian phytogeographical region, this distribution is quite normal. Because in Euro-Siberian region, the relatively humid climate is reflected in the predominantly mesophytic vegetation. Deciduous forest is the usual climax in the middle and lower zones with phanerophytes and hemicryptophytes occurring in abundance (Davis, 1965-1985).

Table 1. The threatened categories of endemic taxa of Beech (*F. orientalis*) associations

Life Form	Endemic taxon	Family	Phytogeographic Region	Threatened Categories
Ph	*Abies nordmanniana* subsp. *bornmülleriana*	Pinaceae	_	LR (Ic-least concern)
Ph	*Crataegus tanacetifolia*	Rosaceae	_	LR (Ic-least concern)
Ph	*Euonymus latifolius* subsp. *cauconis*	Celastraceae	_	LR (nt-near threatened)
Ph	*Lonicera caucasica* subsp. *orientalis*	Caprifoliaceae	_	LR (Ic-least concern)
Ph	*Quercus macranthera* subsp. *syspirensis*	Fagaceae	_	LR (Ic-least concern)
Ch	*Rhododendron ponticum* subsp. *ponticum*	Ericaceae	_	EN (Endangered)
H	*Anchusa leptophylla* subsp. *incana*	Boraginaceae	Irano-Turanian	LR (Ic-least concern)
H	*Anthemis pauciloba* var. *pauciloba*	Asteraceae	Mediterranean	LR (Ic-least concern)
H	*Arenaria ledebouriana* var. *ledebouriana*	Caryophyllaceae	_	LR (Ic-least concern)
H	*Asperula cymulosa*	Rubiaceae	Mediterranean	VU (Vulnerable)
H	*Astragalus campylosema* subsp. *campylosema*	Fabaceae	Irano-Turanian	LR (Ic-least concern)
H	*Campanula lyrata* subsp. *lyrata*	Campanulaceae	_	LR (Ic-least concern)
H	*Cicerbita variabilis*	Asteraceae	_	LR (Ic-least concern)
H	*Cirsium pseudopersonata* subsp. *pseudopersonata*	Asteraceae	_	LR (Ic-least concern)
H	*Digitalis lamarckii*	Scrophulariaceae	Irano-Turanian	LR (Ic-least concern)
H	*Geranium asphodeloides*	Geraniaceae	Euro-Siberian	LR (Ic-least concern)
H	*Geranium cinereum* subsp. *subcaulescens* var. *subacutum*	Geraniaceae	_	LR (Ic-least concern)
H	*Helichrysum arenarium* subsp. *aucheri*	Asteraceae	Irano-Turanian	LR (Ic-least concern)
H	*Lathyrus tukhtensis*	Fabaceae	_	LR (Ic-least concern)
H	*Lathyrus undulatus*	Fabaceae	_	VU (Vulnerable)
H	*Linaria corifolia*	Scrophulariaceae	Irano-Turanian	LR (Ic-least concern)
H	*Onobrychis bornmuelleri*	Fabaceae	_	EN (Endangered)
H	*Onosma armenum*	Boraginaceae	_	LR (Ic-least concern)
H	*Phlomis russeliana*	Lamiaceae	_	LR (Ic-least concern)
H	*Sideritis amasiaca*	Lamiaceae	_	LR-nt (near threatened)
H	*Sideritis germanicopolitana* subsp. *germanicopolitana*	Lamiaceae	_	LR (Ic-least concern)
H	*Trifolium pannonicum* subsp. *elongatum*	Fabaceae	_	LR (Ic-least concern)
H	*Verbascum ponticum*	Scrophulariaceae	_	LR-cd (conservation dependent)
H	*Veronica multifida*	Scrophulariaceae	Irano-Turanian	LR (Ic-least concern)
G	*Allium olympicum*	Liliaceae	_	LR (Ic-least concern)
G	*Crocus speciosus*	Iridaceae	_	LR-nt (near threatened)
G	*Epipactis pontica*	Orchidaceae	_	LR (Ic-least concern)

Abbreviations used: Life forms according to Raunkier (Kılınç et al., 2006): Ph; Phanerophytes, Ch; Chamaephytes, H; Hemicryptophytes, G; Geophytes.

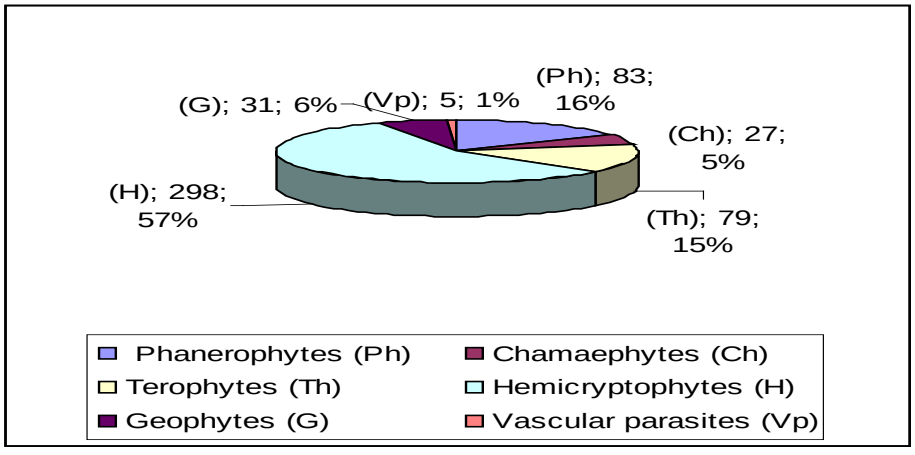

Figure 3. Life forms of plant species in *F. orientalis* associations

According to the phytogeographical region of species, Euro-Siberian origin plants are the most with 120 taxa in *F. orientalis* forests (23%) (Figure 4). Irano-Turanian and Mediterranean origin plants are represented in eastern beech forests with a same low ratio (31-6%). Taxa with multiregional or unknown regions are found in these forests with a high ratio (341-65%). There are 32 endemic taxa in *F. orientalis* forest (6 shrub/tree–26 herb) (6.21%).

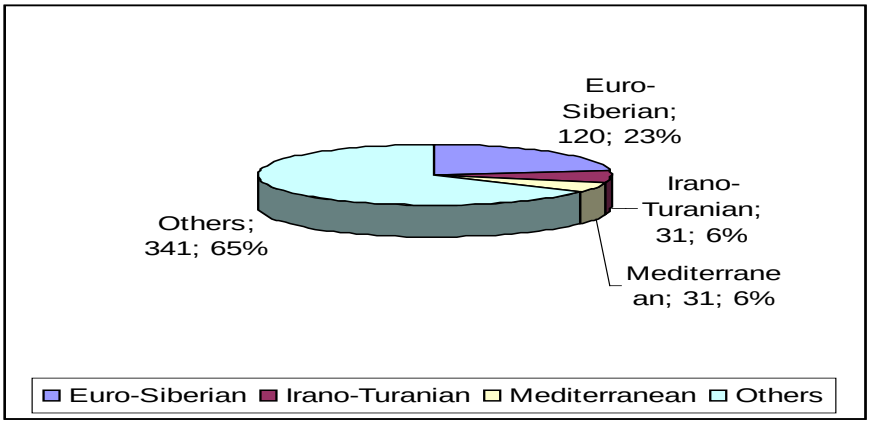

Figure 4. Phytogeographical origins of plant species in *F. orientalis* associations

The dispersion and the ratios of the species gathered from the *F. orientalis* forests according to the biggest five families in the importance order are as fallow: *Asteraceae* 61 (12%), *Fabaceae* 47 (9.0%), *Rosaceae* 37 (7.0%), *Poaceae* 36 (7.0%), *Lamiaceae* 36 (7.0%), multi–regional or unknown phytogeographic origin 306 (58%) (Figure 5).

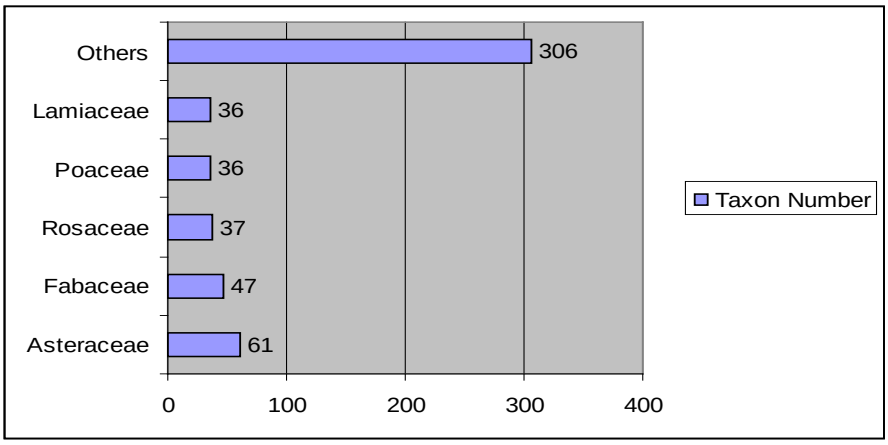

Figure 5. The distribution of families in *F. orientalis* associations

The biggest five genera which are determined according to the taxon numbers in the *F. orientalis* associations is shown in Table 2.

Table 2. First five genera in *F. orientalis* associations

Genera	Taxon Numbers
Galium	10
Campanula – Salvia	9
Veronica – Trifolium	8
Geranium – Rubus - Quercus-Lathyrus-	7
Epilobium – Cardamine – Bromus –Verbascum – Scabiosa – Rumex –Ranunculus – Hypericum – Astragalus	5

Moreover, *F. orientalis* associations were evaluated as syntaxonomic (Table 3). When the studies examined it was seen that, some researchers classified *F. orientalis* associations into "Quercetea-Pubescentis" class and other into "Querco–Fagatea" class. Additionally, according to the study conducted by Ketenoğlu et al. (2010) the *F. orientalis* associations have been included in these two classes.

Akman and Yurdakulol (1980); Ketenoğlu (1981); Aydoğdu (1982); Özen and Kılınç (2002); Kılınç and Karaer (1995); Özen and Kılınç (1995); Kutbay and Kılınç (1995); Yarcı (2000); Bingöl et al. (2007) (second

association in the study area) classified *F. orientalis* associations into "Rhododendro–Fagetalia orientalis" order. Yet, Bingöl et al. (2007) (first association in the study area) and Yıldırım and Kılınç (2011) (both association in the study area) classified *F. orientalis* associations into "Querco-Carpinetalia" order. Yarcı (2002) classified *F. orientalis* association into "Quercetalia–Pubescentis" order. On the other hand, Yayıntaş (1982) and Tatlı et al. (2005) classified them into "Querco–Cedretalia" order (Table 3). According to Ketenoğlu et al. (2010)'s study some *F. orientalis* associations in Turkey can be included into "*Pino sylvestris-Piceetalia orientalis"* and "*Fagetalia sylvaticae"* orders.

Yıldırım and Kılınç (2011) (both association in the study area) and Bingöl et al. (2007) (first association in the study area) classified the associations into "Carpino-Acerion" alliance whereas Tatlı et al. (2005) evaluated them in "Ostryo-Quercion pseudocerridis" alliance. The associations were not represented well at alliance level in other studies. In their study, Ketenoğlu et al. (2010) identified "Quercion frainetto", "Crataego pentagynae-Fagion orientalis", "Alnion barbatae", "Veronico peduncularis-Fagion orientalis" and "Fagion sylvaticae" alliances for some *F. orientalis* associations in Turkey.

Table 3. The syntaxonomic categories of *F. orientalis* associations described in different

			Syntaxonomic Categories			
Research	Study Area	Association	Superclass	Class	Order	Alliance
(Yıldırım and Kılınç, 2011)	İnegöl Mountain (Gümüşhacıköy-Amasya)	*Cardamino bulbiferae-Fagetum orientalis*	Querco-Fagea	Quercetea-Pubescentis	Querco-Carpinetalia	Carpino- Acerion
(Yıldırım and Kılınç, 2011)	İnegöl Mountain (Gümüşhacıköy-Amasya)	*Carpino betuli-Fagetum orientalis*	Querco-Fagea	Quercetea-Pubescentis	Querco-Carpinetalia	Carpino- Acerion
(Bingöl et al., 2007)	Sakarat Mountain (Amasya)	*Pino sylvestri-Fagetum orientalis*	Querco-Fagea	Quercetea-Pubescentis	Querco-Carpinetalia	Carpino- Acerion
(Bingöl et al., 2007)	Sakarat Mountain (Amasya)	*Rhododendro lutei-Fagetum orientalis*	Querco-Fagea	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Türe et al., 2005)	Bilecik-Bursa (Bithynia)	*Trachystemo orientalis- Fagetum orientalis*	-	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Tatlı et al., 2005)	Gümüş Mountain (Kütahya)	*Pino sylvestri-Fagetum orientalis*	Querco-Fagea	Quercetea-Pubescentis	Querco-Cedretalia libani	Ostryo-Quercion pseudocerridis
(Özen and Kılınç, 2002)	Kunduz Forest (Vezirköprü-Samsun)	*Galio-Fagetum orientalis*	-	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Yarcı, 2002)	Istranca Mountains (İstanbul-Bulgaristan)	*Carpino betuli-Fagetum orientalis*	Querco-Fagea	Quercetea-Pubescentis	Quercetalia-Pubescentis	-
(Yarcı, 2000)	Istranca Mountains (İstanbul-Bulgaristan)	*Rhododendro ponticum- Fagetum orientalis*	Querco-Fagea	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Terzioğlu, 1998)	Uzungöl and Surroundings(Trabzon)	*Piceo orientalis-Fagetum orientalis*	-	-	Rhododendro-Fagetalia orientalis	-
(Kutbay and Kılınç, 1995)	Nebyan Mountain (Bafra-Samsun)	*Carpino-Fagetum orientalis*	-	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Özen and Kılınç, 1995)	Between Alaçam-Gerze and Boyabat-Durağan (Sinop)	*Carpino-Fagetum orientalis*	-	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Kılınç and Karaer, 1995)	Sinop Peninsula	*Carpino betuli-Fagetum orientalis*	-	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Aydoğdu, 1982)	Çam Mountains (Düzce-Akçakoca)	*Rhododendro ponticum-Fagetum orientalis*	-	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Yayıntaş, 1982)	Simav Mountain (Simav-Kütahya)	*Fagetum orientalis*	-	Quercetea-Pubescentis	Querco-Cedretalia	-
(Ketenoğlu, 1981)	Kastamonu-İnebolu-Cide	*Rhododendro ponticum-Fagetum orientalis*	Querco-Fagea	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-
(Akman and Yurdakulol, 1980)	Bolu Mountains	*Rhododendro ponticum-Fagetum orientalis*	Querco-Fagea	Querco-Fagatea	Rhododendro-Fagetalia orientalis	-

F. orientalis associations in Turkey were distributed at the altitudes 10-1740 m., on various bedrocks (limestone, andesite, schist, mica schist, flaser gneiss, granite) and in mostly brown forest soils. The ecological tolerance of the associations are very wide relating to the height and bedrock. When different researches examined, the lowest altitude is 10 m. in Sinop Peninsula (Kılınç and Karaer, 1995). The highest distribution is in Kunduz Forest with 1740 m. height (Özen and Kılınç, 2002) (Table 4).

Table 4. The comparison of *F. orientalis* associations defined in various regions relating to distribution height, bedrock and soil

Research	Study Area	Association	Altitude (m.)	Bedrock	Soil Type
(Yıldırım and Kılınç, 2011)	İnegöl Mountain (Gümüşhacıköy-Amasya)	*Cardamino bulbiferae-Fagetum orientalis*	1350-1600	Andesite	Brown Forest Soil
(Yıldırım and Kılınç, 2011)	İnegöl Mountain (Gümüşhacıköy-Amasya)	*Carpino betuli-Fagetum orientalis*	1350-1650	Andesite	Brown Forest Soil
(Bingöl et al., 2007)	Sakarat Mountain (Amasya)	*Pino sylvestri- Fagetum orientalis*	1074-1575	Limestone-Volcanic	Brown Forest Soil
(Bingöl et al., 2007)	Sakarat Mountain (Amasya)	*Rhododendro lutei-Fagetum orientalis*	800-1520	Limestone	Brown Forest Soil – Chestnut Soil
(Türe et al., 2005)	Bilecik-Bursa (Bithynia)	*Trachystemo orientalis-Fagetum orientalis*	550-940	Calcite - Schist	-
(Tatlı et al., 2005)	Gümüş Mountain (Kütahya)	*Pino sylvestri- Fagetum orientalis*	1630-1710	Limestone	Brown Forest Soil
(Özen and Kılınç, 2002)	Kunduz Forest (Vezirköprü-Samsun)	*Galio-Fagetum orientalis*	1150-1740	-	Grayish Brown Podzolic Soil
(Yarcı, 2002)	Istranca Mountains (İstanbul-Bulgaristan)	*Carpino betuli-Fagetum orientalis*	670-710	Flaser Gneiss -Granite	Brown Forest Soil - Podzolic Soil
(Yarcı, 2000)	Istranca Mountains (İstanbul-Bulgaristan)	*Rhododendro ponticum-Fagetum orientalis*	200-400	Granite	Brown Forest Soil - Podzolic Soil
(Terzioğlu, 1998)	Uzungöl and Surroundings (Trabzon)	*Piceo orientalis-Fagetum orientalis*	940-1650	-	Grayish Brown Podzolic Soil
(Kutbay and Kılınç, 1995)	Nebyan Mountain (Bafra-Samsun)	*Carpino-Fagetum orientalis*	150-650	-	Grayish Brown Podzolic Soil
(Özen and Kılınç, 1995)	Between Alaçam-Gerze and Boyabat-Durağan (Sinop)	*Carpino-Fagetum orientalis*	300-900	-	-
(Kılınç and Karaer, 1995)	Sinop Peninsula	*Carpino betuli-Fagetum orientalis*	10-50	-	-
(Aydoğdu, 1982)	Çam Mountains (Düzce-Akçakoca)	*Rhododendro ponticum-Fagetum orientalis*	400-1200	Andesite - Schist - Limestone	-
(Yayıntaş, 1982)	Simav Mountain (Simav-Kütahya)	*Fagetum orientalis*	1300-1700	Mica Schist - Flaser Gneiss	Organic Soils
(Ketenoğlu, 1981)	Kastamonu-İnebolu-Cide	*Rhododendro ponticum-Fagetum orientalis*	800-1100	Limestone - Schist	Brown Forest Soil
(Akman and Yurdakulol, 1980)	Bolu Mountains	*Rhododendro ponticum-Fagetum orientalis*	500-1600	-	Brown Forest Soil

Moreover Atalay (1994) and Işık et al. (1995) classified the Turkish forests according to the floristic regions and determined the distribution heights of *F. orientalis* according to the phytogeographic regions (Table 5). With reference to, *F. orientalis* is distributed at between 500-1200 m. height in Black Sea and Marmara Regions. As in this research, the distribution generally begins from 10 m. (Sinop Peninsula) in the Black Sea Region and 200 m. (Istranca Mountains) in the Marmara Region. The areals ends at 1740 m (Kunduz Forest) in the Black Sea Region and 940 m. (Bithynia) in the Marmara Region.

Table 5. *F. orientalis* forest types within each of the three floristic regions of Turkey (Atalay, 1994; Işık et al., 1995)

Type of floristic region and forest types	Geographic regions	Elevational range where tree species occur
EURO-SIBERIAN "Broad-leaf deciduous and conifer forests"	Black Sea, Marmara	500-1200 m
MEDITERRANEAN "Aegean mountain (Oro-) forests"	Aegean	>1500 m
MEDITERRANEAN "Mediterranean (Oro-) mountain forests"	Mediterranean	1100-1900 m

In *F. orientalis* associations, the common inclination is 0-85 degrees, the tree layer coverage 50-100 % and tree height 6-30 m. These forests usually spread N-NW and NE sides of the mountains (Table 6).

Table 6. The comparison of *F. orientalis* associations defined in different regions relating to the inclination, direction, tree layer height and coverage

Research	Study Area	Association	Height of Tree Layer(m.)	Coverage of Tree Layer (%)	Inclination (%)	Direction
(Yıldırım and Kılınç, 2011)	İnegöl Mountain (Gümüşhacıköy-Amasya)	*Cardamino bulbiferae-Fagetum orientalis*	15	90-95	40-60	N - NW
(Yıldırım and Kılınç, 2011)	İnegöl Mountain (Gümüşhacıköy-Amasya)	*Carpino betuli-Fagetum orientalis*	15	75-90	40-60	N - NW
(Bingöl et al., 2007)	Sakarat Mountain (Amasya)	*Pino sylvestri-Fagetum orientalis*	15-20	85-95	35-40	N - NW
(Bingöl et al., 2007)	Sakarat Mountain (Amasya)	*Rhododendro lutei-Fagetum orientalis*	7-20	65-100	25-40	N – NW -NE
(Türe et al., 2005)	Bilecik-Bursa (Bithynia)	*Trachystemo orientalis- Fagetum orientalis*	10-15	60-80	40-70	N – NW – E – W – NE - S
(Tatlı et al., 2005)	Gümüş Mountain (Kütahya)	*Pino sylvestri-Fagetum orientalis*	18-20	75-100	45-80	W - S
(Özen and Kılınç, 2002)	Kunduz Forest (Vezirköprü-Samsun)	*Galio-Fagetum orientalis*	15-25	90-100	15-50	S – SW – W – N – NW -NE
(Yarcı, 2002)	Istranca Mountains (İstanbul-Bulgaristan)	*Carpino betuli-Fagetum orientalis*	13-14	50-75	10-20	N
(Yarcı, 2000)	Istranca Mountains (İstanbul-Bulgaristan)	*Rhododendro ponticum- Fagetum orientalis*	15	100	0	NE
(Terzioğlu, 1998)	Uzungöl and Surroundings (Trabzon)	*Piceo orientalis-Fagetum orientalis*	20-30	80-90	50-85	NE – SE – E – SW - N
(Kutbay and Kılınç, 1995)	Nebyan Mountain (Bafra-Samsun)	*Carpino-Fagetum orientalis*	10-20	70-90	15-45	NE - N
(Özen and Kılınç, 1995)	Between Alaçam-Gerze and Boyabat-Durağan (Sinop)	*Carpino-Fagetum orientalis*	6-20	85-100	15-40	SE – N – NW – NE - W
(Kılınç and Karaer, 1995)	Sinop Peninsula	*Carpino betuli-Fagetum orientalis*	10-15	70-90	10-40	NW - N
(Aydoğdu, 1982)	Çam Mountains (Düzce-Akçakoca)	*Rhododendro ponticum-Fagetum orientalis*	20-25	65-90	10-40	S – SW – N –SE - NW
(Yayıntaş, 1982)	Simav Mountain (Simav-Kütahya)	*Fagetum orientalis*		65-95	10-30	N – NE - NW
(Ketenoğlu, 1981)	Kastamonu-İnebolu-Cide	*Rhododendro ponticum-Fagetum orientalis*		60-90	10-30	N – NW - E
(Akman and Yurdakulol, 1980)	Bolu Mountains	*Rhododendro ponticum-Fagetum orientalis*		60-95	5-50	S – W – SW - N – NW – E - NE

F. orientalis associations spreaded in Turkey are seen in two main groups according to the Cluster analysis result. The associations included in Cluster groups are generally depended on geographical distribution. Besides, the association away from each other can be found together (Figure 6).

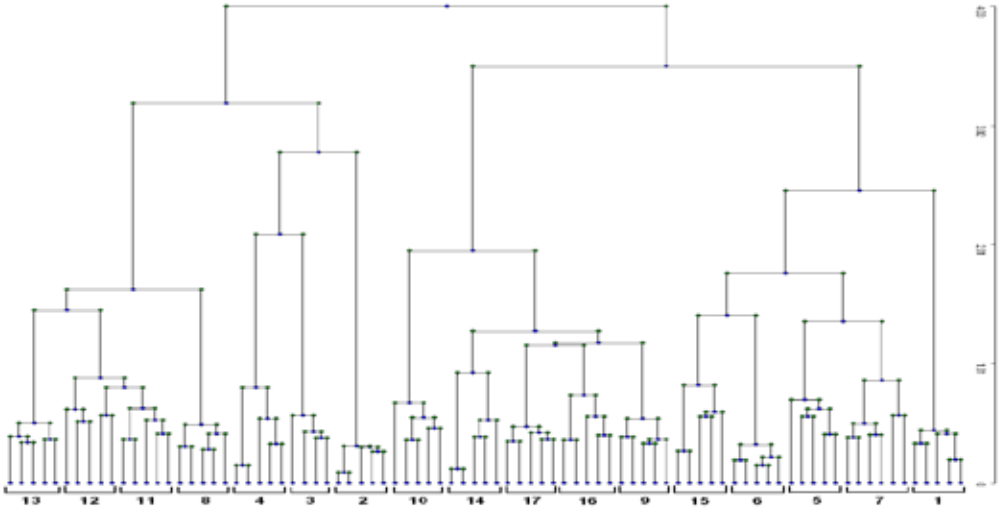

Figure 6. Ward's dendrograme of some Turkish *F. orientalis* (Eastern Beech) forests according to Bray-Curtis method

1. *Cardamino bulbiferae-Fagetum orientalis* (Yıldırım and Kılınç, 2011); 2. *Carpino betuli-Fagetum orientalis* (Yıldırım and Kılınç, 2011); 3. *Pino sylvestri-Fagetum orientalis* (Bingöl et al., 2007); 4. *Rhododendro lutei-Fagetum orientalis* (Bingöl et al., 2007); 5. *Trachystemo orientalis-Fagetum orientalis* (Türe et al., 2005); 6. *Pino sylvestri- Fagetum orientalis* (Tatlı et al., 2005); 7. *Galio-Fagetum orientalis* (Özen and Kılınç, 2002); 8. *Carpino betuli-Fagetum orientalis* (Yarcı, 2002); 9. *Rhododendro ponticum-Fagetum orientalis* (Yarcı, 2000); 10. *Piceo orientalis-Fagetum orientalis* (Terzioğlu, 1998); 11. *Carpino-Fagetum orientalis* (Kutbay and Kılınç, 1995); 12. *Carpino-Fagetum orientalis* (Özen and Kılınç, 1995); 13. *Carpino betuli-Fagetum orientalis* (Kılınç and Karaer, 1995); 14. *Rhododendro ponticum-Fagetum orientalis* (Aydoğdu, 1982); 15. *Fagetum orientalis* (Yayıntaş, 1982); 16. *Rhododendro ponticum-Fagetum orientalis* (Ketenoğlu, 1981); 17. *Rhododendro ponticum-Fagetum orientalis* (Akman and Yurdakulol, 1980).

In DCA ordination diagram, results for Cluster analysis were obtained. Although some associations are called in the same name, they are placed in very different regions in ordination diagram. For example, *F. orientalis* associations 2 and 8 are called with the same name, they have placed in different places in the ordination diagram. However, *F. orientalis* associations 11 and 12 have the same name and they are placed in the diagram close to each other (Figure 7).

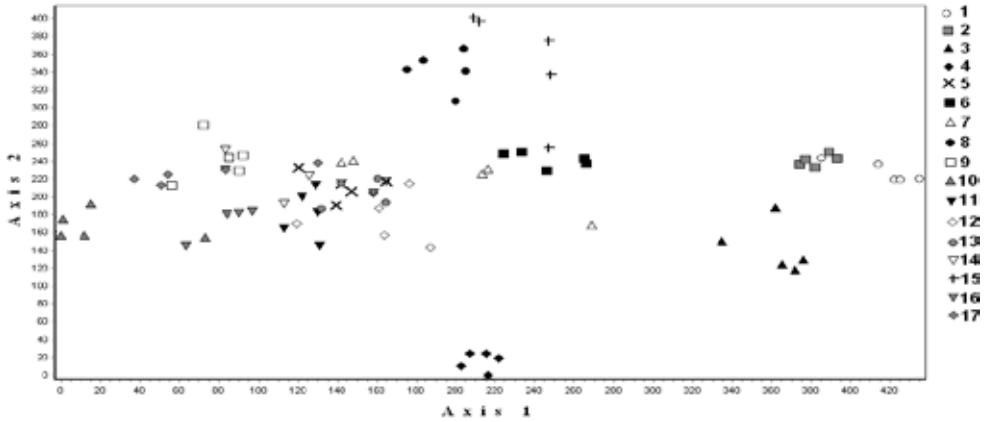

Figure 7. DCA diagram of some Turkish *F. orientalis* (Eastern Beech) forests

1. *Cardamino bulbiferae-Fagetum orientalis* (Yıldırım and Kılınç, 2011); 2. *Carpino betuli-Fagetum orientalis* (Yıldırım and Kılınç, 2011); 3. *Pino sylvestri-Fagetum orientalis* (Bingöl et al., 2007); 4. *Rhododendro lutei-Fagetum orientalis* (Bingöl et al., 2007); 5. *Trachystemo orientalis-Fagetum orientalis* (Türe et al., 2005); 6. *Pino sylvestri- Fagetum orientalis* (Tatlı et al., 2005); 7. *Galio-Fagetum orientalis* (Özen and Kılınç, 2002); 8. *Carpino betuli-Fagetum orientalis* (Yarcı, 2002); 9. *Rhododendro ponticum-Fagetum orientalis* (Yarcı, 2000); 10. *Piceo orientalis-Fagetum orientalis* (Terzioğlu, 1998); 11. *Carpino-Fagetum orientalis* (Kutbay and Kılınç, 1995); 12. *Carpino-Fagetum orientalis* (Özen and Kılınç, 1995); 13. *Carpino betuli-Fagetum orientalis* (Kılınç and Karaer, 1995); 14. *Rhododendro ponticum-Fagetum orientalis* (Aydoğdu, 1982); 15. *Fagetum orientalis* (Yayıntaş, 1982); 16. *Rhododendro ponticum-Fagetum orientalis* (Ketenoğlu, 1981); 17. *Rhododendro ponticum-Fagetum orientalis* (Akman and Yurdakulol, 1980).

The distribution results of Shannon – Wiener diversity index are shown in Figure 8 with bar graphic. The lowest value belongs to *Fagus orientalis* associations 6 and the highest are *F. orientalis* associations 2 and 5. According to the calculations between 2 and 5 quite high Shannon – Wiener diversity index values were obtained.

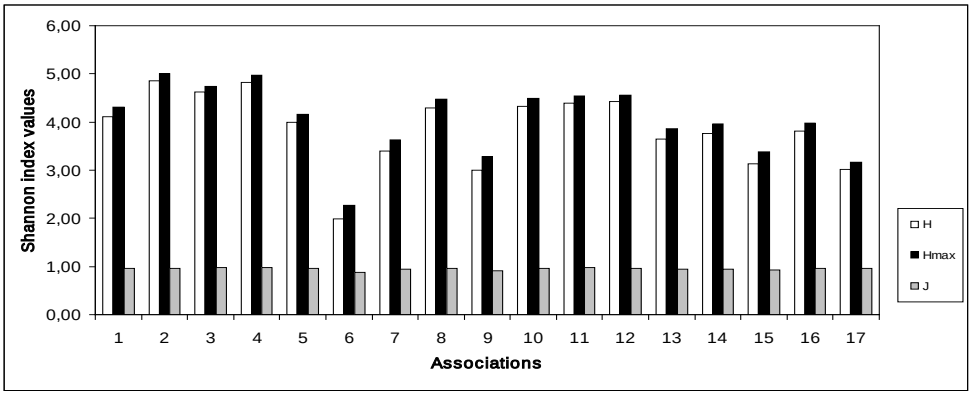

Figure 8. Shannon diversity index values of the some *F. orientalis* associations

1. *Cardamino bulbiferae-Fagetum orientalis* (Yıldırım and Kılınç, 2011); 2. *Carpino betuli-Fagetum orientalis* (Yıldırım and Kılınç, 2011); 3. *Pino sylvestri-Fagetum orientalis* (Bingöl et al., 2007); 4. *Rhododendro lutei-Fagetum orientalis* (Bingöl et al., 2007); 5. *Trachystemo orientalis-Fagetum orientalis* (Türe et al., 2005); 6. *Pino sylvestri- Fagetum orientalis* (Tatlı et al., 2005); 7. *Galio-Fagetum orientalis* (Özen and Kılınç, 2002); 8. *Carpino betuli-Fagetum orientalis* (Yarcı, 2002); 9. *Rhododendro ponticum-Fagetum orientalis* (Yarcı, 2000); 10. *Piceo orientalis-Fagetum orientalis* (Terzioğlu, 1998); 11. *Carpino-Fagetum orientalis* (Kutbay and Kılınç, 1995); 12. *Carpino-Fagetum orientalis* (Özen and Kılınç, 1995); 13. *Carpino betuli-Fagetum orientalis* (Kılınç and Karaer, 1995); 14. *Rhododendro ponticum-Fagetum orientalis* (Aydoğdu, 1982); 15. *Fagetum orientalis* (Yayıntaş, 1982); 16. *Rhododendro ponticum-Fagetum orientalis* (Ketenoğlu, 1981); 17. *Rhododendro ponticum-Fagetum orientalis* (Akman and Yurdakulol, 1980).

The distribution of associations numerically evaluated on the *F. orientalis* vegetation distributed in Turkey is related to the climatic and geographic factors. Similar associations in the same climate zones have similar ordination and cluster results. Besides, different associations with similar floristic composition and ecological conditions come side by side in the DCA ordination diagram and in the branches of dendrogram. The associations with the same name are seen far away to each other. It is resulted from the differences of local climate and floristic composition. The results obtained from numerical methods proved that there is a need revision on the syntaxonomic of the *F. orientalis* vegetation distributed in Turkey (Ketenoğlu et al., 2010).

The diversity in *F. orientalis* association 6 is less than the others and it can be result from the destruction. Besides, the diversity can be decreased because of *Pinus sylvestris* L. which is a coniferous. This association (number 6) is also distributed at higher altitude (Bagnaresi et al., 2002).

Economically important trees in Turkey have historically been harvested to maximize wood production without considering sustainability. As a result, almost half the Turkish forests now are considered degraded in terms of wood production (Kaya and Raynal, 2001). Scientific and historical research indicates that 4.000 years ago the Anatolian landscape was 60%-70% forest and 10%-15% steppe (Davis, 1965-1985; Davis, 1988). However, over-grazing, over-cutting, fires, clearance for agriculture, wars and general misuse of the land have caused a decrease in forest area to 26%, and an increase in steppe area to 24% (Mayer and Aksoy, 1986).

Inspite of over-grazing, over-cutting, fires, clearance for agriculture and all other anthropogenic impacts the plant cover in the country still shows a rich composition (Zohary, 1973). According to the results of forest inventory evaluations up to now, the forest area in Turkey increased 990 thousand ha in the last 30 years. Reasons for this situation can be classified increasing the concious of people about protecting the forest ecosystems, effective forestration in treasury land and other potential areas and forming natural succession in areas suitable for the development of forest ecosystem (www.ogm.gov.tr). On the other hand in Turkey where there is an abundant variety in terms of plants and one third of the plants are endemic, carrying out eclectic studies like this are extremely important (Cansaran and Kaya, 2011).

It is clear that effective conservation management of Turkish forests is an urgent necessity, and much can be transferred from experiences in different country. It is suggested that new approaches and practical applications are needed. Forestry activities, such as silvicultural conversion, restoration and 'close-tonature' silvicultural operations, can be organized effectively if guided by 'naturalness zone maps' (Colak and Rotherham, 2006). The conservation of species and habitats is complicated and involves several steps. Most conservation projects require baseline data that are essential; this may or may not be available or can be collected by local experts (Ghazanfar, 2008).

As a result of present study, Turkish forest lands are highly decreased compared to 4000 years ago. However, in recent years the forest lands are increased. Especially the consciousness of the people and the protection measures play an important role for the increasing of these lands. Also taking above-mentioned measures is quite important for the future of the *F. orientalis* (eastern / oriental beech) forests in Turkey is very important regarding to its economical value and it forms 17.8% of Turkish forests and 40.8% of the Turkish broadleaved high forests with regard to covered area (614.615 ha) (Anonymous, 1987).

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