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ECOLOGY OF *PINUS SYLVESTRIS* L. FORESTS - A CASE STUDY FROM ISTANBUL (TURKEY)

VOLKAN ALTAY

Biology Department, Faculty of Science & Arts, Hatay Mustafa Kemal University, Hatay-Turkey
Corresponding author's email: volkanaltay34@gmail.com

Abstract

This study evaluates the *P. sylvestris* forest community in Istanbul (Turkey). It also includes some of its ecological features. The study was carried out during 2014-2017. *P. sylvestris* community in Istanbul generally grows on sandy and loamy soils, with moderately acidic, non-calcified, non-saline soils with high organic matter content. The soils contain low levels of phosphorus and adequate levels of potassium. The community is distributed between 50-305 m in the area studied. Tree layer dominantly consists of *P. sylvestris*. However, occasional existence of *Quercus infectoria, Q. cerris* and individual existence of *Q. robur* has also been identified. Although shrub layer is often common, the herbaceous layer is not well developed. The most widespread species in the shrub layer are *Rosa canina, Rubus canescens, Crataegus monogyna, Quercus pubescens, Phillyrea latifolia, Erica arborea, Arbutus unedo, Osyris alba, Cistus salviifolius* and *Cistus creticus*. The most widespread species in the herbaceous layer are *Brachpodium sylvaticum, Dactylis glomerata* ssp. *hispanica, Inula oculus-christi* and *Stachys byzantinum*. An examination of floristic composition of the current community in the research area has revealed that the character species of *Quercetea pubencentis* class. It is also represented by the species of Mediterranean origin belonging to the *Quercetea ilicis* and *Cisto-Micromerietea* classes in the shrub layer of the community.

Key words: Community, Ecology, Forest, Istanbul, *Pinus sylvestris*.

Introduction

Pine, one of the important components in several natural ecosystems in the Mediterranean includes the species of genus *Pinus* that especially occupy the mountainous regions. One of these species is *Pinus sylvestris*, a Euro-Siberian forest tree species most widely spread among pine species. It flourishes on many ecologically varying habitats from western Europe to Asia (Soto *et al*., 2010). *P. sylvestris* is found in Europe and Asia, between 37º-70º north latitudes and 7º-137º east longitudes (Güner & Yücel, 2015; López-Sáez *et al*., 2016). The habitat includes all the northern regions and northest border of the tree line is 70º north latitude in Norway. In the south, it spreads out from eastern Asia to Ural mountains and occurs in Russia, Galicia (in Poland), on Carpathian Mountains, in Yugoslavia, Bulgaria with intermittent existence. In Turkey it grows between 41º48´-38º34´ N latitudes and 43º05´-28º50´ E longitudes (Güner & Yücel, 2015). The total forest cover in Turkey is approximately 21 million hectares, out of which the economically important yellow pine constitutes 5% with an area of over 1 million ha (Ozturk *et al*., 2010; Atalay *et al*., 2014).

Yellow pine forests are a component of subhumid-cold continental coniferous forests, generally widespread as natural stands on the south facing slopes of the backward region of Black Sea and high plateaus of NE Anatolia. The pure productive stands of these forests are common around the Erzurum-Kars and Ardahan Plateaus (Atalay & Efe, 2012). Other main distributional areas in Turkey are the Köroğlu Mountains in the southern part of Middle and western part of Black Sea region; in the upper part of the Kelkit basin in the eastern part of Black Sea region; on the upper northern slopes of Sundiken mountains in the N of Eskişehir; and on the upper part of Turkmen mountais in the east Aegean region (Atalay *et al*., 2014). Mixed *Pinus sylvestris* forests are commonly associated with *Abies bornmuelleriana, Fagus orientalis* and *Picea orientalis* in the eastern part of Black Sea region. Other *P. sylvestris* forests are associated with *Abies bornmuelleriana, Fagus orientalis, Buxus sempervirens, Taxus baccata, Corylus avellana*, and *Cornus mass* particularly in Egriova locality in the S of Karabük city, on the northern slopes of Ilgaz and Ulu Mountains; Uluova locality, W of Küre Mountains; and the mountainous areas in the west of Kastamonu plateau in the western part of Black Sea (Atalay *et al*., 2014).

There are numerous reports on the geology and soils, forestry, landscape architecture, as well as ecophysiological aspects such as accumulation of heavy metal and mineral elements, and geographical features of *P. sylvestris* forests in Turkey (Gezer *et al*., 2000, 2002; Carus, 2008; Atalay & Efe, 2012, 2014; Atalay *et al*., 2014; Elveren *et al*., 2015; Güner & Yücel, 2015; Karakoyun & Osma, 2015; Mutlu *et al*., 2016; Osma *et al*., 2017).

Some phytosociological studies have also been conducted on *P. sylvestris* forest vegetation (Akman, 1974, 1976; Akman *et al*., 1978, 1983; Düzenli, 1979, 1989; Quezel *et al*., 1980; Kılınç, 1985; Tatlı, 1985, 1987; Akman & Aydoğdu, 1986; Ekim & Akman, 1990; Kutbay & Kılınç, 1995; Ozen & Kılınç, 1995; Adıgüzel & Vural, 1995; Karaer *et al*., 1999; Cansaran & Aydoğdu, 2001; Tatlı *et al*., 2005; Eminagaoglu *et al*., 2007; Cansaran *et al*., 2010). Moreover, comparative studies on some associations of these forest stands also have been undertaken (Akman, 1995; Gücel *et al*., 2008). A survey of all the investigations in this connections has revealed that no studies have been carried out on the *Pinus sylvestris* forest vegetation in Istanbul. In this study, an attempt has been made to present the information on the community structure of *P. sylvestris* in Istanbul (Turkey) together with their ecological features.

Materials and Methods

Study area: It occurs on the Asian side in the east of Istanbul, between 40º 48' and 41º 16' latitude and 29º 04' and 29º 58' longitude, neighbouring the Black Sea in the north, Marmara Sea in the south, Kocaeli City in the east and Bosphorus in the west (Altay *et al*., 2012a). A total of seven different districts on the Asian side were extensively surveyed namely; Beykoz, Kadıköy, Kartal, Maltepe, Pendik, Sultanbeyli and Ümraniye. The investigations were carried out during 2014-2017. All available species at selected sites were enlisted based on 18 quadrats. The details of the plant community structure with dominant species were recorded (Altay *et al*., 2012a).

Soil analysis: Soil samples collected with a soil auger from a depth of 30 cm from each quadrate were passed through a 2-mm sieve. The Bouyoucos (1962) hygrometer method was used to determine the soil texture, percentage values of three textural fractions, clay (0-2 μm), silt (2-50 μm) and sand (50-2000 μm), were characterized following soil textural triangle. Electrical conductivity was determined according to Anon., (1954) and pH measured with electronic pH-meter in a 1:2.5 soil/water suspension (Altay *et al*., 2012a). $CaCO_3$ was determined with volumetrically with the help of a calcimeter (Altay *et al*., 2012a). Organic matter was measured according to Smith & Weldon (1941), and plant-available soil phosphorus determined spectrophotometrically using Olsen method (Black, 1965; Altay *et al*., 2012a).

Ecological analysis of the plant community: The plants were identified with the help of "Flora of Turkey and the East Aegean Islands" (Davis, 1965-1985). Ecological data was recorded using random quadrat sampling method. In all 18 fixed quadrats each 400 m^2 were laid at each site. All individual plants in the quadrats were counted and Braun-Blanquet (1964) method of classification of vegetation used. For syntaxonomic nomenclature and names of the higher levels of classification methods outlined by Braun-Blanquet (1964), Altay *et al*., (2012a, b), Ozyigit *et al*., (2015), and Sezer *et al*., (2015) were followed.

Results and Discussion

The results have shown that the *P. sylvestris* community was distributed in the studied area, generally grows on sandy and loamy soils, which are moderately acidic, non-calcified, non-saline, rich in organic matter, but has low levels of phosphorus and adequate levels of potassium in soils (Table 1).

The ecological features of the *P. sylvestris* forest community show that in 18 quadrats a total number of 100 taxa are distributed with a total cover of 80 to 95 percent. The slope varies between 5 to 30 degrees and altitude between 50 to 305 m. Tree layer dominantly consists of *P. sylvestris* forests, occasionally accompanied by *Quercus infectoria, Q. cerris* and individuals of *Q. robur*. Although shrub layer is a common feature, herbaceus layer is not well developed. The most widespread species in the shrub layer are *Rosa canina, Rubus canescens, Crataegus monogyna, Quercus pubescens, Phillyrea latifolia, Erica arborea, Arbutus unedo, Osyris alba, Cistus salviifolius* and *C. creticus*. The most widespread species in the herbaceous layer are *Brachpodium sylvaticum, Dactylis glomerata* ssp. *hispanica, Inula oculus-christi* and *Stachys byzantinum* (Appendix 1). The structural characteristics of the dominant tree species forming the forest vegetation significantly affect the spread of forest shrubs and herbaceous taxa. In particular, it plays an active role in the distribution of sun rays to the ground (Öner & Akbin, 2010; Altay *et al*., 2012b). This may be the reason why this community does not contain high number of species in its floristic composition. The development of this community on moderately acidic soil also seems to be a factor responsible for a poor ground flora in this community.

In the neighborhood Başıbüyük (Maltepe district) near Süreyyapaşa Hospital a very local area of mixed *Pinus sylvestris-Pinus pinea* forest is found. The floristic composition of this forest is very poor with very few plant species distributed in the area. The cover percentages of forest shrubs and herbaceous layers is also very low. Especially in the shrub layer, *Phillyrea latifolia, Arbutus unedo, Osyris alba, Rubus canescens, Rosa canina, Quercus coccifera* and *Cistus creticus* are best represented, but *Phillyrea latifolia* occurs infrequently in the area. In the herbaceous layer, we come across the species like; *Bellis perennis, Agrostis capillaris, Calamintha nepeta* and *Brachpodium sylvaticum*.

Several associations of *P. sylvestris* have been described from Turkey. These are dominating or co-dominating the forest vegetation cover. In the Black Sea region, *Pinus sylvestris-Astragalus adzharicus* has been reported from the Tiryal Mountain (Düzenli, 1979), *Vaccinio myrtilli-Pinetum sylvestris* from Giresun-Trabzon (Quezel *et al*., 1980), *Pino sylvestris-Cedretum libani* from Erbaa (Quezel *et al*., 1980), *Daphne glomeratae-Pinetum sylvestris* from Zigana (Quezel *et al*., 1980), *Lilio ciliati-Pinetum sylvestris* from Zigana-Rize (Quezel *et al*., 1980), *Pinus sylvestris* f. *lazica-Epimedium pinnatum* ssp. *colchicum* from the Black Sea region mountains (Quezel *et al*., 1980), *Pinus sylvestris-Quercus petraea* ssp. *iberica* from Ilgaz mountains, and *Abies bornmuelleriana-Pinus sylvestris* and *Pinus sylvestris-Abies bornmuelleriana* from Ilgaz as well as Semen mountains (Akman *et al*., 1983), *Abies bornmuelleriana-Pinus sylvestris*, and *Pinus sylvestris-Daphne pontica* associations from Tosya (Kılınç, 1985), *Daphno ponticae-Pinetum sylvestris* from Bafra (Kutbay & Kılınç, 1995), *Abieti-Pinetum sylvestris* from Sinop (Ozen & Kılınç, 1995), *Ranunculo buhsei-Pinetum sylvestris* from Kelkit Valley (Karaer *et al*., 1999), *Petrorhagio olympicae-Pinetum sylvestris* from Eğerli mountain-Amasya (Cansaran & Aydoğdu, 2001), *Junipero oxycedri-Pinetum sylvestris, Abieti nordmanniana-Pinetum sylvestris, Junipero communi-Pinetum sylvestris,*

and *Pino sylvestris-Piceetum orientalis* from Artvin (Eminagaoglu *et al*., 2007), and *Lathyro tukthensis-Pinetum sylvestris* from Karaömer mountain-Amasya (Cansaran *et al*., 2010). The data published from Central Anatolia reveals that following associaitons are found in this area; *Pinus sylvestris-Orthilia secunda* in Ankara (Akman, 1974, 1976; Akman *et al*., 1978; Akman & Aydoğdu, 1986), *Pinus sylvestris-Doronicum orientale* in Akdağmadeni-Sivas (Düzenli, 1989), *Hyperico confferti-Pinetum sylvestris* in Sundiken mountains-Eskişehir (Ekim & Akman, 1990), *Populo-Pinetum sylvestris* in Soğuksu National Park-Ankara (Adıgüzel & Vural, 1995), and *Fragario vescae-Pinetum sylvestris*, and *Pino sylvestris-Fagetum orientalis* in Gumuş mountains-Kütahya (Tatlı *et al*., 2005). A perusal of data from the Eastern Anatolia region shows that following associaitons are distributed here; *Trifolio-Pinetum sylvestris* in Gavur mountains-Erzurum (Tatlı, 1985), and *Triseto-Pinetum sylvestris* in Allahuekber mountains (Tatlı, 1987).

P. sylvestris forest associations reported from Turkey show that in terms of both character species and in floristic composition they usually differ from each other. The community in the present study area is reported to be a plantation forest and was designated as *Pinus sylvestris* community. However, in these plantations a kind of un-natural *Pinus pinaster* individuals are found in many locations of the research area especially; Beykoz, Maltepe, Pendik-Aydos hill, and Ümraniye districts.

An interpretation of *P. sylvestris* forests in Turkey in terms of plant sociology enlightens the fact that majority of communities come under class Quercetea pubescentis but, a very small number is included in the class Querco-Fagetea (Ketenoğlu *et al*., 2010). An evaluation of the floristic composition of the current community in the research area reveals that, the character species of the Quercetea pubencentis class are noteworthy (Appendix 1). It is also represented by the species of Mediterranean origin belonging to the Quercetea ilicis and Cisto-Micromerietea classes in the shrub layer. The Querco-Fagetea class in this community is represented by two species (Appendix 1).

In spring and summer seasons these forests are a site of attraction for the local weekend visitors for rest, strolling and entertainment. This activity results in the degradation of shrub and herbaceous layers of this forest community. However, both the invasive as well as ruderal plant species enter the composition of these layers. Moreover, some people living at places far away from the city centers cut these forests for of fuel illegally. The acceleration of such anthropogenic activities has led to the formation of areas which have lost their forest characteristics over time. The research area and its environs are very close to the earthquake fault line, a rapid constructions is made in the regions where altitude is high and there are strong bedrocks (Altay *et al*., 2012b). The surroundings of these forests have become a part and parcel of some urban centers, this is another important factor affecting the *P. sylvestris* forests in the study area.

Table 1. Soil characteristics of the areas occupied by *P. sylvestris* community.

Saturation %	pH	EC mmhos / cm	$CaCO_3$ %	Organic matter %	P_2O_5 kg/da	K_2O kg/ da	Sand %	Clay %	Silt %	Texture
57	5.6	0.49	0	6.41	4.97	35.1	59	17	24	SL

EC: Electrical conductivity; **SL:** Sandy and loamy

Conclusions

There has been a great increase in the pine forest plantations during last 20 to 30 years, all through reforestation and rehabilitation programmes, both in south Europe as well as Turkey (Ozturk, 1995; Ozturk *et al*., 2002, 2008, 2010, 2011; Sheffer, 2012; Tecimen *et al*., 2017). These activities lead to a changes in the existing plant community structure of maquis as well as degraded pasturelands (Andrés & Ojeda, 2002; Buscardo *et al*., 2008). All these end up in a reduction or deterioration of biodiversity (Tecimen *et al*., 2017). According to Bremer & Farley (2010) such plantation activities potentially promote biodiversity if implemented for rehabilitation of degraded lands, instead of replacing natural vegetation types like shrublands, maquis or degraded forests. There are many differences of opinions regarding the effects of plantation activities on species diversity in the Mediterranean ecosystems (Maestre & Cortina, 2004; Tecimen *et al*., 2017). The effects of socioeconomically run plantations on plant communities has been a subject of interest in many countries (Hofstede *et al*., 2002; Brockerhoff *et al*., 2003; Tecimen *et al*., 2017). As eqarly as 1996 Chiarucci has studied the relations between the features of plantation areas and the species richness, the density has been investigated but the comparison of plantation areas and natural areas lacks to a large extent (Andrés & Ojeda, 2002; Tecimen *et al*., 2017).

The characteristics of plants vary and their adaptations to the soil on the basis of specific physico-chemical characteristics also differs (Ozturk *et al*., 2016; Altay *et al*., 2013, 2016a, b, 2017, 2018). In view of this, it is important to examine the forest communities from a synecological viewpoint (Ozturk & Seçmen, 1986; Ozturk *et al*., 2017). The trees and forest communities are critical as keystone structures in urban areas. Such communities are decreasing around the human-managed ecosystems all over the world, including agricultural areas, and urban areas (Stagoll *et al*., 2012; Ozturk *et al*., 2017). Consequently, negative results are reported and predicted for biodiversity (Stagoll *et al*., 2012; Ozturk *et al*., 2017). For a best protection of trees and forest communities in the vicinity of populated surroundings and for their continued existence for future generations, there is need for a recognition of the values of such islands of trees in urban areas. Proper management and planning policies in the context of biodiversity are urgent issues (Stagoll *et al*., 2012; Ozturk *et al*., 2017; Altay *et al*., 2018).

Appendix 1. Community structural features of *Pinus sylvestris* in the study area.

*Releve number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Presence
Releve area (m2)	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	
Altitude (m)	229	275	187	115	140	151	160	208	233	112	115	149	50	303	305	237	289	201	
Aspect	S	S	W	W	SW	N	NW	N	N	SW	W	SW	W	S	S	E	N	N	
Slope (0)	15	15	5	30	15	15	15	15	15	15	15	5	30	30	30	15	15	30	
Total cover (%)	80	80	90	80	80	80	80	80	80	90	85	95	95	80	80	95	80	85	
Cover tree layer (%)	80	80	90	80	75	80	80	80	80	90	80	90	95	80	80	95	80	85	
Cover shrub layer (%)	25	65	30	40	50	40	50	40	60	60	70	95	80	70	80	70	80	40	
Cover herb layer (%)	25	10	20	20	20	5	5	5	30	10	20	5	5	5	5	5	1	1	
Pinus sylvestris	44	33	54	43	43	44	44	44	44	54	44	54	54	44	44	54	43	54	V
Querco-Carpinetalia (*), and Quercetea pubescentis																			
Brachypodium sylvaticum	.	.	12	12	12	+2	+2	.	22	+2	12	+2	+2	+2	+2	12	12	+2	V
Rosa canina	11	12	.	.	.	11	.	11	.	11	12	11	11	11	11	.	11	.	IV
Quercus pubescens	11	12	.	.	.	.	.	.	11	.	11	12	11	11	11	12	11	11	IV
Crataegus monogyna	11	.	11	.	.	.	11	.	.	12	11	11	11	11	11	.	11	.	III
Quercus infectoria	.	.	11	.	.	.	.	.	11	11	.	11	.	.	.	11	11	11	II
Mespilus germanica	.	.	.	.	.	12	12	11	.	11	.	11	11	.	.	.	.	.	II
Hypericum perforatum	12	.	+1	+2	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	II
Dorycnium pentaphyllum	.	.	+2	.	.	.	.	.	+1	+1	.	.	.	.	.	.	+1	.	II
Quercus cerris	.	.	.	.	.	11	.	.	.	11	.	11	.	.	.	.	11	.	II
**Cirsium hypoleucum*	.	12	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	I
Lapsana communis var. *intermedia*	.	.	+2	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	I
Sorbus torminalis	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	I
Lonicera etrusca	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Melica uniflora	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Prunus spinosa	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Quercetea ilicis																			
Phillyrea latifolia	22	23	12	22	22	11	.	12	11	11	11	11	11	11	11	12	33	12	V
Erica arborea	11	12	11	11	12	.	11	11	22	22	22	22	12	12	22	22	12	12	V
Arbutus unedo	22	.	.	.	11	.	11	.	11	12	11	22	.	12	12	11	11	11	IV
Osyris alba	12	12	.	.	.	.	.	.	11	11	12	11	.	11	11	12	.	11	III
Rubia tinctoria	+1	+2	.	+1	+2	+2	+1	.	.	+1	.	+1	+2	.	.	.	.	+2	III
Asparagus acutifolius	12	11	.	11	11	.	.	.	.	+1	11	.	11	11	11	.	.	.	III
Cynosurus echinatus	+2	+2	.	+1	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Quercus coccifera	.	.	.	22	.	.	.	11	.	.	.	.	12	.	.	.	.	.	I
Ruscus aculeatus	.	.	.	.	11	.	.	.	.	.	.	.	11	.	.	.	.	11	I
Pistacia terebinthus	.	12	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Juniperus oxycedrus ssp. *oxycedrus*	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	I
Paliurus spina-christi	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Appendix 1. (Cont'd.).

*Releve number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Cisto-Micromerietea																			
Cistus creticus	.	12	.	12	12	.	.	.	11	11	12	.	.	12	11	.	.	11	III
Cistus salviifolius	12	.	12	12	.	.	.	12	.	.	.	12	+1	.	.	11	11	.	III
Lavandula stoechas	.	.	11	11	11	.	.	11	11	.	.	.	.	.	12	.	.	11	II
Anthoxanthum odoratum	.	.	.	+2	+2	.	.	+2	+2	.	+2	+2	+2	.	.	.	.	.	II
Erica manipuliflora	.	.	.	.	.	.	.	.	12	.	.	.	.	.	11	11	11	12	II
Pteridium aquilinum	.	.	.	.	.	22	33	.	.	.	.	.	+1	.	.	.		+2	II
Spartium junceum	.	.	.	.	.	.	.	.	.	.	12	.	.	11	11	.	.	.	I
Melica ciliata	+2	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Sarcopoterium spinosum	.	.	.	.	11	.	.	11	.	.	.	.	.	.	.	.	.	.	I
Rhododendro-Fagetalia (*), and Querco-Fagetea																			
**Hypericum calycinum*	.	.	.	.	.	.	+2	.	.	.	.	+2	12	.	12	22	12	.	II
Smilax excelsa	.	.	.	.	.	+1	+1	.	.	.	.	.	.	.	.	.	.	.	I
Querco-Fagea																			
Dactylis glomerata ssp. *hispanica*	+2	+2	+2	+2	+2	+1	+1	+2	+1	+2	+2	+2	+1	.	+1	+2	+1	+1	V
Galium aparine	12	.	.	.	.	.	.	.	.	.	.	.	.	.	+1	.	.	.	I
Hedera helix	.	.	.	.	.	+1	.	.	.	.	.	.	+1	.	.	.	.	.	I
Daphne pontica	.	.	.	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	I
Other																			
Rubus canescens	12	12	12	.	11	11	12	+1	+1	+1	+1	11	11	+1	11	11	+1	.	V
Inula oculus-christi	.	12	12	12	12	.	.	+2	+1	+1	+2	+2	+1	.	.	.	.	.	III
Stachys byzantinum	12	12	.	+1	+2	.	.	.	.	+1	.	.	+1	.	.	+1	.	+2	III
Agrostis capillaris	11	.	.	+1	.	.	.	12	+1	.	.	.	.	.	.	.	.	.	II
Berula erecta	.	12	+2	+1	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Briza maxima	.	.	+2	+2	+2	.	.	+2	.	.	.	.	.	.	.	.	.	.	II
Holcus lanatus	.	.	+2	.	+1	.	.	.	+1	.	.	+2	.	.	.	.	.	.	II
Muscari neglectum	.	.	+2	+2	.	.	.	.	.	+1	+2	.	.	.	.	.	.	.	II
Sonchus asper ssp. *glaucescens*	.	.	11	+1	+1	.	.	11	.	.	.	.	.	.	.	.	.	.	II
Carlina corymbosa	12	12	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	I
Lolium pereme	+2	.	.	+1	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Sisymbrium officinale	.	.	+1	+1	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Carduus pycnocephalus ssp. *albidus*	.	.	12	+2	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Asphodelus aestivus	.	.	11	12	.	.	.	.	11	.	.	.	.	.	.	.	.	.	I
Quercus robur	.	.	.	11	11	11	.	.	.	.		.	.	.	.	.	.	.	I
Carex flacca	.	.	.	+1	+2	.	.	.	.	.	.	+2	.	.	.	.	.	.	I
Calamintha nepeta	11	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Allium paniculatum	+2	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	.	.	I
Celtis australis	.	11	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Plantago lanceolata	.	.	+2	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I

Appendix 1. (Cont'd.).

*Releve number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Hordeum murinum	.	.	+1		+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Hordeum bulbosum	.	.	.	+2	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cynodon dactylon	.	.	.	+2	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Vicia cracca	.	.	.	+1	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cichorium pumilum	.	.	.	.	.	11	.	.	.	.	.	.	12	.	.	.	.	.	I
Cioenera erecta	.	.	.	.	.	.	.	.	12	.	.	.	.	.	.	+1	.	.	I
Echinops ritro	.	.	.	.	.	.	.	.	11	.	11	.	.	.	.	.	.	.	I
Sanguisorba minor	.	.	.	.	.	.	.	.	.	.	.	.	.	+1	+1	.	.	.	I
Bellis perennis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+2	+1	I
Scutellaria albida ssp. *albida*	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Scabiosa columbaria	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Conyza canadensis	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ammi visnaga	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cichorium intybus	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Lactuca saligna	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Prunella laciniata	.	.	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Digitaria sanguinalis	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Bromus sterilis	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Urospermum picroides	.	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Orchis mascula	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Linum bienne	.	.	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Linum trigynum	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cirsium polycephalum	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium stellatum	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Eryngium campestre	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium subterraneum	.	.	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Medicago minima	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Ornithogalum umbellatum	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Stellaria media	.	.	.	.	+2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Serapias politisii	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Vicia sativa	.	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	.	.	.	I
Iris sintenisii	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	.	.	.	.	I
Ferulago confusa	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	I
Chenopodium botrys	.	.	.	.	.	.	.	.	.	.	.	11	.	.	.	.	.	.	I
Anthemis cretica	.	.	.	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	.	I
Lathyrus undulatus	.	.	.	.	.	.	.	.	.	.	.	.	.	+1	.	.	.	.	I
Linaria genistoides	.	.	.			.	.	.	.	.	.	.	.	.	.	.	.	+1	I

***Releve numbers**: **1-2**: Kartal District, Yakacık forest areas; **3**: Kartal District, Uğur Mumcu neighborhood, forest areas; **4-5**: Maltepe District, Başıbüyük neighborhood, near the Süreyyapaşa Hospital, Forest areas; **6-7**: Umraniye District, Alemdağ Forest areas; **8-9**: Kadıköy District, Findikli neighborhood, Forest areas; **10-11**: Beykoz District, Çavuşbaşı-Baklacı neighborhood, Forest areas; **12**: Beykoz District, Çavuşbaşı-Fatih neighborhood, Forest areas; **13:** Beykoz District, Göztepe neighborhood, Forest areas; **14-15**: Pendik District, Aydos Forest areas; **16**: Pendik-Sultanbeyli Districts, Forest areas; **17**: Sultanbeyli District, near the Forest Management Directorate, Forest areas; **18**: Kartal District, Samandıra-Veysel Karani neighborhood, Forest areas

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