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The influence of aspect on the vegetation of Çataldağ

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Abstract

Çataldağ, a mountain located in the northeast of Balıkesir, is a granitic mass the summit of which has an elevation of 1327 meters (Çobandede). As it lies in east-west direction in terms of its location, there is a striking vegetation contrast between the north and south slopes. The wide distribution of characteristically hygrophilous elements such as Uludağ fir (*Abies bornmülleriana*) and beech (*Fagus orientalis*) on the north slopes of the mountain makes it very interesting. The purpose of this study is to reveal the reason behind this interesting situation and to describe the features of these two slopes by comparing them. The vegetation was examined on site, notes were taken, and samples were collected in the preparation phase of the study. Later, these findings were classified. Based on the observations and materials, a vegetation map with a scale of 1/25.000 was prepared by using forest management plans and topographic maps. Data provided by Mustafakemalpaşa and Kepsut meteorological stations, which respectively represent the north and south slopes, was used in order to find out about the relationship between the vegetation and the climate. Besides, 1/25.000 scaled geological and soil maps were drawn with the purpose of demonstrating the edaphic conditions of plant communities. In order to indicate the orographic influence, cross section views of the vegetation along the north and south slopes were generated. Çataldağ lies in east-west direction, and is about 50 km away from the Marmara Sea as the crow flies. Thus, the north slopes are exposed to sea effects. The aspect, geographical position, and the elevation of the mountain led to the formation of a hygrophilous plant community. The study not only reveals that the aspect has a great influence on the vegetation of the north and south slopes of mountains, but also demonstrates that this area is a border between the phytogeographical regions of the Black Sea and the Mediterranean. In addition, the area is important in that it is the farthest western edge of the land where Uludağ fir (*Abies bornmülleriana*) grows. Beech communities, a dominant plant species on the north slopes, are found as islets and belts in regions situated in further west and south. This proves that Çataldağ is located in the Black Sea phytogeographical region.

Keywords: Çataldağ; aspect; vegetation; Fagus orientalis; Abies bornmülleriana

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1. Introduction

Turkey is very rich in terms of plant species. Distribution of vegetation is affected by mostly by climate. Bu in the regions with rugged territory the aspect and elevation are other factors that affect the vegetation. Vegetation zones occur on the slopes of mountains starting from skirts up to peak. This zonation occur on the mountains in the western Anatolia (Sönmez, 1996; 2001, 2005; Sönmez and Boyraz 2002; Boyraz, 2004; Çal, 2005; Dirmenci, 2006; Demirözer and Macar, 2012).

Çataldağ is a mountain is located in the South of the Marmara Region and on which the provincial border between Balıkesir and Bursa is situated. It is located on the western edge of a massive dome mountain lying between Susurluk River and Emet stream (Kirmastı stream). Çataldağ, with an elevation of 1317 meters, also has the highest summit in this mass.

Çataldağ is geologically a granodiorite mass and geomorphologically a dome (Ketin, 1983; Çelebi et al., 2012). Latest tectonic movements led to ruptures in this plutonic rock and to the formation of dip-slip faults. Bare and steep surface, which forms the characteristic view of the summit area, is in fact a slickenside. Marmara climate, a differentiated type of the Mediterranean climate, prevails in the area (Darkot, 1968). The most important feature of this climate is that the amount of summer precipitation is higher than typical Mediterranean climate. The aspect led to a deep contrast between the north and south-facing slopes. Therefore, there are Black Sea floral elements and a humid forest on the north slopes.

An examination of the average annual temperature reveals that Kepsut is warmer than Mustafakemalpaşa as Kepsut is situated in farther south and faces south.

Mustafakemalpaşa, representing the north of Çataldağ, receives a higher amount of precipitation than Kepsut. The average annual precipitation of Mustafakemalpaşa is 666.5 mm while that of Kepsut is 624.6 mm. That is because Mustafakemalpaşa receives more precipitation in summer than Kepsut.

A comparison of the precipitation regimes of both stations demonstrates that the amount of precipitation that falls in summer makes up 8% and 6% of the total annual amount of precipitation in Mustafakemalpaşa and Kepsut, respectively. The least amount of precipitation falls in summer, which is a feature of the precipitation regime of the Mediterranean climate (Dönmez, 1985). Both stations receive the highest amount of precipitation in winter. The amount of precipitation that falls in winter is equal to 40.4% in Mustafakemalpaşa and 45.2% in Kepsut. By taking this into account, it is possible to say that the precipitation regime of the Mediterranean climate is more typical in Kepsut. On the other hand, in Mustafakemalpaşa, summer drought subsided to some extent.

In order to have an idea of the prevailing winds, we benefited from the wind observations measured by Mustafakemalpaşa climate station (Table 3). An examination of the table shows that north winds prevail in the north of the area. North winds bring rain in winter, and prevent the temperature from rising to extreme levels in summer. As a result, they usually have a positive impact on plant life.

Southern winds bring rain and mild air in winter. They increase temperature and evaporation in summer. Hence, they have an adverse effect on plant life.

The south-facing slopes of Çataldağ are drained by Darıçukur creek; the southwest-facing slopes are drained by Balıklıdere; the west-facing slopes are drained by Bıçkı and Çaylak creeks, and the north-facing slopes are drained by Karadere. The north-facing streams carry plenty of water in every season. Çataldağ is covered with non-calcareous brown forest soils.

While the foothills are mostly covered with alluvial soils, colluvial soils, and rendzinas, non-calcareous brown forest soils prevail at higher elevations. Brown forest soils are also found particularly on limestones in some small areas.

A forest land lies between the foothills and the summit of Çataldağ. The vegetation varies depending on the aspect and elevation. Because people have settled in the region (e.g. Kyzikos and Daskileion) for at least 3000 years, the lower levels of natural vegetation have partly been destroyed, and have been replaced by farmlands and bushes (Bayır, 2004; Sönmez, 2007). It is understood that the lower levels are composed of oak and Turkish pine forests; the mid-levels are occupied oak and black pine forests, and the higher levels are full of beech and fir forests. The north slopes are dominated by humid forests while the south slopes are dominated by dry forests.

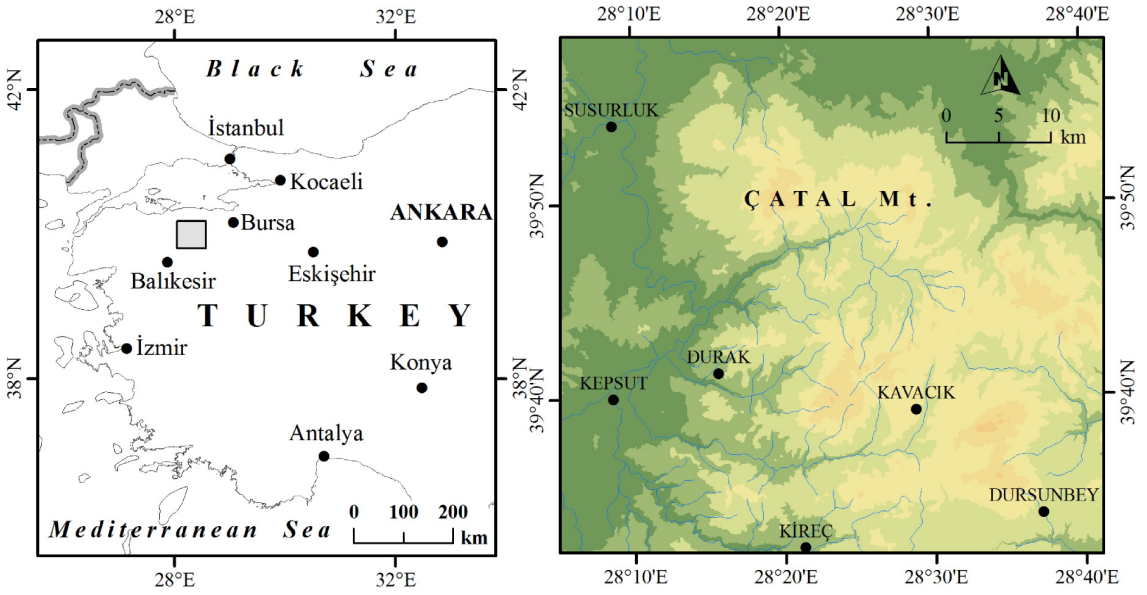

Fig.1. Location of study area

2. Materials and Methods

First of all, a literature review was conducted by going over previous studies carried out in this 1/25.000 scaled topographic maps were used during the field study. In addition, 1/25.000 scaled forest management maps of the area were also taken into consideration. A vegetation map was generated based on these maps. Field studies were carried out and plant samples were collected in order to create the vegetation map. The elevation and the location for each sample was recorded. The dates when these samples were collected were also recorded. Plant samples were dried and collected as herbarium materials. During the field study, information about the plant communities, flora, mainland, soil types and other striking features of the land was recorded. The general condition of the land, vegetation, and species were photographed, and an archive was created. The area was examined twice in fall and spring. After the vegetation was examined, two vegetation cross sections (i.e. vegetation cross sections in the direction of SW-NE and SE-NW) stretching along the area starting from the summit were generated.

Precipitation, temperature, and wind data provided by Mustafakemalpaşa and Kepsut weather stations was used so as to clarify the relationship between the vegetation and the climate. Based on the analysis of the data, tables, figures, and graphics were prepared. Aside from the topographic map, simplified geologic, soil, land use, and vegetation maps were drawn.

Plant specias collected in the field were identified. A floral list containing both the Latin and Turkish names of these materials were prepared (Baytop, 1994; Tuzlacı, 1981; 2007). During this study, which is based on the vegetation, the primary goal was to explain elevation-related changes in vegetation and the relationship between these changes and environmental conditions.

3. Findings

The results of fieldwork suggest that there are different vegetation levels stretching along the way from the foothills to the summit. Hygrophilous species and the forest formation constituted by them are located on the upper levels of the mountain while the forest consisting of xerophytic elements is situated on the lower levels. However, lower and upper forest limits are different on north and south-facing slopes. Uludağ fir (*Abies nordmanniana* subsp.

bornmülleriana), an important element of hygrophilous forests, is exclusively found on the highest part of the north slopes (Efe and Sönmez, 2006). Beech (*Fagus orientalis*) is the dominant element on this slope.

Climatic findings confirm the formation of vegetation belts in Çataldağ. The average temperature on the south slope is higher than that of the north slope (Table 1). The optimum temperature for beech growth is about 8°C (Efe et al., 2013). On the south slope, beeches grow at altitudes higher than 700 meters while they grow under optimal conditions at altitudes higher than 700 meters on the north facing slope. The optimum amount of precipitation for beeches is about 1500 mm. The minimum amount of rain is 800 mm. Both slopes receive the ideal amount of precipitation for beech growth at about 700 meters, and the amount of precipitation can be optimum even at higher altitudes.

Uludağ fir (*Abies bornmülleriana*) likes low temperatures. This is the reason why they are located at elevations higher than 700 meters on the north slope. On the south slope, however, the ideal temperature conditions for Uludağ fir (*Abies bornmülleriana*) are only present near the summit. Çataldağ is a mountain consisting mostly of granites, and it is covered with limeless brown soil and even with podzolic soils on the north facing slope. There are acidic soils beneath beeches and Uludağ fir (*Abies bornmülleriana*). This can be observed by looking at some underbrushes such as *Vaccinium arctostaphylos*, *Ruscus hypoglossum* and *Ilex colchica*.

Fig. 2. A view from the summit of Çataldağ Çobantepe (1317 m) towards Çataltepe in the north. The surface is a slickenside. The surface on which soil was not formed and trees could not cling because of high slope and concavity remains as a bare rocky area.

Fig.3. Oak barrens (Quercus cerris and Quercus frainetto) located at the elevation of 800 meters on the south slope of Çataldağ.

The upper levels of the south slopes are covered with lime-free brown forest soils. These are neutral and low reactive soils. There are brown soils above lime masses.

Table 1. Monthly average temperatures of Mustafakemalpaşa and Kepsut (°C)

Station	Elev. (m)	Months												Year
		1	2	3	4	5	6	7	8	9	10	11	12	
Mustafakemalpaşa	40	5.3	5.8	8.4	12.8	17.1	21.5	23.5	23.2	19.5	15.2	10.2	7.0	14.1
Kepsut	80	5.0	3.8	7.9	12.8	18.0	21.9	24.5	24.5	20.0	16.7	11.5	6.6	14.4
Northern Slope	700	2.0	2.5	5.1	9.5	13.8	18.2	20.2	19.9	16.2	11.9	6.9	3.7	10.8
Southern Slope	700	1.9	0.7	4.8	9.7	14.9	18.8	21.4	21.4	16.9	13.6	8.4	3.5	11.3

Çataldağ is the edge of the Uludağ fir range. This species is not found anywhere in south and west beyond Çataldağ. Those on the north slopes of Mount Ida are considered to be another subspecies, namely *Abies nordmanniana* subsp. *equi-trojani*. Çataldağ can be regarded as a part of the Black Sea phytogeographical region due to these features. Bush formation, which emerged on the lower levels of the south slope because of destruction, is not a characteristically maquis community though it includes some maquis elements. Turkish pine (*Pinus brutia*)

and black pine (*Pinus nigra*) communities situated on the south slope cling to the ground thanks to the aspect, and they do not pose an obstacle to the existence of Çataldağ in the Pontic area.

Table 2. Average monthly precipitation from Mustafakemalpaşa and Kepsut stations (mm)

Station	Elev (m)	Months												Year
		1	2	3	4	5	6	7	8	9	10	11	12	
Mustafakemalpaşa	40	92.9	76.3	63.9	55.0	40.8	24.5	14.2	14.3	28.4	65.7	90.5	100.0	666.5
Kepsut	80	101.4	79.8	66.0	48.7	41.6	24.8	8.6	6.0	27.6	47.5	71.7	100.9	624.6
Northern slope	700	137.3	120.7	90.3	81.4	67.2	33.3	23	23.1	58.7	96	120.8	144.4	995.9
Southern slope	700	148	126.4	91.8	74.5	67.4	31.3	15.1	12.5	51.8	71.4	95.9	147.5	933.6

About 45% of the floristic elements in the area are peculiar to the Black Sea phytogeographical region. The Mediterranean elements compose only about 25% of the area, and 30% of the elements are of unknown origins and they belong to other flora regions.

Table 3. Prevailing Wind Directions of Mustafakemalpaşa by Month (1975-2007).

Period (1975-2007)	Months												Year
	1	2	3	4	5	6	7	8	9	10	11	12	
Prevailing dir.	SW	NE	NE	NE	SW	NE	NE	NE	NE	NE	SW	SW	NE
Blowing num.	1616	1608	1936	1648	1200	1774	2392	2264	1840	1632	1720	2008	15064

4. The Vegetation of Çataldağ

4.1. The Vegetation of the South Slope of Çataldağ

The south-facing slopes of Çataldağ are located above 250 meters and rise to 1317 meters (Figure 1). While the natural vegetation of these slopes is composed of forests, they have been destroyed due to anthropogenic factors for years. The area up to the first 700 meters is currently used as a farmland, yet there are still some forest remnants. On the south slope, Turkish pines (*Pinus brutia*) occupy the area up to 650 meters. However, they were severely destroyed in order to create pastures and farmlands. They evolved into bush communities by undergoing degradation. These bush communities are composed of deciduous plants such as *Paliurus spina-christi*, *Crataegus monogyna*), and of maquis elements such as *Arbutus andrachne*, *Spartium junceum*, and *Phillyrea latifolia*. Turkish oaks (*Q. cerris*) are found among Turkish pines that remain as remnant woodlands.

Black pines (*Pinus nigra*) appear on the upper levels. The black pine zone covers the area up to 700 meters. Oak communities replace them above this level. Turkish oak (*Q. cerris*), Hungarian oak (*Q. frainetto*), and sessile oak (*Q. petraea*) are the main units that constitute this community. On the south slope, the oak zone dominates the area up to the elevation of 900 meters.

Beeches (*Fagus orientalis*) grow above this altitude and are the dominant species until the elevation of 1200 meters. Above this level is the Uludağ fir (*Abies nordmanniana* subsp. *bornmülleriana*) zone. There are yews (*Taxus baccata*) scattered right around the summit. The direct effects of wind can be observed towards the highest point of the mountain. These are deflation trails, flag-shaped trees, cracks in trees and the drought of trees. Due to wind effect, soil has risen to the mainland and to the surface in some places.

As is seen, the lower zone of Çataldağ, up to 900 meters, functions as a dry forest. It turns into a humid forest above this elevation. This can be understood by looking at the underbrushes that constitute the foundation of forests. For instance, alpine elements such as snowdrop (*Galanthus* sp.), Primula, Hyacinth (*Scilla* sp.), and (*Crocus* sp.) are also found on this level (Tümen et al., 2007).

Fig. 4. Snowy beech forest

Fig. 5. Black pines (Pinus nigra) that grow above 700 meters of elevation on the south facing slope of Çataldağ

Fig. 6. Beeches on the Çobandede hill (1317 m) of Çataldağ, cannot grow much due to deformation caused by strong winds and became flag-shaped trees.

Fig. 7. Beeches grow at elevations of 900 meters or higher on the south slope of Çataldağ.

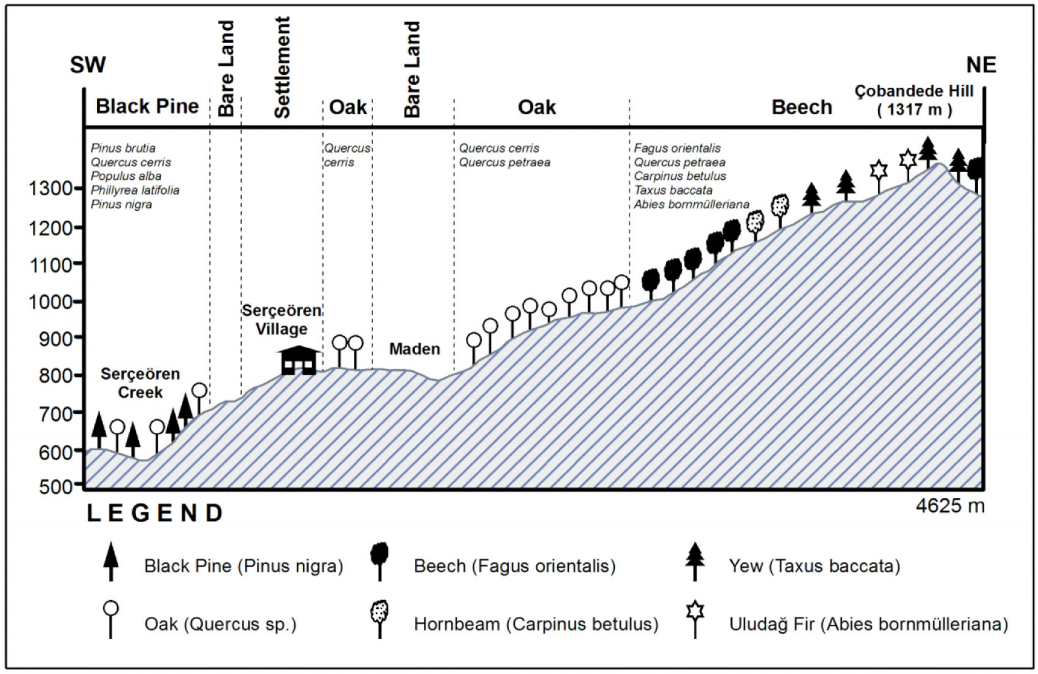

Fig. 8. Vegetation Profiles Serçeören Creek-Çobandede Hill

The Vegetation of the North Slope of Çataldağ: The north slopes of the mountain occupy the area above the elevation of 250 meters like the south slopes.

Some undestroyed parts of this slope are covered with an intense vegetation. The forest belt up to 500 meters consists of oaks. Turkish oaks (*Q. cerris*) are the dominant species in this belt. However, most of the oak belt was destroyed and replaced by farmlands and bush communities. These bushes are comprised mostly of oak bushes. Above the elevation of 500 meters is the beech belt (*Fagus orientalis*), and it stretches all along the way to the elevation of 1100 meters. It is observed that there are also oaks on the lower levels of the beech belt.

These are oak species such as Hungarian oaks (*Q. frainetto*) and sessile oaks (*Q. petraea*). It is seen that there are firs (*Abies nordmanniana* subsp. *bornmülleriana*) mixing with other trees on the upper levels.

Fig. 9. Beech forest on the north slope of Çataldağ.

Fig. 10. Daphne pontica, an understory element of beech forests, is an evergreen plant and a groundcover.

Table 4. Some plant species grow in Çataldağ

Abies nordmanniana subsp. *bornmülleriana*	*Galanthus gracilis*	*Quercus cerris*
Allium sp.	*Genista carinalis*	*Quercus frainetto*
Alnus glutinosa	*Genista tinctoria*	*Quercus petraea*
Anemone blanda	*Hedera helix*	*Rosa canina*
Arbutus unedo	*Hypericum calycinum*	*Rubus idaeus*
Asphodeline lutea	*Ilex colchica*	*Ruscus hypoglossum*
Carpinus betulus	*Juniperus oxycedrus*	*Salix caprea*
Cistus creticus	*Malus sylvestris*	*Sambucus ebulus*
Cistus salviifolius	*Origanun* sp.	*Scilla bifolia*
Corydalis java	*Phillyrea latifolia*	*Sorbus torminalis*
Crocus chrysanthus	*Populus alba*	*Spartium junceum*
Crocus pulchellus	*Populus nigra*	*Taxus baccata*
Daphne pontica	*Primula vulgaris*	*Tilia tomentosa*
Erica arborea	*Primula vulgaris* subsp.*sibthorpii*	*Vaccinium arctostaphylos*
Fagus orientalis	*Prunus laurocerasus*	

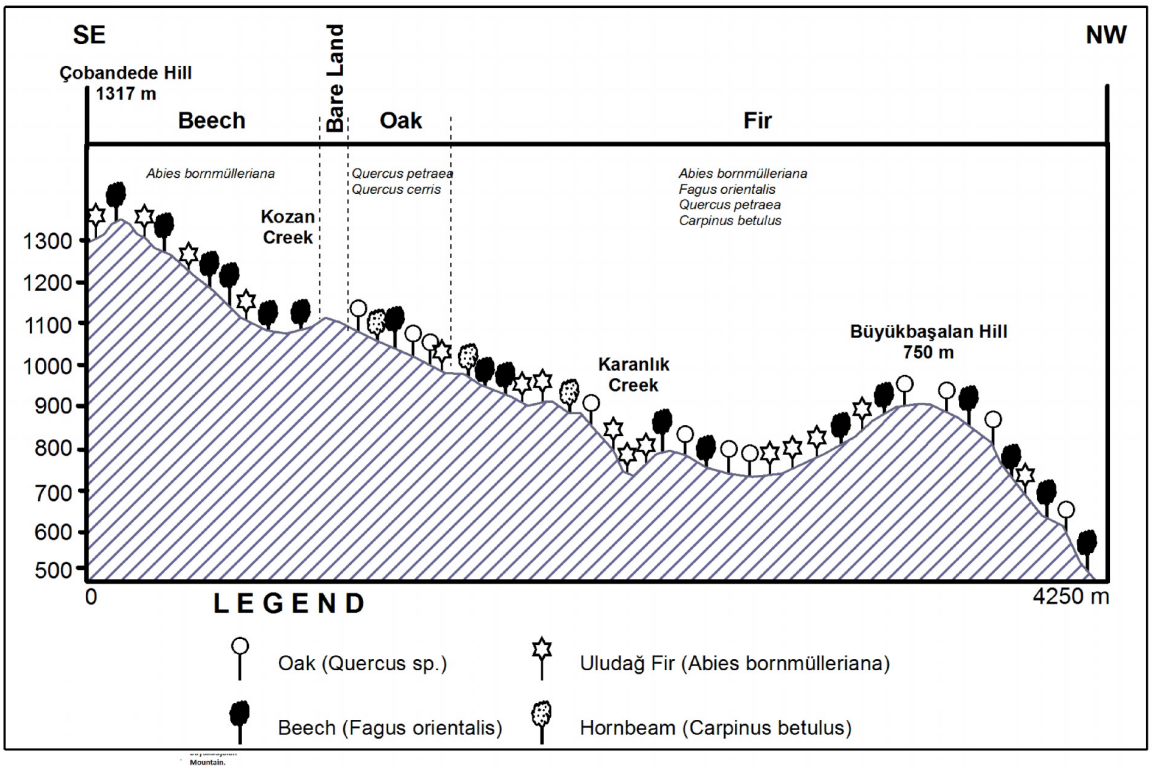

Fig. 11. Vegetation Profile Çobandede Hill-Büyükbaşalan Hill

Fig. 12. Cherry laurel (*Prunus laurocerasus*), an evergreen bush that is one of the elements of the underbrush of beech forests.

Fig. 13. Snowdrop (*Galanthus gracilis*), an herbaceous underbrush element of the beech forest.

Hornbean (*Carpinus betulus*) is another element of this belt. The most striking thing is the underbrush of the beech forests. This understory bush formation is very thick, and it consists of two woody elements, namely cherry laurel (*Prunus laurocerasus*) and daphne (*Daphne pontica*). These two evergreen bushy plants cover the entire ground and make the forest impenetrable.

Holly (*Ilex colchica*), an evergreen plant, is a bushy plant commonly found beneath beeches. Aaron's beard (*Hyperium calycinum*) and butcher's bloom (*Ruscus hypoglossum*) are the typical underbrushes of beech forests (Atalay , 1994; Tümen et al., 2002).

Firs (*Abies nordmanniana* subsp. *bornmülleriana*) dominate the area above the elevation of 1100 meters. Yet, there are also some beeches. There are even small groups of yews (*Taxus baccata*) in some places.

Trees on the upper levels of Çataldağ underwent deformation because of wind effect, and some of them even became dry. Anthropogenic and edaphic factors have played a role in this situation. Beeches have curled towards the prevailing wind direction. Fir trees are partly broken, dry, and flag-shaped. In addition, yews have not grown enough.

5.Conclusions

Çataldağ is interesting when the features of the South Marmara vegetation are taken into account. Due to the aspect effect, it is possible to see Black Sea floral elements on the north slopes and Mediterranean floral elements on the south slopes.

The presence of Uludağ fir on Çataldağ is ecologically and phytosociologically crucial. The aspect undoubtedly has a key role in the sparse distribution of beeches above the elevation of 500 meters on the north slopes, their being the dominant elements above the elevation of 700 meters, and the presence of Uludağ firs on the upper levels of the mountain. The mountain easily benefits from humid and cold air masses coming from the north. Uludağ firs do not exist in the further west than the longitude of Çataldağ. They also do not exist in the further south than the latitude of Çataldağ. Thus, they are within the Black Sea phytogeographical region.

Mediterranean influence prevails on the south facing slopes of Çataldağ. In addition, there are some Mediterranean elements in this area. The aspect-related different features of the two slopes have led to a floristic richness. When someone surpasses the catchment border of the mountain and reaches the north facing slope, they will quickly realize that they have stepped into a whole new ecological environment.

Çataldağ contains various tree species ranging from coniferous trees to broad-leafed ones, some of which are Uludağ fir, beech, and oak species. The area is also very rich in terms of bushes. Maquis elements such as Spanish brooms, Greek strawberry trees, strawberry trees, Phillyreas; deciduous plants such as Jerusalem thorn, common hawthorn, and evergreen and deciduous species, which constitute the underbrush of the beech forests, such as cherry laurels, daphnes, hollies, and blueberries. In the open areas and beneath trees, there are many species belonging to an herbaceous flora. The most significant of them are *Doronicum orientale*, *Primula elatior*, *Galanthus gracilis*, crocus species (*Crocus* sp.), *Anemone blanda*, some hyacinth species (*Scilla* sp.), *Asphodeline lutea and Origanum* sp.) (Table 4).

Çataldağ and its vicinity are floristically, geologically, and geomorphologically qualified enough to be a natural park, and are eligible for nature tourism (Sönmez, 2006). Therefore, the area should be closed to unplanned settlements. This area contains beeches, which are high-quality trees. Thus, first and foremost, extreme and haphazard exploitation of the nature should be prevented. Furthermore, mining prospects and the efforts to establish a wind plant should also be stopped. The area, which has water resources, fresh air, a beautiful landscape, pastures, forests, floristic and faunistic richness, should be handed down to the next generations.

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