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# Vegetation

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## 1 Introduction

Turkey possesses a rich variety of vegetation due to its geomorphological features and varieties of ecological conditions and is located at the intersection of phytogeographical regions of the Mediterranean, Euro-Siberian, and Irano-Turonian. The distinctive vegetation of the country reflects differences in climate, geology, topography, soils and floristic diversity. Ninety percent of the forests in Turkey are 'natural' in origin and contain over 450 species of trees and shrubs. Turkey has 21.2 million ha of forests, covering 27% of the land surface of the country. Most of these forests occur in the mountains. About 42% of the forests in Turkey are composed of coniferous species, 53% of broad-leaved species, and 5% are mixed of coniferous and broad-leaved forests. Furthermore, the mountainous landscapes of Turkey, with their remarkable bioclimatic, geomorphologic, and pedologic diversity, support a great many different high mountain vegetation types (Atalay 1994, 2014; Mayer et al. 1986; Öztürk et al. 1991; Quezel 1986; Yaltırık 1973; Zohary 1973).

Turkey takes place on the Alpine-Himalayan orogenic belt and has a mountainous topography. There are two main orogenic belts: the northern Turkey Mountains in the north and the Taurus Mountains in the south. The isolated volcanic cones more than 3000 m altitude are found in the central and eastern parts of Turkey. Horst and graben systems occur in the west and east Turkey. Orogenic belts have been deeply dissected by the rivers flowing into the seas (Atalay 1987c). These topographic forms are responsible for the formation of the various habitats. Three main climatic types prevail in Turkey, namely the northern part of Turkey under the effect of humid and cold-humid climates, the Mediterranean climate prevailing in the western and southern parts of the

country, and the Continental climate prevailing in the central and eastern parts of Turkey.

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## 2 The Forests of Turkey

The vegetation of Turkey is classified under eight eco-regions, namely the Black Sea, the Marmara Transitional, the Aegean, the Mediterranean, the Mediterranean Transitional, central Anatolian, the eastern Anatolian, and the south eastern Anatolian regions (Atalay 2014) (the geographical position of Turkey is designated in two parts, namely Asia Minor or Anatolia and Thrace—the European side of Turkey—in the Turkish earth sciences and geographical context).

Figure 1 illustrates the different properties of the vegetation compositions of the eco-regions of Turkey.

### 2.1 Forests of the Black Sea Region

The Black Sea ecoregion extends from the Istranca Mountains in the west to Artvin near the Georgian border in the east. The Black Sea region is characterized by a mild-humid and cold-humid climate that only prevails in this Region. The mean annual temperature varies from 14 to 10 °C along the coastal belt up to 1000 m elevation. The average temperature is about 10–6 °C from 1000 to 2000 m. The eastern part of the region is highly humid with an average of 1500–2500 mm annual precipitation. The western part of the region is less humid and has an annual precipitation from 1000 to 1500 mm. The rainy period covers all seasons of the year but the amount of the rainfall varies between seasons. The mean annual precipitation is over 1000 mm, and humid and per-humid climatic conditions are common in the region in general (Atalay 1984, 1987a, b, 1992, 1994, 2010, 2014).

Semiarid subhumid conditions, on the other hand, are dominant in the valleys such as the Çoruh, Gökırmak,

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**Fig. 1** The eco-regions and distribution of vegetation of Turkey (Atalay 2014)



**Fig. 2** Pure oriental beech (*Fagus orientalis*) forest growing under humid mild conditions in the lower belt of the Black Sea Region



**Fig. 3** Northern Anatolian Fir (*Abies nordmanniana*) forest in the foggy and cold-humid habitat of the upper level of the Black Sea Region

Kelkit, and Devrez, which are located in inland areas. The most arid part of the region is the Yusufeli district and its vicinity in the Çoruh valley. During summer, the northern slopes of the mountains are covered with fog. Foggy habitats lead to the decrease of transpiration. Thus, most of the plants are of hydrophytic and hydrophilic character in these areas (Atalay 2014; Yaltırık 1973).

Humid Broad-Leaved Deciduous (Beech, Castanea, Alnus, Tilia and Quercus) Forests

The Black Sea region is very rich in terms of plant species and communities. Forests are composed of different species and floristic composition. Understory flora is associated with *Rhododendron* sp. in general. The main forest communities along the coastal belt of the Black Sea are defined under the





**Fig. 4** Oriental spruce (*Picea orientalis*) and *Rhododendron ponticum* only grow under the heavy foggy and humid-cold conditions in the eastern part of the Black Sea Region



**Fig. 7** Garrique vegetation spreading on the abandoned agricultural fields in the Aegean Region



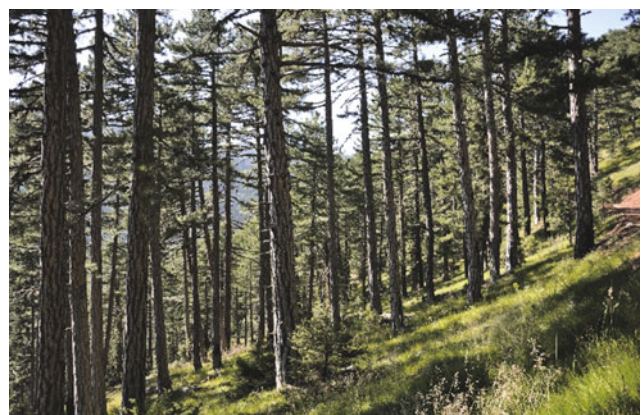
**Fig. 5** A good stand of scotch pine (*Pinus sylvestris*) forest growing on the sunny, subhumid, and cold conditions in NE Anatolia



**Fig. 8** A virgin red pine (*Pinus brutia*) forest with maquis lowerstory grows under direct solar radiation and is very resistant to summer droughts



**Fig. 6** Mixture of shrubby Mediterranean vegetation composed of maquis (yellowish shrubs) and garrique (in the front of photo) is widespread where red pine forests have been completely destroyed



**Fig. 9** A good stand of Anatolian black pine (*Pinus nigra*) growing under subhumid and cold conditions in the vicinity of Beyşehir locality in the upper level of the Mediterranean Region

eastern Black Sea, central, western Black Sea, and The Coastal Belt of the Marmara subregions (Figs. 1 to 5).

### 2.1.1 The Eastern Black Sea Subregion

Humid Broad-Leaved Deciduous (Beech, Castanea, Alnus, Tilia and Quercus) Forests

The high mountains exercise a predominant influence on the climate, and thus on the vegetation. The broadleaf deciduous forests are the main vegetation type of the area. The main forest type of this region is *Fagus orientalis* from the seashore to an elevation of 1700 m (Fig. 2). However, the tree composition of these forests changes in relation to altitude. The *Quercus petraea* subsp. *iberica*, *Castanea sativa*, *Acer platanoides*, *Acer cappadocicum*, *Zelkova carpinifolia*, *Tilia rubra*, and *Pterocarya fraxinifolia* are other broad-leaved species in the oriental beech forests especially between 500 and 1200 meters elevation. The Oriental spruce (*Picea orientalis*) is the dominant tree species at elevations from 1200 to 1500 m. At this subregion, alongside the pure *F. orientalis* forests, other mixed forests composed of beech and oriental spruce, beech + oriental spruce + alder, beech + chestnut, beech, chestnut + red lime, beech + fir, and fir + beech + oriental spruce are also present. These populations have a rich understory of ferns and vines (Atalay 1984, 2014; Yaltırık 1973).

### 2.1.2 The Central Black Sea Region

The natural forests of the subregion are degraded considerably due to the densely populated rural settlements. Productive beech forests are common on the upper part of the Canik Mountains in the vicinity of Akkuş. Oriental beech forests occupying the southern part of the Bafra district are composed of *C. sativa*, *Alnus barbata*, *Alnus glutinosa*, *Prunus* sp., and *Carpinus* sp. The shrub layer of such forests is mainly composed of *Rhododendron flavum* (Atalay 1992).

### 2.1.3 The Western Black Sea Subregion

Coastal mountain ranges, deeply dissected river valleys such as the Gökırmak, Devrez, and the inland mountains of Bolu-Abant-Köroğlu determine the distribution of the vegetation cover of this subregion.

Coastal mountains have productive *F. orientalis* forests and their floristic compositions in the coastal belt are associated with *Pinus brutia*, *Laurus nobilis*, *C. sativa*, *Tilia* sp., and *C. betulus*. The forests of *P. sylvestris*, *Abies bornmulleriana* and mixed *F. orientalis* forests also occur at lower intensity.

### 2.1.4 The Coastal Belt of the Marmara Subregion

Broad-leaved deciduous forests are common in the Yıldız Mountains in Thrace, Çatalca, and Kocaeli Peninsulas, at the

two sides of the Bosphorus. The leading forest populations in these regions are the *F. orientalis*, *C. betulus*, *C. orientalis*, and *Quercus* sp. The northern part of the Kocaeli Peninsula is the main occurrence areas of *Quercus*, *Fagus* and *Castanea* forests (Dönmez 1968, 1979).

The Humid-Subhumid Coniferous (Oriental Spruce, Fir, Black Pine and Scots Pine) Forests

Coniferous forests represent a response to a higher part of the mountains on which cold and humid climatic conditions prevail. The tree species and forest communities change depending on the fog formation level and sunny habitats of the mountains. Pure and mixed *Picea orientalis* (oriental spruce), *P. sylvestris*, and *Abies nordmanniana* forests are common in the east (Fig. 3), meanwhile in the middle and western part of the Black Sea subregions, *P. sylvestris*, *Abies bornmulleriana* and *Pinus nigra* occur on the slopes facing south of the Northern Anatolian Mountains (Atalay et al. 2010; Mayer et al. 1986).

*Picea orientalis* forests occur only in higher elevations between 1500 and 2000 meters in the places where upslope fog formation is common (Fig. 4). The sunny habitats of the northern Anatolian mountains are the main occurrence areas of *P. sylvestris*. In fact, pure *P. sylvestris* forests are common in the upper plateau surfaces of the Northern Anatolian Mountains and in the central part of the mountainous areas (Atalay et al. 2012) (Figs. 1, 5 and 9).

*Abies bornmulleriana* forests are widespread on the slopes facing north in the middle part of the Black Sea region. On the contrary, *Pinus nigra* forests, growing somewhat in the continental part, occur on the lowland part of the mountainous areas. The higher parts of the mountains with intense fog and the northern slopes of the Abant and Bolu mountains are the principal occurrence areas of the pure and mixed *Abies bornmulleriana* forests.

Dry (Oak, Black Pine, Red Pine) Forests

The effects of drought increase towards the inland parts of the Black Sea Region. So that, dry forests begin on the bottom lands of the tectonic corridors and lower levels of the wide river valleys and their south-facing slopes in the inland section of the Black Sea Region (Figs. 1 and 9).

The Shrub (Pseudomaquis and Maquis) Formation

This region contains both Mediterranean shrubs and the mild-humid Black Sea trees called the pseudomaquis (Dönmez 1968; Zohary 1973). Pseudomaquis are widespread as a narrow belt along the Black Sea coast. This shrub formation has been developed following the destruction of the broad-leaved deciduous forests. In other words, degraded forests are mostly replaced or covered by pseudomaquis. Maquis are also common in the bottom land of the valleys and the tectonic depressions lying in the inland part of the Black Sea Region.



## 2.2 The Marmara Transitional Region

This region surrounding the Marmara Sea is the transitional region between the Black Sea mild-cold-humid climate in the north and the Mediterranean climate in the south and west. Thus, it contains both Mediterranean and Black Sea region vegetation and can be divided into three subregions.

### 2.2.1 The Broad-Leaved Deciduous Forests

These forests that are mainly composed of *F. orientalis*, *Tilia tomentosa*, and *C. sativa* are found on the northern slopes of the mountains in this region. *Fagus orientalis* forests are present in the higher parts of the Samanlı mountains in the east to the lower (1000 to 1100 m) in the south. In this area, beech forests are partly composed of *C. betulus*, *Tilia tomentosa*, *P. nigra* and *P. sylvestris*.

The northern slopes, like the Ulu and Domaniç mountains are affected by humid air masses coming from the north. These mass fronts are being intercepted by the mountains, where the northern slopes receive more rainfall than the southern slopes. The upper parts of the mountains are covered by the coniferous forests. *Pinus nigra* forests are widespread on the sunny habitat of the mountains in the south.

Different vegetation covers also yield different soil types in the Euro-Siberian region. For example, acidic soils and/or Podzols are common under the *Fagus*, *Abies*, *P. sylvestris*, and *Picea orientalis* forests. Alkaline soils appear under the *Pinus nigra* and xerophytic shrub communities.

### 2.2.2 The *P. Brutia* and *Quercus* Forests

In the Marmara subregion, the forests are associated with *P. brutia* and *Quercus*, mainly found on the lowland and the south-facing slopes of the mountains. In the areas where *P. brutia* has been removed, *Quercus coccifera*, *Calicotome villosa*, *Paliurus spina-christii*, and *Erica arborea* occur as the dominant shrub vegetation. In these vegetation areas, alkaline soils are common.

## 2.3 The Mediterranean and Aegean Phytogeographical Region

This region covers the surrounding areas of the Marmara Sea in the NW part of Turkey. The Black Sea humid mild and Mediterranean climatic conditions prevail in the Marmara Transitional Region. Thus, this region contains both Mediterranean and Black Sea vegetation.

The mean annual temperature ranges from 18 to 14 °C from the south to the north. The mean January temperature changes between 10 and 5 °C from the Mediterranean coast to the north of the Aegean coast. The mean July temperature is over 20 °C. The mean yearly precipitation changes

between 400 and 2500 mm most of which falls during the winter period. The amount of precipitation increases and temperature decreases towards the higher part of the mountain due to the altitude. The amount of the precipitation of the south-facing slopes of the Taurus Mountains and north-facing slopes of the Aegean Region Mountains is much more than the other slopes (Efe 1998, 2005; Kantarcı 1982; Atalay 2010). These climatic and topographic properties are responsible for the distribution of vegetation formations. Thus, oro-Mediterranean forests composed of oaks, black pine are present over 800 m in the Aegean Region, and mountain forests associated with cedar, fir, and black pine of the Taurus Mountains commence over 800 m (Fig. 8, 9 and 10). The karstic lands of the Mediterranean region are the main occurrence areas of Luvisols and/or Red Mediterranean soils.

### 2.3.1 Shrub (*Maquis* and *Garrigue*) Formation

Shrub vegetation, which is the secondary succession of the thermo-Mediterranean, occurs along the coastal belt of the region and it continues a few hundred kilometers towards the inland part of the area through the grabens of Gediz, Büyük, and Küçük Menderes.

### 2.3.2 Maquis Vegetation

In most cases, maquis have originated from the degradation of red pine (*P. brutia* Ten) forests via human activities. Maquis vegetation is common in the Aegean and Mediterranean geographical regions up to 600–800 m (Fig. 6). Maquis have a deep root system and can occur on a shallow soil cover and stony–rocky areas. Most of them are evergreen and fast-growing species. *Olea europea*, *Ceratonia siliqua*, *Q. coccifera*, *Pistacia palestina*, *Pistacia lentiscus*, and *Arbutus andrachne* are the principal species of the maquis communities. *Quercus coccifera*, *Quercus ilex*, *P. lentiscus*, *Cistus* sp., and *C. villosa* are the species resistant to forest fires, and they rapidly regenerate by root shoots after fire (Yalırık 1973; Atalay 1994; Atalay et al 1998; Atalay 2014).

### 2.3.3 Garrigue (*Phrygana*) Vegetation

One of the most characteristic habitats of the Mediterranean region is Garrigue, a lowland vegetation community of poor soils, composed largely of spiny or aromatic dwarf shrubs. This short shrub vegetation which is termed as low matorral occupies all the Aegean and Mediterranean coastal areas of Turkey without any demand for selective properties related to parent materials. In fact, one can find the garrigue in the same places where both *P. brutia* and maquis grow. But, Garrigue vegetation is dominant in the areas where the natural vegetation/cultivated field were mostly degraded, burned, or abandoned (Fig. 7) (Öztürk 1995; Öztürk et al 2002; Efe 2005; Atalay 2014).

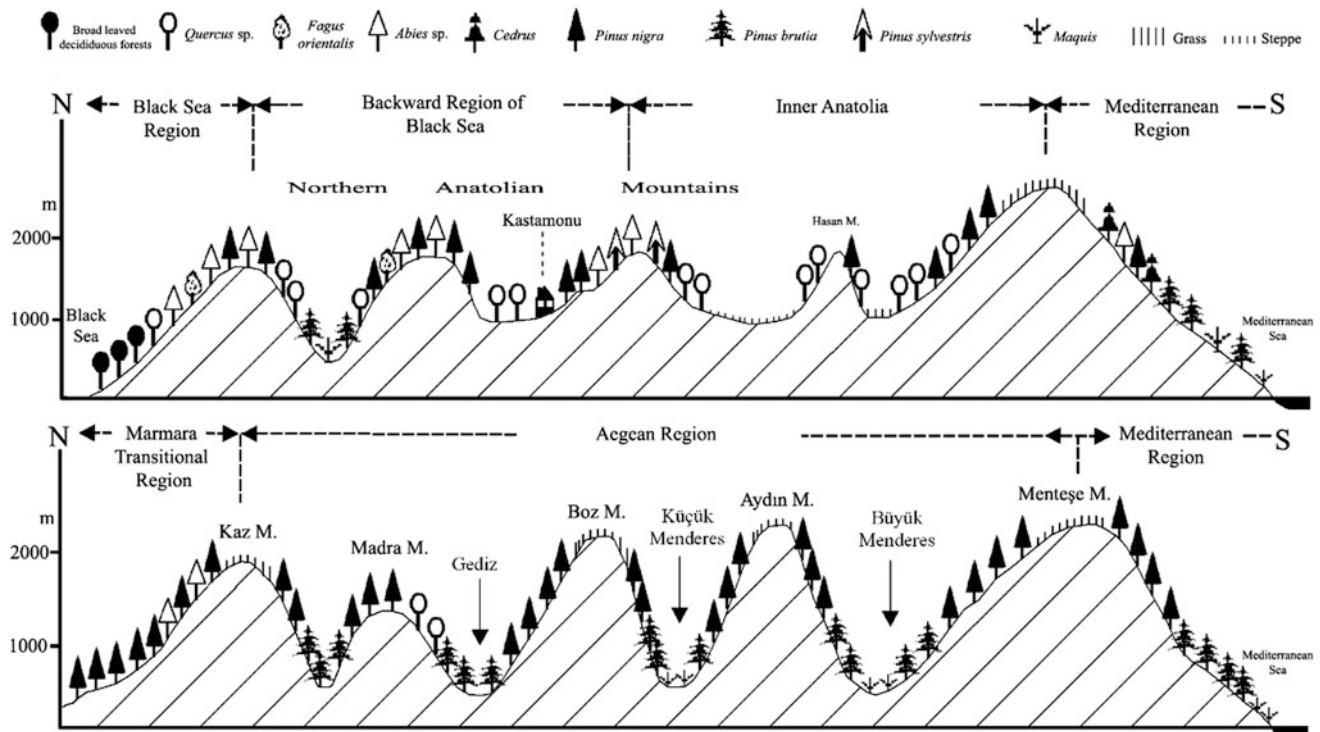


Fig. 10 Vegetation cross sections of Turkey

### 2.3.4 Forest Formations of the Mediterranean Region

The forest formations of the Mediterranean region can be divided into two main groups, namely the Eu-(Lower) Mediterranean and oro-Mediterranean according to climatic and altitudinal conditions.

#### *Pinus brutia* Forests

These are the climax forests of the lower belt of the Aegean and Mediterranean regions and are resistant against drought (Fig. 8). Moreover, the germination, regeneration, and fire resistance of their seeds are much higher than the other forest trees. Burned forest areas are very shortly occupied by red pine communities. Red pines are present at sea level and reach elevations up to 300–400 m in the Marmara, 700–800 m in the Aegean, and 1500 m in the Mediterranean Regions (Atalay et al. 1988).

Biomass productivity and the physiognomic features of *P. brutia* are determined by the physical and chemical properties of the underlying parent materials/rocks, the amount of precipitation, and the ground water level. The biomass productivity is low on the quartzite and peridotite-serpentine parent materials, such as the shrubby red pine stands on serpentine-peridotite parent materials in the Datça Peninsula and in the vicinity of Köyceğiz. In addition to this, poor stands of shrubs exist on the quartzite and siliceous parent materials around the Foça district, north of İzmir. The best productive and widespread regions of red pine forests are in the Mediterranean region. They rise above 1000 m on

the south-facing slopes of the Taurus Mountains and produce the mixed forests of the oro-Mediterranean forest belt (Atalay et al 1998; Atalay et al 2008).

Areas covered by Mediterranean vegetation are also suitable for the formation of Luvisols/Red Mediterranean Soils on the slightly undulating and well-drained flat lands.

### 2.3.5 Mountain Forests of the Mediterranean Region

#### Forest Formations of the oro-Mediterranean Region

In the moist parts of the oro-belt of the Taurus Mountains, *Cedrus libani*, *P. nigra*, and *Abies cilicica* forests are dominant (Figs. 9, 11 and 12). Most of the forests are coniferous, comprising the Anatolian black pine (*P. nigra*), the Lebanese or Taurus cedar (*C. libani*), the Taurus fir (*Abies cilicica*), and juniper (*Juniperus foetidissima* and *Juniperus excelsa*), which form the tree line. *Cedrus libani* occurs in areas affected by the Mediterranean climate, while *P. nigra* prefers inland, continental sites. *Pinus nigra* forests are found between 1200 and 2000 m in the Taurus Mountains. They grow very well on the soft parent materials such as flysch and colluvial deposits and often associated to the *C. libani* and *A. cilicica* in the Taurus Mountains. Pure and good *P. nigra* stands occur around Lake Beyşehir, Lake Eğirdir (Fig. 9), and the Söğüt plateau extending from Antalya to Gazipaşa and to the eastern part of the Taurus Mountains (Karsanti province) (Mayer et al. 1986; Atalay 1987a, 1987b, 1988).



**Fig. 11** A pure and productive cedar (*Cedrus libani*) forest on the north-facing slopes of Western Taurus Mountains. Here, the age of the cedar trees is more than 600 years



**Fig. 12** A pure and productive Taurus fir (*Abies cilicica*) forest growing on the foggy and karstic areas in the vicinity of Çamlıyayla locality, Central Taurus Mountains

*Abies cilicica* forests occur between 1150 and 2000 m elevation on the slopes facing north where pure stands are only found on the north-facing foggy slopes (Fig. 12). The optimum growth areas are generally found between 1200 and 1800 m altitudes. *Abies cilicica* occurs rarely in pure stands but mostly mixed with *P. nigra* and *C. libani*. *Abies cilicica* forests are also found between 1300 and 1500 m in the Nur (Amanos) mountains, east of the Iskenderun Gulf.

*Cedrus libani* forests (Fig. 11), being one of the climax trees of the oro-Mediterranean belt begin at an elevation of 800 m and reach up to 2000 m on the southern slopes of the Taurus Mountains, and also continue to 2200 m in the inner section of the Mountains (Kantarıcı 1982; Mayer et al. 1986; Atalay 1987b, 1988).

Cedar forests being in mixed and pure stands are present from 800 to 2000 m elevations in the vertical direction of the

southern parts and from 1400 to 2100 m in the southern areas of the Taurus Mountains (Fig. 11). They are also present at 1800–2000 m in the Nur Mountains, and descend as low as 500–550 m in the eastern part of the Nur Mountains, west of the immense Kahramanmaraş-Antakya graben extending south to the Red Sea and the Rift Valley. The distribution of the cedar in Turkey clearly reveals that cedar stands do not occur at the extreme maritime and continental conditions. Thus, the optimum growing areas of cedar are found in the transitional region, the zonoecotone, extending from the Mediterranean to central Turkey.

Cedar grows on all parent materials, namely on marly deposits, schists, quartzite, and limestones belonging to the Tertiary, Mesozoic and Paleozoic eras. Pure *C. libani* stands only occur on the slopes facing north of the Taurus Mountains and they grow mostly on the karstic lands providing seed germination within the limestone cracks (Atalay 1987b; Efe 1998).

Juniper (*J. excelsa*, *J. foetidissima*) forests are common on the Taurus Mountains in places where coniferous forests, composed of cedar and black pine, were entirely cleared. This points out that the juniper communities can be considered as the regressive and/or secondary successions of this area. Indeed, the seeds originating from the excrements of the birds easily germinate in the destroyed coniferous forests. In the higher parts of the Taurus forest belt, *Juniperus communis* subsp. *nana* communities are prevalent Oak (*Quercus libani*, *Q. infectoria*, *Q. cerris*) forests that are mainly found between thermo and oro-Mediterranean belts and extend at an altitude of 800–1200 m, where they are common in the western and eastern parts of the Taurus.

As to the Aegean geographical region, oro-Mediterranean forests appear above the *P. brutia* forests on mountainous areas of the Aegean region such as Boz, Aydın, and Menteşe Mountains. Humid forests are found as small stands and only occupy the deep valleys of the northern slopes of Boz and Aydın Mountains. Several *C. sativa* communities are the prominent clusters in the area and are found on the northern slopes between 850 and 1000 m in the Yamanlar Mountain and 800–1300 m in the Boz Mountains.

*Pinus pinea* (stone pine) forests occur on the sandy soils derived from the weathering of granitic rocks in the Kozak Plateau, in the north and central parts of the Aegean region (Atalay 1994).

Dry forests are found on the south-facing slopes of the mountains. Their productivity is generally low and understory vegetation is poor. Dry forests composed of *P. nigra* and oak species such as *Q. infectoria*, *Quercus ithaburensis* subsp. *macrolepis*, *Quercus cerris*, *Quercus frainetto*, *Quercus pubescens* occur on the southern slopes of the Aegean mountains.



## 2.4 The Forests of the Mediterranean Transitional Region

This is the Lakes Region and lies between the Mediterranean and the central Turkish continental climatic areas. There are karstic-tectonic depressions and lakes and closed basins that are separated by the mountain chains in this region. As a whole, this region climatically reflects the semiarid continental influence. The mean annual precipitation decreases as low as 400 mm due to rain shadow. The mean annual temperature on the lowland is about 10–13 °C, the mean winter temperature is above the freezing point. The relative humidity during the summer season is very low (40–50%) (Atalay 2010, 2014).

### 2.4.1 *Pinus Brutia*, *Cedrus Libani* and *Quercus* Forests

These forests are widespread on the lowland between 800 and 1000 m elevations and the productivity of the *P. brutia* forests here is relatively lower than the *P. brutia* forests in the Mediterranean region. The shrub layer of the *P. brutia* forest is mainly composed of *Q. coccifera* and *Paliurus spina-christii*. The *Quercus* forests become dominant towards the north in the tectonic depression (Atalay et al 1998).

*Cedrus libani* and *P. nigra* forests of the Lakes Region are the dominant natural vegetation. The *P. nigra* forest starts after the *Quercus* sp. and replaced by *C. libani* forests on the upper part of the mountains. The productive *C. libani* forests are found on the north-facing slopes of the mountains in the southern part of the region because the northern slopes of the mountains are relatively more humid with cool breezes flowing from the north (Atalay 1987b; Atalay et al. 2010).

## 2.5 Central and Eastern Anatolian Regions

This region encompasses all parts of the central and eastern Anatolian geographical regions. Semiarid continental climatic conditions characterized by snowy and cold winters and hot and dry summers prevail in the region. These are the natural steppe areas of central Turkey and of the depressions of eastern Turkey due to the insufficient amount of annual precipitation (less than 400 mm). The mean annual precipitation of higher areas encircling the lowland region is more than 500–600 mm. Since the area is characterized by a dry continental climate, these forests are resistant to cold temperatures and water shortages and are therefore considered dry or xeric forests (Atalay 1994) with dominant oak species, including *Q. pubescens* and *Q. infectoria*, with steppe vegetation increasing to the east.

### 2.5.1 Dry Forests

The highlands surrounding central Turkey are the main areas of *P. nigra*, *Quercus*, and *Juniperus* (Fig. 13). The remaining areas are occupied with the anthropogenic steppe. *Quercus* stands are found as clusters in the transitional region between the steppe and the forest, whereas the *P. nigra* clusters occur on the mountains over 1200 m.

*Pinus nigra* subsp. *pallasiana* and *Q. pubescens* are the climax forest types of central Turkey. The degraded areas of *P. nigra* forests are occupied by *Q. pubescens* and *J. excelsa*, *J. oxycedrus* and *Q. pubescens*. Dry (*Pinus nigra-Quercus-Juniperus*) forests occur in the mountainous areas encircling central Turkey. Oak stands mainly composed of *Q. pubescens* are common, more or less, in the transitional areas extending between the anthropogenic steppe and the *P. nigra* forests. *Pinus nigra* forests are found at an altitude over 1200 m in the western part of central Turkey. *Pinus sylvestris* forest stands occur on the high plateau surfaces in the vicinity of Akdağmadeni, northeast of central Turkey and also in a good stand on the Sündiken Mountains, in the northwest of central Turkey (Louis 1939; Çetik 1986; Atalay et al. 2012).

The climax forests composed of *P. nigra*, *Quercus*, and *Juniperus* trees are mostly degraded in the higher parts and north-facing slopes of the mountains and is replaced by steppe vegetation. The remnant stands of the oak and black pines are present around Ankara (the Beynam Black Pine Forest) and in the Yozgat National Park.

The steppe vegetation takes place on the lowlands of the Konya and Tuz Lake basins and in Eskişehir. *Artemisia*, *Bromus*, *Achiella*, *Trifolium*, and *Astragalus* species are common in these areas (Çetik 1986; Öztürk et al 2002; Atalay 2014) where Cambisols are widespread (Fig. 14).



**Fig. 13** Dry forest composed of oak (mainly *Q. pubescens*) and black pine (*Pinus nigra*) as the climax forest of the upland part of Central Anatolia





**Fig. 14** Steppe vegetation common in the lowland part of Central Anatolia and in the depressions of East and lowlands of SE Anatolia



**Fig. 15** Tall grass vegetation in the east of Lake Çıldır in the eastern part of East Anatolia

### 2.5.2 Quercus Forests of Eastern Turkey

The moist areas of the middle and western mountains of eastern Turkey are among the productive *Quercus* forest areas of the country. The prominent oak species are *Q. infectoria*, *Q. ithaburensis* subsp. *macrolepis* (synonym *Q. aegilops*), *Quercus brandii*, *Q. libani*, *Quercus robur* subsp. *Pedunculiflora*, *Q. brandii*, and *Q. petraea*. The Mercan (Munzur) and Bingöl Mountains are densely covered by oak forests. The majority of these oak forests have been degraded and/or completely destroyed in many places for fuel wood and fodder. Indeed, dried oak leaves are the main fodder for goats especially during the winter period. More than half of the oak forests in the vicinity of Bingöl were completely degraded in the last two decades (Atalay 1994) due to overgrazing.

### 2.5.3 Tall Steppe and Grass Vegetation

This vegetation is highly spread in the eastern part of Anatolia due to the short summer and long winter periods as well as the higher humidity than that of the central and southeast

Anatolian lowlands (Fig. 15). One can see animal flocks in the tall grass vegetation areas where Chernozems most likely occur due to the relatively higher organic material accumulation under the colder climatic conditions.

## 2.6 The Southeastern Anatolian Region

This is the driest and the warmest region of Turkey partly resembling the eastern and central parts of the country in terms of plant communities and the Mesopotamian floristic region. The mean annual temperature and precipitation are about 17–18 °C and more than 500 mm, respectively. But the amount of annual evapotranspiration is about 1800–2000 mm in the southern lowland of southeast Turkey in turn with a relative humidity as low as 1%. The forests of southeast Turkey can be divided into two groups (Atalay 2014).

### 2.6.1 Pinus Brutia and Quercus Forests

These forests are both mixed and pure and found in the western part of southeast Turkey due to the Mediterranean climatic influence. As a general rule, the pine stands on the lowlands of this region are generally composed of individual trees with poor stem quality.

### 2.6.2 Pure Quercus Forests

These forests are found in the eastern part of the Karaca volcanic mountain. The hilly and deeply dissected mountainous areas of the southeast Taurus Mountains are the natural occurrence areas of oak forests. *Quercus brandii* and *Q. infectoria* subsp. *boissieri* are the dominant oak species in the area. But, productive oak forests are found in very limited localities due to the severe degradation (Çetik 1986).

#### Alpine vegetation

This vegetation is present above the natural timberline in the northeast, north and southeast Anatolian mountains



**Fig. 16** Alpine grass vegetation in the eastern part of the North Anatolian Mountains

(Fig. 16). The short vegetation period supports the growth of the grasses notably belonging to the Alpine environment. The Alpine vegetation is the main grazeland of the animals during the summer period.

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