

FOREST COMPOSITION CHANGES WITH COMPETITION IN THE NORHERN PART OF TURKEY

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Abstract

Turkey, having at least three main climatic types, various land forms and altitudes changing frequently due to mountainous topography, contains more than 10 thousands plant species. The study area on northern Turkey is rich in different forest vegetation types changing from broadleaf deciduous forests to Mediterranean shrublands, and pure or mixed *Pinus sylvestris* var. *sylvestris* forests which resembles taiga forest in northern Hemisphere. Here, under the humid-mild and cold-subhumid conditions, the composition of climax forests are subjected to changes by virtue of excessive forest harvesting, improper silvicultural applications, and abandonment of agricultural fields. This structure leads to the competition for light among trees and shrubs in the Black Sea Region and its southern parts.

In the humid mild climatic conditions prevailing along the coastal belt of Black Sea Region, for instance, abandoned agricultural fields and clear cut areas are occupied firstly by coniferous tree clusters such as *Pinus sylvestris* and *Pinus nigra*. Because the seeds of these conifer tree clusters germinate only when exposed to direct solar radiation on mineral soil as it happens on abandoned agricultural fields. So, the coniferous clusters form the initial succession in the broadleaf deciduous forests. But these clusters may well be converted into pure broadleaf deciduous forests after one rotation period because of the fact that the seeds of these conifer trees do not germinate in the shade of forest understory. The cold humid sunny areas, which are found on the mountainous areas of the northern Anatolia, are the natural occurrence areas of scots pine (*Pinus sylvestris*) forests. Here the seedlings of *Abies nordmanniana* growing underneath the *Pinus sylvestris* forest form a mixed forest of *Pinus sylvestris* and *Abies nordmanniana*. This forest is then converted into pure and/or mixed *Abies* forest in places where *Pinus sylvestris* has been completely removed.

In short, the light factor is the driving force especially in the competition between conifer and broadleaf trees in the cold-humid and cold and mild forest environments of northern Turkey.

Keywords: Competition, Forest, Succession, Human Impact

Introduction

One of the changes of native forests compositions is subjected to the destruction of forest in various ways. In this case, competition occurs between species (interspecific competition) and between individuals of the same species (intra-specific competition). Interspecific competition may occur when, for example, two species may potentially occupy the same habitat (e.g. under the forest canopy) but where one factor, or a combination of factors, may give one the edge over the other. Intra-specific competition occurs in plants, for example, in germination when the emerging seedlings, jostle for light, water and nutriments, with survival going to the most vigorous (Simmons 1982). The other factor of the competition is the excessive cutting of overstory trees growing under the direct solar radiation in a mixed forest. Competition between or among the species is an important factor not only for

reforestation and afforestation activities but also for the application of silvicultural procedures in a given area.

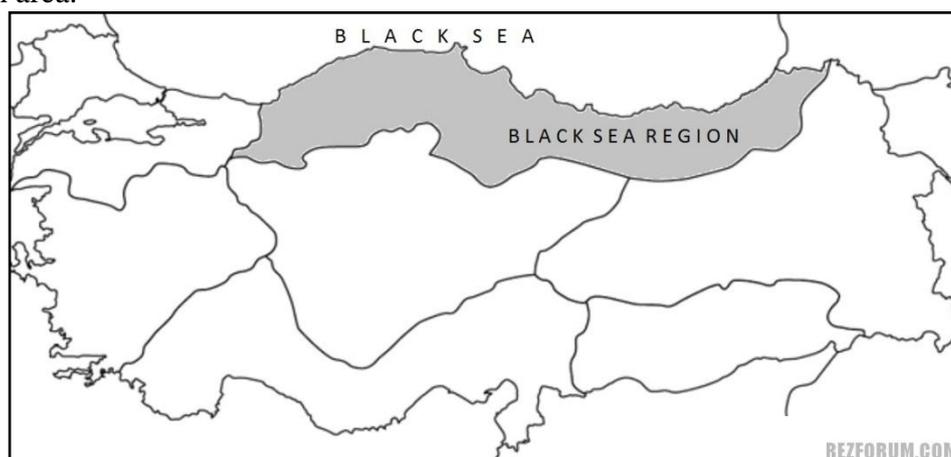


Fig.1. Location map of the study area.

Methods and Materials

This study considers only the distribution of native forest types and vegetation compositions as materials. Forest areas of northern part or Black Sea Geographical Region of Turkey were visited and examined during the period of 1970-2012. The ecological studies carried out by Atalay (1984, 1987b, 1992, and Atalay et al 1988, 2010 and 2012) on *Picea orientalis*, *Cedrus libani*, *Fagus orientalis*, *Pinus brutia*, *Pinus nigra*, *Pinus sylvestris* Forests and their seed transfer regioning and eco-regions and Mayer and Aksoy's studies on forest (1988) provided valuable information about Turkey's vegetation, forest classification and forest vegetation changes caused by human interferences.

During the field study, the relationship between forest areas and their natural environmental characteristics such as topographic factors (altitude, aspect, the direction of the mountain ranges), and climatic data (covering the period of 1975-2006 obtained from nearby meteorological stations), parent materials, soil and biotic factors were taken into consideration

The climatic data of mean annual temperature, precipitation, relative humidity and cloudiness, solar radiation intensity in the vegetation period were taken into account in order to study the relationships between the climatic properties and the distribution of native forests and their classification.

In addition, many topographic profiles and geological cross-sections were drawn in order to study the relationships among the distribution of forest vegetation and parent material, topographic properties and competition.

Findings and discussion

Ecological properties of black sea region

Black Sea Region including southern continental part of it, covers the northern part of Turkey and both of Anatolian and Thrace peninsulas. Based on topography, Black Sea region is divided into two main ecological regions: Black Sea Region and Southern Part of Black Sea Region.

Topography

The Northern Anatolian Mountain range, extending parallel to Black Sea coast in E-W direction, has three mountain ranges based on topography from north to the south. Coastal Belt Mountain ranging from west to east is composed of Akcakoca, Kure, Canik, Giresun, and Eastern Black Sea mountains. The highest summit, exceeding 3000 m, is found on the

Eastern Black Sea Mountains. The tectonic depressions lie in the southern section of Coastal Black Sea Mountain on which semiarid climatic conditions prevail. In the southern part of tectonic depression area the second belt of the Northern Anatolian Mountains extends. Here, the names of the main mountains are; Bolu, Ilgaz, Kose, Otlukbeli, Mescit and Yalnizcam. Their elevations are generally over 2000 m. Third chain called Koroglu Mountain is located on the western part of the study (Fig. 1, 2, 3; Atalay 1987).

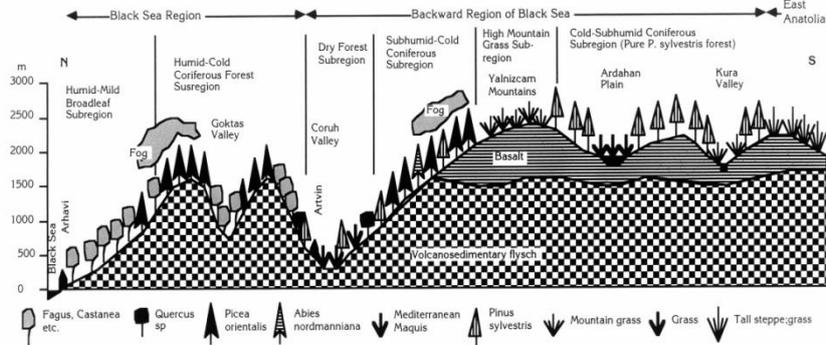


Fig. 2. Topographic and vegetation profile of the eastern part of Black Sea Region

Forest composition of the study area considerably changes depending upon altitude, aspect and continentality factors. Study area is divided into five subregions. Two subregions are established in Black Sea Region and two subregions are found in the backward or southern part of Black Sea Region. A subregion occurs on the upper part of the forest. The main vegetation types of these regions are summarized below.

1. Humid-mild broadleaf deciduous forest subregion. Humid mild broadleaf deciduous forest belt composed of *Fagus orientalis*, *Castanea sativa*, *Tilia rubra*, *T. tomentosa*, *Alnus glutinosa*, *A. barbata*, *Carpinus orientalis*, and many *Quercus* species begins at the Black Sea coast and rises up to 1000-1200 m on the north facing slopes of the mountains. Here, Black Sea humid-mild climate prevails on the northern slopes of the Northern Anatolian Mountains. The mean January temperature which is 5-6°C in the coast falls down to 0°C at an elevation of 1000 m. Average July temperature is about 22-24°C on the coast, down to 18-12°C at 1000 m elevation due to lapse rate is low due to high air humidity. The mean annual precipitation is over 1000 mm (Rize 2300 mm, Zonguldak 1300 mm), all seasons are rainy, and relative humidity is high. There is no water deficiency (Fig. 3).

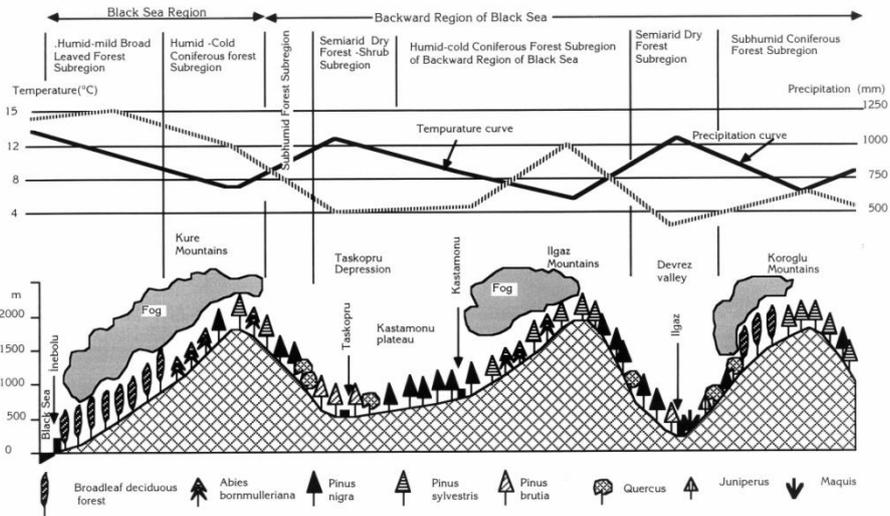


Fig. 3. Topographic, vegetation, temperature, precipitation and ecoregion profile of the middle part of Black Sea Region

2. Humid-cold coniferous forest subregion. This subregion is found on the north facing slopes of the Black Sea coastal mountains between 1000/1200 m and 2000 m elevations. In this belt, coniferous forests are composed of *Picea orientalis* and *Abies nordmanniana* in the eastern parts and *Abies bornmulleriana* dominates in the western parts. The mean annual temperature changing between 6°C and 8°C at an elevation of c. 1000 meters, drops down to 3-4°C at an elevation of c. 2000 m. Mean annual precipitation is over 1000 mm, all seasons or months are rainy and there is no water deficiency during vegetation period. During the summer periods the air mass coming from the Black Sea leads to the fog formation on the slopes facing north.

3. Semiarid dry forest and shrub vegetation subregion in the backward part (south facing slopes) of Black Sea Region. The major rivers, Yesilirmak (Green River), Kizilirmak (Red River) and Çoruh River, flowing through the tectonic depressions discharge from rain-shadow area into the Black Sea. For this reason, here the solar radiation is higher than the coastal belt of Black Sea, and the mean annual rainfall is less than 500 mm, in general. The lower and lower south facing slopes of depressions are the native areas for Mediterranean vegetation composed of red pine (*Pinus brutia*) and maquis vegetation. Toward the upper part of depressions *Quercus* and black pine (*Pinus nigra*) forests start to appear (Fig. 3).

4. Plateaus and High Mountain Coniferous subregion. Due to continentality, the upper parts of the plateau like Kastamonu (1000-1200 m elevation) are the natural occurrence areas of black pine and scots pine (*Pinus sylvestris*), whereas Erzurum-Kars and Ardahan Plateau (1800-2200 m elevation) and Koroglu Mountains in the W of Backward Region of Black Sea and Yalnizcam Mountains in the E of Backward Region of Black Sea Region are the native spreading areas of pure scots pine (*P. sylvestris*) forests. In this subregion fog receiving north facing slopes of the mountains, grow pure oriental spruce (*Picea orientalis*), or *Picea* and *Abies nordmanniana* mixed forests. In the western part of this region, the north facing slopes of the mountains are covered with *Abies bornmulleriana* and *Pinus sylvestris*.

5. Mountain Grass (Alpine and Subalpine) Subregion. The upper parts of the natural timberline where the altitude is over 2000 ms in the Black Sea coastal mountains and the areas over 2500 m in altitude belonging to backward mountains form this subregion. Here the alpine and subalpine grass vegetations are common.

Native forest composition changes via competition

Native forest composition has been subjected to changes depending on both native competition and excessive cutting down some trees especially scots pine trees in the humid and subhumid areas.

Composition changes in the forests can be divided into two main regions.

1. Forest composition change in the broad leaved deciduous forests in the coastal belt of Black Sea Region

As mentioned before, the broad leaved deciduous forests composed of mainly *Fagus orientalis*, *Tilia rubra*, *T. tomentosa*, many *Quercus* species, *Castanea sativa*, *Alnus barbata*, *A. glutinosa* and so on are widespread between the elevations of 0 and 1000 m. The shrub layers of these forests associated with *Buxus sempervirens*, *Ostrya carpinifolia*, *Prunus laurocerasus*, *Rhododendron ponticum*, and many herbaceous species grow under the forest canopy. Forests on backward mountains grow better under foggy conditions during the vegetation period. There are many agricultural fields, for example, tea and hazelnut gardens and cereals fields. When the agricultural fields neighbouring broad leaf forests are abandoned and when these forests are clear cut or excessively cut down are firstly occupied by *Pinus nigra* and *Pinus sylvestris* seedlings; because the seeds of these two pine species germinate on mineral soil or on soft parent material under direct solar radiation. As these seedlings grow

up, the pure *Pinus nigra* or *Pinus sylvestris* clusters are formed in the broad leaved deciduous forest belt. But with the shading of these forest lowerstory, the broad leaf seedlings begin to grow. After a few decades the mixed forest composed of *Pinus sylvestris* and mostly *Fagus orientalis* trees is emerged. In this stage, the regeneration of *Pinus sylvestris* and *Pinus nigra* do not occur in the shaded forest floor. Finally, after a rotation period or felling cycle the number of conifer trees gradually decreases in the mixed forest. So, the climax forest becomes again the dominant forest type in the coastal belt of Black Sea (Fig. 4).

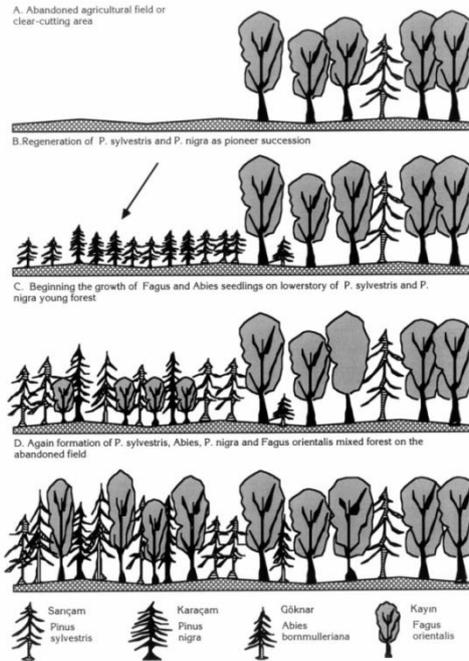


Fig. 4. In the broadleaf forest the growing of pine seedlings on the abandoned agricultural land and formation of mixed forest

2. Forest composition change in pure *Pinus sylvestris* forests

As a general rule, shaded pure *Pinus sylvestris* forest lowerstory is the main regeneration places of *Abies nordmanniana*, *A. bornmulleriana*, *Picea orientalis* and *Fagus orientalis* according to ecological subregions in the Black Sea Region. In other words, diffuse radiation occurring in the ground of pure *Pinus sylvestris* supports the germination of *Abies*, *Picea* and *Fagus* seeds. With the growing of above mentioned seedling mixed coniferous forest and broadleaf and coniferous forest come into scene. The formation of the forest via competition against the light condition can be grouped three forest forms.

a. Pure *Pinus sylvestris* forest change into mixed *Pinus sylvestris*, *Abies nordmanniana* and *Picea orientalis* forest

The orbiomes of the Black Sea coastal mountains, southern mountain ranges and high plateaus are the main occurrence areas of *Pinus sylvestris* forests which receive direct solar radiation. The shady floor of *Pinus sylvestris* forest is suitable for the regeneration of *Abies* and *Picea* in the humid and subhumid areas of Black Sea coastal mountains and backward part of Black Sea Region. Because, their seeds naturally germinate under foggy and/or diffuse radiation conditions. For this reason, almost all *Pinus sylvestris* forests support the germination of the *Picea* and *Abies* in the Eastern Black Sea geographical subregion of Anatolia. As the *Abies* and *Picea* seedlings grow, a few decades later, the mixed forest composed of *Pinus sylvestris* and *Abies* is formed in the Eastern part of Black Sea subregion; whereas the forest composed of *Pinus sylvestris* and *Abies bornmulleriana* is formed in the western part of the Black Sea Region. When *Pinus sylvestris* trees are excessively cut down in the eastern part of the Black Sea region, *Picea orientalis* forest becomes dominant. In this

case, the regeneration of *Pinus sylvestris* can not occur in the shade of *Picea orientalis* forest. Thus, *Pinus sylvestris* forest is replaced by *Picea orientalis* and/or *Picea orientalis* and *Abies nordmanniana*. But *Picea* and *Abies* forests under direct solar radiation may not sustain long time because ecological conditions are not suitable for the growth of this forest.

For example, the regeneration of *Picea orientalis* and *Abies nordmanniana* occurs under the canopy of *Pinus sylvestris* in the direct solar radiation areas of the Şavşat and Ardanuç basins on which subhumid and humid-cold climatic conditions prevail in the backward region of Black Sea. As the *Abies bornmulleriana* and *Picea orientalis* seedlings grow, the forest composed of *Abies*, *Picea* and *P. sylvestris* is formed. When *Pinus sylvestris* trees are excessively cut down for commercial purposes, the mixed forest associated with *Picea* and *Abies* with rarely occurring *P. sylvestris* is formed. Best example is given in the Peynirli forest district in Ardanuc basin. Here 35 years ago, a mixed forest composed of *P. orientalis*, *Abies nordmanniana* and *Pinus sylvestris* was existing. But in 2012 this forest had been converted into a *P. orientalis* and *Abies nordmanniana* forest due to the fact that *P. sylvestris* trees were excessively cut down (Fig. 5).

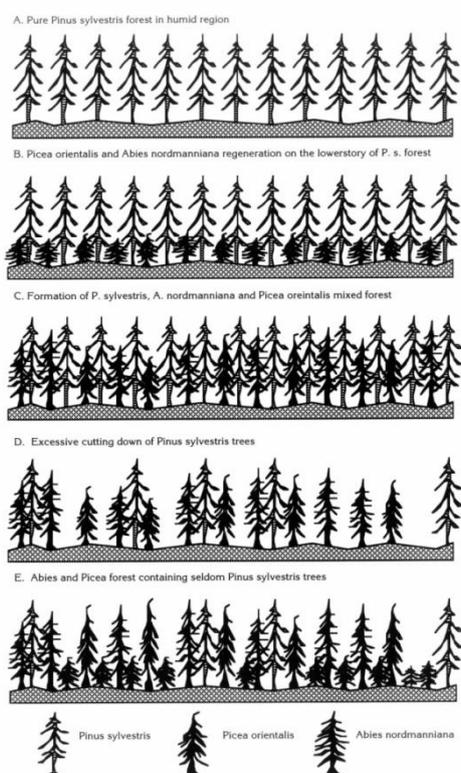


Fig. 5. Pure *Pinus sylvestris* forest changing into coniferous mixed forest associated with *P. sylvestris*, *A. nordmanniana* and *P. orientalis* in the humid/subhumid cold conditions

b. Pure *Pinus sylvestris* forest change into mixed *Pinus sylvestris* and *Abies bornmulleriana* forest

As to the western part of the southern Black Sea Region, there are two main forest types: Pure *Abies bornmulleriana* forests and Pure *Pinus sylvestris* forests. Pure *Abies bornmulleriana* forests grow on fog receiving north facing slopes, and *Pinus sylvestris* forests grow either on sunny north facing slopes which rarely receives fog or undulating area of mountains. As mentioned before, the lower story of *P. sylvestris* forests support the growth of *Abies bornmulleriana* seedlings because of high humidity and shade. As *Abies* seedlings grow, the pure *Pinus sylvestris* forest is changed into a mixed *P. sylvestris* and *A. bornmulleriana* forest. The dominance of *Abies* forest is seen where *P. sylvestris* trees have been cut down. Thus, pure *Pinus sylvestris* forest is replaced by *Abies* forest. Shrinking

examples are found in Uluova, Ballidag and Eđriova localities on the western part of backward subregion of Black Sea Region. Here one can observe *Abies* forest having rarely scattered *P. sylvestris* individuals. But in open lands near or within the forest, pure *P. sylvestris* juveniles are seen. This clearly shows that open sunny areas are suitable for climax forests of *Pinus sylvestris* or *Pinus sylvestris* seems to have climax forest on sunny areas. The main growing reason of *Abies* is related to the diffuse radiation under the forest canopy where humidity condition is better for the growth of fir regeneration (Fig. 5).

c. *Pinus sylvestris* forest change into mixed *Fagus orientalis* and *Abies bornmulleriana* forest

The mixed forests associated with *P. sylvestris*, *Fagus orientalis* and *Abies bornmulleriana* are seen on the north facing slopes of the mountains receiving fog and abundant rainfall on the northwestern part of Black Sea Region. The climatic conditions support the growth of abovementioned trees. In these forests *P. sylvestris* is high to reach the direct solar radiation. In other words, *P. sylvestris* competes with *Abies* and *Fagus* trees to receive adequate light. Here with the excessive cut down of *P. sylvestris*, the mixed forests is changed into *Abies bornmulleriana* and *Fagus orientalis* forest. For example, 30 years ago the mixed forests composed of *P. sylvestris*, *A. bornmulleriana* and *Fagus orientalis* in Buyukduz locality, N of Karabuk city were changed into *Abies* and *Fagus* forests as a result of removing *P. sylvestris* trees by excessive cuttings (Fig. 6).

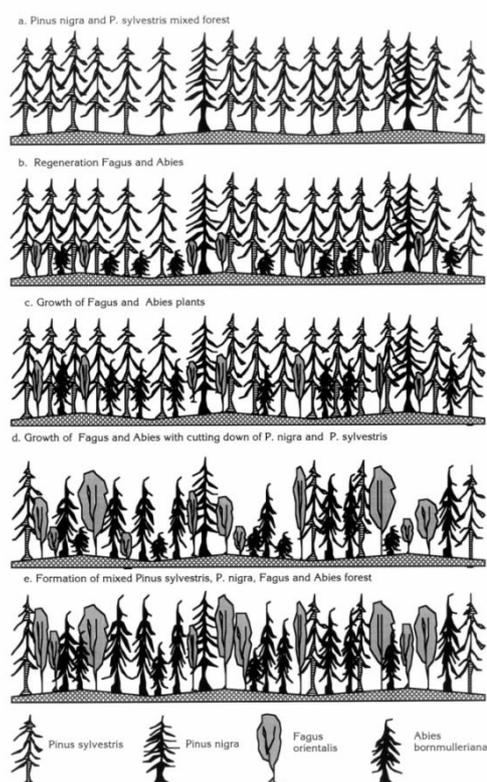


Fig. 6. Successional stage changes of *Pinus sylvestris* forest into mixed coniferous and broadleaf forest.

Conclusion

We have reached at some conclusions about the forest composition changes based on the ecological conditions of forests:

1. Forest composition change in the broadleaf deciduous forest is related to the abandonment of agricultural fields and the clear cutting of the forests. Here, within the broadleaf forest in the humid-mild subregion of Black Sea Coast, the pioneer succession is the coniferous forest formation.

2. Pure *Pinus sylvestris* forests in the humid and subhumid areas are changed into *Pinus sylvestris*, *Picea orientalis* and *Abies nordmanniana* mixed forests through natural processes. With the excessive cut down *Pinus sylvestris* trees, this mixed forest is changed into *Picea orientalis* and *Abies nordmanniana* in the eastern backward region of Black Sea.

3. Pure *Pinus sylvestris* forest in the backward part of Black Sea are converted into *Abies bornmulleriana* forest containing rarely scattered *P. sylvestris* trees as a result of excessive cutting of *P. sylvestris* trees.

4. The main reason of the compositional change for *Pinus sylvestris* in the humid and subhumid areas is the growth of *Abies* and *Picea* seedlings on the lowerstory of *Pinus sylvestris* forest.

5. Light factor in the open area and on the lowerstory of forest is responsible for the mixed forest formation in the humid and subhumid areas.

6. With the application of proper silvicultural activities the mixed forests can be converted into climax forest in the abovementioned areas.

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