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### Abstract

Turkey has very rich in terms of several ecosystems and/or habitats in which various types of flora and fauna are found. These properties of Turkey depend on its geographical latitude, different climatic regions, mountainous topographical conditions. Turkey's forests can be divided into three main forest ecologic systems in terms of floristic composition, forest productivity and climatic properties: Black Sea humid temperate and cold region, Mediterranean subhumid-semiarid region and Semiarid continental region.

Black Sea humid temperate and cold region covers the northern part of Turkey. The coastal belt of the region includes broad-leaved deciduous forests, which are composed of *Fagus orientalis*, *Alnus* sp., *Tilia* sp., *Castanea* sp. and it contains rich undergrowth herbaceous. The foggy higher part of the Northern Anatolian mountains is covered with pine forests, which are associated with *Picea orientalis* (Eastern part of the North Anatolian mountains), *Pinus sylvestris*, *Abies* sp. and *Pinus nigra*. The tectonic depression and deep valleys extending southern section of the region are the main occurrence areas of some Mediterranean shrubs.

Mediterranean subhumid-semiarid region covers the western and southern part of the Anatolia. The lower belt of this region is the main occurrence area of the *Pinus brutia* forests and maquis vegetation. Maquis is widespread in places where *Pinus brutia* forests have been destroyed and degenerated. Maquis vegetation can be considered as secondary vegetation in the Mediterranean region of Turkey. The upper part of the Aegean region is covered with *Pinus nigra*. But Taurus Mountains or oro-Mediterranean belt is the main growth area of the *Cedrus libani*, *Pinus nigra* and *Abies cilicica*.

Semiarid continental region covering the inner parts of Anatolia and Thrace is the main occurrence area of the dry forests, which are associated with *Quercus*, *Juniperus*, some *Pinus nigra* and *Pinus sylvestris*. Steppe vegetation appears in the lower part of this region. The upland encircling Inner Anatolia is mostly covered with oaks. Productive oaks forests are common on the Southeastern Taurus Mountains. Pure *Pinus sylvestris* communities are found in the northeastern part of the Anatolia.

**Key words:** forest ecology, forest ecosystem, forest trees

Turkey's forest classification is made according to ecological regions. Each ecological region fits the main climatic regions or main zonobiomes and phytogeographical region. The mountainous regions form a separate ecological environment called orobiome and latitudinal belts showing different forest communities are common along the mountains. The forests of Turkey can be divided into three main ecological regions.

## BLACK SEA HUMID TEMPERATE AND COLD FOREST REGION

The Black Sea humid temperate and cold region covers the Black Sea Geographical Region and the northern part of the Marmara Geographical Region. The southern boundary of the region follows the northern slopes of the mountains extending E-W direction.

The mean annual temperature varies between 14°C to 10°C along the coastal belt of the Black Sea rising up to 1000 m. The temperature is about 10°C - 6°C between 1000 and 2000 m.

Rainy period covers all seasons of the year but the amount of the rainfall of the season is not equal. The mean annual precipitation is over 1000 mm. Humid and perhumid climatic conditions are common in the region, in general. But semiarid subhumid conditions prevail on the deep valleys and tectonic grabens in the southern sections of the Black Sea Region.

During the summer period the northern slopes of the mountains are covered with fog. Prominent pedogenic process is decalcification which produces acidic soil. Leading forest communities are as follows:

### BROADLEAF DECIDUOUS (BEECH, *CASTANEA*, *ALNUS*, *TILIA* AND *QUERCUS*) FORESTS

Black Sea region, which is very rich in terms of plant species and communities, contains more than 6000 plant species. Forests compose of different species mostly belonging to Euro-Siberian floristic region. Under ground flora is associated with *Rhododendron* sp. in general.

*Fagus orientalis* (Oriental beech), which is the main forest type begins at the sea-shore and continue as high as 1700 m. But tree composition of these forests changes according to altitude and special topographic forms. Other broadleaf trees are common within the oriental beech forests especially between 500 and 1200 m. In this region besides pure *Fagus orientalis* forests the other mixed forests composed of beech and oriental spruce; beech+oriental spruce+alder; beech+chesnut; beech, chustnut+red lime; beech+fir; and fir+beech+oriental spruce are found.

The shrub layer of beech forests mainly composes of *Rhododendron flavum*, *Taxus baccata*, *Prunus laurocerasus*, *Taxus baccata*, *Cornus* sp.

Catalca and Kocaeli peninsulas extending two sides of Bosphorus are the main growing areas of *Fagus orientalis*, *Carpinus* and *Quercus*. Indeed, the northern part of the Kocaeli peninsula is the main occurrence areas of *Quercus*, *Fagus* and *Castanea* forests.

In Thrace-Yildiz mountains *Fagus orientalis* forests begin at an elevation of 250-300 m in the coastal belt and cover the upper part of the mountain, and go on at an elevation of 500 m of the southern sector of the mountains. Although Belgrad forests are composed of *Quercus* forests in general, *Fagus orientalis*, *Castanea sativa* communities are found as small clusters.

In the Southern Marmara subregion, the forests mainly composed of *Fagus orientalis* are found between 800 and 1000 m on north-facing slopes of the western part of Samanlı Mountains. In this mountains beech forests are partly composed of *Carpinus betulus*, *Tilia tomentosa*, *Pinus nigra* and *Pinus sylvestris*. *Abies* and *Fagus* mixed forests are widespread on the southern slopes of the Ulu (Bursa) and Domanic mountains.

### HUMID-SUBHUMID CONIFEROUS (ORIENTAL SPRUCE, FIR, BLACK PINE AND SCOTCH 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/or forest communities change according to the fog formation level and sunny habitats of the mountains. In the east, for example, the pure and mixed *Picea orientalis* (oriental spruce) *Pinus sylvestris* and *Abies nordmanniana* forests are common; meanwhile in the middle and western part of the Black Sea subregions *Pinus sylvestris*, *Abies bornmulleriana* and *Pinus nigra* appear, and in the eastern and southern part of the Marmara Region *Pinus nigra*, *Abies equi-trojani* forests exist. These forests begin after 1000 m and continue up to alpine and subalpine belt.

*Picea orientalis* forest only appears between 1500 and 2000 m height in the places where fog formation is common. Shrub layer of *Picea orientalis* is associated with the *Rhododendron* species, in general.

The sunny habitats of the northern Anatolian mountains are the main occurrence areas of the *Pinus sylvestris*. In fact, pure *Pinus sylvestris* forests are common in the upper plateau surfaces of the Northern Anatolian mountains and in the inner part of the mountainous areas.

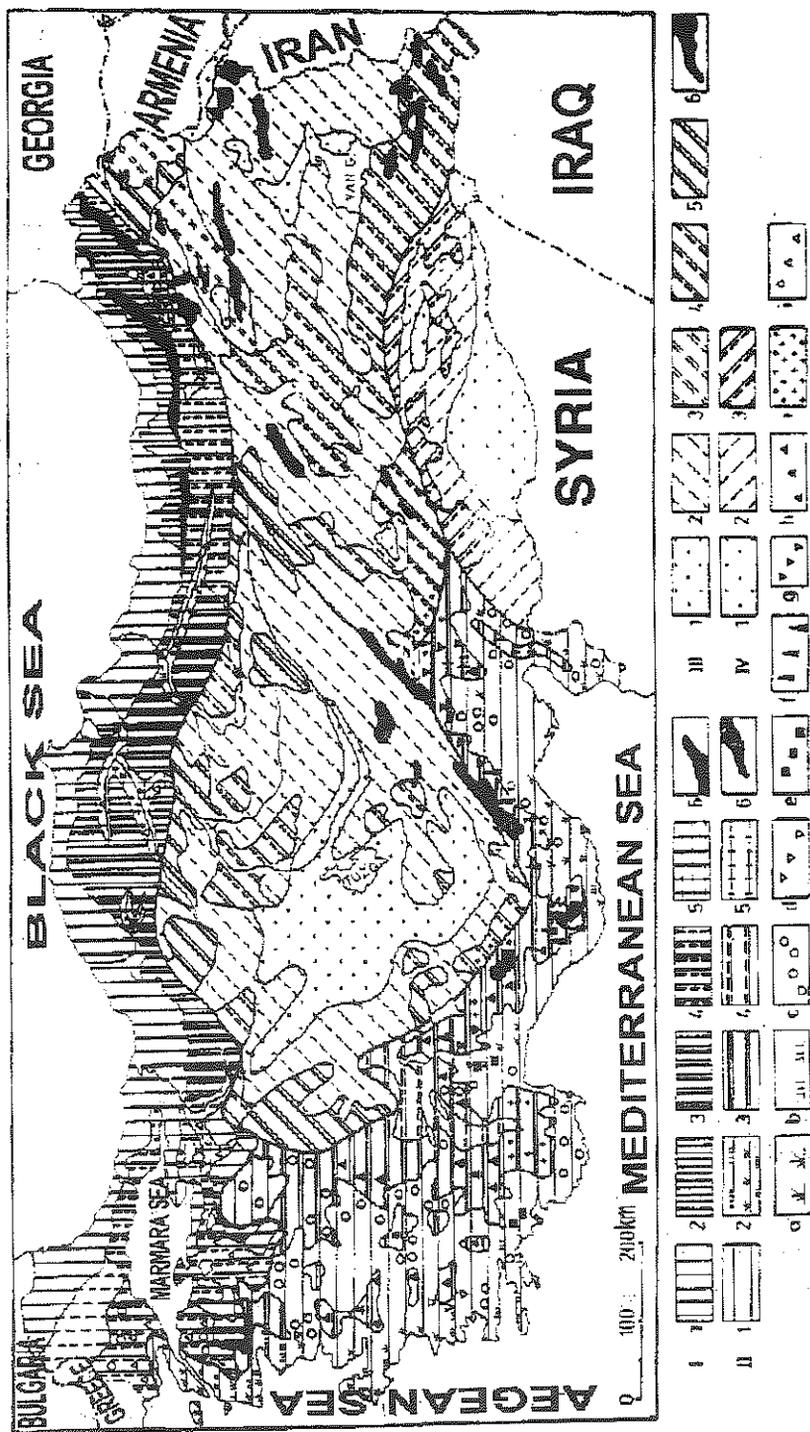
*Abies bornmulleriana* forest is widespread on the slopes facing north in the middle part of the Black Sea region. On the contrary, *Pinus nigra* forests, growing somewhat in the continental part, appear on the lowland part of the mountainous areas.

### DRY (OAK, BLACK PINE, RED PINE) FORESTS

As towards the southern part of Black Sea Region the effects of drought increase. For this reason, dry forests begin to appear on the bottomlands of the tectonic corridors and lower levels of the wide river valleys and their south facing slopes in southern section of the Black Sea Region (Map 1). These forests are characterized by *Quercus*, *Pinus nigra* and *Pinus brutia*, and shrub formations most of which belong to the Mediterranean floristic region.

### SHRUB (PSEUDOMAQUIS AND MAQUIS) FORMATION

This region contains both Mediterranean shrubs and Black Sea tree elements called pseudomaquis. Pseudomaquis is widespread as a narrow belt along the Black Sea coast. Maquis elements are also common in the bottomland of the valley and the tectonic depressions lying in the south of the Black Sea Region.



Map 1. The distribution of forest formations according to regions in Turkey. Legend I: Black Sea Region: 1- Broadleaf deciduous forests (*Fagus orientalis*, *Carpinus*, *Alnus*, *Quercus*, *Tilia*), 2- Mostly oriental spruce (*Picea orientalis*) forests, 3- Pure and mixed coniferous (*Pinus nigra*, *Pinus sylvestris*, *Abies*) forests, 5- Mediterranean shrubs and Red pine (*Pinus brutia*) communities, II- Mediterranean Region 1- Red pine (*Pinus brutia*) forests, 2- Maquis and garrigues communities, 3- Oro-Mediterranean coniferous (*Pinus nigra*, *Abies cilicica*, *Cedrus libani*) forests, 4- Steppe with tree, 5- Oriental beech (*Fagus orientalis*) forests, 6- Subalpine grasses. III- Continental Regions of Inner and Eastern Anatolia: 1- Steppe, 2- Anthropogenic steppe, 3- Tall grass, 4- Oak (*Quercus*) forests, 5- Pure Subalpine grasses. IV- Continental Southeastern Anatolian Region: 1- Short tall and mixed coniferous (*Pinus sylvestris*, *Pinus nigra*, *Quercus*) forests, 6- Alpine vs subalpine grasses. V- Continental Southeastern Anatolian Region: 1- Short tall steppe, 2- Anthropogenic steppe, 3- Oak (*Quercus*) forests

## THE MEDITERRANEAN FOREST REGION

This region covers the coastal belt of the Marmara Sea, western part of the Anatolian and the Mediterranean Geographical Region of Turkey. Mediterranean climate characterised rainy and mild winters, hot and dry summers. The mean yearly precipitation varies between 1800 to 400 mm most of which falls during the winter season. The rainiest parts are of the southern slopes of the Taurus Mountains due to intercepting of fronts. The less ones are found in the deep valley and depressions Mut Basin locating in the central part of Taurus Mountains and intermountain basins in the Lake Region, NW of Mediterranean Geographical Region. The mean yearly temperature ranges from 20°C to 14°C, this figure decreases towards the upper part of the mountainous areas. Relative humidity is more during the summer season than winter due to the fact that the winds blowing from the Mediterranean Sea is dominant during the summer. Leading soil types red Mediterranean soil (Alfisol) on the karstic and slightly undulating areas and mollisols on the marly and soft limestone. Main vegetation formations of this region are as follows:

### SHRUB (MAQUIUS 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 km towards the inland part of the area through the grabens.

Maquis elements have a deep root system so that even they occur on the thin soil cover, stony-rocky areas, especially on the karstic lands. Most of them are evergreen and fast-grow in character. *Quercus coccifera*, *Q. ilex*, *Pistacia lentiscus*, *Cistus sp.* and *Calicotome villosa* are resistant against the forest fire, they start to regenerate with root shoots after forest fire.

Some of maquis elements are found as shrub layer of *Pinus brutia* forest. When *Pinus brutia* forest completely cleared in various reasons, maquis elements become dominant vegetation type. In protected areas maquis elements grow as trees. If red pine is found in the sparse maquis areas commonly occupied by red pine and again the maquis forms the underground shrub layer. But densely maquis area protects the germination of the red pine seeds.

Garrigue or phrygana vegetation, which is termed low matorral occupies all parts of the coastal belt of Mediterranean Sea. These low, thorny formations, composed mainly of hemispherical shrubs, which are generally deciduous during the dry season, have developed where both maquis and red pine forests were completely cleared. There are no selective properties relating to parent materials. In fact one can find the garrigue in the same places where both *Pinus brutia* and maquis grow. But, garrigue vegetation is dominant in the areas where natural equilibrium was mostly deteriorated and brunt areas.

### FOREST FORMATION

Forest formation of the Mediterranean region can be divided into two main

groups called Eu- (Lower) Mediterranean and Oro-Mediterranean according to climatic and altitudinal conditions.

*Pinus brutia* forests form the climax forests of the lower belt of the Aegean, Marmara and Mediterranean regions and resistant against the drought. Red pine begins at the sea level and reaches up to 300-400 m in the Marmara Region, 700-800 m in the Aegean Region and 1500 m in the Mediterranean Region.

Biomass productivity and the physiognomic appearance of the *Pinus brutia* are determined by the physical and chemical properties of parent materials and the amount of precipitation or ground water level. The biomass productivity is very low on the quartzite and peridotite-serpentine parent material. In addition to this, poor stands like shrub exist on the quartzite and siliceous parent material.

## MOUNTAIN FORESTS

In the Mediterranean region, the amount of precipitation increases and temperature decreases towards the higher part of the mountain due to the altitude. The amount of the precipitation on the south-facing slopes of Taurus Mountains and north-facing slopes of the Aegean Region Mountains is much more than the other slopes. Sun radiation intensity is very much than the other slopes. These climatic and topographic properties are responsible for the distribution of vegetation formations. For that reason oro-mediterranean forests are composed of oaks, black pine begin after 800 m in the Aegean Region, and the mountain forests are associated with cedar, fir and black pine of Taurus Mountains commence over 800 m.

A humid forest composed of *Fagus orientalis*, *Acer campestre*, *Tilia rubra* also appears as an enclave on the northern slopes of Murat Mountains.

*Pinus pinea* (stone pine) forests growth mostly on the sandy parent material occur on the granitic rocks in the Kozak Yayla, N of Aegean region, on the gneiss in Kocarli district in the middle part of Aegean Region.

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

## FOREST FORMATIONS OF ORO-MEDITERRANEAN REGION

In the humid parts of the oro-belt of Taurus Mountains, *Cedrus libani*, *Pinus nigra* and *Abies cilicica* forests are dominant.

*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 with the *Cedrus libani* and *Abies cilicica* in the Taurus Mountains. *Abies cilicica* forests occur between 1150-2000 m on the slopes facing north and 1450-1550 m on the slopes facing-south in the Taurus Mountains. *Abies cilicica* appears rarely in pure stands but mostly mixed with *Pinus nigra* and *Cedrus libani*. *Abies cilicica* forests are also

common between 1300-1500 m in the Nur (Amanos) Mountains, E of Taurus.

*Cedrus libani* forests being one of the climax tree of oro-Mediterranea belt begins at an elevation of 800 m and reaches up to 2000 m on the southern slopes of the Taurus Mountains, and also continues 2200 m in the inner section of the Mountains. Cedar grows on all parent materials namely marly deposit, schist, quartzite, and limestones belonging to Tertiary, Mesozoic and Palaeozoic era, Pure *Cedrus libani* stands only occur on the slopes facing north in the Taurus Mountains.

Juniper (*Juniperus excelsa*, *Juniperus foetidissima*) forests are common on the Taurus Mountains in places where coniferous forests, composed of cedar and black pine, were entirely cleared. For this reason it can be stated that juniper communities can be taken into consideration as the regressive and/or secondary succession. Indeed the seeds originating from the excrements of the birds easily germinate in the destroyed coniferous forest areas. In the highest part of the forest belt *Juniperus communis* subsp. *nana* occur.

Oak (*Quercus libani*, *Q. infectoria*, *Q. cerris*) forests are mainly found between thermo and oro-mediterranean belt and extend as a belt at an altitude of 800-1200 m, and are common in the western and eastern parts of the Taurus. The common species of the oak forests are: *Quercus libani*, *Q. frainetto*, *Q. cerris* and *Q. infectoria*. *Q. pubescens*. They begin to dominate in the places where the continental climatic effects prevail.

*Quercus vulcanica*, which is the endemic and relic species for Taurus Mountains, only grows within the karstic depression such as dolines in the Dedegol and Davraz mountains. In this habitat a group of humid trees and shrubs belonging to Euro-Siberian elements such as *Sorbus torminalis*, *Tilia rubra*, *Fraxinus excelsior*, *Ulmus glabra*, *Ostrya carpinifolia* appear.

## FOREST OF INNER- EASTERN AND SOUTHWESTERN ANATOLIAN REGIONS

This region encompasses all part of the Inner, Eastern and South-eastern Anatolian geographical regions. Forests are beginning to appear the edge of the plains and tectonic depressions. Most of the basins are covered with steppe vegetation. As a general rule, continental climatic conditions prevail. There are considerable temperature differences between winter and summer. The amount of annual precipitation is less than 500 mm, in general.

The hottest part of this region is the SE Anatolian plains. In this area the mean annual temperature is about 17°C-18°C. The mean annual temperature, which is less than 12°C in the Inner Anatolia, decreases 4°C at an elevation of over 2000 m in the Erzurum-Kars Plateau.

The mean annual precipitation is under 400 mm in the major part of the region. The higher areas encircling the regions this figure attains 600 mm and more. The amount of precipitation is over 1000 mm in the south-eastern parts of Taurus Mountains.

Dominant pedogenic regime is the calcification representing brown, chestnut and chernozem soils (Mollisols) in the depressions and their surrounding areas. But decalcification process is common on the rainy parts of the region (SE Taurus and NE of the Eastern Anatolian high plateau).

## ANTHROPOGENIC VEGETATION/TREE STEPPE VEGETATION

As the result of the destruction climax forests which are composed of of *Pinus nigra*, *Quercus* and *Juniperus* forests have mostly destroyed in the higher areas and north-facing slopes of the mountains. So destroyed areas have been occupied by the steppe vegetation. Less productive forests, which are found in the Inner Anatolia are as follows:

### DRY (BLACK PINE, OAK, JUNIPER) FORESTS

The distribution of these forests in relation to climatic conditions is as follows:

**Inner Anatolian Region:** The high areas surroundings the Inner Anatolia are the main occurrence areas of *Pinus nigra*, *Quercus* and *Juniperus*, and the remain areas are occupied with the anthropogenic steppe. *Quercus* stands are found as clusters in the transitional region between steppe and forest. *Pinus nigra* clusters are seen on the mountains more than 1200 m. On the other hand, main occupancy areas of *Pinus sylvestris* are found in the northern part of the Inner Anatolia.

*Pinus nigra* forests: *Pinus nigra* subsp. *Pallasiana*, which is the climax vegetation of the subhumid-semiarid areas appears on the limely brown forest soil between 1000-1500 m. Ayas mountain can be considered as the optimum growth area of the black pine.

*Pinus nigra* subsp. *pallasiana* and *Quercus pubescens* are determined as having climax forest types of the Inner Anatolia. The degraded areas of the *Pinus nigra* are followed by *Quercus pubescens* and *Juniperus excelsa*, *J. oxycedrus*.

*Quercus pubescens*, one of the sub-climax forest trees of Inner Anatolia has been expanded as a result of the destruction of *Pinus nigra* subsp. *pallasiana*.

Dry (*Pinus nigra*-*Quercus*-*Juniperus*) Forests occur in the mountainous areas encircling the Inner Anatolia. Oak stands mainly composed of *Quercus pubescens* are common, more or less, in the transitional areas extending between anthropogenic steppe and *Pinus nigra* forests. *Pinus nigra* forests appear at an altitude of more than 1200 m in the western part of the Inner Anatolia.

**Eastern Anatolian Region:** The East Anatolia belonging to Irano-Turanian floristic region is under the continental climatic regime and constitutes the highest region of Turkey. Sun radiation intensity is so high during the summer season that ground becomes very hot due to the low air moisture. For this reason, the upper limits of the tree attaining over 2700 m is higher than that of the other region of Turkey. Above 2500-2700 m alpine and subalpine belt commences in spite of this line is about 2000 m in the coastal ranges.

*Quercus* forests begin above the natural steppe areas and continue as high as subalpine belt. Almost southeastern Taurus Mountains are covered with oaks forests. Oaks forests are in generally in pure stand and place to place mixed forests with juniper are found. The prominent oak species are *Quercus infectoria*, *Quercus itaburensis* subsp. *macrolepis* (synonym *Q. aegilops*), *Quercus brandii*, *Q. libani*, *Quercus robur* subsp. *pedunculiflora* and *Quercus petraea*.

Most part of the Eastern Anatolia oaks has been degenerated and completely

destroyed place to place in order to obtain fuel material and leaf for animals. Indeed, dried oak leaves are the main fodder for goats especially during the winter period. More than half of the oak forest in the vicinity of Bingol Province completely destroyed only for last 20 years. For that reason productive oak forest is found locally.

*Pinus sibirica* forests are found in the northern section of Eastern Anatolia. But the exact distributional areas of these pine forests cannot be determined due to the fact that most of them have been destroyed.

**Southeastern Anatolian Region:** This region, which is the driest and hottest region of Turkey partly, resembles the Eastern and Inner Anatolian regions in terms of plant communities. This region also represents the Mesopotamian floristic region. Forest vegetation of this region is sparse and poor due to climatic conditions. A major part of the oaks forests has been destroyed.

Oak stands having rich in shrub and oak species appear above 850 m on the edge of the steppe and mountains of Sanliurfa province in the west and east. Leading *Quercus* species for the region are *Quercus brandii* and *Quercus infectoria subsp. boissieri*.

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