A general survey of the vegetation of north - eastern anatolia

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Introduction

The study area named NE Anatolia which is bounded by the Erzurum–Rize line on the west, the Erzurum–Tuzluca line or the Aras river valley on the south, comprises the subregion of the Eastern Black Sea and the subregion of Erzurum–Kars in Eastern Anatolia. From the vegetational point of view, the lower part of the Eastern Black Sea Mountains was covered by broad–leaved forests, and the upper section was occupied by pine forests. The southern slopes of the East Black Sea Mountains were covered by xerophytic and winter hardy forest from the bottom to the upper section, while the slopes facing the north of the ranges were covered by winter hardy and humid forests such as spurce, fir and Scotch pine. The upper watershed areas of the Çoruh river basin were occupied by oak, juniper, and shrub formations.

The northern slopes and upper part of the continental sector of Eastern Anatolia were occupied by scotch pine.

Natural steppe vegetation was common on the tectonic corridor of the Aras valley, the Oltu basin, and the Kağızman–Tuzluca basin. Destroyed forest areas were covered by the mountain steppe which belong to the İrano–Turanian elements. Tall prairie–like grass was seen between the Erzurum–Kars plateau. Alpine and subalpine grasses were widespread on the upper part of mountains.

The aim of this short article is to explain the distribution of vegetation–formation and the evolution of vegetation and floristic composition in this region.

A) BASIC ECOLOGICAL CONDITION OF THE VEGETATION COVER

1— GEOMORPHOLOGY

In the northern section of the study area, the Black Sea Mountains extend in the direction of E–W. The volcanic plateau, tectonic corridors and basins are located in the southern region of the area. The northern section of the area was affected by the orogenic and epirogenic movement which took place during

he Tertiary and Early Quaternary, while the volcanic activities and fault movetments have continued from the Neogene to the Quaternary.

The Black Sea mountains are generally composed of flysches, volcanic rocks such as basaltes, andesites, spilites, volcanic brecchia and volcano– sedimantary formations which belong to the Mesozoic and Tertiary ages. The granite masses which were injected during the Alpine orogeny, occur in most parts of the Black Sea Mountains.

The Tertiary sedimentary and volcano–sedimentary formations containing sodic and saline materials formed under the hot climatic coditions in closed basins such as the Oltu-Narman and Tuzluca-Kağızman Kötek basin. Flysches and limestones are common between the southern section of the Black Sea Mountains and the northern part of the East Anatolia masses. The substratum of the area was composed of ophiolites ,containing peridotite, serpantine and other ultrabasic rock and radiolarite.

The most part of the plateau and mountain areas of Eastern Anatolia were covered by volcanic masses such as basaltes, andesites and volcanic tuffs and sands. The broad plateaus of Eastern Anatolia extend on the basaltes. Tectonic depressions such as Göle, Ardahan, Çıldır, Oltu, and the Aras river corridor extend among the mountains such as Yalnızçam, Allahüekber, Kargapazarı. The mountains and basins extend in the direction of NE–SW and E–W.

The orogenic mountains of the given area were dissected deeply and narrowly by the Çoruh river and its tributaries. Thus, the orogenic ranges are cut by deep and narrow valleys. The altitude of the Black sea mountains are as follows: Kaçkar Mountain 3982 m, Marsist hill 3334 m and Kurt M. 3224 m above sea level. There are great changes in the altitude between the mountains and river valleys. For example, the Çoruh valley vicinity of Yusufeli is about 600 m and about 7–8 km north of the valley the Black Sea Mountains rise up to 3000 m. The difference of altitude between the tectonic basin and mountain areas is more than 500 metres .

The altitudes of the main mountains and hills rising from the volcanic masses are Yalnızçam Mont. 2710, Cin Mon. 2957, Mescit M. 3239 m, Kargapazarı M. 3045 m, Zozan M. 2908 m, Allahüekber M. 3120 m, Kısır M. 3197 m, Akbaba M. 3026 m, and other main mountains located in the southern part of Sarıkamış town: eg Süphan M. 2909 m., Balıklı M. 2858, m. Aladağ 3136 m., Yağlıca M. 2901 m Dumanlı M. 2699 m. Isolated volcanic peaks occuring in the vicinity of Lake Çıldır are Kısır M. 3197 m and Akbaba M. 3026 m.

The distribution of vegetation was largely affected by the exposition and altitute of the given area. For example, although the northern slope of the Black Sea Mountains was covered by humid– tempere and humid–cold forest, the so-

uthern slopes of the mountains were occupied by oaks and scotch pine, and the scotch pine also appears on the north slopes of Eastern Anatolia, In spite of the scotch pine seen on the north slopes of the mountains of Eastern Anatolia such as Yalnızçam, and the Allahüekber Mountains; oaks, juniper and mountain steppe are also common on the south slope of the above–mentioned mountains. The slopes facing the north of the Oltu basin are covered with *Pinus slyvestris* while on the southern slopes of the Mountains juniper and oaks are common.

The different vegetation formations or belts are arranged depending upon the altitude along the slope of the mountains. In other words, the vegetation formations extending from the bottom to the top were determined by altitude. For instance, the vegetation formation of the north facing slope of the Black Sea mountains from sea level to the peaks are as follows: Broad leaved forest 0–1100/1200 m, mixed and pine forest 1200–2000 m and sub–alpine and alpine meadows above 2000 m. In addition, in the continental sector of the given area, especially around Sarıkamış, steppe vegetation rises as high as 2000 m and then, scotch pine begins at about height of 2000 m. and the pines climb up to 2600 m. and the alpine meadow formation begins at about 2600 and continues to the summits of the mountains.

2— CLIMATE

Temperature : The mean annual temperature is about 12–14°C along the coastal region of the Black Sea (Rize 14.2, Hopa 14.8). The valley areas of the Çoruh river and its main tributaries are the second warmest areas of the study area. The mean annual temperature of the depression varies from 13 to 10°C (Artvin 12.7, Şavşat 10.2, Ardanuç 12.0, İspir 9.8, Oltu 10.2, Yusufeli 15.0°C). The coldest region of Turkey is the Erzurum–Kars plateau area where the mean annual temperature is about 3–4°C. (Kars 4.2, Ardahan 3.7, Sarıkamış 3.2).

January temperature : The most striking characteristic of winter especially January is the sharp constrast between the Black Sea coast and the interior reaches of the Çoruh river valley which shows positive anomalies and the largest negative anomalies occur. In the continental interior, for instance, the mean annual temperature for January is about 7.0 for Rize, 8.4 Hopa, 3.4 for Artvin, and 3.8 for Yusufeli, the absolute minima of the stations recorded are –7, –4.8, –16.1 and –8°C respectively.

The january temperatures are below –8°C in the continental interior (Kars –11.6, Ardahan –10.8, Sarıkamış –8.9). Absolute minimum temperatures are also recorded on the northeastern plateau. These figures are as follows: –31.6 at Sarıkamış, 35.6 at Ardahan, –39.6 at Kars, –42 at Erzurum.

July and August temperatures : There is not a great variation in the summer temperatures throughout the area. The temperatures are recorded as

follows: 15°C for Sarıkamış, 22.6 for Rize, 26 for Yusufeli. The absolute maxima are more than 35°C. The temperature of the continental interior and of the lowland part of the valleys are increased due to continentality.

Precipitation : Mean annual precipitation ranges from 2500 mm to 250 mm. The distribution of the precipitation is largely affacted by exposure and altitude. The northern slopes of the Black Sea mountains receive more than 2000 mm (Rize 2457 mm, Hopa 2068 mm). On the other hand it is below 300 mm in the intramontane basin and the lower watershed area of the Çoruh river (Iğdır 251 mm, Yusufeli 295 mm). The mean annual precipitation of other areas especially the plateau and the high basins varies from 650 to 400 mm (Artvin 645 mm, Şavşat 792 mm, Ardanuç 446 mm, İspir 440 mm, Sarıkamış 577 mm, Kars 527 mm, Kağızman 423 mm, Ardahan 520 mm.).

Cloudiness and Fog : The mean annual cloudiness is about 0.6–0.7 on the Black Sea coast. But during the summer period, the high parts of the Black Sea mountains are largely covered by clouds especially every afternoon during July and August. Towards the inner section, these figures decrease.

As to the relative moisture, the mean annual relative moisture is more than 70 percent along the Black Sea coast. The figures decrease toward the inner section of the given area. The lowest figures are recorded in the depression areas (Iğdır 62, Oltu 58, Kağızman 57).

There is a close relationship between the climate and vegetation cover in the study area. In addition the climatic peculiarity of the area is illumunated by the vegetation formations as well as the zonal soils.

The broad – leaved deciduous forests are dominant on the coastal zone in the prevailing subhumid– mild climate. The mixed forest which is associated with *Picea orientalis* and *Fagus orientalis* is common towards the highlands of the Black Sea Mountains. Precipitation up to about 2000 mm and more, combined with occasional summer fog creates the high humidity that favours essentially complete coverage of *Picea orientalis, Fagus orientalis* and various hydrophyte herbs.

The character of the vegetation cover changes sharply change between the north and the south slopes of the mountains due to differentiation of precipitation or humudity conditions.

Xerophytic and some heliophytic plants are found in places where the slopes face south of the Black Sea Mountains because of the fact that the slopes are rain–shadowed and sunny and winter–hardy dry forests also extend. In the lower parts of the Çoruh river valley system the xerophytic shrub, some of which belongs to the Mediterranean region, is seen on the lower parts of the Çoruh valley especially in places where the slopes face south.

The northern slopes of the inner section of the mountains that are fully exposed to moisture winds blowing in the summer period, are covered by Scotch pine forests and stands. On the other hand, winter–hardy pine forests are also found on the high plateau of Erzurum–Kars subregion in places of prevailing cold and subhumid condition.

The depression or basins of Eastern Anatolia support the growth of steppe vegetation because of having–not sufficient precipitation, and the amount of evapotranspration in these basins occuring during the summer period is as high as Central Anatolia. At the same time, the summer drought is not sufficient to grow trees. For this reason that the natural steppe vegetation are widespread in places where the basins and the slopes are facing the south.

3— SOILS

The greater part of the study area is covered by intrazonal soils due to erosion. For the reason that, zonal soils are seen under the dense vegetation cover and on the flat lands. The main soil types are summarized below.

Brown soils are common on the flat and slightly undulating areas of the plains such as Erzurum, Pasinler-Horasan. Chestnut soils occur in the Narman basin and the high section of Erzurum plain. The soils develop under the semi–arid climatic condition and steppe vegetation.

Chernozem soils have developed the vicinity of Sarıkamış, Göle, Ardahan and Çıldır the altitute being 1700–2000 m.

Brown forest soils are being formed under the forests. The soils can be divided into two types: The limely brown forest soils are common to the lower section of the *Pinus silvestris* forest located around the Oltu basins, while non limely forest soils are widespread in the upper section of the pine forests and within the moist region of the area. For example, in the Black Sea region, non limely brown forest soils having rich organic content, are common.

The yellowish – reddish podzolic soils having rich organic content and acid–reaction have developed on the clayey deposits which belong to the Pliocene in the coastal region of the Black Sea. The main texture of the soil is clay and clayey loam. Brown podzolic soils are also found out the vicinity of Şavşat, Veliköy and Karagöl localities, in the northeastern section of the area.

On the other hand, the intrazonal soils are widespread where on the rugged and inclined areas and natural vegetation covers were completly destroyed. The texture, colours and other pericularities of the soils were determined by the parent materials. For instance, sandy, sandy-stony-gravelly soils occur where there were decomposed granite and flysches of Crataceous and Eocene.

Saline and alkaline soils are common on the eroded slopes of the Oligocene and Oligo–miocene formation located in the Oltu basin, and Kötek–Kağızman–

Tuzluca basin. The pH of the soils varies between 8–9 and the electrical conductivities range from 8 to 54. The saline and alkaline deposits slide when it becomes saturated with water.

4— BIOTIC FACTORS

The major part of the forest of the inner section of North–Eastern Anatolia have been degraded and destroyed by overcutting, heavy grazing, and other types of mismanagements through centuries. The destroyed forest areas were largely occupied by the mountain steppes. The forests which were being grown on the dry habitats and/or under the semi–arid climatic condition and relic scotch pine forests were severely affected by the biotic factors such as overcutting and heavy grazing. It is clearly indicated that, for example,,80 per cent of the forests of the Oltu watershed basin have been ruined by the human factors.

As to the Eastern Black Sea region, overcutting beech forests locating on the river valley and its immediate surroundings were replaced by the alder communities. And destroyed oriental spruce forest areas were occupied by the *Rhododendrons*. The upper limits of the natural timberline were descended as low as 400–500 m due to the destruction of the natural forests. The forests containing oriental spruce, beech, chestnut, scotch pine which are located in the vicinity of Göktaş (Murgul) town were completely ruined by the sulphureous gases derived from the copper factory.

The natural herb composition of the meadow and grasslands were deteriorated by the over grazing, so the meadows largely covered by the spiny and bitter herb species such as *Verbascum* and *Astragalus* species.

The Oligocene, Oligo – Miocene salty, limely. gypserous and alkali deposits exposed because of the fact that the original soil cover was eroded and so climax species eliminated and these areas were sparsely covered by the halophytic herb species.

Severe soil and parent material erosion are being prevailed in places where the natural vegetation covers were destroyed and destructed.

B) VEGETATION FORMATIONS

The vegetation formation of the study area can be divided into three types according to the ecological conditions, floristic composition and the vegetational forms.

As it is known, the Eastern Black Sea region from the floristic point of view, is rich. As a matter of fact, 4000–5000 species are found in the region. In addition, the flora belonging to the four floristic regions is also seen in the area. The flora is also rich in relic and endemic species.

The natural occurence and floristic composition of the plants will be explained in the following paragraphs.

1— FOREST FORMATIONS :

The forests are widespread on most parts of the East Black Sea region and on the slopes facing north and high areas more than 2000 m in the north section of Eastern Anatolia. The forests may be classified according to the shape and/or forms and ecological condition.

1.1. Perhumid–humid and temperate broad leaved forests :

The forests extend on the lower section of the north slopes of the East Black Sea Mountains and the forests continue as far as Artvin and Muratlı along the Çoruh river valley. The forests are composed of beech (*Fagus orientalis*) chestnut (*Castanea sativa*), alder (*Alnus barbata* and *A. glutinosa*), hornbeam (*Carpinus betulus* and *C. orientalis*), basswood (*Tilia rubra*), ash (*Fraxinus ornus, F. oxycarpa*), hazelnut (*Corylus avellana, C. pontica*), elm (*Ulmus montana, U. campestris*), cherry aurel (*Prunus laurocerasus*), *Ostrya carpinifolia,* dogwood (*Cornus mas, C. australis,* oaks (*Quercus dschorochensis, Q. petraea*), *Rhododendron ponticum, Rhododendron caucasicum, Rhododendron flavum, Rhododendron smirnovii,* Honduras sarsaparilla (*Smilax officinalis, Smilax excelsa*), *Hedera helix, Hedera colchica,* beam (*Sorbus torminalis*).
The main forest communities can be summarized in the following lines.

1.1.1. Beech *(Fagus orientalis)* forests :

The forests dominating the northern slopes of the Northern Anatolia Mountains and of Istranca Mountain (in Trachia) are common on the slopes facing north of the Eastern Black Sea Mountains. Beech trees begin on the coastal region of the Black Sea sand continue as high as 1900–2000 m., and penetrate toward the inner section as far as Artvin and Camili via the Çoruh river valley. The optimum growing sites of the beech forests are between 500 m and 1500 m.

The beech forests are associated with the *Alnus barbata* (alder), *Carpinus betulus, C. orientalis* (European hornbeam), *Ulmus montana* (elm), *Tilia rubra* (basswood), *Castanea sativa, Castanea rubra* (European chestnut), *Buxus sempervirens,* and *Rhododendron species.* Leading species existing in the shrub layer of the forest are *Laurocerasus officinalis, Acer cappadacocicum, Sorbus torminalis, Vaccinium arctostaphyllos, Rhododendron luteum, Rh. ponticum, Rh. ungernii.* Groundflora of the forests generally consist of hygrophyle herbaceaous such as *Sambucus ebulus, Neottia nidus–arvis, Thelypteris limbosperme, Blechum spicant, Circaea lutetiana, Rubus caucasicus.* On the northern section of Tiryal Mountain located NE of Artvin, the beech forests form a community with *Rubus caucasicus* which is the endemic species for the area.

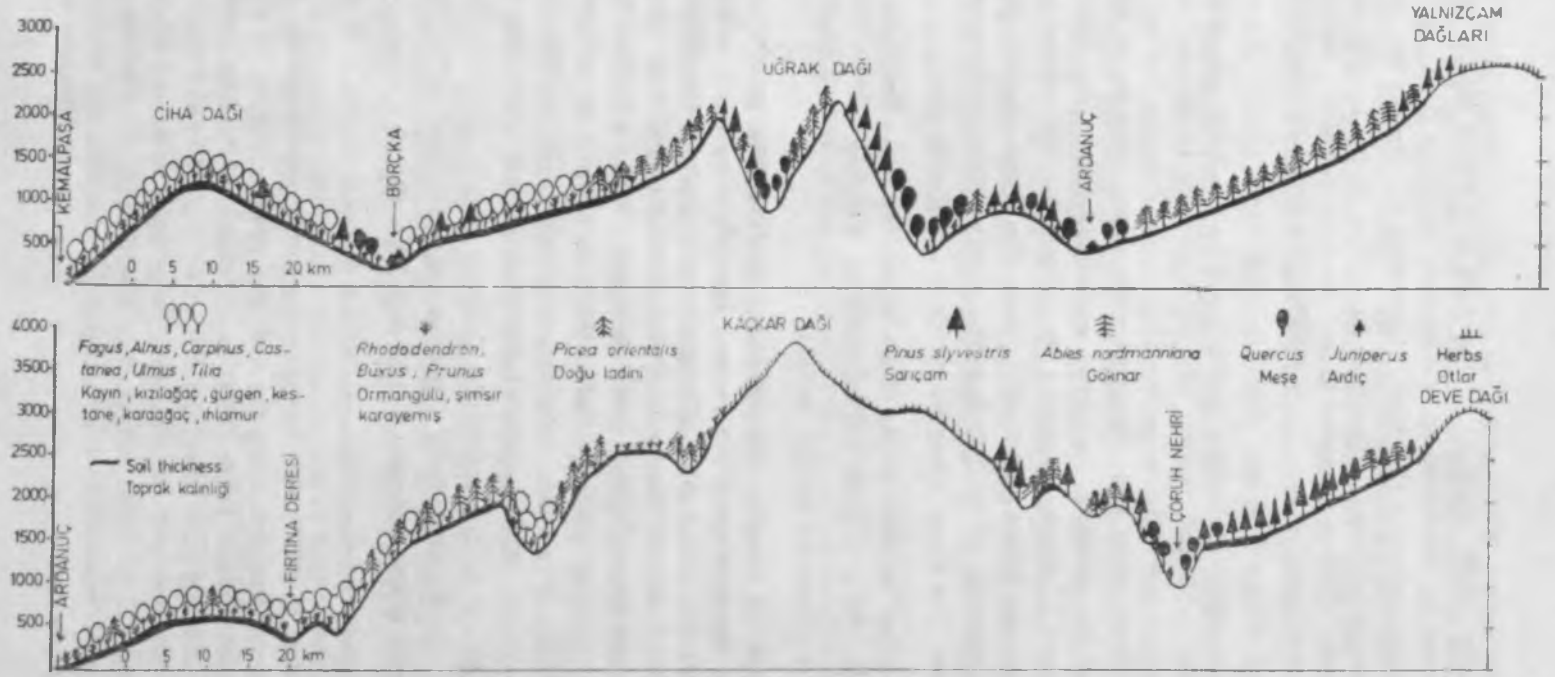


Figure 2 : The simplified vegetation profiles of the study area, in direction of N-S
Şekil 2 : Kuzey-güney yönünde alınmış genel vejetasyon örtüsü profilleri

The undergrowth plant species of the pure and mixed beech forests are: *Lapsana communis* L., *Anthemis* sp. *Campanula lactiflora* Bieb., *Salvia glutinosa* L. *Ptaridium aquilinum* (L.) Kahn., *Calystegia* sp., *Rumex* sp., *Holcus lanatus* L., *Lapsana comminus* L., *Geranium* sp., *Urtica dioica* L., *Ethyrium fillix–toemina* (L.) Roth., *Cotinus coggyria* Scop., *Prunella vulgaris* L.,*Albizzia jülibrissin* Durazz., *Phytolacca ameriacana* L., *Sambucus ebulus* L., *Prunella vugaris* L., *Rubus* sp.

Destroyed wet habitat of the beech forest areas were occupied by *Rubus* species.

Some shrub communities and Pinus silvestris stands also occur within the beech forest belt. For example, *Vaccinium arctostaphyllos* L., *Sambucus ebulus* L., *Calluna vulgaris* L., *Smilax excelsa* L. is growing on the yellowish–reddish podzolic soil between Arhavi and Fındıklı town. The *Pinus silvestris* stands are also seen at an elevation of 10–200 m in the places extending between Arhavi and Fındıklı town. The *Pinus silvestris* stands are probably relic.

Towards the upper section of the beech forests the *Picea orientalis* (oriental spurce) increases and it is often accompanied by beeches.

1.1.2. Chestnut *(Castanea sativa)* **forests :**

The forests exist as pure stands and mixed with the other decidocus forests. One of the pure chestnut forest which was found out by the Düzenli (1982) occurs on the NW–SW slopes of Tiryal Mountain at a height of 450-700 m. Chestnut trees from small communities on the coastal land of the Black Sea region. The chestnut forests are associated with the beech (*Fagus orientalis*) and alder (*Alnus barbata*). Leading shrub species of the pure chesnut forest of the Tiryal Mountain are *Corylus avellana, Vaccinium arctostaphyllosa, Rhododendron ponticum, Rh. luteum, Acer cappadocicum, Laurocerasus officinalis, Frangula alnus, Cerasus avium, Sorbus torminalis, Carpinus betulus, Quercus petreae* and *Ulmus montana*. On the other hand, the trees are widespread within the beech forest especially in places between 0/100 and 1000 m.

1.1.3. Alder *(Alnus barbata)* **forests :**

The trees growing in mild and humid – perhumid environments, generally occur on the coastal area and along the river and streams valleys. As a matter of fact, the alder communities begin at the coastal region of the area and continue as high as the subalpine zone along the valleys of rivers. For example, the alder stands begin at sea level and continue as high as 2000 m named Aşağı Kavran Yaylası along the Çamlıhemşin stream. The forests, extending along the river and streams are often associated with the *Buxus sempervirens* and *Rhododendron* and *Prunus laurocerasus*.

On the other hand, flooded areas with stones and gravels are firstly covered by the *Alnus barbata* plants and the areas can be returned to the alder forest within 5–6 years after flooding.

Major *Alnus barbata* forests are also seen, outside of the valley, in the southern part of Çayeli and Arhavi town and between Hopa and Sarp town.

1.1.4. Other broad–leaved forests :

It is clearly stated that there are rarely any pure stands covering the vast areas within the broad–leaved forest belt of such region because of the fact that ecological conditions are favourable for several deciduous trees and shrubs to grow. For this reason in some localities one or a few tree species are dominant and in another places other one, is dominant

Leading forest communities are basswood (*Tilia rubra*), hornbeam (*Carpinus orientalis* and *Carpinus betulus*), birch (*Betula torminalis*), hazelnut (*Corylus avellana, C. pontica*) and oaks (*Quercus dschorochensis* and *Quercus petrea*), elm (*Ulmus montana*). Most parts of the communities are associated or mixed with beech forests.

Oak associations are widespread along the Çoruh valley and its main tributaries. *Quercus dsahorhensis* forests are confined the vicinity of Artvin, Borçka and the lower section of the Çoruh valley slopes facing south between Yusufeli–İspir.

Quercus petraea subsp. *iberica* communities are also found in the dry habitats where within the Çoruh valley between Artvin and Borçka and in the vicinity of the Tiryal Mountain. The tree climbs up to 1300 m on Tiryal Mountains. The oaks are found both in pure form and mixed with shrubs. For example, leading shrub species forming, consisting the shrub layer of the *Quercus petraea* of Tiryal Mountain are *Crataegus curvicephala, C. microphylla, Cornus koenigii, Carpinus betulus, C. orientalis, Juniperus oxycedrus, Arbutus andrachne, Mespilus germanica,* and *Rosa canina* (Düzenli 1982).

One of the significant *Buxus sempervirens* community which covers area of a few hectares, occurs on the Çamlıhemşin valley, 10–12 km north of Çamlıhemşin, vicinity of Meydan village. The height of the *Buxus sempervirens* is more than 5–6 m and its diatemer is about 35–40 cm. The trees, in shrub form, are also found along the valley under the community of beech and alders and is mixed *Rhododendron, Prunus laurocerasus.*

The natural and/or uncultivated hazelnut communuties are confined to the upper section of the natural forests. The hazelnut extends above the oriental spurce forests and also pure hazelnut communities occur. For example, the pure hazelnut is seen in the southern part of Çamlıhemşin stream at an elevation of 1800–2000 m and others are found out in the İkizdere streams at approximately the same elevation.

Rhododendron communities, beginning at sea level and rising as high as 2400–2500 m are common both in the broad leaved or decidous forests and in oriental spruce (*Picea orientalis*) forests. The shrubs are dominant where the natural forests were destroyed. The slopes facing northern of the East Black Sea mountains are covered by *Rhododendron ponticum, Rh. caucasicum, Rh. smirnovi, Rh. flavum,* place to place. The diatemer of some *rhododendron* existing in the SW part of Arhavi, is about 40 cm.

The most part of the *Rhododendron* are mixed with the *Picea orientalis, Buxus sempervirens, Prunus laurocerasus* in places where the habitat is wet. On the other hand, the conifer and broad–leaved trees also appear at the bottom of the valleys especially in the southern section ot the Black Sea mountains. The following trees being new record are found in the NW part of Barhal watershed at an elevation of 1800–1900 m., NW of Yusufeli town: *Pinus silvestris* L., *Taxus baccata* L. *Acer trautvetteri* Medw., *Ribes bieberstini* Berl. ex DC., *Sorbus caucasica* Zinselr. var. Yaltirikii Gökşin, *Betula pendula* Roth.

1.2. Conifer forests of cold-humid regions:

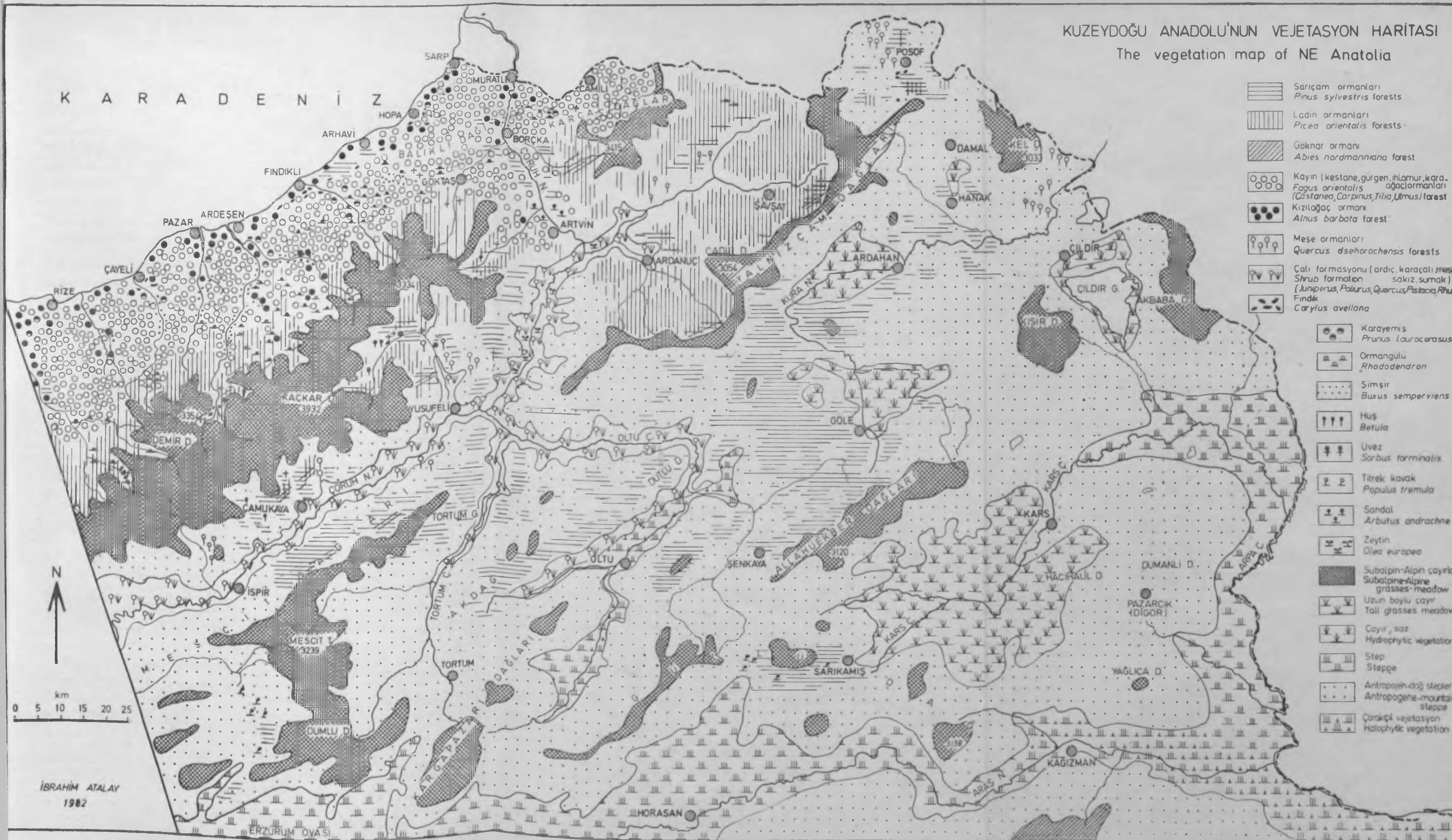
The upper section of the East Black Sea Mountains and the slopes facing north of the mountains of the inner section are largely occupied by the conifer species such as oriental spurce, Scotch pine and firs.

1.2.1. Oriental spruce *(Picea orientalis)* forests :

The forests are only confined to the Eastern Black Sea region and are distributed throughout the greater part of the Caucasus and it forms about 200 000 hectares of pure and mixed natural forest. Oriental spruce (*Picea oientalis*) is seen at about 100 m on the Black Sea coast and reaches above 2000 m on the north slope of the Eastern Black Sea Mountains. In this sector *Picea orientalis* form pure stands above 2000 m.

The oriental spruce forests are mixed with beech, elm (*Ulmus montana*), maple (*Acer platanoides*), and *Rhododendron* species above 1000 m. It is generally pure and sometimes accompanied by *Rhododendron* and *Corylus avellana* the upper part of the East Black Sea Mountains; for example, the oriental spurce forest which is located in the Tiryal mountains between 1600–2100 m. is associated with *Rhododendron ungernii, Rh. ponticum, Rh. luteum, Sorbus aucuparia, Cornus koenigii, Vibrium orientale, Vaccinium arctostaphyllos, Ilex colchica, Acer trautvetteri, Carpinus betulus,* and *Rhus coriaria* where the forest was destroyed. As above mentioned natural oriental spruce areas are occupied by *Rhododendron* species in destroyed areas.

The northern slopes of the southern slopes of the Black Sea mountains in the inner section are growing areas of the oriental spruce, especially in mixed with firs and Scotch pine. For instance, the pure and mixed *Picea orientalis* stands


KUZEYDOĞU ANADOLU'NUN VEJETASYON HARİTASI
The vegetation map of NE Anatolia
Sarıçam ormanları
Pinus sylvestris forests
Ladin ormanları
Picea orientalis forests
Goknar ormanı
Abies nordmanniana forest
Kayın (kestane, gurgen, ıhlamur, kara-ağaç) ormanları
Fagus orientalis (Castanea, Carpinus, Tilia, Ulmus) forest
Kızılağaç ormanı
Alnus barbata forest
Meşe ormanları
Quercus dsehorochensis forests
Çalı formasyonu (ardıç, karaçalı, meşe, sakız, sumak)
Shrub formation (Juniperus, Paliurus, Quercus, Pistacia, Rhus)
Fındık
Corylus avellana
Karayemiş
Prunus laurocerasus
Ormangulu
Rhododendron
Şimşir
Buxus semperviens
Huş
Betula
Uvez
Sorbus torminalis
Titrek kavak
Populus tremula
Sandal
Arbutus andrachne
Zeytin
Olea europea
Subalpin-Alpin çayırları
Subalpine-Alpine grasses-meadow
Uzun boylu çayır
Tall grasses meadow
Çayır, saz
Hydrophytic vegetation
Step
Steppe
Antropojen-dağ stepleri
Antropogene-mountain steppe
Çorakçıl vejetasyon
Halophytic vegetation
K A R A D E N İ Z
SARP
MURATLI
HOPA
ARHAVİ
CAMİLİ
BORÇKA
FINDIKLI
GÖKTAŞ
ARDEŞEN
PAZAR
ARTVİN
ÇAYELİ
RİZE
ŞAVŞAT
ARDANUÇ
POSOF
DAMAL
HANAK
ARDAHAN
ÇILDIR
ÇILDIR G.
AKBABA D.
KISIR D.
KEL D.
3033
ÇADIL D.
3054
3415
3334
KAÇKAR D.
3932
3354
DEMİR D.
YUSUFELİ
ÇORUH N.
OLTU Ç.
DUTLU D.
TORTUM G.
GÖLE
KURA N.
YALNIZÇAM DAĞLARI
ALLAHUEKBER DAĞLARI
3120
KARS
KARS Ç.
HACIHALİL D.
DUMANLI D.
PAZARCIK (DİGOR)
ARPA Ç.
CAMUKAYA
İSPİR
OLTU
ŞENKAYA
MESCİT T.
3239
TORTUM Ç.
AKDAĞ
TORTUM
SARIKAMIŞ
YAĞLICA D.
DUMLU D.
KARGAPAZARI DAĞLARI
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occur in the northern slopes of the inner section of Eastern Black Sea Mountains locating between İspir and Yusufeli and in the northern section of the Barhal watershed area which is located in the north of Yusufeli town.

As to the inner section, the northern part of Yalnızçam mountains or the slopes facing north are completely covered by the oriental spruce. Here, the forest begins at about 700–800 m and continues to 2400 m. and the elevation is the highest limit for the spruce and it reaches its optimum development above 1200 m. The upper level of the oriental spruce is located on the north slope of Yalnızçam Mountains, where scotch pine (*Pinus silvestris*) and fir (*Abies nordmanniana*) trees are also seen.

The undergrowth of the orientale spruce forests of the Yalnızçam mountains consists of widespread herbs such as *Geranium* sp., *Rhynchocorys* sp., *Centaurea salicifolia* Bieb. ex Wild., *Ballardia* sp., *Valeriana alliaeriifolia, Lapsana communis* L., *Silene vulgaris* (Moench) Garchke, *Lathyrus* sp., *Malabaila* sp., *Rhinanthus angustifolius* and other hydrophytic herbs.

Toward the upper section of the orientale spure forest belt some deciduous shrub and trees occur in small clonal grcves which in the aggregate cover on the stony and wet habitats. *Betula pendula* Roth. community and *Rosa montana* Chaix ssp. woronowii (Lonacz) Ö.Nillson, *Prunus divaricatus* L., *Ribes alpinus* L. *Ribes biebersteinii* and some subalpine herbaceous plant species such as *Geranium psilostemon* Ledeb., *Eryngium giganteum, Chaerophyllum temulum* L., *Papaver lateritum* Koch., *Pimpinella rhodantha Boiss., Achiella milletdium, Lapsana communis* L., *Minuartina* sp., *Sedum* sp., *Vibirnum lantana* L., *Achiella* sp., *Sedum spurium* Bieb., *Polygonum bistorta*. commons in the southern end of the Çamlıhemşin watershed in the Hisarlı yayla locality at height of about 1900–2100 m. in the southern end of the Çamlıhemşin watershed.

2.2. Mixed conifer (*Picea orientalis–Abies nordmanniana–Pinus silvestris*) forests :

The high parts of the northern slopes of the inner section of the Eastern Black Sea Mountains are mostly covered with mixed conifer forests including *Picea orientalis, Abies nordmanniana* and *Pinus silvestris*. For example on the slopes facing the north part of Çamlıkaya and N and NE part of Yusufeli generally rouse the above mentioned mixed forest. *Pinus silvestris* and *Abies nordmanniana* stands generally occur in subhumid and lower area than those of *Picea orientalis* stands. Other mixed forest stands are also seen on the north slopes of Yalnızçam Mountain especially above 2000 m, and the upper area of Balcı stream which is located 15 km N of Borçka and Camili and the Posof watershed areas.

Another pure *Pinus silvestris* stands are also seen on the Ziyaret Mountain which is located the north of Yusufeli town. The undergrowth of the forest stand,

here, is variously composed of shrubs (*Juniperus foetidissima* Wild, *Juniperus oxycedrus* subsp. *oxycedrus, Ostraya carpinifolia, Acer campestre* L., *Cotinus coggyria* Scop.) and of grasses (*Senecio vernalis, Teucrium chamaedrys* L., *Amelanchier* sp., *Saxifraga* sp., *Knutia* sp., *Teucrium chamaedrys* L., *Astragalus* sp., *Thymus* sp., *Origanum rotundifolium, Galium* sp., *Trifolium* sp., *Phleum* sp.) in others.

1.2.3. Scotch pine (*Pinus silvestris* or *slyvestris*) forests :

Scotch pine forests occuping most parts of the inner and high sections of the Northern Anatolia Mountains, and also growing under the perhumid and semiarid climatic conditions and on the different parent material, begin at the Black Sea level and continue towards the interior, especially towards the south of Sarıkamış. *Pinus silvestris*, beginning at sea level in the East Black Sea region, one of the climbing higher pine species reaching as high as 2700 m on the Allahuekber ranges, due to continentality. Although the pine prefer the slopes facing south in the inner section of the Black Sea Mountain, it is found on the north slopes and upper levels of the mountains in the continental parts of such areas. The natural occurence of the pines depends upon the factors of exposition, elevation and humudity ratio prevailing during the vegetation period.

The pure and mixed pin stands take place on the high plateau and the mountains of the NE Anatolia continental areas where sub humid– cold climatic conditions prevail. And they also occur on the slopes facing north which take winds bearing moisture.

Pinus silvestris stands, which are located behind the Eastern Black Sea region, begin at about 140 m. in the vicinty of Borçka in the Çoruh valley, penetrate to the inner section and climb up to 2000–2200 m., while the forests of the Eastern Anatolia begin above the natural steppe boundary at about 2000–2100 m and continue as high as 2500–2700 m. In Eastern Anatolia pure scotch pine forests cover large areas of the Allahüekber ranges, and the vicinity of Sarıkamış town. The optimum growing areas of *Pinus silvestris* forests are on the basaltes and volcanic sands and tuffs in the vicinity of Sarıkamış, Göle and the north side of Allahüekber mountains. As a matter of fact good stand of *Pinus silvestris* are seen in those areas. On the other hand good *Pinus silvestris* stands are seen to have been developed on the soft volcanic deposits containing tuffs and sands and on the flysch formations. Just as, the germination of the *Pinus silvestris* seeds easly takes place on such deposits and the deposits are covered with pine plants during a short time.

As above mentioned it is stated that pure *pinus silvestris* forests occur in the NE part of East Anatolia. In these areas the cold– humid and subhumid climatic contitions prevail. Mixed *Pinus silvestris* stands are common both on the

north and on the south slopes of the Black Sea Mountains. For example, the *Pinus silvestris* forest located on the Tiryal Mountains is often associated with *Picea orientalis, Quercus dschorochensis* and *Populus tremula*. Leading species forming the shrub layer of the forest are *Crataegus curvisepala, C. microphylla, Rhododendron luteum, Carpinus orientalis, Juniperus oxycedrus, Cistus creticus*. Herbaceous species of pine are as follows: *Astragalus adzharicus* (dominant species), *Trifolium ambigum, Trachynia hispidum, Seseli andronekii, Uechritzia armena, Setaria viridis*.

According to these data the ecological conditions of Scotch pine forest could be summarized as follows: From the climatological point of view pines are being grown in places where those are prevailing cold and humid–subhumid climatic conditions where they get direct radiation during the vegetation periods, and from the edaphic point of view, where sandy soils and deposits are suitable for growing pines. Both conditions have been realized in the vicinity of Sarıkamış area.

2— DRY FORESTS and SHRUBS

The dry forests and/or shrub formations are widespread on the lower watershed areas of the Çoruh river, and its lower slopes. As above mentioned, the formation are grown under semiarid climatic conditions are prevailing within the Çoruh river valley. As a matter of fact the xerophytic trees and shrubs are only being grown in the valley areas due to insufficient precipitation. Dry and stony habitats of the lower section of the valley are sparsely covered with the *Paliurus spina–christ, Juniperus oxycedrus, Quercus dschorochensis, Rosa canina, Cistus creticus* and *Rhus coriaria* grow in places like the vicinity of Yusufeli, Ardanuç, town and Lake Tortum, between Lake Tortum and Yusufeli and along the lower basin of the Oltu Stream. *Olea europea, Punica granatum,* fig (*Fiscus carica*), apricot tree and mulberry trees are also seen in such valleys because of sufficient temperatures. On the other hand some Mediterranean elements such as *Arbutus andrachne, Arbutus unedo* and *Pinus pinea* are also found along the Çoruh river valley especially between Artvin and Borçka. Dry and stony habitat of Ardanuç area are also sparsely covered by the shrubs. *Juniperus oxycedrus* subsp. *oxycedrus, Jasminum fruticans* L., *Rhus coriaria* L., *Paliurus spina–christi* is seen along the Peynirli stream, at a height of 600–900 m. 10 km south of Ardanuç. Most part of the slopes of the Çoruh valley are bare due to very steep slopes and the destruction of natural vegetation cover.

3— HERBACEOUS FORMATIONS

Herbaceous formation can be divided into four main types according to the ecological condition and physiognomic appearance, and both are found above the natural forest belt, and under part of the forest. On the other hand antrogen

mountain steppes occur in places where natural forests were destroyed and degenerated.

3.1. Subalpine and alpina meadows

The meadows belonging to the alpine region or Euro–Siberian region species begin to be seen in the upper section of the forest belt and continue the highest peaks of the Mountain ranges. The occurence limits of the meadows are higher in the continental part of East Anatolia than the Eastern Black Sea Mountains due to continentality. Just as the lower limit of the meadow is about 2200 m on the slopes facing north and is nearly 2500–2700 m in the mountains of East Anatolia.

The vegetation period of alpine vegetation is about 3–4 months, in the other words, as a general rule by the second and third week of june the plants start blossoming and form seeds in short periods and the plants, without become yellow and dried are covered by the snow during September. The alpine meadow areas are the most important pasture places of the region from the standpoint of cattle breeding.

The Alpine meadows can be classified into a few types according to the species, the conditions of soil, parent material and climate, conditions. As a matter of fact the herbaceous formations/vegetations of the Black Sea Mountains are groupped into two main types.

3.1.1. Mountain grasses: The grasses growing on the soils and being rich in organic content and C.E.C. (cation exchance capacity) and acide reaction, are widespread in the lower part of the alpine region.

Leading herb species of the meadows are *Festuca violacea, Campanula, tridentale, Alchemilla caucasica, Thymus nummularia, Primula algida, Heracleum apiitolium.* Among the species *Festuca vioacea* form a community. Main shrubs are also *Vaccinium myrtllus* and *Rhododendron caucasicum.*

In addition, *Daphane glomerata – Veronica gentianoides* are founds as communities. Leading species of the communities are *Daphane glomerata, Veronica gentianaoides, Anthoxanthum odoratum, Ranunculus oreophilus, Primula elatior* subsp. Meyeri, *Cerastium dahuricum, Alopecurus gerardii, Primula virgida, Draba hispida, Astragalus viridissimus, Stachys macrantha, Geranium ponticum, Polygonum bistorta,* and *Anthyllis boissieri.*

3.1.2.High mountain grasses: The high mountain areas are covered with sparse and short vegetation due to the fact that the vegetation period is very short, the soil forming processes are not sufficient and also snow and stone, and boulder avalanches.

Leading vegetation communities of high mountain aeras are *Anthemis pectinata* including *Drabe hispida, Tarexacum scaturiginosum, Oxytropis albana, Androsace villosa, Cerastium gnaphalodes*, 2– *Adrosace villosa–Scorzonera soidlitzii* which grows on the dry, stony, active and thin soil and 3– *Potentilla oweriniana–Aster alpinus* ,containing *Potentilla geranioides, Alchemilla sericea, Sempervivum globrum* and *Sedum pilosum* species.

The nearly flat and undulating basaltes plateaus of Eastern Anatolia prevailing humid and subhumid climatic conditions are mostly covered with meadow grasses while the spiny cushion communities and other herbs are widespread on the dry, stony and subhumid–semiarid places. For example a place Çikles düzü extending the eastern part of Şenkaya town are covered with meadow grasses including *Taraxacum crepidiforme, Muscari commutatum, Gagea* sp., *Festuca ovina, Alopecurus aucheri, Myosotis lithospermifolia, Convolvulus* sp., *Salvia* sp., *Draba brunifolia, Caltha polypetala, Ranunculus* sp.

3.2. Mountain (Antropogene) steppes :

The major part of the mountains of Eastern Anatolia, in a broad sense, have been covered by herbaceous formations. These steppes, as a general rule, resulted due to the destruction of natural vegetation and over grazing. As a matter of fact, the original soil cover eroded as a result of the deterioration of natural equilibrium. So the eroded and deteriorated enviroments were occupied by the especially spiny–cushion herbaceous belonging to the Irano–Turanian species. And the species have located as natural or climax species on the destroyed areas. On the other hand, the semi–arid climatic condition prevailing the above mentioned mountain areas and submature soils, have encouraged the growth of the herbaceous. That is, the herbaceous communities are well adapted to the mountain areas.

A study dealing with the mountain steppe was carried out by Çetik and Tatlı(1975) in places on the northern slope of the Palandöken mountains which is located in S of Erzurum. According to this study, the steppe vegetation of the mountain was described in three communities and two subcommunities. The *Astragalus eriocephalus* community is well adapted to the mountain steppe and is dominant on the gravelly gentle slopes of the mountain. The community is represtented in two subcommunities: The subcommunity of *Artemisia austriaca* is well established in the eroded superifical soils at an altitude of 1950–2000 m, the subcommunity is also characterized by other species such as *Eryngium billardieri, Veronica austriaca, Carex oreophial* and *Astragalus cinereus*. Another second subcommunity of *Silene spergulifolia* founds at the height of 2000–2500 m., is charracterized by the species of *Poa* sp., *Silene spergulifolia* and *Ziziphora rigida*.

The *Thymus fallax–Galium verum* L. community is confined to silt and loam soils on the gentle slopes between the altitudes 2250 and 2400 m and other species

are often mixed with *Astragalus eriocephalus, Festuca ovina,* and *Bromus tommentelus.*

The *Poa longifolia* Trin. community occupies the southern slopes of the upper levels of the mountain at the altitude of 2750–2850 m. The leading species of the community are *Poa longifolia, Astragalus cauduculosus, Bromus erectus, Hieracium pilosella, Helictotrichon pratense* and *Koeleria cristata, Helichrysum pilactum, Minuartina anatolica.*

3.3.— Tall grasses (similar to prairie) :

Tall meadow grasses occur between the natural steppe belt and the Scotch pine belt in places where the prevailing semiarid–subhumid in the vicinity of Sarıkamış-Göle-Kars-Digor at the height of 1800-2000 m. The climate of the area is semiarid–subhumid,and the climatic soil type of the mentioned area is chernozem soils.

Tall grass vegetation founding between Sarıkamış and Selim town at the height of 1800–1900 m is composed of *Salvia* sp., *Cichorium inthybus* L., *Cirsium hypoleucum* L., *Eryngium campestre* L., *Dactylis glomerata.* On the other hand, the plateau areas extending between Kars and Ardahan are mostly covered by the tall grasses including *Onosma* sp., *Cirsium* bp., *Vicia* sp., *Galium verum, Alyssum* sp., *Hyoscyamus reticulatus* L., *Peganum harmala* L. *Cephalaria* sp., *Daucus carota* L. *Salvia amasiaca, Bromus* sp.

3.4.— Steppe vegetation :

Steppe vegetation is not only found in the lower section of Central Anatolia but also seen in the tectonic depression and the watershed basins of Eastern Anatolia. As a matter of fact, most part of the Erzurum plain, the corridor of the Aras valley between Pasinler and Iğdır, and the lowest section of the Oltu–Narman basin is covered by steppe vegetation. The above mentioned areas are suitable areas for the growth of steppe vegetation both in climatic and in soil condition. Just as, the semiarid conditions prevails during the summer or vegetation period, and climatic soil types are the brown soils and chestnut soils. By the first week of April, geophytes start blossoming and form their seeds in short periods. Perennials also start developping from mid june. During the the mid and end of the spring and first month of summer the steppe has a beautiful appearence and is covered with various coloured flowers. After June only some deep rooted perennials such as species of *Astragalus, Acantholimon, Verbascum, Euphorbia* are green while other shallow rooted species of steppe become yellow or dried.

The herb species of the Erzurum plains are *Adonis aestivalis, Alyssum linifolium, A. desertorum, Isastis glauca, Holosetum umbellatum, Silene armena,*

Polygonum polycnemoides, P. aviculare, Rumex crispus, Astragalus galegiformis, A. atrocarpus, A. caudiculosus, A. cinereus, Coronnilla orientalis, Lotus corniculatus, Trifolium pratense, Falcaria vulgaris, Anchusa italica, A. angustissima, Calamintha graveolens, Mentha tomentosa, Salvia syriaca, S. virgata, Thymus fallax, Achiella bieberstini, Anthemis trinctoria, A. cretica, Artemisia caucasica, A. austriaca, Centaurea depressa, C. iberica, C. glastifolia, C. pulcherrima, Cirsium arvense, Senecio vernalis, Taraxacum serotinum, Xeranthemum annuum, Euphorbia virgata, E. arvalnis, E. cheiradenia, Alium rotundum, A. karataviense, Agropyron intermedium, A. repens, Avena fatua, Bromus erectus B. tectorum, Lepturus filliformis, Lolium temulentum, Phragmites communis, Poa bulbosa.

Phragmites communis, Equisetum remosissimum, Polygonum amphibeum, Lepturus filliformis occur in places where ground water levels are high along the Karasu river and at local places within the plain.

Salsola kali, Plantago craccifolia, Hippurus and *Camphorosma* are abundandant where the soil is saline along the lowest part of the plain between Ilıca–Kahramanlar and Karasu–Çiflikköy.

The steppe vegetation is also widespread within the upper section of the Çoruh river watershed and along the Aras river valley. For example, the following steppe communities which were discovered within the Tortum valley especially between Tortum town and Lake Tortum are (Aksoy 1981):

1– *Artemisia austriaca–A. marschalliana,* 2– *Lepidium gramimifolium–Centaurea simplicicaulus,* 3– *Rumex scutatus–Centrathus longifolius,* 4– *Caragana grandiflora–Minuartia lineata,* 5– *Astragalus microcephalus–Atraphaxis grandiflora,* 6– *Astragalus erinaceus–Achillea schischkinii,* 7– *Campanula betulifolia–Saxifraga paniculata.*

On the other hand, the halophytic plants such as *Onosma sericeum, Dianthus erythrocoleus, D. balansae, Camphorosma monspeliacum, Linaria armeniaca, Coronilla orientalis, Gypsophylla sphaerocephale, Hedysarum elegans, Helichrysum plicatum, Consolida hohenackeri* etc. are widespread on the saline and alkali deposits of the Oligocene which were deposited within the Oltu-Narman and the Kağızman–Kötek basin.

One of the natural steppe area is also widespread within the lower section of Aras River basin. The Aras valley basin extending between Kağızman and Tuzluca town are sparsely covered by the steppe herbs and some halophytic herbs. The leading species which were collected from the such area are *Thymus* sp., *Eryngium campestre* L., *Xeranthemum annuum* L., *Centaurea virgata* Lam., *Chenopodium botrys* L., *Cerastium* sp., *Teucrium polium* L., *Cnyodon dactylon* L., *Senecio vernalis* Waldst et Kit., *Draba polytricha* Ledeb., *Alhagi pseudealhagi* (Bieb) Desv., *Althaea* sp., *Achiella* sp., *Chenopodium botrys* L., *Linum* sp., *Amaranthus albus* L., *Bromus* sp., *Sideritis* sp., *Salvia verticillata, Centaurea*

polypodiifolius Boiss., *Euphorbia* sp., *Erysimum* sp., *Centaurea carduiformis Salvia syriaca, Crambe orientalis* L., *Phlomis pungeus, Stipa* sp.

C) FLORISTIC COMPOSITION and EVOLUTION OF VEGETATION COVER :

The vegetation of the study area from the standpoint of phytogeographical could be distinguised into two major regions (Davis 1965, 1971 and Zohary 1971). The northern section of the area belong to the Colchic subprovince of the Euro–Siberian region and the southern and NE part of the area concern the Irano–Turanian region. But the plants belonging to the other phytogeographical region are also found especially in the north and NE part of the given area.

The distribution of the plants of the Tortum valley, located in the south of the area, according to the phytogeographical region and subregion are as follows (Aksoy, 1981):

Phytogeographic region	Per cent
Irano–Turanian	46.0
Euro–Siberian	11.7
Irano–Tur., Mediterranean	6.3
Irano–Tur., Euro–Siberian	3.9
Mediterranean	2.9
Euxine	1.9
Hyrcano–Euxine	0.8
Irano–Tur., Euro–Sib., and Mediter.	16.5
Unknown	10.5
	100.0

Leading Euro – Siberian plants which were found in the Tortum valley are *Veronica anagallis–aquatica, Inula oculus–cristi, Erigeron acer, Filipendula vulgaris, Fragaria viridis, Campanula betulifolia, Myosotis arvensis* and *Solanum indivisium.*

Metiterranean elements, founding at the bottom of the valley are *Cotinus coggyria, Jasminum fruticans, Cerasus prostrata, Enarthrocarpus arcuatus, Anthemis triumfettii* and *Capparis spinosa.*

In addition some plants (62 species) are endemic for the Tortum valley.

On the other hand, the distribution of the plants of the Tiryal Mountain, located NE of Artvin in the Eastern Black Sea region, according to phytogeographic region are as follows (Düzenli 1982):

Photo 1 : Alder **(Alnus barbata)** in the foreground and tea plantation garden in the background which is located between Fındıklı and Arhavi Town, on the Black Sea coastal land, at about an elevation of 200 metres, is seen

Foto 1 : Fındıklı-Arhavi kasabası arasında 200 m. kadar yükseklikte önde kızılağaç, arkada çay bahçesi görülmektedir.

Photo 2 : A Reddish-Brownish podzolic soil profile and shrub vegetation containing some Mediterranean plants, between Arhavi and Fındıklı town.

Foto 2 : Fındıklı-Arhavi arasında kırmızımsı - kahverengimsi podzolik toprak profili ve bazı Akdeniz bitkileri ihtiva eden çalı vejetasyonu.

Photo 3 : A general view of the humid-temperate forest which is associated with **Fagus orientalis, Castanea sativa, Carpinus betulus, Alnus barbata** etc. at about 700 m. in the Kavran tributary of the Çamlıhemşin watershed area.

Foto 3 : Çamlıhemşin Kavran havzasında 700 m. civarında kayın, kestane, gürgen ve kızılağaç vs. den ibaret nemli ılıman ormanın genel görünüşü.

Photo 4 : A General view of the forest containing **Fagus orientalis, Carpinus betulus, Alnus barbata** and **Picea orientalis** at a height of 750-800 m. between Çamili-Borçka in the Eastern Black Sea Region.

Foto 4 : Doğu Karadeniz'de Borçka-Camili arasında 750-800 m. civarında kayın, gürgen, kızılağaç ve ladinden ibaret bir ormanın genel görünüşü.

Photo 5 : Pure **Picea orientalis** forest locating at about a height of 1700-2000 m. in the southern part of Çamlıhemşin watershed within the «natural conservation belts».

Foto 5 : Çamlıhemşin havzasının güneyinde «tabiatı koruma kuşağında» 1700-2000 m. civarındaki saf ladin ormanı.

Photo 6 : A Pure **Pinus silvestris** stand which is located in the Balcı watershed, 7-8 km. SE of Borçka at about 500 m.

Foto 6 : Borçka'nın 7-8 km. GD sunda Balcı havzasında 500 m. civarında saf sarıçam koruluğu.

Photo 7 : The community of **Rhododendron - Prunus laurocerasus** at about a height of 1000 m. in the Çamlıhemşin watershed.

Foto 7 : Çamlıhemşin havzasında 1000 m. civarında Ormangülü - Karayemiş topluluğu.

Photo 8 : The conifer forest which is composed of **Picea orientalis, Pinus silvestris** and **Abies nordmanniana** on the slopes facing the north of the Yalnızçam Mountains at a height of 2300 metres.

Foto 8 : Yalnızçam dağlarının kuzeye bakan yamacı üzerinde 2300 m. de ladin, sarıçam ve göknardan oluşmuş iğne yapraklı orman.

Photo 9 : A general view of the limely brown forest soil profile which is being developed on the marly deposit and the under **Quercus dschorochensis** and **Juniperus**, at about 1000 m, 6 km. N of Ardanuç town.

Foto 9 : Ardanuç'un 6 km. kadar kuzeyinde 1000 m. civarında marnlı depo üzerinde ve meşe ile ardıç altında gelişmiş olan kireçli kahverengi orman toprağı profilinin genel görünüşü.

Photo 10 : A general view of the Aras river basin the vicinity of Kağızman town from the west tho the east. This depression area was sparsely covered by the steppe vegetation. The halophytic herbs occur on the eroded slopes on the hills containing the saline and alkali materials.

Foto 10 : Kağızman civarında Aras nehri havzasına batıdan doğuya doğru bakış. Bu depresyon alanı seyrek olarak step vejetasyonu ile kaplıdır. Çorakcıl otlar alkali ve tuzlu materyal ihtiva eden erozyona uğramış yamaçlarda bulunmaktadır.

Photo 11 : A glacial cirque lake at a height of 3200 m. which is situated 6 km. SW of Kaçkar Hill and the high alpine mountain grasses.

Foto 11 : Kaçkar Tepesinin 6 km. GB sında 3200 m. yükseklikteki bir glasiyal sirk gölü ve yüksek alpin dağ çayırları (13.8.1982).

Photo 12 : A general view of Kaçkar Hill being at a height of 3982 m. and high alpine mountain grasses and rocky places.

Foto 12 : 3982 m. yüksekliğindekt Kaçkar tepesinin ve yüksek dağ çayırları ile kayalık alanların genel görünüşü.

Phytogeographic region	Per cent
Euro–Siberian	50.5
Pluriregions	31.0
Irano–Turanian	7.5
Mediterranean	5.0
Cosmopolite	1.0
Unknown	5.0
	100.0

The floristic composition of the Euro–Siberian plants of Tiryal Mountain are 36 % Euxine, 8 % Hyrcano, 4 % Caucasica and the remaining plants belong to the other subregion of Euro-Siberian.

The plants belonging to the Caucasica province are:

Picea orientalis (L.) Link
Pyrus communis L. subsp. *caucasica* (Fred.) Browicz.
Dryopteris caucasica Fraser–Jenks et Corley
Colutea armena Boiss. et Huet.
Oxytropis albana Stev.
Pimpinella rhondantha Boiss.
Centaurea salicifolia Bieb et Willd. var. *purpurascens*
Linum hypericifolium Salisb.

The following plants belong to the Hyrcano–Euxine:

Serum stoloniferum Gmel.
Sedum spurium Bieb.
Draba siliguosa Bieb.
Cardamine tenera Gmel.
Lonicera iberica Bieb.
Androsace albana Stev.
Myosotis syvatica Hoffm.
Arnebia pulchra (Roemer of Schult.) Edmondson
Saxifraga paniculata Miller subsp. *cartilaginea* (Willd.) D.A. Webb.

The euxine element founding on the Tiryal Mountain are:

Abies nordmanniana (Stev.) Spach. subsp. *nordmanniana*
Campanula collina Bieb.
Hedera colchica (C. Koch.) C. Koch.
Pachyphragma macrophyllum (Hoft.) Rasch.
Heracleum apifolium Boiss.
Bupleurum falcatum L. subsp. *polyphyllum*
Corylus avellana L.
Rhododendron smirnovii Trautv.

The euro–siberian elements of the area are:

Veronica officinalis L.
Pirola media Swartz.
Sorbus aucuparia L.
Rubus hirtus Waldst. et Kit.
Acer campestre L.
Epilobium montanum L.
Ranunculus bruticus Willd.
Rosa pimpinellaaifolia L.

The Mediterranean plants occuring between Borçka–Artvin, Artvin–Ardanuç, and Artvin–Lake Tortum, and Artvin–Oltu within the valley of Çoruh river and its main tributaries are:

Olea europea (which grows between Yusufeli and Artvin along the Çoruh valley),
Paliurus spina–christi,
Arbutus andrachre (only found NE of Artvin),
Cistus creticus, Rhus coriaria, Juniperus oxycedrus.

The plants of different floristic regions found in the study area clearly indicate that the climatic changes or fluctuations are shown to have occured during the Quaternary period.

The relic species and/or communities have resulted due to climatic changes. Dissected topograpy and deeply incised valleys that have been formed by different ecological enviroments realized the stabilizing of the plants belonging to the different floristic regions. For example, xerophytic or dry forest stands occur on the slopes facing south of the Çoruh valley systems, while hdyrophytic vegetation is found on the slopes facing northern of the mentioned watershed.

With an understanding of ongoing relic species and climatic changes and evolution of vegatition cover, it is possible to make paleo–phytogeographic and paleoclimatic reconstructions during the Quaternary especially Holocene. Period. The evaluation of this position can be made possible with the pollen examination or palyonological determination which have been taken from the peat and sediment deposits. There are two researches which were carried out in the Eastern Black Sea region and the Lake Van area. These researches were examined by the pollen data. The studies will be summarized as follows:

The changes of vegetation cover occupying the Eastern Black Sea region and its climatic fluctuations were considerably found out by the study of Aytuğ et al (1975) depending upon pollen data which were taken from the peat deposits which are located in a place named Ağaçbaşı Yaylası at about a height of 1887 m, 67 km S of the Sürmene town, Trabzon.

During the period of 9000–7000 years before present (B.P.) the area mentioned above and its surroundings, were covered by the forests of *Picea orientalis, Pinus silvestris, Castanea sativa* and *Fagus orientalis*. But *Picea orientalis* forests have been more widespread than other forests. During this time tree species indicated that the area had been underwent to humid–cold climatic condition.

Castanea sativa Mill. forest has been dominated in the period of c. 7000–4000 B.P. The period can be divided into two subperiods, according to the pollen data. In the early time of this period, the mixture of the *Pinus silvestris* and *Abies nordmanniana* in the forest composition is more than that of other species, while towards the ends of the period *Ulmus* sp. and *Fagus orientalis* forest increased in that composition, that is, the occurence of *Pinus silvestris* and *Abies nordmanniana* began to decrease in the forest composition.

These differences which were found out in the forest composition have shown that at the temperature has increased at the beginning of the second period, and humidity conditions have increased by the end of this period.

The third period which has been prevailed during the period of 4000–2000 B.P. temperature, has increased while humidity or precipitation has decreased The dominance of the *Castanea sativa* forest has also continued during this period. The existance of the *Quercus* L. sp. and *Carex* L. sp. in abundance reflected that the sub–humid and mild climates have prevailed during this period.

During for the last 2000 years or fourth period the *Castaea sativa* and *Quercus* forests were replaced by the *Picea orientalis* forest. The pollen data indicated that the cold and humid climatic conditions began to prevail again in the mentioned area. The same condition is being continued in the present day, in other words, the cold–humid climate is generally permanent, at least from 2000 B.P. up till the present day.

On the other hand, a palynological examination was carried out on a series of samples from two sediment cores recovered in the southwestern part of Lake Van. According to the research that was carried out by Zeist and Woldring (1978), the changes that occured both in vegetation cover and in climate can be summarized as follows

During the period of c. 9600–6400 B.P. steppe vegetations prevailed in the Lake Van area. Only scattered oak and birch stands would have been present. *Chenopodiaceae, Ephedra* and *Artemisia* alternately played a prominent part in the steppe vegetation. At this time, insufficent humidity, not the temperature, was the limiting factor for tree growth. Minor changes in climate in the period of c. 9600–6400 B.P are suggested by the changes in the composition of the steppe vegetation and by the curves for *Quercus* and *Betula*.

In the period of c. 6400 to 3400 B.P. steppe vegetation was gradually replaced by forest. In addition to *Quercus, Pistacia* must have been a common tree in the open forest stands (forest steppe). The composition of the herb vegetation differed from that of the early–Holocen setppes in that now *Graminee e* played a dominant part. The expansion of trees between c. 6400– and 3400 B.P. points to a significant increase in humidity, which must have been the result of higher precipitation.

For the last 3400 years mixed–oak forest have constituted the natural vegetation in the Lake Van area, or at least in the area to the southwest and the west of the Lake. In addition to *Quercus,* various other trees and shrubs formed part of the forest vegetations. The climate of the last 3400 years must have been relatively moist.

The glacial and periglacial features formed on the highland of the Kaçkar and Mescit Mountains indicate the cold–humid climate prevailing during the Pleistocene. According to the method of the bottom elevation of cirques the post glacial permanant snow line descended down to 2750 metres both on the Kaçkar and on the Mescit Mountains.

Vegetation evolution of the area probably took place during the past 15–20000 years B.P. can be summarized in the following lines.

During the post–glacial period the mountains such as Kaçkar, Mescit and Yalnızçam were covered by glaciers and at this time, Euro–siberian elements probably covering the high level of the mountains moved as far south as the Lake Van area. The high part of Eastern Anatolia was occupied by the *Pinus silvestris* and partly *Betula torminalis* stands.

The span of time when temperature was significantly warmer than the postglacial time, during the period of 10000-6000 years B.P. the highland of the Black Sea Mountains were capped by *Picea orientalis* and *Pinus silvestris,* and tempere mixed and broad–leaved forests also appeared on the coastal section of the East Black Sea, while the Lake Van area and tectonic depression of Eastern Anatolia such as the Erzurum plain and Aras corridor had been occupied by the Irano–Turanian steppe vegetation.

During the climatic optimum that had occured between 5000–7000 years B.P. the temperature was warmer than today. The broad–leaved and some xerophytic vegetation probably widespread on the coastal land of the Black Sea region and the upper section of the mountains was probably covered by mixed and conifer forests and some mediterranean elements also entered to the inner section of the Çoruh river watershed area.

The steppe vegetation which has been widespread was probably replaced by dry forest. The mountain areas of Eastern Anatolia were partly occupied by the *pinus silvestris* forests.

As a general rule, after the climatic optimum, the climafe of the interior area gradually dried. out. The winter hardy forest of Eastern Anatolia that had grown up earliar through the inner basins was retarded northward and was replaced by the xerophytic steppe plants, more tolerant of the colder, drier climate.

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Özet

Kuzeydoğu Anadolu'nun vejetasyonu üzerine genel bir araştırma

Batıda Rize-Erzurum, güneyde Erzurum-Tuzluca veya Aras vadisi arasında kalan Kuzeydoğu Anadolu vejetasyon örtüsü yönünden orman, kuru orman-çalı ve otsu olmak üzere üç ayrı formasyona ayrılmıştır.

1 — **Orman formasyonu** ağaç formu ve ekolojik koşullara göre sınıflara ayrılmıştır. Kayın **(Fagus orientalis)**, kızılağaç **(Alnus barbata, A. glutinosa)**, kestane **(Castanea sativa)**, gürgen **(Carpinus orientalis, C. betulus)**, ıhlamur **(Tilia rubra)**, dişbudak **(Fraxinus ornus, F. oxycarpa)**, fındık **(Corylus avellana, C. pontica)**, karaağaç **(Ulmus montana, U. campestris)**, karayemiş **(Prunus laurocerasus)**, kayacık **(Ostraya carpinifolia)**, şimşir **(Buxus sempervirens)**, ormangülü **(Rhododendron ponticum. Rh. Caucasicum, Rh. smirnovii, Rh. flavum)** vb. ağaç ve ağaççıkların çoğu kez karışık olarak oluşturduğu geniş yapraklı nemli ılıman ormanlar, Doğu Karadeniz dağlarının kuzey yamaçları boyunca 1000-1100 m. ye kadar yükselirler ve ayrıca Çoruh vadisi boyunca Artvin'e kadar sokulurlar. Doğu Karadeniz dağları

ve Yalnızçam dağlarının kuzeye bakan yamaçları boyunca 1000 m. den sonra hakim olmağa başlayan soğuk nemli ve sisli ortamları tercih eden ladin **(Picea orientalis)** ormanları, Doğu Karadeniz silsilesinin güney kesiminde kuzeye bakan yamaçlarında ladin, göknar **(Abies nordmanniana)**, sarıçam **(Pinus silvestris)** karışımından meydana gelen ormanlar bulunmaktadır. Doğu Karadeniz dağlarının güneye bakan iç kısımdaki dağların kuzeye bakan yamaçlarında ve Erzurum-Kars platosu'nun 2000 m. den yüksek kesimlerinde sarıçam **(Pinus silvestris)** ormanları görülmektedir.

2 — Kışı nisbeten ılık geçen ve yıllık ortalama yağışın 400 mm. yi aşmadığı Çoruh vadisi boyunca ardıç **(Juniperus excelsa, J. oxycedrus)**, karaçalı **(Paliurus spina-christi)**, meşe **(Quercus dschorochensis, Q. petrea)**, tüylü laden **(Cistus creticus)**, dere kenarlarında sumak **(Rhus coriaria)** vb. ağaç ve çoğunluluğu çalıların oluşturduğu seyrek topluluklar, **kuru orman** ve **çalı formasyonu**'nu oluşturmaktadır.

3 — **Otsu formasyon** : Aras havzasının 2000 m. den alçak kesimlerinde, Erzurum ovasında ve Oltu-Narman havzasının tabanında stepler yaygındır. Kars, Göle ve Sarıkamış dolaylarında Çernezyom toprakları üzerinde uzun boylu çayırlar, dağlık alanlarda ormanların tahrip edildiği yerlerde antropojen dağ stepleri, ormanın üst sınırından sonra Avrupa-Sibirya elementlerinin hakim olduğu subalpin ve alpin çayırlar baskındır. Oltu-Narman havzasındaki, İspir güneyindeki Miyosen ve Kötek-Kağızman-Tuzluca dolaylarındaki Oligosen tuzlu-alkali evaporit çökelleri üzerinde halofil ve halofitler çok seyrek olarak bulunmaktadır.

Araştırma sahasının kuzeyi Avrupa-Sibirya flora bölgesine, Doğu Karadeniz bölümü bu bölgenin Kolşik sektörüne, güneydeki depresyon alanları İran-Turan flora bölgesine girmektedir. Ancak, Kolşik sektörde bazı Akdeniz elementlerinden kokar ardıç **(Juniperus oxycedrus)**, karaçalı **(Paliurus spina-christi)**, sandal **(Arbutus andrachne)**, zeytin **(Olea europea)** (Yusufeli-Artvin arasında) vs., İran-Turan bölgesine ait özellikle otsular bulunmaktadır. Buna karşılık güneyde ise Akdeniz, Avrupa-Sibirya, çok bölgeli elementler yer almaktadır. Bölgede çok yaygın olarak bulunan relik topluluklarda postglasiyalden beri meydana gelen ikilm değişmeleri etkili olmuştur. Nitekim, Doğu Karadeniz bölgesinde son 8000 yıl içerisinde dört, Van Gölü yöresinde son 15.000-20.000 yıl boyunca en az dört kez önemli sayılacak iklim değişmeleri olmuştur.

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