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**THE LOCAL BIOMES (GEO-BIOMES) OF MOUNT MURAT
FROM A GEO-ECOLOGICAL PERSPECTIVE, WEST OF
TURKEY**

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Abstract

Mount Murat (2309 m), which is located in the Interior Western Anatolia Division of the Aegean Region and is aligned roughly in the northwest-southeast direction, provides a rich environment comprising the regional, the divisional and the local geo-biomes of three different geo-ecosystems that are influenced under the topographical and the lithological factors in addition to the geographical location.

The western and the southern parts of Mount Murat are included as a part of the divisions of the Aegean Geocological Region. The Lower Aegean Division bordering from the western part of the mountain along the Gediz valley is represented by the Calabrian pine (*Pinus brutia Ten.*). The southern part of the mountain is located on the Central Western Anatolian Plateau within the borders of the Aegean Mountain division, which is represented by the oak and the European Black Pine (*Pinus nigra*). The northern and the northwestern slopes of the mountain belong to the Marmara dry forest, humid and semi-humid forests while the higher altitudes belong to the Marmara Mountain-Grass Division. The eastern part of the mountain belongs to the Central Anatolian Dry Forest-Anthropogenic Steppe Division.

In addition to these, other local geo-biomes, where different topographical and lithological properties loom large, are also present.

In this study, the local biomes, which stand out in the Mount Murat, are investigated from a geo-ecological perspective.

Keywords: Geo-biomes (local biomes), Geo-ecosystems, Mount Murat, Aegean Region, mountain ecosystems, Turkey

Öz

Ege Bölgesi'nin İç Batı Anadolu Bölümü'nde yer alan ve kabaca kuzeybatı-güneydoğu yönünde uzanan Murat Dağı (2309), coğrafi konumu yanında topoğrafik ve litolojik faktörlerin belirleyici etkisiyle üç farklı jeo-ekosistemin bölge, bölüm ve yerel biyomlarını (jeo-biyom) içeren zengin bir ortam oluşturur.

Murat Dağı'nın batı ve güney kesimi, Ege Jeokolojik Bölgesi'nin bölümlerine dâhildir. Dağın batı kesiminden Gediz vadisi boyunca sokulan Ege Alt bölümü kızılçamlarla temsil edilir. Dağın güneyi ise İç Batı Anadolu platosu üzerinde karaçam ve meşelerle temsil edilen Ege Dağ Bölümü dâhilindedir. Dağın kuzey ve kuzeybatı yamaçları Marmara kuru orman, nemli ve yarı nemli orman bölümüne girerken üst kesimler ise Marmara dağ-çayır bölümüne girmektedir. Dağın doğu kesimi ise İç Anadolu Kuru Orman-Antropojen step bölümü dâhilindedir.

Bunların dışında, farklı topoğrafik ve litolojik (anakaya/anamateryal) özelliklerin etkilerinin ön plana çıktığı jeobiyomlar (yerel biyomlar) bulunmaktadır.

Bu çalışmada Murat Dağı'nda ortaya çıkan yerel biyomlar jeokolojik açıdan incelenmiştir.

Anahtar Kelimeler: Jeo-biyomlar (yerel biyomlar), jeo-ekosistemler, Murat Dağı, Ege Bölgesi, dağ ekosistemleri, Türkiye

1. Introduction

The northern slopes of Mount Murat, which is located in the Interior Western Anatolian Division of the Aegean Region, are located within the Kütahya city borders while its southern slopes are located within the Uşak city borders. Mount Murat, which is roughly aligned in the northwest-southeast direction, rises abruptly in the west, in the eastern part of the Gediz valley, which is 900 m high while it rises gradually on the Central Western Anatolian plateaus at an altitude of 1200 m. The Gediz valley and Mount Şaphane are located to the west, Mount Tava to the north and the Banaz Rivulet Basin and Mount Elma to the south and the Central Western Plateau to the east of the mountain (Fig. 1).

Mount Murat, which was located within Hersinian aged massive structures, provided the basis for the surrounding sedimentation (Yalçınlar, 1955). The oldest unit in the area was the Paleozoic aged green schist, which are of cover-schists nature on the Menderes massive structure.

Upper Cretaceous aged mélanges (peridotite, gabbro, dunite, ophiolite, crystallized limestone, cherted limestone) cover wide areas in the Mount Murat enclosed in the İzmir-Ankara zone. In addition to the Paleocene aged granites in the Baklan Hill (1960) located in the south of Mount Murat where Paleozoic and Mesozoic aged units cover wide areas,

Neogene aged rhyolitic and dacitic surface volcanites are present in the southern skirts of the mountain (around Karacahisar) and in the east (Gökdağ), andesites, tuffites and agglomerates are present in the west near Karaağaç (Günay et al., 1986; Aytaç, 2003; Semenderoğlu and Aytaç, 2005). Other than these, Neogene aged lacustrine fragmented units are present in the outer skirts of the Mount Murat (Fig. 2).

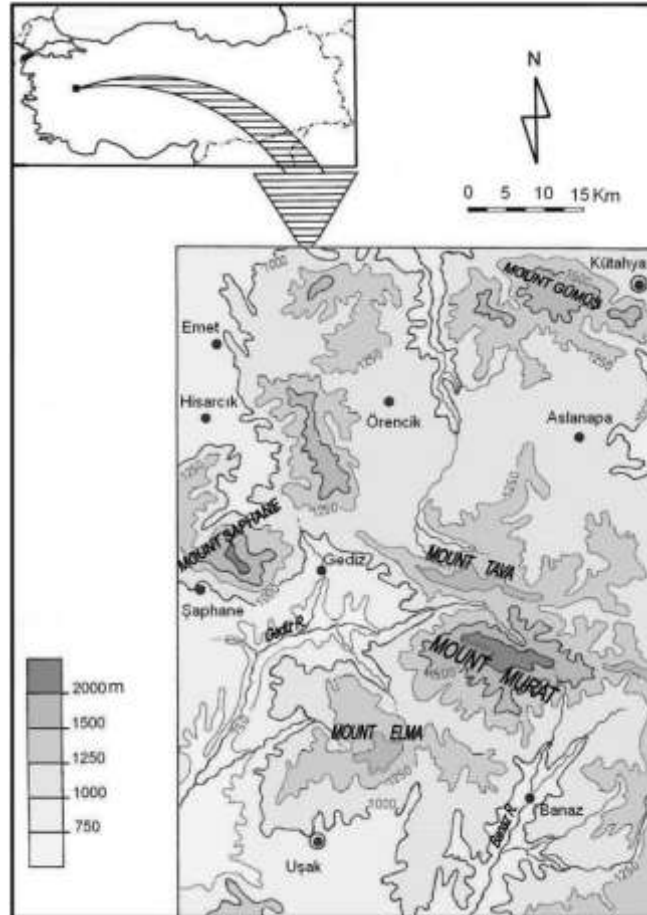


Fig. 1. Mount Murat and its close surroundings

The orogenic movements which had occurred during the Paleozoic and Mesozoic eras are effective in the structural features of the Mount Murat. But in acquiring the present formation of the morphological structure of Mount Murat the vertical tectonic movements (Neo-tectonic movements) which had occurred towards the end of Neogene, specifically in the Quaternary period are the major determinants. The western part of Mount Murat that rose gradually as a result of the tectonic movements in the Quaternary Period was cleaved by the Baybuyan Rivulet and the northern part was split by the Karapınar Rivulet. In addition to the highest altitude peak Kartal Tepe (2309), the peaks Tınaz T. (2097), Kırkpınar T. (2218), Öküzkaşası (2213) and Baklan T. (1956) are the other significant peaks. The acknowledged

peaks are located on the upland region corresponding to the Alpine/Sub-Alpine vegetation stage as well as on top of Pre-neogene erosion surfaces covering wide areas at altitudes higher than 1900-2000 m (Semenderoğlu and Aytaç, 2005).

Mount Murat is located in the confrontation area of the European-Syberian phytogeographical region from the north, the Irano-Turanien region from the east and Mediterranean region from the west. The location of the mountain, its topographical properties (altitude, extending direction, exposition, being deeply dissected by streams, etc.) together with its lithological properties provided the formation of a diverse environment in terms of varying ecological conditions and related phytological species and communities.

Except for the collection of plant samples for various purposes, the first most comprehensive study on the flora and the vegetation of Mount Murat has been conducted by Çırpıcı (1981, 1989). In these studies and in his following publications (1993, 2005), it was reported that of the 890 taxa, 117 were European-Syberian elements, 119 were Mediterranean elements and 95 were Irano-Turanien elements and the three phytogeographical regions were represented in a surprising balance in Mount Murat.

More recently, Aytaç (2003) has mentioned the vegetation of the mountain in his study on the planning of Mount Murat as a national park. The most recent study directly concerned with the vegetation geography of Mount Murat is conducted by Semenderoğlu and Aytaç (2005) and 3 new species (*Fagus sylvatica*, *Corylus colurna*, *Sorbus roopiana*) have been identified of the European-Syberian elements.

Above mentioned studies were concerned with the flora and the vegetation properties of Mount Murat and as of today, no study has been conducted on the geocological properties and local biomes of the mountain.

In this study, it is aimed to identify the local biomes (geobiomes) of the mountain through evaluation of the climate, the topography, the bedrock/parent material, the soil and the biotic factors that were effective in the formation of the local biomes.

Studies about geoecosystems and ecoregions are now at the beginning phase in Turkey and there aren't any studies about local biomes yet. This study is expected to contribute to the conceptual development about both geoecosystems and especially local biomes in Turkey and in the world.

2. Material and Methods

The topological maps of 1/25 000 and 1/100 000 scale that were prepared by the Cartography General Commandment, the climatologic data on the Uşak, Kütahya and Gediz stations that were acquired from the State Meteorological Service, the soil inventory reports that were prepared by the General Directorate for the Rural Services, the forest management maps of the Kütahya and Denizli Forest Regional Managements and the geological maps and reports that were prepared by the General Directorate for Mineral Research and Exploration were made use of during the study. In addition, the publications by the above mentioned researchers were also helpful during the field studies.

The basic method that was utilized during the study is as given below. Climatologic data from the comparison stations were used in order to determine the effect of climate which is a very distinct determinant for the identification of ecological units. These factors, under the control of altitude and topographical effects, were evaluated in light of the distribution of the vegetation belts.

The geology-lithology map highlighting specifically the physical and the chemical properties of the rocks which were effective in the formation of the local biomes (geobiomes) has been prepared by using the geological map that was acquired from the General Directorate for Mineral Research and Exploration.

Various soil samples from different bedrock/parent material, exposition and altitudinal conditions of the mountain were taken and analyzed in the Soil Research Laboratory of Manisa City Directorate for Agriculture. The results of the physical and the chemical analyses were used to evaluate the environments that characterize the various ecological regions, divisions and local biomes.

Lastly, the ecological units of the study field were identified by the evaluation of the climatologic, topographical, lithological properties of the field as well as the soil properties together with the natural vegetation, the biotic factors and the field observations, and the ge-ecosystem map of the field was prepared.

The book “Ecoregions of Turkey” (2002) and its map by Atalay were made use of in the identification of the ecological regions and the divisions. Atalay has divided Turkey into 3 main climate regions (the Mediterranean Climate Region, the Black Sea Climate Region and the continental regions; the Central and the Eastern Anatolian regions) together with 3 transitional regions among the main climate regions (Marmara, Southeast Anatolian and Mediterranean transitional regions) totaling up to 6 ecological regions. The ecological regions were further divided into divisions based on the altitudes, exposition and other variables based on these factors. Additionally, the regions and the divisions are further divided into local biomes based on the sandy/salty soil and parent material characteristics and wetland characteristics. For this reason, it can be concluded that Atalay has basically applied Walter’s ecological classification system on the scale of Turkey.

H. WALTER has divided the geo-biosphere comprising the continental ecosystems into 9 zonobiomes based on the main climate belts on earth. Since the climate is the main determinant, the soil and vegetation (zonal soil and zonal vegetation) types are also characteristic of the zonobiomes (Walter, 2002). However, mountains among these zonobiomes may present themselves as different biomes (orobiome) with different climate conditions hence with different environmental conditions based on their altitudes (Walter, 2002). Similarly, some extreme soil types may harbor separate biomes (pedobiome) where azonal vegetation is encountered. H. WALTER has roughly defined the areas where lithosoles were present as “lithobiome”, the sandy soil as “psammobiome” and the salty soil as halobiome” under the pedobiome title (Walter, 2002). However, it is useful to classify the bedrock/parent material, the special soil conditions and the biomes reflecting the effect of the morphology under the title of “geobiomes” enclosing all local biomes. Among these, the classification of the “lithobiome” reflecting the effect of the bedrock (lithology) and the “geomorphobiome” highlighting the geomorphological / topographical factors is suitable (Semenderoğlu, 2001).

Some lands may constitute local biomes invaded by the azonal vegetation where psammophytes are present in the sand lands and coarse sand basins, halophytes are present in salty soil or hydrophytes are present in periodically or continuously water invaded fields. However, the soil may not always be the primary determinant. Sandy soil may form on certain types of rocks (granite, quartzite, gneiss, sandstone, acid surface rocks, etc.). Specifically, the sandy shallow soils in the mountain areas may not be the primary determinant for the growth

of the forest trees. This is because trees provide their nutritional and water needs directly from the bedrock through the layers of the bedrock, the crack systems and via their deeply invading roots into the schistosity surfaces. For this reason, it is not appropriate to reduce the role of lithology to only rocky and marginal fields.

Sometimes the topographical factors or the morphological factors may play a primary or a secondary role together with other minor factors. This situation is frequently encountered in hilly areas with steep slopes which are cleaved deeply by streams. In this study, bedrock (lithology) has been defined as the “lithobiome” when within the above explained scope, it appears as the main local determining factor.

The topographical and the geomorphological factors are defined as the “geomorphobiome” when they are the local determinants. However, sometimes the bedrock (lithology) and the topographic factors (exposition, altitude, the position of the field cleavage, etc) are not enough by themselves and they play an effective role together in the formation of the local biomes. For instance, lithology might play a primary role together with one or more of the topographical factors. The term “litho-morphobiome” is used for this situation. In this case, since significant biomes such as lithobiome and geomorphobiome cannot be categorized as pedobiomes, the local biomes including the pedobiome are investigated under the title, “geo-biomes”.

İ. ATALAY used nomenclatures such as the “Mediterranean Climate Region”, the “Continental Region” and the “Marmara Transitional Region” corresponding to zonobiomes in a very rough sense, or sometimes to large transition regions in the classification of Turkey’s ecological regions. In this study, the term “geo-ecosystem” (Mediterranean Geo-ecosystem, Continental Geo-ecosystem, Marmara Geo-ecosystem, etc.) is used for large ecological units where the climate is the main natural determinant factor. The reason for that is the authors’ opinion that the climate and the other related natural components to be evaluated within ecological classification should loom large. In other words, climate and other natural components (vegetation, soil properties, etc.) need to be the means whereas ecological evaluations and classifications need to be the aim. It would be more appropriate to evaluate climate, soil properties, vegetation and other environmental components as the “properties of the ecological units”. In addition, Atalay has sub-divided some regions among the vast climatic regions in terms of both climatic and other environmental conditions. For instance, the Mediterranean Climatic Region is divided into the Aegean Region, the Mediterranean Region and the Mediterranean Transitional Region. Here, a confusion regarding the Aegean Region and the Mediterranean Region might occur since in the same location, the geographical regions with the same names are present. In addition, the naming is also not suitable from an ecological point of view as well as in terms of classification. Owing to the pre-mentioned reasons, a naming as the “Aegean Geo-ecological Region” for the Aegean Region, the “Marmara Geo-ecological Transition Region” for the Marmara Transitional Region and the “Central Anatolian Geo-ecological Subregion” for the Central Anatolian Region was considered appropriate.

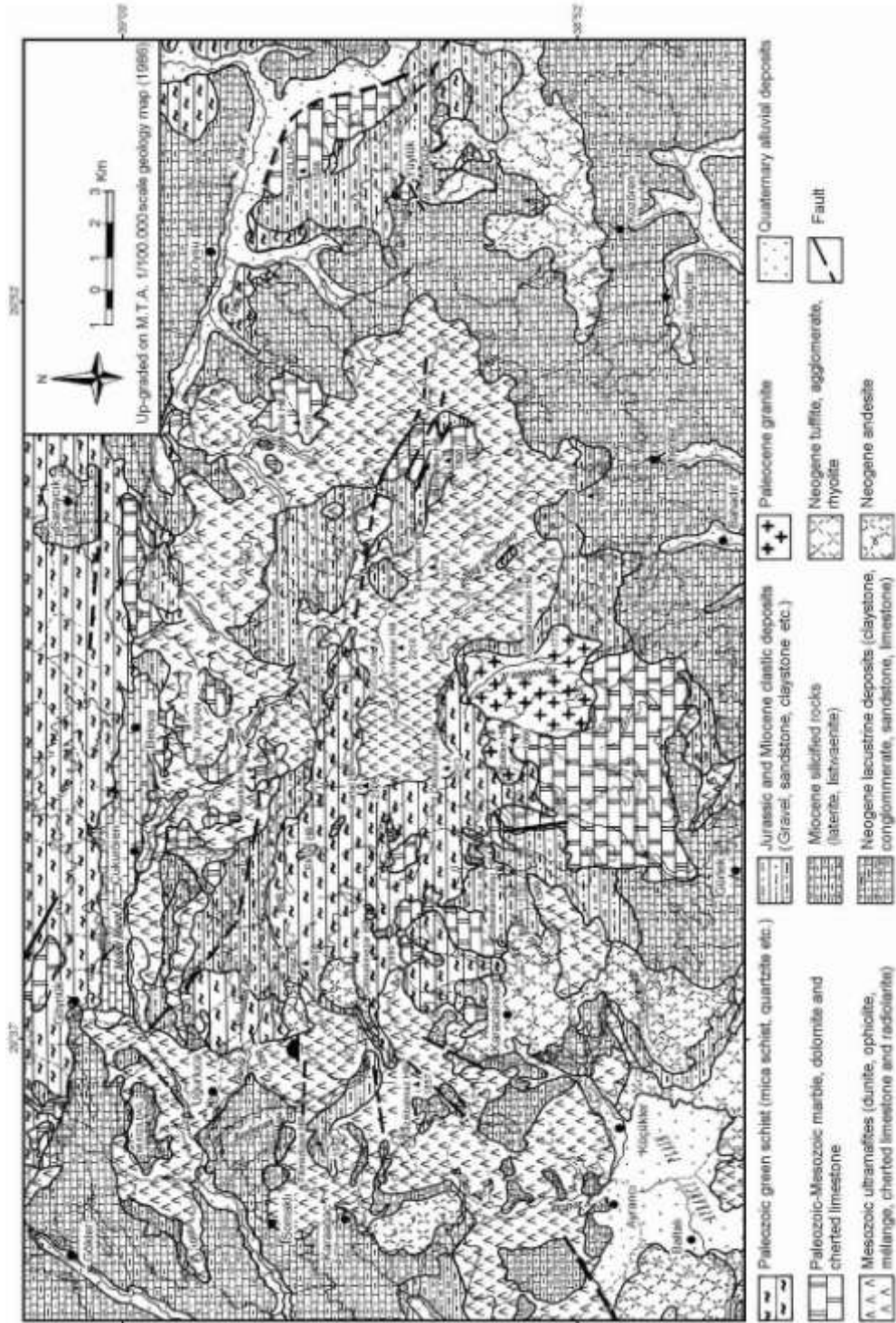


Fig. 2. The geo-lithological map of Mount Murat.

3. Results

3.1. Local Biomes Of Aegean Geo-Ecological Region

The Aegean Geocological Region, as one of the main ecological units in Mount Murat, is represented by the Lower Aegean (Red pine / Calabrian pine) Division, the Aegean Mountain (European Black Pine) Division and the Aegean Mountain Grass Division. The Lower Aegean (Red pine) Division obtrudes towards the west of Mount Murat along the Gediz tectonic corridor and the valley of the Mount Murat Rivulet towards the east, which is also an important tributary of the Gediz River (Fig. 1, 6, 8). There is not found any local biome in the Lower Aegean Division.

3.1.1. The Local Biomes (Geo-biomes) of the Aegean Mountain (Black pine) Division

The Aegean Mountain Division encloses the southern slopes of Mount Murat starting in the southwesterly direction towards the east. The Aegean Mountain Division is separated from the Central Anatolian Dry Forest-Anthropogenic Steppe Division in the east which is exposed to the cold and dry climatic effects of the Central Anatolia (Fig. 8).

In the Aegean Mountain Division mainly formed by the determinant effect of the climate possessing mainly a dry forest characteristics with the black pine, with the effect of the bedrock coming forward at times supported by topographical factors such as the exposition and the altitude as the secondary factors, the presence of local biomes (geo-biomes) loomed large.

3.1.1.1. Litho-biomes on Green Schist and Quartzite: Paleozoic aged muscovite and granated green schist and quartzite on which sandy soil formed are present in the Aegean Mountain Division right in the northeast of Karacahisar village (Fig. 2). Soil that is relatively more acidic character forms on these rocks depending on the climate and especially the precipitation conditions. The bedrock also has the same effect. Although in the Aegean Mountain Division on the southern slopes of Mount Murat the black pine of dry forest characteristics were dominant, some euxine Black Sea elements were also present on the green schist and quartzite rocks. Hazel (*C. avellana*) communities were present within the valley on green schist and quartzite between 1500 and 1750 m to the northeast of Karacahisar deeply cut by the branches, such as the Fındıklı Rivulet of the Banaz River and the common aspen (*P. tremula*) communities were present in the northwestern slopes of the valleys. Here, although the lithology is the main determinant factor, altitude, exposition and the cleaving position of the land have been secondary factors that were effective in the formation of the growth conditions for the indicated Euro-Siberian originated Black Sea elements (Fig. 2 and 8). Marble is also present embedded in the green schist positioned as lenses. The areas with marble elements constitute the areas that do not support the growth of the euxine Black Sea elements.

Also in the Aegean Mountain Division, around the Baklan Hill local beech, the common aspen with the Scots pine and the Scots pine/black pine communities on green schist and quartzite are not detected on the ultramafites, limestone and marble at the same altitude and direction of view as well as other bedrocks such as the Jurassic aged clastic sediments. Here, the beech and the common aspen are present on the green schist and quartzite on the northwestern slopes of the valley at 1600-1700 m roughly along the northeast-southwest direction located to the southwest of the Öküzkaşası Hill. The natural environmental component that provided the formation of suitable environments for the limited growth of the beech (*Fagus orientalis*) and the common aspen (*P. tremula*) is the bedrock. Nevertheless, in addition to the effect of the fog and the humid air creeping in eaves towards the south slope

passing over the north slope, secondary factors such as the exposition and altitude were also effective in the alpine/sub-alpine (mountain grass division) level. In addition, although beeches and common aspens are secured by the Baklan Hill in the east in the northwest slope of the valley, they may take shelter in the secured area that was protected from the effects of the dry whether coming from the east from Central Anatolia (Fig. 8).

Scots pines (*Pinus sylvestris*) also exist together with the black pines on schist and quartzite between 1750 and 2000 m to the east of the Baklan Hill. This field corresponding to the spring part of the Tepedelen Rivulet bordering the sub-alpine level faces southeast. This explains the reason why beeches and other euxine elements were not present. The altitude as well as the presence of the cold and dry weather creeping from the east during winter partially supports the presence of the Scots pine together with the black pine. However the main factor is again the sandy soil producing bedrock. Although Scots pines were present on the green schist and quartzite, black pines were present on the lens positioned marbles embedded in green schist adjacent to each other although all other components were the same. Moreover, even within very short distances that can be represented in terms of meters, Scots pine on green schist and quartzite and the black pine on the marble lens right next to it display almost a geo-ecological dance. Here, the monumental Scots pine (the Tepedelen pine) with an age over 500 located in the Tepedelen area to the north of the Baklan Hill (1966) is located on a quartzite lens.

The common aspen populations are present on the west and northwest facing slopes on the green schist and quartzite that are outcrops within the ultramafites to the west of the Ardıçolođu ridge which is more towards the east. The common aspen population is completely surrounded by the black pines and they are present in the form of an enclave in the shape of a lens fitting the borders of the green schist-quartzite outcrop. Here, although the susceptibility to humid air on the western and the northwestern slopes plays an important role, the main determinant for the formation of the geo-biome has clearly been the lithology.

3.1.1.2. Lithobiome on the granite: Paleocene aged acid intrusive rocks in the composition of granite exist to the east and to the west of the Baklan Hill (1966) in the Aegean Mountain Division in the southern slope of Mount Murat (Fig. 2). The weathering product of granite, arena is present abundantly in the surrounding area and sandy soil is formed on the granites. Sandy-clay structured, mediocre acidic (pH: 5.69) soil exists on the granites in the northwest facing slopes below the pure Scots pine populations at 1919 m. Provided all other prerequisites are fulfilled, local biomes in which Scots pines are present exist also on granites such as green schist and quartzite producing sandy soil in Mount Murat. Although the granite field in the west covers a narrow area, the granite area on the east is thoroughly vast. Although black pines exist on the granites in the east up to the altitude of 1800 m, Scots pines begin to mix with them at around 1800 m and at higher altitudes, the population becomes pure Scot pine forests. Black pines are present on the chalk schist and the marble corresponding to the contact metamorphism zone among the granites of the east and the west at 1900 m. As a result, the main determinant factor in the presence of the Scots pine in the environment is the granite bedrock and the altitude plays a secondary role supporting the extending of the Scots pine (Fig. 6, 8).

3.1.1.3. Karstic Lithobiomes on Dolomitic Limestone and Limestone: Mesozoic aged limestone, dolomitic limestone, marble and chalk schist are present in the upper sections to the south of the Mount Murat in the Aegean Mountain Division, starting from the north of

Gürlek at 1500 m towards the Baklan Hill (1966). The presence of marble and chalk schist in the upper levels around the Baklan hill is related to the contact metamorphism of the Paleocene granite intrusion (Günay et al., 1986). Brownish-red Mediterranean soil is present specifically along the cracks and the layer surfaces of this unit (This soil was formed probably during the interglacial periods in the Quaternary). The same geo-biome is present in patches around Karacahisar. The dominant forest tree of the geo-biome is the black pine. Rarely, the laurel leaved snail tree (*C. laurifolius*) accompanies the black pine. However, up to 1700-1750 m, in addition to *Q. cerris*, *Q. infectoria* and *J. excelsa*, lots of *J. oxycedrus*, *P. terebinthus* and *Rhus coriaria* are encountered in the form of bushes. Different from the general characteristics of the Aegean Mountain Division, Mediterranean elements and common species of the Mediterranean phyto-geographical region (the Lower Aegean (Red pine) division in the study area) are also encountered on the limestone and the dolomitic limestone rocks. In addition, in the study area within the Aegean Mountain (Black pine) Division at lower altitudes, different Mediterranean elements were not encountered on different bedrocks. This situation points at the presence of the limestone and a local biome (geo-biome) on the limestone. The effect of the bedrock is distinctly prevailed although the altitudes do not support this formation (Fig. 2, 6, 8).

As it is known, the process of dissolution takes place within the cracks and on the layer surfaces in the limestone containing many cracks and layer surfaces. These sections which are appropriate for the circulation of water and air expand in time as the CaCO_3 dissolves in water and is removed from the environment. At the end, the gaps within the limestone are filled with iron and aluminum containing clay residues causing the formation of the terra-rossa soil. This type of soil has a high water retention capacity owing to the fact that it contains clay. The limestone, which is usually light in color, reflects the excess radiation during the dry and the hot period enabling the minimization of the humidity loss. The natural vegetation, specifically the bush vegetation regenerates easily following fires and other destructions through their roots preserving their viability that were protected between the cracks and the layers. For this reason, the regeneration capability of especially the Mesozoic aged limestone rocks is very high. Since this situation is related to the process of karstification, the “karstic litho-biome” terminology was suited appropriate (Semenderoğlu, 2001).

3.1.1.4. Riolitic tuffites and litho-biomes on rhyolites: Miocene aged rhyolites and riolitic tuffites are present in the Aegean Mountain Division around Karacahisar. This acid surface rocks are of granite composition between 1250-1500 m, even up to 1650 m at times and on top of these rocks, 10-15 cm shallow layer of sandy soil of slightly acidic nature (pH: 6.07) was present on A-C horizon reflecting the properties of the bedrock. Common aspen populations in enclave formation are present under the black pines on the acid rocks within the ultramafites at 1650 m of altitude in the ultramafite-rhyolite and rhyolitic tuffite transition to the southeast of the Kazıkbatmaz Hill and in locations where the black pines were destroyed. *C. laurifolius* and *Astragalus* sp. populations as well as *J. oxycedrus* are present in patches in between the common aspen. However, although common aspen populations are present, the environment is completely of dry forest appearance. The common aspen is seen on the west and the northwest facing slopes up to the ridges. Black pine and oak populations are present on the ultramafites and the volcanism dependent rocks of silsified laterite nature (laterite-listwaenites) and on local travertines in the surrounding area. Bush formed *Populus tremula* populations are present between 1250 and 1700 m on the northern-northwestern slopes of Kavaklı Ridge and the Sarıtaş Hill on the rhyolites and the tuffites to the south of Karacahisar. Black pines are present on the eastern slopes and oak populations are present in patches where the black pines are destroyed. Although in the western slopes of Mount Murat, to the south of Karaağaç between 1250 and 1500 m on andesites the environment is more susceptible to the

westerly and northwesterly humid winds, a euxine element, the common aspen is not encountered and only black pines (*P. nigra*) occupied the area. In other words, the andesite field which is similar in altitude, and more advantageous for *Populus tremula* in terms of direction of view and position, they cannot find the suitable growth environment that they find on the rhyolites around Karacahisar. As a conclusion, the Karacahisar rhyolites and tuffites form a separate local biomes on which the common aspen can grow, the exposition is an important secondary factor and altitude also plays a partial role while the effect of lithology clearly has the determinant role in the natural environment (Fig. 8).

3.2. The Local Biomes of Marmara Geo-Ecological Transition Region

The Marmara Transition Region possesses the climatic characteristics of the Black Sea, the Mediterranean and the Central Anatolian continental climates. The northern slopes of the mountains possess the Black Sea elements (Euxine species) whereas oaks are common in the south facing lower slopes and black pines are common in the higher slopes. The red pine populations and the macchia are present in the lower valley basins and in lower slopes facing south. The Marmara Transition Region creeps towards the northern parts of the West Central Anatolian plateaus (Atalay, 2002).

Four different divisions have been identified within the context of the Marmara Transition Region in Mount Murat. These are the Marmara Dry Forest Division, Marmara Semi-Humid Forest Division, Marmara Humid Forest Division and the Marmara Mountain-Grass Division (Fig. 6, 8). In addition to these, several local biomes have also been identified, which are formed by the effect of the bedrock or the effects of the morphology in the divisions looming large.

3.2.1. Local Biomes of the Marmara Dry Forest Division

The Marmara Dry Forest Division continues in the north following the lower border of the Marmara Semi-Humid Forest Division the north of Gökdağ in the east. The Central Anatolian Dry Forest Anthropogenic Steppe Division supersedes the Marmara Dry Forest Region to the east of the Gökdağ-Kızıldağ line due to the increase in the continental effects.

The western slopes of Mount Murat (hot springs region and surroundings), the Fikirsizkaya Hill (1552) and the Kazıkbatmaz Hill (1857) to the west of the Baybuyan valley and the hot springs region to the east of the valley between the Tınaz Hill (2097) and the Çatmalmezar Hill (1990), specifically owing to the humid winds from the northwest possess the Marmara Geoecological Region characteristics. However, since the western slopes receive relatively more radiation, the Marmara Dry Forest Division characteristics represented by the black pines present themselves.

3.2.1.1. Lithobiome on the green schist and quartzite: The Paleozoic aged green schist and quartzite constitute a local biome on the northwest facing slopes to the east of the hot springs region in Mount Murat within the Marmara Dry Forest Region. Being partly affected from the humid northwesterly winds up to some extent during the vegetation period, being susceptible to the Aegean climatic effects from the west, receiving more radiation in comparison to the northwestern and the northern slopes of the mountain resulted in the dominance of the Marmara Dry Forest Division characteristics in the local biome. The local biome represented by the Scots pine and the black pine, also includes local marbles embedded in green schist and quartzite, Miocene aged rhyolites and Transitional zones towards ultramafites. The marble and the ultramafites support the black pine whereas the rhyolites and

specifically the green schist/quartzites support the Scots pine. However, the topographical factors, especially the altitude and the exposition locally reduce or enhance the effect of the bedrock and they may affect and control the presence and the combination of the Scots pine and the black pine.

The field, where the Paleozoic aged green schist and quartzites were effective as the lithobiome, goes as low as 1750 m in the west and in the south whereas to the east of the Tınaz Hill, the pure Scots pine populations are seen even at higher altitudes than 2000 m. They roughly continue along the upper course of the deeply dissected valley of the Gürlü Rivulet extending in E-W direction in the north (Fig. 7, 8).

Scots pines and black pines are present in mixed form along the line towards the Gürlü Rivulet following the 1900 m contour line to the southwest of the Tınaz Hill (2097) in the Sarıçiçek Upland at around 1850 m towards northeast except for the discontinuities resulting from the marbles in the green schist. The Scots pines are reduced relatively more along the line at locations where rhyolites are dissected. Along the northwest facing slope, there are no topographical unevenness except for little and shallow valleys. Any deciduous euxine Black Sea element has not been encountered in these little valleys except for rare bush formed hornbeam (*C. betulus*). Although the green schist and quartzite characteristics continue towards the west, lower around the hot springs areas at 1450 m, the Scots pines gradually are replaced by the black pine populations possessing again a dry forest characteristic (The Scots pine completely disappears at 1750 m). Although the altitudinal and expositional conditions are similar, the Scots pines are replaced by the black pines in the south towards the Sarıçiçek Upland district since the ultramafites were present. However, the dry forest characteristics change suddenly in the deep valley of the Gürlü Rivulet close to the north. From the basin of the valley until the upsides of slopes, the transition is towards the Marmara Humid Forest Division containing rich euxine elements including the beech. The rarity of the Black Sea elements although the bedrock and the altitude supports the formation in the indicated region of the biome, and the black pine dominating the Scots pine was because the humidity was not enough for the Black Sea elements and the radiation was too much although the environment is too humid for the Scots pine. In the end, the environment is dominated by the black pine which is relatively an ecologically much more tolerant species. The slope not being cleaved by streams except for the Gürlü Rivulet, the exposition being northwest although the slope being on the western side of the mountain, thus remaining rather deprived of the humid air mass creeping from the northwest, has played an important role in the appearance of this situation. However, the bedrock was the main determinant factor in the formation of a local and suitable environmental condition resulting in the presence of the Scots pine.

Towards the east, to the peak of the Tınaz Hill, the density of the Scots pine populations increases at around 1950 m on green schist and quartzite rocks as the altitudes increase. Starting at 1950 m, the Scots pines constituted pure populations to the east of the Tınaz Hill. Up to the altitude of 2050 m, only Scots pines exist even on the marbles embedded in green schist rocks. The Scots pines are observed as individuals up to 2100 m irrespective of the bedrock. The western side of Mount Murat is where the Scots pines were attained at their highest altitudes. However, deformations may occur on these Scots pines because of the extreme winter conditions, the snow pressure and the winds.

The Baybuyan Rivulet valley to the west of the Çatmalımezar Hill around the Çatmalı Gedik location, extends in the direction of E-W. The contact between the ultramafites in the west (periodite, gabbro, diabase, serpentinite) and the green schist and quartzites was located in that area (Fig. 2). Pure black pine populations are present on ultramafites at 1750 m on the south facing slopes of the valley in the west. The Scots pine only gets into the picture at 1850

m getting mixed with the black pine (Fig. 3, 8). Although the Scots pine forests were relatively dominant on the green schist and quartzite rocks to the east, at the same exposition and altitude, black pines get mixed in the dry forest environment. At altitudes higher than 1850 m, the Scots pine forests get purer until the mountain grass division (Fig. 4, 8). There, the soil samples collected at 1750 m from the acid brown forest soil on top of the ultramafites indicates that the soil is of clay-mud textured, mediocre acidity (pH: 5.93) and with a cation exchange capacity (CEC) of about 35. The soil on the green schist and quartzite rocks below the Scots pine is generally of silty-sandy mud structure and it has a mediocre acidic reactivity (around pH: 5.5). The CEC varies between 27 and 29. The higher acidity of the soil on the ultramafites than the ultramafites below the humid forests on the northern slopes of Mount Murat is related to the fact that they are in contact with the green schist and quartzite rocks around the Çatmalımezar Hill.

Scots pine populations of 95% pureness are detected on the green schist and quartzite rocks in the south of the valley on the north facing slopes at the same altitude (1750). Black pines form pure populations to the west, at the same altitude and exposition on the ultramafites, however, Scots pines get mixed with them at higher altitudes (Fig. 5).

The Scots pines exist densely on the green schist and quartzite rocks and rhyolites until the Marmara Mountain Grass Division on both slopes of the valley to the east of the Baybuyan valley. The rising and the cooling of the humid air channelized towards the Baybuyan valley, releasing some of this humidity at lower courses as it gets directed towards east, in other words its modification to fulfill the ecological requirements of the Scots pine plays a role in this in addition to the altitude and the bedrock type (Fig. 4). Because the Scots pine attains the best environment for growth in Mount Murat on the green schist and quartzite rocks specifically at this section of the valley, they are observed to be of high quality in terms of height and volume (Fig. 5).

As a conclusion, on the green schists and quartzites form sandy-silty mud textured soils that is relatively of more acidic character based on the precipitation condition of the environment. When other factors such as the exposition and altitude support the local biome to some extent, a suitable environment for the growth of the Scots pine is obtained.

3.2.1.2. Lithobiome on the rhyolites: Rhyolites exist in the south of the Tınaz Hill, to the west of Mount Murat cutting the green schist and quartzite rocks (Fig. 2). Rhyolites, resulting in sandy and shallow soil reflecting the bedrock characteristics do not support the presence of the Scots pine as much as the green schist and the quartzite does. The understory level is drier and poorer in terms of the accompanying species. However, it is distinguished as a local biome owing to its effectiveness in the presence of the Scots pine where it exists (Fig. 7, 8).

3.2.2. Local Biomes of Marmara Semi-Humid Forest Division

The Marmara Semi-Humid Forest Division of the Mount Murat is located at the transition zone between the Marmara Dry Forest Division and the Marmara Humid Forest Division on the northern slopes of Mount Murat.

The black pines dominate the ridges separating the valleys and specifically on the east facing slopes in the Marmara Semi-Humid Forest Division while many Black Sea elements among which the common aspen (*P. tremula*) possessing the highest invasion ability among the euxine elements is also present are mixed with the semi-humid forests in the valley basins

and on the northwestern slopes of the valleys depending on the exposition. Among these, *Sambucus ebulus*, *S. nigra*, *Sorbus umbellata*, *Acer campestre*, *A. hyrcanum* subsp. *keckianum*, *A. Platanoides* are mixed with the semi-humid forests in the lower portions of the Karapınar valley than 1350m, *Tilia rubra* subsp. *caucasica*, *corylus avellana*, *Viburnum tinus*, *Fraxinus ornus*, *Euonymus latifolia* and *Lonicera caucasica* subsp. *Orientalis* together with *Fagus orientalis*, *Carpinus betulus*, *Q. cerris* and *Q. Pupescens*. The beeches are mixed with the semi humid forests at altitudes higher than 1300-1350 m on the northern slopes (Semenderoğlu and Aytaç, 2005), (Fig. 6).

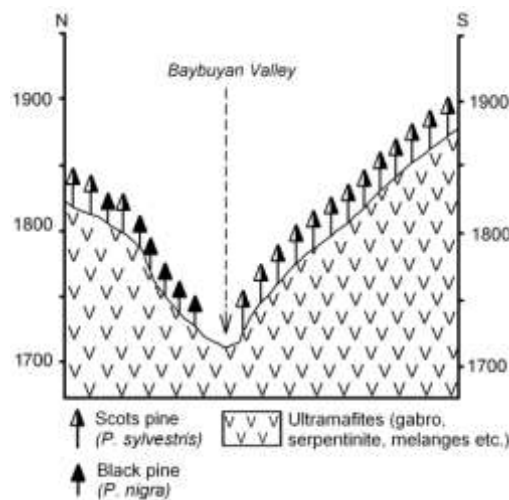


Fig. 3. The distribution of the black pine and the Scots pine populations with respect to the exposition and altitude in the slopes of the Baybuyan valley comprised of ultramafites around the Çatmalı Gedik region.

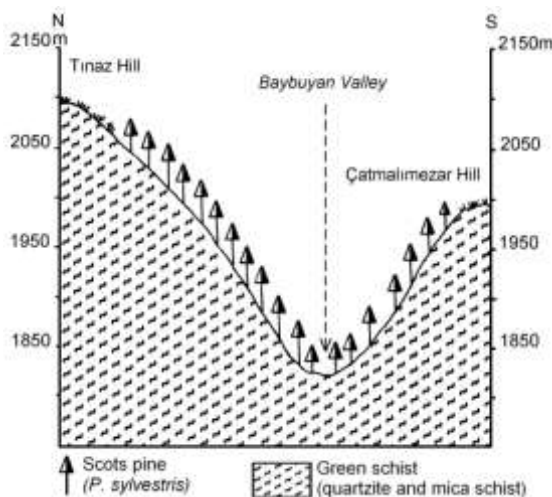


Fig. 4. The lithobiome on the green schist and quartzite rocks in the upper courses of the Baybuyan valley. The pure Scots pine populations are observed at both valley slopes starting at 1800 m until the alpine-subalpine level.

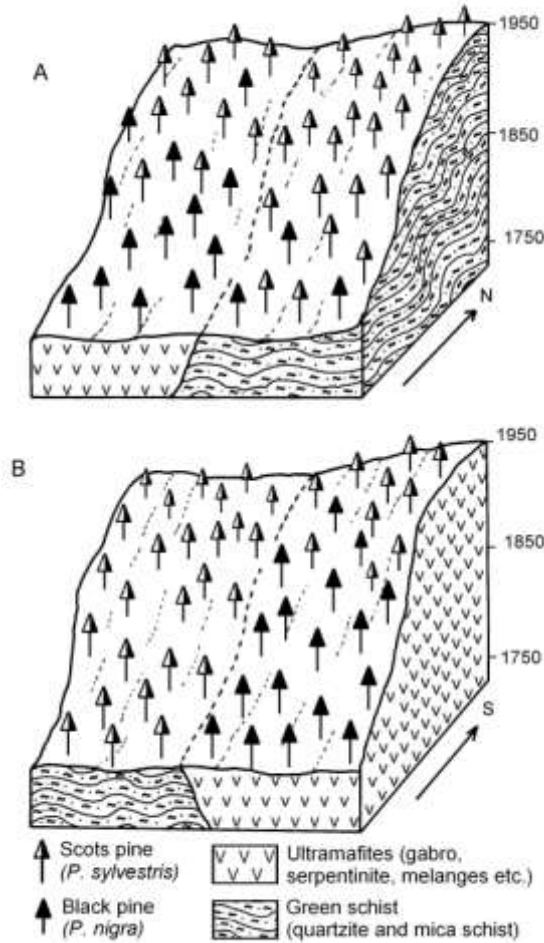


Fig. 5. A: The lithobiome on the green schist and quartzite rocks on the south facing slopes of the Baybuyan valley in the Çatmalı Gedik district (the Scots pines were observed on the green schist and quartzite rocks starting at 1700 m and it gets attention that they dominate the environment at higher altitudes).

B: While passing through pure Scots pine population starting at 1750 m on the green schist and quartzite lithobiome on the north and northwest facing slopes again in the Çatmalı Gedik district, the black pine was only observed to get mixed with the Scots pine starting at altitudes of 1850 m on the ultramafites.

The Marmara Humid Forest Division begins at approximately 1500 m in the northern slopes of Mount Murat, above the the upper border of Marmara Semi-Humid Forest Division and it continues up to altitudes of 1900-2000 m until the Marmara Mountain Grass Division within the study area (Fig. 6, 7, 8). The presence of beech (*F. orientalis*) joining the humid forest body along the zone is much more dominating in comparison to the Semi-Humid Forest Division.

Although the exposition and the altitude play an important role in the species composition in the Marmara Humid Forest Division, the bedrock not to play any important determinant role in the formation of the local biomes.

One jeo-morpho biome and one litho-morpho biome were determined as local biomes in the Marmara Semi-Humid Forest Division.

3.2.2.1. The Geo-morphobiome Displaying the Characteristics of the Humid Forest in the Baybuyan Valley Basin: An extremely colorful geocological meeting point is encountered to the west of Mount Murat with the interference of the Mediterranean climate creeping in from the west and the south west, the Marmara transition climate creeping in from the northwest and the north together with the effects of the morphological-topographical factors. In the basin of the Baybuyan valley that is deeply cleaved roughly in the NW-SE direction, beeches and other euxine Black Sea elements constituted the Marmara Humid Forest Division characteristics whereas as moved upwards in both slopes of the valley, firstly the beeches recede from the environment and then with increased radiation, the common aspen together with the Black Sea elements in decreasing numbers present the Marmara Semi-Humid Forest characteristics. At higher altitudes on the west and northwest facing slopes, the common aspen also rarefies and they change into the bush form leaving space to the Marmara Dry Forest environment. This situation is related to the increased radiation in the upper slopes facing the west and the northwest and the increased susceptibility of this section of the mountain to the effects of the Mediterranean climate approaching from the west. Nevertheless, the common aspen attain on the east and northeast facing slopes of the valley together with the black pines up to higher levels in comparison to the west and northwest facing slopes of the valley, indicating the continuance of the semi-humid forest characteristics (Marmara Semi-Humid Forest Division) (Fig. 7, 8).

The valley of the Baybuyan Rivulet merging with the Mount Murat Rivulet at 900 m around Somaklı is susceptible to the humid northwesterly winds.

The humid forest conditions at the basin of the valley occur at the altitudes of 1250-1500 m. So the humid northwesterly winds rise 300-500 m in a short distance cooling adiabatically along the way. Therefore, the relative humidity in the valley basin increases more in comparison to the slopes that receive more radiation and the formation of more fog is observed. Especially during the summer period, the fogs formed along the valley basin are effective in the occurrence of the humid forest characteristics with the presence of the beech, in the first place.

The humid air mass that is channeled through the valley hitting the northern slopes of the Çatmalımezar Hill causing fog and precipitation provides suitable conditions for the presence of beeches together with the semi-humid forests on the upper sections of the slope.

As a conclusion, the ecological conditions in the Baybuyan valley display variation with the climatic effect of mainly the topographical factors (exposition, altitude, cleavage of the land and orogenic range), the biotic factors and the human effects (successive populations of the common aspen following the fire). Since the geomorphology has been the main determinant factor in the formation of the deciduous humid forests in the deep and the

secluded valley basin together with beeches and the other euxine elements, it has been regarded as a geo-morphobiome within the Marmara Semi-Humid Forest Division. However, the geo-morphobiome carrying the humid forest characteristics at the basin of the valley still resides under the semi-humid forest environment owing to its specific conditions.

3.2.2.2. The Gökdağ Litho-morpho Biome on the Green Schists and Quartzites:

The Gökdağ massive structure, which is the highest point of Mount Murat in the east at 1644 m displays humid forest characteristics as a result of the bedrock and the topographical factors although it is located within the Marmara Semi-Humid Forest Division. The central regions of the mass forming apparent and high reliefs due to tectonic movements and differential erosion are comprised of green schist and quartzite (Fig. 2). Sandy soil has formed on the rocks constituting the mass that is surrounded by the fault scarps in the north and the east. The soil is of acidic character as a response to the increased precipitation with the effects of the exposition and the altitude. Species-rich humid forests dominated by the beeches, hornbeams and the common aspens have found themselves a suitable environmental growing conditions on the northern slopes in accordance with this fact (Fig. 7, 8). *Q. cerris* also accompanies the humid forest body comprising a green understory level in addition to other humid euxine elements such as *A. hyrcanum*, *A. platanoides* and *A. campastre*. Occasionally, the Scots pine and the black pine also participate in the leaved forest based on the conditions of the exposition. Although the altitude and the bedrock (schist and quartzite) support the humid species in the eastern and the southern sections of the mountain, a transition towards the black pine forests of dry forest character is observed due to the effect of the exposition. In conclusion, the altitude and the exposition indicate the effects of topography and geomorphology, whereas the bedrock and the soil that formed on top indicate the effect of lithology being dominant on the formation of the humid forest growth conditions in the area.

3.3. Central Anatolian Geo-Ecological Region

This geo-ecological region is characterized by continental semi-arid climatic conditions and represented by the Dry Forest-Anthropogene Steppe Division which is exposed to continental effects of Central Anatolia in the East of Mount Murat.

3.3.1. The Local Biomes Of Central Anatolian Dry Forest-Anthropogenic Steppe Division

The Central Anatolian Dry Forest-Anthropogenic Steppe Division creeps towards the area of study from the east, by the Interior Western Anatolian Plateau via Afyon - Dumlupınar (Fig. 8). The division is adjacent to the Aegean Mountain Division to the southeast of the mountain, to the Marmara Dry Forest Division in the northeast, to the Marmara Semi-Humid Forest Division in a limited area around Gökdağ. The Central Anatolian Dry Forest-Anthropogenic Steppe Division is more exposed to the dry and cold air masses coming from the Central Anatolia from the east. Environmental conditions where the summer draught is felt more than the Aegean Mountain (Black pine) and the Marmara Dry Forest Divisions, where the relative humidity is relatively low and the evapo-transpiration is more is becoming more apparent.

Within the Central Anatolian Dry Forest-Anthropogenic Steppe Division, to the southeast of Mount Murat, a local biome (geo-biome) exists where the Scots pines form pure and mixed populations with the black pine at 1500 to 1700 m of altitude (Fig. 7, 8).

3.3.1.1. The Scots pine-Black pine Geo-morphobiome between the Gökdağ and the Bereker Hill: Needle-leaved forests of mixed Scots pine and black pine or pure Scots pine exist in patches on the high eastern and the southeastern slopes to the southeast of Mount Murat exposed to the cold and the dry winds of the Central Anatolia. The acid brown forest soil exists in the semi-humid/semi-arid environmental conditions on ultramafite rocks (periodite, gabbro, diabase and serpentinite) between the Bereker Hill and Gökdağ and on partial neogenic lacustrine deposits and although the common aspens are occasionally encountered in the valleys and on the understory level, generally *C. laurifolius* is common on the understory level and in the open areas. Generally, the natural range of Scots pine is concentrated in boreal and continental regions and on acid, podzolic soils over siliceous substrata (Kelly & Connolly, 2000). But here, the presence of the Scots pine does not depend on the bedrock but on the determinant effects of the location, the exposition and the altitude. The local biome (geo-biome) is partially affected by the humid northwesterly wind masses although it is not directly exposed to the effects. However, it is more exposed to the continental effects approaching from the east, from Central Anatolia. As a result, the sufficient humidity and the low temperatures enabled by the altitude, the exposition and the location, enables the appearance of the local suitable conditions of growth that result in the observation of pure Scots pine populations at high altitudes and of mixed populations of Scots pine and black pine at altitudes up to 1500 m (Fig. 7, 8).

4. Conclusion

Mount Murat is in contact with the Aegean Geocological Region in the west. The northern slopes gape towards the Marmara Geocological Transition Region and the Dry Forest Anthropogenic-Steppe Division including anthropogenic steppe environments of the continental Central Anatolian Region in the east at locations.

Mount Murat does not typically represent the characteristics of the regions and the divisions in terms of the species composition since it is located at the interaction zone of different climates, phytogeographies and therefore different geocological regions and divisions. This situation results in a fierce competition across different species and populations. For these reasons, the topography or the geomorphological factors (altitude, exposition, the cleavage of the land) together with the bed rock/parent material (lithology in general terms) enabled the formation of local biomes that enable different environments from the general characteristics of the regions and the divisions. Although the altitude and the exposition play an important role in the species composition in the humid forest division, the bedrock does not have a significant effect.

Ultramafites that are very common in the area of study together with the Jurassic aged units (sandstone, clay stone, conglomerate), the neogenic lacustrine sedimentary deposits, andesites, andesitic tuffites and agglomerates not to play a determinant role in terms of the local biomes. However, the green schist and quartzite, rhyolite and the riolitic tuffites together with the Mesozoic aged dolomitic limestone and limestone constitute an environment within the ecological region and the division that they are in and consequently a local biome creating a difference in the species composition. Granites, rhyolites and the riolitic tuffites form sandy material as a product of disintegration and therefore sandy soil forms on top of them. Also, relatively more acidic characterized soils form on them which do not in accordance with the environment that they are in. The Paleozoic aged green schist and quartzite also display similar characteristics. In other words, they display similar characteristics to the soil of the Marmara Humid and Semi-Humid Forest Divisions where the excess precipitation leaches the lime and the other cations from the soil replacing them with the hydrogen ions (H^+) causing the soil to

display acidic character. Because of this reason, the common aspen and other deciduous species in addition to the European-Syberian elements such as the Scots pine secure the suitable environment of growth that they require and form populations on bedrocks that form sandy and relatively more acidic soil in addition to the black pines of dry forest character in the Aegean Mountain and Dry Forest Divisions. However, two things need to be highlighted here. First of all, the mentioned bedrocks are generally not sufficient enough to create lithobiomes by themselves. They require the support of several secondary factors, especially the exposition and the altitude in order to form the local biomes. For instance, the common aspen grows on the rhyolite, riolitic tuffite, green schist and quartzite rocks only on the northwest facing slopes at certain altitudes in the Aegean Mountain Division in the south. The common aspen does not exist on the rhyolites below 1700 m on the northwest facing slopes. That is to say the exposition and the altitude can limit the effect of the lithology. Due to that reason, the lithobiomes are shown on the ecosystem maps through the identification of the locations where they form differences in the natural environment instead of the borders of the geological formations. Similarly, Scots pines also exist together with the black pines on the rhyolites within the Marmara Dry Forest Division to the south of the Tınaz Hill. For this reason, the area, where the rhyolites were present, were identified as a lithobiome. However, mainly due to the altitude, the common aspen and other deciduous European-Syberian elements do not exist on this lithobiome. Similarly, within the borders of the Aegean Mountain Division, no other deciduous European-Syberian element except for the Scots pine that has a low temperature requirement exists at altitudes higher than 1850 m to the south of the Baklan Hill. In a similar manner, the Scots pines can exist at altitudes as low as 1750 m on the green schist and quartzite to the south of the Çatmalimezar Hill on the west. In other words, the role of lithology might take different forms depending on the effect of the altitude factor.

The Mesozoic aged dolomitic limestone and the limestone in the Aegean Mountain Division, on the other hand, form a separate lithobiome (carstic lithobiome). The reddish brown Mediterranean soil exists within the crevices and the layer surfaces of these rocks. The encounter with some previously mentioned Mediterranean elements and some species commonly seen in the Mediterranean climate region on the carstic lithobiome is probably related to the prevalence of the limestone in the Mediterranean basin in the Alpine-Himalayan belt and the special adjustment of the Mediterranean vegetation in these types of areas during the Tertiary Period.

A different situation exists in Gökdağ Hill located at the furthest reach in the west of the Marmara Semi-Humid Forest Division. The green schist and quartzite on the mass that had uplifted by the local faulting and the tectonic movements as well as the topographical factors are effective in the appearance of the humid forest characteristics in a limited location. Here, a litho-morphobiome where the altitude, the exposition, the topography or the geomorphological factors play a role together with the lithology is considered.

The needle-leaved forests of dry forest character where the Scots pine, mixed Scots pine and black pine populations exist on the eastern and the southeastern high slopes within the Central Anatolian Dry-Forest-Anthropogenic Steppe Division in the southeast of Mount Murat. The bedrock does not play any role on the presence of the Scots pine. This area is partially affected from the humid winds from the northwest. However, it is more exposed to the continental effects approaching from the east. The altitude also supports the presence of the Scots pine populations. In conclusion, a geo-morphobiome that is suitable for the growth of the

Scots pines appears as a result of the complex interactions among the topographical-morphological factors.

Another local biome which is affected completely by the topographical and the geomorphological factors exists to the west of Mount Murat in the NW-SE direction along the deeply cleaved Baybuyan Rivulet where the bedrock does not have a significant effect. The humid forest conditions with abundant beech is prevalent in the deep and the secluded valley basin based on the humid winds channeled to the valley from the northwest and the fog conditions. However, the higher slopes of the valley are more exposed to the Mediterranean climatic conditions and are exposed to more radiation. Because of these reasons, a gradual shift towards semi-humid and dry forest characteristics is observed in the upper slopes. The position of the valley and its direction together with the topographical/geomorphological factors (exposition, altitude, the cleavage situation of the valley) have played a determinant role in this outcome.

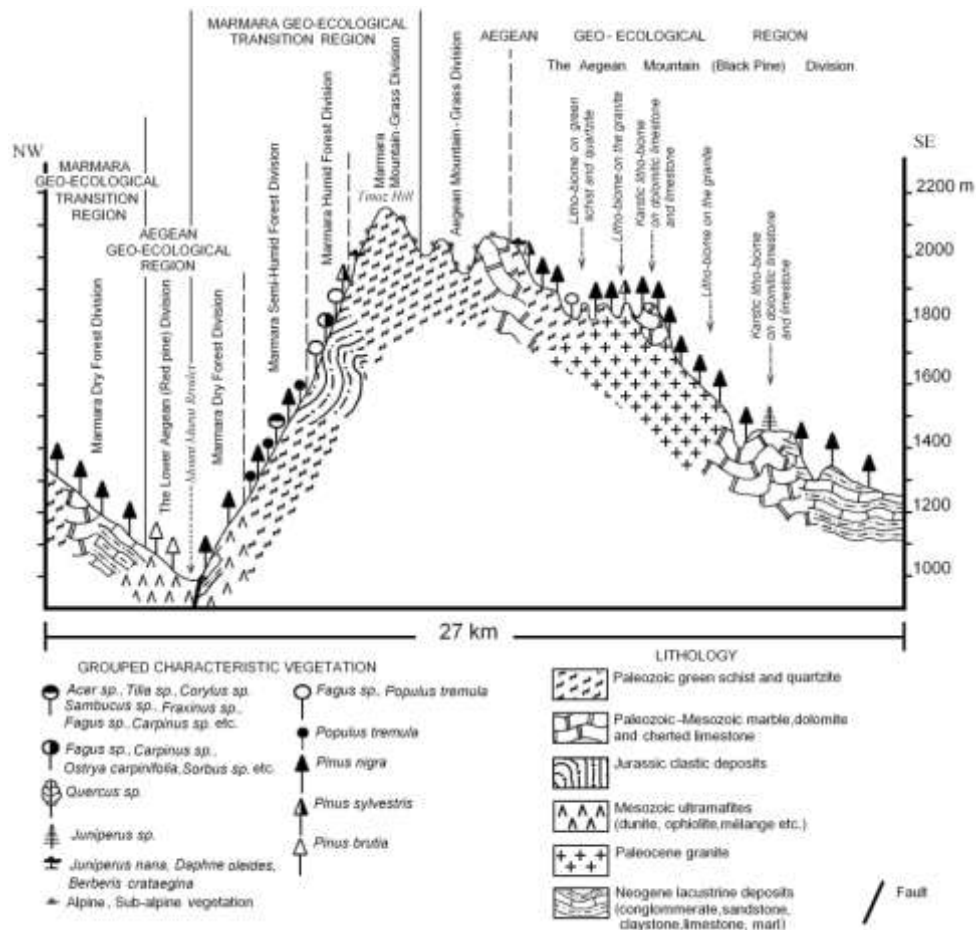


Fig. 6. The geo-ecological cross section displaying the geo-ecological regions, the divisions and the local biomes of Mount Murat in the direction of NW-SE.

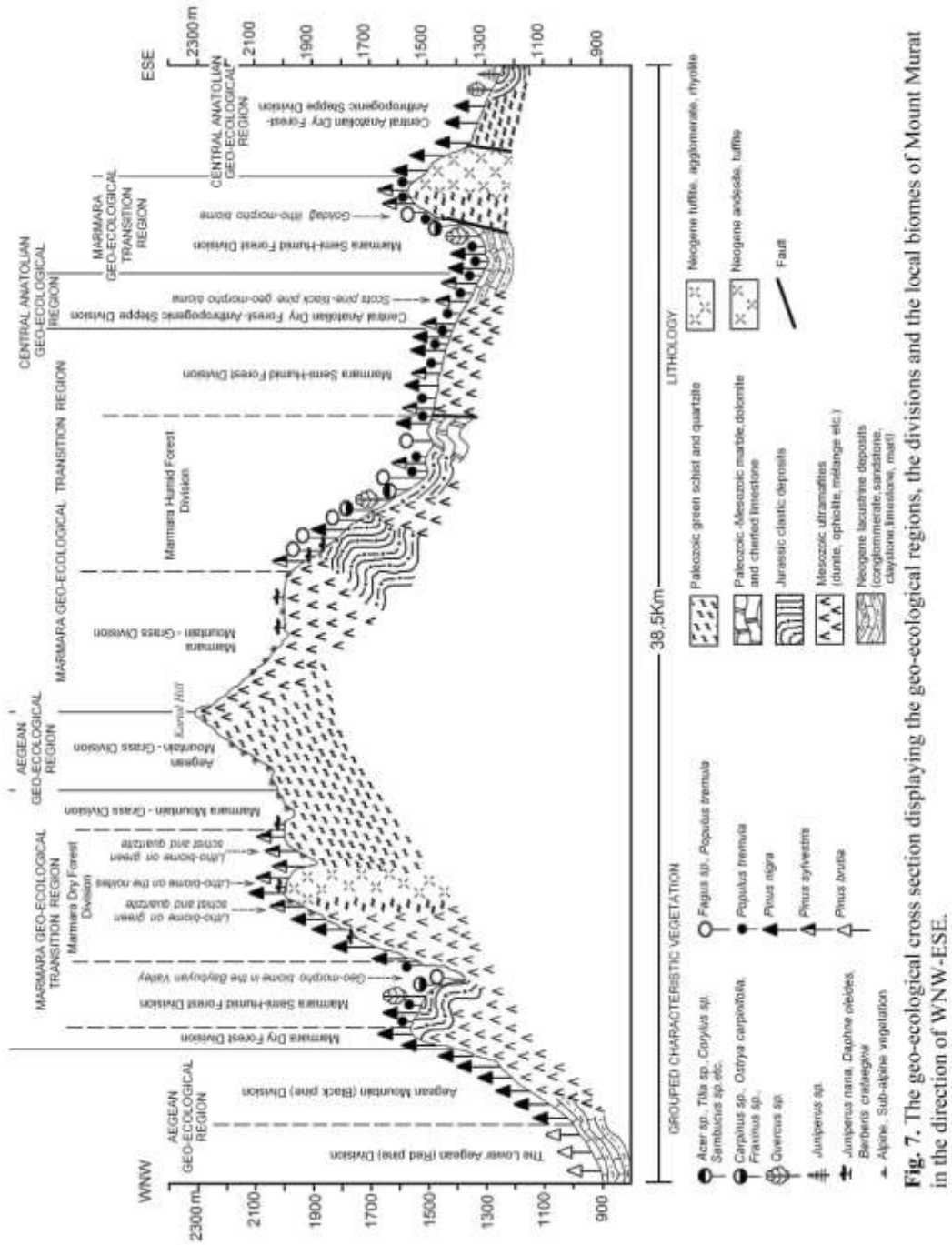


Fig. 7. The geo-ecological cross section displaying the geo-ecological regions, the divisions and the local biomes of Mount Murat in the direction of WNW-ESE.

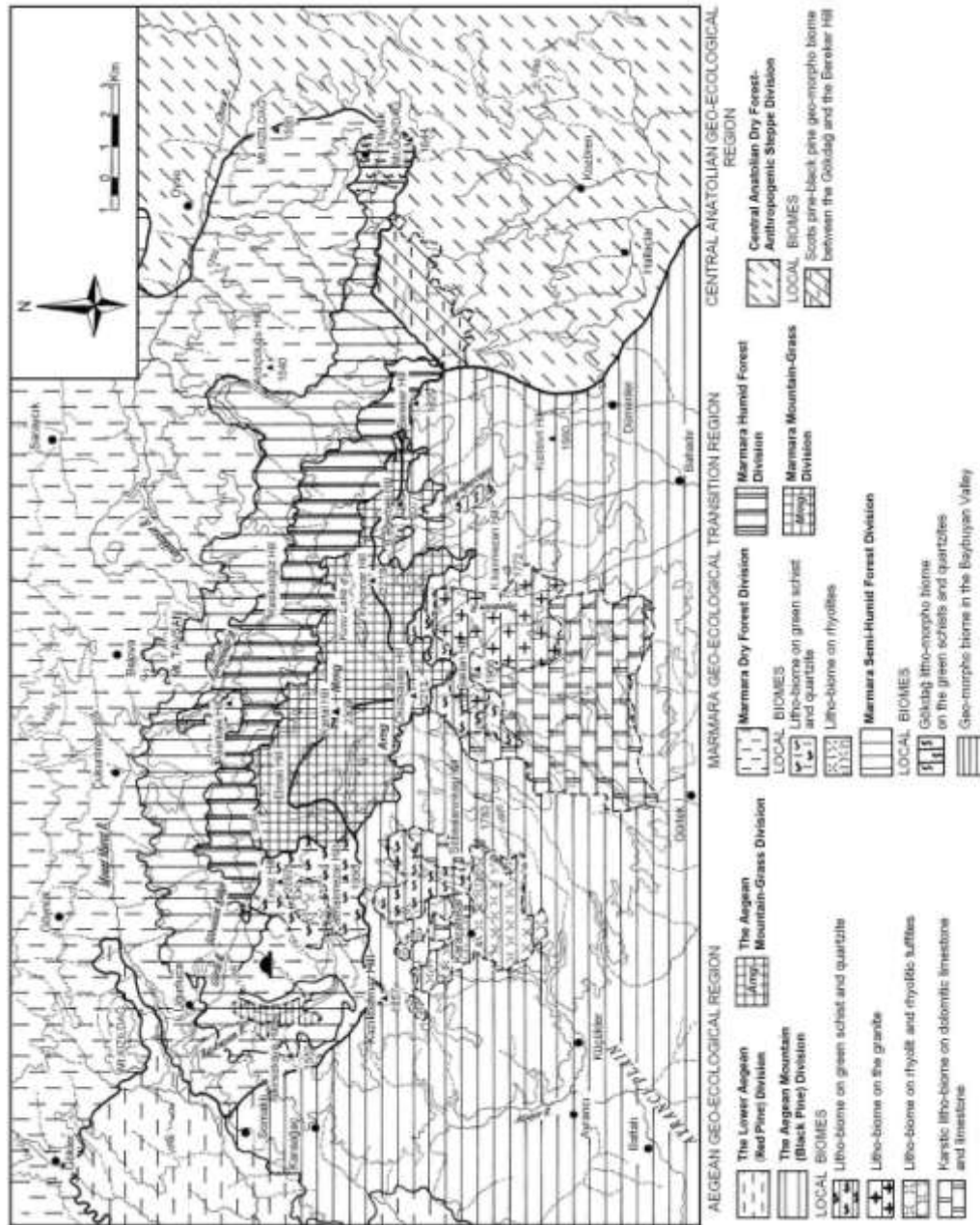


Fig. 8. The Geo-ecosystem map of Mount Murat

REFERENCES

- ATALAY, İ. (2002 a) *Ecoregions of Turkey*. İzmir, The Ministry of Forestry Press, No. 163, Meta Press,
- ATALAY, İ. (2002 b) *Ecoregions of Turkey. Turkey-Romania Geographical Academic Seminar on The Geographical Potential, Problem and Sustainable Development.*, İstanbul, Turkey, İnkılap Press.
- AATALAY, İ. (1994) *Turkey Vegetation Geography*. İzmir, Turkey, E. U. Press.
- ATALAY İ (2008) *Ecosystem Ecology and Geography*. Volume I, The Ministry of Environment and Forestry Publications, No. 327, İzmir, Turkey, META Press.
- AYTAÇ, A. S. (2003) Planning of the National Park Located in the Mount Murat and its Evaluation in Terms of Environmental Education. Unpublished master's thesis, Institute of Educational Sciences, University of Dokuz Eylül, İzmir, Turkey.
- BAILEY, R.G. (1998) *Ecoregions. The Ecosystem Geography of The Oceans and Continents*. Springer-Verlag, New York.
- GÜNAY, E., AKDENİZ, N., ŞAROĞLU, F., ÇAĞLAYAN, A. (1986) *Geology of Mount Murat and the Gediz Region*. Institute of Mineral Research and Exploration, Ankara, Turkey, Compiled Report No. 8046.
- ÇIRPICI, A. (1981) Research on the Flora of Mount Murat. Lectorship Thesis, Botanical and Genetics Chair, University of İstanbul, İstanbul, Turkey.
- ÇIRPICI, A. (1989) Flora of Mount Murat. *Doğa Journal*. Tübitak, S 2, volume 13, 157-221.
- ÇIRPICI A 1993. Some endemic plants from Murat Dağı. *Proceedings of the 5th OPTİMA Meeting*, 8-15 September pp 505-518
- ÇIRPICI A 2005. Murat Dağı. *Türkiye'nin 122 Önemli Bitki Alanı*, WWF Türkiye 141-143, İstanbul
- Forest Management Maps, 1 / 25 000 scale forest management maps including the Mount Murat prepared by the Kütahya and Uşak Directorates Management.
- KELLY, D.L., CONNOLLY, A., (2000) A Review Of The Plant Communities Associated With Scots Pine (*Pinus Sylvestris* L.) In Europe, and An Evaluation Of Putative Indicator/Specialist Species. *Silviculture and biodiversity of Scots pine forest in Europe (Conference) Investigación Agraria, Sistemas y Recursos Forestales 2000* No. Fuera de Serie 1 pp. 15-39, Spain
- SEMENDEROĞLU, A. (2001) Eco-systems and the Ecological Units of the Urla-Çeşme Peninsula. *IIIrd National Conference on the Coastal and Marine Areas in Turkey* (June 26-29, 2001) Abstract Book. Editors; E. Özhan, Y. Yüksel. İstanbul, Turkey, 313-320.
- SEMENDEROĞLU, A., AYTAÇ A.S. (2005) Vegetation Geography of Mount Murat. *National Geography Congress (İ. Yalçınlar Symposium)*, (September 29-30, 2005), Abstract Book. İstanbul, Turkey, 649-657.

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- YALÇINLAR, İ. (1970) Discussions on the Structure and the Relief Formations of the Western Anatolia. *Journal of Geography Institute*, University of İstanbul, V 9, No 17, 69-92.
- WALTER, H. (2002) *Vegetation of the earth : The Ecological Systems of The Geo-Biosphere*, (German “Vegetation und Klimazonen” Translated from the 7th edition by Siegmund W Breckle, 4th edition, Completely Revised and Enlarged Edition, Stuttgart), Springer-Verlag, Berlin, Heidelberg, New York.