



## Flora and vegetation in a special protected area of Mount Taygetos, Southern Greece

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### Abstract

Greece is characterized by special rich flora and fauna. Flora and vegetation between Natural and Forest ecosystems (burned and unburned areas) in the Special Protected Area, of Mount Taygetos, Southern Greece were investigated. The most frequently occurring plants were *Helictochloa agropyroides* and *Galium peloponnesiacum* in the herbaceous plants of Natural ecosystem-Burned areas and Natural ecosystem-Unburned areas. The most frequently occurring woody species was *Cistus creticus* in Natural ecosystem-Burned areas and Natural ecosystem-Unburned areas. Also, the most frequently occurring herbaceous and woody plants *Bromus sp.* and *Cistus creticus*, respectively, in Forest-Burned areas. Moreover, the herbaceous plant and woody plant species that occurred most frequently were *Daucus carota* and *Sesleria taygetea* and *Cistus creticus* in Forest-Unburned areas. Moreover, the data revealed significantly higher alpha herbaceous plant diversity in Forests-Unburned areas, Natural Ecosystems-Unburned areas, Forests-Burned areas than in Natural Ecosystems-Burned areas. Furthermore, Natural Ecosystems-Unburned areas and Forests-Unburned areas exhibited the highest values of alpha woody plant diversity followed by Forests-Burned areas, whereas the Natural Ecosystems-Burned areas had the lowest values. Conclusively, Mount Taygetos is a purely Mediterranean mountain, in view of its general physiognomy, climate, soil and mainly the biogeographical significance of its rich flora.

**Keywords:** Biodiversity, Endemic species, Environment, Monitoring, Conservation, Mediterranean.

### Introduction

Greece with lengthiness 132.000km<sup>2</sup> and population 10.500.00 citizens, located as the southeast region of Balkan peninsula and it belongs in Mediterranean zone of paleoartical biogeographic region. Characterized by big weather variety (29 climate zones according to Thornwaite), fact that occurs from geographical position, the complicated repousse of land and the existence of sea. The biggest part of the land can consider as Mediterranean type, (mild and wet winters, hot and dry summers). It is a country with intense repousse, with the 2/3 of territory covered with mountains of middle height, almost 1500m. Also characterized by extensive coastline (almost 15.000 km) and many systems of islands in the offings of Aegean and Ionian<sup>1</sup>.

More specifically, it is located in the limits of three continents (European, Asian and African), includes big topographical variety (big number of islands, steep changes of landscape-form marine to alpine, in a straight line of a few kilometers-extended fragmentation of land, many rivers, valleys, gorges, peninsulas etcetera), distinguished by a complicated geological structure and the calmness of anthropogenous influence in environment. Also, demonstrates a large variety of geomorphological formations (big number of caves and other underground formations) and stones (pro-alpine, alpine and after alpine) and all the categories of grounds that formed under the

Mediterranean climate (entisols, inceptisols, alfisols, vertisols). The combine of all factors, completion in the big biological treasury of the country<sup>1</sup>.

This Country is characterized by special rich flora and fauna, with special big number of macro-fungi, big variety of ecosystems and landscapes, as big numbers of endemism in plant and animal kingdom. The flora of Greece consists today 5.652 species and 1.893 subspecies of angiosperms plants, these represent 6.600 taxa belonged to 1.072 genus and 185 families. Greece is also an important area of Europe and Mediterranean with 1.278 endemic species (22.2% of the total number of species) and 452 endemic subspecies, impersonating 1.461 taxa (22.1% of the total number of taxa). As it comes to fauna, by this day are recorded 23.130 species of animals in land and fresh water, by these the 3.956 are endemic in this country as other 3.500 sea species<sup>2,3</sup>.

The forest area, that includes the forests and the rest forested Gaia, as it referred in the European Report of Forests in 2007, it covers more than the half of the territory of Greece (data of 2005), according to these data, the forests covers the 29,1% and the rest forested lands 21,6%. From the data in this report the forest land in Greece appears almost stable in fifteen years at 1990-2005 (6.511.000 Ha, 6.525.000 Ha and 6.532.000 Ha for the years 1990, 2000 and 2005, respectively), while the territory

of the rest forested land, appears respective reduction (2.7880.000 Ha in 2005 compared with 3.212.000 Ha in 1990).

The vegetation of an area is the result of the interaction of a number of factors such as climate, geomorphology, human impact etc. Of course, the primary factor, at least in the vegetation composition, the flora of an area. The various plant species in their natural environment not only displayed their form or random combine of plants, but make specific plant communities, which together constitute the vegetation of an area. Regarding the vegetation zones identified in Taygetos, decisive shapes of plant communities physique is the geographical position, altitude, soil and bioclimatic characteristics<sup>4</sup>.

According to the distribution of vegetation zones of Dafis (1973)<sup>5</sup>, which is based mainly in the Braun-Blanquet system, in the region of Taygetos divided into three different zones vegetation: the eu-mediterranean the para-mesogeiki and Alpine- subalpine zone<sup>4</sup>.

Hence, the main purpose of the present study is to investigate the flora and vegetation between Natural and Forest ecosystems (burned and unburned areas) in the Special Protected Area, with rare species of plants, fascinating landscapes and ecosystems, of Mount Taygetos, Southern Greece (*Site of Community Importance: GR2550006*).

## Materials and methods

**Study area:** The present study was designed at Special Protected Area of Mount Taygetos, Southern Greece (*Site of Community Importance: GR2550006*), during the period July-August 2016 (Figure-1). Mount Taygetos (2,407 m.) is a mountain range including the highest peaks of Peloponnissos (2407 m). Geologically, it is a continuation of the Gavrovo-Tripoli zone composed of phyllites, plated limestones and flysch. Together with mountain range of Parnonas it is the oldest area of Peloponnissos. Its length is about 40 km and its southern limits touch Mt. Sangias while the northern one is the Langada gorge.

The forest ecosystems of the mountain are dominated by the Greek endemic Greek Fir (*Abies cephalonica*) and excellent clusters of Black Pine (*Pinus nigra*). This ecosystem is a true botanical paradise, hosting more than 160 endemics, 32 of which have been recorded as local endemics. Taygetos ranks first in invertebrate endemism in Southern Greece, whereas its habitats also host a rich fauna of vertebrates, including many raptor species of birds and a few groups of Golden Jackals (*Canis aureus*)<sup>6</sup>. Unfortunately, wildfires in 2005 and 2007 spent much of the forests on the central west slopes, and only about half stay.

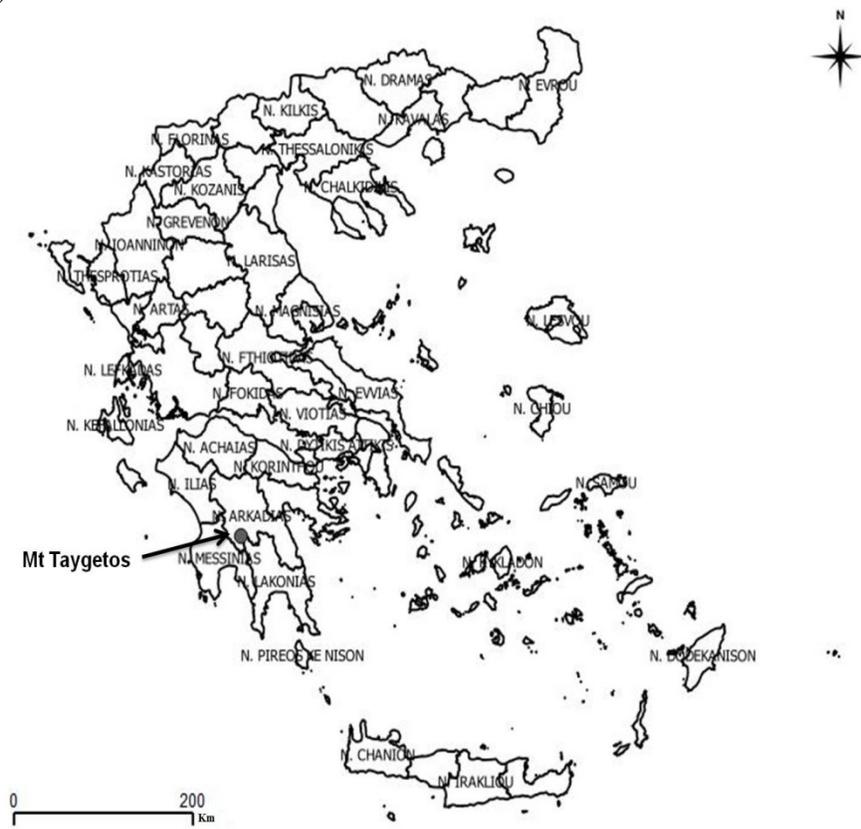


Figure-1: Study area.

**Flora and vegetation survey:** The sampling of flora was carried out in May 2016 in randomly selected plots of 0.25 m<sup>2</sup> (0.5 x 0.5 m). Species richness, frequency of occurrence and density were estimated<sup>7</sup>. Woody Vegetation was recorded in randomly selected sampling plots of 100 m<sup>2</sup> (10 x 10 m). Species richness, density and their coverage were measured<sup>8</sup>.

**Statistical analysis:** Flora and vegetation data was evaluated for normality and homogeneity with the Kolmogorov–Smirnov and Shapiro–Wilk tests. These data were transformed using log(x + 1) when necessary to meet normality assumptions. For the analysis of the above data, General Linear Model (GLM, Type III Sum of Squares) (One-way ANOVA) was used with good results. All statistical analyses for the flora and vegetation data were performed using the software package IBM SPSS Statistics ver. 19.0 for Windows<sup>9</sup>.

Moreover, alpha-diversity indices such as species richness, Shannon-Wiener, Simpson, Fisher’s alpha and Evenness index were estimated using Species Diversity and Richness IV software (comparisons between burned and unburned areas were made with the randomization test of Solow (1993))<sup>10</sup>. For a detailed description of the mathematical background of the above alpha diversity indices, see Seaby and Henderson (2006)<sup>11</sup>.

**Results and discussion**

**Chorological form:** In the Figure-2 and 3 are presented the Chorological study which is an important stage for conserving flora and vegetation diversity, and it provides useful information about naturalized flora and vegetation taxa that have immigrated from one mainland to others.

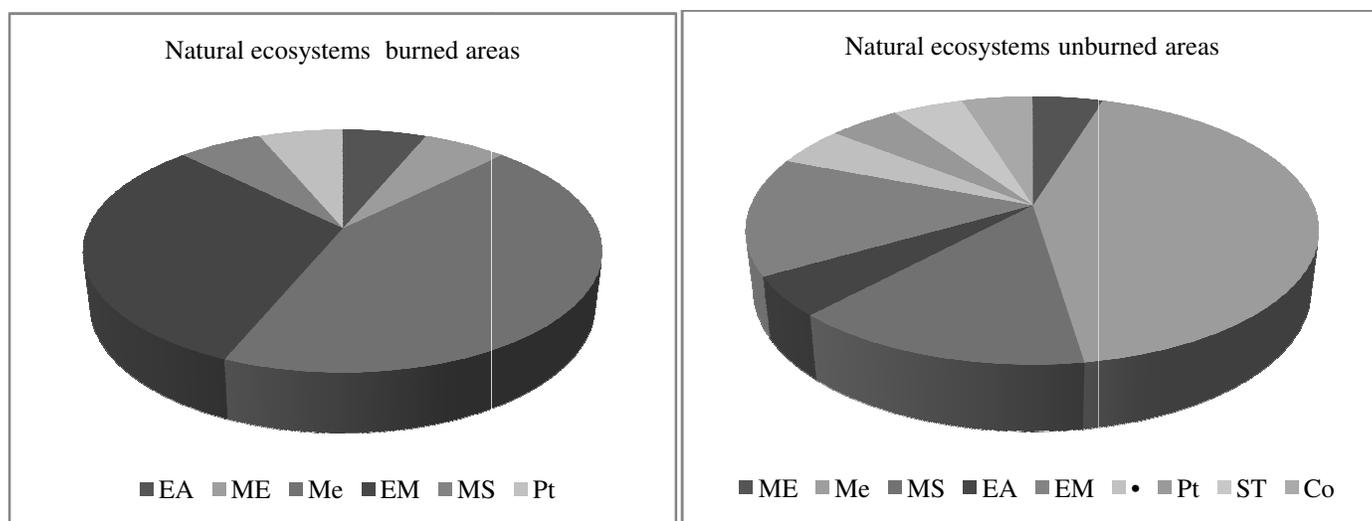


Figure-2: Chorological form of plants (Appendix 1).

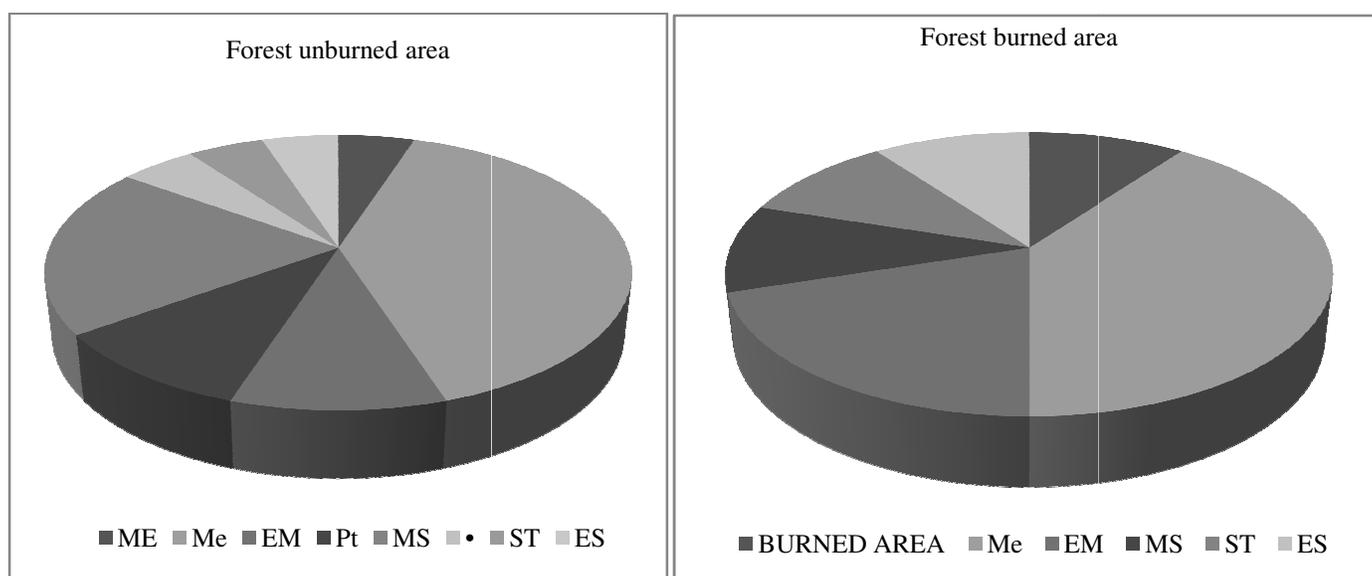


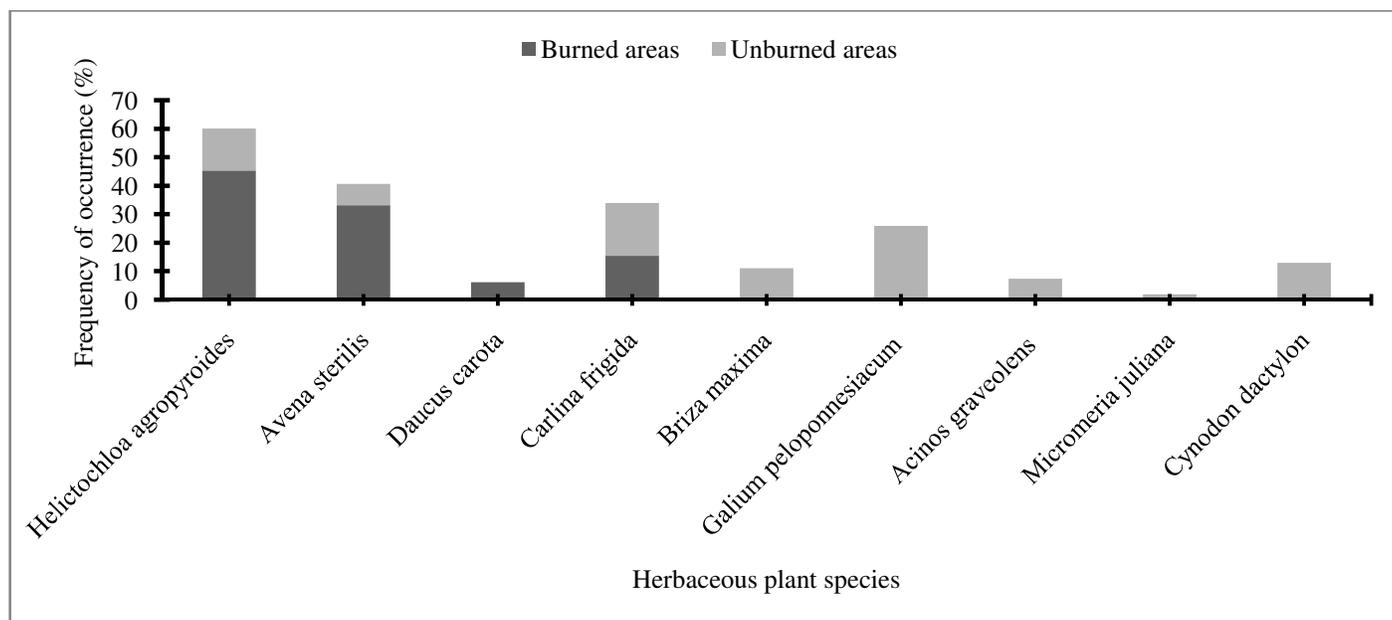
Figure-3: Chorological form of plants (Appendix 1).

**Herbaceous and woody plant species richness and composition:** In total, in the ecosystems studied 10 and 16 species of herbaceous (Natural ecosystem-Burned areas: 4, Natural ecosystem-Unburned areas: 9) and woody (Natural ecosystem-Burned areas: 10, Natural ecosystem-Unburned areas: 11) plants, respectively, were recorded (Table-1, 2). The most frequently occurring plants were *Helictochloa*

*agropyroides* (45.3%) and *Galium peloponnesiacum* (25.9%) in the herbaceous plants of Natural ecosystem-Burned areas and Natural ecosystem-Unburned areas (Figure-4). Moreover, *Cistus creticus* (woody plant species) was frequent in Natural ecosystem-Burned areas (39.8%) and Natural ecosystem-Unburned areas (35.5%) (Figure-5).

**Table-1:** Herbaceous plant species in Natural ecosystems (burned and unburned areas).

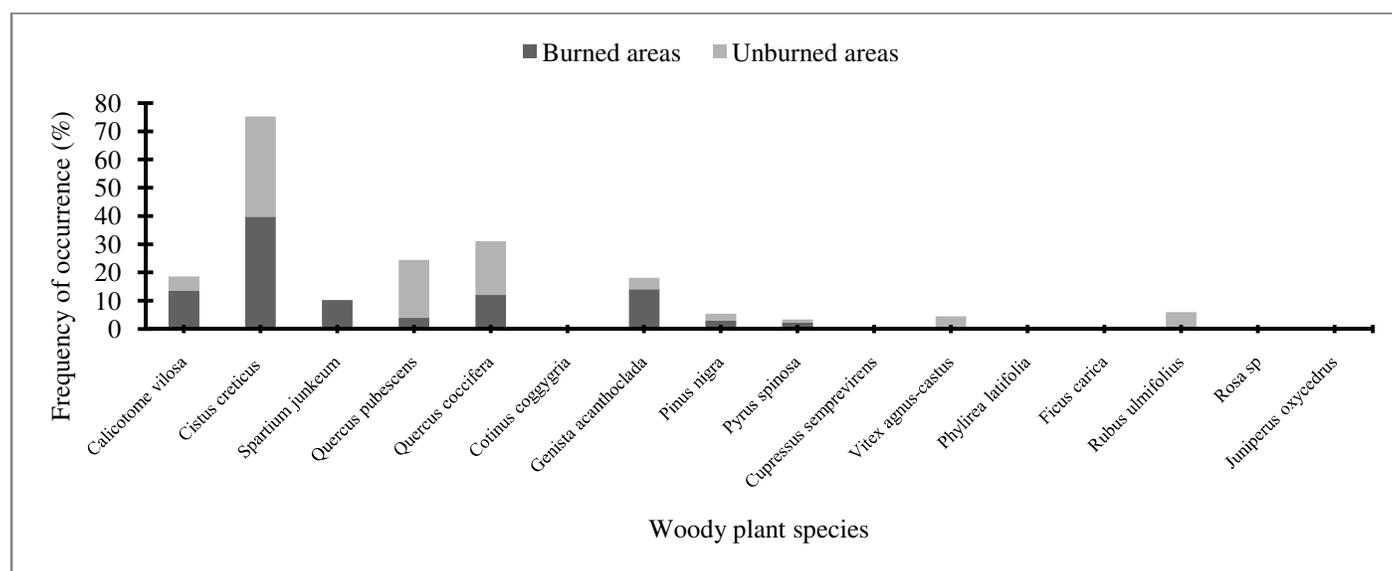
Herbaceous plants	Natural ecosystem-Burned areas	Natural ecosystem-Unburned areas
<i>Cynodon dactylon</i>		+
<i>Dactylis glomerata</i>		+
<i>Helictochloa agropyroides</i>	+	+
<i>Briza maxima</i>		+
<i>Galium peloponnesiacum</i>		+
<i>Acinos graveolens</i>		+
<i>Carlina frigida</i>	+	+
<i>Avena sterilis</i>	+	+
<i>Micromeria juliana</i>		+
<i>Daucus carota</i>	+	
Total number	4	9



**Figure-4:** Herbaceous plant occurrence (%) in Natural Ecosystems.

**Table-2:** Woody plant species in Natural ecosystems (burned and unburned areas).

Woody plants	Natural ecosystem-Burned areas	Natural ecosystem-Unburned areas
<i>Calicotome vilosa</i>	+	
<i>Cistus creticus</i>	+	+
<i>Cotinus coggygia</i>	+	
<i>Cupressus semprevirens</i>	+	
<i>Genista acanthoclada</i>	+	
<i>Pinus nigra</i>	+	+
<i>Pyrus spinosa</i>	+	+
<i>Quercus coccifera</i>	+	+
<i>Quercus pubescens</i>	+	+
<i>Spartium junkeum</i>	+	
<i>Ficus carica</i>		+
<i>Juniperus oxycedrus</i>		+
<i>Vitex agnus-castus</i>		+
<i>Rubus ulmifolius</i>		+
<i>Rosa sp.</i>		+
<i>Phyllirea latifolia</i>		+
Total Number	10	11



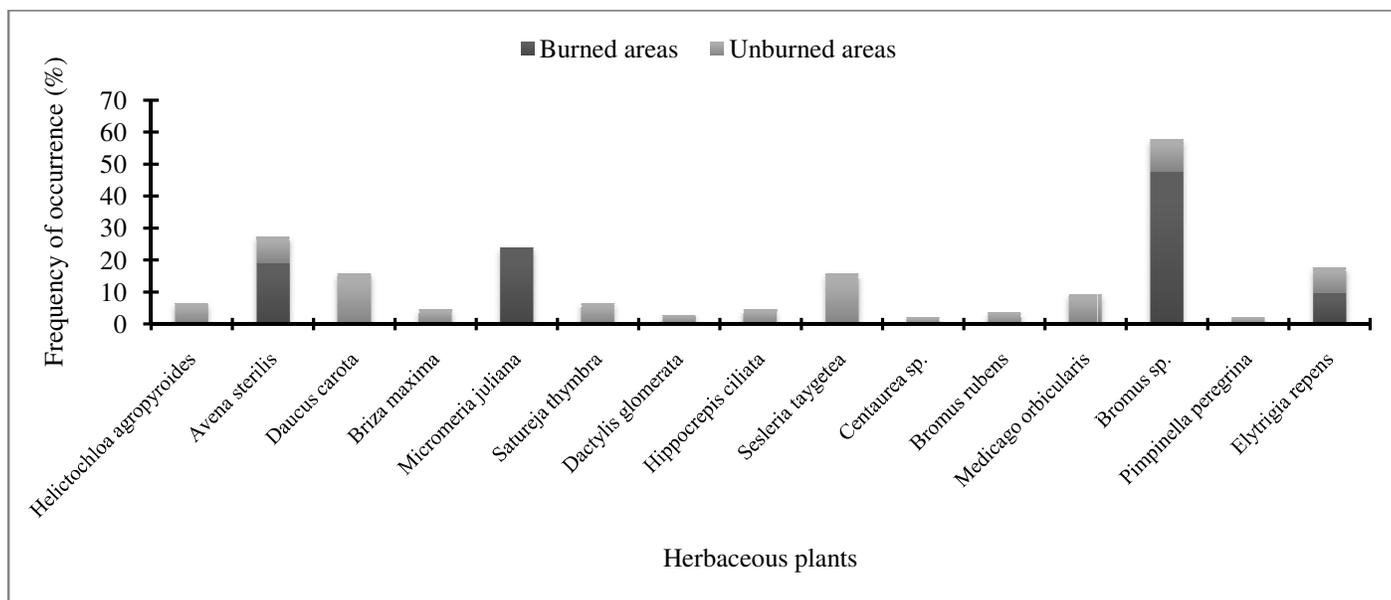
**Figure-5:** Woody plant occurrence (%) in Natural Ecosystems.

Also, in the Forest ecosystems (burned and unburned areas), 15 herbaceous (burned areas: 14, unburned areas: 4) and 8 woody plant species (burned areas: 4, unburned areas:7) were detected in the present study area (Table-3, 4). The most frequently occurring flora and vegetation species were *Bromus sp.* (47.6%)

and *Cistus creticus* (29.0%), respectively, in Forest-Burned areas. Moreover, *Daucus carota* (15.7%) and *Sesleria taygetea* (15.7%) (herbaceous plant species) and *Cistus creticus* (30.0%) (woody plant species) were the most frequently occurring species in Forest-Unburned areas (Figure-6, 7).

**Table-3:** Herbaceous plant species in Forest ecosystems (burned and unburned areas).

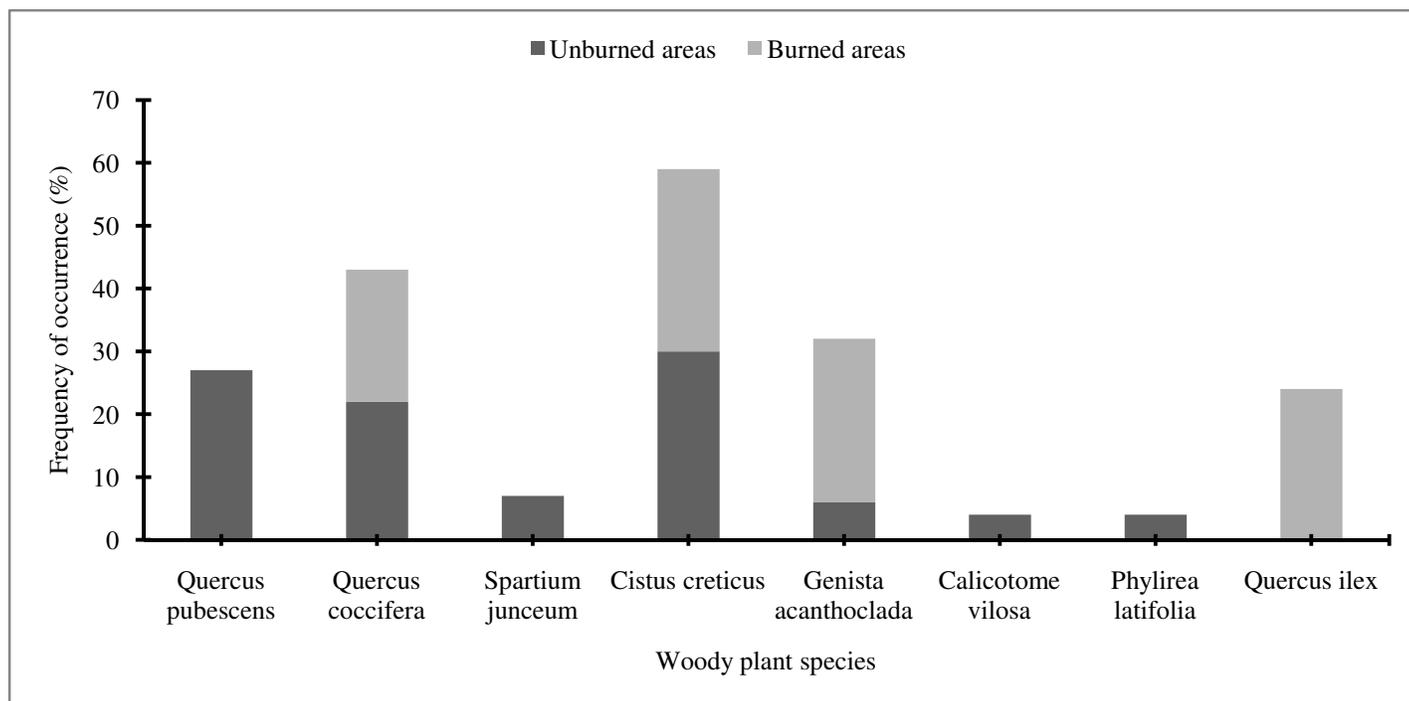
Herbaceous plants	Forest ecosystem-Burned areas	Forest ecosystem-Unburned areas
<i>Bromus sp.</i>	+	+
<i>Micromeria juliana</i>	+	
<i>Elytrigia repens</i>	+	+
<i>Avena sterilis</i>	+	+
<i>Daucus carota</i>		+
<i>Satureja thymbra</i>		+
<i>Dactylis glomerata</i>		+
<i>Hippocrepis ciliata</i>		+
<i>Centaurea sp.</i>		+
<i>Bromus rubens</i>		+
<i>Medicago orbicularis</i>		+
<i>Briza maxima</i>		+
<i>Helictochloa agropyroides</i>		+
<i>Sesleria taygetea</i>		+
<i>Pimpinella peregrina</i>		+
Total number	4	14



**Figure-6:** Herbaceous plant occurrence (%) in Forest Ecosystems.

**Table-4:** Woody plant species in Forest ecosystems (burned and unburned areas).

	Forest ecosystem-Burned areas	Forest ecosystem-Unburned areas
<i>Quercus pubescens</i>		+
<i>Quercus coccifera</i>	+	+
<i>Spartium junceum</i>		+
<i>Cistus creticus</i>	+	+
<i>Genista acanthoclada</i>	+	+
<i>Calicotome vilosa</i>		+
<i>Phyllirea latifolia</i>		+
<i>Quercus ilex</i>	+	
<i>Total number</i>	4	7



**Figure-7:** Woody plant occurrence (%) in Forest Ecosystems.

**Alpha diversity in herbaceous and woody plants:** According to Table-5, the results showed higher alpha flora diversity in Forests-Unburned areas, Natural Ecosystems-Unburned areas, Forests-Burned areas than in Natural Ecosystems-Burned areas. Also, Natural Ecosystems-Unburned areas and Forests-Unburned areas exhibited the highest values of alpha woody plant diversity followed by Forests-Burned areas, whereas the Natural Ecosystems-Burned areas had the lowest values (Table-6). In the ecosystems of Southern Greece, recurring natural fires

have an important influence on the vegetation. Alterations to the fire regime have important effects for many elements in these ecosystems, including the composition of the vegetation<sup>12</sup>. According to Nowak et al. (2002)<sup>13</sup> species richness and diversity reflect the influence of anthropogenic disturbance on revegetation after several incidents of fire. Studies of disturbances under the effects of fire in tallgrass prairie<sup>15</sup> showed that a combination of grazing and burning favor the highest species diversity<sup>12</sup>.

**Table-5:** Alpha diversity indexes of flora in Natural Ecosystems and Forests (burned and unburned areas).

Alpha diversity indices	Natural Ecosystems-Burned areas	Natural Ecosystems-Unburned areas	Forests-Burned areas	Forests-Unburned areas
<i>Shannon-Wiener</i>	1.13d	1.91b	1.23c	2.45a
<i>Simpson</i>	2.97d	6.76b	3.38c	11.18a
<i>Fisher's alpha</i>	1.23d	2.59b	1.46c	4.28a
<i>Eveness</i>	0.37d	0.63b	0.41c	0.82a

**Table-6:** Alpha diversity indexes of vegetation in Natural Ecosystems and Forests (burned and unburned areas).

Alpha diversity indices	Natural Ecosystems-Burned areas	Natural Ecosystems-Unburned areas	Forests-Burned areas	Forests-Unburned areas
<i>Shannon-Wiener</i>	1.76c	1.88a	1.70d	1.83b
<i>Simpson</i>	4.65c	5.06a	4.52d	4.74b
<i>Fisher's alpha</i>	2.19c	3.15a	1.96d	3.10b
<i>Eveness</i>	0.60c	0.68a	0.57d	0.65b

**Appendix-1**

Abbreviation	Chorological category	Chorological category description
Bk	Balkan	Taxa restricted to Balkan countries, occasionally extending to adjacent part of SE Europe
BI	Balkan-Italian	Taxa restricted to Balkan countries and Italy (amphi-Adriatic)
BC	Balkan-C European	Taxa distributed in the Balkans, Carpathians, Alps and adjacent areas (mainly in the mountains)
BA	Balkan-Anatolia	Taxa restricted to Balkan countries and to Asia minor (Anatolia), occasionally extending to S Ukraine (Crimea), adjacent Caucasian countries (Georgia, Armenia) or N Iraq
EM	E Mediterranean	Taxa restricted to the E Mediterranean, occasionally extending to S Italy or adjacent Caucasian countries
Me	Mediterranean	Taxa with circum-Mediterranean distribution including Portugal, occasionally extending to the Caucasus area and N Iran
MA	Mediterranean-Atlantic	Taxa restricted to maritime W Europe and the Mediterranean
ME	Mediterranean-European	Taxa restricted to the Mediterranean and temperate Europe, occasionally extending to NW Africa and the Caucasus area
MS	Mediterranean-SW Asian	Taxa distributed in one or more Mediterranean countries and extending to SW and C Asia
Eu	European	Taxa with a distribution all over Europe. In S European countries this category in fact represents the C European element
EA	European SW Asian	European taxa (occasionally reaching N Africa) with a distribution extending to SW Asia, occasionally reaching C Asia
ES	Euro-Siberian	Taxa with main distribution in temperate Eurasia (occasionally reaching the Caucasus area)
Pt	Paleotemperate	Taxa of extratropical Eurasia including the Himalaya and E Asia, not (or at most marginally) extending to North America
Ct	Circumtemperate	Taxa of both extratropical Eurasia and North America

Abbreviation	Chorological category	Chorological category description
IT	Irano-Turanian	Taxa with main distribution in arid SW and C Asia, extrazonally extending to the Mediterranean
SS	Saharo-Sindian	Taxa with main distribution in arid N Africa and SW Asia, extrazonally extending to the Mediterranean
ST	Subtropical-Tropical	Taxa widespread in the warmer regions of both hemispheres
Bo	(Circum-) Boreal	Taxa with main distribution in N and above and high montane Eurasia (occasionally extending to North America)
AA	Arctic-Alpine	Taxa with main distribution beyond the N and above the high montane timberlines of Eurasia (occasionally extending to North America)
Co	Cosmopolitan	Taxa distributed in all continents, i.e. beyond the N hemisphere. This category may be given in brackets after the known or supposed native distribution in cases of taxa that have been spread worldwide by humans
•	Greek endemics (incl. Single-island and single-mountain endemics)	Taxa with a distribution restricted to territory of Greece, i.e. to one or more of the 13 floristic regions
[trop., subtrop., neotrop., pantrop., N-Am., S-Am., Europ., Pontic., Caucas., Arab., Arab. NE-Afr., S-Afr., E-As., SE-As., Austral., unknown]	origin of alien taxa in [ ]	[tropical, subtropical, neotropical, paleotropical, pantropical, North American, South American, European, Pontic, Caucasian, Arabian, Arabian and NE African, E Asian, SE Asian, Australian, unknown, or optionally a combination of these

## Conclusion

Mount Taygetos is a purely Mediterranean mountain, in view of its general physiognomy, climate, soil and mainly the biogeographical significance of its rich flora. It is the oldest areas of the Peloponnese. This ecosystem is a true botanical paradise, hosting important endemic plant species which are valuable in the landscape. On the basis of the above, it is necessary to estimate and monitor their population size and dynamics in all the season of the year, in order to effectively protect them.

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