

## Greek oak woodlands: A species account on their ecological and socio-economic role

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### Abstract

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This paper outlines the distributional, ecological, social-economic and management data for all the evergreen and deciduous oak taxa dominating and/or participating in the floristic composition of Greek oak woodlands.

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### Introduction

Greece, like all European Mediterranean countries, was originally covered by oak woodlands. Greek deciduous oak woodlands cover a surface area of around 1,500,000 hectares, which corresponds to 44% of the total forested area of the country, or 76% of the deciduous broadleaved forests. The forests and shrubs of evergreen oaks, mostly Kermes and Holm oak, cover a significant area of around 470,000 hectares.

Thirteen oak species have been recognized in Greece: three evergreen and ten deciduous.

### Evergreen oak species

1. *Quercus coccifera* L. is a large tree with great reproductive capabilities and resistance to forest fires and overgrazing. It can reach heights of 20 metres and diameters of over 1 metre. *Q. coccifera* woodlands can be seen today only on the island of Crete (Rouvas forest in Idi) and the Lidorikios mountains. In the rest of Greece, it is found in coppices or stands of trees around rural churches or cemeteries. The Kermes oak shows wide ecological tolerance and its distribution ranges from the warmest zone of evergreen broadleaved forests to the warmest zone of deciduous oaks (*Ostryo-Carpinion*). *Q. coccifera* is drought-resistant and indifferent to substrate material, although it does usually occur on limestone substrates. The once healthy Kermes oak woodlands, either pure or mixed with other evergreen or deciduous species, have been transformed into shrubs of varying levels of degradation – from pseudomauquis to short, sparse, shrubs of garrigue.

The climate of the Kermes oak's distribution zone is characterized by spring and autumn rainfall and relatively mild winters. Snowfall is often observed in the upper *Ostryo-Carpinion* zone and temperatures frequently fall below zero. This zone contains permanent settlements whose inhabitants were previously farmers and stock raisers. Many of the Kermes oak ecosystems, which were woodlands mixed with other evergreen species in warmer zones and deciduous species (*Pistacia terebinthus*, *Jasminum fruticans*, *Fraxinus ornus*, *Carpinus orientalis*, *Cercis siliquastrum*, *Quercus pubescens*) in the upper, colder zone, have been reclaimed, and the land is now used for agriculture or other land uses (settlements, infrastructure, etc). Two factors contributed to this reclamation trend: the area's climate, which is suitable for permanent settlement, and the suitability of the soil for agricultural cultivation (soils of this zone are rich in clay and organic matter). Naturally, agriculture occurs in the most fertile plains or soils on gentle slopes. However, woodlands that were not reclaimed and that are found on less fertile soils on steeper slopes have also undergone great degradation. *Q. coccifera*, in the form of firewood, carbon or branches, was the primary energy source for heating lime kilns, ovens, tsipouro distillation, etc. Apart from excessive exploitation for biomass collection, goat grazing and forest fires have also played an important role in the degradation of Kermes oak ecosystems.

In spring, the tender foliage of the Kermes oak is sought after by goats, but goats feed on the leaves and young tender shoots of *Q. coccifera* and *Carpinus orientalis* all year round, especially in the summer when most of the ground vegetation has dried up. Another basic reason for the degradation of these ecosystems is wildfire. Wildfires occur frequently in this ecological zone and most are started by farmers. The copious yearly growth of oaks also plays an important role in biodiversity conservation, as these trees are the base of many food chains for small and larger mammals and birds.

Today, the pressures from firewood collection and grazing have reduced significantly and thus a gradual process of natural rehabilitation has begun. Generally, we can identify three *Q. coccifera* ecosystems:

- Oak areas that are still grazed and have a sparse structure with frequent empty spaces and low shrubs. This is the most degraded form.
- Oak areas that are no longer grazed or coppiced, or not intensely grazed, and hence undergo restoration. In these areas *Q. coccifera* is regenerating and starts to take a tree-like form. Its height surpasses the grazed shrub height, while some occasional individuals of *Q. pubescens* and other deciduous broadleaved species appear in tree-like form.
- Mixed stands of *Q. coccifera* and *Carpinus orientalis* on north-facing slopes. These are also found undergoing restoration and oak individuals appear more frequently.

Kermes oak formations played, and still play, an important economic and ecological role. Their wood and carbon were important energy sources, and their branches were the basis for the pastoral farming practice, especially goat breeding. Concurrently, their ability to produce suckers protected the soil from erosion. They also provide shelter for a range of animal species. If we ever decide to erect a monument for one of our trees, then this tree would be *Q. coccifera*.

2. *Quercus aucheri* Jaub. et Spach. is an evergreen shrub or short tree. It is very similar to and often confused with *Q. coccifera*, however, it differs from *Q. coccifera* by its leaves, which are smaller and have a light down. *Q. aucheri* is a species of macchie vegetation (thermo-Mediterranean zone) and is found growing on the SE Aegean islands (from Samos to Rhodes). This taxon is endemic to the SE Aegean and SW Anatolia. It is an occasional species and always grows together with other evergreen broadleaved species or Mediterranean conifers (*Pinus brutia* or *Cupressus*).

3. *Quercus ilex* L. (Holm oak, Chêne vert, Steineiche) is an evergreen tree, 15-20(-30) m in height, of the colder and wetter Eu-Mediterranean zone. The taxon has a smaller ecological distribution than *Q. coccifera*. It is found in all the coastal areas of W Greece and W Crete, the upper broadleaved evergreen zone in E Peloponnisos and eastern mainland Greece, the eastern slopes of Mts Pilio, Mavrovouni and Ossa, the lower slopes of Mts Olimbos, Pieria, S and E Chalkidiki, and Agion Oros, and the coastline of Macedonia and Thrace. It is also found sporadically on the N and NE Aegean Islands.

The once dense Holm oak forests, always mixed with other evergreens or deciduous species, were either cleared to obtain agricultural land or land to build settlements and infrastructure, or degraded and transformed into logged forests, closed or sparse shrubs, garrigue, or phrygana. The dominance of the following evergreen species is characteristic of Holm oak formations: *Quercus ilex*, *Q. coccifera*, *Phillyrea latifolia*, *Arbutus unedo*, *A. andrachne*, *Laurus nobilis*, *Erica arborea*, *E. manipuliflora* and *Myrtus communis*. In these formations, the appearance of deciduous taxa such as *Pistacia terebinthus*, *Cotinus coggygria*, *Fraxinus ornus*, *Cercis siliquastrum* and *Quercus pubescens*, is sporadic. The structure of Holm oak formations, which are presently degraded and in the form of dense (macchie) or sparse shrubs, depends on soil erosion, substrate and the prevailing local climate. In this way, forests or shrubs with *Arbutus* sp., *Erica arborea* and *E. manipuliflora* occur in the most degraded sites, forests or shrubs of *Q. ilex*, *Q. coccifera*, *Phillyrea latifolia*, *Arbutus unedo*, and *A. andrachne* occur in moderately degraded sites, and forests or shrubs of *Q. ilex*, *Arbutus unedo*, *A. andrachne*, *Fraxinus ornus*, *Laurus nobilis* and *Cercis siliquastrum* occur in the least degraded sites. Complex forests of this type are presently found on Mt Athos, especially the eastern side of the peninsula, the eastern slopes of Mts Pilio, Mavrovouni, Ossa, Olimbos, Pieria, as well as western Greece and the Ionian Islands. These forests and the dense macchie shrubs are of significant biological interest. Their aesthetic value is immense, as most are situated close to areas with tourist development, and their drainage and protective functions are also significant. These forests are of economic importance as *Q. ilex* produces firewood and carbon of excellent quality.

The natural rehabilitation of the shrubs and logged forests into tall forests is relatively easy. Another characteristic of these forests, apart from that they form an integral part of the Mediterranean landscape, is their ability to regenerate quickly after forest fires.

### Deciduous oak species

As mentioned above, 44% of the Greek forests and 76% of the deciduous forests are oak. These forests have always played an important economic, ecological and cultural role and are tied to many Greek myths and traditions. It is not by chance that Greeks identify the concept of "tree" with oaks.

The extensive oak forests, and the size and longevity of their trees, influenced the culture of our predecessors so much that they attributed the trees and forests with mysterious and superhuman powers. The oak was dedicated to the Greek god of Zeus and was supposed to have the power of prophecy. The priests of the Dodoni oracle spoke their prophecies through the rustling of oak leaves. The oak was the sacred tree of the Macedonian kings who crowned heroes and contest winners with wreaths of its branches. All oak forests were considered abodes of the Hamadryad nymphs and it was believed that each single tree represented one Hamadryad. When one tree rotted or was felled, its respective Hamadryad also died.

Despite the respect that the ancients showed for oaks and oak woodlands, they used its wood for many purposes – mostly due to its qualities. Oak wood was used for firewood, carbon, and construction wood used for shipbuilding, furniture construction, and stakes for fences and palisades. Acorns also played an important role, and apart from being food for many wild herbivores and omnivores, were used for pig and goat feed. According to Theophrastus, Herodotus and Aelianos, the ancient Arcadians dined on acorns. However, during the Second World War, the inhabitants of many areas survived by making bread from acorn flour, especially from *Q. pubescens* acorns.

Today, only a few oak forests remain as high forests and most are low coppiced forests. In many areas of Greece, especially W Macedonia and Thrace, the inhabitants cut oak branches in August and stack them in ricks to ensure winter food for their animals, especially goats. Oak forests are found on hilly semi-mountainous and mountainous areas in C and N Greece (Epirus, W, C and E Macedonia, Thrace, Chalkidiki, Thessalia) and also in mainland Greece, Peloponnisos, Euboea Island, Crete, and some NE Aegean Islands.

The species that make up the Greek deciduous oak forests are:

1. *Quercus infectoria* Olivier (Syn.: *Quercus lusitanica* Lam.) This is a semi-evergreen shrub or tree growing up to 10 m in height. It is found in macchie zones in forests with *Pinus halepensis*, or forms pure stands, and grows from sea level to 300 m altitude. *Q. infectoria* is an E Mediterranean and Near East species. Two subspecies of this taxon occur in Greece:

a) subsp. *infectoria* which is found growing on the E Aegean islands of Lesbos, Chios, and Samos, but has its main distribution in Anatolia and Syria, and

b) subsp. *veneris* (A. Kern.) Meikle, which grows only on Rhodes. Elsewhere, this taxon is found in Cyprus, S Anatolia, Syria, Palestine, Iraq and Iran.

Due to their limited distribution range, both subspecies play a minor economic and ecological role, but should be protected for biodiversity reasons.

2. *Quercus ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt. This is a deciduous tree growing up to 15 m in height, with a strong trunk and broad crown. This taxon grows in Mediterranean and semi-Mediterranean zones, and in Greece is

found in pure or mixed stands occurring from sea level to 600(-1200) m altitude. Individual trees or small plantations may be found in agricultural zones (on Rhodes it is often found in olive groves). Today, this is the only oak species that forms high forest stands. This taxon is absent from inner Greece and the small islands. In previous years, this taxon was of great economic importance as its wood was used to construct huge drums used in the tanning process. Today its role is mostly aesthetic as its trees and stands form an integral element of many areas. This taxon does not form extensive forests.

3. *Quercus trojana* Webb subsp. *trojana* (Syn.: *Quercus macedonica* A. DC.). This is a semi-evergreen tree growing to heights of 15 m. Forests of the Macedonian oak have very limited distributions in Greece and are found mostly in W Macedonia and E Epirus. These forests, like *Q. pubescens*, are found in lower zones surrounded by settlements. Therefore they are subject to very strong ecological pressures that have led to their degradation.

Today, almost all the Macedonian oak forests are degraded, with the exception of a few stands or groves found growing around rural churches. As this taxon has a very small distribution and is in danger of extinction, Macedonian oaks should be expanded, at least in the form of protected public forests without management, and when degradation factors have been removed (grazing and extensive coppicing) should be regenerated naturally.

The following species occur in these ecosystems: *Quercus pubescens*, *Acer mospessulanum*, *A. campestre*, *Carpinus orientalis*, *Ostrya carpinifolia*, *Cercis siliquastrum*, *Fraxinus ornus*, *Cornus mas* and *C. sanguinea*.

4. *Quercus trojana* Webb subsp. *euboica* (Papaioannou) K. I. Chr. (Syn.: *Quercus euboica* Papaioannou). This is a deciduous or semi-evergreen shrub or tree of small height. The taxon is endemic to NE Euboea Island, close to the villages of Kerasia, Tsapournia, and Pappades. It grows together with other species or in small stands and coppices. Due to its small distribution area and low number of individuals, it should be protected and its population expanded *in situ*.

5. *Quercus pubescens* Willd. is a deciduous oak species growing up to 25 m in height usually in the lower deciduous oak zone. It is found throughout Greece often in the upper evergreen zone, in deciduous broadleaved shrubs (Shibljak), in combination with *Q. frainetto*, or more rarely in pure stands. Sporadic trees of large dimensions also occur along roadsides or fields from 100-1200 m altitude. This is an exceptionally polymorphic species and various subspecies and varieties have been distinguished from time to time, making *Q. pubescens* a subject of discussion and dubiety. Although most of the subspecies and varieties distinguished are considered clinal patterns and do not have distinct geographical restrictions, the taxonomic problem has not yet been solved conclusively. Thus from time to time, many synonymous species have been recognized such as: *Quercus humilis* Miller, *Q. lanuginosa* O. Schwarz, *Q. virgiliana* Ten., *Q. crispata* Stev., *Q. brachyphylla* Kotschy, *Q. pubescens* subsp. *anatolica* O. Schwarz and *Q. rechingeri* O. Schwarz. In Flora Hellenica these are all described under the heading of *Q. pubescens* Willd.

The downy oak previously formed extensive forests with understoreys of *Q. coccifera* and *Carpinus orientalis*. These forests contributed greatly to the economy of sub-mountainous regions. *Q. pubescens* acorns make excellent pig feed, and its

wood was used as firewood and for the construction of fence stakes and barrels. When dried, its leaves were an excellent winter feed for goats and sheep.

Exhaustive woodcutting in combination with overgrazing, especially around settlements, led to the degradation and disappearance of the original forests. Today, the downy oak is found as remnants in regenerating ecosystems of *Q. coccifera* and *Carpinus orientalis* in the upper, colder evergreen broadleaved forest zone, especially in the ecotone between evergreen and deciduous broadleaved forests. It is also found in coppices and stands on limestone substrates, ridges and south-facing slopes in the lower deciduous oak zone.

The ecological value of the downy oak ecosystems is great due to its large biodiversity and because its fruits and leaves are the basis of various food chains. Some remnants of the once extensive *Q. pubescens* forests resemble botanical gardens with their wide variety of both woody and herbaceous species.

**6. *Quercus brachyphylla* Kotschy.** Although CHRISTENSEN in Flora Hellenica (STRID & TAN 1997) does not recognize *Q. brachyphylla* as a separate species, it is regarded a separate ecotype of *Q. pubescens* easily distinguished by its small leaves and geographical distribution. It is found in Crete (Rethymno) and the upper zone of broadleaved evergreens in SE Peloponnisos, E mainland Greece, and the Athos Peninsula.

**7. *Quercus frainetto* Ten.** (Syn.: *Quercus conferta* Kit, *Q. hungarica* Hubeny ex Rochel, *Q. esculiformis* O. Schwarz). This is a deciduous oak species that grows up to 30(-35) m in height and is important for wood production. It forms extensive pure or mixed forests that occupy almost one third of the total Greek forests and 80% of the deciduous oak forests. It is found growing in semi-mountainous areas of mainland Greece from Peloponnisos to N Greece and Thrace.

*Q. frainetto* is the most valuable and important oak species in Greece, due to the surface area its ecosystems cover and its valuable wood used for both firewood and furniture making. Its bulky wood being pale-coloured, lustrous, with many flecks (medulla rays), in combination with its strength and durability, make it valuable for parquetry and furniture. The acorn is also valuable as it makes an excellent food for pigs, and the taxon's foliage is an important animal foodstuff, especially for goats. *Q. frainetto* ecosystems are found on limestone, siliceous and serpentine substrates. They mainly grow in heavy clay soils and red clays that are unsuitable for cultivation, and this is probably the reason why these ecosystems have undergone less reclamation than other oak forests.

In the past, broadleaved oak ecosystems have undergone intensive exploitation with excessive tree felling, coppicing and overgrazing, and many now appear in degraded or shrub form. The regulation of tree felling, and mostly reduction of grazing by goats and sheep, has allowed these ecosystems to regenerate naturally. The result of this regeneration is that where we would have seen shrub-like formations of broadleaved oaks 25-30 years ago, we now see spectacular ecosystems with oak in the canopy and *Carpinus orientalis* and other species in the understorey and mid-layer.

Ecosystems of this type are presently found in various levels of degradation and therefore have various growth capacities. All these forests are managed by coppicing, which aims to mostly produce firewood. However, because this species produces good quality wood when it grows on good sites, it should be transformed into seed

germination form using tissue culture and extending its growth time. Wherever *Q. frainetto* ecosystems neighbour ecosystems of *Pinus nigra* subsp. *pallasiana*, *Abies cephalonica* or *A. borisii-regis*, one can observe a gradual invasion of the latter species into this ecotone. These species tend to substitute the broadleaved oak or form mixed stands of oak-pine or oak-fir.

**8. *Quercus petraea* (Mattuschka) Liebl.** is a deciduous oak species. In Greece, the species is represented by the following two subspecies:

**a) subsp. *petraea*** (Syn: *Quercus sessiliflora* Salisb.): This is very rare in Greece and I personally doubt whether typical examples of this taxon exist.

**b) subsp. *medwediewii*** (A. Camus) Menitsky (Syn.: *Quercus iberica* H. Bieb., *Q. dalechampii* Ten., *Q. polycarpa* Schur): A deciduous oak with straight trunks and heights of over 30 m. This taxon grows in the Balkans, Anatolia, Caucasus and N Iran. It differs from the typical *Q. petraea* by its leaves, acorn-cups, and the colour of its wood, which varies from chestnut- to dark-brown.

Despite its sporadic appearance, this is the second most economically important deciduous oak species in Greece. The taxon is present in N and S Pindos, N Greece, Thrace, NE Chalkidiki, and Mts Pilio, Mavrovouni, Ossa, Olimbos, Pieria and Vermio. It grows in slightly sandy-clayey soils, on acidic siliceous substrates (granites, gneisses, mica schists, and psammites, in the colder deciduous oak zones. Its forests have lower biodiversity than other broadleaved oak forests.

**9. *Quercus cerris* L.** (Syn.: *Quercus austriaca* Willd., *Q. tournefortii* Willd., *Q. thracica* Stef. & Nedjalkov). The bitter or Turkey oak is deciduous and grows to 25 m in height. It occurs in the upper oak forest zone (*Quercetum montanum*) and has an understorey with *Carpinus orientalis* or *Ostrya carpinifolia*. It grows mostly on limestone, dolomitic limestone or serpentine substrates throughout mainland Greece but mostly in N Greece. As its acorns and foliage are not eaten by animals and its wood not used for firewood, ecosystems of this taxon have undergone the least degradation of all the oak ecosystems.

Wherever *Q. cerris* ecosystems neighbour fir ecosystems, one can observe a gradual invasion of the latter species. Fir is often observed in the understorey and mid-layer of *Q. cerris* forests and many fir forests in Greece originate from the substitution of degraded, or not, *Q. cerris* ecosystems, aged trees of which can occasionally be found as remnants.

**10. *Quercus robur* L.** subsp. *pedunculiflora* (K. Koch) Menitsky (Syn.: *Quercus pedunculiflora* K. Koch, *Q. rhodopea* Velen., *Q. mestensis* Bondev & Gancev). A deciduous oak of the Balkan Peninsula, Transcaucasia and Anatolia, that grows to 25m in height. In Greece, this taxon appears as remnants of formerly extensive wetland forests in deltas of the largest rivers in N Greece. In the plains of Thessaly, E Macedonia and Thrace, it appears as solitary trees or small stands around rural churches, or as remnants of hydrophilous hardwood forests formations of *Fraxinus angustifolia* and *Ulmus minor*.

This taxon is endangered with extinction in Greece and should therefore be protected. In addition, its distribution should be expanded using *in situ* methods when restoring wetland ecosystems.

Finally, I would like to emphasize that due to their wide biodiversity and the habitats they create for various plant and animal species, the economic, ecological and aesthetic value of Greek oak forests is immense. They are managed mostly by coppicing, with or without reserves. These forests produce mainly firewood and only a small amount of their wood is used for other purposes. When these coppices revert to high forests, a process that has already begun, they become the most valuable forests of our country due to their ability to produce valuable wood for construction, parquet and furniture construction.

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