

Quercus pyrenaica in Europe: distribution, habitat, usage and threats

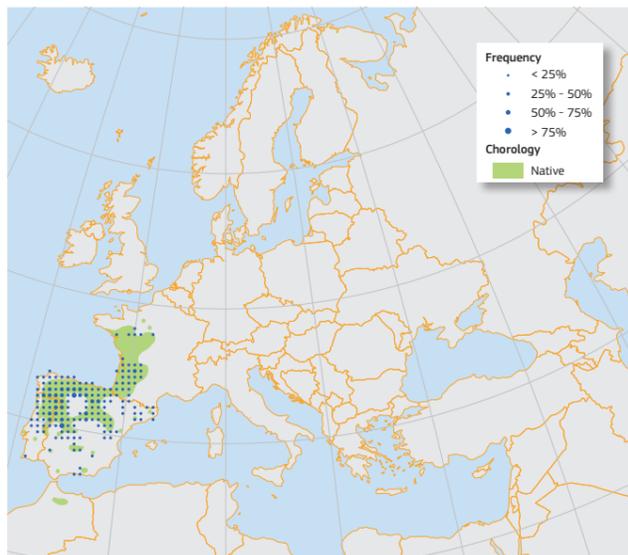
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Pyrenean oak (*Quercus pyrenaica* Willd.) is a medium-sized oak with an irregular crown, growing up to 20-25 m. It is a deciduous species but the hairy leaves are shed only in spring, an adaptation to hot climates. It is distributed throughout the western Atlantic-Mediterranean regions (West France, Portugal, Spain and North Morocco) through a wide range of altitudes, from sea level to over 2000 m. This oak is an intermediate tree between temperate and Mediterranean species, growing prevalently in mid mountain areas on siliceous soils. It is a dominant and key species of the forest formations it occupies, with stands that tend to be closed. It is a major tree in Iberian Peninsula **silviculture**, but these forests have now seriously deteriorated, principally due to historical human actions and wild fires.

Pyrenean oak (*Quercus pyrenaica* Willd., syn. *Quercus toza* Bosc) is a medium-sized oak up to 20m, rarely exceeding 25 m. It has a straight and slender trunk with a thick and cracked grey-brown bark. The crown is wide, lobed and irregular, with many ramifications. The main branches are **flexuose** and develop quite high^{1,2}. The root system is strong, equipped with numerous shallow, spreading, **stoloniferous** secondary roots, and reaches a depth of 50cm^{2,3}. It has also a deep tap root, which allows the trees to reach deep soil water content⁴. This oak is a deciduous and **mercescent** tree⁵. The leaves are simple and alternate, with deeply, pronounced, irregular lobes (4 to 8 pairs) and are velvety downy with stellate hairs on sides, conferring an ashen colour and aiding in resistance to periodic drought^{1,2,6,7}. They are very variable in size, measuring 7-20cm in length and 4 to 10cm in width. The colour is shiny green on the top side and paler underneath^{2,8,9}. Commonly **galls** developed by parasite insects are present over the leaves. The stalk is green or cream green, densely **pubescent** and up to 22mm in length. The buds are ovoid-conic 4 to 9mm in length and are tilted and clustered at the ends of the small branches². This tree species is **monoecious**. The female flowers are arranged agglomerated or grouped in small clusters, blooming in spring^{2,5}. The golden pendent male catkins appear early summer and are wind pollinated^{5,8}. Acorns are about 4cm in length and 1 to 2.5 cm wide, oblong, ripened in autumn and dispersed principally by birds and micro-mammals^{2,5}. It has an average longevity of 300 years².

Distribution

Pyrenean oak is characterised by an Atlantic-Mediterranean distribution: from western and south-western France, to the Iberian Peninsula (Spain and Portugal) and northern Morocco⁷. Spain and Portugal represent about 95% of its natural distribution area, so the species can almost be considered as endemic to the Iberian Peninsula¹⁰. This oak is found at a wide range of altitudes, from sea



Map 1: Plot distribution and simplified chorology map for *Quercus pyrenaica*. Frequency of *Quercus pyrenaica* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *Q. pyrenaica* is derived after several sources²⁸⁻²⁹.

level to 2100m in Sierra Nevada¹. Both the scientific and common name of this oak refer to the Pyrenees although it is almost non-existent in those mountains. The German botanist Karl Ludwig von Willdenow named it on the basis of dry samples received with a wrong sticker that described its origin in the Pyrenees⁵.

Habitat and Ecology

This oak is a typical sub-Mediterranean mountainous species, occupying transitional areas between sub-humid temperate and Mediterranean semi-arid conditions^{3,7}. It is less commonly found towards the southern limit of its distribution area, taking

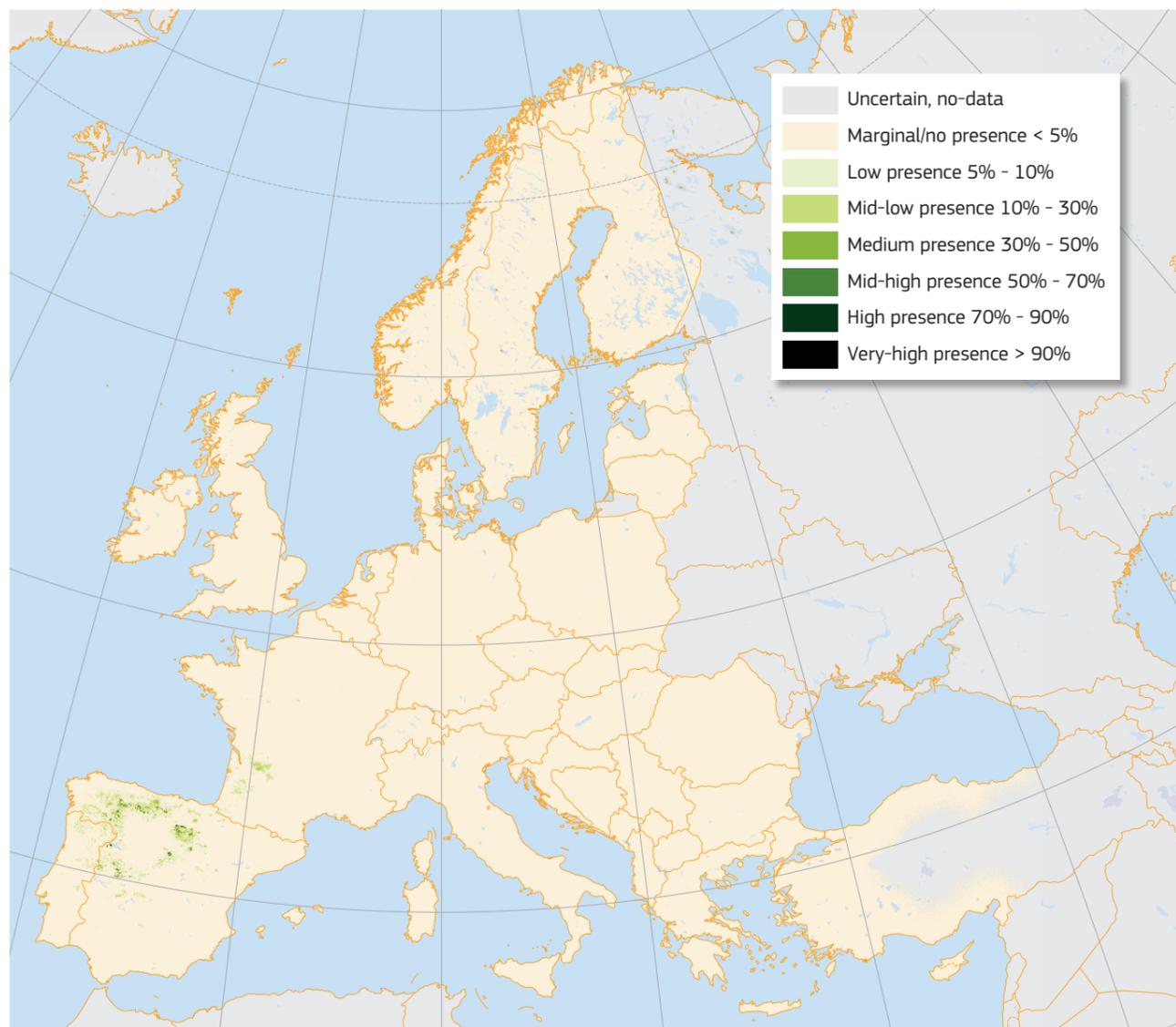


Crimson foliage in winter: leaves shed in spring when new leaves emerge. (Copyright Miquel Llop, www.flickr.com: CC-BY)

refuge in moist and cool montane areas^{11,12}. It has a short growing season, which may determine its distribution³. It grows with a minimum summer precipitation of 100mm and average annual rainfall around 600mm. Summer drought is one of its limiting factors, and it avoids the driest areas¹³. Its water and soil requirements are intermediate between those of pure Atlantic and pure Mediterranean oaks¹⁴. This oak withstands cold and heat, but requires a certain amount of moisture². It prefers the shade, to moderate its transpiration². It appears mainly on the mountainside and foot of siliceous mountains, rarely in limestone and dolomites, and prefers loose soils and a sandy texture⁶. Like most oaks, it does not form a persistent seed bank in the soil⁵. Owing to the wide distribution of Pyrenean oak, there is great variability among stands of this species in Spain in terms of silvicultural and ecological conditions⁵. Throughout its natural range, it is usually the key species of the forest formations it occupies, although towards the limit of its northern distribution it is mixed with species of more Atlantic habits, such as pedunculate oak (*Quercus robur*) and sessile oak (*Quercus petraea*)¹⁵, and towards the south with **sclerophyllous** Mediterranean species, such as evergreen oak (*Quercus ilex*) or even cork oak (*Quercus suber*)⁴. Their formations tend to be closed, although depending on the level of management their overall appearance can range from extremely closed forest to different degrees of openness, including **dehesa**, the traditional agro-silvo-pastoral open wood for livestock raising¹³. The current characteristics of these ecosystems are associated with their historic use for humans or with disturbances linked to these uses, such as fire, which forms part of the traditional management of these areas^{10,16}.

Importance and Usage

Thanks its high resprouting capability, the Pyrenean oak forests have been widely managed as coppice with silvo-pastoral uses, such as firewood, livestock grazing and charcoal production. Currently, in many of these oak coppices the extraction of fuel



Map 2: High resolution distribution map estimating the relative probability of presence.



Isolated tree with new leaves in spring in Montesinho Natural Park (Bragança, northeastern Portugal). (Copyright Miguel Vieira, www.flickr.com: CC-BY)



Deeply lobed leaf with velvety stellate hairs on both sides giving an ashy-green colour.
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wood is neglected and grazing is the prevalent use¹⁷. Its wood is of worse quality than the pedunculate and sessile oak and is less usable because its trunk is not very thick and is more irregular. It is used mainly for poles and railway sleepers. The bark is rich in tannins, so it has been used in leather industries⁶. Its wood presents structural characteristics (grain, porosity, permeability) ideal for barrel manufacturing¹⁸. This oak is also cultivated as an ornamental tree, often described as 'Pendula' form for its weeping outer shoots even if there no distinctive cultivars^{5, 9}. The Pyrenean oak forests have a great landscape importance in Iberian Peninsula, forming forest ecosystems rich in species. For these reasons they are actually protected by European legislation¹³.

Threats and Diseases

The Pyrenean oak forests have seriously deteriorated as a result of historical human actions, ceding a great part of their cover to agriculture, pastures, intense charcoal felling and the favouring of other tree species of major silvicultural interest such as pines^{16, 19, 20}. Habitat fragmentation has gradually reduced the quality and extent of these scattered forests, due also to recurrent fires, which have seen an enormous increase in frequency over the recent decades and now representing the main disturbance^{10, 16}. After perturbations, degraded Pyrenean oak forest may be replaced by **sclerophyllous** oaks, such as the evergreen oak and the cork oak, which are better adapted to the poorer soils and the drier conditions¹⁹. While root and stem resprouting is vigorous, its natural regeneration, particularly at southern locations, is poor due to low and scattered acorn production, high rates of acorn predation by several animals and frequent seedling damage by diverse herbivores. Plantations of Pyrenean oak often suffer heavy losses, primarily from summer drought^{19, 21}. Pest outbreaks are recorded principally for insect defoliators. Pyrenean oaks, like other oaks, can be seriously damaged by the green oak leaf roller moth (*Tortrix viridana*) and the gypsy moth (*Limantria dispar*), this latter able to feed several on tree species but preferring oaks. Forest defoliations can also be caused by the brown-tail moth (*Euproctis chrysorrhoea*), an invasive and generalist tree pest²⁰. As for the other oaks, Pyrenean oak is vulnerable to root pathogens of the genus *Phytophthora* (*P. cinnamomi*, *P. ramorum*)²². Furthermore, it is moderately susceptible to *Cryphonectria parasitica*²². The powdery mildew (*Erysiphe quercicola*) is a fungus which may have significant impacts on regeneration or on mature oaks in decline²³. The bacteria *Brenneria quercina* has been identified in central Spain, which is the causal agent of bark cankers and associated, among other factors, with the oak decline syndrome affecting Spanish oak forests^{24, 25}.



Grazed forest dominated by Pyrenean oak near Canencia (Madrid, Spain).
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Grey-brown bark with longitudinal cracks and covered by lichens.
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Apple-shaped gall formed by the oak gall wasp *Andricus quercustoxae* where its larvae feed and develop.
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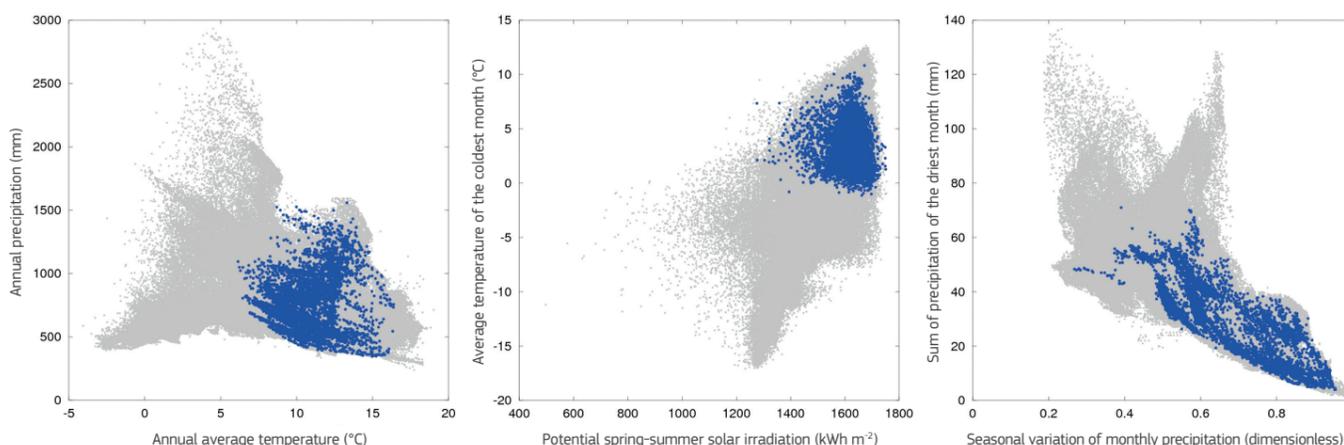
Oblong green acorns covered by scaled cups from 1/3 to 1/2 of their length.
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Field data in Europe (including absences) ● Observed presences in Europe ●

Autoecology diagrams based on harmonised field observations from forest plots.



This is an extended summary of the chapter. The full version of this chapter (revised and peer-reviewed) will be published online at <https://w3id.org/mtv/FISE-Comm/v01/e01f807>. The purpose of this summary is to provide an accessible dissemination of the related main topics.

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