Quercus ilex L. and *Quercus rotundifolia* Lam.: Two Different Species

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Abstract

Two evergreen oaks from Southern Europe have a confusing taxonomic history: *Q. ilex* and *Q. rotundifolia* (=*Q. ballota* Desf.) In this article we will discuss the salient differences between the two taxa, provide a key for the two species, and include a taxonomy review.

Key words: *Quercus ilex*, *rotundifolia*, Mediterranean, differences, acorns, taxonomy, nomenclature, leaf, distribution.

Introduction

The presence of two closely related sclerophyllous *Quercus* species in the Mediterranean area has been a continuous source of taxonomic confusion. The first publication on this subject was by Linnaeus (1753), who described *Quercus ilex* ("*QUERCUS foliis ovato-oblongis indivisis serratisque, cortice integro .... Variant foliis integerrimis & serratis, saepius etja in eadem arbore; difficile fine cortice distingitur a Subere*") with material from France or Italy.

In 1785 Lamarck described a new sclerophyllous species from the Mediterranean area, very close to *Quercus ilex*, but clearly different : "*Quercus foliis ovato-subrotundis, dentato-spinosis, supra è cinereo & viridi glaucis, subtus incanis. N. An ilex foliis rotundioribus & spinosis, è luco gramuntio*". The material used for this description was grown in a garden of Mister M. Cels, and the acorns came from a tree from Northern Africa or Southern Spain.

The differences between the two types are clear. The Linnean *Quercus ilex* has lanceolate leaves, without spines, and petioles are more than 0.8 mm long; Lamarck's *Quercus rotundifolia* has oblong-to-circular, spiny leaves, pubescent on both sides, with small petioles up to 0.9 mm, having spines.

At the time these type descriptions were made, communication between botanists was poor and access to published descriptions of new species was limited. This resulted in many errors of synonymy in botanical nomenclature, such as the names *Quercus ballota* Desf., *Quercus avellaniformis* Colmeiro & Boutelou, *Quercus gracilis* Lange or *Quercus alsina* Pall., and was the source of misinterpretations of *Quercus ilex* L. and *Quercus rotundifolia* Lam.

Geographical differences

There are important differences between these two taxa of the genus *Quercus*. First, these species have distinct and mostly separate geographical distributions. *Q. ilex* L. grows along the northern Mediterranean sea coast, from Greece to Northern Spain and probably to northern of Morocco; *Q. rotundifolia* Lam., on the other hand, grows in the western Mediterranean basin from northern Spain to the Western Sahara.

Q. ilex L. grows wild in Albania, Bosnia, Bulgaria, Croatia. Greece, France, Hungary, Italy, Montenegro, Spain, Switzerland and Turkey.

Q. rotundifolia Lam. grows wild in Algeria, France, Morocco, Spain, Tunisia and Western Sahara (see Figure 1).

Q. ilex L. occurs from sea level to 1200-1400 meters elevation, in mixed or homogeneous forests (with Q. *cerrioides* Willd., *Q. pubescens* Willd. or *Q. pyrenaica* Willd., and sometimes with *Q. robur* L.), frequently on basic soils having typical scrub and climber vegetation formed by sub-sclerophyllous to mesophyllous species such as *Viburnum tinus* L., *Buxus sempervirens* L., *Erica* spp., *Myrtus communis* L., *Cistus laurifolius* L., *Rosa sempervirens* L., and *Lonicera periclymenum* L.

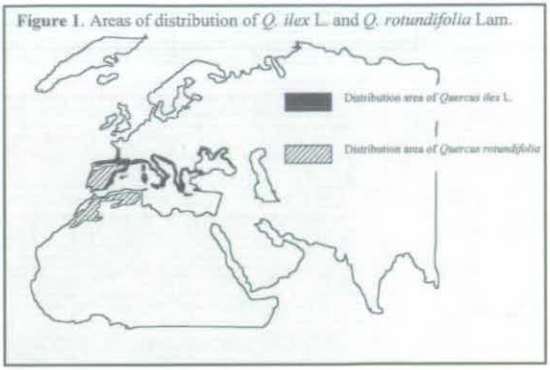


Figure 1. Areas of distribution of *Q. ilex* L. and *Q. rotundifolia*

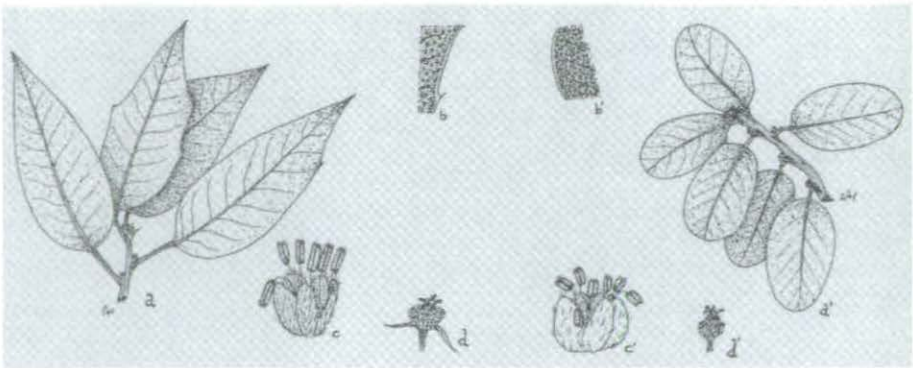
Q. rotundifolia occurs from sea level to 1800-2100 meters elevation, on a variety of soils, alone or with other species of *Quercus*, such as *Q. suber* L., *Q. pyrenaica* Willd., *Q. faginea* Lam., or *Q. coccifera* L., and sometimes with *Q. canariensis* Willd. The scrub and climber vegetation of this forest consists of sclerophyllous species, such as *Cistus* spp., *Lavandula* spp , *Abutus unedo* L., and *Smilax aspera* L.

Leaf differences

For many authors (Camus, 1936-1954; Schwarz, 1964; Amaral, 1990) the best characteristic distinguishing the two taxa is leaf morphology.

Q. ilex L. has lanceolate to oblong leaves, with 7-10 pairs of secondary veins, the margins entire to serrate, glabrous and with a clear hyaline edge. Young trees sometimes have leaves with spiny margins. On the lower leaf surface, pubescence is slight to dense; the upper surface is subglabrous or has star-shaped hairs, occasionally glabrous. The petiole is 4-15 mm long. The upper surface of the leaf is dark green .

Figure 2. Leaf and flower differences of *Q. ilex* (a,b,c,d) and *Q. rotundifolia*(a',b',c', d'). a: leaf, buds and branch; b: margin of leaf; c: male flower; d: female flower. Scale 1:1.5 cm in a; 1: 0.4 cm in b, c and d.



Q. rotundifolia has oblong to rotund leaves, with 4-8 pairs of veins, the margins entire or with spines, pubescent or glabrous, but with a thin hyaline edge; leaves of young trees always have spiny margins. The upper surface is pubescent; the lower slightly pubescent. The petiole is 3-12 mm long. Leaf colour above is greenish blue, and is ash-coloured below (see figure 2).

Flower differences

Petals of the male flower of *Q. ilex* are pubescent or glabrescent, with an acute apex; stamen number varies from 4 to 7; stamen filament length is greater than that of the petals.

Male flower petals of *Q. rotundifolia* are glabrous or glabrescent, with an obtuse apex; stamen number varies from 5 to 12; filament length is less than, equal to, or greater than the petals. Female flowers in *Q. rotundifolia* and *Q. ilex* are very similar, but those of *Q. ilex* sometimes have flower bracts in the lower portion of the future cupule (see figure 2).

Fruit differences

Fruits of these two *Quercus* species vary greatly in morphology and in the external characteristics of the acorn and cupule. Acorns of *Q. ilex* have a more acute apex and are small; acorns of *Q. rotundifolia* are larger, with an apex round to acute (Vázquez et al., 2000).

The big difference between *Q. ilex* and *Q. rotundifolia* acorns is the taste. Acorns of *Q. rotundifolia* are sweet, while those of *Q. ilex* are bitter. Chemical analysis of the acorns shows clear differences between them. Rafii et al. (1992) found that *Q. rotundifolia* acorns had more lipid concentration (6.3-11.3%) than *Q. ilex* acorns (3.1-4.3%), as well as greater protein concentration (0.73-0.97% vs. 0.5-0.6%).

Earlier, Rafii et al., (1991) had found differences between the two species in the concentration of unsaturated fatty acids. Acorns of *Q. ilex* had lower levels of unsaturated fatty acids (78.9 (1.40) than those of *Q. rotundifolia* (81.6 (1.48). Also the distribution of the fatty acids was different for the two species; *Q. ilex* had higher concentrations of the linoleic, linolenic, and palmitic fatty acids than *Q. rotundifolia*, as well as higher concentrations of oleic and stearic fatty acids.

Genetic differences

Molecular studies of populations of *Q. ilex* and *Q. rotundifolia* have found clear differences between distant populations, but much smaller molecular differences between populations growing close together (Rafii, 1988).

Other authors such as Michaud et al. (1995), found differences within the same species and similarities between the two species when they were growing near each other in southern France and northern Spain. Separate populations of *Q. rotundifolia* from Rif (Morocco) and Algeciras (South Spain) were genetically similar to a population of *Q. ilex* from Cyprus. These

Francisco Vazquez examines a group of *Quercu rotundifolia* in northern Spain in an area where this species is sympatric with the closely related *Quercus ilex*.
Photo copyright Guy and Edie Sternberg.

results suggest hybridisation between the two species in areas where they are growing together. Also, these results indicate phylogenetic proximity of the two species, although they are still differentiating.

Differentiation and hybridization between the two species.

With the above information, it is clear that differentiating between the two species is easier in individuals from distant areas, but very difficult in areas where the two are found living together.

Hybridization and introgression take place because of self-breeding and crossing with other species, or with other individuals of the same species, as confirmed by Yacine et al., (1997) in the case of the *Q. ilex* L.

Various authors have noted the presence of small populations or individuals of *Q. ilex* in typical areas of *Q. rotundifolia*. Maire (1961) documents the existence of *Q. ilex* in the Rif next to *Q. rotundifolia*; Vicioso (1950) found *Q. ilex* individuals in the north part of Huelva province (Spain), in typical areas of *Q. rotundifolia*. The opposite situation has not been widely reported, but in southern France in typical areas of *Q. ilex*, it is possible to find populations of *Q. rotundifolia* (Barbero et. al., 1980).

In contact areas in southern France and northern Spain, where both species grow together in the same habitat, there are many trees with intermediate characters between the two species. In areas with a single species only, but where both species grew together previously, it is today possible to find individuals with intermediate characteristics between the two species.

The most confusing characters are leaf and acorn morphology and flavour of the acorns. Trees in hybrid populations have characteristics intermediate for these characters. The more stable characters are male and female flower morphology, but are of limited use since they are inconspicuous and of short duration.

Study of the hybridisation between the two species found individuals with intermediate characters in northern Spain. These have been known as *Q. ilex* x *Q. rotundifolia*. We propose naming these populations as *Q.* x*autumnalis* nothospec. nov. forest hybrids.

Quercus xautumnalis F. M. Vázquez, S. Ramos & E. Doncel nothospec. nov.
= *Quercus ilex* L. x *Q. rotundifolia* Lam.
Diagnosis:
Arbor cum ramuli tomentosi. Gemmae ovato-globulosae, squamis pubescentibus. Folia supra subtomentosa, subtus tomentosa; marginis integer, lanceolata vel oblonga cum apicem obtusis et basi rontunda. Lamina cum 5-9 nervis lateralis; 2-5(-6) cm longa, 0,8-1,2(-1,9) cm lata. Petiolus pubescentibus, 8-16(22) mm longus. Fructus 14-27(35) mm longus, amarus.

Description:

Tree with tomentose branches. Bud ovate globular, with pubescent scales. Leaf subtomentose above and tomentose below lower with entire margin, from lanceolate to oblong with obtuse apex and rounded base. Leaf 5-9 lateral veins; 2-5(6) cm long and 0.8-1.2(-1.,9) wide. Petiole pubescent, 8-16(22) mm long. Fruit 14-27(35) mm long, bitter.

Holotype:
Spain: Huesca, near San Juan de la Peña, 22, 10, 2001, E. Doncel, G. Sternberg, R. Lance, M. Conggeshall, E. Balbuena, SS. Ramos et F.M. Vázquez. HSIA

Nomenclature and taxonomy

Because of the above information, we think that the two taxa can be considered separate species based on clear differentiating taxonomic characters, their clear and separate distributions, and the chemical and genetic studies that confirm their separation into two groups.

Key:

- Plants with petals in male flowers pubescent to glabrescent; leaves lanceolate, with more than seven pairs of secondary veins and glabrous margins; acorns bitter and apex normally acute ..... *Q. ilex* L.

- Plants with petals in male flowers glabrous to glabrescent; leaves round, oblong to lanceolate, with three to seven (sometimes eight) pairs of secondary veins and pubescent to glabrescent margins; acorns sweet and apex normally obtuse (acute some of the time) ..... *Q. rotundifolia* Lam.

Nomenclature:

Q. ilex L., Sp. Pl. 995 (1753).
Q. smilax L. Sp. Pl. 994 (1753).
Q. gramuntia Sauvage *ex L. Sp.* Pl. 995 (1753).
Q. sempervirens Mill., *Gard. Dict.* ed. 8:3 (1768).
Q. integrifolia Steud., *Nomencl. Bot.* 1: 673 (1821).
Q. alpina Endl. *Gen. Pl., Suppl.* 4(2): 25 (1848).
For more information see Govaerts & Frodin., 1998.
Ind. loc.: *Habitat in Europa australis.*
Lectotype: LINN 1128-4 see in Microfiche.

Q. rotundifolia Lam., *Encycl.* 1: 723 (1785).
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Q. alzina Lapeyr., *Hist. Arb. Pyr.*, 584 (1813).
Q. avellaniformis Colmeiro & Boutelou, *Examen de las Encinas*, 9 (1854).
Q. ilex var. *ballota* (Desf)DC., *Prodr.* XVI(2): 39 (1864).
Q. ilex subsp. *ballota* (Desf.)Samp. Bol. Soc. Brot. 24: 102 (1908-1909).
Q. *ilex* subsp. *rotundifolia* (Lam.)O. Schwarz ex Tab. Mor., Bol. Soc. Brot. ser. 2, 14: 122 (1940).
Q. *ilex* subsp. *smilax* C. Vicioso, Rev. Gen. Quercus España, 166 (1950).

For more information see Govaerts & Frodin., 1998.

Ind. loc.; *Ce Chêne croît naturellement en Espagne.*
Lectotype: P-LAMARCK see in Microfiche.

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