

# Diversity of the Gall Oak (*Quercus faginea* Lam.) in the Iberian Peninsula

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## Summary

Morphological study of the Gall Oak (*Quercus faginea* Lam.) complex from the Iberian Peninsula has demonstrated the presence of four different taxa: *Quercus faginea* subsp. *faginea* var. *faginea* Lam., *Quercus faginea* subsp. *faginea* var. *alpestris* (Boiss.) F.M.Vázquez, M.Gutiérrez & S.Ramos comb. nov. *Quercus faginea* subsp. *broteroi* var. *broteroi* (Coutinho) A.Camus, and *Quercus faginea* subsp. *broteroi* var. *tlemcenensis* (A.DC.) Trabut & Batt. The difference between these is most evident in the leaf morphology. A historical review of descriptions of the group shows a diversity of names based on variations associated with geographical distribution and morphological characteristics of the leaves. But it is noteworthy that many names are synonymous or refer to hybrids within the group. Parallel study of the morphological and geographical distribution of the taxa has revealed little correspondence between ecological and geographical factors and morphological characteristics. The final results show high diversity in the southern Iberian Peninsula for the Gall Oak complex, with less diversity in northern areas of the Peninsula.

**Key Words:** Taxonomy, Distribution, Morphology, Southern Iberian Peninsula, Chorology.

## Introduction.

The *Q. faginea* groups have two distinctive species in the Mediterranean Basin: *Q. faginea* Lam., and *Q. infectoria* Oliv. We can recognize the two species by morphological characteristics of the leaves and peduncles: *Q. faginea* Lam. has leaves up to 12 cm long, with peduncles up to 5.5 cm long, whereas *Q. infectoria* Oliv. has leaves which average up to 8 cm in length, with average peduncles up to 2 cm in length. Marginal pubescence of the leaves and flower morphology are very close in the two.

The *Q. faginea* complex found in the western part of the Mediterranean area is one of the most diverse of all oak species and in which the parental type is more frequently expressed among hybrids found in the zone (Huguet del Villar, 1938; Huguet del Villar, 1949; Saenz de Rivas & Rivas Martínez, 1968; Vázquez, 1995). The Gall Oak complex is defined by a combination of factors such as the morphological diversity of the proposed taxa (Vicioso, 1950; Saenz de Rivas,

1967; El Abidine & Fennane, 1995), hybridization processes, and insufficient knowledge of the morphological range of the proposed taxa.

The objective of this work is two-fold: to study the morphological and geographical diversity and distribution of the Gall Oak complex in the Iberian Peninsula, and to review the historical treatment of the main taxa of the group.

### **Materials and methods**

The study is based on a review of the historical names and a complementary morphological and geographical study of the materials from the Iberian Peninsula conserved in the herbarium of the Centro de Investigación-La Orden-Valdesequera (HSS).

The review of the historical names associated with the *Q. faginea* complex in the Iberian Peninsula (and adjacent territories such as North Africa) is based on study of type specimens and on original descriptions with their names of the Gall Oak from the western part of the Mediterranean Basin. All relevant proposed taxa were reviewed and assessed, although the synonyms and invalidly published names were not (Appendix 1).

Morphological study was accomplished through review of leaf characters: dimensions, margin morphology, abaxial surface pubescence and number of ribs.

The analysis and morphological characterizations were correlated with geographical study, because it is necessary to recognize possible influences from the environment on morphological traits. It was also necessary to ascertain whether the geographical distribution of the supposed taxa had any influence on the noted characters. Sixty morphological characters were studied, and the best and clearest representatives of the differences among the proposed taxa (rib numbers, length, width, surface area, and pubescence of the blade) were selected (Appendix 2, 3).

All the results will be shown together with the characters noted in the herbarium materials studied from the Jussieu family herbarium in Paris, (P-JU). These consisted of 150 consecutive vouchers of the Gall Oak complex from the Iberian Peninsula. (Appendix 1).

### **Results**

Results will be shown in two sub-sections: 1) review of historical treatments, and 2) morphological and geographical analysis.

#### **Review of historical treatments**

*Q. faginea* Lam. Lamarck published three different species of Gall Oak from Portugal: *Q. humilis*, *Q. lusitanica* (with two varieties) and one rare species which he named *Q. faginea* (1785). The first and second species have similar descriptions; the second variety of the second species and the first species are actually the same taxon. Moreover, the materials/types conserved in P-JU are very variable, and very frequently correspond to the same taxon. Note that Miller had previously published a *Q. humilis* from England, possibly based on *Q. robur* materials (1768). This fact invalidates both of the names *Q. humilis* Lam. and *Q. humilis* Mill. and partially also *Q. lusitanica* Lam. *A nomenclature conservatum*

proposal for *Q. lusitanica* Lam. is probably advisable, as has been mentioned by Schwarz (1964). In addition, the *Q. lusitanica* concept is broad and overlaps with the concept of *Q. faginea* Lam. This was the main obstacle to the correct identification of *Q. faginea* during the first years of the twentieth century, and many researchers regard as *Q. lusitanica* the material associated with *Q. faginea*.

The type specimen of *Q. faginea* Lam., conserved in P-JU, shares features with three other proposed taxa: *Q. valentina* Cav., part of *Q. alpestris* Boiss., and part of *Q. australis* Link. Camus's proposal (1936-39) to change the name *Q. lusitanica* Lam to *Q. faginea* is probably the best solution for the correct understanding of the Gall Oaks' diversity in the *Q. faginea* complex (See Lamina 1).

***Q. valentina*** Cav. Cavanilles (1793) included a new name for the Gall Oak, which had been described previously by Lamarck (1785) as *Q. lusitanica* Lam. The opinion of Cavanilles (1793) was that the concept of *Q. lusitanica* Lam. was too broad and that the proposed new species, *Q. valentina* Cav., was justified because it showed differences in the length and the morphology of the leaves. He finally relegated *Q. lusitanica* Lam. (the prior and valid name) to the list of synonyms of *Q. valentina* Cav. By the rules of the International Code of Botanical Nomenclature, however, this name is invalid because it subordinates a validly published prior name.

Cavanilles (1793) also does not comment on the other taxa which had been established by Lamarck in 1785, although he asserts that *Q. valentina* Cav. is very close in the morphology of its leaves to *Q. lusitanica* Lam. In fact, Cavanilles (1793) was describing the same taxon which had been previously described by Lamarck (1785) as *Q. faginea* Lam.

Finally, the morphotype described by Lamarck (1785) and the one indicated by Cavanilles (1793) were very close, because the leaves on both were serrate, with spines, ovate-lanceolate, sub-pubescent below, and from medium to short in length. Two descriptions were supplied for the morphology of the leaves.

***Q. australis*** Link. Researchers such as Saenz de Rivas point out (1967) that *Q. australis* Link is close to *Q. faginea* s.s., but the original description by Link (1831) states “*.fol. ovalibus basi cordata mucronato-dentatis subtus tenui pubescentibus.*” In fact, the leaves of *Q. faginea* Lam. are not cordate and are normally attenuate.

The notion of leaf pubescence is similar to that in *Q. faginea* Lam., which has short hairs on the underside of the leaf. These are characters typical of the lectotype of *Q. faginea* Lam. (P-JU).

The mixture of characters, e.g. cordate leaves with medium pubescence, suggests a hybrid, e.g. *Q. faginea* subsp. *broteroi* × *Q. faginea* subsp. *faginea*. *Q. australis* Link is probably a hybrid between the two taxa just cited and is typical for Southern Portugal.

The latter proposal is supported by Saenz de Rivas (1967), where he indicates that the distribution of hair types in *Q. australis* Link *sensu* Vicioso and Saenz de Rivas has hair length between *Q. faginea* subsp. *broteroi* and *Q. faginea* subsp. *faginea*.

***Q. alpestris*** Boiss. Boissier (1838) recognized a new oak from Málaga which was clearly different from *Q. faginea* Lam., *Q. valentine* Cav., and *Q. pseudosuber* Desf. because of the nature of the margin and surface of the leaves.

He also indicated that the new taxon had oblong-lanceolate leaves and short deciduous pubescence (“*minusve tomentos deciduis*”) on the underside of the leaf. The new species grows at altitudes higher than 1,000 m mixed with *Abies pinsapo* Boiss., in areas with high humidity and with snow cover for part of the year.

The morphology of the leaf is close to *Q. faginea* Lam. (Schwarz, 1936); Saenz de Rivas (1967) confirms the proximity/distance between the leaves of *Q. faginea* when these are compared with those of *Q. alpestris* Boiss. Later on, Blanca & al. (1999) show the different morphology of the leaf shape and the margin. Amaral (1990) and Govaerts & Frodin (1998) think that they are the same taxon. The list of opinions and authors could be extended, but exemplars of putative *Q. alpestris* Boiss. have leaves with crenate and mucronate margins, while those of *Q. faginea* Lam. have leaves with serrate margins. The pubescence in the two cases is similar. Finally the leaves of putative *Q. alpestris* have greater length than width, whereas the leaves of *Q. faginea* are equal in size or a little longer than they are wide. In our opinion *Q. alpestris* is close to *Q. faginea*, and it may possibly be a simple variation associated with a particular habitat (see Lamina 2).

***Q. pseudosuber* var. *tlemc[s]jenensis*** A.DC. The main characteristic indicated by Alphonse De Candolle (1864) for separating the new taxon was glabrous anthers. But variations associated with pubescence of the anthers are numerous. We can find in a single population of *Q. faginea* Lam. independent exemplars with high and medium pubescence and pilose to smooth anthers.

Deep/shallow dentate margins on the leaf is the second character indicated by De Candolle. As seen before, we can state that the enormous variations associated with characteristics of the margin and the size of the blade are not characters useful for discrimination of taxa in the *Q. faginea* complex.

Moreover, the pubescence associated with the abaxial surface of the leaf is both a new character and one which is irrelevant for the possible segregation of the taxon, because long hairs and high pubescence on the underside of the leaf are typical of other taxa in the group, e.g. *Q. faginea* subsp. *broteroi* (Coutinho) A.Camus.

We consider finally the “*tlemcenensis*” concept in the *Q. faginea* group. As a taxon alongside *Q. faginea* subsp. *broteroi* (Coutinho) A.Camus, with an oblong blade (longer than wide and a little serrate or dentate), this should probably be regarded as a simple variation, with the taxonomic level of *forma* (see Lamina 3).

***Q. lusitanica* var. *broteroi*[i]** Coutinho. The south-western Iberian Peninsula is characterized by the presence of evergreen oaks such as *Q. rotundifolia* Lam., *Q. suber* L. and *Q. coccifera* L., together with one deciduous oak: *Q. faginea* subsp. *broteroi* (= *Q. lusitanica* var. *broteroi* Coutinho). This oak occurs in mountains with *Q. faginea* subsp. *faginea* and *Q. pyrenaica* Willd.

Arid growing conditions, strong light, high temperatures, and poor soils explain some of the features of the Lusitanian Gall Oak: medium to large leaves, mucronate to crenate margins, tomentose underside with long and diverse hairs, pilose anthers, pubescent, long, sub-deciduous leaves. In this it is similar to new taxa such as *Q. lusitanica* subsp. *navarrana* O.Schwarz, proposed by Schwarz (1936-37) for the northwestern part of the Iberian Peninsula. Schwarz associates these traits with arid growing conditions, not to possible hybridization between *Q.*

*robur* × *Q. faginea* (under *Q. lusitanica*).

All authors nowadays recognize this as an accepted taxon, but some such as Rivas Martínez & Saenz de Rivas (1991) accord it *species* rank. Others (Carvalhos & Amaral, 1954; Amaral, 1990; Govaerts & Frodin, 1998) - the great majority - consider the taxon to be a *subspecies*. Studies investigating the proximity of *Q. faginea* subsp. *faginea* and *Q. faginea* subsp. *broteroi* are abundant and always conclude that there is indeed a high similarity in type of habitat, in leaf and flower morphology, and in part, in flowering period. There also possibly exist fertile hybrids between the two taxa, which make the segregation of the two subspecies difficult (see Lamina 4).

***Quercus lusitanica* var. *maroccana*** Braun-Blanq. & Maire. This is an oak “species” found in northwest Africa among populations of Evergreen Oak (*Q. rotundifolia* Lam.) and in cedar forests (*Cedrus atlantica* (Endl.) Carrière) there. The main characteristics of this taxon are traits associated with the leaves: large, with a crenate to dentate margin and a slight pubescence on the bottom surface. The leaves remind us of *Q. lusitanica* var. *mirbeckii*, sensu Braun-Blanque & Maire (1924), but they are more coriaceous

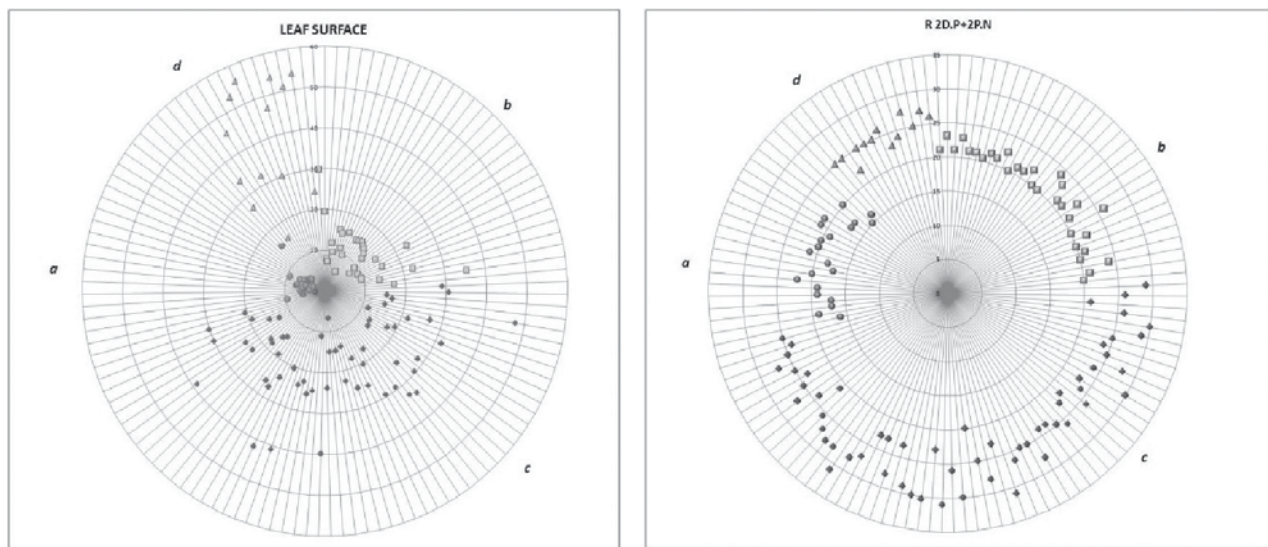
Study of the type specimen shows a Gall Oak similar to *Q. lusitanica* var. *broteroi* (Coutinho 1888) with large leaves and short pubescence. The petiole, size of the leaves, and general morphology are reminiscent of the leaves of *Q. canariensis* Willd. In fact, the materials associated with the type specimen display a combination of characteristics between *Q. lusitanica* var. *broteroi* and *Q. canariensis*. It is thus possible that *Q. lusitanica* var. *maroccana* is an African hybrid between *Q. canariensis* and *Q. faginea* (*Q. lusitanica* var. *broteroi*), as was suggested by Camus (1936-39).

### **Morphological and geographical analysis**

Morphological analysis reveals the presence of numerous overlapping characters. The discrimination of taxa in the Gall Oak complex in the Iberian Peninsula is based on combinations of foliar characters. Figure 1 shows the distribution of the results for the surface of the leaf in the four putative taxa. “Faginea” and “alpestris” show the smallest leaf surface, intermediate leaf surface is represented by “broteroi”, and the greatest size of leaf surface is represented by examples of “tlemcenensis”.

The relation ‘ $2 \times$  number of secondary ribs +  $2 \times$  pubescence density’ is another character identifying the four groups in the Gall Oak complex. The “broteroi” and “tlemcenensis” groups show the maximum value for this parameter, while the lowest value is in the “alpestris” group; the “faginea” examples have intermediate value.

Other morphological characters were evaluated and contrasted. Valid results were obtained for density of pubescence on the bottom surface of the leaf. The rest of the characters analyzed did not yield valid criteria for the identification and segregation of the potential taxa. These include morphology of the leaf margin, petiole length, pubescence on the upper leaf surface, number of ribs, length and width of the blade, acorn size, morphology of the cupules, and the type of hairs on the leaves and the reproductive organs.



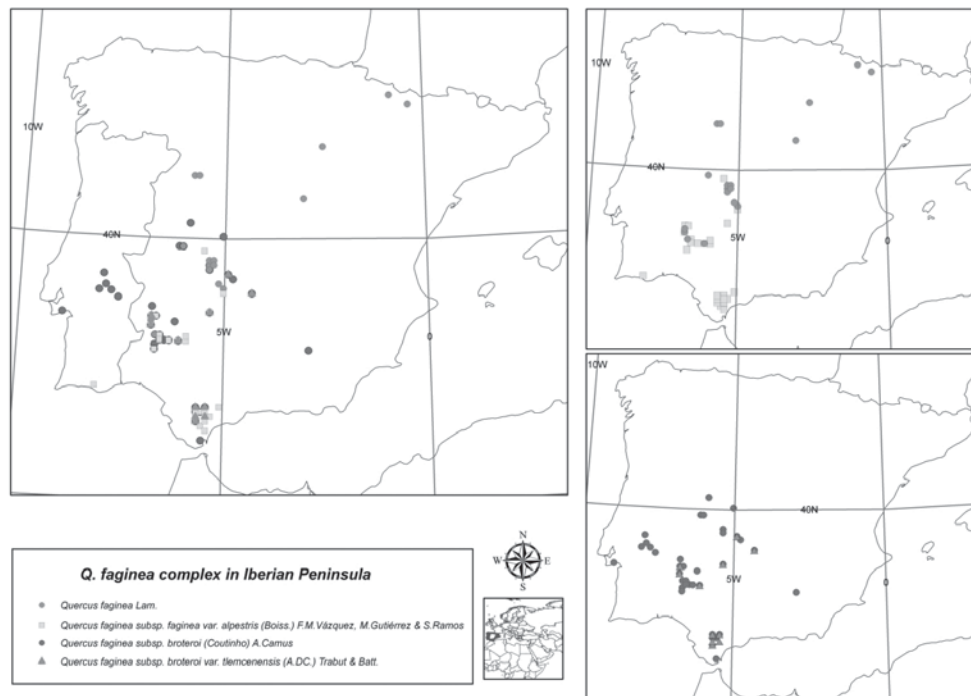
**Figure 1.** Distribution of results for the relation “ $2 \times$  number of secondary ribs +  $2 \times$  pubescence density on the lower leaf surface” (**R 2D.P+2P.N**) and “Leaf surface value” (**LEAF SURFACE**), for the four groups of the Gall Oak studied from the Iberian Peninsula studied: **(b)** “alpestris”, **(c)** “broteroi”, **(a)** “faginea” and **(d)** “tlemecenensis”.

When analyzed according to geographical distribution, the potential groups did not reveal differences. The latitude, longitude, and altitude considered for the four groups show irregular distribution in all cases. But there are definitely patterns in the distribution of the “alpestris”, “broteroi” and “tlemecenensis” groups in the southern part of the Iberian Peninsula, while the “faginea” group appears throughout in the same geographical area (see Figure 2 and Map 1).

### Discussion and conclusions

Consideration of historical treatments combined with new morphological study suggest several potential morphologically related taxa, although they would not necessarily be accepted, since morphological differences can result from different environmental conditions. Frequent hybridization in the group is another source of confusion and the basis for creation of new taxa. Finally, the geographic distribution of morphological characters, combined with hybridization, have caused different names and taxa to be proposed, which has increased confusion in the Gall Oak complex.

With revision of names, and the proposal of specific morphological groups, we can define four clear groups that can be differentiated by the following keys:



**Map 1.** Distribution of the Gall oak taxa from the Iberian Peninsula studied here: *Q. faginea* subsp. *faginea* var. *alpestris* (yellow), *Q. faginea* subsp. *broteroi* var. *broteroi* (red), *Q. faginea* subsp. *faginea* var. *faginea* (blue) and *Q. faginea* subsp. *broteroi* var. *tlemecenensis* (green).

**Figure 2.** Distribution of results for the geographical characters **Latitude** (°) and **Altitude** (m), for the four groups of the Gall Oak from the Iberian Peninsula studied here: ■(b) “alpestris”, ◆(c) “broteroi”, ●(a) “faginea” and ▲(d) “tlemecenensis”.

### Keys for identification of the Gall Oak complex of the Iberian Peninsula

- 1.- Small to average leaf blade, up to 3.5 cm wide. Leaf underside glabrous to glabrescent ..... **2.**
- 1.- Average to large leaf blade 2.5-6.5 cm wide. Leaf underside glabrescent to pubescent ..... **3.**
  
- 2.- Leaf underside glabrous to sub-glabrous, up to 2.5 cm wide  
*Q. faginea* subsp. *faginea* var. *faginea*
- 2.- Leaf underside glabrescent, up to 3.5 cm wide  
*Q. faginea* subsp. *faginea* var. *alpestris*
- 3.- Leaf underside pubescent, 4-8(10) cm long  
*Q. faginea* subsp. *broteroi* var. *broteroi*
- 3.- Leaf underside glabrescent to pubescent, 7-13 cm long  
*Q. faginea* subsp. *broteroi* var. *tlemecenensis*

Based on review of the morphological characters, geographical distribution and historical treatment, we propose the following taxonomic scheme for the Gall Oak complex from the Iberian Peninsula:

***Quercus faginea*** Lam., *Encycl. (Lamarck)* 1(2): 725. 1785 [1 Aug 1785]. (Lectotype: P-JU, n° 17093! Lower exemplar) (See Lamina 1)

Synonymous: *Quercus valentina* Cav., *Icon.* 2: 25, tab. 129 (1793) ex descr., nom illeg. = *Quercus faginea* Ten. *Syll. Pl. Fl. Neapol.*: 469 (1831), nom. illeg. = *Quercus lusitanica* subsp. *faginea* (Lam.) A.DC. in A.P.de Candolle, *Prodr.* 16(2): 17 (1864) ≡ *Quercus lusitanica* subsp. *faginea* (Lam) A.DC. in A.P. de Candolle, *Prodr.* 16(2): 17 (1864) ≡ *Quercus lusitanica* var. *valentina* (Cav.) A.DC. in A.P.de Candolle, *Prodr.* 16(2): 17 (1864). ≡ *Quercus lanuginosa* var. *faginea* Nyman, *Consp. Fl. Eur.*: 661 (1881) = *Quercus lusitanica* f. *microphylla* Coutinho, *Bol. Soc. Brot.* 6: 69 (1888) ≡ *Quercus lusitanica* f. *vulgaris* Coutinho, *Bol. Soc. Brot.* 6: 68 (1888), nom. inval. ≡ *Quercus faginea* subvar. *vulgaris* (Coutinho) A.Camus, *Chênes, Atlas* 2: 113 (1935), nom. inval. ≡ *Quercus lusitanica* subsp. *valentina* (Cav.) O.Schwarz, *Cavanillesia*: 8: 72 (1936) ≡ *Quercus faginea* subvar. *microphylla* (Coutinho) A.Camus, *Chênes, Texte* 2: 180 (1939) ≡ *Quercus faginea* subsp. *eufaginea* A.Camus, *Chênes, Texte* 2: 172 (1939), nom. inval. ≡ *Quercus lusitanica* var. *vulgaris* (Coutinho) C.Vicioso, *Rev. Gen. Quercus Esp.*: 107 (1950), nom. inval. ≡ *Quercus faginea* var. *oscensis* P.Monts., *Bull. Soc. Échange Pl. Vasc. Eur. Occid. Bassin Médit.* 22: 62 (1988).

***Quercus faginea* subsp. *faginea* var. *alpestris*** (Boiss.) F.M.Vázquez, M.Gutiérrez & S.Ramos **comb. nov.** (See Lamina 2)

Basionym: *Quercus alpestris* Boiss., *Elech. Pl. Nov.*: 83 (1838) (Lectotype: G-BOIS!)

Synonyms: *Quercus lusitanica* subsp. *alpestris* (Boiss.) Nyman, *Consp. Fl. Eur.* 661 (1881) ≡ *Quercus lusitanica* f. *microcarpa* Coutinho, *Bol. Soc. Brot.* 6: 68 (1888) ≡ *Quercus lusitanica* var. *alpestris* (Boiss.) Coutinho, *Bol. Soc. Brot.* 6: 68 (1888) ≡ *Quercus alpestris* var. *vulgaris* (Coutinho) A.Camus, *Chênes, Texte* 2: 166 (1939), nom. inval. ≡ *Quercus alpestris* var. *microcarpa* (Coutinho) A.Camus, *Chênes, Texte* 2: 166 (1939) ≡ *Quercus faginea* subsp. *alpestris* (Boiss.) Maire, *Fl. Afrique Nord* 7: 100 (1961).

***Quercus faginea* subsp. *broteroi*** (Coutinho) A.Camus, *Chênes, Texte* 2: 179 (1939) (See Lamina 3)

Basionym: *Quercus lusitanica* var. *broteroi* [i]Coutinho, *Bol. Soc. Brot.* 6: 68, Est. 1 figs. H-K (1888)

Synonyms: *Quercus hybrida* Brot., *Fl. Lusit.* 2: 31 (1805) = *Quercus lusitanica* var. *boissieri* (Reut.) A.DC. in A.P.de Candolle, *Prodr.* 16(2): 18 (1864) = *Quercus lusitanica* var. *hybrida* (Brot.) Nyman, *Consp. Fl. Eur.* 661 (1881) = *Quercus lusitanica* f. *macrophylla* Coutinho, *Bol. Soc. Brot.* 6: 69 (1888) = *Quercus lusitanica* f. *vulgaris* Coutinho, *Bol. Soc. Brot.* 6: 69 (1888), nom. inval. = *Quercus lusitanica* subsp. *broteroi* (Coutinho) Mouill., *Traité Arbr. Arbriss.*: 1162 (1892) =



*Quercus faginea* subvar. *macrophylla* (Coutinho) A.Camus, *Chênes, Atlas* 2: 113 (1935) ≡ *Quercus lusitanica* subsp. *navarrana* O.Schwarz, *Repert. Spec. Nov. Reg. Veg.*, 38: (1936) ≡ *Quercus faginea* subsp. *broteroi* (Coutinho) A.Camus, *Chênes, Texte* 2: 179 (1939) ≡ *Quercus faginea* subvar. *bullata* (Coutinho) A.Camus, *Chênes, Texte* 2: 180 (1939) ≡ *Quercus faginea* var. *bullata* (Coutinho) A.Camus, *Chênes, Texte* 2: 178 (1939) ≡ *Quercus faginea* var. *eubroteroi* A.Camus, *Chênes, Texte* 2: 179 (1939), nom. inval. ≡ *Quercus broteroi* (Coutinho) Rivas Mart. & Sáenz de Rivas, *Rivasgodaya*, 6: 104 (1991).

***Quercus faginea* subsp. *broteroi* var. *tlemcenensis*** (A.DC.) Trabut & Batt., *Fl. Alg.*: 21 (1888) (See Lamina 4)

**Basionym:** *Quercus pseudosuber* var. *tlemcenensis* A.DC, in A.P.de Candolle *Prodr.* 16(2): 44 (1864)

**Synonyms:** *Quercus lusitanica* subvar. *sublobata* Coutinho, *Bol. Soc. Brot.* 6: 69 (1888) ≡ *Quercus lusitanica* f. *submembranacea* Coutinho, *Bol. Soc. Brot.* 6: 67 (1888) ≡ *Quercus lusitanica* f. *salicifolia* Coutinho, *Bol. Soc. Brot.* 6: 68 (1888) ≡ *Quercus faginea* var. *tlemcenensis* (A.DC.) Jahand. & Maire, *Cat. Pl. Maroc* 2: 165 (1932) ≡ *Quercus tlemcenensis* Huguét del Villar, *Trab. Lab. Bot. Fac. Sc. Alger* 452 (1938) ≡ *Quercus faginea* subvar. *sublobata* (Coutinho) A.Camus, *Chênes, Texte* 2: 180 (1939) ≡ *Quercus faginea* var. *submembranacea* (Coutinho) A.Camus, *Chênes, Texte* 2: 177 (1939) ≡ *Quercus lusitanica* var. *salicifolia* (Coutinho) C.Vicioso, *Rev. Gen. Quercus Esp.* 108 (1950) ≡ *Quercus lusitanica* var. *submembranacea* (Coutinho) C.Vicioso, *Rev. Gen. Quercus Esp.* 112 (1950) ≡ *Quercus faginea* subsp. *tlemcenensis* (A.DC.) Maire & Weiller ex Greuter & Burdet, *Willdenowia* 12(1): 44. (1982).

The area with the greatest diversity in the Gall Oak complex is concentrated in the southern portion of the Iberian Peninsula, especially in areas of low altitude, with habitat shared by populations of Cork Oak (*Quercus suber* L.) and Algerian (Mirbeck's) Oak (*Quercus canariensis* Willd.).

Finally, hybridization is probably the source of two taxa associated with *Q. faginea* in historical treatments: *Q. australis* Link (= *Q. faginea* subsp. *faginea* × *Q. faginea* subsp. *broteroi*) and *Quercus lusitanica* var. *maroccana* Braun-Blanq. & Maire (= *Q. canariensis* × *Q. faginea* [*Q. lusitanica* var. *broteroi*])

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## Appendix 1

### MATERIALS STUDIED

#### *Quercus faginea* Lam. subsp. *faginea* var. *faginea*

SPAIN: HS: BADAJOZ: Garbayuela HSS 7276; Hoya Santa María HSS 6154; Puerto Peña, HSS 5424; Cabeza de la Vaca, Tentudía, HSS 4814; Calera de León, Tentudía, HSS 4813; Valle de Matamoros, HSS 17766; Valle de Santa Ana, arroyo de los molinos, HSS 2458; Valle de Santa Ana, HSS 17648. CÁCERES: Guadalupe, El Humilladero, HSS 5207; Guadalupe, HSS 5206; La Calera, HSS 17882; Navalvillar Ibor, HSS 2507; Navatrasierra, HSS 11151. GUADALAJARA: Torija, márgenes de carretera, HSS 7532; Torija, HSS 7498. HUESCA: Sabiñaningo, HSS 2427; Valle Ansón, HSS 7565. SALAMANCA limite Zamora, HSS 3394; Valdelosa, HSS 16859. SORIA Calatañazor, HSS 10152; Calatañazor alrededores, HSS 10153.

#### *Quercus faginea* subsp. *faginea* var. *alpestris* (Boiss.) F.M.Vázquez, M.Gutiérrez & S.Ramos

SPAIN: HS: BADAJOZ: El Pintado, HSS 4632; Fuente de León, HSS 3720; Hoya Santa María, próximo al pueblo, HSS 6128; Hoya Santa María, alcornocales, HSS 6121; Hoya Santa María, HSS 6132; Jerez Caballeros, HSS 1224; Salvaleón, localidad, HSS 6614; Salvaleón, hacia Salvatierra, HSS 17633; Salvaleón, HSS 6523; Siruela, HSS 11463; Valle de Matamoros, HSS 25907. CÁDIZ: Alcalá de los Gazules, HSS 10391; Algar, HSS 10520; Arcos de la Frontera, HSS 10381; Castellar de la Frontera, HSS 10349; El Bosque, HSS 10323; Puerto de Galis, HSS 10459; Puerto de Galis a Arcos de la Frontera, HSS 10458; Jimena de la Frontera, localidad, HSS 10342; Jimena de la Frontera, HSS 10344; Ubrique, HSS 10445. CIUDAD REAL: Puebla de Don Rodrigo, límite provincial con Badajoz, HSS 6404; Puebla de Don Rodrigo a límite con Badajoz, HSS 6403; Luciana, HSS 6391. MÁLAGA: Cortes de la Frontera, localidad, HSS 1079; Cortes de la Frontera, HSS 10372; Gaucin, localidad, HSS 10339; Gaucin, HSS 1033; Ronda, HSS 1220  
PORTUGAL: LU: ALGARVE: Sierra Calderon, HSS 6466.

#### *Quercus faginea* subsp. *broteroi* var. *broteroi* (Coutinho) A.Camus

SPAIN. HS: BADAJOZ: Cabeza la Vaca, HSS 1108; Cíjara, HSS 6572; Cíjara hacia Orellana, HSS 6585; Cíjara, hacia Herrera del Duque, HSS 6586; Fregenal, hacia Higuera la Real, HSS 3479; Fregenal, HSS 3732; Hoya Santa María, hacia Puebla del Maestre, HSS 5506; Hoya Santa María, HSS 6108; Jerez Caballeros, HSS 1227; Jerez Caballeros, localidad, HSS 2486; La Parra, HSS 5030; Monesterio, HSS 7235; Salvaleón, HSS 6527; Salvaleón, localidad, HSS 6538; Salvaleón, hacia Salvatierra, HSS 6619; Salvatierra Barros, HSS 4988; Salvatierra Barros, hacia Salvaleón, HSS 13054; Segura León, HSS 1098; Tentudía, HSS 4966; Valle de Santa Ana, HSS 1323; Valle de Santa Ana, arroyo de los molinos, HSS 3488; Zafra, HSS 16908. CÁDIZ: Algar, HSS 10518; El Bosque, HSS 10326; Puerto de Galis hacia Arcos, HSS 10450; Galis, HSS 10454;

Grazalema, HSS 4824; Ubrique, HSS 10441; Ubrique, localidad, HSS 10446. CÁCERES: Piornal, HSS 5530; Serradilla, HSS 5562; Villareal hacia Torrejón el Rubio, HSS 5806; Villareal, HSS 5807. CIUDAD REAL: Puebla de Don Rodrigo, límite provincial con Badajoz, HSS 6399; cerca Luciana, HSS 6375; Luciana, localidad, HSS 6423; Luciana, HSS 6444. GUADALAJARA: Torija, HSS 7535. HUELVA: Galaroza, HSS 8523; Santa Ana, alrededores, HSS 5220; Santa Ana, HSS 5221. JAÉN: Cazorla, HSS s/n. MÁLAGA: Gaucin, localidad, HSS 10329; Gaucin, HSS 10334. TOLEDO: Navalcán, HSS 16729.

PORTUGAL. LU: ALENTEJO: Avis a Cano, HSS 6837; Avis, HSS 6839;

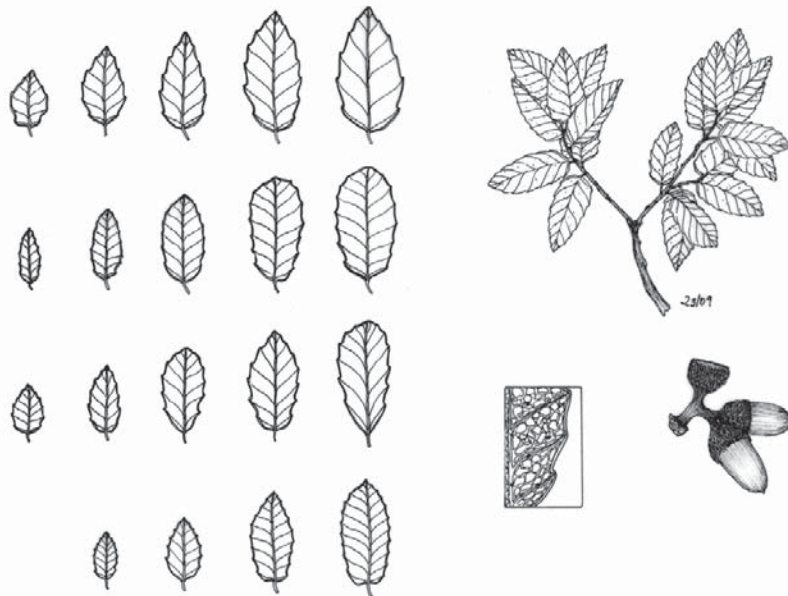
Cabeçao, alcornocal, HSS 6806; Cabeçao, localidad, HSS 6926; Cabeçao, HSS 6941; Cano, HSS 5344; Estremoz, hacia Portalegre, HSS 6770;

Estremoz, HSS 6771; Ponte do Sor, HSS 5296. ALGARVE: Sierra Calderon, HSS 6464; Sierra Calderon, HSS 6465. ESTREMADURA: Arrabida, HSS 7493; Setubal, HSS 7454

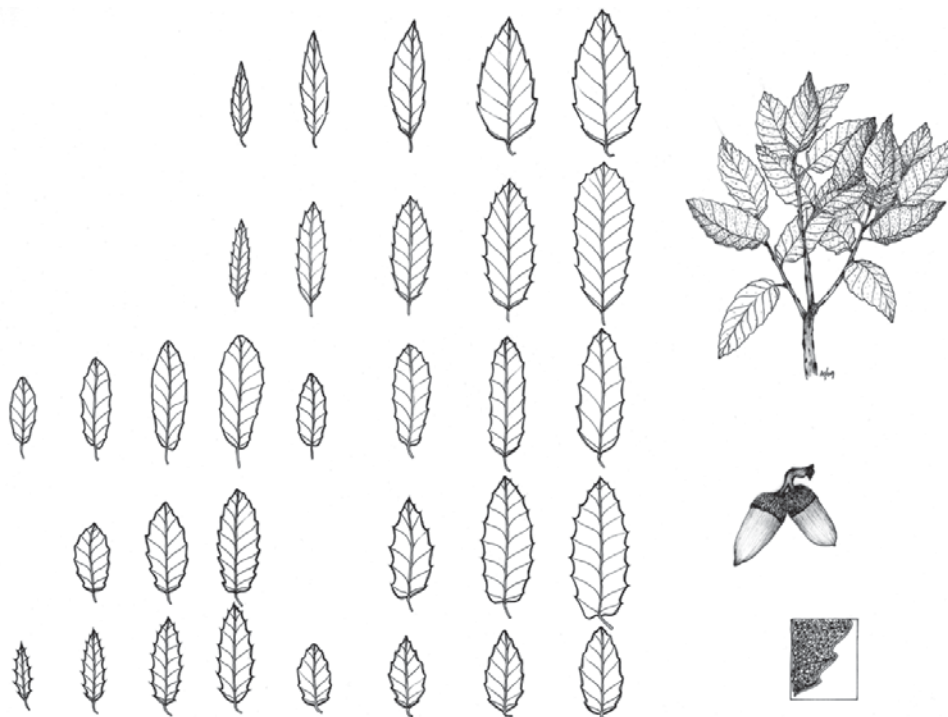
***Quercus faginea* subsp. *broteroi* var. *tlemcenensis* (A.DC.) Trabut & Batt.**

SPAIN. HS: BADAJOZ: Cíjara, HSS 6571; Hoya Santa María, HSS 5499; Salvaleón, hacia Salvatierra, HSS 6611; Salvaleón, HSS 6563; Salvatierra Barros, HSS 1114; Valle de Matamoros, HSS 25908; Valle de Santa Ana, HSS 3466. CÁDIZ: Arcos de la Frontera, HSS 10384; Puerto de Galis, HSS 10463; Grazalema, HSS 4826; Ubrique, HSS 10379. CÁCERES: Navatrasierra, HSS 11155. CIUDAD REAL. Puebla de Don Rodrigo, proximidades al límite con Badajoz, HSS 6436; Luciana, HSS 6383.

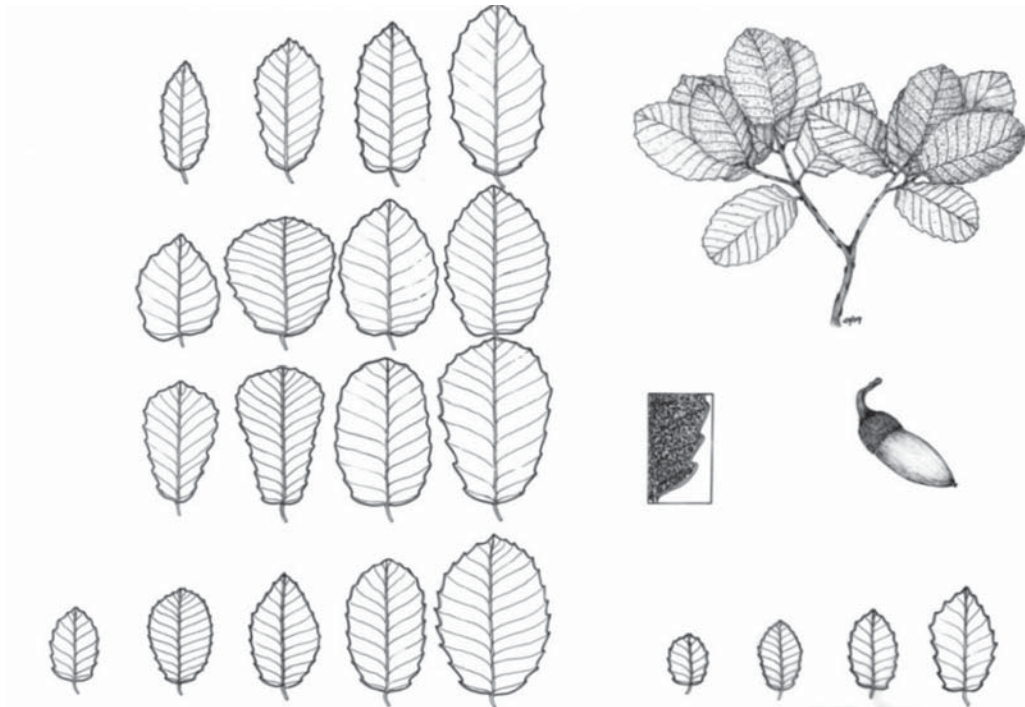
Appendix 2



**Figure 1.** Diversity of leaves, acorn, margin of leaf, and branch of *Quercus subsp. faginea var. faginea* Lam.

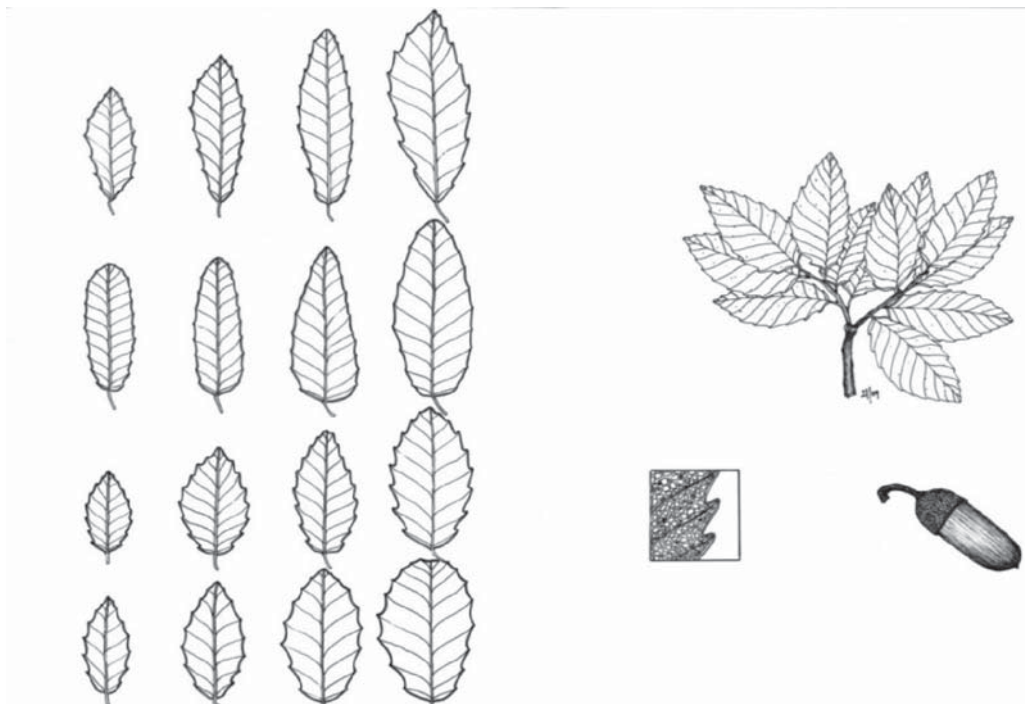


**Figure 2.** Diversity of leaves, acorn, margin of leaf, and branch of *Quercus faginea subsp. faginea var. alpestris* (Boiss.) F.M.Vázquez, M.Gutiérrez & S.Ramos.



**Figure 3.**

Diversity of leaves, acorn, margin of leaf, and branch of *Quercus faginea* subsp. *broteroi* (Coutinho) A.Camus.



**Figure 4.**

Diversity of leaves, acorn, margin of leaf, and branch of *Quercus faginea* subsp. *broteroi* var. *tlemcenensis* (A.DC.) Trabut & Batt.

### **Appendix 3 Morphological Characters Studied**

#### **LEAF**

1. Length of the blade (cm)
2. Width of the limb (cm)
3. Petiole length (mm)
4. Petiole section
5. Margin type
6. Margin pubescence
7. Adaxial pubescence
8. Abaxial pubescence
9. Surface of the blade
10. Number of ribs
11. Rib types
12. Enervation types
13. Adaxial hair types
14. Abaxial hair types

#### **MALE FLOWERS**

15. Catkin length (mm)
16. Number of flowers per catkin
17. Catkin pedicel length (mm)
18. Catkin pubescence
19. Petal length (mm)
20. Petal width (mm)
21. Petal margin
22. Petal pubescence
23. Anther length (mm)
24. Anther pubescence
25. Anther color
26. Filament length (mm)
27. Filament pubescence
28. Filament section

#### **FEMALE FLOWERS**

29. Inflorescence present
30. Number of flowers per inflorescence
31. Number of flowers per branch
32. Flower length (mm)
33. Flower width (mm)
34. Flower pubescence
35. Cupule length (mm)
36. Cupule width (mm)
37. Cupule pubescence
38. Cupule bract morphology
39. Cupule bract imbrications
40. Peduncle length (mm)
41. Peduncle pubescence
42. Insertion peduncle-cupule type

## FRUIT

43. Length (mm)
44. Width (mm)
45. Weight (gr)
46. Surface color
47. Surface pubescence
48. Surface type
49. Cupule morphology
50. Cupule length (mm)
51. Cupule width (mm)
52. Cupule pubescence
53. Cupule bract morphology
54. Cupule bract imbrications

## BUD MORPHOLOGY

55. Length (mm)
56. Width (mm)
57. Bract secondary morphology
58. Bract primary morphology
59. Bract margin
60. Bract pubescence