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Comparison of the autoecology of *Quercus robur* L. and *Q. petraea* (Mattuschka) Liebl. stands in the Northwest of the Iberian Peninsula

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Abstract. The purpose of the present work is to characterize the functioning of the ecosystems of semideciduous and deciduous Atlantic oaks in the northwest of the Iberian Peninsula. The studied species were: *Quercus robur* L. and *Quercus petraea* (Mattuschka) Liebl. To advance in the knowledge of the autecology of these species it is necessary to descend at the regional level and describe in detail the variability of the environment to determine their potential, and to decide the silvicultural treatments to be applied to preserve them and to analyze future actuations in order to a possible expansion. The analysis of the results allows knowing differences in continentality and site conditions, with more precipitation, soil variability and humidification in *Q. petraea* forests respect to *Q. robur*. These information represent appropriate measures for the sustainable and multifunctional management of these forests, useful as indicators environmental and forestry parameters as well as the conservation status of these formations.

Keywords: Autoecology, habitat, *Quercus robur, Quercus petraea*, Iberian Peninsula, Galicia.

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Introduction

Both the studied species belong to the genus *Quercus*, although there are differences with regard to their distribution. *Quercus robur* L. appears almost all over Europe, from the Atlantic Ocean to the Urals, from Norway to the Iberian Peninsula and Italy, with its southern border on Sicily, although it does not appear in Greece and Turkey. The best stands are on the Danube and Rhin valleys and on French large areas (Díaz-Fernández et al. 1995). In the Iberian Peninsula it is abundant on the Cantabrian and Atlantic coast, stretching down Portugal to Sierra de Sintra, being abundant in Galicia and Asturias.

On the other hand, *Quercus petraea* (Mattuschka) Liebl., is a species with a very concrete distribution area, more reduced than other Fagaceae. Its natural stretching area spans to the most Western European border, specially to the centre and South. It is spread from the Nordic countries to Sicily and from the British Isles to the extinct USSR, reaching Western Asia.

Within the Iberian Peninsula, its distribution appears very disperse, but, however, it is larger than *Quercus robur*´s. Concretely, it is exclusively manifested in the northern area and only in the northern mountain range, from Galicia to Catalonia, being its main manifestations the chains of Leon, Palencia, Santander, Basque Country and Navarra (Amaral 1990, Vila-Lameiro 2003).

The two species are shortly used for reforestations on the Iberian Peninsula, being frequently found forests formed by pollard trees used to obtain firewood. The abundance of trees from sprat of stool, or even root, justifies their regeneration method as a coppice forest, but without selection of the best coppice shoots and, therefore, these trees use to have a low commercial value (Díaz-Maroto 1997).

Natural regeneration of oak is increasingly abundant on abandoned agricultural lands, which have very good improvement possibilities by means of an adequate management, as they are formed by young, vigorous and little damaged stems because unfortunate silvicultural treatments were not applied, as they were in another stands (pollard or selective felling of the best specimens). Getting oak stems with good forest habit is difficult and it requires a specific silviculture which has not been applied on the study area. Trees that naturally had these characteristics related to the production of quality timber have been indiscriminately harvested, which has lead to an important genetic degradation of these stands (Álvarez et al. 2000).

However, little frequent operations as cleaning and brush out allow to abandon rapidly the state of "oak scrubland" present in many stands, in which strong competence affects very much to the growth, and being also more sensitive to fires (Vila-Lameiro 2003). The initial density of oak stands must be higher than 10000 stems/ha, which lets improving their shape.

It is necessary to respect the layer of shade-loving species in subsequent operations, which usually exists naturally and favour the formation of good quality oak stems. Thinnings will be moderated, due to the sharp trend of oaks to form sprouts, which are stimulated by lighting of their trunk, and the dominant and codominant trees will be specially managed (Vila-Lameiro 1998).

In case of scrublands where a previous selection of 400 to 600 sprouts/ha has been done after a clear cut, it is possible to practice coppicing with standards, keeping the accompanying coppice shoots to reduce the appearance of epicormic shoots and the incidence of wind (Álvarez et al. 2000).

The aims of the present work are the following: (i) to study the distribution of natural stands of *Quercus robur* L. and *Quercus petraea* (Mattuschka) Liebl. from the NW of the Iberian Peninsula; (ii) to characterize ecologically those species and determine their biotic potential, quantifying the relation among different environmental factors (e.g. physiography, climate, soil) with growth and production of these stands; (iii) to analyze the possible site indicators based on ecological parameters, such as habitat indicators of the oak stands from peninsular NW.

Material and methods

Study area

The study area is located on the NW of the Iberian Peninsula, covering Galicia, Asturias and Leon. The studied stands are located on the Western Galician mountains and along the dividing Astur-Leonese (*Quercus petraea*), or spread all over the *Galician* territory (*Quercus robur*). These forests come from natural regeneration, from seed or from sprout of stool or root (Díaz-Maroto 1997, Vila-Lameiro 2003) (Figure 1).

Sampling design

Due to the dispersion and heterogeneity of the studied oak stands, it is unviable to initially stratify them (Díaz-Maroto 1997, Díaz-Maroto et al. 2005), so the study area has been considered as one unit, eliminating certain regions where the site particularities make the presence of some of the two studied species very difficult. As no stratification of the territory was made, the location of the stands was chosen attending to a certain criterion of homogeneity, trying to maximize the representation of the characteristics of each region. Initially, it was considered a minimum stand area between 0.5 and 1 ha, which would permit installing inventory plots without any problem derived from the border effect (Hummel 1959, Díaz-Maroto 1997, Grandas et al. 1997). The election of the sampling site must be resolved so that the chosen point does not present any accidental char-

Figure 1 Study area ubication

acteristic regarding to the region which it is representing.

When the stands were located, a permanent display of 92 sampling plots was installed with a rectangular shape and variable dimensions, attending to the stand density, so the number of trees of which diameter is bigger than the minimum inventoriable (5 cm) is not below 50 (Hummel 1959, Rondeux 1993). Physiographic, dendrometric and profile data were taken, which, together with the climatic ones adapted to the sampling points, were useful to elaborate a group of parameters of the physiograhic, climatic and edaphic habitat of each species (Gandullo et al. 1991, Timbal & Aussenac 1996, Rubio et al. 1997, Blanco et al. 2000, Gómez et al. 2002).

Elaborated parameters

A total amount of 39 parameters was elaborated, 26 ecological descriptive parameters of the biotope (Gandullo et al. 1983, 1991, Castroviejo 1988, Timbal & Aussenac 1996, Rubio et al. 1997, Johnson et al. 2002) and of the environmental conditions which determine regeneration and growth of oak stands (Ashton & Larson 1996, Humphrey & Swaine 1997, Kelly 2002) and 13 parameters which characterize dasometrically and silviculturally the different studied stands (Pardé & Bouchon 1988, Timbal & Aussenac 1996, Díaz-Maroto 1997, Barrio 2003, Vila-Lameiro & Díaz-Maroto 2005). Then, these parameters are described in Table 1.

To choose the meteorological observatory it was taken into account a group of factors, such as: geographic proximity, orientation, altitude, slope, similar relief, etc. When the most adequate observatory of the region was chosen, the data were altitudinally corrected, when needed, according to the procedure of Carballeira et al. (1983) and Retuerto & Carballeira (1990).

The 20 upper centimetres of soil were considered for the superficial values of the edaphic parameters, except when there are more than one layer at that deepness, and the pondered mean was calculated. When the total value of the parameter is considered within the soil profile, the pondered mean is taken according to Russel and Moore method (1968).

Table 1 Physiographic, climatic, edaphic and stand parameters maganed to characterizate *Quercus robur* and *Q. petraea* plots

Parameter type	Abbreviation	Name	Description	Units
Physio-graphic	ALT	Mean altitude	Mean height of the stand over the sea level	Meters
	PTE	Mean slope	Mean slope of the land of the plot	Percentage
	ORI	Orientation		Degrees
	PROF	Soil deepness	From the surface to the parent rock	Centimetres
	DM	Distance to the sea	Distance to the sea	Kilometres
Climatic	PT	Total annual precipitation		Milimetres
	PE	Summer precipitation	Between July and September	Milimetres
	TM	Mean annual temperature		Celsius degrees
	TMA	Mean annual temperature of the absolute maximums		Celsius degrees
	TmA	Mean annual temperature of the absolute minimums		Celsius degrees
Edaphic	PH and PHS	Total and superficial pH in H_2O	Current acidity on soil	Dimensionless
	MO and MOS	Total and superficial organic matter	Percentage of humified organic matter in soil	Percentage
	N and NS	Total and superficial nitrogen	Percentage of nitrogen in soil	Percentage
	C/N and C/NS	Total and superficial carbon-nitrogen ratio		Percentage
	P and PS	Total and superficial available phosphorus	Content of available phosphorus	Ppm
	K and KS	Total and superficial changeable potassium	Content of changeable potassium	Ppm
	Ca and CaS	Total and superficial changeable calcium	Content of changeable calcium	Ppm
	Mg and MgS	Total and superficial changeable magnesium	Content of changeable magnesium	Ppm
Stand parameters	DEN	Number of stems per hectare		Trees/ha
	DMA	Arithmetic mean diameter		Centimetres
	DMC	Quadratic mean diameter		Centimetres
	DED	Standard deviation of the diametric distribution		Centimetres
	CVD	Coefficient of variation of the diametric distribution		Dimensionless
	DOM	Dominant diameter		Centimetres
	HMA	Mean arithmetic height		Metres
	HMC	Mean quadratic height		Metres
	DEH	Standard deviation of the height distribution		Metres
	CVH	Coefficient of variation of the height distribution		Dimensionless
	HDA	Assman dominant height		Metres
	IHA	Hart Index		Dimensionless
	ICZ	Czarnowski Index		Dimensionless

Statistical analyses

With the values of the 26 ecological parameters and the 13 silvicultural descriptives of the biotope and the dasometric and silvicultural structure of the oak stands a database was elaborated which, at a first stage, was undergone to an univariable statistical analysis (Walpole et al. 1999). Subsequently, the following characteristic values were determined (Gandullo et al. 1983, 1991, Rubio et al. 1997, Blanco et al. 2000, Gómez et al. 2002): (i) inferior limit (LI - minimum value of the parameter); (ii) inferior threshold (UI - minimum value of the parameter, excluding 10% - percentile 10); (iii) mean (M - mean value of the parameter); (iv) superior threshold (US - maximum value of the parameter, excluding 10% of the highest values (percentile 90); (v) superior limit (LS - maximum value of the parameter).

It is possible to calculate on the basis of these values the physiographic, climatic and edaphic limits and define the habitats of oak stands, according to the following criteria (Gandullo et al. 1983, 1991, Gaines & Denny 1993): (i) to describe as central or optimum habitat, with regard to a parameter, the interval defined by the superior and inferior thresholds and made up by 80% of sampling points, excluding 10% of those in which the parameter take on the highest values and the other 10% in which it reaches the lowest values, and, (ii) to consider as marginal habitat, with regard to a parameter, the intervals comprised between inferior limit and inferior threshold and between superior threshold and superior limit, made up by the remaining 20%.

The central habitat defines the most suitable physiographic, climatic and edaphic conditions, while, with regard to the marginal habitat, the non optimum condition of any parameter makes more doubtful the suitability of that site, although its current presence can be due to different compensations among ecological factors, or even to other parameters which were not considered for the study (Gandullo & Sánchez 1994, Díaz-Maroto et al. 2006a).

This is a first approximation to describe adequately the phytocenose of the stands of both species on the NW of the Iberian Peninsula, as not all elaborated parameters will be equally important or significant as environmental descriptors, but some will define with higher precision than others the distribution of these formations (Gandullo et al. 1983, 1991, Gaines & Denny 1993).

Once the habitat is defined through a discriminat analysis, parameters with higher descriptive weight were identified (Hix 1988, Kent & Coker 1996). To make this analysis has been used the method proposed by Hill (1973) and Hill et al. (1975), which allows reaching a dichotomic classification of different plots, sampled randomly, using for that the program TWINSPAN (Hill 1979a, 1979b, Pisces Conservation LTD. 1999). When the classification is made, any other point of the territory can be automatically introduced, so the whole study area can be classified. The initial point of this method is the construction of a matrix plots-attributes (parameters), where columns are the parameters and rows the plots, so each plot is defined by the presence or absence of each considered attribute. The program makes a reciprocal averaging ordination (R.A.O.) which leads to divide the group of plots into two; subsequently each group is defined, as approximate as possible, through a series of indicators and so on, until a complete dendrogram of plots classification is obtained. When this dendrogram is finished, another is made with regard to the parameters, analyzing the fidelity of them to each defined group of plots. This program can be run when data are discret, as the absence or degree of presence of some species, or, with regard to continuous variables, as in this case, being then necessary, first of all, to convert them into a binary form (presence = 1, absence = 0) so each parameter is converted into so many attributes as the number of intervals that have been considered (Aramburu et al. 1984, Gandullo et al. 1991).

Each classificatory parameter was divided into three intervals of which limits were established on a way that the number of plots included in each of them was approximately equal to one third of the total. For this, the values of their mean and standard deviation were taken, as in principle the distribution of plots according to the values of each parameter is unknown (Martínez et al. 1992). So, limits of each interval are defined according to the following way (Díaz-Maroto 1997): (i) Inferior interval < Mean of the parameter - Standard deviation (< M-DE); (ii) Mean interval = Mean of the parameter ± Standard deviation (> M-DE; < M + DE); (iii) Superior interval > Mean of the parameter + Standard deviation (> M+DE).

Later, a bivariate analysis (correlation matrix) was made between silvicultural information and dasometrical and silvicultural parameters, which give information about the current situation of the stands, and between silvicultural information and the parameters that describe the biotope, fruits of the discriminant analysis (Walpole et al. 1999).

Subsequently, the correlation matrix between silvicultural information and dasometric/silvicultural parameters and descriptives of the environment, obtained with the discriminant analysis, made possible to set out an Principal Component Analysis (PCA) (SAS Institute Inc. 2004). With this, it could be identified how dasometric/silvicultural and ecological parameters, more significantly related, explain the variability of oak stands of both studied *Quercus* species (Timbal & Aussenac 1996, Jobson 1991, Ryan 1997).

The idea of PCA consists of obtaining lineal combinations of the original variables, so they explain the most possible quantity of variability of data. The PCA technique presents a double use: it allows representing optimally within a small dimension space, observations of a general space with bigger dimension. It also allows converting the original variables which are generally correlated, into new non correlated variables that make the interpretation easier (SAS Institute Inc. 2004).

According to the obtained results, the silvicultural state of these forests was modelled through a stepwise multivariate regression (Ryan 1997, SAS Institute Inc. 2004), to study how each component varies with regard to the other measured parameters. For this, the resultant vector of the ACP is used as a dependent variable and all the measured parameters as independent variables. The resulting regression equation defines a hiperplane within a multidimensional space. For more than one independent variable, as it happens in this case, the graphic representation of the present relations in a regression model turns out little intuitive, complex and useless, working out easily to come from the equation of the lineal regression model:

$$V1 = A_0 + A_1 x_1 + A_2 x_2 + \dots\dots + A_n x_n \qquad (1)$$

According to this model or equation, the dependent variable ($V1$) is interpreted as a lineal combination of a group of n independent variables (x_n), where each of them is accompanied by a coefficient (A_n) which indicates the relative weight of that variable within the equation; the equation also includes a constant (A_0).

Results

Univariate analysis of the ecological parameters

In Table 2 are observed the general physiographic and edaphic characteristics of each plot for both species, *Quercus robur* and *Q. petraea*. The univariate description of the ecological parameters of both species is shown in the Table 3. All this information from physiographic, edaphic and climatic parameters is joined in the Figures 2 and 3 where is represented the comparative physiographic-climatic and edaphic habitats between *Q. robur* - *Q. petraea*.

With regard to silvicultural characteristics, in Table 4 are shown the statistics of the 13 stand parameters considered, capturing the heterogeneity between them.

Subsequently, to choose which of these silvicultural/dasometric parameters explain the better the use and current situation of the oak stands on the NW of the peninsula, and to study the possible relation with the biotope, two bivariable analysis of the correlation matrix were done (Tables 5 and 6).

As consequence of these analysis, a discriminant analysis of the plots was developed and the obtained results show that parameters with a higher classificatory weight in the habitat of the studied species have been for *Q. robur* (Díaz-Maroto et al. 2005, Vila-Lameiro & Díaz-Maroto 2005) the physiographic (ALT, PTE, PROF and DM), and climatic ones (PT, TM, TMA and TmA). For *Q. petraea* (Díaz-Maroto et al. 2006b), it was obtained a physiographic parameter: ALT and several edaphic: PHS, KS, MOS and Ca.

Comparative analysis between species

For *Quercus petraea*, as for *Q. robur*, the greater variability is obtained on the ORI parameter with a CV > 70% and, as a particu-

Table 2 General physiographic and edaphic characteristics of *Quercus robur* and *Q. petraea* plots (altitude in meters; slope in %)

Quercus robur						
Sampling Plot	Altitude	Slope	Orientation	Parent Rock	Texture	Soil Type
A Pena	650	0	-	Granite	Sandy	Dystric Cambisol
A Rúa	240	14	North	Schists	Sandy	Dystric Cambisol
Ancares	1075	60	North	Quartzites	Sandy-Loam	Dystric Cambisol
Bańos de Molgas	565	10	Northwest	Granite	Sandy	Dystric Cambisol
Barcía	740	12	Southwest	Quartzites	Sandy	Dystric Cambisol
Boimente	510	8	Northeast	Granodiorite	Sandy	Dystric Cambisol
Cerceda	420	17	North	Granite	Sandy-Loam	Dystric Cambisol
Cerqueiros 1	393	55	Northwest	Schists	Sandy-Loam	Gleyic Cambisol
Cerqueiros 2	400	60	East	Schists	Sandy-Loam	Humic Umbrisol
Coiró	320	20	Northeast	Granite	Sandy-Clay	Dystric Cambisol
Curtis	480	27	South	Granite	Sandy-Clay	Humic Umbrisol
Fragavella	620	48	Southeast	Granite	Sandy	Humic Umbrisol
Gomaríz	220	27	North	Granite	Sandy	Distric Regosol
Lagoa	110	8	Southwest	Granodiorite	Sandy	Distric Regosol
Lobios	790	53	North	Granite	Sandy	Humic Regosol
Lourizán	60	8	Northwest	Gneiss	Sandy	Dystric Cambisol
Monfero	500	48	Northwest	Schists	Sandy-Loam	Dystric Cambisol
Monte Marronda 1	800	72	Northeast	Schists/Quartzites	Sandy-Loam	Distric Regosol
Monte Marronda 2	670	58	Northeast	Schists/Quartzites	Loam	Humic Regosol
Monte Marronda 3	540	60	Northeast	Schists	Loam	Humic Regosol
Monte San Fitoiro 1	620	0	-	Granite	Sandy	Dystric Cambisol
Monte San Fitoiro 2	630	15	Northwest	Granite	Sandy-Loam	Dystric Cambisol
Monte San Fitoiro 3	690	25	North	Granite	Sandy-Loam	Dystric Cambisol
Ourantes	380	65	Northeast	Granite	Sandy	Dystric Cambisol
Ribeiro	360	21	Southeast	Schists	Sandy-Loam	Dystric Cambisol
S.Miguel de Bacurín	500	0	-	Granite	Sandy	Dystric Cambisol
Salvaterra do Mińo	80	12	Northeast	Granite	Sandy	Dystric Cambisol
Serra do Candán 1	540	38	Northwest	Schists	Loam	Dystric Cambisol
Serra do Candán 2	550	22	Northwest	Schists	Loam	Dystric Cambisol
Serra do Candán 3	600	12	North	Schists	Loam	Dystric Cambisol
Serra do Invernadoiro	1300	35	North	Slates	Sandy-Loam	Dystric Cambisol
Siador	600	27	Northwest	Granite	Sandy	Dystric Cambisol
Sobrado dos Monxes	520	0	-	Gneiss with biotite	Sandy	Dystric Cambisol
Teixeiro	300	10	East	Slates/Quartzites	Loam	Humic Umbrisol
Valdín	1080	36	East	Granite	Sandy	Humic Regosol
Viloalle	265	23	Southeast	Granodiorite	Sandy-Clay	Dystric Cambisol
Xesta	740	25	Southwest	Granite	Sandy	Dystric Cambisol
Xestoso	600	19	Northeast	Schists	Sandy	Dystric Cambisol
Xunqueira de Ambía	565	7	Northwest	Granite	Sandy	Dystric Cambisol

Table 2 (continuation)

Quercus petraea						
Sampling Plot	Altitude	Slope	Orientation	Parent Rock	Texture	Soil Type
Ancares 1	1220	52.06	Northeast	Granite	Loam	Distric Regosol
Ancares 2	1000	57.15	Northwest	Granite	Loam	Distric Regosol
Ancares 3	965	80.98	Southeast	Schists	Loam-Clay	Humic Umbrisol
Ancares 4	1310	52.61	East	Schists	Loam-Clay	Humic Umbrisol
Ancares 5	1215	49.86	West	Granite	Loam	Distric Regosol
Ancares 6	1190	53.17	West	Granite	Sandy-Loam	Umbric Regosol
Baleira	840	42.45	Northwest	Slates	Loam	Umbric Regosol
Candin 1	1230	38.79	Northwest	Slates	Loam	Umbric Regosol
Candin 2	1070	62.73	North	Slates	Loam	Umbric Regosol
Cangas 1	1000	75.36	East	Slates	Loam-Sandy	Umbric Regosol
Cangas 2	1100	75.08	East	Slates	Loam-Sandy	Umbric Regosol
Cerredo 1	1120	36.40	Northeast	Slates	Sandy-Loam	Umbric Regosol
Cerredo 2	975	26.79	Northeast	Slates	Loam-Sandy	Umbric Regosol
Cerredo 3	1040	23.45	Northwest	Slates	Sandy-Loam	Umbric Regosol
Cerredo 4	1165	78.13	East	Slates	Loam-Sandy	Umbric Regosol
Cerredo 5	1120	37.39	Northwest	Slates	Loam-Sandy	Umbric Regosol
Cerredo 6	1080	42.65	North	Slates	Loam	Umbric Regosol
Cortes	860	28.30	Northeast	Granite	Loam-Sandy	Umbric Regosol
Courel 1	1165	70.02	-	Slates	Loam	Humic Umbrisol
Courel 2	1395	48.77	-	Slates	Loam	Umbric Regosol
Courel 3	1050	31.53	Northwest	Slates	Loam-Sandy	Umbric Regosol
Fondos 1	1110	74.00	Northwest	Slates	Loam	Umbric Regosol
Fondos 2	960	62.73	Southwest	Slates	Loam	Umbric Regosol
Ibias 1	900	66.94	North	Slates	Loam	Umbric Regosol
Ibias 2	800	54.07	Northwest	Slates	Loam	Umbric Regosol
Ibias 3	750	41.01	Northeast	Slates	Loam-Sandy	Umbric Regosol
Lena 1	970	28.49	East	Slates	Loam	Dystric Cambisol
Lena 2	1075	59.14	South	Slates	Loam	Dystric Cambisol
Meira	665	24.93	Southeast	Slates	Loam	Humic Umbrisol
Palacios 1	1160	73.19	Northeast	Slates	Loam	Umbric Regosol
Palacios 2	1035	47.27	Northeast	Slates	Loam-Sandy	Umbric Regosol
Palacios 3	1180	56.81	East	Slates	Loam	Umbric Regosol
Palacios 4	1145	35.41	Southeast	Slates	Loam-Sandy	Umbric Regosol
Palacios 5	1025	90.04	East	Slates	Loam	Umbric Regosol
Palacios 6	1000	25.86	Northwest	Slates	Loam-Sandy	Umbric Regosol
Pastoriza	540	7.87	North	Slates	Loam	Humic Umbrisol
Pintinidoira 1	1200	57.74	-	Slates	Loam	Umbric Regosol
Pintinidoira 2	1050	52.06	Northeast	Slates	Loam	Humic Umbrisol
Pontenova 1	725	53.17	Northwest	Granite	Loam	Umbric Regosol
Pontenova 2	550	57.74	West	Granite	Loam	Umbric Regosol
Pontenova 3	690	46.63	West	Granite	Loam	Umbric Regosol
Suarbol 1	1175	42.45	Southeast	Granite	Loam	Distric Regosol
Suarbol 2	1165	38.39	North	Granite	Loam	Distric Regosol
Suarbol 3	1245	50.95	North	Granite	Loam	Distric Regosol
Teverga 1	995	42.45	Northwest	Granite	Loam-Sandy	Umbric Regosol
Teverga 2	1030	29.81	Southwest	Granite	Loam-Sandy	Umbric Regosol
Teverga 3	1160	24.19	West	Slates	Loam	Umbric Regosol
Teverga 4	1125	20.71	West	Slates	Loam	Umbric Regosol
Villablino 1	1235	36.59	Northwest	Quartzites	Loam	Umbric Regosol
Villablino 2	1230	51.17	West	Slates	Loam-Sandy	Umbric Regosol
Villablino 3	1375	57.04	East	Slates	Loam-Sandy	Umbric Regosol
Villablino 4	1400	45.36	Southwest	Slates	Loam-Sandy	Umbric Regosol

Table 3 Descriptive statistics of the ecological parameters in *Quercus robur* and *Q. petraea* forests

Para-meter	Standard deviation		Arithmetic mean		Variation coefficient		Maximum		Minimum		Kurtosiss	
	Q .robur	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*
ALT	260.20	196.35	539.05	1053.37	48.27	18.64	1300.00	1395.00	60.00	540.00	1.32	0.58
PTE	20.92	17.61	27.61	48.42	75.78	36.36	72.00	90.04	0.00	7.87	-0.84	-0.28
ORI	135.47	122.39	163.26	165.31	82.98	74.04	358.00	359.00	0.00	0.00	-1.70	-1.63
PROF	25.77	44.62	93.59	103.56	27.54	43.08	150.00	190.00	46.00	25.00	-0.43	-1.01
DM	28.24	20.80	41.81	84.75	67.55	24.54	135.00	129.00	0.50	34.00	2.21	1.07
PT	298.76	249.12	1345.24	1589.52	22.21	15.67	1947.00	2006.00	772.00	1150.00	-0.62	-1.23
PE	49.01	28.75	160.22	192.52	30.59	14.93	283.00	227.20	61.00	143.50	0.36	-1.38
TM	1.41	2.05	11.34	8.75	12.43	23.39	14.60	10.95	7.30	5.00	1.23	-0.41
TMA	2.17	2.80	24.16	20.80	8.98	13.45	28.80	23.40	20.00	17.70	0.32	-2.08
TmA	2.49	2.94	0.36	-2.62	684.67	-112.13	6.20	-0.10	-4.30	-5.90	-0.16	-2.11
PH	0.45	0.36	4.83	4.73	9.38	7.72	6.15	5.65	3.92	4.23	0.97	0.48
PHS	0.51	0.43	4.68	4.59	10.80	9.29	6.53	5.60	3.82	3.90	3.55	0.23
MO	5.17	4.04	8.65	7.83	59.80	51.59	23.31	19.83	1.04	1.82	0.23	1.16
MOS	7.76	4.56	12.85	10.09	60.38	45.16	34.21	24.31	1.19	2.89	0.46	0.74
N	0.18	0.11	0.31	0.25	57.87	42.85	0.79	0.55	0.04	0.07	1.19	0.44
NS	0.23	0.13	0.44	0.32	52.58	39.11	1.02	0.72	0.05	0.10	-0.48	0.80
C/N	4.52	3.75	14.61	17.92	30.96	20.95	29.60	25.14	6.90	8.83	2.32	-0.25
C/N S	4.26	4.06	16.75	14.07	25.42	28.86	30.10	20.99	10.40	6.63	2.55	-0.76
P	28.59	7.49	21.33	9.53	134.04	78.61	117.20	24.80	0.40	0.93	3.36	-0.21
PS	28.94	14.49	19.38	12.57	149.34	115.23	119.50	52.69	0.40	0.76	5.62	3.40
K	40.38	52.90	72.31	90.04	55.84	58.75	231.00	275.09	9.00	25.69	5.38	4.54
KS	50.12	56.19	102.72	114.68	48.79	49.00	252.00	264.51	19.00	37.10	0.74	0.58
Ca	216.00	275.67	120.10	203.21	179.84	135.66	1297.00	1135.07	3.00	13.19	24.04	5.03
CaS	284.99	342.47	170.38	291.29	167.26	117.57	1704.00	1431.85	4.00	14.01	22.81	4.18
Mg	21.22	42.50	28.72	45.54	73.90	93.32	85.00	164.96	0.00	3.76	0.80	2.80
MgS	38.01	46.78	49.10	61.88	77.40	75.61	143.00	198.87	0.00	4.79	0.06	1.03

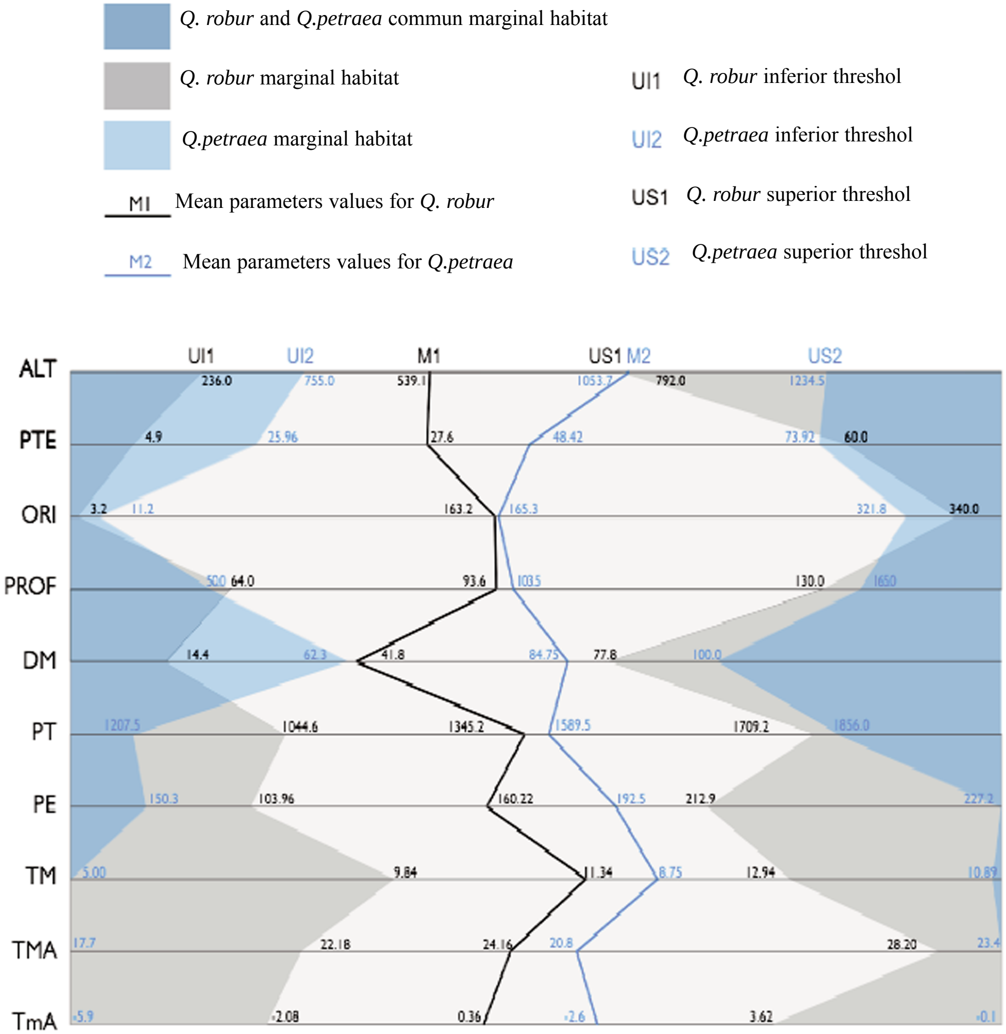

Figure 2 Physiographic and climatic habitat of *Quercus robur* and *Q. petraea*

lar case, on TmA, where 100% is exceeded. The lowest variability corresponds to TMA with a CV < 15%.

Observing the central physiographic-climatic habitat, it can be concluded that *Quercus robur* is located on lower altitude areas than *Q. petraea*; the superior threshold on which *Q. robur* is established reaches 792 m and the inferior threshold of *Q. petraea* is 755 m. This means that both species are inserted, with regard to the altitude, within a small range (Figure 2), being on both species the North orientation the most frequent.

Slope values show that *Quercus petraea* is settled on sites with a higher mean slope than *Q. robur*, with a mean slope getting on for 50% and scarce stands with slope lower than 30%. On the other hand, the mean slope of *Q. robur* stands does not reach 30%.

In order to the edaphic study, soils on which *Quercus petraea* is established present a dominant silt texture, with scarce presence of sandy and clay textures (Table 2). Soils are mainly of the type dystric cambisol on stands of *Q. robur* and umbric regosol on the ones where *Q. petraea* is settled, with percentages >

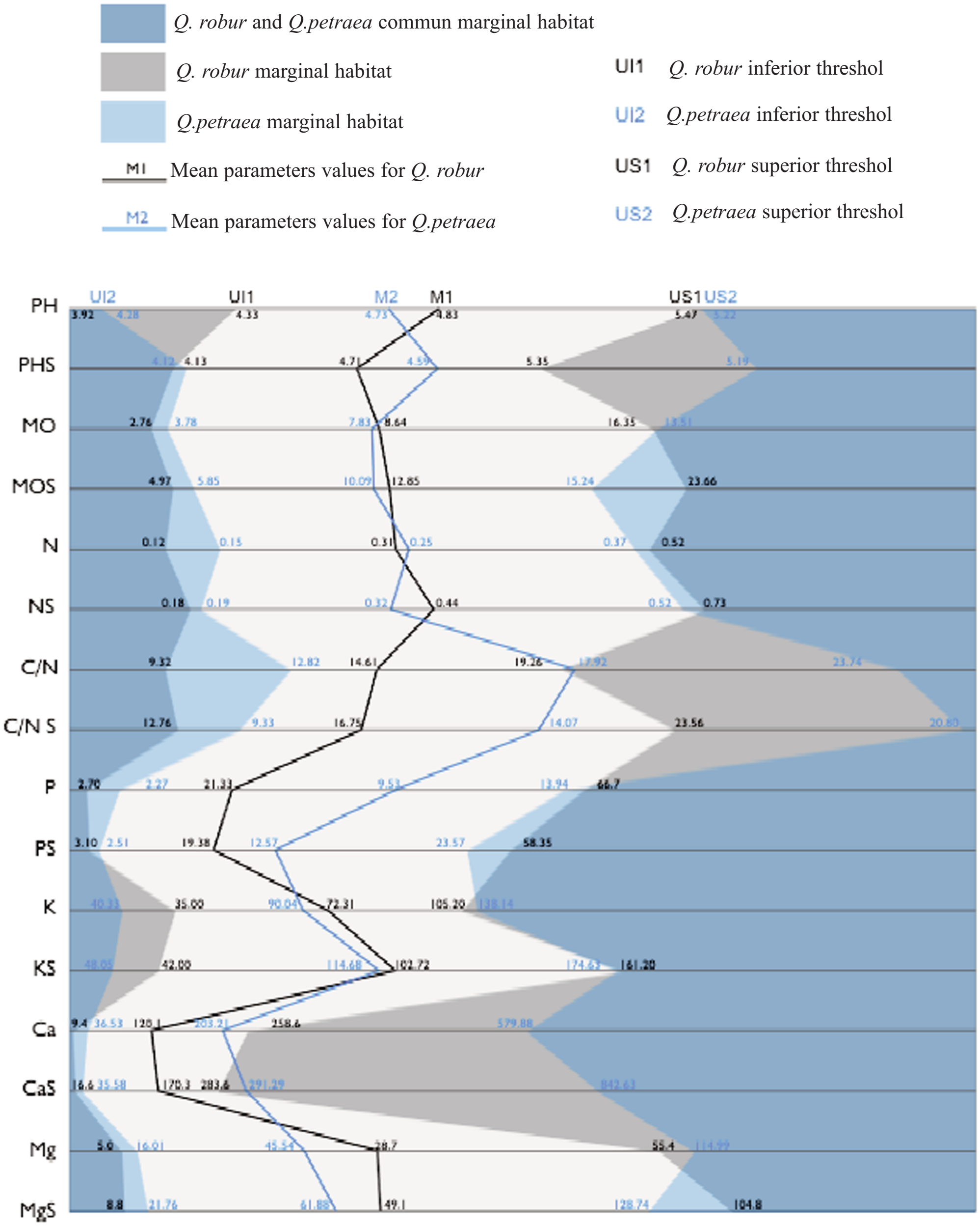

Figure 3 Edaphic habitat of *Quercus robur* and *Quercus petraea*

50% on both cases (Table 2), dominating soils of siliceous nature with high acidity.

Regarding to the percentage of organic matter, there is generally low variation between total and superficial values (Table 3), presenting the soils in which *Q. robur* is established a value of superficial organic matter slightly higher. A few *Q. robur* stands exceed 20% of MOS, while in *Q. petraea* only two plots come close to this value.

Despite the described heterogeneity of these stands, there are not such noticeable differ-

Table 4 Descriptive statisticals of the dasometric and silvicultural parameters in *Quercus robur* and *Q. petraea* forests

Parameter	Standard deviation		Arithmetic mean		Variation coefficient		Maximum		Minimum		Kurt	
	Q. robur	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*	*Q. robur*	*Q. petraea*
DEN	537.05	495.88	999.69	989.98	53.72	50.09	2058.98	2950.00	333.33	267.00	-0.43	3.50
DMA	10.27	7.88	25.63	21.40	40.06	36.82	46.38	41.54	12.10	2.36	-0.97	0.91
DMC	10.87	7.22	27.28	23.79	39.85	30.36	50.29	43.21	12.50	11.95	-0.87	0.48
DED	4.51	2.75	8.94	8.51	50.41	32.27	24.35	15.51	2.88	3.74	2.66	0.02
CVD	10.92	11.2	35.01	39.73	31.18	28.24	55.34	65.00	17.49	16.60	-1.06	-0.51
DOM	14.58	7.64	40.59	35.20	35.92	21.7	70.11	55.10	20.55	18.70	-1.03	0.44
HMA	4.23	3.25	14.48	15.75	29.19	20.63	25.10	23.91	7.87	11.26	0.79	-0.13
HMC	4.30	0.39	14.88	3.98	28.9	9.71	25.13	4.89	7.97	3.36	0.57	-0.50
DEH	0.79	0.94	3.23	3.00	24.55	31.37	4.99	5.76	1.74	1.07	-0.07	0.52
CVH	4.92	6.28	21.79	19.80	22.58	31.72	31.44	39.00	15.22	6.53	-1.14	0.67
HDA	4.58	3.93	17.07	17.47	26.84	22.48	28.87	27.30	9.28	10.18	0.93	0.33
IHA	6.47	5.91	21.49	20.54	30.11	28.78	33.42	37.00	10.14	11.00	-0.69	1.59
ICZ	14.74	11.11	20.53	23.12	71.79	48.06	71.00	56.16	6.92	7.03	3.81	1.10

Table 5 Pearson linear correlation coefficients in *Quercus robur* forests. Signification level (s): *, s > 95%; **, s > 99%; n.s., non significant

	DEN	DMA	DMC	DED	CVD	DOM	HMA	HMC	DEH	CVH	HDA	IHA	ICZ
DEN	1.000	-0.513**	-0.551**	-0.624**	-0.430**	-0.476**	-0.438*	-0.469**	n.s.	n.s.	-0.374*	-0.502**	n.s.
DMA		1.000	0.995**	0.694**	n.s.	0.959**	0.756**	0.774**	0.336*	n.s.	0.682**	n.s.	n.s.
DMC			1.000	0.764**	n.s.	0.969**	0.732**	0.757**	0.360*	n.s.	0.662**	n.s.	n.s.
DED				1.000	0.660**	0.777**	0.385*	0.447**	0.413*	n.s.	0.361*	n.s.	n.s.
CVD					1.000	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.581**	-.403*
DOM						1.000	0.665**	0.690**	0.345*	n.s.	0.610**	n.s.	n.s.
HMA							1.000	0.993**	0.625**	n.s.	0.954**	-0.439*	0.674**
HMC								1.000	0.649*	n.s.	0.961**	-0.411*	0.642**
DEH									1.000	n.s.	0.674**	n.s.	0.414*
CVH										1.000	n.s.	n.s.	n.s.
HDA											1.000	-0.532**	0.687**
IHA												1.000	-0.817**
ICZ													1.000

ences regarding to the dendrometric/silvicultural parameters (Table 4). On *Q. robur* stands there is a high variability on DEN, DED and IZC parameters with a variation coefficient higher than 50% (Table 4); the other parameters present a CV lower than 40%. In *Q. petraea* only DEN parameter has higher CV than 50%, exactly 50.09%. Both species present low CV with regard to the stand parameters connected to the variable height.

Finally, regarding to the data distribution, the criteria of dispersion and centrality of a normal variable are achieved in both species. Only regarding to the density of *Q. petraea* or to the Czarnowski Index of *Q. robur* it looks like some plots present values which condition

Table 6 Pearson linear correlation coefficients in *Quercus petraea* forests. Signification level (s): *, s > 95%; **, s > 99%; n.s., non significant

	DEN	DMA	DMC	DED	CVD	DOM	HMA	HMC	DEH	CVH	HDA	IHA	ICZ
DEN	1.000	-0.604**	-0.782**	-0.510**	n.s	-0.602**	-0.455**	-0.387**	n.s	0.372**	-0.365**	-0.491**	0.584**
DMA		1.000	0.823**	-0.604**	-0.305*	0.660**	0.604**	0.547**	n.s	-0.351*	0.472**	n.s	n.s
DMC			1.000	0.596**	n.s	0.784**	0.639**	0.554**	n.s	-0.350*	0.508**	0.361**	-0.329*
DED				1.000	0.598**	0.731**	0.400**	0.337*	n.s	n.s	0.433**	n.s	n.s
CVD					1.000	n.s	n.s	n.s	n.s	0.667**	n.s	n.s	n.s
DOM						1.000	0.493**	0.429**	n.s	n.s	0.465**	n.s	n.s
HMA							1.000	0.774**	n.s	-0.353*	0.885**	-0.285*	0.383**
HMC								1.000	n.s	-0.305*	0.680**	n.s	n.s
DEH									1.000	n.s	312*	-0.291*	n. n.s
CVH										1.000	n.s	n.s	n.s
HDA											1.000	-0.510**	0.413**
IHA												1.000	-0.781*
ICZ													1.000

that normality. This is because they are natural stands where no management or improvement work has been done and where natural phenomena (wind, snow, etc.) have been able to condition the distribution curve of ages and diameter dimensions.

Analysis of the habitat of *Quercus* spp.

A Principal Components Analysis (PCA) was done for reducing the number of statistically significant parameters and to explain as much variability as possible in the oak stands of the study area. For this, the dendrometric/silvicultural variables have been used, with the exception of the ones related to the height because many stands were silvicultural managed, pollarding stems and selecting the best specimens, which affected negatively to these variables.

The obtained results of this analysis confirm their validity, as they throw a KMO coefficient close to 0.7 (SAS Institute Inc. 2004), and 85% of the total explained variance is exceeded in both studied species. From these results, the possibility of modelizing the habitat of these stands was set up through a multivariant regression analysis (Ryan 1997), choosing as dependent variable for each species the first vector resulting from the ACP and, as independent, every mentioned parameter in section “Univariate analysis...”.

In Table 7 are shown the adjusting coefficients of the obtained models for both species. The model for *Quercus petraea* stands is the one which presents the lowest percentage of adjustment of variability, with an R^2 value of 0.507. In the other hand, the model obtained for *Q. robur* presents an R^2 value of 0.929.

The standard error of the estimate is low, which indicates that dispersion in these models is quite low. As for R^2 coefficient, the standard error is higher in the model of *Q. petraea*, as this reaches 1.36 (Table 7); however, for *Q. robur* it is quite lower, as this does not reach one. The standard error in the model for *Q. robur* presents a specially low value (0.16), indicative of an adjustment of the model not very adequate.

Tables 7 and 8 have all the necessary information to construct the regression equation which explains each model. That is, regression coefficients are the ones accompanying the independent variables of each model (in this case, the independent variables are the measured

Table 7 Adjustment coefficients and estimate error of *Q. petraea* and *Q. robur* models

	Model	R	R^2	Estimation standard error
Quercus petraea	1	0.712	0.507	1.360
Quercus robur	2	0.964	0.929	0.624

Table 8 Regression coefficients of *Quercus robur* model

Model	Non Standardized Coefficient		Standardized Coefficient	T	Sig.
	B	Standard Error	Beta		
Constant	-7.575	5.759		-1.315	0.236
ALT	0.000	0.002	0.032	0.068	0.948
PTE	0.027	0.014	0.559	1.978	0.095
ORI	-0.001	0.001	-0.066	-0.380	0.717
PROF	0.003	0.013	0.072	0.221	0.832
DM	-0.002	0.022	-0.064	-0.112	0.914
PT	-0.004	0.003	-1.331	-1.515	0.181
PE	0.024	0.017	1.195	1.397	0.212
TM	2.424	0.908	2.898	2.669	0.037
TMA	-0.778	0.452	-1.710	-1.721	0.136
TmA	-0.629	0.368	-1.612	-1.711	0.138
PH	-0.220	2.104	-0.092	-0.105	0.920
PHS	-0.085	1.950	-0.043	-0.043	0.967
MO	-0.222	0.325	-0.988	-0.683	0.520
MOS	0.100	0.154	0.794	-0.649	0.540
N	-1.911	6.435	-0.272	-0.297	0.776
NS	3.597	3.269	0.825	1.100	0.313
C/N	0.060	0.146	0.257	0.408	0.698
C/N S	-0.028	0.114	-0.117	-0.244	0.815
P	0.033	0.014	0.971	2.471	0.048
PS	-0.011	0.012	-0.330	-0.951	0.379
K	0.012	0.024	0.319	0.481	0.648
KS	-0.002	0.015	-0.073	-0.116	0.911
Ca	-0.004	0.007	-0.794	-0.472	0.654
CaS	0.003	0.006	0.857	0.477	0.650
Mg	0.058	0.073	1.119	0.803	0.452
MgS	-0.043	0.037	-1.589	-1.149	0.294

parameters). These coefficients indicate the weight of each variable on the model. The constant and the variables with a higher weight are used to adjust the regression equations of each model. These are the ones which present a higher value of the non standardized regression coefficient. It is necessary to point out that these coefficients are not independent among them and the concrete estimated value for each coefficient is adjusted attending to the presence of the other independent variables.

The model of *Quercus petraea* depends on less parameters than the one of *Q. robur*, as it is adjusted with a lower number of variables (Table 9); although a higher number of variables is used, the statistical adjustment does not improve and, however, it leads this model to explain a lower percentage of variability.

In the case of *Quercus robur* it is possible to explain 92% of the variability with the following model:

$$V_1 = -7.575 - 1.911\ N - 0.778\ TMA + 3.597\ NS + 2.424\ TM \qquad (2)$$

where: *N* - total nitrogen, *TMA* - mean annual temperature of the absolute maximums, *NS* - superficial nitrogen and *TM* - mean annual temperature.

For *Quercus petraea* the adjusted model only explains 50.7% of the existent variability:

$$V_2 = 36.692 - 34.990\ NS - 6.793\ PH - 0.754\ C/N\ S + 1.137\ MO \qquad (3)$$

where: *NS* - superficial nitrogen, *PH* - pH in water, *C/N S* - superficial carbon-nitrogen ratio and *MO* - organic matter.

Both models have a probability of error (α) < 5%, as they are adjusted with a fiducial probability of 95%. The residuals distribution is observed on figures 4 and 5 when brought face

Table 9 Regression coefficients of *Quercus petraea* model

Model	Non Standardized Coefficient		Standardized Coefficient	*T*	Sig.
	B	Standard Error	Beta		
(constante)	36.692	60.257		0.609	0.569
ALT	-0.002	0.008	-0.335	-0.252	0.811
PTE	0.029	0.029	0.600	1.013	0.357
ORI	0.002	0.004	0.298	0.623	0.561
PROF	0.020	0.035	1.174	0.589	0.582
DM	0.040	0.167	0.305	0.240	0.820
PE	-0.012	0.056	-0.327	-0.223	0.832
PH	-6.793	11.245	-2.750	-0.604	0.572
MO	1.137	3.528	5.453	0.322	0.760
NS	-34.990	105.005	-4.532	-0.333	0.752
C/N	0.196	1.087	0.489	0.180	0.864
C/N S	-0.751	2.632	-2.716	-0.285	0.787
P	0.078	0.258	0.549	0.302	0.775
PS	0.040	0.220	0.299	0.180	0.864
KS	-0.009	0.009	-0.609	-0.1000	0.363
CaS	-0.002	0.012	-0.979	-0.191	0.856
Mg	0.050	0.136	2.383	0.372	0.725
MgS	0.014	0.144	0.761	0.096	0.927

to face with the predicted values (axis *x*). The model of *Q. petraea* presents a better residuals distribution (figure 5), with most of the values nearby the coordinate (0,0) forming a cloud and presenting no distribution trend as it happens with *Q. robur*, which presents a clear lineal trend. This leads to question the previously commented better adjust of data in *Q. robur* (R^2 = 0.929 %) due to its worst dispersion of the generated residuals.

Disscusion

Natural stands of *Quercus robur* and *Q. petraea*, within the study area, come into contact along an ecotone zone forming, sometimes, mixed forests and making hybrids easily, appearing many stems of the hybrid *Quercus x rosacea* Bechst.

The obtained results of the discriminant analysis of the plots show that parameters with a higher classificatory weight in the habitat of the studied species have been for *Q. robur* (Díaz-Maroto et al. 2005) the physiographic (ALT, PTE, PROF and DM), and climatic ones (PT, TM, TMA and TmA). For *Q. petraea* (Vila-Lameiro & Díaz-Maroto 2005, Díaz-Maroto et al. 2006b), it was obtained a physiographic parameter - ALT and several edaphic ones - PHS, KS, MOS and Ca. Some of these parmeters use to be discriminant with these species (Gandullo et al. 1983, Díaz-Maroto et al. 2006a).

In the second discriminant analysis, meeting the silvicultural information and the environmental descriptive parameters, obtained from the former discriminant analysis (Díaz-Maroto et al. 2007b), the most connected silvicultural parameters are, for *Q. robur* stands (Díaz-Maroto et al. 2005) - DMA, DMC, HMA, HMC and HDA, and for *Q. petraea* stands - DMA, DMC, HMA, HMC and DOM. This relation was also obtained by Díaz-Maroto et al. (2006b) in previous studies in the Asturias oaklands.

However, this is not exactly coincident with the parameters which result significant on a multivariant regression analysis which assesses the silvicultural state of these stands. For *Q. petraea*, the edaphic parameters are the ones that better define it. However, for *Q. robur* are the climatic parameters, but with important information given also by the edaphic ones, which had no significant weight on the discriminant analysis.

Regarding to the edaphic parameters of *Q. petraea*, there is a high variability in many

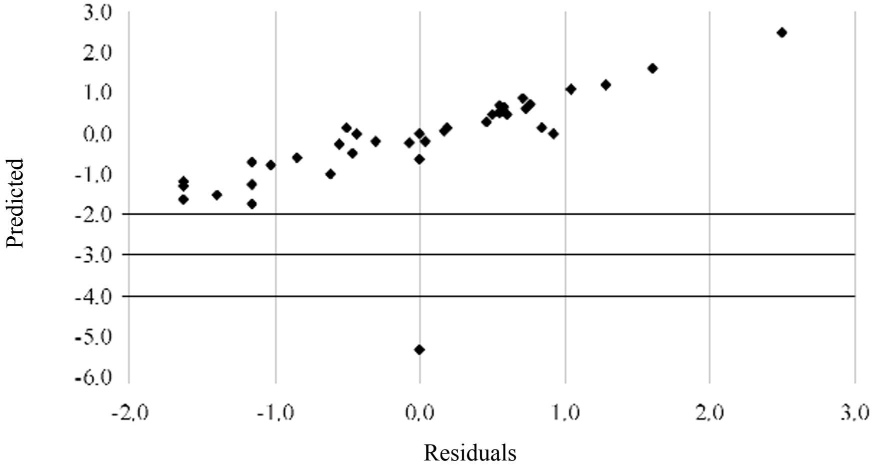

Figure 4 Predicted and residual values distribution of *Quercus robur* model

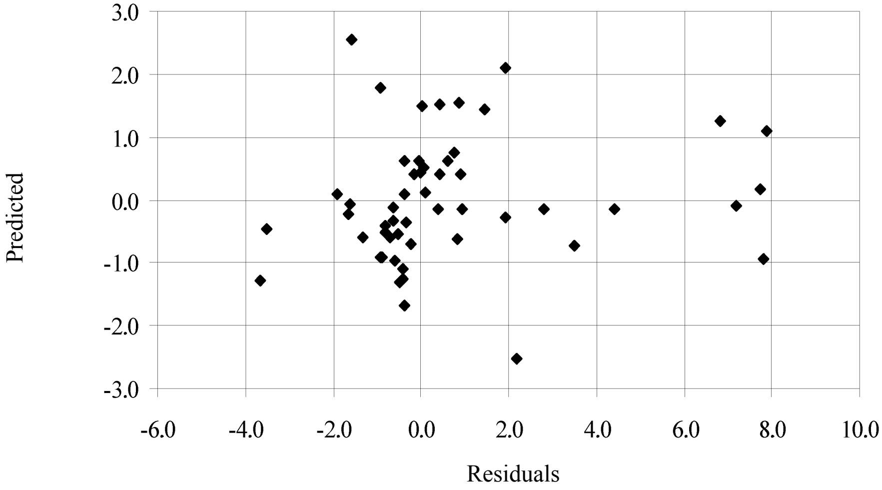

Figure 5 Predicted and residual values distribution of *Quercus petraea* model

parameters due to the range of existing soils, from siliceous to calcareous nature. However, the superficial and total pH values, present a little variation on both species, with soils generally quite acid. This is the typical distribution managed for *Quercus* spp. forests in the north of the Iberian Peninsula, as commented Gandullo et al. (1983), Díaz-Fernández et al. (1995), Vila-Lameiro & Díaz-Maroto 2005 and Díaz-Maroto et al. (2006a).

It is remarkable for both species, that the values of some edaphic parameters present a close standard deviation, and, in some occasions, even higher that the arithmetical mean. This gives an idea of the great variability of soils where these species are located, from soils with optimum conditions to those relics on which both difficultly survive. Previous studies of autoecology of oaks obtained similar results but with a minor contrast (Díaz-Maroto et al. 2005, Díaz-Maroto et al. 2006a, 2007b).

Both species need great soil deepness. *Q. petraea* presents a very developed and powerful root system, specially attending to the later-al secondary roots (Ceballos & Ruiz de La Torre 1979, Vila-Lameiro 2003), and *Q. robur* has a powerful main root which penetrates deeply in the soil (Ceballos & Ruiz de la Torre 1979, Timbal & Aussenac 1996).

The central habitat of the parameter distance to the sea is between 15 and 78 km for *Q. robur* stands and between 62 and 100 km for *Q. petraea* ones, which agrees with the potential distribution of the vegetation within the study area (Izco 1987). This coincides with the climatic conditions, existing a majority contribution of precipitation during winter and, in many cases, enough during summer so there is not water shortage. The mean precipitation values presented by *Q. petraea* (for winter and summer) are slightly higher than *Q. robur´*s (Figure 2), requiring both high environmental moisture (Díaz-Maroto et al. 2006b, 2007a) and, generally, low thermical amplitude (Retuerto & Carballeira 1991).

As it´s been already commented, on the marginal physiographic-climatic habitat (Figure 2), the existence of oak stands set up by *Quercus robur* is remarkable on regions far away from its potential area. In these cases, quite a lot of hybrid stems coming from the combination with *Q. petraea* use to appear, specially on mountain areas, as described years ago as well Ceballos & Ruiz de la Torre (1979), as Amaral (1990).

C/N ratio presents a low variation between total and superficial values. *Quercus robur* presents a slightly higher value than *Q. petraea* within the whole profile; however, in the upper 20 cm is *Q. petraea* the one presen-ting a higher value (Figure 3), because the low pH values do not lead to optimum humification conditions (Gallardo et al. 1995, Díaz-Maroto et al. 2007a).

Finally, macronutrient concentrations in soils where *Quercus petraea* is established, with the exception of phosphorus, present higher values than the observed in *Q. robur* stands. It is remarkable the great difference with regard to Ca and Mg parameters, attending to the total or superficial values, because soils under *Q. petraea* present values that result the double than under *Q. robur* (Figure 3).

Conclusion

Q. robur stands grow on lower regions and with less continentality than *Q. petraea* ones, being in both species the North orientation the dominant. The mean slope of the stands where *Quercus petraea* grows is getting on 50%, however *Q. robur* ones do not reach 30%. The mean precipitation values are slightly higher on *Quercus petraea* stands, presenting both species high edaphic and environmental moisture requirements.

There are *Quercus robur* stands on regions far away from their potential area, where there are usually quite a lot of stems hybridizated with *Q. petraea*, specially on mountain areas.

The soils under both kinds of forests present a great variability with regard to the values of several edaphic parameters, specially in *Quercus petraea*, due to the range of substrates with siliceous and calcareous lithologies. The dominant texture of soils under *Q. robur* is sandy and mainly classified as dystric cambisol, and soils under *Q. petraea* are silt, with dominance of umbric regosols. Soils on which *Q. robur* stands are settled present a slightly higher value of superficial organic matter and of total C/N ratio; however, superficial C/N ratio is higher on soils under *Q. petraea*. The concentrations of macronutrients in soils under *Quercus petraea*, with the exception of phosphorus, present higher values than soils under *Q. robur*. It is remarkable the great difference regarding to the parameters Ca and Mg, as *Q. petraea* presents values which double the ones found for *Q. robur*.

The stands of both species are quite heterogeneous, except with regard to silvicultural parameters, which present quite a lot of similarities. The discriminating analysis of the plots shows that parameters with higher classificatory weight have been, for *Quercus robur*, of physiographic nature, (ALT, PTE, PROF and DM) and climatic (PT, TM, TMA and TmA). For *Quercus petraea* it was obtained a parameter of physiographic nature - ALT and several edaphic ones - PHS, KS, MOS and Ca. The multivariant regression analysis of the silvicultural state shows that, in the case of *Quercus petraea*, the edaphic parameters are the ones that best define it. However, regarding to *Q. robur*, these are the climatic parameters, with certain importance of the edaphic ones.

The modelization of the habitat of these stands with a regression analysis throws uneven and non conclusive results, with a better adjustment of data for *Quercus robur*, but with bigger error for final prediction, as the residuals cloud shows a clear lineal trend. *Q. petraea* presents worst adjustment, but with better results for prediction with regard to the remainders.

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