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Contribution to the Iberian thermomediterranean oak woods (Spain, Portugal): the importance of their teaching for the training of experts in environmental management

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Original

Contribution to the Iberian thermomediterranean oak woods (Spain, Portugal): the importance of their teaching for the training of experts in environmental management / Cano, E., Piñar Fuentes, J.C., Cano Ortiz, A., Quinto Canas, R., Rodrigues Meireles, C., Mauro, R., Pinto Gomes, C.J., Spampinato, G., Musarella, C.M.. - In: PLANT BIOSYSTEMS. - ISSN 1126-3504. - (2024), pp. 1-21. [10.1080/11263504.2024.2404431]

Availability:

This version is available at: <https://hdl.handle.net/20.500.12318/152168> since: 2024-11-19T14:00:47Z

Published

DOI: <http://doi.org/10.1080/11263504.2024.2404431>

The final published version is available online at: <https://www.tandfonline.com/doi/full/10.1080/11263504>.

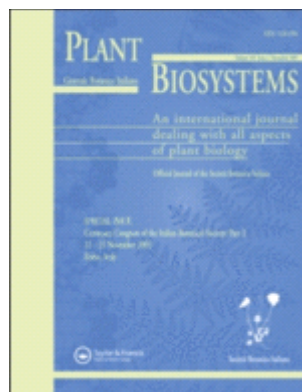
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**CONTRIBUTION TO THE IBERIAN THERMOMEDITERRANEAN
OAK WOODS (SPAIN, PORTUGAL): THE IMPORTANCE OF
THEIR TEACHING FOR THE TRAINING OF EXPERTS IN
ENVIRONMENTAL MANAGEMENT**

Journal:	<i>Plant Biosystems</i>
Manuscript ID	TPLB-2024-0163.R3
Manuscript Type:	Original Article
Date Submitted by the Author:	27-Aug-2024
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Keywords:	holm oak, vegetation series, dynamics, environmental management, association

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**CONTRIBUTION TO THE IBERIAN THERMOMEDITERRANEAN OAK WOODS
(SPAIN, PORTUGAL): THE IMPORTANCE OF THEIR TEACHING FOR THE
TRAINING OF EXPERTS IN ENVIRONMENTAL MANAGEMENT**

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ABSTRACT

The study of the holm oak forests of the lower and upper mesomediterranean of the south of the Iberian Peninsula, and new syntaxons of holm oak forests not assigned until now are contributed. The plant dynamics is provided and completed, and the importance of the learning of plant description and dynamics by university students, future environmental managers, is specified. Taking into account the strong anthropic action with the consequent destruction of holm oak forests, it is necessary to enhance the knowledge of plant dynamics to decipher the potential vegetation, and to be able to apply the vegetation series as a basis for agronomic and forestry management. In this work we propose a new vegetation series. We propose the association *Aristolochio baeticae-Quercetum rotundifoliae* nova for the biogeographic sector Granadino-Almijarese (Montes de Málaga), and as a first dynamic stage the microforest of *Olea europea* var. *sylvestris* obtained by deforestation. The study of the Iberian olive groves allows us to propose two new associations *Aristolochio baeticae-Oleetum sylvestris* and *Ephedro fragilis-Oleetum sylvestris*

Key words: Holm oak forest; vegetation series; dynamics; environmental management; association; holm oak and olive plant communities

INTRODUCTION

As for the holm oak groves, we recorded the associations of the lower thermo- and mesomediterranean, all of them from environments with dry ombrotype. 1) *Pyro*

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10 *bourgaeanae-Quercetum rotundifoliae* Rivas-Martínez 1987 thermophilic faciation with
11 *Myrtus communis* L. 2) *Paeonio coriaceae-Quercetum rotundifoliae* Rivas-Martínez
12 1965 thermophilic faciation with *Pistacia lentiscus* L. 3) *Rubio longifoliae-Quercetum*
13 *rotundifoliae* Costa, Peris & Figueroa 1983. 4) *Rhamno oleoidis-Quercetum*
14 *rotundifoliae* Rivas-Martínez in Rivas-Martínez, Fernández González, Loidi, Lousa &
15 Penas 2002. 5) *Rhamno laderoi-Quercetum rotundifoliae* Rivas-Martínez, M.T^a Santos
16 & Ladero 2011. 6) *Myrto communis-Quercetum rotundifoliae* Rivas Goday in Rivas
17 Goday, Borja, Esteve, Galiano, Rigual & Rivas-Martínez 1960. 7)
18 Thermomediterranean holm oak groves in the mountains of Malaga. The study area of
19 this last association corresponds to the mountains of Malaga (Axarquense district),
20 which belongs to the biogeographic province of Béica. The study of these areas arises
21 from the ascription of the thermomediterranean holm oak forests and their dynamic
22 stages to communities of the southwestern Iberian territories, perhaps due to the poor
23 state of conservation of the Axarquian holm oak forests, which creates gaps in
24 knowledge and management. While the thermomediterranean associations are included
25 in the *Quercus rotundifoliae-Oleion sylvestris* alliance (Rivas-Martínez et al. 2001;
26 Rivas-Martínez et al. 2011a, b), the mesomediterranean holm oak forests of southern
27 Iberia are included by this author in the *Paeonio broteri-Quercenion rotundifoliae*
28 suballiance including *Quercion broteroi* of the *Quercetea ilicis* class (Rivas-Martínez
29 1975, 1987; Rivas-Martínez et al. 2011a).

30 In western Iberia and specifically in the western Iberian Mediterranean province, the
31 mesomediterranean holm oak forest grows in dry environments and siliceous substrates,
32 corresponding to the *Pyro bourgaeanae-Quercetum rotundifoliae* association described
33 by Rivas-Martínez (1987), being very well represented in the south the thermophilic
34 faciation with *Myrtus communis* L., holm oak forests that represent the transition to the
35 thermophilic *Myrto communis-Quercetum rotundifoliae*. These holm oak forests and
36 their dynamics have been studied by different authors (Cano 1987; Sánchez Pascual
37 1994; Melendo 1998; Rodríguez Torres 2016; Valle et al. 2004). The first dynamic
38 stage of these holm oak groves is a kermes oak grove belonging to *Asparago albi-*
39 *Rhamnetum oleoidis* Rivas Goday in Rivas Goday, Borja, Esteve, Galiano, Rigual &
40 Rivas-Martínez 1960, typical of the ravines of the southwest of the Iberian Peninsula,
41 which later gives way to a *Cistus ladanifer* L. and *Cistus monspeliensis* L. thicket and
42 finally a *Lavandula sampaiosa* scrub. Ass. *Genisto hirsutae-Cistetum ladaniferi* Rivas
43 Goday 1956 subas. *cistetosum monspeliensis* Rivas Goday 1956 and ass. *Scillo*
44 *maritimae-Lavanduletum pedunculatae* Ladero 1970

45 In the thermomediterranean environments, reaching in some cases the lower
46 mesomediterranean, we detected several climax associations, the Valencian and
47 Murcian-Almerian thermo-mediterranean holm oak groves were described by Costa et
48 al. (1983), *Rubio longifoliae-Quercetum rotundifoliae*. In the south of the Iberian
49 Peninsula there are several associations; *Rhamno oleoidis-Quercetum rotundifoliae*
50 described by Rivas-Martínez et al. (2002), for the thermomediterranean of the Betic
51 province on calcareous substrates, previously, Rivas Goday et al. (1959) in their study
52 on the *Quercetea ilicis* hispanica described the association *Myrto communis-Quercetum*
53 *rotundifoliae*, very well represented in the ravines of Sierra Morena (Mariano-
54 Monchiquense sector), the dynamics of these holm oak groves corresponds to that
55 mentioned above, and with the holm oak groves of the lower mesomediterranean.
56 Recently, three holm oak associations have been described for the south of the Iberian
57 Peninsula. The *Rhamno laderoi-Quercetum rotundifoliae* association has been described
58 by Rivas-Martínez et al. (2011b) for the upper thermomediterranean and lower
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mesomediterranean on outcrops of basic substrates of the Luso-Extremaduran territories.

The knowledge of these plant formations, which act as the basis of knowledge in environmental management, both at forest and agricultural level, is essential for the training of future managers, so it is necessary to transfer this knowledge to universities and research centers. These plant formations constitute the climaxes or heads of vegetation series; for the training of future managers it is essential that they know the phytosociological method (Braun-Blanquet 1979), and certain concepts, such as plant association, which are the characteristic and companion species (Cano-Ortiz 2021a,b,c); as well as the dynamics of the vegetation, since the alteration as a consequence of fires and deforestation, makes it difficult for professionals to identify the potential vegetation, however the reconstruction of the potential vegetation can be done through the current dynamic stages, since in several cases the climaxes have been described; but the dynamic stages have been ignored, have not been sufficiently studied or erroneously established.

This work has two fundamental objectives: 1) to characterize the climax vegetation of the territory from a phytosociological point of view and 2) to understand the vegetation dynamics of the climax of holm oak groves to enhance its knowledge and value as a habitat. Since the vegetation climaxes and their dynamics have been described in some cases (Pérez Latorre et al. 1999, 2008, 2009, 2015), the dynamics of the new holm oak climax is studied, being this fundamental for the management to be carried out by agrarian and environmental managers.

The sampling area of the field inventories carried out is biogeographically located in the Montes de Málaga (Axarquense District, Sector Granadino - Serrano Almijareense, and in the Hoyano Malagueño district of the Sector Rondeño of the Betic Province), between 36.7°N - 37°N and 4.7° W - 4.2°W (Figure 1).

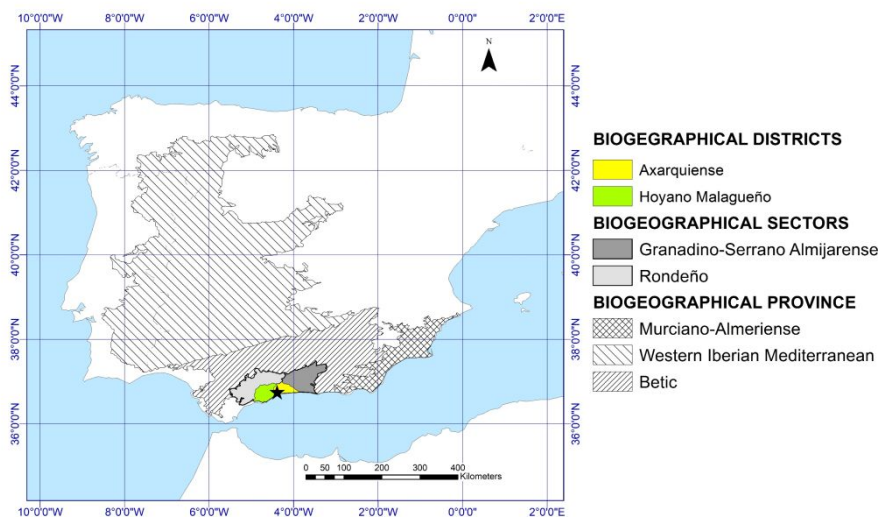


Figure 1: Study area and distribution of own inventories.

MATERIAL AND METHODS

Study area.

The study area comprises the southern third of the Iberian Peninsula. From a biogeographical point of view, the compiled samplings are encompassed in the biogeographical Betic province, Murciano-Almeriense province and the Cordilleran-Maritime sector of the western Iberian Mediterranean province (Rivas-Martínez et al. 2017).

The sampled area corresponds to the Axarquía (Malaga), where materials such as lites, siliceous sedimentary rocks, quartz, carboniferous sedimentary radiolarians, marine bottoms of the Maláguide complex dominate. The territory presents a soft modeling with altitudes ranging from sea level to 1030 m, from the climatic point of view the temperatures are mild and the generalized precipitations cause a dry ombrotype, except in the elevated areas. The area has been greatly altered by human action as it is very close to the town of Malaga, however, there are different studies on the flora and vegetation that serve as a basis for our research.

From the bioclimatic point of view, the area presents a Mediterranean Pluvial-Seasonal Oceanic bioclimate, from a semi-hyperoceanic attenuated to a semi-continental attenuated. The bioclimatic floor of the samples ranges from a lower thermomediterranean to an mesomediterranean, with a dry ombrotype, with a dominance of the lower dry ombrotype in the thermo-Mediterranean areas (Table 1).

Table 1: Bioclimatic characterization of the sampled territory. Lat = Latitude, Lon = Longitude, Ic = Simple continentality index, Itc = Compensated thermicity index, Tp = Positive temperature, Io = Ombrothermal index.

Locality	Lat.	Lon.	Alt.	Ic	Itc	Tp	Io	Continentality belt	Thermotype	Ombrotype
Torremolinos, Pueblo	36,623	-4,514	85	12,9	467	2.323	2,8	WEAK SEMIHYPEROCEANIC	Upper inframediterranean	Lower Dry
Málaga, Escuela de Capacitación Agraria	36,717	-4,563	40	18,6	357	2.066	2,3	WEAK SEMICONTINENTAL	Upper thermomediterranean	Lower Dry
Málaga, Vivero Central	36,667	-4,485	10	14,6	375	2.039	2,6	STRONG EUOCEANIC	Upper thermomediterranean	Lower Dry
Málaga, Aeropuerto	36,668	-4,481	5	13,6	430	2.203	2,5	WEAK SEMIHYPEROCEANIC	Lower thermomediterranean	Lower Dry
Colmenar, Torrijos	36,828	-4,363	731	15,9	295	1.745	4,1	WEAK EUOCEANIC	Lower mesomediterranean	Lower subhumid
Málaga, Las Contadoras	36,827	-4,384	760	15,7	308	1.777	3,7	WEAK EUOCEANIC	Lower mesomediterranean	Lower subhumid
Málaga, El Cerrado	36,813	-4,384	618	15,9	339	1.897	3,2	WEAK EUOCEANIC	Lower mesomediterranean	Upper Dry
Málaga, El Boticario	36,779	-4,384	449	14,2	368	1.981	2,8	STRONG EUOCEANIC	Upper thermomediterranean	Upper Dry
Pantano del Agujero	36,774	-4,432	100	14,0	405	2.104	2,5	STRONG EUOCEANIC	Lower thermomediterranean	Lower Dry
Málaga, Ciudad	36,725	-4,427	53	13,2	431	2.204	2,3	WEAK SEMIHYPEROCEANIC	Lower thermomediterranean	Lower Dry

Málaga, Carmelitas	36,728	-4,423	9	14,5	433	2.269	2,1	STRONG EUOCEANIC	Lower thermomediterranean	Lower Dry
IFAPA Centro de Campanillas	36,729	-4,561	60	15,4	431	2.192	2,4	WEAK EUOCEANIC	Lower thermomediterranean	Lower Dry
IFAPA Churriana	36,674	-4,503	19	14,4	426	2.200	2,2	STRONG EUOCEANIC	Lower thermomediterranean	Lower Dry
Málaga	36,757	-4,538	58	15,1	420	2.205	2,0	WEAK EUOCEANIC	Lower thermomediterranean	Lower Dry

Elaboration of the databases.

The initial 2,750 inventories were subjected to various filtering processes in order to discard those samples that were not very representative (13 own field inventories are provided). First, the nomenclature and taxonomy of the different species, subspecies and varieties of plants included in the inventories were homogenized and updated using the criterion of valid and accepted names from Plants of the World Online (POWO 2024), except in the following cases: *Rhamnus lycioides* L. subsp. *laderoi* Rivas Mart. & J.M.Pizarro, *Crataegus monogyna* Jacq. subsp. *brevispina* (G.-Kunze) Franco, *Dactylis glomerata* L. subsp. *hispanica* (Roth) Nyman, *Dactylis lusitanica* Stebbins & D.-Zoary, and in specific cases Flora Iberica, for *Rhamnus oleoides* L. var. *angustifolia* Lange ex Willk. in Willk. & Lange

Commented [Eusebio C1]: J.M.Pizarro
Corr. R1

Commented [Eusebio C2]: G.Kunze
Corr. R1

Commented [Eusebio C3]: D.Zohary
Corr. R1

Commented [Eusebio C4]: Delete "in Willk. & Lange"
Corr. R1

The first selection criterion consisted of analyzing the floristic composition of characteristic species of the class *Quercetea ilicis* and lower units, calculating the proportion of characteristic species of each inventory with respect to the total number of characteristic species in the whole data matrix. For this purpose, the list of species ascribed to a syntaxonomic unit of Rivas-Martinez et al. (2002) was followed. According to this criterion, only inventories in the upper 25th percentile were taken into account. Thus 688 inventories were selected and georeferenced in 200x200 meter grids, considering toponymic location, altitude and orientation, as well as reference to orthophotographs, roads and trails. All this was implemented in a Geographic Information System (GIS), from which, by means of various rasters of topographic, climatic, and edaphic information, it was possible to assign to each georeferenced inventory various environmental variables.

The ArGIS 10.3 software was used to develop the cartographic database and the Geographic Information System. XLSTAT was used for the ordination and multivariate statistical analysis. 2023.3.1 (Lumivvero, 2024). XLSTAT statistical and data analysis solution. New York, USA. <https://www.xlstat.com/es>

For the topographic variables, a 20x20 meter Digital Terrain Model was used, from which several variables such as orientation, slope and altitude were derived. For edaphic variables, the soil physical and chemical properties raster (Ballabio et al. 2016, 2019) was used. For the climatic variables, WORLDCLIM (Fick, 2017) was used. The climatic variables were corrected by using data from 1458 thermopluviometric stations of the Iberian Peninsula using the Random Forests algorithm (Piñar-Fuentes, 2023). Subsequently, the database associated with each sampling was completed with the bioclimatic classification (Rivas-Martínez et al. 2007).

A second filtering was carried out considering only those inventories located in the thermomediterranean and lower mesomediterranean bioclimatic floor. Thus, a total of 395 inventories were selected for subsequent comparative analysis with the new field samples (Table 2). To cover all the holm oak formations of the southern Iberian Peninsula, all the phytosociological inventories in the literature in which *Quercus rotundifolia* Lam. was the dominant species were taken into account. This was initially done to cover as much variability as possible in the *Quercus rotundifolia* forests of the southern Iberian Peninsula. When only a few publications are taken into account, there is a possibility that some of the variability with respect to the floristic and ecological composition of these communities is not fully covered. In addition, there are publications that contain tables of inventories originally defined as unknown associations, not syntaxonomically framed, which when compared globally with other described communities, are strongly related to these described communities. Thus, starting from a large number of inventories, which applying certain criteria of quality, homogeneity and importance of the species that compose each sample in a global context with respect to all the original samples, allows us to select and be quite restrictive so that those samples finally selected are the optimal representatives of each of the described communities studied.

Table 2: Inventories of each association and facies used in the analysis.

Associations	N° Samples
<i>Myrto communis- Quercetum suberis (McQr)</i>	
<i>Halimium halimifolium</i> sandy facies	1
Subass. lavanduletosum viridis	8
Subass. quercetosum suberis	59
Subass. Typical quercetosum rotundifoliae	9
<i>Rhamno oleoidis- Quercetum rotundifoliae (RoQr)</i>	
Subass. juniperetosum turbinatae	9
Subass. rhamnetosum velutini	10
<i>Genista equisetiformis</i> Calcareous schist facies	6
Subass. rhamnetosum angustifoliae	3
Subass. quercetosum suberis	5
Subass. Typical quercetosum rotundifoliae	31
<i>Rubio longifoliae- Quercetum rotundifoliae</i>	

(RpQr)		
<i>Phlomis almeriensis</i>		
Almeria facies	RpQr_Ph_al	21
Subass. Typical quercetosum rotundifoliae	RpQr_Qr	9
Rhamno laderoi-Quercetum rotundifoliae (RIQr)		
<i>Arum neglectum</i> clayey facies	RIQr_An	1
<i>Phlomis purpurea</i> facies	RIQr_Ph	14
Subass. Typical quercetosum rotundifoliae	RIQr_RI	8
Pyro bourgaeanae-Quercetum rotundifoliae (PbQr)		
Subass. Myrtetosum communis and others thermophilus facies	PbQr_Mc	76
Paeonio coriaceae-Quercetum rotundifoliae (PcQr)		
Subass. Typical quercetosum rotundifoliae	PcQr_Qr	73
<i>Phlomis almeriensis</i> Almeria facies	PcQr_Ph_al	5
Subass. Pistacietosum lentisci	PcQr_PI	34
Thermomediterranean Holm oak groves Montes de Málaga (AbQr)		
Own samples	AbQr	13

Multivariate principal component analysis.

In a first step, the reference inventories (typus) of each of the holm oak associations were identified, and then a discriminant analysis was carried out and a probabilistic ascription of each of the 395 filtered inventories to each of the associations taken into consideration was performed. Discriminant analysis makes it possible to assign probabilities of belonging to a prefixed group, depending on several variables. Its main objective is to find a linear combination of variables that maximizes the separation between groups. The variables taken into consideration are, on the one hand, the floristic composition of each inventory (only species belonging to the class *Quercetea ilicis* or lower rank) and, on the other hand, the environmental variables assigned to each inventory (Table 3). The variables were classified into three categories, topographic variables, edaphic variables and bioclimatic variables. At the time of the principal components analysis (PCA), the topographic variables were not significant, but the set of edaphic and bioclimatic variables appear perpendicular to each other, which means that they are not correlated with each other, but they are correlated with the associations studied.

Once the a priori doubtful inventories were assigned to the centroids of each of the associations studied, also considering their biogeographical location, a PCA was

performed with the objective of establishing which environmental variables best characterize the different associations. For this purpose, Spearman's correlation distance was used, due to the nature and distribution of the data, as well as an Oblimin-type rotation of the axes, since it is assumed a priori that there is a correlation between the different factors and the environmental variables. This exploratory analysis of the variables allows the selection and reduction of those best correlated with the data. Table 4 shows the variables that correlate best with the inventory data.

Table 3 Environmental variables used for each of the selected inventories.

Variable	Units	Description
Topographic variables		
Slope	degrees	Terrain's surface inclination relative to the horizontal plane.
Aspect	degrees	Slope's cardinal direction on the terrain surface
Edaphic variables		
pH_CaCl	no units	pH measured in CaCl
pH_H2O	no units	pH measured in water
AWC	%	Soil water retention capacity.
Bulk_Dend	kg/m ³	Bulk density of soil
Coarse_Frag.	%	Coarse soil fragments < 2 mm
Sand	%	Percentage of sand in soil
Silt	%	Percentage of silt in soil
Clay	%	Percentage of clay in soil
N	mg/Kg	Soil nitrogen content
P	mg/Kg	Soil phosphorus content
K	mg/Kg	Soil potassium content
CN	no units	Carbon-nitrogen ratio
CaCO₃	mg/Kg	Soil calcium carbonate content
CEC	cmol/kg	Cation exchange capacity
MO_Part	%	Organic matter in visible soil particles
MO_asociad	%	Organic matter bonded to mineral soil particles.
Bioclimatic variables		
Ic	°C	Simple continentality index
I_{tc}	tenths of degree	Compensated thermicity index
Tp	tenths of degree	Positive temperature
Io	I°C	Ombrothermal index
Ios₂	I°C	Ombrothermal index June-July
Ios₃	I°C	Ombrothermal index June-July-August
Ios₄	I°C	Ombrothermal index May-June-July-August
PEs	mm	Summer Potential evapotranspiration
PE	mm	Potential evapotranspiration
Iar	no units	Aridity index
IH	no units	Humidity index

Table 4: Correlation and contribution of the environmental variables to each of the first two axes (F1 and F2), in bold type those variables selected according to their correlation with the axes are shown, discarding those variables that are not very representative or highly correlated with each other (marked with an asterisk). In these cases, the variable best correlated with axes F1 and F2 was chosen.

	Contribution F1	Contribution F2	Correlation F1	Correlation F2
pH_CaCl*	0,386	12,090	-0,219	0,879
pH_H2O*	0,041	11,119	-0,101	0,837
AWC	0,376	8,455	0,131	0,718
Bulk_Dend	0,058	6,403	-0,033	-0,629
Coarse_Frag	2,291	1,501	0,437	-0,329
Sand	0,000	10,456	0,038	-0,808
Silt*	0,090	5,444	0,052	0,579

Clay*	0,023	10,016	-0,085	0,793
N	0,343	1,091	0,177	-0,270
P	0,090	2,424	0,062	0,385
K	0,701	1,898	-0,251	0,357
CN	1,262	0,421	0,321	-0,179
CaCO3	0,034	10,096	0,008	0,791
CEC	0,830	9,427	0,211	0,754
MO_Part1*	2,663	0,975	0,466	-0,271
MO_asociad*	2,526	0,617	0,452	-0,220
lc	5,279	1,829	0,619	0,304
ltc*	9,536	1,094	-0,843	-0,215
tp*	10,502	1,498	-0,883	-0,257
lo*	9,026	0,018	0,835	-0,079
los2*	6,851	0,528	0,716	0,142
los3*	8,287	0,336	0,791	0,102
los4*	10,834	0,551	0,903	0,136
PEs*	1,378	0,543	-0,336	0,202
PE*	10,907	0,979	-0,903	-0,198
lar*	7,844	0,095	-0,781	0,119
IH*	7,844	0,095	0,781	-0,119

Ordination analysis.

Discriminant analysis allows assigning probabilities of belonging to a prefixed group, depending on several variables. A discriminant analysis was used in the data set to assign according to environmental variables and floristic composition. In order to eliminate the noise that may be caused by poorly correlated species, and to unify the correlations between environmental variables, species and associations, a hierarchical ascending classification was carried out to evaluate the similarities of the samples in relation to the rest of the samples of the different associations. A dissimilarity criterion was used based on the Mahalanobis distance, which uses the covariance between the different variables. Such that:

Where $Md(x)$ is the Mahalanobis distance, x is the vector with the values of the variables, in this case the first three axes of the discriminant analysis were used as variables, which accounted for 83.12% of the observed variability. μ is the vector of the means of the variables in the data set, and S is the covariance matrix. The decision to use this distance lies in the fact that it is less sensitive to the scales of the variables than other distances such as the Euclidean distance and can capture nonlinear relationships between variables. The agglomeration method used in the flexible linkage method with a $\beta = -0.8$.

For the phytosociological analysis and statistical treatment, we selected only the thermophilic associations of the thermo- and lower mesomediterranean belt, due to the importance of climax formations in the management of a territory in which the dynamics the dynamics of the holm oak forests are studied.

RESULTS

Based on the environmental variables and floristic composition of the inventories, the discriminant analysis was able to satisfactorily classify most of the samples first ascribed to different associations according to the bibliography. The greatest uncertainty arose when establishing differences between *Myrto communis-Quercetum rotundifoliae* (McQr) and the rest of the Mariano-Monchiquense associations, with inventories whose

environmental characteristics and floristic composition correspond better to other associations, as can be seen in the confusion matrix of the discriminant analysis (Table 5).

This is to be expected in the case of the *Pyro bourgaenae-Quercetum rotundifoliae* (PbQr) holm oak groves, since the inventories of their thermophilic facies have been included, and the *Rhamno laderoi-Quercetum rotundifoliae* (RIQr) holm oak groves are described for thermal territories on decarbonated calcareous materials, so that the floristic composition and other variables have very similar ranges. On the other hand, the representatives of the facies on Axarquian calcareous shales of the *Rhamno oleoidis-Quercetum rotundifoliae* (RoQr) holm oak groves, are similar or present more affinity with the samples taken from the *Aristolochio baeticae-Quercetum rotundifoliae nova* (AbQr).

This closeness between the different associations can be seen in the centroid plots of each of the associations, with the 95% probability ellipses along the first three factors of the discriminant analysis F1, F2 and F3 that represent 83.12% of the variability generated in the inventory matrix (Figure 2). The variability represented by the F1 and F2 axes alone can discriminate most of the associations. The oak groves of *Rubio longifoliae-Quercetum rotundifoliae* (RpQr) are the best discriminated and, therefore, those that a priori present the most genuine combination of variables in the F1 and F2 axes. This discrimination is still evident in the combination of F1 and F3 axes and, to a lesser extent, in F2 and F3. The samples ascribed to the AbQr show a clear discrimination in factors F1 - F2 and F2 - F3. This is interesting insofar as the F1-F3 combination shows some similarity with the holm oak forests of the McQr. In any case, the discriminant analysis in the first three factors shows the great similarities, and therefore, the low capacity that the combination of selected variables show to be able to clearly and reliably discern the thermophilic facies of the PbQr, McQr and RIQr holm oak groves.

Table 5: Discriminant analysis validation confusion matrix, and the percentage of correct classifications.

From \ To	AbQr	McQr	PbQr	PcQr	RIQr	RoQr	RpQr	% Correct
AbQr	13	0	0	0	0	0	0	100,00%
McQr	0	50	14	0	11	2	0	64,93%
PbQr	0	13	61	0	2	0	0	80,26%
PcQr	1	0	1	107	0	2	1	95,53%
RIQr	0	0	0	0	56	0	0	100,00%
RoQr	4	1	2	0	0	57	0	89,06%
RpQr	0	0	0	0	0	0	56	100,00%

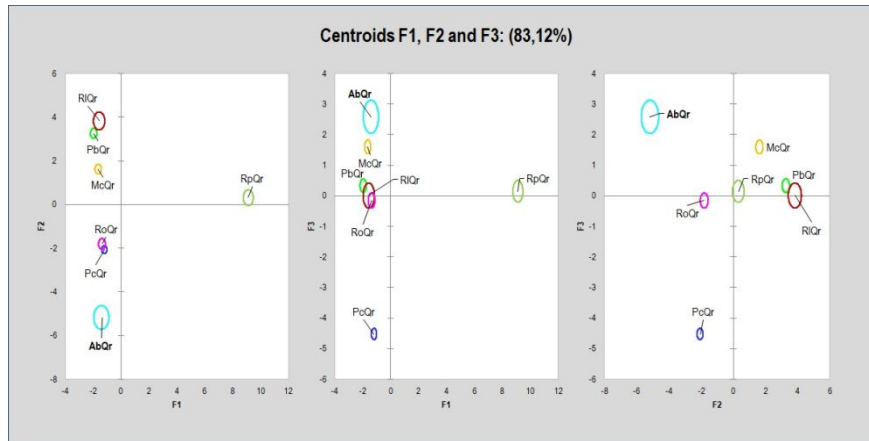


Figure 2: Segmentation graph along the first three factorial axes (F1, F2 and F3) showing the closeness or remoteness between the different associations and their correlation with each factor, as well as the ellipses of probability at 95% significance.

The hierarchical ascending classification, with the inventories already assigned to the most probable associations, shows this relationship of similarity in the floristic composition between the different climatophilic holm oak forests in their floristic composition. Although in the studied area of the Granada-Almijaran territories they are classified under dry and sub-humid-humid ombrotypes, it is in the dry and thermomediterranean ombrotype where there is an oak grove that does not correspond to the *Myrto communis-Quercetum rotundifoliae* as it presents floristic, dynamic, and biogeographical differences. This thermomediterranean siliceous *Myrto-Quercetum* holm oak forest was described by Rivas Goday et al. (1959) and later typified by Rivas-Martínez (1987) for the ravines of Sierra Morena (Marianico-Monchiquense sector); likewise, this holm oak forest differs from the *Rhamno oleoidis-Quercetum rotundifoliae* that occupies a large part of the Hispalense sector (Betica province), due to its basophilic character, as can be seen in Figure 3.

All these holm oak groves have in common that they are in the thermomediterranean bioclimatic floor and dry ombrotype, but they present different floristic composition, ecology and biogeography. This can be observed from the results of the PCA (Figure 4), where the linear combination of the environmental variables in the first two axes F1 and F2 represent 70.26% of all the variability of the data matrix. From the ecological characterization point of view, the PCA in the first term, like the basophilic oak groves of *Paenonia coriacea-Quercetum rotundifoliae* (PcQr), present significant correlations with the edaphic variables related to the presence of carbonates, high pH levels and clay soils. From a bioclimatic point of view, these holm oak groves are the coldest and most continental, and humid within the context of a thermo-mesomediterranean bioclimatic floor and a lower dry-subhumid ombrotype. This is evidenced by the presence of the point cloud of these holm oak groves, close to the variables with which they are positively correlated, and far from the variables with which they are negatively

correlated. The opposite case can be observed in the associations PbQr and McQr, which are correlated to sandy soils (the facies with *Halimium halimifolium* (L.) Willk. are described for sandy rañas of the lower countryside of the Guadalquivir Valley by Rivas-Martínez et al. [2011a) and the subassociation *lavanduletosum viridi* Quino Canas et al. 2018 (Quinto-Canas et al. 2018) for the westernmost areas; they show a negative correlation to high pH values presence of carbonates, clayey soils, with lower water retention capacity as expected for these silicic associations on quartzite, sandy, schistose materials.

From a bioclimatic point of view, these holm oak groves have an affinity for the most thermal and oceanic territories, but not arid, as they are located at the opposite extreme to the high values of continentality (Ic). From the edaphic and bioclimatic point of view, RIQr holm oak forests, like the RpQr ones, present intermediate correlations between the PbQr and PcQr forests in their thermophilic facies. In fact, the RIQr forests are more suitable (or the variables related to precipitation carry more weight) for higher values of Ic than the RpQr and PbQr ones. Instead, the typically thermomediterranean RpQr samples show greater affinities for temperature- and aridity-related variables

The thermomediterranean holm oak forests of basic RoQr character are located in the lower part of the graph showing shared correlations both with edaphic variables related to high carbonate levels, clayey soils, high pH, and at the same time, with high values of aridity and temperature and evapotranspiration, although the more humid and neutroacid *Quercus suber* L. facies (Rivas-Martínez et al. 2011b), are positioned away from the pH and aridity variables and closer to the Io variables and sandier soils. These facies, due to their floristic composition, as well as their biogeographic location and bioclimatic characterization could be included in the thermomediterranean cork oak forest of *Bupleurum gibraltarium* Lam. and *Quercus suber*.

Finally, the bioclimatic characterization of the holm oak groves proposed as *Aristolochio baeticae-Quercetum rotundifoliae*, show correlations with the variables that present high values of aridity and thermicity, located at a distance from the continentality variable, being this variable quite significantly and negatively correlated with these holm oak groves. In other words, they are the most oceanic of the Betic oak groves studied, with an average Ic of 15.36 (± 1.02) and the most thermophilic with an average Tp of 2243 (± 82).

The thermomediterranean holm oak forest of Granada-Almijareense (Montes of Málaga) developed on slate is characterized by the presence of thermophilic elements *Chamaerops humilis* L., *Asparagus aphyllus* L., *Aristolochia baetica* L., *Phlomis purpurea* L., *Olea europaea* L., var. *sylvestris* Brot., *Bupleurum gibraltarium*. Considering the above-mentioned differences, we propose as new the holm oak *Aristolochio baeticae-Quercetum rotundifoliae nova* (Table 6, inv. 1-13 typus inv.2), of siliceous-basic nature, which is included in the *Quercus rotundifoliae-Oleion sylvestris* alliance. This new holm oak forest presents floristic differences with respect to the dynamic typology of other thermomediterranean holm oak forests with species such as *Genista umbellata* (L.-Her.) Poir. subsp. *equisetiformis* (Spach) Rivas Goday & Rivas Mart., *Clematis cirrhosa* L., *Ononis speciosa* Lag., *Chamaerops humilis*.

Table 6.- Ass. *Aristolochio baeticae-Quercetum rotundifoliae nova*

Commented [Eusebio C5]: L.Her
Corr. R1

	AbQr 1	AbQr2Typu s	AbQr3	AbQr 4	AbQr 5	AbQr6	AbQr 7	AbQr8	AbQr 9	AbQr1 0	AbQr1 1	AbQr1 2	Ab Qr 13
Surface m2	300	300	600	300	400	600	600	600	600	600	600	600	600
Altitude m.	174	197	288	172	786	913	746	193	513	726	315	528	598
Coverage	55	40	45	55	85	60	60	55	70	65	90	60	65
Orientation	E	S	W	N	W	SE	S	NE	NE	SE	E	NE	NE
Inclination	5	9	10	20	10	4	10	20	25	10	20	5	5
Average veg. hight m.	6	4	6	5	6	8	6	7	6	5	6	6	6
Characteristics association and superior units													
Association Characteristics and Species of <i>Pistacio-Rhamnetalia</i> and <i>Quercetalia ilicis</i>													
<i>Quercus rotundifolia</i>	3	2	2	2	4	3	3	3	3	3	4	3	3
<i>Phlomis purpurea</i> subsp. <i>purpurea</i>	2	1	+	.	2	2	1	1	.	+	2	2	2
<i>Chamaerops humilis</i>	2	.	1	2	+	.	.	1	.	.	1	1	2
<i>Daphne gnidium</i>	+	.	.	+	.	.	+	.	.	.	+	.	+
<i>Quercus coccifera</i> subsp. <i>coccifera</i>	.	.	.	.	.	+	+	.	.	.	2	.	+
<i>Olea europaea</i> var. <i>sylvestris</i>	.	1	+	2	.	.	1	2	.	1	1	2	.
<i>Aristolochia baetica</i>	1	1	1	1	1	.	.	.	2	+	2	1	.
<i>Asparagus albus</i>	2	+	+	1	.	.	.	1	1	+	1	2	.
<i>Rhamnus alaternus</i>	+	.	.	2	3	1	2	1	2	1	1	.	.
<i>Rhamnus lycioides</i> subsp. <i>laderoi</i>	+	+	+	.	.	.	.	2	1	1	+	.	.
<i>Smilax aspera</i>	+	.	.	.	.	.	.	.	.	.	1	.	.
<i>Asparagus acutifolius</i>	+	.	.	.	.	.	.	.	.	.	1	.	.
<i>Asparagus aphyllus</i> subsp. <i>aphyllus</i>	+	.	+	1	1	.	.	1	.	.	1	.	.
<i>Crataegus monogyna</i> subsp. <i>brevispina</i>	.	.	.	.	.	.	.	.	+	.	+	.	.
<i>Lonicera implexa</i>	.	.	.	.	.	.	.	.	.	.	1	.	.
<i>Clematis flammula</i>	.	.	.	.	.	.	.	.	.	.	1	.	.
<i>Pistacia lentiscus</i>	+	.	.	.	.	.	.	+	+	.	.	.	.
<i>Ceratonia siliqua</i>	2	2	1	.	.	.	.	1	.	.	.	.	.
<i>Arbutus unedo</i>	.	.	.	.	.	1	1	.	.	.	.	.	.
<i>Bupleurum gibraltaricum</i>	.	.	.	.	2	.	+	.	.	.	.	.	.
<i>Cheirolophus sempervirens</i>	+	.	.	.	.	1	+	.	.	.	.	.	.
<i>Phillyrea angustifolia</i>	.	.	.	.	.	+	.	.	.	.	.	.	.
<i>Bupleurum fruticosum</i>	.	.	.	.	.	2	.	.	.	.	.	.	.
<i>Myrtus communis</i>	+	.	+	+	.	.	.	.	.	.	.	.	.
<i>Juniperus oxycedrus</i> subsp. <i>badia</i>	.	.	.	+	.	.	.	.	.	.	.	.	.
<i>Osyris alba</i>	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Clematis cirrhosa</i>	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Quercus suber</i> var. <i>suber</i>	.	.	.	.	.	1	.	.	.	.	.	.	.
<i>Teucrium fruticans</i>	1	.	.
<i>Coronilla juncea</i>	1	.	.
Companions													
<i>Adenocarpus telonensis</i>	.	+	+	+
<i>Allium roseum</i>	+	.

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10	<i>Asparagus horridus</i>	+	.	+	.	.	.	1
11	<i>Asphodelus aestivus</i>	+	.
12	<i>Brachypodium retusum</i>	+	+	.	.	+	.	1	.	.	.	1	.
13	<i>Calicotome villosa</i>	+	+	1	+	+	.	1	1	1	.	.	.
14	<i>Capparis sicula</i>	+	.	+	.	.	.	.	+	.	.	.	.
15	<i>Cistus albidus</i>	.	.	.	1	+	1	+	.	+	1	1	2
16	<i>Cistus crispus</i>	.	.	.	.	+	.	.	.	.	.	.	.
17	<i>Cistus ladanifer</i> subsp. <i>ladanifer</i>	+	.	.	.	+	1	+	.	.	.	.	.
18	<i>Cistus monspeliensis</i>	+	.	+	1	.	+	1	.	.	1	1	.
19	<i>Cistus salvifolius</i>	+	.	.	1	.	+	.	.	+	.	.	.
20	<i>Cynara humilis</i>	.	+	.	.	.	.	+	.	.	.	.	.
21	<i>Digitalis purpurea</i> subsp. <i>purpurea</i>	.	.	.	.	.	.	.	.	1	.	.	.
22	<i>Genista umbellata</i> subsp. <i>equisetiformis</i>	2	+	1	.	.	1	1	.	+	1	.	.
23	<i>Hyparrhenia sinaica</i>	+	.	.	.	.	.	.	.	.	.	.	.
24	<i>Lavandula stoechas</i> subsp. <i>stoechas</i>	+	.	.	1	.	.	.	.	.	+	.	1
25	<i>Lonicera periclymenum</i> subsp. <i>hispanica</i>	.	.	.	.	.	.	.	.	.	.	1	2
26	<i>Ononis speciosa</i>	.	.	.	.	1	.	.	.	.	.	.	.
27	<i>Origanum virens</i>	.	.	.	.	.	.	.	.	.	.	.	+
28	<i>Ptilostemon hispanicus</i>	+	.	.	+	1	.	.	.	+	.	1	.
29	<i>Retama sphaerocarpa</i>	1	+	+	+	1	.	+	+	+	.	+	.
30	<i>Rosa canina</i> subsp. <i>canina</i>	.	.	.	.	.	.	.	.	+	.	.	.
31	<i>Rubia peregrina</i> subsp. <i>peregrina</i>	.	.	.	.	1	.	.	.	+	1	.	2 1
32	<i>Petrosedum sediforme</i>	.	.	.	.	.	.	+	.	.	.	.	.
33	<i>Spartium junceum</i>	.	.	.	.	.	+	.	.	.	.	.	.
34	<i>Thapsia villosa</i> var. <i>villosa</i>	.	.	.	.	.	.	.	.	.	.	.	1
35	<i>Thymus baeticus</i>	.	.	.	+	.	.	.	.	.	.	.	.
36	<i>Ulex parviflorus</i> subsp. <i>parviflorus</i>	+	.	.	1	1	+	1	.	+	+	1	1
37	<i>Drimys maritima</i>	.	.	.	.	.	.	.	.	.	.	.	+
38	<i>Ricinus communis</i>	+	.	.	.	.	.	.	.	.	.	.	.
39	<i>Nicotiana glauca</i>	1	.	.	.	.	.	.	.	.	.	.	.
40	<i>Lavandula multifida</i>	+	+	+	+	.	.	.	.	.	.	.	.
41	<i>Macrochloa tenacissima</i> subsp. <i>tenacissima</i>	+	.	.	.	.	.	.	.	.	.	.	.
42	<i>Opopanax chironium</i>	1	.	.	.	.	.	.	.	.	.	.	.
43	<i>Carlina gummifera</i>	.	.	.	.	.	.	.	.	.	+	.	.
44	<i>Cytisus grandiflorus</i>	.	.	.	.	.	.	.	.	.	.	.	.

Localities: AbQr. Camino de los Almendrales Km 3 (36° 44' 55N/ 4° 23' 75W). AbQr2. Camino de los Almendrales (36° 45' 5N/4° 23' 10W). AbQr3. Prox. Finca La Brisa (36° 44' 25N/4° 23' 10W). AbQr4. Cerrado Calderón (36° 44' 20N/4° 22' 45W). AbQr5. Camino de Colmenar (30S0376947/4037401). AbQr6. Camino de Colmenar (30S0378428/4075391). AbQr7. Camino de Comares (30S0383264/4073380). AbQr8. Prox. Camino de Albahaca (30S0376847/4067545). AbQr9. Totalán a Comares (30S0384566/4071098). AbQr10. Totalán a Comares (30S0384225/4072362). AbQr11. Camino de Almogía MA: 3402 (30S0364797/4076052). AbQr12. Camino de Monterroso (30S0359677/4081596). AbQr13. Camino de las Lomas a Álora (30S0355707/4079810).

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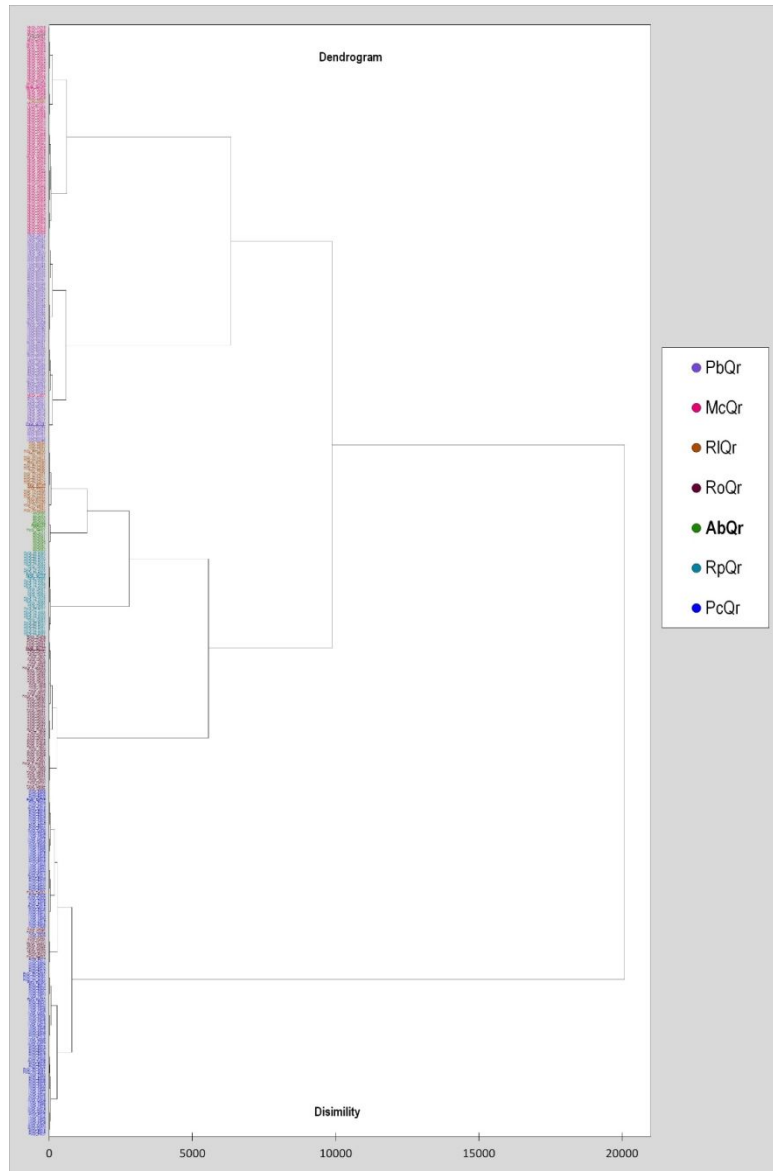


Figure 3: Dendrogram of hierarchical ordination of the 395 selected samples, using the Mahalanobis distance.

The first dynamic stage of this holm oak grove is a secondary *Olea europea* var. *sylvestris* wild olive grove. Although Rivas-Martínez et al. (2002, 2011a) include the wild olive *Olea europea* var. *sylvestris* as a characteristic species of *Quercetea ilicis*, the structure of these microforests, the ecological conditions, and the difference between the

number of species belonging to the orders of *Quercetea ilicis* are different: *Quercetalia ilicis* presents 26.2% of species and *Pistacio lentisci-Rhamnetalia alatarni* 47.5%, being class species in both orders, and before the dominance of species belonging to *Pistacio-Rhamnetalia alatarni*. These formations of wild olive trees have arisen due to an edaphic influence combined with a climatic change. Although we consider that the olive groves of Axarquia are secondary micro-forests, the reality is that the loss of soil together with the decrease in precipitation, with a lower dry ombroclimate, has allowed the installation of these micro-forests. We cannot include these communities in the *Quercus rotundifoliae-Oleion sylvestris* alliance because they present different floristic and ecological conditions. Consequently, we propose to include the communities dominated by *Olea europea* var. *syvestris* in the *Oleo-Ceratonion siliquae* alliance.

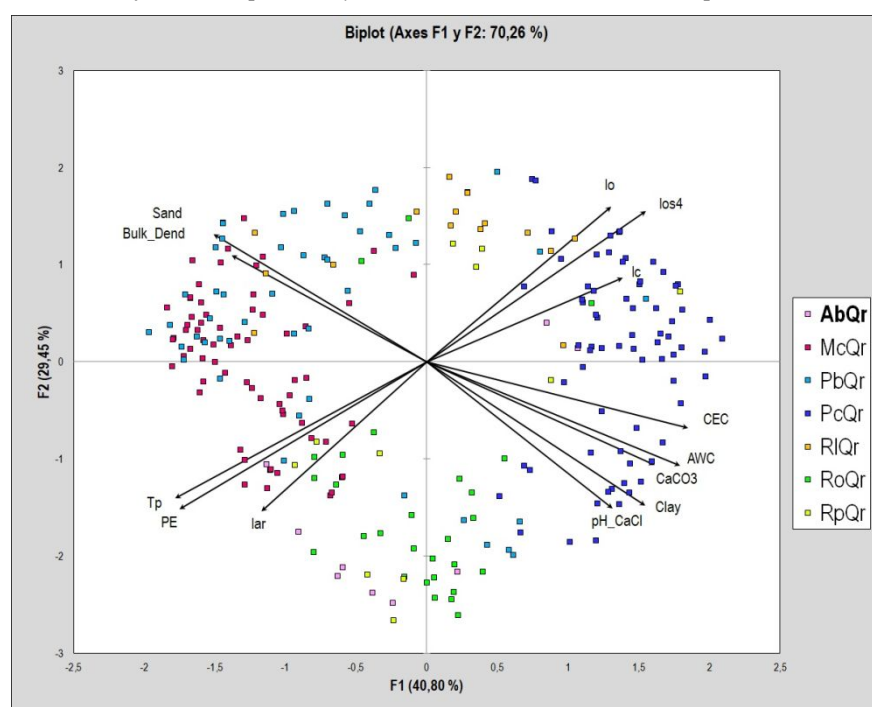


Figure 4: Principal component analysis (PCA) of the selected inventories, in bold the proposed new oak forest *Aristolochio baeticae-Quercetum rotundifoliae*.

The floristic, ecological, dynamic and biogeographical differences allow us to propose the new association *Aristolochio baeticae-Oleetum sylvestris nova* (Table 7, inv. 1-6 typus inv.4). This new syntaxon differs from *Aro italici-Oleetum sylvestris* of very clayey substrates (vertisols) by ecological, floristic, dynamic and catenary features, as well as from *Asparago albi-Oleetum sylvestris* Rivas-Marínez et al. 2011 of Luso-Extremaduran distribution, an association described by Rivas-Martínez et al. (2011a). Due to name prioritization, the new name *Rhamno laderoi-Oleetum sylvestris* has been proposed for this syntaxon, since the association *Asparago albi-Oleetum sylvestris* was

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10 described by [Bacchetta et al. \(2003\)](#) for Sardinia. Since [Gianguzzi and Bazan \(2019\)](#)
11 made the name change proposal by applying article 31 of the ICPN, the Spanish
12 association is *Rhamno laderoi-Oleetum sylvestris* [Gianguzzi & Bazan 2019](#) ([Cantó et al.](#)
13 [2011](#), [Gianguzzi & Bazan 2019](#)). Earlier studies on wild olive groves ([Rivas-Martínez](#)
14 [et al. 2001, 2002, 2011a, 2011b](#); [Nieto et al 1990, 1991](#)) have shown that communities
15 of *Olea europaea* var *sylvestris* grow on vertisols and in edaphoxerophilic
16 environments, whereas the association we propose does so on siliceous materials, an
17 association that gives way to *Asparago aphylli-Calicotometum villosi* [Rivas-Marínez](#)
18 [1975](#) and this one to *Lavandulo stoechadis-Genistetum equisetiformis* [Rivas Goday &](#)
19 [Rivas-Martínez 1969](#). This new wild olive grove has strong ecological, bioclimatic,
20 biogeographical, and floristic differences with *Viburno tini-Oleetum sylvestris* [Costa et](#)
21 [al. 1994](#) that was described by its authors for the subhumid areas of the Lisbon region
22 on vertisols of calcareous origin ([Costa et al. 1994](#)).

23 [Perez Latorre et al. \(2008\)](#) include the Axarquía wild olive grove in the association
24 described by [Benabid \(1984\)](#) for Morocco, *Tamo communis-Oleetum sylvestris* [Benabid](#)
25 [1984](#). Although [Rivas-Martínez \(1987\)](#) accepted this association for Spain, he later
26 separates these communities from the Moroccan ones ([Rivas-Martínez et al. 2002;](#)
27 [2011a, 2011b](#)), and describes for Spain the association *Aro italici-Oleeum sylvestris*
28 [Rivas-Martínez & Cantó 2002](#) in [Rivas-Martínez et al. 2002](#). In the PhD thesis of
29 [García Fuentes](#), we mentioned an edaphoxerophyllous community of *Ephedra fragilis*
30 [Desf.](#) and *Olea europaea* var. *sylvestris*, a community developed in the lower
31 thermomediterranean and mesomediterranean on basic substrates, which we proposed
32 for the Hispalense sector, and which was neither published nor typified, *Ephedro*
33 *fragilis-Oleetum sylvestris* [García Fuentes & Cano nova](#) (Table 8 inv. 1-7, typus inv. 4).

34 The ordination analysis of the associations of *Olea europaea* var. *sylvestris* studied in
35 the south of the Iberian Peninsula, clearly reveals four distinct syntaxons due to their
36 floristic differences (Figure 5). The inventories carried out by [Pérez Latorre et al. \(2008\)](#)
37 in the Axarquía region (Málaga), were ascribed to the Moroccan association (TcOs), but
38 in our study they are grouped with the RIOs inventories. This is confirmed by the
39 synthetic table (Table 9).
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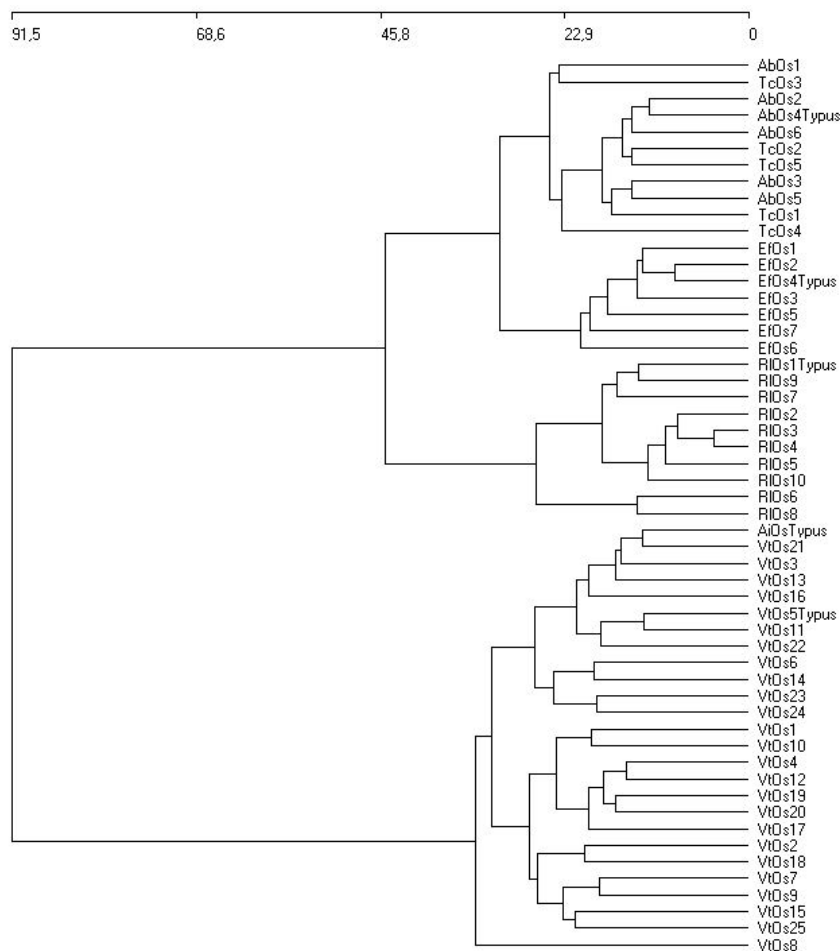


Figure 5: Hierarchical ascending classification of *Olea europaea* var *sylvestris* forests. In this case, due to the lower number of inventories, the Euclidean distance and Ward's agglomeration method were used.

Table 7.- *As. Aristolochio baeticae-Oleetum sylvestris nova*

	AbOs1	AbOs2	AbOs3	AbOs4	AbOs5	AbOs6
Surface m ²	300	600	300	200	300	500
Altitude m.	105	291	226	537	176	215
Coverage %	60	60	45	90	60	90
Orientation	W	S	NW	E	E	W
Inclination	10	8	25	8	20	25
Average veg. height m.	3	3,5	2,5	3,5	3,5	5
Characteristics association and superior units						
<i>Olea europaea</i> var. <i>sylvestris</i>	3	3	2	4	3	5
<i>Phlomis purpurea</i> subsp. <i>purpurea</i>	+	+	1	2	2	2
<i>Chamaerops humilis</i>	+	+	2	2	-	2

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10	<i>Ceratonia siliqua</i>	1	1	1	-	1	1
11	<i>Asparagus albus</i>	1	-	+	1	-	2
12	<i>Asparagus aphyllus</i>	1	-	1	1	-	+
13	<i>Rhamnus alaternus</i>	3	1	+	-	-	1
14	<i>Aristolochia baetica</i>	2	2	1	1	-	-
15	<i>Rhamnus lycioides</i> subsp. <i>laderoi</i>	-	-	+	1	+	1
16	<i>Asparagus horridus</i>	+	-	1	-	-	1
17	<i>Quercus rotundifolia</i>	-	+	+	+	-	-
18	<i>Pistacia lentiscus</i>	1	-	-	-	-	-
19	<i>Smilix aspera</i>	+	-	-	-	-	-
20	<i>Rubia peregina</i> subsp. <i>longifolia</i>	1	-	-	-	-	-
21	<i>Ptilostemom</i> <i>hispanicus</i>	-	-	+	-	-	-
22	<i>Juniperus oxycedrus</i> subsp. <i>badia</i>	-	-	+	-	-	-
23	<i>Quercus coccifera</i> subsp. <i>coccifera</i>	-	-	+	-	-	-
24	<i>Myrtus communis</i>	-	-	-	1	-	-
25	<i>Quercus suber</i>	-	-	-	+	-	-
26	<i>Bupleurum</i> <i>gibraltarcum</i>	-	-	-	+	-	-
27	Companions						
28	<i>Calicotome villosa</i>	+	1	+	-	+	1
29	<i>Genista umbellata</i> subsp. <i>equisetiformis</i>	+	1	-	+	-	+
30	<i>Lavandula stoechas</i>	+	-	-	1	-	+
31	<i>Ulex parviflorus</i>	-	+	-	1	-	+
32	<i>Retama</i> <i>sphaerocarpa</i>	-	1	-	+	-	+
33	<i>Brachypodium</i> <i>retusum</i>	+	-	-	-	-	1
34	<i>Dactylis hispanica</i>	+	-	-	-	-	-
35	<i>Orobanche hederaceae</i>	+	-	-	-	-	-
36	<i>Oloptum miliaceum</i>	+	-	-	-	-	-
37	<i>Spartium junceum</i>	+	-	-	-	-	-
38	<i>Marrubium vulgare</i>	+	-	-	-	-	-
39	<i>Lavandula multifida</i>	+	-	-	-	-	-
40	<i>Adenocarpus</i> <i>telonensis</i>	-	1	-	-	-	-
41	<i>Salvia rosmarinus</i>	-	-	1	-	-	-
42	<i>Cistus salvifolius</i>	-	-	-	1	-	-
43	<i>Vinca difformis</i>	-	-	-	1	-	-
44	<i>Cistus monspeliensis</i>	-	-	-	-	1	1
45	<i>Juniperus turbinata</i>	-	-	-	-	+	-
46	<i>Cistus crispus</i>	-	-	-	-	+	+
47	<i>Fumana thymifolia</i>	-	-	-	-	-	+

Localities. AbOs1. Monte Gibralfaro, Málaga (30S0374142/4065242). AbOs2. Camino de los Almendrales (30S0376340/4069022). AbOs3. Camino de Albahaca (30S0376796/4067213). AbOs4. Almogia-Antequera MA:3403 (30S0360491/4081264). AbOs5. Prox Cerrado Calderón (30S0376764/4067317). AbOs6. Pro. Cerrado Calderón (30S0376801/4067439).

Table 8. Ass. *Ephedro fragilis-Oleatum sylvestris* García Fuentes & Cano nova

	<u>EfOs1</u>	<u>EfOs2</u>	<u>EfOs3</u>	<u>EfOs4</u>	<u>EfOs5</u>	<u>EfOs6</u>	<u>EfOs7</u>
Surface area m2	<u>100</u>	<u>300</u>	<u>200</u>	<u>200</u>	<u>400</u>	<u>400</u>	<u>200</u>
Altitude m.	<u>600</u>	<u>630</u>	<u>490</u>	<u>530</u>	<u>500</u>	<u>420</u>	<u>480</u>
Coverage %	<u>85</u>	<u>40</u>	<u>40</u>	<u>65</u>	<u>60</u>	<u>50</u>	<u>50</u>
Orientation	<u>E</u>	<u>±</u>	<u>S</u>	<u>SE</u>	<u>±</u>	<u>SW</u>	<u>±</u>
Inclination %	<u>9</u>	<u>±</u>	<u>27</u>	<u>72</u>	<u>±</u>	<u>90</u>	<u>±</u>

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Average height veg m.	4	3.5	4	3	4	2.5	3
Characteristics association and superior units							
Olea europaea var. sylvestris	1	2	2	3	3	1	2
<i>Ephedra fragilis</i>	4	1	1	1	+	2	+
<i>Juniperus oxycedrus</i> subsp. oxycedrus	+	.	.	.	.	.	.
<i>Rhamnus oleoides</i> subsp. oleoides var. angustifolia	.	+	1	+	+	.	.
<i>Asparagus albus</i>	.	1	2	2	.	2	2
<i>Clematis flammula</i>	.	+	.	.	.	.	.
<i>Arisarum simorhinum</i>	.	1	1	.	1	1	.
<i>Pistacia terebinthus</i>	.	.	.	1	.	.	.
<i>Jasminum fruticans</i>	.	.	.	.	.	.	1
<i>Asparagus acutifolius</i>	.	.	.	.	.	.	+
<i>Crataegus monogyna</i> subsp. brevispina	.	.	.	.	.	.	+
<i>Quercus rotundifolia</i>	.	.	.	.	.	.	+
Companions							
Macrochloa tenacissima	1	.	.	.	.	+	.
<i>Oloptum miliaceum</i>	1	.	.	.	.	.	.
<i>Marrubium vulgare</i>	1	.	.	.	+	+	.
<i>Artemisia barrelieri</i>	+	.	.	.	.	+	.
<i>Retama sphaerocarpa</i>	+	.	.	1	.	1	.
<i>Thymus orospedanus</i>	.	1	1	.	.	.	.
<i>Phagnalon saxatile</i>	.	.	+	.	.	+	1
<i>Hyparrhenia hirta</i>	.	.	.	1	+	+	1
<i>Ballota hirsuta</i>	.	.	.	+	.	.	+
<i>Thymus zygis</i> subsp. gracilis	.	.	.	.	1	.	.
<i>Teucrium lusitanicum</i>	.	.	.	.	1	.	.
<i>Teucrium pseudo-chamaepitys</i>	.	.	.	.	1	+	.
Dactylis glomerata subsp. hispanica	.	.	.	.	+	.	.
<i>Lepidium subulatum</i>	.	.	.	.	.	+	.
<i>Asphodelus fistulosus</i>	.	.	.	.	.	+	2
<i>Micromeria graeca</i>	.	.	.	.	.	.	+
<i>Valantia muralis</i>	.	.	+	.	.	.	.
<i>Asphodelus fistulosus</i>	.	.	+	.	.	.	.
<i>Thapsia villosa</i>	.	.	+	.	.	.	.
<i>Melica minuta</i>	.	.	.	1	.	.	.
<i>Paronychia argentea</i>	.	.	.	+	.	.	.
<i>Asphodelus albus</i>	.	.	.	.	+	.	.
<i>Thapsia foetida</i>	.	.	.	.	+	.	.
<i>Brachypodium retusum</i>	.	.	.	.	+	.	.

Asphodelus aestivus	.	.	.	.	.	+	.
Muscari neglectum	.	.	.	.	.	+	.
Convolvulus althaeoides	.	.	.	.	.	+	.
Asplenium ceterach	.	.	.	.	.	.	+
Sanguisorba minor	.	.	.	.	.	.	+
Drimys maritima	.	.	.	.	.	.	+
Umbilicus rupestris	.	.	.	.	.	.	+
Campanula erinus	.	.	.	.	.	.	+
Ficus carica	.	.	.	.	.	.	+

Localities. Efos1. Puente Padilla (30SVG38). Efos2. Cerro Peñaflores (30SVG48). Efos3. Prox. Ayo. de la Cuezuela (30SVG28). Efos4. Cerro Cabeza Grillos (30SVG56). Efos5. Majada Amapola (30SVG38). Efos6. Cerro de Tallan (30SVG38). Efos7. Prox. El Berrueco (30SVG28).

Table 9. Synthetic table of the associations of wild olive trees studied. AbOs = *Aristolochio baeticae-Oleetum sylvestris*. TcOs = *Tamo communis-Oleetum sylvestris*. EfOs = *Ephedro fragilis-Oleetum sylvestris*. RIOs = *Rhamno laderoi-Oleetum sylvestris* synonyms: (AaOs = *Asparago albi-Oleetum sylvestris*). VtOs = *Viburnum tini-Oleetum sylvestris*. AiOs = *Aro italici-Oleetum sylvestris*.

Synthetic table	AbOs	TcOs	EfOs	RIOs	VtOs	AiOs
Quercetalia llicis species						
<i>Rhamnus alaternus</i>	III	V			V	
<i>Smilax aspera</i>	I	V			IV	
<i>Quercus rotundifolia</i>	III	III	I		I	
<i>Asparagus aphyllus</i>	III	I			III	
<i>Rubia pergrina subsp. longifolia</i>	I				V	
<i>Quercus suber</i>	I				I	
<i>Juniperus oxycedrus subsp. badia</i>	I					
<i>Daphne gnidium</i>		II		II	II	
<i>Viburnum tinus</i>		I			IV	
<i>Clematis cirrhosa</i>		II				2
<i>Asparagus acutifolius</i>		III	I	II		
<i>Clematis flammula</i>		I	I			
<i>Arisarum vulgare</i>		IV				
<i>Rubia pergrina subsp. peregrina</i>		II				
<i>Arisarum simorrhinum</i>			III	V		
<i>Ruscus aculeatus</i>				II	III	+
<i>Pyrus bourgaeana</i>				II		
<i>Arisarum vulgare var. clusii</i>					IV	
<i>Phillyrea latifolia</i>					III	
<i>Rosa sempervirens</i>					II	
<i>Anemone palmata</i>					I	
<i>Carex distachya</i>					I	
<i>Paeonia broteroi</i>					I	

Bupleurum rigidum subsp. paniculatum					I	
<i>Lonicera implexa</i>					I	
<i>Lonicera etrusca</i>					I	
<i>Carex hallerana</i>					I	
<i>Eryngium tricuspidatum</i>						1
Arisarum simorhinum var. subexertum						1
Smilax aspera var. altissima						2
Pistacio-Rhamnetalia species						
<i>Olea europea var. sylvestris</i>	V	V	V	V	V	4
<i>Asparagus albus</i>	III	V	IV	V	IV	1
<i>Pistacia lentiscus</i>	I	II		II	III	2
Rhamnus lycioides subsp. laderoi	III	IV		V		
Phlomis purpurea subsp. purpurea	V	V			I	1
Quercus coccifera subsp. coccifera	I	II		I	II	
<i>Chamaerops humilis</i>	IV	II				+
<i>Ceratonia siliqua</i>	IV				II	
<i>Myrtus communis</i>	I			I	I	
<i>Juniperus turbinata</i>	I				I	
<i>Aristolochia baetica</i>	III	V				1
<i>Calicotome villosa</i>	IV					
<i>Asparagus horridus</i>	III					
Bupleurum gibraltarium	I					
<i>Osyris alba</i>		IV		I	II	
<i>Pistacia terebinthus</i>		I	I	II		
<i>Osyris quadripartita</i>		I				
<i>Jasminum fruticos</i>			I	I	I	
<i>Ephedra fragilis</i>			V			
Rhamnus oleoides subsp. oleoides var. angustifolia			III			
Juniperus oxycedrus subsp. oxycedrus			I			
<i>Rhamnus oleoides</i>					III	1
Crataegus monogyna subsp. brevispina					I	1
Coronilla valentinus subsp. glauca					II	
<i>Euphorbia characias</i>					I	
<i>Arbutus unedo</i>					I	
<i>Teucrium fruticans</i>					I	
<i>Erica arborea</i>					I	
<i>Bupleurum fruticosum</i>					I	
Cytisetea scopario-striati species						
<i>Retama sphaerocarpa</i>	III	V	II	V		
Genista umbellata subsp. equisetiformis	III	I				
<i>Adenocarpus telonensis</i>	I	I				

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10	<i>Cytisus arboreus</i>		I				
11	<i>Cytisus malacitanus</i>		I				
12	<i>Cytisus bourgaei</i>			V			
13	Rosmarinetea and Cisto-Lavanduletea species						
14	<i>Cistus monspeliensis</i>	II	I		I		
15	<i>Cistus salviifolius</i>	I			I		
16	<i>Salvia rosmarinus</i>	I			I		
17	<i>Ulex parviflorus</i> subsp. <i>parviflorus</i>	III	II				
18	<i>Lavandula stoechas</i>	III	I				
19	<i>Cistus crispus</i>	II					
20	<i>Fumana thymifolia</i>	I					
21	<i>Ptilostemom hispanicus</i>	I					
22	<i>Cistus albidus</i>		I		I		
23	<i>Thymus orospedanus</i>			I			
24	<i>Thymus zygis</i> subsp. <i>p. gracilis</i>			I			
25	<i>Lepidium subulatum</i>			I			
26	<i>Lavandula sampaloana</i>			V			
27	<i>Genista hirsuta</i>			I			
28	<i>Ulex jussiaei</i>				I		
29	<i>Astragalus lusitanicus</i>				I		
30	Lygeo-Stipetea tenacissimae species						
31	<i>Lavandula multifida</i>	I			I		
32	<i>Brachypodium retusum</i>	II	II	I		1	
33	<i>Iris planifolia</i>		I				
34	<i>Lapiedra martinezii</i>		I				
35	<i>Phagnalon saxatile</i>			II	I		
36	<i>Dactylis glomerata</i> subsp. <i>hispanica</i>			I	I		
37	<i>Hyparrhenia hirta</i>			III			
38	<i>Convolvulus althaeoides</i>			I			
39	<i>Macrochloa tenacissima</i>			I			
40	<i>Teucrium pseudocamaeipitys</i>			I			
41	Species of other phytosociological classes						
42	<i>Vinca difformis</i>	I	IV		IV	1	
43	<i>Oloptum miliaceum</i>	I		I	III	2	
44	<i>Marrubium vulgare</i>	I		II			
45	<i>Spartium junceum</i>	I	II				
46	<i>Orobancha hederæ</i>	I					
47	<i>Bryonia cretica</i> subsp. <i>dioica</i>		III		II	III	+
48	<i>Arum italicum</i>		I			IV	2
49	<i>Drimys maritima</i>		II	I	III	III	
50	<i>Tamus communis</i>		II			IV	
51	<i>Rubus ulmifolius</i>		I			III	
52	<i>Asphodelus ramosus</i>		I			I	
53	<i>Crataegus monogyna</i> subsp. <i>brevispina</i>		III	I	II		
54	<i>Ballora hirsuta</i>		II	I	II		
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10	<i>Melica minuta</i>	II	I			
11	<i>Thapsia villosa</i>	I	I			
12	<i>Ficus carica</i>	I	I			
13	<i>Clematis vitalba</i>	II				
14	<i>Silene vulgaris</i>	II				
15	<i>Asperula aristata</i> <i>subsp. scabra</i>	I				
16	<i>Campanula rapunculus</i>	I				
17	<i>Carthamus arborescens</i>	I				
18	<i>Lobularia maritima</i>	I				
19	<i>Narcissus serotinus</i>	I				
20	<i>Ranunculus bullatus</i>	I				
21	<i>Asphodelus fistulosus</i>		II			
22	<i>Artemisia barrelieri</i>		I			
23	<i>Asphodelus aestivus</i>		I			
24	<i>Asphodelus albus</i>		I			
25	<i>Asplenium ceterach</i>		I			
26	<i>Campanula erinus</i>		I			
27	<i>Thapsia foetida</i>		I			
28	<i>Micromeria graeca</i>		I			
29	<i>Muscari neglectum</i>		I			
30	<i>Paronychia argentea</i>		I			
31	<i>Sanguisorba minor</i>		I			
32	<i>Teucrium lusitanicum</i>		I			
33	<i>Umbilicus rupestris</i>		I			
34	<i>Valantia muralis</i>		I			
35	<i>Asphodelus microcarpus</i>			IV		
36	<i>Hyparrhenia sinaica</i>			II		
37	<i>Thymus maslichina</i>			I		
38	<i>Thymus zygis</i> <i>subsp. gracillius</i>			I		
39	<i>Dactylis lusitanica</i>			I		
40	<i>Cheilanthes tinaii</i>			I		
41	<i>Rumex induratus</i>			I		
42	<i>Digitalis thapsi</i>			I		
43	<i>Smyrnium olusatrum</i>				IV	+
44	<i>Oxalis pes-caprea</i>				IV	
45	<i>Geranium purpureum</i>				IV	
46	<i>Urtica membranacea</i>				IV	
47	<i>Parietaria judaica</i>				III	
48	<i>Acanthus mollis</i>				II	
49	<i>Hedera helix</i> <i>subsp. canariensis</i>				II	
50	<i>Lonicera periclymenum</i> <i>subsp. hispanica</i>				II	
51	<i>Ruta chalepensis</i>				II	
52	<i>Orobanch</i> <i>ramosa</i> <i>subsp. nana</i>				II	
53	<i>Galium aparine</i>				II	
54	<i>Sonchus oleraceus</i>				II	
55	<i>Prunus spinosa</i> <i>subsp. insititoides</i>				I	
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<i>Ulmus minor</i>					I	
<i>Calamintha baetica</i>					I	
<i>Fraxinus angustifolia</i>					I	
<i>Iris foetidissima</i>					I	
<i>Fumaria capreolata</i>					I	
<i>Solanum nigrum</i>					I	
<i>Mercurialis annua</i>					I	
<i>Brachypodium phoenicoides</i>					I	
<i>Salvia sclareoidis</i>					I	
<i>Salpichroa organifolia</i>					I	
<i>Asparagus asparagoides</i>					I	
<i>Opuntia maxima</i>					I	
<i>Silene dioica</i>					I	
<i>Viola riviniana</i>					I	
<i>Allium roseum</i>					I	
<i>Polypodium cambricum</i>					I	
<i>Biscutella valentina</i> subsp. <i>lusitanica</i>					I	
<i>Allium neapolitanum</i>					I	
<i>Narcissus obesus</i>					I	

DISCUSSION

Results of the present study on the thermophilic climaxes of the holm oak forest in the southern Iberian Peninsula reveal the existence of a new *Quercus rotundifolia* forest and its dynamics. We consider it essential to establish these dynamics, to subsequently deduce the potential vegetation, which is essential for environmental and agricultural management, the vegetation series being the basis for territorial planning.

The study area, which corresponds to the Montes de Málaga (Axarquense district, Granadino-Serrano-Almijareense sector), has suffered a great anthropic impact, which has caused a decrease in the *Quercus rotundifolia* forest, this being the cause for having erroneously included these holm oak groves in the *Myrto communis-Quercetum rotundifoliae* (Perez Latorre et al. 2008). In this case the holm oak forest has been replaced by a secondary microforest of *Olea europea* var. *sylvestris*, which is degraded to *Aspargo aphylli-Calicotomentum villosae*. This new wild olive microforest presents strong differences with *Viburno tini-Oleetum sylvestris* Costa et al. 1994, an association that was not typified, so we proceeded to its lectotypification (Costa et al. 1994). Os bosques de zambujeiro (*Olea suropaea* L. var. *sylvestris* Miller): Vegetação potencial dos vertisolos das áreas termomediterrânicas da Extremadura portuguesa. Anais Inst. Super. Agron. 44(2):497-513, table 1, lectotype inv. 5 Tapada da Ajuda).

Therefore, the need to know in detail the dynamics, since there are assumptions in which there is no other way to elucidate the climax, which we consider fundamental for a management on the recovery of the climax, and therefore its knowledge should be enhanced by academics.

The mesomediterranean dry and bathophilic oak groves belong to the *Paeonio coriaceae-Quercetum rotundifoliae* association, which presents as first dynamic stage a

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10 kermes oak of the *Crataego monogynae-Quercetum cocciferae* Martínez Parras et al.
11 1984 association (Martínez Parras et al. 1984), and depending on the biogeographic
12 sector in which this oak grove is located, the serial thicket can be different, but in all
13 cases these thickets belong to the *Lavandulo-Genistion boissieri* alliance. However, the
14 thermophilic facies of this holm oak forest, typical of the lower mesomediterranean,
15 presents other dynamic stages, with the *Asparago albi-Quercetum cocciferae* Rivas-
16 Marínez in Rivas Marínez et al. 2002 kermes oak grove as the first dynamic stage,
17 which in lithosols is replaced by *Eryngio-Ulicion erinacei* thyme grove.

18 In the western Iberian Mediterranean province (Toledano-Tagano and Marianico-
19 Monchiquense sectors) (Rivas-Martínez et al. 2007), the mesomediterranean holm oak
20 forest corresponds to the association *Pyro bourgaeanae-Quercetum rotundifoliae*
21 (Rivas-Martínez 1987). In this case the first dynamic stage is a holm oak of
22 *Hyacinthoido hispanicae-Quercetum cocciferae* (Rivas Goday in Rivas Goday, Borja,
23 Esteve, Galiano, Rigual & Rivas-Martínez 1960) Peinado & Martínez Parras 1985, with
24 rockroses and lavenders as serial scrub belonging to the alliance *Ulici argentei-Cistion*
25 *ladaniferi*. This association in the lower mesomediterranean presents the thermophilic
26 facies with *Myrtus communis*, whose first dynamic stage is a thicket of *Asparago albi-*
27 *Rhamnetum oleoidis*, which in skeletal soils is replaced by a thicket of *Scillo-*
28 *Lavanduletum pedunculatae* Ladero 1970

29 In the thermomediterranean territories there is a holm oak forest, which in some cases
30 can radiate to the lower mesomediterranean. The association *Rubio longifoliae-*
31 *Quercetum rotundifoliae* is characterized by *Quercus rotundifolia*, *Rubia peregrina* L.
32 subsp. *longifolia* (Poir.) O.-Bolòs, *Rhamnus oleoides* subsp. *assoana* Rivas Mart. &
33 J.M.-Pizarro, *Chamaerops humilis* and *Osyris quadripartita* Salm. ex Decne. As the
34 latter two species are exclusively thermomediterranean, this association does not reach
35 the lower mesomediterranean. According to Costa et al. (1983) these Valencian-
36 Tarragona holm oak groves were deforested for the planting of *Ceratonia siliqua*
37 (carob) trees. These crops are currently abandoned and only small amounts remain. As
38 for the dynamics of these holm oak groves, the first stage corresponds to a *Quercus*
39 *cocciferae-Lentiscetum* Br.-Bl. et al. 1936 kermes-oak woodland, which is in turn
40 replaced by *Rosmarino-Ericion*.

41 In the south of the Iberian Peninsula there are several associations, *Rhamno oleoidis-*
42 *Quercetum rotundifoliae* described by Rivas-Martínez et al. (2002). The typus of this
43 association has occurred in Gaucín (Málaga), for the thermomediterranean belt on
44 calcareous substrates For years these oak groves were ascribed to the North African
45 association *Smilaco mauritanicae-Quercetum rotundifoliae* Barbero et al. 1987
46 (Barbero et al. 1981, 1992), which has been corrected by their authors, who establish
47 *Asparago albi-Rhamnion oleoidis* as the first dynamic stage, with the serial thicket
48 corresponding to *Saturejo-Coridothymenion*. Recently, Rivas-Martínez et al. (2011b)
49 described the association *Rhamno laderoi-Quercetum rotundifoliae* for the upper
50 thermomediterranean and lower mesomediterranean islets on basic substrates of the
51 Luso-Extremaduran territories, an association that according to their authors is vicariant
52 of the two closest associations *Rhamno oleoidis-Quercetum rotundifoliae* and *Paeonio*
53 *coriacea-Quercetum rotundifoliae*, developed on basic substrates of the Betic
54 biogeographic province. Floristically, this association presents, among other species,
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10 *Quercus rotundifolia*, *Rhamnus lycioides* L. subsp. *laderoi* Rivas Mart. & J.M.Pizarro
11 (Rivas-Martínez & Pizarro 2011a) with some subhumid territorial elements such as
12 *Arbutus unedo* L., *Viburnum tinus* L., *Rhamnus oleoides* L. subsp. *oleoides* and, in
13 some cases *Bupleurum fruticosum* L.; the presence of acidophilic and basophilic
14 elements confirms that the calcareous substrates of Cretaceous origin have undergone
15 decarbonation. In this case the authors do not explain the dynamics, however Rivas-
16 Martínez et al. (2002), published the new association of kermes oak *Asparago albi-*
17 *Quercetum cocciferae* (*Asparago albi-Rhamnion oleoidis*) for the Luso-Extremaduran
18 limestone islets (Sierra de los Santos, Badajoz), and textually states that “it is a lower
19 mesomediterranean kermes oak grove of a dry-subhumid environment of the
20 Marianico-Monchiquense sector, which acts as a dynamic stage of the vegetation of
21 *Quercus rotundifolia*”. However, these authors do not establish the dynamics for these
22 forests of the Cretaceous limestones, the *Saturejo-Coridothymenion* kermes oak and
23 thyme belonging to the dynamic stages.

24 The holm oak forests described by Quinto Canas et al. (2021) for the Iberian southwest
25 on siliceous substrates, belong to the *Ulici argentei-Quercetum rotundifoliae* Quinto
26 Canas 2021 association. In this case, the authors do establish the plant dynamics, and
27 propose the *Asparago albi-Rhamnion oleoidis* alliance as the first dynamic stage,
28 although they do not mention a specific association. This association corresponds to the
29 *Asparago albi-Rhamnion oleoidis*, a community that on poorer soils gives way to the
30 *Genisto hirsutae-Cistetum ladaniferi*. Recently Piñar et al. (2017) published the new
31 association *Bupleuro gibraltarici-Quercetum rotundifoliae* Piñar Fuentes et al. 2017 of
32 edaphoxerophilic character for the marmoreal limestones of Sierra Grazalema. Being an
33 edaphoxerophilic formation, these authors do not speak of dynamics, but they do show
34 the behavior of the biotope, since the climatic data indicate a subhumid-humid
35 ombrotype. Nevertheless, the territory has a dry behavior (Cano et al. 2007, 2021,
36 2022).

37 The new association that we propose *Aristolochio baeticae-Quercetum rotundifoliae*
38 presents a specific dynamic. The first stage is the wild olive tree *Olea europaea* var.
39 *sylvestris* for places where the ombrotype is dry superior, consequently it is possible to
40 recover the holm oak forest. However, for the places where the lo has become dry
41 inferior, the holm oak forest is irrecoverable and the new climax is *Olea europaea* var.
42 *sylvestris* microforest. This wild olive grove gives way to the *Calicotome spinosa* scrub
43 belonging to the *Asparago aphylli-Calicotometum villosae* association, a thorny
44 community that in lithosols becomes *Lavanduo stoechadis-Gensitetum equisetiformis*,
45 while the edge of the holm oak grove is a *Genisto equisetiformis-Retametum*
46 *sphaerocarphae* Asensi, Díez & Nieto 2005 broom. The typology of the new holm oak
47 association departs from the rest of the associations studied (Figure 4). However, some
48 authors in previous studies (Pérez Latorre et al. 1999, 2008, 2008, 2009, 2015) included
49 these holm oak groves in the association *Myrto communis-Quercetum rotundifoliae*
50 and as a dynamic stage in *Asparago albi-Rhamnion oleoidis*, dynamics poorly
51 established, since the absence of *Rhamnus oleoides* in the study area justifies the
52 absence of the syntaxon *Asparago albi-Rhamnion oleoidis*. This may be due to the
53 alteration that the territory has historically suffered. The differences between the
54 thermo- and lower mesomediterranean holm oak forests are expressed in the cluster
55 analysis (Figure 3) and in the synthetic table (Table 10), in which we do not take into
56 consideration the edaphoxerophilous climaxes because of their totally different
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10 dynamics from the climatophilous ones. However, the inventories AbQr5, AbQr6 and
11 AbQr7 tend to move away from the rest, which should be located in the lower
12 mesomediterranean with dry upper-subhumid ombrotype and soils with less carbonates
13 and lower pH. However, in certain situations it is necessary to rely on the dynamics of
14 these forests to elucidate which is the climax, due to the profound alteration that these
15 forests have undergone.

16 In this analysis of the climaxes of thermomediterranean holm oak forests, we found
17 that the authors do not always establish the plant dynamics, so it is difficult for the
18 vegetation series to be used as a basis for sustainable development. Consequently, in
19 all phytosociological research it is necessary to establish the plant dynamics (Figure 6).
20 It is through the dynamic stages that the climax of a territory can be deduced in the
21 event that it has been greatly altered. Therefore, we wish to propose that in their
22 geobotanical courses, future professionals should receive training not only in the
23 ecological and floristic aspects of plant communities, but also in the phytosociological
24 methodology (Cano-Ortiz 2021a, b,c).



48 Figure 6 Dynamic diagram of the *Aristolochio baeticae* - *Quercus rotundifoliae*
49 sigmetum vegetation series.

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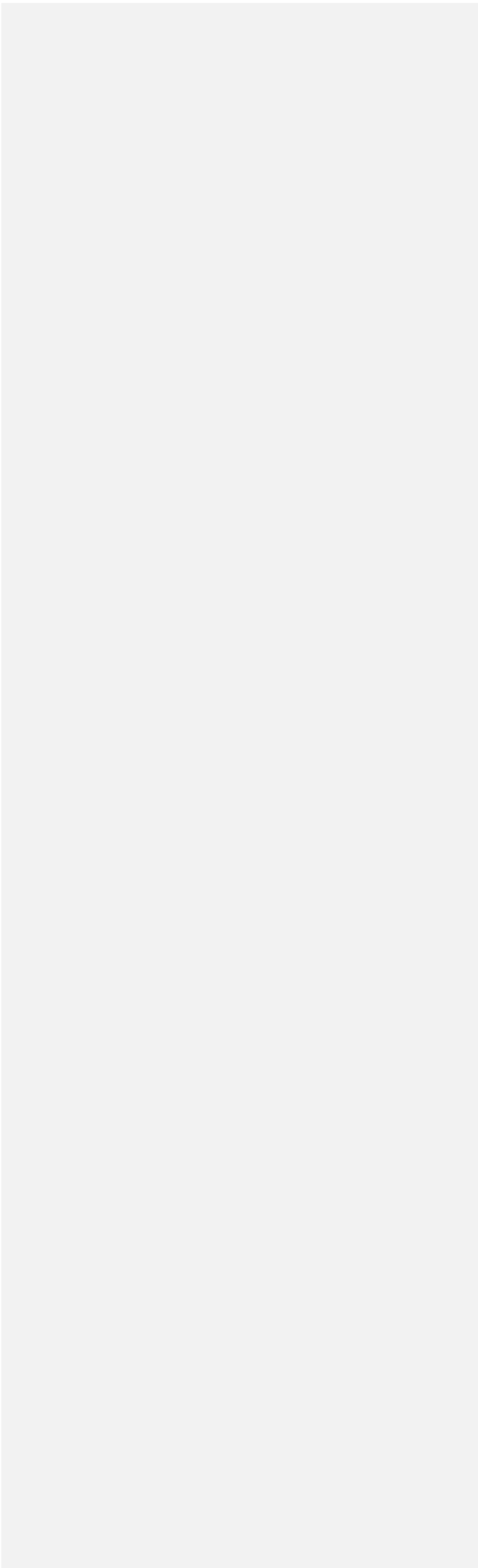


Table 10.- Synthetic table of the associations studied (to identify the name of the syntaxons, see Table 2).

	McQr	RIQr	PcQr	PcQr	RpQr	RoQr	RoQr	AbQr	RoQr	RoQr	RIQr	McQr	PcQr	RIQr	PbQr	McQr	PbQr	RpQr	RoQr	McQr	RoQr	
	McQr_Hh	RIQr_An	PcQr_Qr	PcQr_Ph_al	RpQr_Ph_al	RoQr_Rang	RoQr_Rv	AbQr	RoQr_Ge	RoQr_Qs	RIQr_Rl	McQr_Lv	PcQr_Pl	RIQr_Ph_pu	PbQr-Mc	McQr_Qs	PbQr_Qr	RpQr_Qr	RoQr_Jt	McQr_Qr	RoQr_Qr	
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<i>Daphn e gnidiu m</i>	V	.	IV	I	II	IV	III	II	IV	III	V	IV	IV	III	IV	IV	III	IV	V	III	IV	
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<i>Olea europa ea var. sylvestr is</i>	.	V	.	.	II	IV	IV	IV	I	III	V	III	I	III	III	V	IV	III	V	V	IV	
<i>Aspara gus acutifol ius</i>	V	V	II	I	III	II	.	I	I	.	III	.	III	III	II	II	II	V	IV	I	III	
<i>Smilax aspera var. aspera</i>	V	V	.	.	II	.	IV	I	II	II	II	.	III	II	III	III	II	III	V	III	IV	
<i>Rubia peregri na subsp. peregri na</i>	.	.	V	III	III	.	II	II	II	I	I	II	IV	II	II	V	IV	I	.	I	II	
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11	<i>peregrina</i>																							
12	subsp.																							
13	<i>longifolia</i>	.	V	.	.	I	I	II	.	I	I	V	IV	II	II	
14	<i>Arisarum</i>																							
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17	<i>simorhinum</i>																							
18	<i>Pulicaria</i>																							
19	<i>odora</i>	V	I	I	.	I	I	I	.	.	I	I	
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21	<i>halleriana</i>			II	.	II	I	I	III	.	I	
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23	<i>estrusca</i>																							
24	<i>Vincetoxicum</i>			I	I	.	I	.	.	.	I	.	.	.	I	
25	<i>nigrum</i>	V	.	I	I	.	I	.	I	
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Galium scabrum
Moehringia pentandra
Piptatherum paradoxum
Galium maritimum
Quercus broteroi
Paeonia broteri
Hyacinthoides hispanica
Pyrus bourgaeana
Quercus faginea subsp. *faginea*

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<i>Osyris alba</i>	I	.	.	I	.	I	I	.	I	II	I	I	I	.	I	I	II
<i>Ceratonia siliqua</i>	.	.	.	I	I	II	I	II	I	II	.	.	I	III	II	III
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<i>Teucrium fruticosum</i>	.	.	I	I	.	.	II	.	II	II	II	III	II	.	.	I	II
<i>Asparagus albus</i>	II	.	II	IV	I	.	II	.	I	.	I	I	.	.	.	III	I
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<i>Juniperus oxycedrus</i> subsp. <i>oxycedrus</i>	.	.	I	IV	II	.	IV	.	II	II	.	.	I
<i>Rhamnus lycioides</i> subsp. <i>lycioides</i>	I	.	.	.	I	.	.	.	I	I	I	.	.	I	.	.	.
<i>Bupleurum fruticosum</i>	I	I	I	II	I
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Ziziphus lotus
Arenaria montana subsp. *intricata*
Barlia robertiana
Asparagus albi-
Rhamnus oleoides
Phlomis purpurea subsp. *purpurea*
Rhamnus oleoides subsp. *oleoides*
Aristolochia baetica



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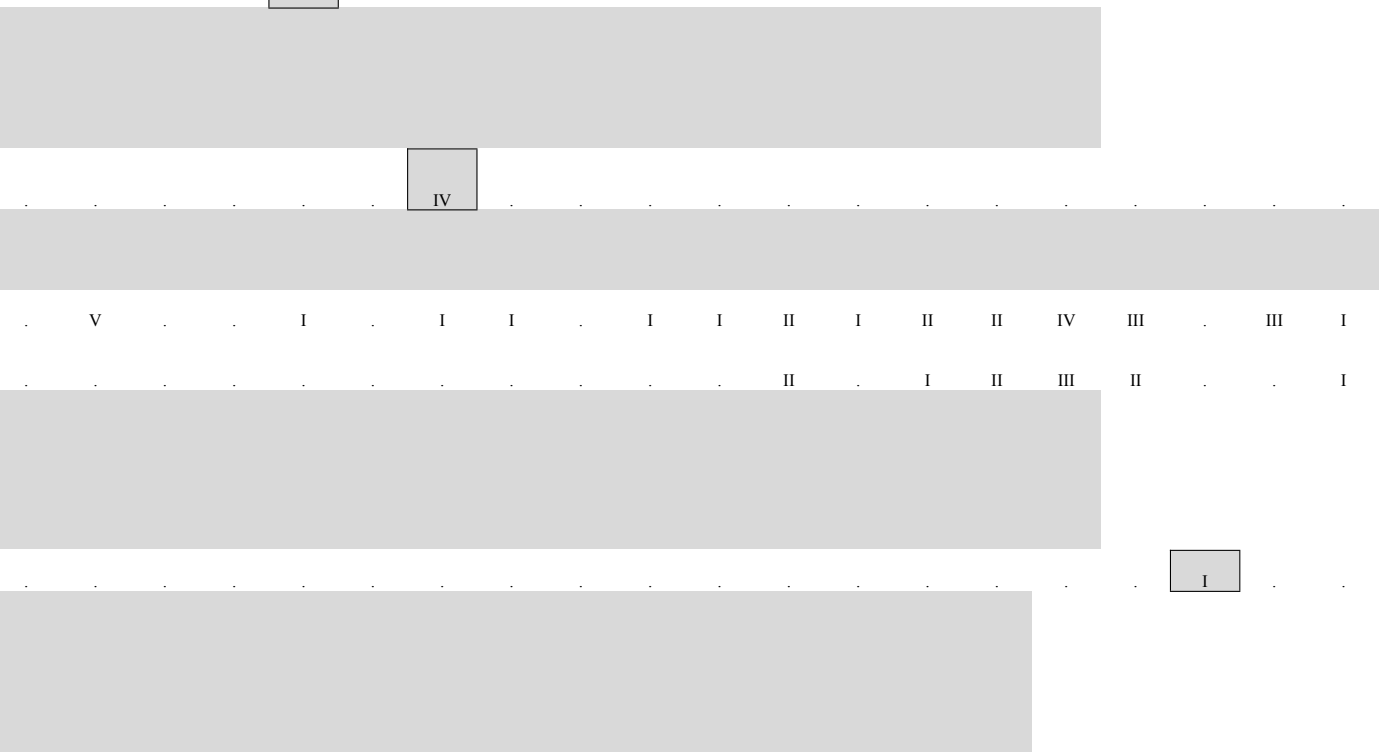
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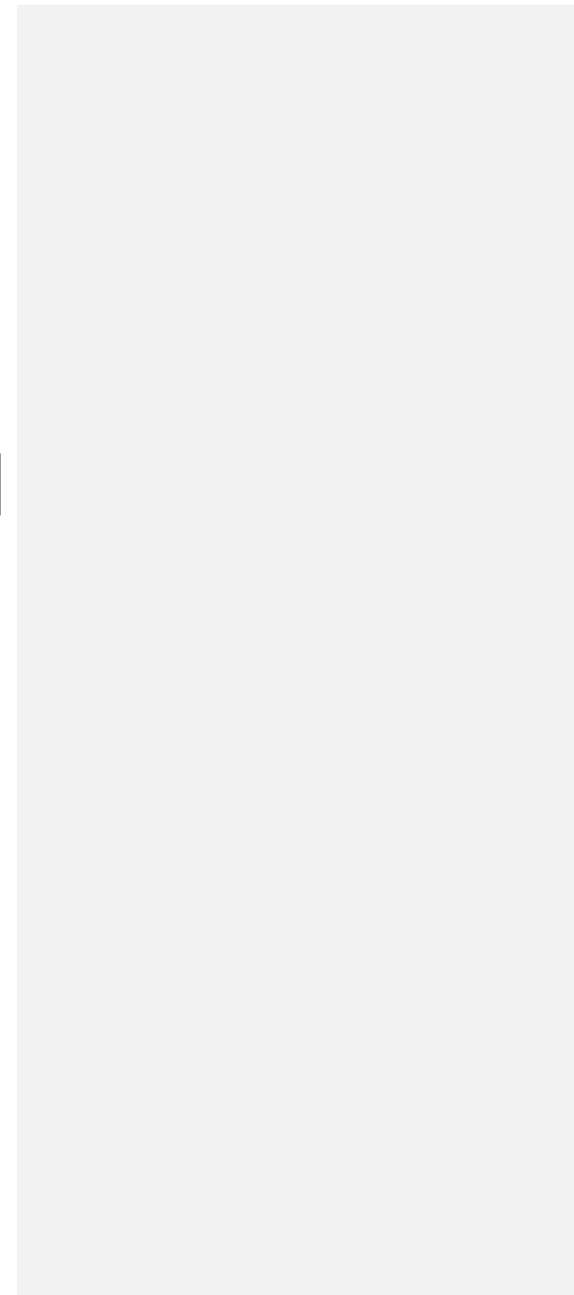
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CONCLUSIONS

Six published holm oak associations from the central and southern Iberian Peninsula are analyzed, located in thermo- and lower mesomediterranean environments, plus a new series in thermomediterranean territories, which together constitute seven vegetation series. The study of these series reveals that in some of them the dynamics have not been established or have been only partially established. Given the importance of the different dynamic stages in agricultural and forestry management models, the dynamics of each of these series is studied in detail and the existing or little studied gaps are mentioned. The holm oak forests of some territories have been ascribed to associations that do not correspond to the territorial reality, which, in the opinion of some authors, is due to the poor state of conservation of the holm oak forests. However, considering the remains of holm oak groves still existing and analyzing the dynamic stages, we have been able to obtain a new association for the Montes de Málaga, where the ombrotype is still dry superior. This new holm oak grove *Aristolochio baeticae-Quercetum rotundifoliae* presents as a first dynamic stage a new micro-forest of *Olea europaea* var. *sylvestris* *Aristolochio baeticae-Oleetum sylvestris*. The holm oak wood was ascribed by other authors to *Myrto communis-Quercetum rotundifoliae*, and the wild olive tree to *Asparago albi-Rhamnetum oleoidis*, syntaxa typical of the Mariano-Monchiquense sector, while the new syntaxa we propose are in the Malacitano-Almijareense sector. For this reason, we propose that the descriptions of new syntaxa should carry a dynamic study, which favors the sustainable management of the territories to which they belong. In the study of the Iberian wild olive trees, we also propose the association *Ephedro fragilis-Oleetum sylvestris* for the territories of the Guadalquivir valley (Andalusia).

REFERENCES

- Bacchetta G, Bagella S, Biondi E, Farris E, Filigheddu R, Mossa L. 2003. Su alcune formazioni a *Olea europaea* L. var. *sylvestris* Brot. della Sardegna. *Fitosociol.* 40 (1): 49-53.
- Ballabio C, Lugato E, Fernández-Ugalde O, Orgiazzi A, Jones A, Borrelli P, Montanarella L, Panagos P. 2019. Mapping LUCAS topsoil chemical properties at European scale using Gaussian process regression. *Geoderma* 355: 113912.
- Ballabio C, Panagos P, Montanarella L. 2016. Mapping topsoil physical properties at European scale using the LUCAS database. *Geoderma* 261:110–123.
- Barbero M, Quezel P, Rivas-Martínez S. 1981. Contribution à l'étude des groupements forestiers et préforestiers du Maroc. *Phytocenologia* 9(3): 311-412.
- Benabid A. 1984. *Étude phytosociologique des peuplements forestiers et préforestiers du Rif centre-occidental (Maroc)*. Travaux de l'Institut Scientifique. Série Botanique 34.
- Braun Blanquet J. 1979. *Fitosociología. Bases para el estudio de las comunidades vegetales*. Ed. Blum, pp. 820. Madrid, España.
- Cano E, Cano-Ortiz A, Piñar Fuentes JC, Quinto Canas R, Igbareyeh J, del Río S, Pinto CJ. 2022. Ecological and Syntaxonomic Analysis of *Pinus halepensis* Mill. in the

Iberian Peninsula and Balearic Islands. *Land* 11, 369. <https://doi.org/10.3390/land11030369>

Cano E, Rodríguez Torres A, Pinto Gomes CJ, García Fuentes A, Torres JA, Salazar C, Ruiz L, Cano Ortiz A, Montilla R. 2007. Analysis of the *Juniperus oxycedrus* L. in the centre and south of the Iberian peninsula (Spain and Portugal). *Acta Bot. Gallica* 154 (1): 79-99.

Cano E, Valle F, García Fuentes A, Salazar C, Sanz B, Torres JA, Jalut G. 1995. Esparto-Grass (*Stipa tenacissima* L.) Communities in the southeastern Iberian Peninsula. *Colloque Scientifique BIO'MES 95*. pp. 153-161, Marsella, France.

Cano E. 1987. Estudio fitosociológico de la sierra de Quintana, Jaén, España. Tesis Doctoral. Universidad de Granada

Cano-Ortiz A, Piñar Fuentes JC, Cano E. 2021a. Didactics of Natural Sciences in Higher Secondary Education. *IJHSSE* 8(10): 6-10. doi: <https://doi.org/10.20431/2349-0381.0810002>

Cano-Ortiz A, Piñar Fuentes JC, Ighbareyeh JMH, Quinto Canas R, Cano E. 2021b. Aspectos Didácticos en la Enseñanza de Conceptos Geobotánicos. *IJHSSE* 8(4), 271-276. doi: <https://doi.org/10.20431/2349-0381.0804022>

Cano-Ortiz A, Piñar Fuentes JC, Cano E. 2021c. Proposals for the learning of plant diversity. 5 th International virtual conference on educational research and innovation-CIVINEDU. Conferencie Proceeding CIVINEDU 2021. Publisher Aldaya Press. Editor: Redine. pp.325-327.

Cano Ortiz A, Spampinato G, Piñar Fuentes JC, Pinto Gomes CJ, Quinto-Canas R, Cano E. 2021. Taxonomy, Ecology and Distribution of *Juniperus oxycedrus* L. Group in the Mediterranean Basin Using Bioclimatic, Phytochemical and Morphometric Approaches, with Special Reference to the Iberian Peninsula. *Forests* 12: 703. <https://doi.org/10.3390/f12060703>.

Costa JC, Capelo JH, Lousa M. 1994. Os bosques de zambujeiro (*Olea europaea* L. var. *sylvestris* Miller): Vegetação potencial dos vertisolos das áreas termomediterrânicas da Extremadura portuguesa. *Anais Inst. Super. Agron.* 44(2): 497-513.

Costa M, Peris JB, Figuerola R. 1983. Sobre los carrascales termomediterráneos valencianos. *Lazaroa* 4: 37-52

Fick SE, Hijmans RJ. 2017. WorldClim 2: New 1 km spatial resolution climate surfaces for global land areas. *Int. J. Climatol.* 37: 4302–4315.

García Fuentes A. 1996. Vegetación y Flórua del Alto Valle del Guadalquivir: Modelos de Regeneración. Tesis Doctoral. Universidad de Jaén

Gianguzzi, L., Bazan, G. 2019. The *Olea europaea* L. var. *sylvestris* (Mill.) Lehr. forests in the Mediterranean area. *Plant Sociology*, 56(2): 3-34. doi: 10.7338/pls2019562/0.

Lumivero, LLC. 2024. XSLTAT statistical and data analysis solution. New York, USA. <https://www.xslat.com/es>

1
2
3
4
5
6
7
8
9
10 Martínez Parras J M^a, Peinado M, Alcaraz F. 1984. Estudio de la serie
11 mesomediterránea basífila de la encina (*Paeonio-Querceto rotundifoliae* S.). Lazaroa 5:
12 119-129.

13 Martínez Parras J M^a, Peinado M, Alcaraz F. 1987. Comunidades vegetales de Sierra
14 Nevada. Serv. Publ. Universidad de Alcalá de Henares. 74 pp.

15
16 Melendo Luque M. 1998. Cartografía y ordenación vegetal de Sierra Morena: Parque
17 Natural de Cardena y Montoro (Córdoba). Tesis Doctoral. Dpto. Biología Animal,
18 Vegetal y Ecología. Universidad de Jaén.

19 Nieto Caldera JM^a, Pérez Latorre A, Cabezudo B. 1991. Biogeografía y series de
20 vegetación de la provincia de Málaga. Acta Botánica Malacitana 16(2): 417-436.

21
22 Nieto J M^a, Pérez Latorre A, Cabezudo B. 1990. Datos sobre la vegetación silicícola de
23 Andalucía I. Acta Botanica Malacitana 15: 179-192.

24
25 Pérez Latorre A, Caballero G, Casimiro-Soriguer F, Gavira O, Cabezudo B. 2008.
26 Vegetación del sector Malacitano-Axarquense (Comarca de la Axarquía, Montes de
27 Málaga y Corredor del Colmenar. Málaga (España). Acta Botánica Malacitana 33: 215-
28 270

29 Pérez Latorre A, Caballero G, Casimiro-Soriguer F, Gavira O, Cabezudo B. 2009.
30 Vegetación de la Cordillera Antequerana Oriental (Subsector Torcalense). Málaga-
31 Granada (España). Acta Botánica Malacitana 34:145-173.

32
33 Pérez Latorre A, Casimiro-Soriguer F, Cabezudo B. 2015. Flora y Vegetación de la
34 Sierra de Alcaparain (Málaga, España). Acta Botánica Malacitana 40: 107-156.

35
36 Pérez Latorre A, Galán de Mera A, Navas P, Navas D, Gil Y, Cabezudo B. 1999. Datos
37 sobre la flora y vegetación del Parque Natural de los Alcornocales (Cádiz-Málaga,
38 España). Acta Botánica Malacitana 24: 133-184.

39 Pinto Gomes CJ, Cano Ortiz A, Quinto Canas R, Vila-Vicoça C, Martínez Lombardo
40 M^aC. 2012. Analysis of the Cytisetea scopario-striati scrubs in the south-west-centre of
41 the Iberian Peninsula. Acta Botanica Gallica 159(2): 251-266.
42 <http://dx.doi.org/10.1080/12538078.2012.696937>.

43 Pinto Gomes CJ, Paiva Gerreira RJP. 2005. Flora e Vegetação do Barrocal Algarvio
44 (Tavira-Portimão). Ed. Comissão de Coordenação e Desenvolvimento Regional do
45 Algarve. 354 pp.

46
47 Piñar Fuentes JC, Cano Ortiz A, Musarella CM, Pinto Gomes CJ, Spampinato G, Cano
48 E. 2017. Rupicolous habitats of interest for conservation in the central-southern Iberian
49 península. Plant Sociology 54(2), Suppl. 1: 29-42.

50
51 Piñar fuentes JC. 2023. Influencia del cambio climático en la vegetación andaluza:
52 especial referencia a los hábitats de interés comunitario. Tesis Dissertation.
53 Universidad de Jaén. <https://hdl.handle.net/10953/2496>

54 POWO 2024. "Plants of the World Online. Facilitated by the Royal Botanic Gardens,
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10 Kew. Published on the Internet; <http://www.plantsoftheworldonline.org/>
11 Retrieved 07 March 2024."

12 Quezel P, Barbero M, Benabid A, Rivas-Martínez S. 1992. Contribution a l'étude des
13 groupements forestiers et pre-forestiers du Maroc Oriental. *Studia Bot.* 10: 57-90.

14
15 Quinto-Canas R, Vila-Vicoça C, Meireles C, Paiva-Ferreira R, Martínez-Lombardo M^a,
16 Cano Ortiz A, Pinto Gomes C. 2010. A contribute to the knowledge of the
17 climatophilous cork-oak woodlands from Iberian southwest. *Acta Botanica Gallica:*
18 *Botany Letters*, 157(4), 627-637. doi: 10.1080/12538078.2010.10516236

19
20 Quinto Canas R, Cano-Ortiz A, Musarella CM, del Río S, Raposo M, Piñar Fuentes JC,
21 Pinto Gomes C. 2021. *Quercus rotundifolia* Lam. Woodlands of the sothewestern
22 Iberian Peninsula. *Land*, 10, 268, <https://doi.org/10.3390/land10030268>.

23
24 Quinto Canas R, Vila-Vicoça C, Paiva Ferreira R, Cano Ortiz A, Pinto Gomes CJ. 2012.
25 The Algarve (Portugal) climatophilous vegetation series: a base document to the
26 planning, management and nature conservation. *Acta Botanica Gallica* 159(3), 289-298.
27 <http://dx.doi.org/10.1080/12538078.2012.377150>.

28
29 Quinto Canas R, Mendes P, Cano Ortiz A, Musarella CM, Pinto Gomes CJ. 2018.
30 Forest fringe communities of the southwestern Iberian Peninsula. *Revista Chapingo*
31 *Serie Ciencias Forestales y del Ambiente*, 24(3), 415-434. doi:
32 10.5154/r.rchscfa.2017.12.072.

33
34 Rivas Goday S, Borja J, Esteve F, Galiano EF, Rigual A, Rivas-Martínez S. 1959.
35 Contribución de la *Quercetea ilicis hispánica*. Conexión de las comunidades hispánicas
36 con *Quercus lusitánica* s.l. y sus correlaciones con las alianzas de *Quercetalia ilicis*,
37 *Quercetalia pubescentis* y *Quercetalia robori-petraeae*. *Anales Inst. Bot. Cavanilles*
38 17(2), 285-406 (publ. ef.: 27.04.1960).

39
40 Rivas Martínez S, Belmonte D. 1987. Sinopsis de la clase *Cytisetia scopario-striati*.
41 *Folia Bot. Matritensis* 3, 1-14

42
43 Rivas Martínez S, Fernández-González F, Loidi J, Lousã M, Penas A. 2001. Lista de
44 comprobación sintaxonómica de las comunidades de plantas vasculares de España y
45 Portugal a nivel de asociación. *Itinera Geobotanica* 14, 5-341.

46
47 Rivas Martínez S, Fernández-González F, Izco J, Loidi J, Lousã M, Penas A. 2002.
48 Comunidades de plantas vasculares de España y Portugal. Addenda a la lista
49 sintaxonómica de 2001. Part I. *Itinera Geobotanica* 15(1), 5-432.

50
51 Rivas-Martínez, S., Díaz González, T. E. Fernández González, F., Izco Sevillano, J.,
52 Loidi Arregui, J., Lousã, M. F., & Penas Merino, Á. 2002. Vascular plant communities
53 of Spain and Portugal: addenda to the syntaxonomical checklist of 2001. Part II. *Itinera*
54 *geobotanica* 15(2), 433-922.

55
56 Rivas Martínez S, Márquez R, Lizana M. (Eds.) 2003. Atlas y Manual de Los Hábitat
57 de España, Dirección General de Conservación de la Naturaleza, Ministerio de Medio
58 Ambiente: Madrid, España, pp. 1-406.

1
2
3
4
5
6
7
8
9
10 Rivas Martínez S, Pizarro JM. 2011. Avance del sistema taxonómico de *Rhamnus* L. &
11 *Frangula* Mill. (Rhamnaceae) de la Península Ibérica y Baleares. *Revista Internacional*
12 *de Investigación Geobotánica* 1, 55-78

13 Rivas Martínez S. 1975. La vegetación de la clase *Quercetea ilicis* en España y
14 Portugal. *Anales Inst. Bot. Cavanilles* 31(2), 205-259

15 Rivas Martínez S. 1987. Las series de vegetación de España. 1:400.000. ICONA. pp.
16 268

17 Rivas Martínez S. et al. 2007. Mapa de series, geoseries y geopermaseries de vegetación
18 de España. *Itinera Geobotanica* 17, 5-436

19 Rivas Martínez S. et al. 2011a. Mapa de series, geoseries y geopermaseries de
20 vegetación de España. Parte I. *Itinera Geobotanica* 18(1), 5-424

21 Rivas Martínez S. et al. 2011b. Mapa de series, geoseries y geopermaseries de
22 vegetación de España. Parte II. *Itinera Geobotanica* 18(2), 415-800

23 Rivas-Martínez S, Rivas-Sáenz S. & Penas A. 2011. Worldwide bioclimatic
24 classification system, *Global Geobotany* 1:1–634.

25 Rivas-Martínez, S., Penas, Á, Díaz González T.E, Cantó, P., del Río, S., Costa, J.C.,
26 Herrero, L. & Molero, J. 2017. Biogeographic: Units of the Iberian Peninsula and the
27 Balearic Islands to District Level, A Concise Synopsis. In Loidi J. (ed.) *The Vegetation*
28 *of the Iberian Peninsula. Plant and Vegetation* 12: 131-188. Ed. Springer. DOI
29 10.1007/978-3-319-54782-4

30 Sánchez Pascual N. 1994. Estudio fitosociológico y cartográfico de la comarca de
31 Despeñaperros. Tesis Doctoral. Dpto. Biología Vegetal. Universidad de Granada.

32 Valle F. et al. 2004. Datos botánicos aplicados a la gestión del medio natural andaluz
33 III: modelos de gestión de la vegetación. Ed. Consejería de Medio Ambiente. Junta de
34 Andalucía.

35 Xavier Font 2023. Sistema de Información de la vegetación Ibérica y Macaronésica.
36 Version 1.6. Banc de dades de biodiversitat de Catalunya.

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4
5
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8
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10
11
12
13
14
15
16
17
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