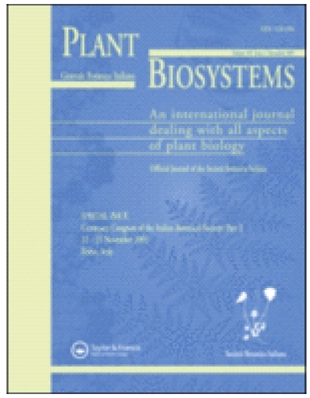
Research and management of thermophilic cork forests in the central-south of the Iberian peninsula



RESEARCH AND MANAGEMENT OF THERMOPHILIC CORK FORESTS OF THE CENTRAL-SOUTH OF THE IBERIAN PENINSULA

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Keywords:	Cork oak, dynamics, management, association, vegetation series

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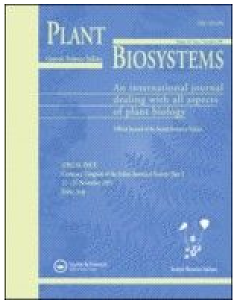

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RESEARCH AND MANAGEMENT OF THERMOPHILIC CORK FORESTS IN THE CENTRAL-SOUTH OF THE IBERIAN PENINSULA

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ABSTRACT

The investigated Iberian cork oak forests represent one of the ecosystems of greatest interest in the Iberian Peninsula, not only because of the ecosystem services they provide, but also because they are unique habitats in Europe and North Africa (habitat 9330). Due to the interest they present, we carried out this study in order to obtain as exhaustive knowledge as possible, and to be able to offer environmental managers more information.
We examined 12 cork oak associations in the Iberian Peninsula, both in their floristics, ecology and distribution as well as in terms of their dynamics, and we discovered that there are climaxes of *Quercus suber* L. whose dynamics have not been established. We make a name correction because the name of the taxon used for the binomen *Junipero badiae-*

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Quercetum suberis Rivas-Martínez et al. 2002 nom corr, is not valid. We also propose the correction of the name of the association *Cheirolopho sempervirentis-Quercetum suberis* Pérez Latorre, Cabezudo in Pérez Latorre et al. 2008 nom. corr. The dynamics for the *Cheirolopho sempervirentis-Quercetum suberis* cork oak forest and the *Cheirolopho sempervirentis-Arbutetum unedonis* nova and *Bupleuro gibraltarici-Quercetum suberis* nova associations, and two plant communities are described. Based on the results obtained and the ICPN mandate, we propose to synonymize *Oleo sylvestris-Quercetum suberis* Rivas Goday, Galiano & Rivas-Martínez ex Rivas-Martínez 1987= (syn: *Aro neglecti-Quercetum suberis* Rivas-Martínez & Díez Garretas 2011).

Keywords: Cork oak, dynamics, management, association, vegetation series.

INTRODUCTION

Cork oak (*Quercus suber* L.) forests are located in the thermo and mesomediterranean belt, on subhumid ombrotype and siliceous substrates. Unlike gall oaks (*Quercus faginea* Lam.), cork oak forests avoid the cold of the plateau and dominate in environments ~~of~~ with an oceanic influence in the south and southwest of the Iberian Peninsula (Spain and Portugal). *Quercus suber* is a species that has its dominance in the Iberian Peninsula reaching the north of Morocco and Algeria, Sardinia and the south of peninsular Italy. We recorded for the Iberian Peninsula 12 syntaxa with association rank and two subassociations

These Ecosystems are of ~~high~~ great interest because they present high ecosystem services, such as the use of cork as a natural resource, and because they are unique habitats in Europe and North Africa. Therefore, we consider that this is reason enough to promote their exhaustive study, with the objective of a better knowledge. However, we are facing ecosystems that may be in danger due to climate change (Jankó et al. 2022; Mechergui et al. 2023). These climaxes, quite affected by human action, generally do not present a good state of conservation. Indeed, in northwestern Algeria, Medjahdi et al. (2018) in their diversity study only mention the existence of cork oak groves. In Italy, Guarino et al. (2021) have recently studied the habitats of Sicily and central Italy, and Casavecchia et al. (2021), where they only mention the habitat "*Quercus ilex* L. and *Quercus rotundifolia* Lam. forests", without mentioning the existence of *Quercus suber* forests.

Moreover, in the study by Fois et al. (2021) on the habitats of Sardinia, they do not mention the thermo-mediterranean cork oak forests, previously studied by Serra et al. (2002).

1) (LvQs) *Lavandulo viridis-Quercetum suberis* Quinto-Canas, Vila-Viçosa, Meireles, Paiva-Ferreira, Martínez-Lombardo, Cano-Ortiz & Pinto Gomes 2010.
2) (AdQs) *Adenocarpo decorticantis-Quercetum suberis* Martínez-Parras, Peinado & Alcaraz 1987.
3) (AdQr_qs) *Adenocarpo decorticantis-Quercetum rotundifoliae quercetosum suberis* Rivas-Martínez 1987 subas. *quercetosum suberis* Martínez Parras, Peinado, Alcaraz 1987.
4) *Myrto communis-Quercetum rotundifoliae* Rivas Goday in Rivas Goday, Borja, Esteve, Galiano, Rigual & Rivas-Martínez 1060 *quercetosum suberis* Martínez Parras, Peinado, Alcaraz 1987.
5) (TbQs) *Teucrio baetici-Quercetum suberis* Rivas-Martínez ex Díez-Garretas, Cuenca & Asensi 1988.
6) (OsQs) *Oleo sylvestris-Quercetum suberis* Rivas Goday, Galiano & Rivas-Martínez ex Rivas-Martínez 1987.

Commented [ECC1]: All species have been reviewed, and the authorships of those species that did not have them have been included. All included authorships are highlighted in green to differentiate them from previous corrections in red.

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7) (CsQs) *Centaureo sempervirentis-Quercetum suberis* Pérez Latorre, Cabezudo in Pérez Latorre, Caballero, Casimiro-Soriguer, Gavira & Cabezudo 2008.
8) (AnQs**)** *Aro neglecti-Quercetum suberis* Rivas-Martínez & Díez Garretas 2011.
9) (AaQs**)** *Asparago aphylli-Quercetum suberis* J. C. Costa, Capelo, Lousã & Espirito-Santo 1996.
10) (ShQs**)** *Poterio agrimonioidis-Quercetum suberis* Rivas Goday in Rivas Goday, Borja, Esteve, Galiano, Rigual & Rivas-Martínez 1960 = *Sanguisorbo hybridae-Quercetum suberis* Rivas Goday & Borja in Rivas Goday, Esteve, Galiano, Rigual & Rivas-Martínez 1960 nom. mut. Rivas-Martínez 2011.
11) *Teucrio salviastri-Quercetum suberis* Pinto-Gomes, Carlos; Paiva-Ferreira, Rodrigo & Meireles, Catarina 2007
12) *Smilaco asperae-Quercetum suberis* Pinto Gomes, Ladero, Gonçalves, Mendes & Lopes 2003
13) *Bupleuro gibraltarici-Quercetum suberis* nova

Based on the information provided, it is indeed plausible to hypothesize that cork oak groves in warmer areas, or those susceptible to the impacts of climate change due to accelerated global warming, may exhibit gaps in both their floristic composition and structural attributes. Consequently, the primary objectives of the current study are were, on the one hand, to carry out an integral study of the cork oak forests of the center-south of the Iberian Peninsula from the phytosociological and ecological point of view, and on the other hand, to provide new data about the thermophilic cork oak forests of the south of the Iberian Peninsula, and their relationship with other similar *Quercus suber* L. forest communities. As secondary objectives, the aim was ~~is~~ to characterize from an ecological point of view the relationship between the floristic composition and co-occurrence of these formations with certain environmental variables.

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MATERIAL AND METHODS

We investigated cork oak forests in the center and south of the Iberian Peninsula (Figure 1). A total of 915 inventories in which *Q. suber* L. stands out as the dominant species were compiled from the literature as well as from the SIVIM (Iberian and Macaronesian Vegetation Information System) and our own sampling data.

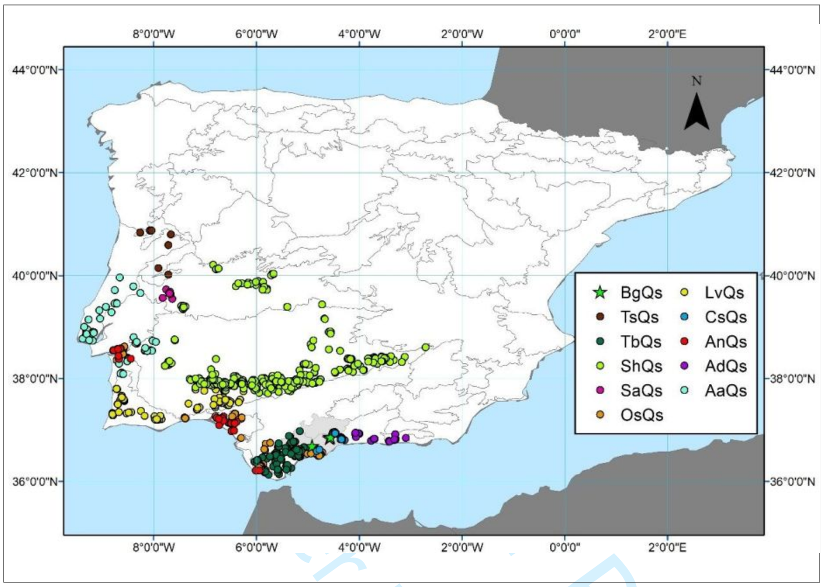

Figure: 1 Distribution of cork oak forests in the central-southern Iberian Peninsula. AaQs = *Asparago aphylli-Quercetum suberis*, AdQs = *Adenocarpo decorticantis-Quercetum suberis*, AnQs = *Aro neglecti-Quercetum suberis*, BgQs = *Bupleuro gibraltarici-Quercetum suberis*, CsQs = *Centaureo sempervirentis-Quercetum suberis*, LvQs = *Lavandulo viridis-Quercetum suberis*, OsQs = *Oleo sylvestris-Quercetum suberis*, SaQs = *Smilaco asperae-Quercetum suberis*, ShQs = *Sanguisorbo hybridae-Quercetum suberis*, TbQs = *Teucrio baetici-Quercetum suberis*, TsQs = *Teucrio salviatri-Quercetum suberis.*

1. Sampled Area.

The sampled area corresponds to the Axarquia (Malaga), where materials such as lidites, siliceous sedimentary rocks, quartz, radiolarians of the Carboniferous, marine bottoms of the Malguide complex dominate. The territory presents a gentle modeling with altitudes ranging from sea level to 1,030 m; from a climatic point of view the temperatures are mild and the general precipitation causes a dry ombrotype, while the sub-humid with a tendency to humid only exists in the peaks facing north and northwest (Figure 2), placing the study mainly in the districts of Alora, Almogia and Colmenar. The area has been altered by human action throughout history, however, there are several studies on the flora and vegetation that serve as a basis for our research.

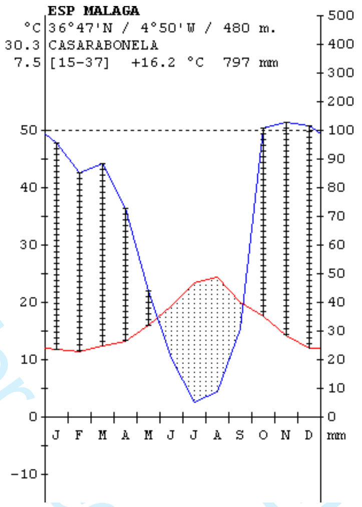

Figure 2.- Bioclimatic diagrams of the study area. Mediterranean pluviseasonal oceanic Thermo-Mediterranean, sub-humid-humid (Casarabonella) cork oak environments.

Knowledge of these plant formations (cork oak forests), which act as a basis of knowledge in environmental management, both at the forestry and agricultural levels, is essential for the training of future managers, and it is therefore necessary to teach them in universities and research centers. These plant formations constitute the climaxes or headwaters 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 characteristic and companion species (Cano-Ortiz 2021a,b,c); as well as the dynamics of the vegetation, since the alteration of the climax 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 by analysing the present dynamic stages.

2. Elaboration of the databases.

In a first phase, from the information present in the inventories, we proceeded to georeference those samples that lacked coordinates at least with a precision of 500 meters on a side. For this, in addition to the information of altitude, orientation, slope and locality, we used the cartography of land use, as well as aerial orthophotography. All this was implemented in a Geographic Information System (GIS), using QGIS 10.3 software.

For each sampling, different edaphic and bioclimatic variables were assigned. Edaphic variables were obtained from Maps of Soil Chemical Properties at European Scale based on LUCAS 2009/2012 topsoil data and Topsoil Physical Properties for Europe (based on LUCAS topsoil data (Ballabio et al. 2016, 2019). And climate variables were obtained from the WorldClim database (Fick et. al, 2017). This climatic database has been corrected by introducing data from 1,458 complete thermo-

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pluviometric stations of the entire Iberian Peninsula, whose averages are greater than 30 years (Piñar Fuentes, J.C., 2023) and interpolating the residuals using the Ramdom Forests algorithm. The external variables used for the interpolation of the residuals by Ramdom Forests can be seen in Table 1.

Table 1: Geographic and topographic variables used for the correction of bioclimatic parameters of the WorldClim raster.

Variable	Units/range
Latitude	decimal degrees
Longitude	decimal degrees
Altitude	meters
Shading Orientation Relief	No units, values 0-255
Shading Orientation SE	No units, values 0-255
Radiation	W
Distance to the Atlantic coast	Km
Distance to the Mediterranean coast	Km
Distance to de coast	Km
Wind speed	m/s
Relief roughness	No units, values 0-255
Curvature perpendicular to slope	No units, values 0-255
Curvature paralell to slope	No units, values 0-255
Relief curvature	No units, values 0-255
Slope	º
Orientation	º

In parallel, the nomenclature of taxa was standardized, considering works such as Flora Iberica (Castroviejo et. al. 1986), Nova Flora de Portugal (Amaral do Franco 1971), Flora de Andalucía Oriental (Blanca et. al. 2011), Flora de Andalucia Occidental (Valdés et. al. 1987), and the Plants of the World Online (POWO) database (POWO 2024). Abundance/dominance values were transformed and approximated to % cover, "5, 4, 3, 2, 1 and +" equals 85%, 65%, 45%, 25%, 12%, 6%.

1) Data preparation and filtering

Once the database was established, with the species, abundances, and edaphic and bioclimatic parameters, the most representative samples were selected. To do this, we began by partitioning the inventories using the K-medoids algorithm. In K-medoids, the representative inventories (medoids) are chosen iteratively. Initially, random points are selected. Then, the medoids are iteratively adjusted, replacing each medoid with another point in the cluster that minimizes the sum of the distances to the rest of the points in the cluster. This process is repeated until there are no significant changes in the medoid assignment or until a maximum number of iterations is reached. The partitioning of the data into 50 clusters was established (number greater than the number of associations studied), those inventories that formed a cluster by themselves were discarded, and after elimination, the medoids were iterated again, until the number of inventories per cluster contained at least one of the typus inventories of each of the associations. After this filtering criterion, 304 inventories 23 of our own inventories and 281 taken from the literature (Annex 1) of the 12 associations studied were considered for the analysis.

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After carefully selecting the inventories, we centered and standardized the data. Our next step involved an exploratory hierarchical ascending classification using the following techniques: Dissimilarity Distance: We employed the Bray-Curtis dissimilarity distance to measure the dissimilarity between samples. Agglomeration Method: We used Ward's agglomeration method to group similar samples together. Cluster Evaluation: The Calinski & Harabasz index guided our clustering process. For the specific case of two clusters, the index yielded a value of 32.95. This approach allowed us to organize the data effectively and identify distinct clusters within the cork oak forests. Once the cophenetic relationships between the different communities studied were established, the modified phytosociological importance index (IVIm) was calculated:

$$IVIm = ((Fr+Dr))/Frt$$

where Fr is the relative frequency of occurrence of the species in each previously established cluster; Dr is the mean relative dominance (measured in cover) in each established sampling cluster; and Frt is the relative frequency of occurrence in all inventories. Frt is intended to penalize species that occur in many different communities or clusters. Subsequently, the IVIm values are used to select those species (variables) that best represent the community. In this case, the 95th percentile IVIm value for each type of cork oak grove was taken into account.

2) Multivariate statistical analysis

The multivariate statistical analysis is carried out, first of all, by performing a Principal Component analysis (PCA) to evaluate the behavior of the environmental variables, as well as the ordination on the axes of the inventories. A rotation of the Oblimin axes with a delta of 0.5 and Kaisser normalization was chosen in order to standardize the eigenvalues as well, since the environmental variables are expected to be correlated to a greater or lesser extent with the different types of associations. The type of correlation used is Spearman's correlation, since the data do not comply with the precepts of normality. The Kaiser-Meyer-Olkin sampling measures (KMO) indicated values between 0.640 and 0.965. A KMO below 0.5 suggests that the data are not suitable for factor analysis.

In order to further investigate the relationships between the different environmental variables and the floristic composition of the different associations, a canonical correspondence analysis was performed, in which the species to be taken into account were those selected according to the IVIm. In this case, those variables with a squared cosine greater than 0.4 in any of the first three axes were taken into account, since they accounted for 60.62% of the variance. The variables taken into account are shown in Table 2. Due to the high disparity in the cosine squares between the environmental variables and the bioclimatic variables, it was decided to perform two CCAs, one with the environmental variables and the other with the bioclimatic variables.

Table 2: Squared cosines of the contributions of each selected environmental variable. The values in bold correspond for each variable to the factor for which the squared cosine is the largest and is greater than 0.4. As can be seen, the bioclimatic variables are strongly correlated with the first three factors (AWC = Soil Water Holding Capacity, CN = Carbon/Nitrogen Ratio, MAOM = Oxidizable Organic Matter). For the bioclimatic parameters, the World Bioclimatic Classification (Rivas-Martínez et al. 2011c) was followed.

Variable	D1	D2	D3	Variable	D1	D2	D3
AWC	**0,498**	0,086	0,155	Tp	0,164	0,006	**0,621**
Coarse Frag	0,000	0,006	**0,465**	PEs	0,060	**0,437**	0,029

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Silt	0,057	0,095	**0,444**	Iar	0,009	**0,850**	0,012
Clay	**0,447**	0,010	0,123	Id	0,020	**0,447**	0,169
CN	0,004	**0,482**	0,001	IH	0,009	**0,851**	0,012
MAOM	0,053	**0,439**	0,125	Im	**0,833**	0,000	0,117
Ios4	**0,822**	0,006	0,111	Ioe	0,009	**0,851**	0,012
Ic	0,000	0,274	**0,508**	Ios1	**0,636**	0,000	0,016
Io	0,010	**0,751**	0,070	Ios2	**0,846**	0,000	0,077
Itc	0,095	0,027	**0,730**	Ios3	**0,802**	0,003	0,151

RESULTS

1) Classification and relationship between the different types of cork oak groves.

In the initial phase, which involved classifying, standardizing, and organizing samples from the literature, we observe the existence of two primary types of cork oak forests based on their floristic composition. These two groups are distinctly separated by a Calinski & Harabasz index of 32.951 and a dissimilarity value of 2.7 (Figure 3). These two groups, in turn, are formed by the different associations described. On the one hand, we can observe the cooler, more humid and continental associations of *Quercus suber*, highlighting *Teucrio salviastri-Quercetum suberis* (TsQs), a cork oak grove located further north, of very humid Mediterranean or temperate sub-Mediterranean environments, of edaphoxerophilous character (Pinto-Gomes C. et. al. 2007).

The rest of the cork oak groves in this group are composed of *Sanguisorbo hybridae-Quercetum suberis* (ShQs), *Teucrio baetici-Quercetum suberis* (TbQs), *Adenocarpo decorticantis-Quercetum suberis* (AdQs) and *Centaureo sempervirentis-Quercetum subeis* (CsQs) = *Cheirolopho sempervirentis-Quercetum suberis*. Some samplings seem to show more affinity with the next group, composed of those associations more thermophilic, oceanic and less humid, since several variants or thermophilic sub-associations are described, which once put in a general context with the rest of the associations, have more affinity in their floristic composition than with those originally described. This second group is formed by the cork oak groves of *Asparago aphylli-Quercetum suberis* (AaQs), *Lavandulo viridis-Quercetum suberis* (LvQs), *Smilaco asperae-Quercetum suberis* (SaQs), the more thermophilic facies of TbQs and ShQs, as well as *Aro neglecti-Quercetum suberis* (AnQs) and *Oleo sylvetris-Quercetum suberis* (OsQs), these two associations, show a fairly high internal heterogeneity, which complicates the interpretation of the dendrogram, since they present a very close floristic composition, so much so that there is more similarity between the typus established between the two forests than between most of the cork oak forests sampled in the same biogeographic and bioclimatic zones of each one. Finally, this group includes the samples proposed as a new type of cork oak forest, the *Bupleuro gibraltarici-Quercetum suberis*, as well as the thermophilic variants of CsQs and AdQs.

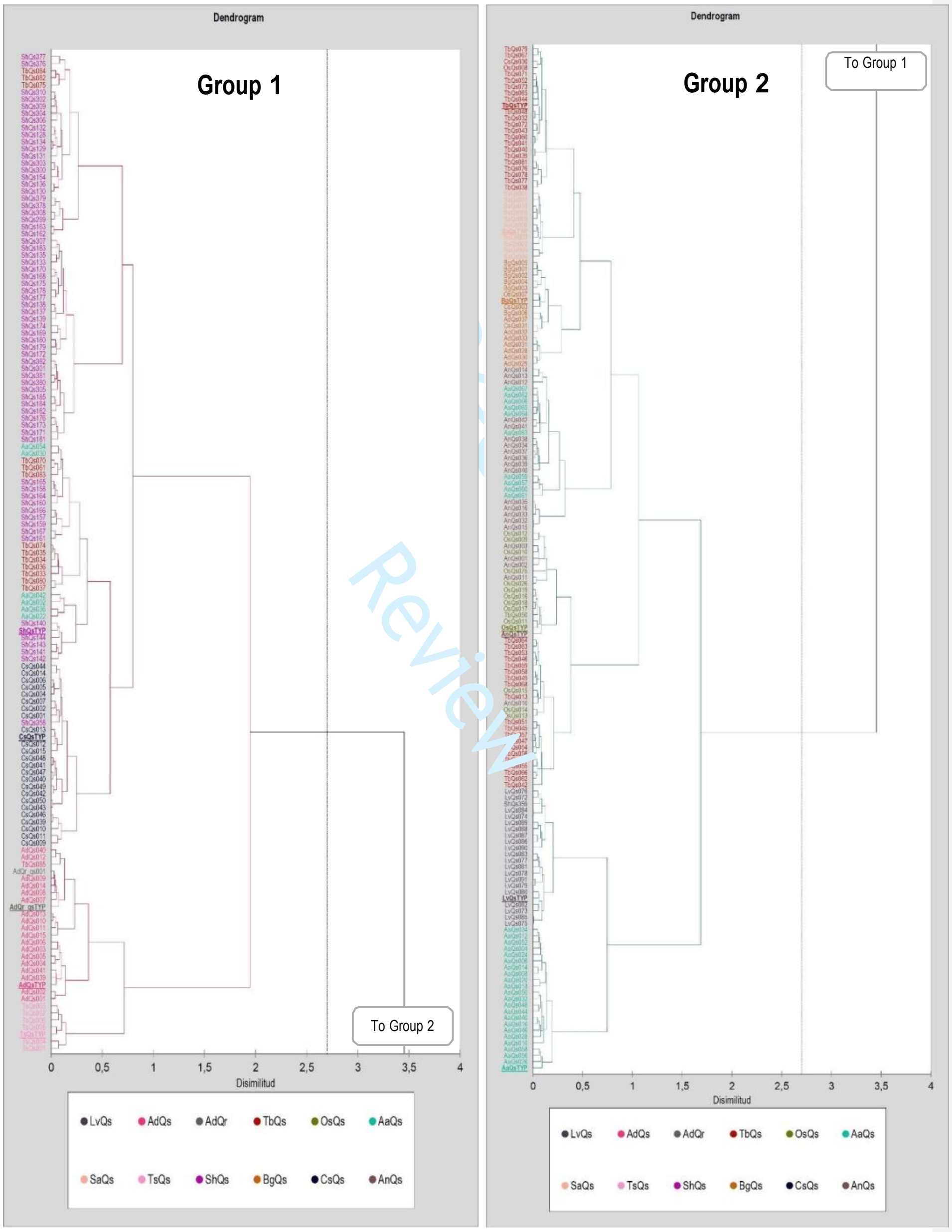

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Figure 3: Hierarchical ascending classification of the samples used in the analysis, in bold and underlined, the inventories considered as typus of the different associations. The two groups are separated according to the Calinski & Harabasz index of 32.951 for a dissimilarity of 2.7.

The principal component analysis The PCA reduced the dimensionality of the environmental variables used to two principal components, with the first two axes representing 44.66% of the variability (inertia) observed in the environmental variables used, increasing the inertia to 60.62% if three axes are included. As can be seen in Figure 4, the climatic variables that are most correlated with the different associations, on the one hand are the cork oak groves called TsQs, strongly positively correlated with variables related to water availability (Ios1-4, Io), and almost without periods of summer drought (sub-Mediterranean environments). From the edaphic point of view, they are also correlated with stony or sandy soils. On the other hand, they correlate negatively with variables related to high Mediterranean and aridity values. Edaphically, they are located in soils that are poor in carbonates and clays.

The cork oak forests of AaQs correlate well with relatively humid bioclimates, with high values of Io, IH, Ioe, low values of aridity (Iar), and from the edaphic point of view, they prefer sandy soils, rich in particulate organic matter, with low levels of carbonates and clays.

AdQs prefers environments with a continental trend (high Ic), with low values in Io, Ioe and IH. It correlates negatively with the compensated thermicity index (Itc) and positive temperature (Tp), indicating a colder thermoclimate. From the edaphic point of view, they prefer for loamy and stony soils poor in organic matter and with low C/N ratios. The holm oak groves with cork oaks of AdQr are grouped within the rest of the cork oak groves of AdQs. There are no bioclimatic or edaphic differences that allow discerning any sub-association.

The cork oak groves of AnQs and OsQs have similar affinities, and there are no environmental or edaphic variables, of those studied, that really allow a segregation of both types of cork oak groves. In Figure 3, the heterogeneity of the samples assigned in origin to this type of cork oak forest could already be glimpsed, being groups of AnQs inventories, more similar to other better established cork oak forests, identifying themselves better with AaQs cork oak forests, on sandy soils in oceanic environments (negatively correlated with Ic), but with a sufficiently high correlation by thermal environments to make these variables more relevant. Another group of samples, which include both typus, do correlate with thermal environments, with high evapotranspiration (EP), with oceanic tendency, and to a lesser extent with soils that are certainly carbonate without being calcareous. These samples correspond to both AnQs and OsQs, therefore, there seem to be few differences both in their floristic composition and in discriminating environmental variables.

Quercus suber formations called CsQs are well defined in the PCA, showing positive correlations with edaphic variables indicating calcareous soils (CEC and $CaCO_3$), as well as negatively correlated with variables such as Io, IH, Ios1-4 and positively correlated with Iar, K, or summer evapotranspiration (Pes). It is located in areas with low values of Itc and Tp.

LvQs, although they present low correlations with environmental variables, their floristic composition makes them form a fairly homogeneous forest type, since they are agglutinated they form a well-defined cluster (Figure 3). However, they prefer for warm environments (high values of Itc, Tp), relatively dry (low values of Io, IH, but not high values of Iar). The best negatively correlated variable seems to be Ic, therefore, they are distributed in oceanic environments (low values of Ic).

The cork oak forests of Lusitanian distribution SaQs, are well defined by variables such as Ios1-4, or Im, PE and to a lesser extent, soil stoniness, carbonates, Itc and Tp. According to the PCA in Figure 4, a strong negative correlation can be observed with the Mediterranean index (Im), being therefore of oceanic distribution, and positively correlated with the compensable ombrothermal indexes (Ios1-4), as well as with stony soils ~~and~~ poor in carbonates, in environments with not very high Itc and Tp.

The cork oak forests with the largest distribution area correspond to the ShQs denomination. Most of the samples are fairly well defined by the variables Ic, Io, Itc and Tp, with little relevance to edaphic variables. These are the most continental cork oak groves, largely due to the fact that most of them are distributed quite far from the sea. From the point of view of the relationship with the variables that denote the ombroclimate, it is possible to observe the high negative correlation that exists between Io and the position of the ShQs inventories. The same occurs with Itc and Tp, denoting that the distribution of ShQs is defined by low values of Itc and Tp, high values of Ic, and low values of Io, and Im.

The cork oak groves called TbQs, show a certain heterogeneity with the cork oak groves of AnQs and OsQs, which do not seem to have a clear edaphic and bioclimatic differentiation with the variables involved. Nevertheless, most of the samples form a fairly homogeneous group, positively correlated with high values of Itc and Tp, low values of Ic, Id. From the edaphic point of view, they are distributed on soils with high C/N ratio, and rich in oxidizable organic matter (MAOM). To a lesser extent, they correlate with high values of Io, Ioe and IH.

Finally, the samples called BgQs form a fairly homogeneous group, although close to CsQs and certain samples of AnQs and OsQs. The best positively correlated variables are PEs, CaCO3, Iar, CEC. And to a lesser extent Itc, Tp and Im. With a negative sign, the most highly correlated variables are Ios1-4, Io, IH and CN. Therefore, the BgQs cork oak groves are distributed on soils with some carbonates, although not of a limestone nature, with high CEC, in drier places than the rest of the cork oak groves, and somewhat thermophilic.

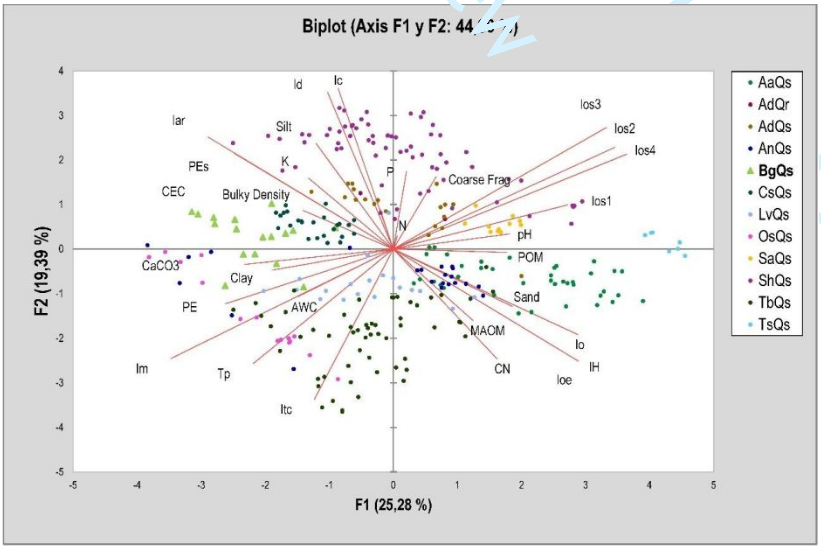

Figure 4: Biplot of the Principal Component Analysis of the first two axes, the variables are represented by vectors, the vectors closest to the axes and of greater length are those that contribute more variance to the axes. The colored points represent the inventories analyzed.

Once the relationships between the different types of *Quercus suber* formations and the bioclimatic and edaphic variables have been delimited, the analysis of canonical correspondences allows us to establish which plant species are most correlated with the bioclimatic and edaphic variables. Figure 5 shows 7 groups of species correlated with different environmental variables. The permutation test with 1000 iterations of configurations between variables, samplings and species, yields a P-value < 0.001, therefore, the species data of the inventories are linearly related to the variable data for each inventory analyzed. The risk of rejecting the null hypothesis H0 when true is less than 0.01%. The inertia or variability explained by the first two axes is 67.83%, which is distributed as 40.91% of variability explained by the F1 axis and 26.92% explained by F2. The F1 axis can be interpreted as a gradient of humidity, or of increasing water availability from left to right, with the variables related to aridity and high evapotranspiration (Iar and Pes) on the left, and the variables related to water availability (Io, Ios1, Ios4) on the right. On this axis, the edaphic variables with the best correspondence with the F1 axis are MAOM and CN, and there seems to be a certain positive relationship between higher values of MAOM and CN and higher values of Io, Ios1 and Ios4. The F2 axis seems to indicate a gradient of thermicity and oceanicity, with variables related to thermicity at the bottom and Ic (continentality) at the top. The most relevant edaphic variables are % sand and stoniness (Coarse frag.), which are inversely related and at the same time follow an increasing gradient with F1.

On the one hand, species that are close to high values of Io, Ios1 and Ios4 can be observed. Species such as *Teucrium salviastrum* Schreb., *Quercus robur* L. subsp. *broteroana* O.Schwarz, *Ilex aquifolium* L. or *Hedera ibernica* (G.Kirchn.) Bean, seem to characterize and differentiate the cork oak forests of TsQs, as can be observed when comparing the ACP with the CCA. This is consistent with the original description of these fomations (Pinto-Gomes et. al. 2007).

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Another set of species that are located in favor of the water bonanza gradient, and far from high values of Iar and Pes, is formed by *Simetis matiazzi* (Vand.) Sacc., *Quercus pyrenaica* Willd., *Cytisus striatus* (Hill) Rothm. subsp. *striatus* or *Agrostis curtisii* Kerguélen. These species can be representative and characterize associations such as SaQs, AaQs in their more mesophilic facies, even some wetter facies of ShQs.

A third group of species is formed by *Ulex baeticus* Boiss., *Acer monspesulanum* L., *Quercus faginea* Lam. or *Paeonia broteri* Boiss. & Reut., which seem to align towards a gradient of continentality, or decreasing in thermicity, species, therefore, of more or less cold and not very continental places, these species are present in cork oak forests as CsQs, TbQs, ShQs in its coldest facies or AdQs.

Species such as *Thymelaea hirsuta* (L.) Endl., *Adenocarpus decorticans* Boiss., *Citus laurifolius* L., *Silene nevadensis* (Boiss.) Boiss. or *Celtica gigantea* (Link) J.M.Vázquez & Barkworth, show positive correlation with the F2 axis, located in an increasing gradient of continentality, loamy or slightly sandy soils and already with a slight tendency towards drier ombroclimates. This cohort of species characterizes quite well the cork oak forests of AdQs, and coincides to a greater or lesser extent with the differential species mentioned in their description (Martínez Parras 1987; Rivas-Martínez et al. 2011a,b). The presence of *Pterospartum lasianthum* (Spach) Talavera & P.E. Gibbs or *Paeonia broteri* Boiss. & Reut. as an indicator of ShQs among other cork oak forests is consistent with the cold and continental prefer (always within the context of formations with *Quercus suber* L.) of these cork oak forests.

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The species furthest to the left of the water availability gradient, and therefore the most xerophytic in the context of *Quercus suber* formations, are *Ulex pariflorus* Pourr., *Bupleurum gibraltaricum* Lam., *Juniperus oxycedrus* L., *Genista umbellata* (L´Hér.) Poir. subsp. *equisetiformis* (Spach) Rivas Goday & Rivas Mart., *Retama sphaerocarpa* (L.) Boiss., *Halimium atriplicifolium* (Lam.) Spach or *Lavandula stoechas* Lam. subsp. *caesia* Borja & Rivas Goday. These species characterize to a greater or lesser extent the cork oak groves proposed as BgQs, or CsQs. In the lower zone of this group, the presence of *Osyris lanceolata* Hochst. & Steud. and *Cistus monspeliensis* L., already denotes a slight thermophily of these species.

The most representative species of the more thermal and less continental cork oak groves, and on sandy soils to a certain extent, or at least on soils with little stony soil, form a fairly homogeneous group consisting of *Halimium halimifolium* (L.) Willk. subsp. *multiflorum* (Salzm. ex Dunal) Maire, *Margotia gummifera* (Desf.) Lange, *Lavandula pedunculata* (Mill.) Cav., *Ulex welwichianus* Planch, *Juniperus navicularis* Gand., *Juniperus phoenicea* subsp. *turbinata* (Guss.) Nyman , *Stauracanthus genistoides* (Brot.) Samp., *Rhamnus oleoides* L. or *Corema album* (L.) D.Don. This extensive cohort of species characterizes, to a greater or lesser extent, the more thermophilic and sabulic cork oak forests such as AnQs, OsQs, LvQs, or facies on AaQs sands. This group, therefore, denotes the close ecological, bioclimatic and edaphic relationships between these formations of *Quercus suber*.

Finally, there is a group of more or less generalist species, but with a clear preference for warm climates and not very continental, located more or less in the center of the gradient of hydric availability and to a lesser extent towards sandy soils, or at least not very stony and poor in organic matter. This cohort is represented by *Quercus coccifera* L., *Olea europaea* L. *sylvestris* (Mill.) Lehr, *Myrtus communis* L., *Arum italicum* Mill., *Laurus nobilis* L., *Smilax aspera* L. or *Quercus lusitánica* Lam. These species are present in several cork oak forests such as AaQs, LvQs, TbQs, or more oceanic facies of ShQs or SaQs.

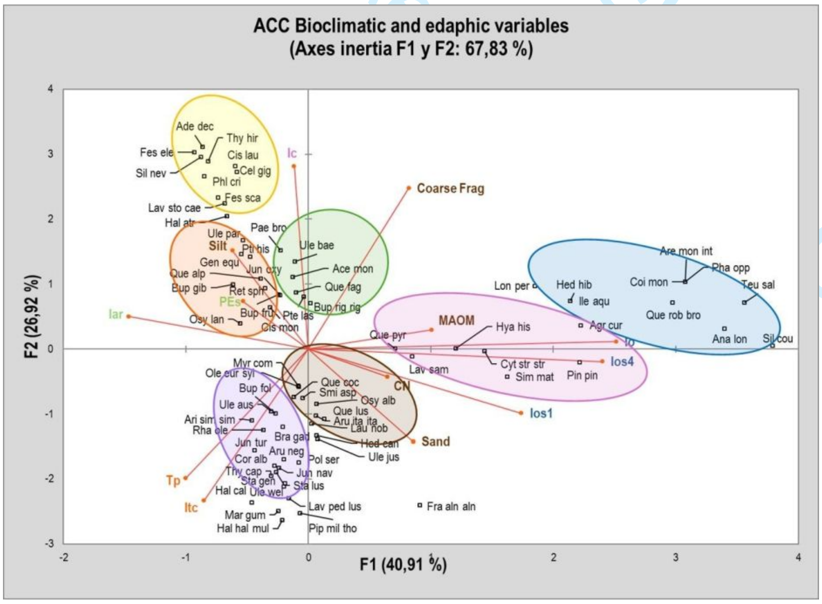

Figure: 5. Biplot of the first two axes F1 and F2 of the canonical correspondence analysis. The F1 axis corresponds to an increasing gradient from left to right of the water availability, as

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environmental variables related to water availability are correlated with this axis. The F2 axis corresponds to an increasing gradient of thermicity and oceanicity from top to bottom, since variables related to thermicity and thermal amplitude (continentality) correlate with the F2 axis. Edaphic variables would correspond better with F3 (not represented, although there is a diagonal component with a gradient from silty to sandy soils, the variable "Sand" correlates negatively with Silt, organic matter and soil stoniness.

2) Phytosociological analysis

This study provides a new cork oak association for the subhumid-humid-siliceous-basic Thermo-Mediterranean zone of the Malaga-Baetic province territories (Granadino-Serrano-Almijarense sector, Axarquiense district) (Rivas-Martínez et al. 2011c). In the area there are two types of cork oak forest, the *Cheirolopho sempervirentis-Quercetum suberis*, described by its authors in the Sierra de Málaga (Pérez Latorre et al. 2008), on substrates formed by slate, quartz and sandstone in the subhumid mesomediterranean floor of the Montes de Málaga. The authors also include those somewhat more thermophilic formations on flyschoid quartzite sandstones of the Colmenar corridor, recognize the presence of *Arbutus unedo* L. for these cork oak forests, but do not establish any dynamics for them. Hence the need to establish the dynamics of these forests, otherwise future managers will not have the capacity to manage these natural areas.

Our study of these thermo- and mesomediterranean cork oak forests provides two new associations, a new cork oak forest, a new arbutus grove, and two communities, one *of Lavandula stoechas* L. and *Cistus populifolius* L. subsp. *major* (Dunal) Heywood and another of *Adenocarpus telonensis* (Loisel) DC., *Cytisus grandiflorus* (Brot.) DC. and *Cytisus arboreus* (Desf.) DC. subsp. *catalaunicus* (Webb) Maire that acts as a fringe of these cork oak forests.

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We propose the arbutus grove as *Cheirolopho sempervirentis-Arbutetum uendonis* nova (table 3 inv. 1-7 typus inv. 4), a shrubland characterized by *Arbutus unedo* L., *Bupleurum fruticosum* L., *Viburnum tinus* L., *Cheirolophus sempervirens* (L.) Pomel = *Centaurea sempervirens* L., arbutus grove that we include in the suballiance *Bupleurenion fruticosi* Torres, Pinto Gomes & Cano 2002 in Rivas-Martínez 2011, described by its authors for decarbonated substrates (Torres et al. 2002). This new association differs from the closer association *Cytiso baetici-Arbutetum unedonis*, described for the Aljibe and westernmost areas of Málaga by Nieto et al. (1990,1991), due to the lack of species such as *Cytisus baeticus* (Webb) Maire, *C. villosus* Pourr., *Teline linifolia* (L.) Webb, *Ulex baeticus* Boiss., this being an eastern vicariant of the previous one with a less oceanic character. The geological substrates on which this arbutus grove is established are formed by slate, quartzite and sandstone. These materials present significant amounts of carbonates, which are contributed by the ascent of these by capillarity from the relatively shallow rocky layers; the scrub that would replace this arbutus grove is a community of *Lavandula stoechas* and *Cistus populifolius* subsp. *major* (table 4). This community develops in both the meso and thermo-Mediterranean, and its floristic composition is *Cistus populifolius* L., *Ulex parviflorus* Pourr., *Cheirolophus sempervirens* (L.) Pomel, *Lavandula stoechas* L., *Cistus albidus* L., *Cistus monspeliensis* L., *Cistus ladanifer* L., *Genista umbellata* (L´Her.) Poir. subsp. *equisetiformis* (Spach) Rivas Goday & Rivas Mart. The edge of the *Centaureo sempervirentis-Quercetum suberis* forests corresponds to a broom community formed by *Adenocarpus telonensis* (Loisel) and *Cytisus grandiflorus* DC (table 5).

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In the thermomediterranean sub-humid areas (Almogía, Álora, Pizarra) there is a cork oak grove developed on various siliceous substrates, slates, sandstones and quartzites, of thermomediterranean and dry upper-sub-humid character. This cork oak forest is a new association for the Axarquia region (Malacitano-Almijarense sector). The new association is proposed for the thermomediterranean with its own floristic composition, *Quercus suber* L.,

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Chamaerops humilis L., *Buplerum fruticosum* L., *Bupleurum gibraltaricum* Lam, *Rhamanus alaternus* L., *Rhamnus laderoi* Rivas Mart. & J.M.Pizarro, *Asparagus aphyllus* L., *Aristolochia baetica* L., *Juniperus oxycedrus* subsp. *badia* (H.Gay) Debeaux

Bupleuro gibraltarici-Quercetum suberis nova (table 6 b inv. 1-7 typus inv. 1) and as a first dynamic stage presents a woodland of *Aristolochio baeticae-Arbutetum unedonis* Torres, Valle, Pinto, García, Salazar et Cano 2002. *bupleuretosum gibraltarici* Torres, Valle, Pinto, García, Salazar et Cano 2002, a woodland that is replaced by the aforementioned community of *Lavandula stoechas* L. and *Cistus populifolius* L. subsp. *major* (Dunal) Heywood. The dendrogram (Figure 3) reveals a

homogeneous group of these cork oak groves, which are well differentiated from the rest of the thermo- and mesomediterranean cork oak groves. In a comparative analysis of the typus between the thermomediterranean associations closest to the proposed AnQs, TbQs, OsQs and SaQs, it is observed that there are clear floristic differences (table 7), which is expressed by the differential floristic package of *Bupleurum gibraltaricum* Lam., *Rhamnus laderoi* Rivas Mart. & J.M. Pizarro, *Osyris lanceolata* Hochdt. & Steud., *Cystisus arboreus* (Desf.) DC. subsp. *catalaunicus* (Webb) Maire , *Quercus faginea* Lam. subsp. *alpestris* (Boiss.) Maire, *Juniperus oxycedrus* L., *Genista umbellata* (L´Her.) Poir. subsp. *equisetiformis* (Spach) Rivas Goday & Rivas Mart (Rivas-Martínez et al. 2002; Díez et al. 1988; Rivas-Martínez 1987; Pinto Gomes et al. 2003). In this analysis of the typus there is a high coincidence between AnQs and OsQs being located together in the cluster (Figure 3). This is because there are no edaphic, bioclimatic, biogeographic and floristic differences, so that according to the International Code of Phytosociological Nomenclature articles 23 and 44 (Teurillat et al. 2021), we must synonymize AnQs to OsQs whose typification was made. Although both syntaxons are based on different nomenclatural types, they belong to the same syntaxon, being therefore heterotypic syntaxonomic synonyms. *Oleo sylvestris-Quercetum suberis* Rivas Goday, Galiano & Rivas-Martínez ex Rivas-Martínez 1987 (syn: *Aro neglecti-Quercetum suberis* Rivas-Martínez & Díez Garretas 2011).

Table 3.- As. *Cheirolopho sempervirentis-Arbutetum unedonis*

Nº inv.	1	2	3	**4**	5	6	7	
Surface m2	200	200	200	**300**	200	200	200	
Altitude m.	914	910	879	**919**	897	879	878	
Coverage %	95	85	95	**95**	90	55	70	
Orientation	N	NW	E-NE	**N-NW**	NE	NE	N-NE	
Inclination %	6	10	20	**20**	15	6	10	
Average veg hight m.	2	3	2	**3,5**	2	2	2,5	
Characteristics species and superior units								
Arbutus unedo	3	4	3	**5**	3	3	3	V
Bupleurum fruticosum	5	2	5	**2**	4	1	1	V
Cheirolophus sempervirens	1	1	2	**2**	2	1	+	V
Quercus suber	+	+	1	**+**	1	+	+	V
Phlomis purpurea	2	1	+	**-**	+	1	1	IV
Phillyrea angustifolia	1	+	-	**+**	+	1	+	IV
Bupleurum gibraltaricum	+	-	-	**-**	-	-	-	IV
Coronilla juncea	-	1	-	**-**	-	-	-	IV
Lonicera implexa	-	+	+	**+**	+	-	-	III
Rubia peregrina	-	-	+	**-**	1	2	-	II
Quercus rotundifolia	+	+	-	**+**	-	-	-	II
Crataegus monogyna	-	-	1	**-**	-	2	-	I
Lonicera peryclimenum	-	-	-	**-**	-	+	-	I
Quercus subsp. *alpestris*	-	-	+	**+**	-	-	-	I

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Rhamnus alaternus	-	-	-	-	-	2	-	I
Viburnum tinus	-	-	-	-	-	+	+	I
Companions species								
Cistus albidus	1	+	+	+	1	1	1	V
Cytisus grandiflorus	-	2	1	+	2	1	+	IV
Ulex parviflorus	1	-	-	+	+	+	+	III
Genista umbellata subsp. *equisetiformis*	1	-	1	-	-	-	+	II
Cistus salviifolius	+	1	-	+	-	-	-	II
Cistus ladanifer	-	1	-	+	-	-	1	II
Lavandula stochas	1	+	-	-	-	-	1	II
Cistus monspeliensis	-	-	-	+	-	-	1	I
Cistus populifolius subsp. *major*	-	-	-	1	-	-	-	I
Halimium atriplicifolium	-	1	-	-	-	-	-	I
Dactylis hispanica	-	+	-	-	-	-	-	I
Rubus ulmifolius	-	-	+	+	-	-	-	I
Ptilostemom hispanicus	-	-	-	+	-	-	-	I
Rosa canina	-	-	-	+	-	-	-	I
Sedum sediforme	-	-	-	-	+	-	-	I
Rosa sempervirens	-	-	-	-	-	+	1	I
Smilax aspera	-	-	-	-	-	+	-	I

Localities:

30S0378332/4075435 Camino Colmenar (Montes de Málaga)
30S0378345/4076075 Procimidades Ecomuseo Torrijos (Montes de Málaga)
30S0379700/4078589 A-7000 Colmenar-Málaga
30S0378046/4075380 A-7000 Colmenar-Málaga
30S0379689/4078401 A-7000 Colmenar-Málaga
30S0379254/4076018 A-7000 Colmenar-Málaga

Table 4.- Community of *Lavandula stoechas* and *Cistus populifolius* subsp. *major*

	1	2
Surface m2	200	200
Altitude m.	919	524
Coverage %	90	50
Orientation	N-NW	SW
Inclination %	20	5
Average veg hight m.	1,5	1,8
Characteristics species of community		
Cistus populifolius subsp. *major*	4	2
Cistus ladanifer	+	+
Landula stoechas	+	+
Cistus albidus	1	-
Cistus salviifolius	1	-
Ulex parviflorus	1	-

Genista umbellata subsp. *equisetiformis*	-	1
Companions species of community		
Quercus suber	+	+
Cheirolophus sempervirens	1	-
Arbutus unedo	+	-
Quercus rotundifolia	+	-
Quercus subsp. *alpestris*	+	-
Scrophularia scorodonia	+	-
Senecio malacitanus	+	-
Cytisus grandiflorus	1	-
Chamaerops humilis	-	+
Myrtus communis	-	+
Phlomis purpurea	-	+
Origanum virens	-	+
Erica arborea	-	+
Brachypodium retusum	-	+

30S0378046/4075380 Colmenar-Málga A 7000
30S0360646/4081067 Almogía-Monterroso

Table 5. Community of *Adenocarpus telonensis* and *Cytisus grandiflorus*

	1	2
Surface m2	200	200
Altitude m.	840	859
Coverage %	50	60
Orientation	N	NW
Inclination %	7	10
Average veg hight m.	2	1,8
Characteristics species of community		
Cytisus grandiflorus	2	3
Adenocarpus telonensis	+	1
Cytisus arboreus catalaunicus	+	-
Retama sphaerocarpa	+	-
Companions species of community		
Genista umbellata subsp. *equisetiformis*	1	1
Lavandula stoechas	+	+
Plomis purpurea	1	-
Cistus ladanifer	+	-
Ulex parviflorus	+	-
Rosmarinus officinalis	+	-
Ptilostemom hispanicus	+	-
Cheirolophus sempervirens	+	-
Halimium atriplicifolium	+	-
Quercus suber	-	+

Quercus rotundifolia	-	+
Rubia peregrina	-	+
Quercus coccifera	-	+
Rubus ulmifolius	-	+
Cistus albidus	-	+
Daphne gnidium	-	+

30S0379667/4075202	Camino de Comares
30S0379662/4079923	Prox. Venta el Pinar

Table 6.- a) As. *Cheirolopho sempervirentis-Quercetum suberis*. b) As. *Bupleuro gibraltarici-Quercetum suberis*

	a)							b)						
Surface m2	600	600	600	600	600	600	600	**600**	600	600	600	600	600	400
Altitude m.	799	842	945	804	897	910	877	**458**	556	484	560	557	524	640
Coverage %	80	75	90	60	70	60	80	**60**	60	60	60	60	60	60
Orientation	N	N	N	W	NE	NE	NE	**E**	NE	N	NE	NE	SW	E
Inclination %	10	8	15	20	20	8	15	**10**	8	10	8	5	5	25
Average veg hight m.	8	7	7	7	7	8	6	**7**	7	7	6	6	7	15
Characteristics species and superior units														
Quercus suber	4	4	4	3	3	3	4	**3**	3	3	3	3	3	3
Centaurea sempervirens	1	2	2	2	2	2	2	**.**	.	.	.	.	.	.
Arbutus unedo	2	2	.	.	.	+	1	**+**	.	.	.	.	.	+
Bupleurum fruticosum	2	2	.	.	1	.	.	**1**	.	.	.	.	.	.
Brachypodium sylvaticum	.	.	1	.	.	.	.	**.**	.	.	.	.	.	.
Calicotome villosa	.	+	.	.	.	.	.	**+**	.	.	.	.	.	+
Chamaerops humilis	.	.	.	.	.	.	.	**1**	2	.	2	1	2	2
Bupleurum gibraltaricum	.	.	.	.	.	.	.	**2**	2	1	1	1	2	1
Asparagus aphyllus	.	.	.	.	.	.	.	**1**	1	2	2	2	2	2
Aristolochia baetica	.	.	.	.	.	.	.	**1**	1	2	2	2	2	2
Phlomis purpurea	.	.	1	1	2	+	+	**1**	1	1	2	2	2	2
Osyris lanceolata	.	.	.	.	.	.	.	**.**	.	2	1	2	1	1
Crataegus monogyna subsp. *brevispina*	.	.	2	1	.	.	+	**.**	+	.	.	.	.	.
Daphne gnidium	.	1	1	.	.	.	1	**+**	.	.	.	.	.	1
Lonicera implexa	+	+	.	1	1	.	1	**1**	.	.	.	.	.	.
Myrtus communis	.	.	.	.	.	.	.	**.**	2	2	.	.	1	.

Olea sylvestris	.	.	.	.	.	.	.	1	2	1	.	+	2	.
Phillyrea angustifolia	.	.	.	1	.	.	+	.	.	.	.	.	.	.
Ptilostemon hispanicus	.	+	.	+	+	.	1	.	.	.	.	.	.	+
Quercus coccifera	+	.	.	+	.	+	+	+	+	.	.	1	.	.
Quercus rotundifolia	1	1	+	1	.	.	2	1	+	+	+	1	.	+
Rhamnus alaternus	.	.	+	1	.	.	+	1	+	.	.	+	.	.
Rubia peregrina subsp. longifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Rubia peregrina subsp. peregrina	1	.	+	+	1	2	1	.	+	.	.	.	1	.
Ruscus aculeatus	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Smilax aspera var. altissima	.	.	.	.	.	.	.	+	1	.	.	.	.	.
Smilax aspera var. aspera	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Teucrium fruticans	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Thapsia garganica	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Viburnum tinus	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Vinca difformis	.	.	.	.	.	.	.	.	1	.	.	.	.	.
Coronilla juncea	1	.	.	.	.	+	.	.	.	.	.	.	.	.
Quercus faginea subsp.*alpestris*	.	.	2	.	.	.	.	1	.	.	1	1	.	.
Asparagus acutifolius	.	.	.	.	.	+	.	.	+	+	.	.	.	.
Asphodelus aestivus	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Asphodelus albus	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Asplenium onopteris	.	.	+	.	.	.	.	.	.	.	.	.	.	+
Digitalis purpurea	.	2	.	.	.	.	.	.	.	.	.	.	.	.
Doronicum plantagineum	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Erica arborea	.	2	.	.	.	.	.	.	.	+	.	.	.	.
Juniperus oxycedrus	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Rhamnus laderoi	.	.	.	.	.	.	.	+	+	.	.	.	.	.

Asparagus albus	.	.	.	.	.	.	.	**1**	.	.	.	.	.	.
Lonicera periclymenum	.	.	.	.	.	2	.	**.**	.	.	.	.	.	.
Juniperus oxycedrus subsp. badia	.	.	.	.	.	.	.	**+**	.	.	.	.	.	2
Companion species														
Cytisus grandiflorus	1	1	+	1	2	1	+	**.**	.	.	.	.	.	.
Cytisus arboreus subsp. catalaunicus	.	.	.	.	.	.	.	**+**	.	.	.	.	.	.
Adenocarpus telonensis	.	.	.	.	.	.	.	**1**	2	2	.	.	1	.
Cistus albidus	1	+	1	+	1	+	1	**1**	+	.	2	.	.	1
Cistus crispus	.	.	.	.	.	.	.	**.**	+	+	.	1	+	.
Cistus ladanifer	1	+	+	.	.	.	1	**1**	.	.	.	.	.	.
Cistus monspeliensis	.	+	+	.	.	.	1	**.**	+	1	2	1	1	2
Cistus populifolius subsp. *major*	.	.	.	.	.	.	.	**.**	.	.	.	.	+	.
Cistus salviifolius	1	+	1	.	.	.	.	**.**	.	1	+	.	.	1
Lavandula stoechas	+	+	+	.	.	.	1	**.**	+	+	2	1	.	1
Lotus parviflorus	.	1	.	.	.	.	.	**.**	.	.	.	.	.	.
Origanum virens	.	.	1	.	.	.	.	**.**	.	.	.	.	+	.
Pteridium aquilinum	.	.	.	.	.	.	.	**.**	.	.	.	.	.	1
Rosa canina	.	.	+	1	.	.	.	**.**	.	+	+	.	.	.
Rosa sempervirens	.	.	.	.	.	.	1	**.**	.	.	.	.	.	.
Rosmarinus officinalis	.	.	+	.	.	.	.	**+**	.	.	.	.	.	.
Rubus ulmifolius	.	.	+	.	+	.	+	**.**	.	.	.	.	.	.
Scilla maritima	.	.	.	.	.	.	.	**.**	.	.	+	+	+	.
Thymus mastichina	.	.	.	.	.	.	.	**.**	.	.	.	.	.	+
Ulex parviflorus	1	.	1	+	.	+	1	**.**	1	1	1	1	1	2
Halimium atriplicifolium	1	.	.	.	.	.	.	**.**	.	.	.	.	.	.
Genista umbellata subsp. *equisetiformis*	+	.	.	+	1	.	1	**+**	+	.	1	.	1	1

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Retama sphaerocarpa	.	.	.	+	.	.	+	.	.	.	+	+	+	.
Hedera helix	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Helichrysum serotinum	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Plantago radicata	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Brachypodium retusum	.	1	.	.	.	.	1	**1**	.	.	.	.	.	.
Asplenium trichomanes	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Abies pinsapo	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Asplenium billotii	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Selaginella denticulata	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Genista scorpius	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Stipa tenacissima	.	.	.	.	.	.	.	.	.	.	.	.	.	+

Localities:

Cs-Qs	*Cheirolopho sempervirentis-Quercetum suberis*	
Cs-Qs9	Prox. Ecomuseo Torrijos	30S0378395/4076091
Cs-Qs10	Camino de Comares	30S0379667/4075201
Cs-Qs11	Totalan a Comares	30S0385092/4037965
Cs-Qs12	Venta del Pinar	30S0379735/4079961
Cs-Qs13	Colmenar-Málaga A:7000	30S0379689/4078401
Cs-Qs14	Colmenar Málaga	30S0379260/4078401
Cs-Qs15	Galvey a Comares	30S0379371/4075592
Bg-Qs	*Bupleuro gibraltarici-Quercetum suberis*	
Bg-Qs1	Almogía-Antequera Ma:3403	30S0361139/4030092
Bg-Qs2	Almogía-Antequera Ma:3403	30S0360491/4081264
Bg-Qs3	Almogia-Monterroso	30S0361013/4080100
Bg-Qs4	Almogia-Monterroso: Camino Ermita Cruces	30S0359523/4078247
Bg-Qs5	Almogia-Monterroso: Cerro Santi Petri	30S0059276/4077714
Bg-Qs6	Almogia-Monterroso	30S0360646/4081067

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Bg-Qs7 Cerro Hijar: Tolox 36º 41 7N/4º 55 47 W

Table 7.- Comparative table between the typus of the associations studied and the new association (BgQs)

Commented [ECC30]: Authorities in spot color corrected

Typus associations	AaQsTYP	AdQr_qsTYP	AdQsTYP	AnQsTYP	BgQsTYP	CsQsTYP	LvQsTYP	OsQsTYP	SaQsTYP	ShQsTYP	TbQsTYP	TsQsTYP
Characteristic species												
Quercus suber L.	5	2	3	5	3	5	5	5	4	5	4	4
Arbutus unedo L.	1				+	+	3		1	+	1	2
Daphne gnidium L.	+	1			+	+	+		+			
Olea europaea var. *sylvestris* (Mill.) Lehr				1	1		+	2	1		+	
Viburnum tinus L.	2			2		+	+		3	1		
Ruscus aculeatus L.	1					+		2		2	1	
Rubia peregrina subsp. *longifolia* (Poir.) O.Bolòs							1	1	+		+	
Rubia peregrina L. subsp. *peregrina*	1	1				+	1			+		
Smilax aspera L. var. *aspera*	1			+				3	2		+	
Asparagus aphyllus L.	+			1	1			1				
Crataegus monogyna subsp. *brevispina* (Kunze) Franco	+	1				+					2	
Erica arborea L.						+	1		2			1
Pistacia lentiscus L.	1			3			+	3	+			
Quercus coccifera L. subsp. *coccifera*	3				+	1		2				
Rhamnus alaternus L. subsp. *alaternus*	+			2	1				+			
Lonicera etrusca G. Santi	2						1			1		
Lonicera implexa Aiton					1	1	+					
Aristolochia baetica L.				3	1			2				
Myrtus communis L.							+	+	2			
Phillyrea angustifolia L.									1		+	1
Quercus faginea Lam. subsp. *faginea*		+				+	+					

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Quercus rotundifolia Lam.		2	+		1					
Arisarum vulgare Targ.-Tozz.	2								1	
Arum italicum subsp. *neglectum* (Towns.) Prime				1				1		
Asparagus acutifolius L.				1				1		
Asplenium onopteris L.						+	+			
Carex distachya Desf.	+			1						
Chamaerops humilis L.					1			+		
Hyacinthoides hispanica (Mill.) Rothm.							+			
Juniperus oxycedrus subsp. *badia* (H.Gay) Debeaux					+				2	
Luzula forsteri subsp. *baetica* P.Monts.	+									+
Quercus broteroi (Cout.) Rivas Mart.	+						+			
Rosa sempervirens L.	+									1
Smilax aspera var. *altissima* Moris & De Not.					+		+			
Teucrium fruticans L.						+		1		
Sanguisorba hybrida (L.) Font Quer							+			1
Phillyrea latifolia L. subsp. *latifolia*	+									+
Osyris alba L.	2									
Quercus Xairensis Franco & Vasc.	+									
Arisarum simorrhinum Durieu. var. *simorrhinum*				1						
Clematis flammula L.				1						
Rhamnus oleoides L. subsp. *oleoides*				+						
Asparagus albus L.					1					
Bupleurum fruticosum L.					1					
Bupleurum gibraltaricum Lam.					2					
Quercus faginea subsp. *alpestris* (Boiss.) Maire					1					
Rhamnus lycioides subsp. *laderoi* Rivas Mart. & J.M.Pizarro					+					
Carex halleriana Asso.						+				
Doronicum plantagineum L. subsp. *plantagineum*						+				

Ceratonia siliqua L.							+					
Quercus broteroi x Quercus robur							+					
Quercus lusitanica Lam.							+					
Quercus x andegavensis nothosubsp. subandegavensis							+					
Clematis cirrhosa L.								2				
Paeonia broteri Boiss. & Reut.										+		
Pyrus bourgaeana Decne.										+		
Arenaria montana L. *subsp. intricata* (Ser.) Pau												1
Scilla monophyllos Link												+
Companion species												
Tamus communis L.	+			1		+	1		+	+		
Rubus ulmifolius Schott	1	+	+				+				+	
Brachypodium sylvaticum (Huds.) P.Beauv.		1				+	+			+		
Cistus salviifolius L.						2	+			+	+	
Pteridium aquilinum (L.) Kuhn subsp. *aquilinum*	1	+							+	2		
Genista triacanthos Brot.	+						+		+	+		
Arum italicum Mill. subsp. *italicum*	1									+	+	
Cistus ladanifer L. subsp. *ladanifer*		2			1				+			
Digitalis purpurea L. subsp. *purpurea*	+		+							+		
Geranium purpureum Vill.	+			2						+		
Origanum virens Hoffmanns. & Link						+			+	+		
Thapsia villosa var. *villosa* L.		+	+				1					
Ulex parviflorus Pourr. subsp. *parviflorus*		2	+			1						
Cheirolophus sempervirens (L.) Pomel	+					1						
Hedera canariensis Willd.	1									1		
Deschampsia stricta Hack.	1						+					
Iris foetidissima L.	1							+				
Hypericum perforatum L. subsp. *perforatum*	+						+					

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Euphorbia characias L.	1		1							
Teucrium scorodonia L. subsp. *scorodonia*	2									+
Vinca difformis Pourr.	1			+						
Biarum galiani Talavera	1									
Calamintha baetica Boiss. & Heldr.	1									
Cephalanthera longifolia (L.) Fritsch	+									
Fraxinus angustifolia Vahl subsp. *angustifolia*	1									
Lathyrus clymenum L.	+									
Orobanche hederae Vaucher ex Duby	+									
Polypodium serratum (Willd.) A. Kern.	+									
Prunus spinosa subsp. *insititioides* (Ficalho & Cout.) Franco	2									
Silene longicilia (Brot.) Otth	1									
Ulex jussiaei Webb	1									
Urginea maritima (L.) Baker	+									
Carlina corymbosa L. subsp. *corymbosa*		+					+			
Geranium lucidum L.		+	1							
Holcus lanatus L.		+								
Jasione montana L. subsp. *montana*		+								
Bellis perennis L.		+								
Cistus laurifolius L.		2								
Clinopodium vulgare L. subsp. *vulgare*		+								
Lavandula stoechas subsp. *caesia* Borja & Rivas Goday		+								
Sanguisorba minor Scop. subsp. *minor*		2								
Thymus mastichina (L.) L. subsp. *mastichina*		+								
Clinopodium vulgare subsp. arundanum (Boiss.) Nyman			1							+
Dactylis glomerata subsp. *hispanica* (Roth) Nyman			+			+				
Adenocarpus decorticans Boiss.			2							
Arabis stenocarpa Boiss. & Reut.			+							

Festuca scariosa (Lag.) Asch. & Graebn.	+						
Saxifraga granulata L.	1						
Silene alba var. divaricata (Rahb) Walters	+						
Silene nevadensis (Boiss.) Boiss.	+						
Bryonia dioica Jacq.		+					+
Ulex australis subsp. *australis* Clemente		+			1		
Elaeoselinum foetidum (L.) Boiss.		+					
Galium aparine L. subsp. *aparine*		+					
Halimium calycinum (L.) K.Koch		+					
Halimium halimifolium (L.) Willk subsp. *halimifolium*		+					
Oxalis pes-caprae L.		+					
Pinus pinea L.		2					
Urtica membranacea Poir. in Lam.		+					
Calicotome villosa (Poir.) Link			+		+		
Adenocarpus telonensis (Loisel.) DC. in Lam. & DC.			1				
Brachypodium retusum (Pers.) P.Beauv. subsp. *retusum*			1				
Cistus albidus L.			1				
Cytisus arboreus subsp. *catalaunicus* (Webb) Maire in Emb. & Maire			+				
Genista umbellata subsp. *equisetiformis* (Spach) Rivas Goday & Rivas Mart.			+				
Phlomis purpurea L. subsp. *purpurea*			1				
Rosmarinus officinalis L.			[illegible]				
Cytisus grandiflorus (Brot.) DC. subsp. *grandiflorus*				+			+
Calamintha nepeta subsp. *sylvatica* (Bromf.) R.Morales				+		+	
Campanula rapunculus L.				+			
Lavandula stoechas L. subsp. *stoechas*				+			
Opopanax chironium (L.) W.D.J.Koch				1			
Ptilostemon hispanicus (Lam.) Greuter				+			
Rosa canina L. subsp. *canina*				1			

Cistus populifolius subsp. *major* (Dunal) Heywood	+					
Aristolochia paucinervis Pomel		+			+	
Cistus populifolius L. subsp. *populifolius*		+		+		
Bellis sylvestris subsp. *sylvestris* Cirillo		+				
Calamintha baetica Boiss. & Reut.		+				
Cytisus striatus (Hill) Rothm subsp. *striatus*		1				
Dactylis lusitanica (Stebbins & Zohary) Rivas Mart. & Izco		+				
Genista hirsuta Vahl subsp. *hirsuta*		+				
Glandora prostrata subsp. *lusitanica* (Samp.) D.C.Thomas		+				
Lavandula viridis L'Hér.		2				
Lavandula x_alportelensis P. Silva, Fontes & Myre		+				
Picris echioides L.		+				
Sedum forsterianum Sm. in Sowerby		+				
Ulex argenteus Welw. ex Webb		+				
Calamintha nepeta (L.) Savi subsp. *nepeta*			1		+	
Piptatherum miliaceum (L.) Coss. subsp. *miliaceum*			+			
Piptatherum miliaceum subsp. *thomasii* (Duby) Freitag			2			
Calluna vulgaris (L.) Hull				+		
Conopodium marianum Lange				+		
Cytisus striatus subsp. *eriocarpus* (Boiss. & Reut.) Rivas Mart.				+		
Lavandula luisieri (Rozeira) Rivas Martínez				+		
Lithodora lusitanica (Samp.) Holub				+		
Pulicaria odora (L.) Rchb.				+		
Selaginella denticulata (L.) Spring				+		
Thapsia minor Hoffmanns. & Link				+		
Lonicera periclymenum subsp. *hispanica* (Boiss. & Reut.) Nyman.					+	+
Aira caryophyllea L. subsp. *caryophyllea*					+	
Bellis sylvestris subsp. *pappulosa* (DC.) Coste					+	

Cistus psilosepalus Sweet	+		
Cynosurus echinatus L.	+		
Cynosurus elegans Desf.	+		
Epipactis helleborine (L.) Crantz subsp. *helleborine*	+		
Geum sylvaticum Pourr.	+		
Melica minuta L.	+		
Moehringia pentandra J.Gay	+		
Ranunculus ficaria L.	+		
Rhagadiolus stellatus (L.) Gaertn.	+		
Silene latifolia Poir.	+		
Viola sepinicola subsp. *glabrescens* Becker	+		
Teline monspessulana (L.) K.Koch		2	
Cistus monspeliensis L.		1	
Teucrium pseudoscorodonia Desf.		1	
Genista tridens (Cav.) DC. subsp. *tridens*		+	
Armeria beirana Franco			1
Arrhenatherum baeticum (Romero Zarco) Rivas Mart.			+
Celtica gigantea (Link) J.M.Vázquez & Barkworth			+
Coincya monensis (L.) Greuter & Burdet			1
Conopodium majus (Gouan) Loret in Loret & Barrandon subsp. *majus*			1
Dianthus lusitanus Brot.			1
Erica australis subsp. *aragonensis* (Willk.) Cout.			+
Lonicera periclymenum subsp. *hispanica* (Boiss. & Reut.) Nyman			1
Phalacrocarpum oppositifolium (Brot.) Willk.			+
Sedum brevifolium DC.			+
Sedum hirsutum All.			+
Silene acutifolia Link ex Rohrb.			+

Teucrium salviastrum Schreb.

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DISCUSSION

In the Iberian Peninsula, cork oak groves are distributed in thermo- and mesomediterranean subhumid environments on siliceous, silicibasic and decarbonate substrates.

The studied material is included in 12 associations and a subassociation of cork oak grove, plus the subassociation *quercetosum suberis* of the *Myrto comunis-Quercetum rotundifoliae* sintaxon described by Martínez Parras et al. (1987) for the Sierra de Cázulas at 700 m. This inventory can be included in the new cork oak association we propose (BgQs), associations mostly distributed in the south of the Iberian Peninsula, included by Rivas-Martínez (2011a) in *the Quercion broteroi* and *Quercion rotundifoliae-Oleion sylvestris* alliances. The *Quercus suber* L. cork oak groves corresponding to the *Adenocarpo decorticantis-Quercetum suberis* association described for the siliceous territories of the subhumid Mesomediterranean Alpujarras-Almijarenses were described by Martínez Parras et al. (1987), these authors describe the sub-association *quercetosum suberis* in this same work, for the holm oak forests of *Adenocarpo decorticantis-Quercetum rotundifoliae*, a sub-association that actually corresponds to the catenary contact between both associations, so the types of association and sub-association are close (Figure 3).

These cork oak groves present as a first dynamic stage the broom of *Cytisus scoparius* (L.) Link and *Adenocarpus decorticans* Boiss., which when degraded by soil loss originate a thicket of *Thymus gadorensis* (Pau) Jalas and *Cistus laurifolius* L. presenting in their clearings the hemicryptophyte grasses of *Celtica gigantea* (Link) F.M. Vazquez & Barkworth and *Festuca elegans* Boiss. In the Luso-Extremaduran territories, the subhumid siliceous mesomediterranean cork oak grove belongs to the *Poterio agrimonoidis-Quercetum suberis=Sanguisorbo hybridae-Quercetum suberis* association, which occupies large areas in the Marianica mountain range and the Montes de Toledo, an association described by Rivas Goday et al. (1960), in their contribution to the Hispanic *Quercetea ilicis*, later typified by Rivas-Martínez (1987), the *Junipero lagunae-Quercetum suberis* cork oak grove has recently been published as a new association by Rivas-Martínez et al. (2002), a syntaxon very close to the Marianico-Monchiquenses and Toledano-Taganos cork oak forests, constituting a northern vicariant of *Sanguisorbo hybridae-Quercetum suberis*, a forest of cork oaks and junipers located in the Lusitanian-Durian sector, an association described as climatophilic and edaphoxerophilic, according to its authors presenting as a first dynamic stage a *Cytiso multiflori-Retametum sphaerocarpae* broomwood. The taxon *Juniperus oxycedrus* L. subsp. *lagunae* Pau is an invalid name, as we have already demonstrated in previous works by Cano-Ortiz et al. (2021). Since the correct name is *Juniperus oxycedrus* L. subsp. *badia* (H.Gay) Debeaux it is necessary to change the name of the association to *Junipero badiae-Quercetum suberis* Rivas-Martínez, Aguiar, Cantó & Ladero 2002 nom corr. (CIPN, art. 44) (Theurillat et al. 2021). The cork oak forests of *Sanguisorbo hybridae-Quercetum suberis* develop in the foothills protected from the cold winds of the La Mancha plateau. Its first dynamic stage is a *Phillyreo angustifoliae-Arbutetum unedonis* arbutus grove described by Rivas Goday et al. (1960) for the shady areas of Sierra Morena, these tall thickets give way to thickets of *Cistus populifolius* L. and Erica australis heaths corresponding to the associations *Polygalo microphyllae-Cistetum populifolii* and *Erico australis-Cistetum populifolii*.

Pérez Latorre et al. (2008), describe the association *Cheirolopho sempervirentis-Quercetum suberis* for the sierra of Málaga (Axarquiense region), which develops on boulders, quartz and sandstones of the subhumid mesomediterranean in the Axarquía-Málaga region, the authors also include the slightly more thermophilic cork oak groves on quartzite flyschoid sandstones of the Colmenar corridor in this association, and recognize the presence of an *Arbutus unedo* fringe for these cork oaks, but do not establish any dynamics for them, although Pérez Latorre et al. (2008,2009) include these cork oaks in the association *Phillyreo angustifoliae-Arbutetum*

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unedonis Rivas Goday & Galiano in Rivas Goday et al. 1960, which is not correct due to the presence of differential species *Centaurea sempervirens*, *Bupleurum fruticosum*. According to Flora Iberica *Centarurea sempervirens* L. is a basionym of *Cheirolophus sempervires* (L.) Pomel, therefore the correct name is the latter. Therefore, in accordance with article 44 of the ICPN we correct

the name of the association *Cheirolopho sempervirentis-Quercetum suberis* Pérez Latorre, Cabezudo in Pérez Latorre, Caballero, Casimiro-Soriguer, Gavira & Cabezudo 2008 nom. corr. The lack of studies on the existing dynamic stages in the area has allowed us to propose the new association *Cheirolopho sempervirentis-Arbutetum uendonis*, which acts as the first dynamic stage of the cork oak grove, being the edge of the grove the community of *Adenocarpus telonensis* (Loisel) DC.and *Cytisus grandifloras* DC., and the serial stage a thicket of *Lavandula stoechas* L. and *Cistus populifolius* L. subsp. *major* (Dunal) Heywoid.

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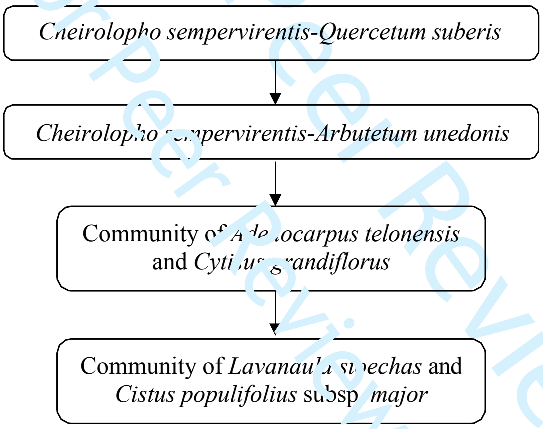
Dynamics of the Mesomediterranean Axarquian subhumid silicebasic series of the cork oak (*Quercus suber*) = *Cheirolopho sempervirentis-Querco suberis sigmetum*



Regarding the thermomediterranean cork oak forests, we observed clear floristic differences between SaQs, LvQs, AaQs described for Portuguese areas (Pinto Gomes et al. 2003; Quinto Canas et al. 2010, 2021; Costa et al. 1996, 2021); in Spanish territories TbQs, OsQs and AnQs have been described (Diez et al. 1988; Rivas-Martínez et al. 1980; Rivas Martínez et al. 2002), the latter two having strong edaphic, bioclimatic, biogeographic and floristic coincidences, so that according to the International Code of Phytosociological Nomenclature we propose their synonymization and maintain OsQs as a priority (Figure 3). In the rest of the subhumid, thermo-Mediterranean areas (Almogía, Álora, Pizarra) there is a cork oak grove developed on various siliceous substrates, slate, sandstone and quartzite; thermo-Mediterranean cork oak grove that we cannot include in *Myrto-Quercetum suberis* described by Barbero et al. (1981) for Morocco, although this association was tentatively proposed for Sardinia by Serra et al. (2002), cork oak groves that in our opinion must constitute a different climax than the cork oak groves of Morocco. Nor can the cork oak grove of the Montes de Málaga be referred to the *Teucrio baetici-Quercetum suberis* described by Diez Garretas et al. (1988) for the territories of the Aljibe de Cádiz, as well as to the *Asparago aphylli-Quercetum suberis* described in Portugal by Costa et al. (1996, 2001), which presents a totally different dynamic to the one we propose, existing in addition great floristic, ecological and dynamic differences with *Oleo-Quercetum suberis* described by Rivas-Martínez (1987). The cork oak forest that Pérez Latorre et al. (2008) include

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Myrto-Quercetum suberis does not correspond

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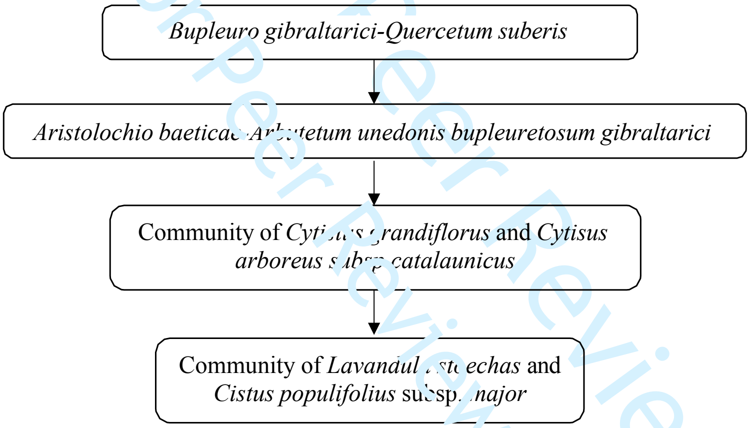
the *Myrto-Quercetum suberis* does not correspond because there are strong floristic, biogeographical and catenary contact differences. However, the subassociation *quercetosum suberis* described by Martínez Parras et al. (1987) for the thermo-Mediterranean holm oak forests of the Sierra de Cazula (Sierra Nevada, Granada) should be included in the association that we propose BgQs. This new association constitutes the head of the Axarquian thermo-Mediterranean subhumid subhumid silicic series of the cork oak (*Quercus suber*) = *Bupleuro gibraltarici-Querco suberis sigmetum*. This cork oak grove is very well differentiated from the rest of the Iberian thermo-Mediterranean cork oak groves, and as a climax forest it has its own dynamics.

Dynamics of the Axarquian thermo-Mediterranean subhumid silicibasic series of the cork oak (*Quercus suber*) = *Bupleuro gibraltarici-Querco suberis sigmetum*



CONCLUSIONS

The study of the Iberian cork oak forests reveals that they are ecosystems of high ecosystemic interest, so we consider it essential to describe the climax communities, and that these are known by future researchers and environmental managers. However, due to the high anthropization that exists in some territories, the dynamic stages should be studied, since in certain circumstances it is necessary to deduce the climax from its degradation stages. Therefore we highlight the value of plant dynamics for the knowledge of the climax. In this work we update the state of the syntaxis of the thermo-Mediterranean cork oak forest, and we propose the dynamics of those climaxes for which they were not yet, and a new cork oak forest for those of Axarquia (Málaga) *Bupleuro gibaltarici-Quercetum suberis*.

Syntaxonomic scheme

Quercetea ilics Br.-Bl. ex A. & O.Bolòs 1950

Queercetalia ilicis Br.-Bl. ex Molinier 1934 em. Rivas-Martínez 1975

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Quercion broterioi Br.-Bl., P. Silva & Rozeira 1956 em. Rivas-Martínez 1975
Adenocarpo decorticantis-Quercetum suberis Martínez Parras, Peinado & Alcaraz 1987
Junipero badiae-Quercetum suberis Rivas-Martínez, Aguiar, Cantó & Ladero 2002 nom corr.
Sanguisorbo hybridae-Quercetum suberis Rivas Goday in Rivas Goday, Borja, Esteve, Galiano, Rigual & Rivas-Martínez 1960
Cheirolopho sempervirentis-Quercetum suberis Pérez Latorre, Cabezudo in Pérez Latorre, Caballero, Casimiro-Soriguer, Gavira & Cabezudo 2008 nom. corr.

Querco rotundifoliae-Oleion sylvestris Barbero, Qézel & Rivas-Martínez em. Rivas-Martínez, Costa & Izco 1986
Aro neglecti-Oleetum sylvestris Rivas-Martínez & Cantó 2002 corr. Rivas-Martínez 2011
Asparago aphylli-Quercetun suberis J.C.Costa, Capelo, Lousa &Espirito-Santo 1996
Oleo sylvestris-Quercetum suberis Rivas Goday, Galiano & Rivas-Martínez ex Rivas-Martínez 1987
Teucrio baetici-Quercetum suberis Eicas-Martínez ex Diez Garretas, Cuenca & Asensi 1988
Myrto communis-Quercetum suberis Barbero, Benabid, Quézel & Rivas-Martínez 1981
Bupleuro gibraltarici-Quercetum suberis nova

Pistacio lentisci-Rhamnetalia alaterni Rivas-Martínez 1975
Ericion arboreae Rivas-Martínez 1987
Bupleurenion fruticosi Torres, Pinto Gomes & Cano 2002 in Rivas-Martínez 2011
Aristolochio baetici-Arbutetum unedonis bupleuretosum gibraltarici Torres, Pinto Gomes & Cano in Torres, F. Valle, Pinto Gomes, A. Garía, Salazar & Cano 2002
Cheirolopho sempervirentis-Arbutetum unedonis nova

Cytisetea scopario-striati Rivas-Martínez 1975
Cytisetalia scopario-striati Rivas-Martínez 1975
Retamion sphaerocarpae Rivas-Martínez 1981
Community of *Adenocarpus telonensis* and *Cytisus grandiflorus*

Cisto-Lavanduletea Br.-Bl. in Br.-Bl., Molinier & Wagner 1940
Lavanduletalia stoechadis Br.-Bl. in Br.-Bl., Molinier & Wagner 1940 em. Rivas-Martínez 1968
Cistion ladaniferi Br.-Bl. ex A. & O. Biòs 1950
Community of Lavadnula stoechas and *Cistus populifolius* subsp. *major*

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