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Geobotanical Study of the Microforests of *Juniperus oxycedrus* subsp. *badia* in the Central and Southern Iberian Peninsula

Eusebio Cano [1], Carmelo M. Musarella [1,2,*], Ana Cano-Ortiz [1], José C. Piñar Fuentes [1], Alfonso Rodríguez Torres [3], Sara Del Río González [4], Carlos J. Pinto Gomes [5], Ricardo Quinto-Canas [6,7] and Giovanni Spampinato [2]

1. Department. of Animal and Plant Biology and Ecology, Section of Botany, University of Jaén, Campus Universitario Las Lagunillas s/n, 23071 Jaén, Spain; ecano@ujaen.es (E.C.); anacanor@hotmail.com (A.C.-O.); jcpfuentes@gmail.com (J.C.P.F.)
2. Department of AGRARIA, "Mediterranea" University of Reggio Calabria, Località Feo di Vito, 89122 Reggio Calabria, Italy; gspampinato@unirc.it
3. Oficina del Cambio Climático, Consejería de Agricultura, Medio Ambiente y Desarrollo Rural, Junta de Castilla-La Mancha, C/Quintanar de la Orden, s/n. 45071 Toledo, Spain; alfonsor@jccm.es
4. Department of Biodiversity and Environmental Management (Botany), Mountain Livestock Institute (CSIC-ULE), Faculty of Biological and Environmental Sciences, University of León, Campus de Vegazana s/n, 24071 León, Spain; sriog@unileon.es
5. Department of Landscape, Environment and Planning, Institute for Mediterranean Agrarian and Environmental Sciences (ICAAM), School of Science and Technology, University of Évora (Portugal), Rua Romão Ramalho, nº 59, 7000-671 Évora, Portugal; cpgomes@uevora.pt
6. Faculty of Sciences and Technology, University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal; rjcanas@ualg.pt
7. Centre of Marine Sciences (CCMAR), University of Algarve, Campus de Gambelas, 8005-139 Faro, Portugal

* Correspondence: carmelo.musarella@unirc.it; Tel.: +39-0965-169-4374

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Abstract: We have studied *Juniperus oxycedrus* L. subsp. *badia* (H.Gay) Debeaux in the central and southern Iberian Peninsula, where the macrobioclimate ranges from Mediterranean-pluviseasonal-oceanic to Mediterranean-pluviseasonal-continental, and the thermotype from the thermo- to the supramediterranean. The relevés were taken following the Braun-Blanquet phytosociological methodology. A statistical treatment was applied to establish a separation among *Juniperus* communities. To understand the presence of *Juniperus* communities in territories dominated by species in the *Quercus* genus, we applied Thornthwaite's formula to calculate potential evapotranspiration. The general cluster analysis clearly distinguishes two groups of plant communities and separates the different associations in each group. All the plant communities growing on rocky crests and in extremely steep sloping areas are significantly influenced by the soil. The ombroclimatic index does not explain the presence of plant communities influenced by substrate, so we proposed a new ombroedaphoxeric index which explains the presence of *Juniperus* communities in territories with a thermotype between the thermo- and supramediterranean. The areas of distribution of *Juniperus* species are expanding due to the spread of rocky areas; this phenomenon causes an increase in edaphoxerophilous areas and a decrease in climatophilous ones. We propose four new plant associations, with updated structures and floristic compositions. Efficient conservation is possible in both the territories studied (Spain and Portugal) through the implementation of specific cross-border cooperation projects.

Keywords: *Juniperion lagunae*; cross-border cooperation; landscape evolution; cluster analysis; conservation; sustainable development; territorial cohesion; ombroedaphoxeric index; phytosociology; SCI areas

1. Introduction

There are around 60 woody species worldwide belonging to the genus *Juniperus* L. (Cupressaceae, gymnosperms), which is divided into three sections: *J.* sect. *Caryocedrus* Endl., *J.* sect. *Juniperus*, and *J.* sect. *Sabina* Spach [1]. The *J. oxycedrus* group is included within *J.* sect. *Juniperus* [2,3], and is distributed throughout the Mediterranean region, including eastern Portugal and Morocco, and extending as far as northern Iran [4]. According to Amaral Franco [4], the species *J. oxycedrus* L. has three clearly differentiated subspecies. *J. oxycedrus* L. subsp. *oxycedrus* occurs in the CS territories of the Iberian Peninsula, extending toward the Italian Peninsula, Sardinia, Corsica, Croatia and Slovenia [4–6]. *J. oxycedrus* L. subsp. *macrocarpa* (Sm.) Ball is widely distributed through the Mediterranean Region and W of Asia, until Syria [4,5]. *Juniperus oxycedrus* L. subsp. *badia* (H.Gay) Debeaux is restricted to Spain, Portugal and N Africa [4]. The *J. oxycedrus* group includes also *J. navicularis* Gand. (syn.: *J. oxycedrus* L. subsp. *transtagana* Franco) and *J. deltoides* R.P. Adams [syn.: *J. oxycedrus* L. subsp. *deltoides* (R.P. Adams) N. G. Passal], which was described and characterised as a new species by Adams and Tashev [7,8] for Greece, as distinct from *J. oxycedrus*. Adams and collaborators [3,9] recently reported the distribution of *J. deltoides* for Italy, Croatia, Greece, Turkey, Azerbaijan, Bulgaria, Cyprus, and Israel, and established phytochemical differences with *J. oxycedrus* due to its higher limonene and lower alpha-pinene contents. As specified previously by Adams et al. [10] and Salido et al. [11], there are clear phytochemical differences between the three subspecies of *J. oxycedrus*. Adams [12] also established major molecular differences between *J. oxycedrus* subsp. *oxycedrus*, *J. oxycedrus* subsp. *badia*, *J. oxycedrus* subsp. *macrocarpa*, and *J. navicularis*, and accordingly raises them to the rank of species. Adams et al. [13] subsequently showed that the differentiation of *J. deltoides* from *J. oxycedrus* at a level that is consistent with the divergence of *J. navicularis* and *J. macrocarpa* from *J. oxycedrus* is based on leaf essential oil composition, RAPD (Random Amplification of Polymorphic DNA) fingerprinting and ITS (Internal Transcribed Spacer) sequence data. Roma-Marzio et al. [14] recently proposed an identification key for the *Juniperus oxycedrus* group based on a combined phytochemical and morphometric approach.

Juniperus oxycedrus subsp. *macrocarpa* is typical of dunes and coastal sand flats and may occasionally occupy rocky areas. The communities of this taxon present on the Iberian Peninsula were described and included in the alliance *Juniperion turbinatae* by Rivas-Martínez [15], along with other communities dominated by *Juniperus navicularis* (*J. oxycedrus* L. subsp. *transtagana* Franco) and *Juniperus phoenicea* L. subsp. *turbinata* (Guss.) Nyman, also typical of psammophilous environments and dunes in coastal zones.

J. oxycedrus subsp. *oxycedrus* and *J. oxycedrus* subsp. *badia* are present on the Iberian Peninsula on both acid and basic hard substrates. The main differences between these two taxa according to Amaral Franco [4] mainly concern their physiognomy and the size of their mature fruits. Whereas the subspecies *oxycedrus* tends to take the form of a bush, the subspecies *badia* is a pyramid-shaped tree of considerable size. The mature galbuli in the first do not generally exceed 1 cm in size, while in the subspecies *badia*, they are over 1 cm. Coincidentally these subspecies are frequently found coexisting in similar biotopes, which has led to frequent confusion among some authors.

Bolòs & Vigo [16] included the var. *lagunae* Pau-which has the same characters as the subspecies *badia*- within the subspecies *oxycedrus*. Rivas-Martínez et al. [17], based on the work of Vicioso [18], formulated the new combination *Juniperus oxycedrus* L. subsp. *lagunae* (Pau ex C.Vicioso) Rivas Mart. [= *Juniperus oxycedrus* L. subsp. *badia* (H.Gay) Debeaux].

All this serves to highlight the complexity of this taxon, whose area of distribution is still insufficiently known. However, its presence in the central and southern Iberian Peninsula is very evident. In these territories it grows in formations with a broad extension, generally on rocky areas and in biotopes with shallow soils where *Quercus ilex* L. subsp. *ballota* (Desf.) Samp. (= *Quercus rotundifolia* Lam.) ceases to be dominant or simply cannot exist due to the lack of ecological and/or soil conditions necessary for these taxa to develop [19].

These are also phytocoenoses of considerable ecological interest owing to the presence of the companion endemics in these plant communities, which form small islands of vegetation; they act as species reservoirs as they are used for agriculture or livestock farming and have thus avoided destruction by human action. A similar condition may arise in forest fringe communities, as evidenced by Quinto-Canas et al. [20]. In these phytocoenoses it is frequent to find endemic species with varying degrees of distribution on the peninsula, such as *Echinospartum ibericum*, *Adenocarpus argyrophyllus*, *Digitalis purpurea* subsp. *mariana*, *Sideritis lacaitae*, *Coincya longirostra*, *Cytisus scoparius* subsp. *bourgaei*, *Cytisus striatus* subsp. *eriocarpus*, *Genista hirsuta*, *G. polyanthos*, *Dianthus crassipes*, *D. lusitanus*, *Digitalis thapsi*, *D. purpurea* subsp. *heywoodii*, *D. purpurea* subsp. *mariana*, *Securinega tinctoria*, *Lavandula stoechas* subsp. *luisieri*, *L. stoechas* subsp. *sampaiana*, *Thymus mastichina*, *T. granatensis* subsp. *micranthus*, *T. zygis* subsp. *gracilis*, and *Antirrhinum graniticum* subsp. *onubensis* [21]. These species live in sites of community interest (SCI) due to the presence of habitats such as Habitat 8220 "Siliceous rocky slopes with chasmophytic vegetation", and contain plant species including *Digitali thapsi-Dianthetum lusitani* Rivas-Martínez ex Fuente, *Jasiono marianae-Dianthetum lusitani* Rivas Goday, and *Coincyo longirostraae-Dianthetum lusitani* [22]. However, the dominant species in these environments is *J. oxycedrus* subsp. *badia*. These areas can therefore be classified as hotspots of interest for conservation. All these associations are included in the Habitats 2000 directive, which emphasises the ecological importance of these areas, and the need to study them for their subsequent conservation [23].

The areas dominated by *Juniperus* species are currently undergoing a process of expansion in response to the increase in rocky areas, which extend every year due to deforestation, forest fire, and, consequently, to soil erosion [23]. Fire is a widespread problem for the conservation of several plant communities in the Iberian Peninsula [24], leading to the spread of edaphoxerophilous zones and a decline in climatophilous ones. There are therefore more potential areas that could act as a refuge for endemic species [23].

The aim of this work was to study the communities of *J. oxycedrus* subsp. *badia* present in the central and southern Iberian Peninsula and included in Habitat 5210 "Arborescent matorral with *Juniperus ssp*.". This update on their structures and floristic compositions can be used to implement an efficient form of conservation for these communities.

2. Materials and Methods

2.1. Study Area

Location, Climate, Geomorphology and Soils

Juniper communities are well represented in several biogeographic units, and can be found in both the more continentalised central and eastern areas and in the more oceanic Portuguese territories, in siliceous and limestone areas. This research was therefore conducted in the central and southern Iberian Peninsula (Figure 1).

We studied 100 weather stations in the central-southern Iberian Peninsula, 29 of which have an Ombrothermic Index (IO) [25] between 3.6 and 6.3, implying that this territory has a subhumid-humid ombrotype [26]. The 71 remaining weather stations have an IO of between 2.02 and 3.6, with a predominance of a dry ombrotype throughout the whole territory. The continentality values range from 10.8 for Santiago Do Cacen (Portugal) to 21.7 in Vianos (Albacete, Spain). All this explains the presence of a Mediterranean-pluviseasonal-oceanic macrobioclimate in the westernmost areas of the territory in the study, and a Mediterranean-pluviseasonal-continental macrobioclimate in the easternmost territories. The thermotype ranges from thermomediterranean in the warmest territories near the Guadalquivir river valley, and supramediterranean on the crests of the Iberian plateau. However, the mean values for IO (3.89), IC (Continentality Index) [25] (18.54), and ITC (Compensated Thermicity Index) [25] (284) clearly express the territorial dominance of the dry-subhumid ombrotype, the mesomediterranean thermotype and the Mediterranean-pluviseasonal-oceanic macrobioclimate. The continental influence of the plateau is present in the easternmost areas (Jaén, Ciudad Real, and Toledo), where there is also evidence of the Mediterranean-pluviseasonal-continental macrobioclimate [23].

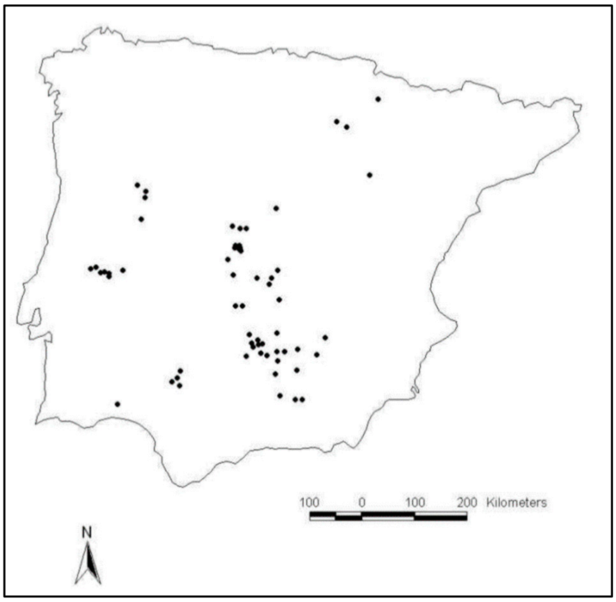


Figure 1. Study area and distribution of *Juniperus oxycedrus* subsp. *badia* on the Iberian Peninsula [19].

All these areas share the characteristic of being small mountain ranges formed by quartzite, granite, pre-Cambrian slate, limestone and dolomitic limestone, with altitudes ranging between 280-1500 m.

2.2. Methods

For the nomenclature we followed References [17,18,21,27–37] for vascular plants and References [19,38] for plant communities.

We used 134 samplings taken over a wide territory (Spain and Portugal). This was done by visiting the different territories and collecting relevés from all the communities dominated by the subspecies *J. oxycedrus* subsp. *oxycedrus* and *J. oxycedrus* subsp. *badia*. Specifically, nine plant communities were studied. Among these, five have been published previously [19,39] and four are new to science.

The relevés were taken following the Braun-Blanquet phytosociological methodology, as described in works such as Braun-Blanquet [40] and Géhu & Rivas-Martínez [41]. A relevé is a rigorous inventory of the taxa present in a study area and their degree. After compiled this inventory, the taxa coverage is evaluated by assigning a quantitative index according to the abundance-dominance and sociability scales proposed by Braun-Blanquet [40]. The abundance-dominance scale combines an estimate between the number of individuals of each existing species and the area occupied in the inventory area. The quantitative indexes (in bold) and their values are the following: **+**—Few individuals with very poor coverage (from 0.1% to 1%); **1**—Very abundant individuals with low coverage (from 1% to 10%); **2**—Individuals very abundant or covering at least 1/20 of the surface (from 10% to 25%); **3**—Any number of individuals covering $\frac{1}{4}$ to $\frac{1}{2}$ of the surface (from 25% to 50%); **4**—Any number of individuals covering $\frac{1}{2}$ to $\frac{3}{4}$ of the surface (from 50% to 75%); **5**—Any number of individuals covering more than $\frac{3}{4}$ of the surface (from 75% to 100%).

A statistical treatment with PAST (PAleontological STatistics) [42] and CAP© (Community Analysis Package) was applied to establish a separation between *Juniperus* communities. We compiled an Excel© table with 134 relevés x 294 species. A hierarchical clustering analysis has been applied, applying Ward's minimum variance method, using the Euclidean distance and a Detrended Correspondence Analysis (DCA). To understand the presence of *Juniperus* communities in territories dominated by species of the genus *Quercus*, we used Thornthwaite's formula, $ETP_{monthly} = 16(10.T/I)^a$, to calculate potential evapotranspiration, and Montero Burgos & González Rebollar's 0.2ETP (Potential Evapotranspiration) [43]. We prepared a new Ombroedaphoxeric Index (Ioex) with these data which justifies the presence of microforests of *Juniperus* species in a comparative analysis with the Ombrothermic Index (IO) proposed by Rivas-Martínez & Loidi [25].

3. Results

3.1. Phytosociological Classification Based on Numerical Analyses

All the communities of *J. oxycedrus* subsp. *badia* share the fact that they are permanent communities with an edaphoxerophilous character, which is imposed by the rocky substrate caused by soil loss. Although the territorial ombrotype could allow the survival of *Quercus* species, only *Q. coccifera* can do so in warmer territories.

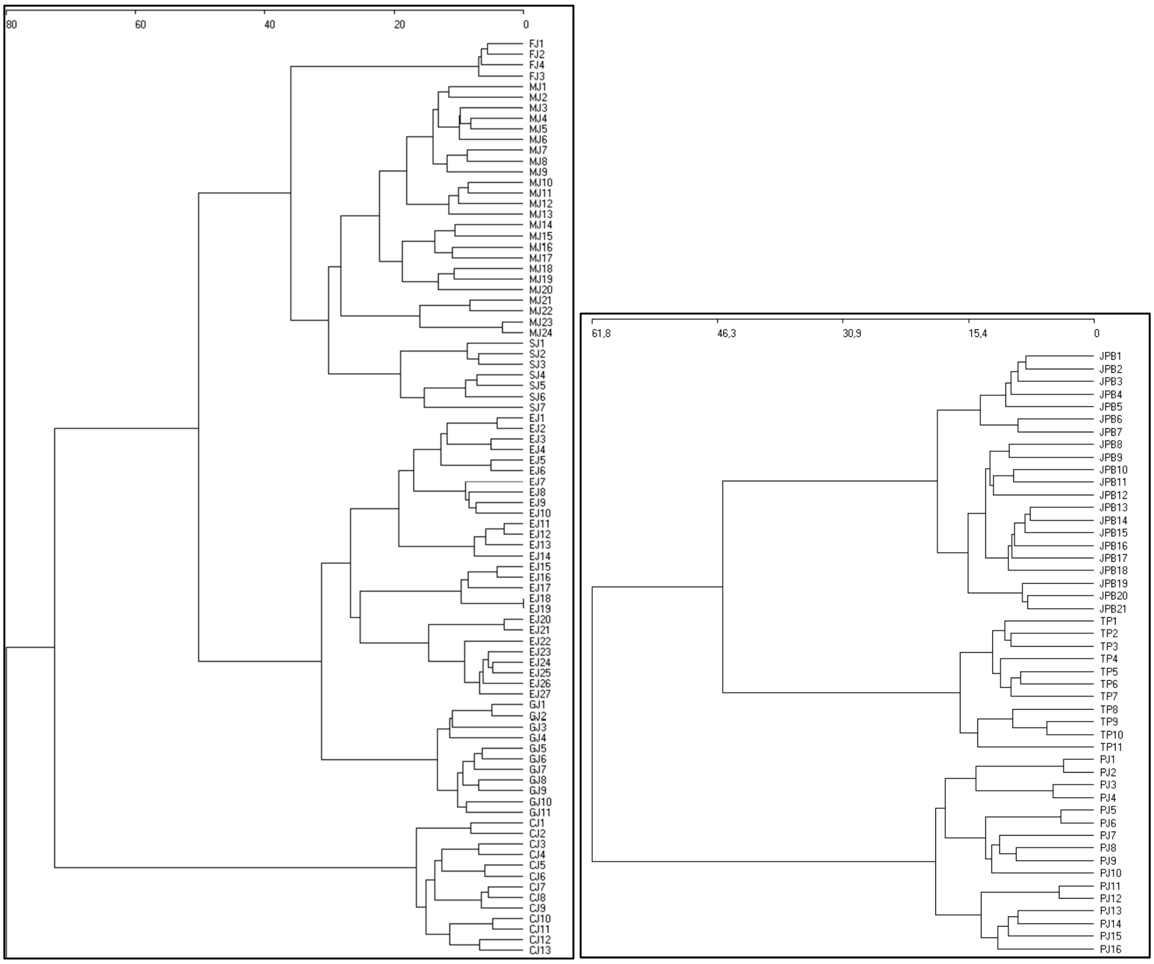
The nine communities analysed are: *Juniperetum phoeniceae-badiae* (JPB), *Teline patentis-Pistacietum terebinthi* (TP), *Myrto communis-Juniperetum badiae* (MJ), *Echinosparto iberici-Juniperetum badiae* (EJ), *Cytiso eriocarpi-Juniperetum badiae* (CJ), *Stipo tenacissimae-Juniperetum badiae* (SJ), *Pistacio terebinthi-Juniperetum badiae* (PJ), *Genisto polyanthi-Juniperetum badiae* (GJ) and *Festuco merinoi-Juniperetum badiae* (FJ).

The general cluster analysis clearly distinguishes two well-delimited groups: GI (FJ, MJ, SJ, EJ, GJ, CJ) (Figure 2a) and GII (JPB, TP, PJ) (Figure 2b), and separates the different associations in each group. The groups of relevés in the study belong to different plant communities, as these groups reveal clear floristic, bioclimatic, catenal and biogeographic differences, as described below.

The new DCA statistical treatments clearly separated the three associations in the subgroup: MJ, SJ and CJ. CJ was described by its authors as *Cytiso eriocarpi-Juniperetum lagunae* [19] for the southwest of the peninsula on siliceous substrates and in subhumid-humid environments, whereas SJ was described for the territories in the central peninsula as *Stipo tenacissimae-Juniperetum lagunae* [19], and shows significant floristic differences with CJ. The new association we propose in this work-MJ-is found in areas of the Sierra Morena on siliceous substrates and in dry-subhumid environments (Figure 3).

The subgroup of associations EJ and GJ grows in the Mariánico-Monchiquense sector on siliceous substrates (Paleozoic slate and quartzite), with an ombroclimate ranging from dry to humid; EJ was described by Cano et al. [19] for the supramediterranean belt as *Echinosparto iberici-Juniperetum lagunae*. The new association we propose is found in the mesomediterranean belt and is totally lacking in *Echinospartum ibericum*. The analysis of these two associations confirms their statistical separation. Both associations are in the Mariánica mountain range. The low frequency of *E. ibericum* explains the sole dominance of *J. oxycedrus* subsp. *badia*. The slight floristic differentiation between EJ and GJ is due to the fact that the main differentiating floristic elements, *E. ibericum* and *Genista polyanthos*, are infrequent in their respective plant communities; whereas *E. ibericum* is exclusive to the supramediterranean thermotype, *G. polyanthos* has its optimum in the thermo- and mesomediterranean, and may occasionally reach the supramediterranean, which explains the greater frequency of the microforests of *Juniperus*.

In contrast, the new association GJ contains species of interest such as *G. polianthos*, which acts as a differential species from the exclusively supramediterranean association of *Echinosparto iberici-Juniperetum badiae*. We therefore propose the new syntaxon *Genisto polyanthi-Juniperetum badiae* (Table 1 relevés from 1 to 11, *typus* relevé 1), located in the Marianico-Monchiquense sector. The juniper forest of *J. oxycedrus* subsp. *badia* in the eastern territories of the Iberian Peninsula (Portugal) is present in small mountain ranges with a quartzite character and frequent mesophytic flora, thanks to the continued prevalence of the mesomediterranean thermotype and subhumid-humid ombrotype. There is therefore a significant floristic component with an oceanic character, such as *Erica arborea*, *Viburnum tinus* and *Cytisus eriocarpus*, a community that has been described as *Cytiso eriocarpi-Juniperetum badiae*, very different from *Cytiso tribracteolati-Juniperetum oxycedri* which represents the edge of the cork-oak forest *Teucrio baetici-Quercetum suberis*, according to Pérez Latorre et al. [44].



(a) **(b)**

Figure 2. (**a**) General cluster of the six associations in group GI with Ward's method; (**b**) general cluster of the three associations in group GII with Ward's method.

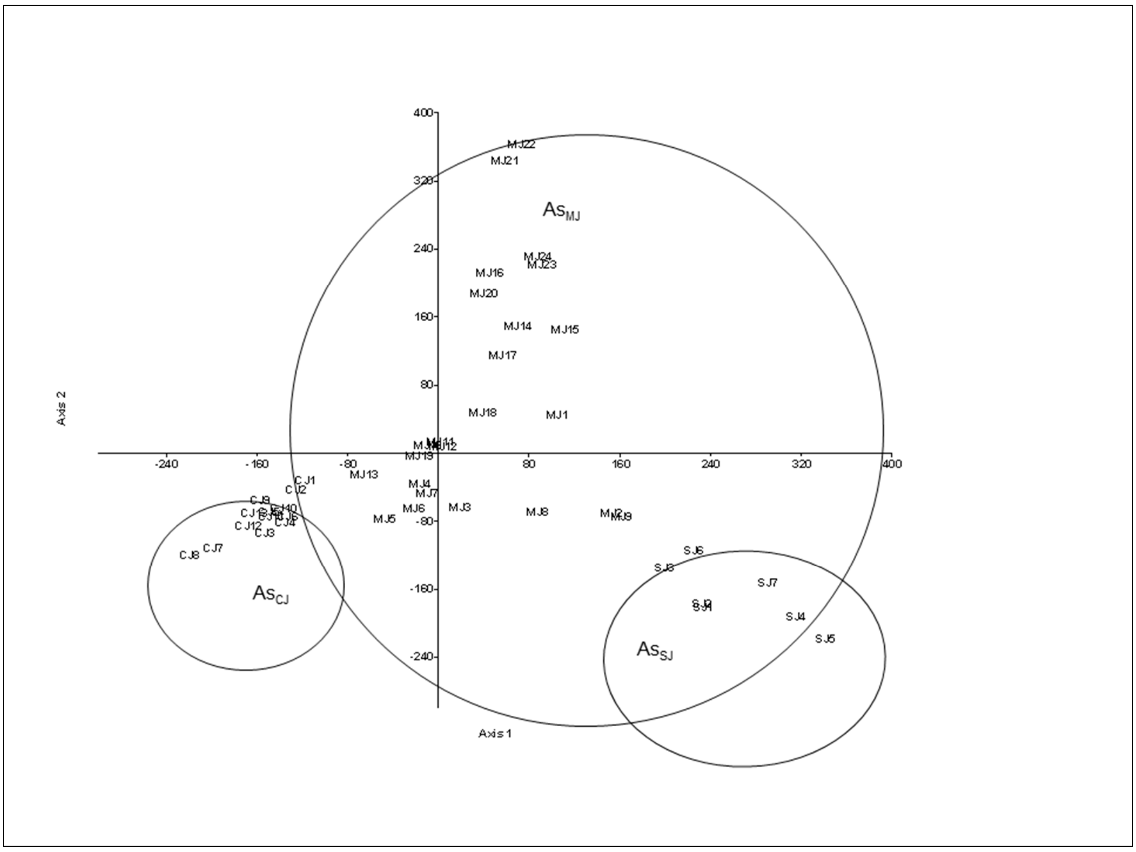


Figure 3. DCA (Detrended Correspondence Analysis) of the associations *Myrto communis-Juniperetum badiae* (MJ), *Stipo tenacissimae-Juniperetum badiae* (SJ), and *Cytiso eriocarpi-Juniperetum badiae* (CJ) in group GI.

Table 1. Association *Genisto polyanthi-Juniperetum badiae* (GJ) *nova*.

Order no.	1	2	3	4	5	6	7	8	9	10	11	
Area in m^2	200	200	400	200	100	400	300	300	500	200	200	
Altitude in m 1 = 10	989	1243	423	1228	1004	1233	981	995	900	1021	1229	
Cover rate %	15	55	75	60	30	60	25	20	60	25	25	
Orientation	-	-	E	-	-	N	NE	W	W	E	N	
Slope %	-	-	3	-	-	20	4	3	20	50	5	
Average veg. height (m.)	1.2	0.5	0.9	1.5	1.3	1.8	1.4	1.5	1.5	1.3	1.5	
Cluster no.	GJ1	GJ2	GJ3	GJ4	GJ5	GJ6	GJ7	GJ8	GJ9	GJ10	GJ11	
Characteristics of Association and Higher Units												**P**
Juniperus oxycedrus subsp. *badia*	2	3	3	2	2	2	2	2	3	2	2	11
Genista polyanthos	2	3	3	3	2	2	2	2	1	2	2	11
Quercus rotundifolia	+	1	-	1	+	+	+	+	1	+	1	10
Phillyrea angustifolia	-	-	+	-	-	-	-	+	+	-	-	3
Erica arborea	-	-	-	-	-	+	-	-	-	-	+	2
Juniperus oxycedrus subsp. *oxycedrus*	+	-	-	-	-	-	-	-	-	-	-	1
Pistacia lentiscus	-	-	1	-	-	-	-	-	-	-	-	1
Asparagus acutifolius	-	-	+	-	-	-	-	-	-	-	-	1
Companions												
Dianthus lusitanus	-	+	-	-	1	1	+	1	1	1	1	8
Cistus ladanifer	+	1	+	-	-	-	+	+	+	+	1	8
Jasione mariana	-	-	-	-	1	1	2	1	-	+	+	6

Table 1. *Cont.*

Order no.	1	2	3	4	5	6	7	8	9	10	11	
Arrhenatherum bulbosum	-	-	-	1	+	-	+	+	-	1	+	6
Linaria saxatilis	-	-	-	+	1	1	-	+	-	1	-	5
Sedum brevifolium	-	-	-	-	+	-	1	1	+	+	-	5
Halimium ocymoides	+	+	-	-	-	+	1	-	-	-	-	4
Rosmarinus officinalis	+	-	+	-	-	-	-	+	+	-	-	4
Asphodelus albus	-	-	-	1	-	+	+	+	-	-	-	4
Rumex angiocarpus	-	-	-	+	+	-	+	-	-	-	-	3
Thymus mastichina	-	-	+	+	-	-	-	-	-	-	-	2
Urginea maritima	-	-	-	-	-	-	-	+	+	-	-	2
Umbilicus rupestris	-	-	-	-	+	-	-	-	-	+	-	2
Dactylis lusitanica	-	-	+	+	-	-	-	-	-	-	-	2
Elymus caninus	-	-	-	-	-	-	+	-	-	+	-	2
Digitalis mariana	-	-	-	-	-	-	-	-	-	+	2	2

Other species: *Cistus populifolius x C. salvifolius* GJ1(1), *Cistus albidus* GJ3(+), *Retama sphaerocarpa* GJ3(+), *Nerium oleander* GJ3(1), *Flueggea tinctoria* GJ3(+), *Corrigiola telephiifolia* GJ3(+), *Scirpus holoschoenus* GJ3(+), *Scrophularia canina* GJ3(+), *Fraxinus angustifolia* GJ3(+), *Festuca elegans* GJ4(1), *Elymus hispanicus* GJ4(+), *Armeria capitella* GJ4(1), *Sedum forsteranum* GJ4(+), *Petrorhagia nanteuillii* GJ4(+), *Halimium umbellatum* subsp. *viscosum* GJ5(+), *Poa bulbosa* GJ6(+), *Vulpia myuros* GJ7(+), *Lamarckia aurea* GJ7(+), *Mucizonia hispida* GJ8(+), *Dipcadi serotinum* GJ8(+), *Lavandula luisieri* GJ8(+), *Conopodium bourgaei* GJ9(+), *Asplenium billotii* GJ9(+), *Sedum dasyphyllum* GJ10(+), *Geranium purpureum* GJ10(+), *Anogramma leptophylla* GJ10(+), *Stipa gigantea* GJ10(+), *Conopodium capillifolium* GJ10(+), *Narcissus rupicola* GJ10(+), *Festuca rothmaleri* GJ10(+), *Coincya longirrostra* GJ11(+), *Genista florida* GJ11(1).

P = number of Presences; **-** = absent. **Localities:** GJ1. Mount Manzano. Near Torre Castañarejo (30S0449835/4256709); GJ2. Collado Grande. Torre Vigilancia (30S0443300/4257119); GJ3. Mouth of the Montoro River (30S0417604/4253109); GJ4. Pico Estrella. Finca Ruichoto (30S0448476/4250771); GJ5. Mount Manzano. Peñón de Atilano (30S0447322/4255301); GJ6. Abulagoso (30S0385725/4258301); GJ7. Cañada Real (30S0450280/4256964); GJ8. Piedrallana (30S0450483/4256122); GJ9. Mount Manzano (30S0450025/4257173); GJ10. Umbría Monroi. (30S0447629/4254779); GJ11. Collado Grande. Torre Vigilancia (30S0443228/4257178).

The community described by us as *Stipo tenacissimae-Juniperetum badiae* grows on carbonated and neutrobasophilous soils. Its floristic composition includes a dominance of *J. oxycedrus* subsp. *badia* and *Stipa tenacissima*, with other basophilous elements such as *Staehelina dubia* and *Ruta chalepensis*, together with the thermophilous elements *Olea europea* var. *sylvestris* and *Osyris alba*. These last are common to the new association we propose-*Myrto communis-Juniperetum badiae nova*-whose floristic composition comprises *J. oxycedrus* subsp. *badia*, *Pistacia terebinthus*, *P. lentiscus*, *Phlomis purpurea*, *Myrtus communis*, *Aristolochia baetica*, *Asparagus aphyllus*, and *Olea europea* var. *sylvestris*. This association is found on rocky crests on slate, quartzite and granite in thermal gorges in the Sierra Morena, and in the lower dry mesomediterranean thermotype (Table 2 rel. 1 to 24, typus rel. 18). It is close to *Stipo tenacissimae-Juniperetum badiae*, but is differentiated from it by the type of substrate, thermocline, floristic composition and biogeography, as this latter association was described for eastern territories in the Toledano-Tagano sector in contact with the Manchego sector, while the association we propose here is in the Mariánico-Monchiquense sector. Group GII is formed by JPB, TP and PJ. In this case, a DCA analysis highlights the separation between the three plant communities. PJ was described for the central peninsula (Toledano-Tagano sector) on siliceous substrates, and in the dry-subhumid mesomediterranean, whereas the two new associations proposed-JPB and TP-grow on basic substrates in the Subbetic biogeographic sector, with sufficient floristic differences for the three associations to be clearly defined in the ordination analysis (Figure 4).

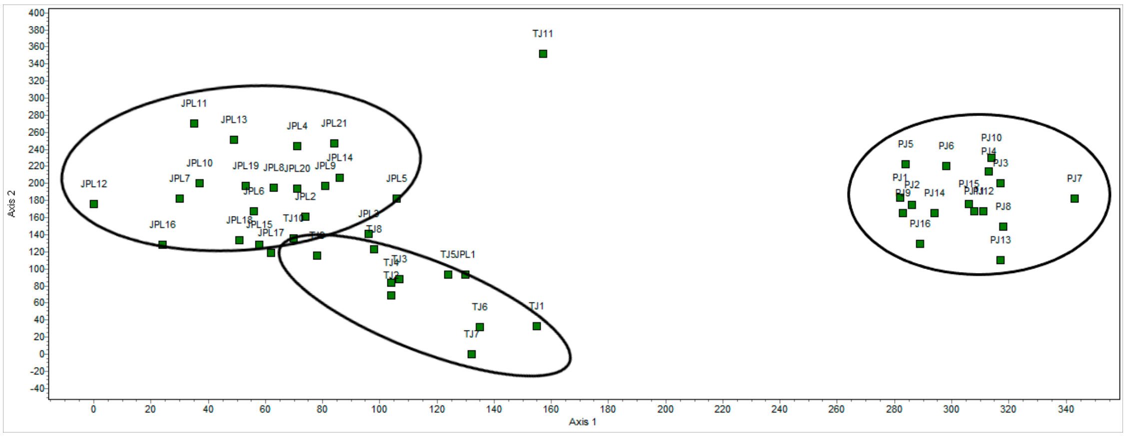


Figure 4. DCA ordination analysis of the associations *Juniperetum phoeniceae-badiae* (JPB), *Teline patentis-Pistacietum terebinthi* (TP) and *Pistacio terebinthi-Juniperetum badiae* (PJ) in group GII.

The subgroup GII_{JPB}, *Juniperetum phoeniceae-badiae nova*, represents the juniper forest with Phoenicean juniper (*Juniperus phoenicea*), a highly abundant plant formation in the Subbético sector, growing in subhumid mesomediterranean environments on calcareous and dolomitic limestone substrates. This is an edaphoxerophilous community with a predominance of *J. oxycedrus* subsp. *badia*, *J. oxycedrus* subsp. *oxycedrus* and *J. phoenicea* (Table 3 rel. 1 to 21 *typus* rel. 17).

Group GII includes GII_{PJ} *Pistacio terebinthi-Juniperetum badiae* for Toledan territories and in the north of the province of Ciudad Real. Particularly significant are the communities of *Pistacia terebinthus* in the Subbético mountain ranges that grow in the subhumid-humid meso- and supramediterranean belt in rocky areas or debris fields on mountainsides. This community is physiognomically dominated by *Pistacia terebintus*, with other floristic elements such as *J. oxycedrus* subsp. *badia*, *J. phoenicea* and *Teline patens*. We propose the association *Teline patentis-Pistacietum terebinthi nova* (Table 4 relevés From 1 to 11 *typus* relevé 2). This association is differentiated from *Phillyreo latifoliae-Pistacietum terebinthi*, by Pavón Núñez et al. [45], for the absence of the thermophilous elements *Clematis cirrhosa*, *Aristolochia baetica*, *Rhamnus oleoides*, and *R. velutinus*, which are present in the typus of the association. The authors of *Phillyreo latifoliae-Pistacietum terebinthi* used relevés from the thermo- and mesomediterranean for their description. For this reason, relevés 3, 4 and 5 in Table 1 from the Subbético territories do not correspond to the association described. We must differentiate the thermomediterranean forest of *Pistacia terebinthus* from the meso- and supramediterranean forests in the Bétic biogeographic province.

Table 2. Association *Myrto communis-Juniperetum badiae* (MJ) *nova*.

Order no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Area in m^2	500	500	400	300	400	400	150	500	500	400	400	300	400	200	500	500	500	400	400	600	500	500	500	600	
Altitude in m 1 = 10	600	820	1019	1006	568	988	240	820	780	912	832	766	842	1141	300	451	480	650	503	391	280	300	420	600	
Cover rate %	70	100	40	30	60	55	80	95	95	60	100	60	60	30	60	75	65	80	75	60	60	60	75	65	
Orientation	W	NE	S	SW	S	SW	NE	SW	SW	W	NW	S	S	S	SW	E	E	SW	E	E	NW	SW	NE	NE	
Slope %	40	20	25	75	60	60	10	25	30	15	10	12	20	90	25	30	35	20	95	40	40	25	25	15	
Average veg. height (m.)	3.5	5	4	2.5	2.5	2.5	3	5	5	4	2.5	4	3	1.5	3.5	7.0	7.0	5	4.5	3:5	3	3	7.5	8.0	
Cluster no.	MJ1	MJ2	MJ3	MJ4	MJ5	MJ6	MJ7	MJ8	MJ9	MJ10	MJ11	MJ12	MJ13	MJ14	MJ15	MJ16	MJ17	MJ18	MJ19	MJ20	MJ21	MJ22	MJ23	MJ24	
Characteristics of Association and Higher Units																									**P**
Juniperus oxycedrus subsp. *badia*	3	4	2	2	3	3	3	5	4	3	5	3	3	4	3	4	3	3	2	1	4	4	3	4	24
Quercus rotundifolia	1	2	+	1	+	+	-	-	1	-	+	1	1	+	+	+	+	1	1	1	-	-	-	-	17
Phillyrea angustifolia	1	1	-	+	1	1	1	1	-	-	+	1	1	-	-	1	1	1	+	+	-	-	-	-	15
Pistacia terebinthus	+	+	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1	-	-	+	1	2	+	+	11
Myrtus communis	-	-	-	-	-	-	-	-	-	+	1	3	2	1	-	1	-	2	-	-	1	1	1	1	11
Pistacia lentiscus	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	1	1	1	2	2	9
Arbutus unedo	-	-	-	-	-	1	+	-	-	+	1	-	+	1	-	1	+	-	-	-	-	-	-	-	8
Quercus coccifera	1	+	-	-	-	-	-	+	+	-	-	-	-	1	1	+	-	-	-	-	-	-	-	-	7
Olea europea var. *sylvestris*	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	2	2	3	4	3	-	-	-	-	7
Rhamnus oleoides	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	2	2	2	2	7
Jasminum fruticans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	1	1	1	1	6
Erica arborea	-	-	-	-	-	-	-	-	-	+	+	+	1	-	-	+	-	-	-	-	-	-	-	-	5
Asparagus albus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	2	1	1	-	-	5
Daphne gnidium	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	1	-	-	-	+	-	-	-	4
Smilax aspera	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-	-	+	-	4
Phlomis purpurea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	1	2	-	-	4
Osyris alba	-	+	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Juniperus oxycedrus subsp. *oxycedrus*	+	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Rhamnus alaternus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	3
Quercus broteroi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	3
Asparagus acutifolius	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	2
Thapsia villosa	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	2
Phillyrea latifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	1	-	-	-	2

Table 2. *Cont.*

Order no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Asparagus aphyllus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2
Rubia peregrina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Viburnum tinus	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Crataegus monogyna	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Pyrus bourgaeana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	1
Teucrium fruticans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	1
Pistacia x saportae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	1
Quercus suber	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Quercus marianica	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Quercus canariensis	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	1
Companions																									
Cistus ladanifer	-	-	-	+	+	+	2	-	2	1	+	1	1	1	1	-	1	+	+	+	1	-	-	-	16
Rosmarinus officinalis	-	-	-	-	-	-	-	+	2	1	+	2	+	-	1	-	+	+	+	+	+	+	-	-	13
Cistus albidus	+	-	-	-	-	+	-	-	-	-	-	-	-	1	1	+	1	-	-	+	+	+	+	+	11
Cheilanthes maderensis	-	+	1	+	1	-	-	-	-	+	-	-	1	-	-	-	-	+	1	-	-	-	+	+	10
Urginea maritima	-	+	-	-	-	-	-	-	1	+	+	+	+	+	-	-	-	+	-	+	-	-	-	-	9
Dianthus lusitanus	-	-	1	+	-	+	-	-	+	-	-	-	-	1	1	-	-	-	2	+	-	-	-	-	8
Lavandula sampaiana	-	-	-	-	+	+	+	+	+	-	-	-	-	-	-	1	-	-	1	-	-	+	-	-	8
Umbilicus rupestris	-	+	1	-	+	+	-	-	-	+	-	-	+	-	-	-	-	+	+	-	-	-	-	-	8
Sedum brevifolium	-	-	1	-	-	+	-	-	-	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	5
Mucizonia hispida	-	-	-	-	-	-	-	-	-	+	-	-	+	-	+	-	-	+	+	-	-	-	-	-	5
Asphodelus albus	-	-	-	-	-	+	1	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Bryonia cretica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	+	+	5
Astragalus lusitanicus	-	-	-	-	-	-	+	-	-	+	+	1	+	-	-	-	-	-	-	-	-	-	-	-	5
Dactylis hispanica	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	4
Jasione mariana	-	-	-	+	-	+	-	-	-	-	-	-	1	-	-	-	-	-	-	+	-	-	-	-	4
Asplenium ceterach	-	+	1	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	4
Arrhenatherum bulbosum	-	-	-	-	-	+	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	4
Halimium atriplicifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	1	+	+	+	-	-	-	-	-	-	-	4
Digitalis heywoodii var. *albicans*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	+	+	-	-	-	-	-	-	-	4
Sedum dasyphyllum	+	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3

Table 2. *Cont.*

Order no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Thymus mastichina	-	-	-	-	-	-	-	-	+	-	-	-	-	-	1	-	-	-	-	-	+	-	-	-	3
Sanguisorba minor	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+	3
Tamus communis	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	1	-	-	-	-	-	-	-	3
Nerium oleander	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	1	-	-	-	-	3
Anogramma leptophylla	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	3
Selaginella denticulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	+	3
Cytisus scoparius subsp. *bourgaei*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	-	-	3
Micromeria graeca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	+	-	+	3
Halimium umbellatum subsp. *viscosum*	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3
Genista hirsuta	-	1	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	3
Lavandula luisieri	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	3
Cistus salvifolius	-	1	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	3

Other species: *Coincya longirrostra* MJ7, MJ15(+), *Sedum sediforme* MJ1, MJ9(+), *Retama sphaerocarpa* MJ9, MJ20(+), *Vitis vinifera* subsp. *sylvestris* MJ14, MJ16(+), *Adenocarpus argyrophyllus* MJ4, MJ5(+), *Erica scoparia* MJ7(2), MJ8(+), *Halimium ocymoides* MJ7(1), MJ13(+), *Cytisus striatus* subsp. *eriocarpus* MJ2(1), MJ19(2), *Adenocarpus telonensis* MJ2(1), MJ8(+), *Rubus ulmifolius* MJ1(+), MJ20(+), *Digitalis mariana* MJ20, MJ21(+), *Aristolochia baetica* MJ21, MJ22(1), *Jasonia glutinosa* MJ1(+), *Polygala rupestris* MJ1(+), *Helianthemum croceum* MJ1(+), *Fraxinus angustifolia* MJ15(+), *Antirrhinum graniticum* subsp. *onubensis* MJ16(+), *Flueggea tinctoria* MJ21(+), *Dianthus crassipes* MJ21(1), *Linaria saxatilis* MJ6(+), *Calluna vulgaris* MJ13(1), *Cheilanthes hispanica* MJ4(+), *Helichrysum serotinum* MJ9(+), *Teucrium gnaphalodes* MJ2(+), *Teucrium pseudochamaepitys* MJ9(+), *Cheilanthes tinaei* MJ2(+), *Stipa capensis* MJ10(+), *Hyacinthoides hispanica* MJ3(+), *Pterocepalus diandrus* MJ13(+).

P = number of Presences; **-** = absent. **Localities:** MJ1. Mora de Toledo (Toledo) [19], (*Stipo tenacissimae-Juniperetum lagunae*); MJ2. Mora de Toledo (Toledo) [19], (*Stipo tenacissimae-Juniperetum lagunae*); MJ3. Collado Sierra de la Solana (30S0404372/4259526); MJ4. Puerto Viejo (30S0382806/4254598); MJ5. Crestones cuerda sierra Chillón (30S0334946/4289958); MJ6. Sierra de Solana (30S0404372/4259526); MJ7. Aldea Cerezo al Yeguas (Cardeña); MJ8. Puerto Lapice (C.Real) [19], (*Stipo tenacissimae-Juniperetum lagunae*); MJ9. Marjaliza (Toledo) [19], (*Stipo tenacissimae-Juniperetum lagunae*); MJ10. Sierrra Madrona (30S04067709/4250513); MJ11. Sierra Quintana (oeste) (30S0391176/4250840); MJ12. Swamp of the Garganta (30S0374625/4260280); MJ13. Camino Peña Escrita-Finca Valmayor (30S0387688/4255453); MJ14. Puerto Viejo (30S0382806/4254598); MJ15. Aldea Cerezo al Yeguas (Cardeña); MJ16. Aldea Cerezo al Yeguas (Cardeña); MJ17. Aldea Cerezo al Yeguas (Cardeña); MJ18. Near San Benito (30S0352613/4271155); MJ19. Easternmost Sierra Almadén (30S0346378/4291566); MJ20. Mouth of the Montoro River (30S0417854/4253846); MJ21. Garganta del Río Viar (Sevilla) [19], (Community of *Phlomis purpurea*); MJ22. Garganta del Río Viar (Sevilla) [19], (Community of *Phlomis purpurea*); MJ23. Garganta del Río Viar (Sevilla) [19], (Community of *Phlomis purpurea*); MJ24. Garganta del Río Viar (Sevilla) [19], (Community of *Phlomis purpurea*).

Table 3. Association *Juniperetum phoeniceo-badiae* (JPB) *nova*.

Order no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Area in m^2	150	250	150	250	250	250	200	400	150	200	400	400	500	150	500	250	250	200	600	500	600	
Altitude in m 1=10	50	105	95	69	105	95	115	135	140	115	115	120	105	110	105	113	120	157	130	100	95	
Cover rate %	40	70	80	65	60	60	40	65	50	75	65	65	70	45	65	70	75	60	60	60	60	
Orientation	N	W	SW	S	N	S	N	E	NW	E	SE	SE	S	SW	S	SW	SW	S	S	SW	SW	
Slope %	40	15	25	15	15	25	25	20	15	15	14	10	20	25	20	15	15	20	45	20	15	
Average veg. height (m.)	2.0	2.5	2.5	2.0	2.0	2.5	3.0	2.5	1.8	4.0	2.5	4.0	2.5	2.0	2.5	2.5	2.0	2.0	4.0	2.0	1.8	
Cluster no.	JPB1	JPB2	JPB3	JPB4	JPB5	JPB6	JPB7	JPB8	JPB9	JPB10	JPB11	JPB12	JPB13	JPB14	JPB15	JPB16	JPB17	JPB18	JPB19	JPB20	JPB21	
Characteristics of Association and Higher Units																						**P**
Juniperus phoenicea	1	-	-	1	1	2	2	+	3	4	3	3	3	1	2	3	3	3	2	3	1	19
Juniperus oxycedrus subsp. *badia*	+	3	4	3	3	3	3	3	1	1	+	2	3	2	3	3	3	2	3	3	3	21
Juniperus oxycedrus subsp. *oxycedrus*	-	1	1	-	-	-	-	2	2	1	1	1	2	2	3	2	2	+	-	1	3	15
Quercus rotundifolia	-	+	-	-	+	1	+	+	+	+	1	+	-	-	-	1	+	+	+	+	+	15
Pistacia terebinthus	-	-	+	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	+	-	-	5
Pistacia lentiscus	1	-	-	1	-	-	-	-	-	-	-	-	1	+	-	-	-	-	-	-	-	4
Quercus coccifera	1	-	-	+	1	1	-	-	-	-	+	-	1	+	-	-	-	-	-	-	-	7
Asparagus acutifolius	+	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	3
Jasminum fruticans	+	-	-	-	-	+	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	4
Daphne gnidium	-	+	-	1	+	-	1	-	-	-	1	-	+	-	+	+	-	-	1	+	+	11
Quercus faginea	-	+	-	1	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	5
Thapsia villosa	-	+	-	-	+	-	+	+	+	-	+	+	-	-	-	+	-	+	-	-	-	9
Carex hallerana	-	-	1	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	1	-	4
Rhamnus myrtifolius	-	-	1	-	-	-	-	1	-	-	-	+	-	-	-	-	-	2	-	-	-	4
Pinus halepensis	-	-	-	+	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	3
Phillyrea latifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	1
Pinus salzmannii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	2
Lonicera periclymenum subsp. *hispanica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	1
Ptilostemon hispanicus	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	2
Hedera ibernica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	2

Table 3. *Cont.*

Order no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Rubia peregrina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	2
Bupleurum rigidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	1
Ilex aquifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	1
Clematis flammula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	1
Rhamnus alaternus	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Smilax aspera	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Teline patens	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Melica minuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	1
Paeonia broteroi	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Companions																						
Rosmarinus officinalis	+	2	2	-	1	1	-	-	-	-	-	-	+	+	-	1	1	-	1	+	-	11
Thymus orospedanus	-	1	1	-	-	+	2	2	-	-	-	+	-	-	-	+	+	-	+	-	+	10
Asphodelus albus	-	+	+	-	-	-	1	+	+	+	1	+	-	-	-	+	-	-	-	-	-	9
Phlomis lychnitis	-	-	-	-	-	-	+	1	+	+	+	1	-	+	+	-	-	-	-	-	+	9
Brachypodium retusum	-	-	-	-	+	+	-	+	-	+	-	1	1	-	+	-	-	-	-	+	+	9
Thymus mastichina	-	-	-	+	-	-	1	-	+	+	2	1	+	-	-	-	1	-	-	-	+	9
Cistus albidus	-	-	-	-	-	1	-	2	+	-	-	+	+	+	-	1	-	-	-	-	-	7
Dactylis hispanica	-	-	-	-	+	+	-	+	+	-	-	-	+	+	-	-	-	-	-	-	-	6
Lavandula latifolia	-	1	+	-	1	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	5
Thymus zygis subsp. *gracilis*	-	1	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	+	-	5
Cistus monspeliensis	-	+	-	2	-	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	5
Teucrium capitatum	-	+	-	-	-	-	-	+	1	-	-	-	-	-	-	-	+	-	-	-	-	4
Crataegus laciniata	+	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	4
Aphyllantes monspeliensis	-	-	-	+	-	-	-	-	+	-	1	-	-	-	-	-	-	-	+	-	-	4
Urginea maritima	-	-	-	-	-	-	-	+	-	-	-	+	-	+	+	-	-	-	-	-	-	4
Halimium atriplicifolium	-	1	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Eryngium campestre	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	3
Teucrium rotundifolium	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	2

Table 3. *Cont.*

Order no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Rosa canina	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	2
Berberis hispanica	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	1	-	-	-	2
Retama sphaerocarpa	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Helianthemum syriacum	-	-	-	-	-	-	2	+	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Helianthemum cinereum subsp. *rotundifolium*	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	2
Erinacea anthyllis	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	+	-	2
Helictotrichon filifolium	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	2
Genista scorpius	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	2
Crocus serotinus subsp. *salzmannii*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	2
Genista boissieri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	2
Santolina canescens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	+	2

Other species: *Rubus ulmifolius* JPB1(+), *Phagnalon saxatile* JPB1(+), *Linum tenue* JPB3(1), *Helianthemum ledifolium* JPB3(+), *Buxus sempervirens* JPB9(2), *Filipendula vulgaris* JPB7(+), *Plantago lanceolata* JPB7(+), *Ornithogalum narbonense* JPB7(+), *Polygala monspeliaca* JPB7(+), *Ophrys tenthrediniferfa* JPB7(+), *Anthyllis vulneraria* subsp. maura JPB2(+), *Arrhenatherum album* JPB8(+), *Fumana paradoxa* JPB9(1), *Lotus corniculatus* JPB9(1), *Sanguisorba minor* JPB9(+), *Crupina crupinastrum* JPB10(+), *Helleborus foetidus* JPB10(+), *Geranium purpureum* JPB11(+), *Narcissus assoanus* JPB11(+), *Scorpiurus muricatus* JPB12(+), *Sherardia arvensis* JPB12(+), *Medicago rigidula* JPB12(+), *Crepis vesicaria* subsp. *haenseleri* JPB12(+), *Bellis perennis* JPB12(+), *Echinaria capitata* JPB12(+), *Poa annua* JPB12(+), *Rumex bucephalophorus* JPB12(+), *Verbuscum giganteum* JPB14(+), *Prunus spinosa* JPB14(+), *Asplenium ceterach* JPB15(+), *Cytisus scoparius* subsp. *reverchonii* JPB16(+), *Fumana laevipes* JPB16(+), *Paronychia argentea* JPB16(+), *Amelanchier ovalis* JPB16(1), *Muscari giennense* JPB17(+), *Rhagadiolus stellatus* JPB17(+), *Thymus granatensis* JPB18(+), *Biscutella sempervirens* JPB18(+), *Staehelina dubia* JPB20(+), *Linum suffruticosum* JPB19(+), *Fumana thymifolia* JPB20(+), *Lonicera splendida* JPB20(+), *Leuzea conifera* JPB20(+).

P = number of Presences; **-** = absent. **Localities:** JPB1.—Casilla de los Rajones. JPB2 and JPB5.—Alto de las Muelas. JPB3.—Los Yegüerizos. JPB4.—Bujaraiza. JPB6.—Los Palancares. JPB7.—La Fresnedilla. JPB8.—Collado de la Traviesa. JPB9 and JPB18.—Lancha de la Escalera. JPB10.—La Morra. JPB11.—Fuente del Milano. JPB12.—Hoya de Miguel Barba. JPB13 and JPB17.—Vilches. JPB14.—La Canaleja. JPB15.—Aguascebas Reservoir. JPB16.—San Antón. JPB19.—Rise to the birth of the Guadalquivir. JPB20 and JPB21.—Highway Quesada-Pozo Alcón.

Table 4. Association *Teline patentis-Pistacietum terebinthi* (TP) *nova*.

Order no.	1	2	3	4	5	6	7	8	9	10	11	
Area in m^2	300	250	200	300	200	250	250	300	200	250	300	
Altitude in m 1 = 10	60	57	65	95	74	85	95	103	105	105	130	
Cover rate %	60	60	70	100	80	100	100	70	70	60	70	
Orientation	N	NE	N	SE	N	N	NW	N	S	S	S	
Slope %	5	15	5	5	30	10	20	5	2	25	40	
Average veg. height (m.)	3.0	2.0	2.0	8.0	2.5	4.0	4.5	3.5	2.0	3.0	3.0	
Cluster no.	TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9	TP10	TP11	
Characteristics of Association and Higher Units												**P**
Pistacia terebinthus	3	3	3	5	4	5	5	3	4	3	3	11
Juniperus oxycedrus subsp. *badia*	+	1	-	-	+	-	1	1	1	2	1	8
Quercus coccifera	+	+	1	1	2	+	+	-	1	-	-	8
Quercus rotundifolia	+	-	+	+	1	1	1	1	+	+	-	9
Jasminum fruticans	1	-	+	-	+	+	+	-	-	-	1	6
Pistacia lentiscus	+	+	1	2	+	-	-	+	-	-	-	6
Teline patens	-	2	+	-	+	1	2	-	+	-	-	6
Asparagus acutifolius	+	+	-	1	-	-	-	-	-	-	-	3
Rhamnus alaternus	1	1	-	-	-	-	+	-	-	-	-	3
Quercus faginea	-	-	-	-	-	-	-	+	1	+	-	3
Thapsia villosa	-	-	-	+	-	-	-	-	+	-	-	2
Smilax aspera	-	+	-	1	-	1	-	-	-	-	-	3
Tamus communis	+	1	1	-	-	-	-	-	-	-	+	4
Ruscus aculeatus	-	+	+	-	-	-	-	+	-	-	-	3
Arbutus unedo	-	-	+	-	+	1	-	+	-	-	-	4
Juniperus phoenicea	+	2	-	-	-	-	-	-	-	-	-	2
Hedera ibernica	+	-	-	-	-	2	-	-	-	-	-	2
Rubia peregrina	-	-	+	-	-	+	+	-	-	-	-	3
Phillyrea latifolia	-	+	1	-	-	-	-	-	-	-	-	2
Lonicera periclymenum subsp. *hispanica*	-	-	-	-	1	1	-	-	-	-	-	2
Phillyrea angustifolia	-	-	-	-	-	-	-	+	-	-	-	1
Olea europea var. *sylvestris*	1	-	-	-	-	-	-	-	-	-	-	1
Viburnum tinus	-	-	-	-	-	1	-	-	-	-	-	1
Pinus pinaster	-	-	-	-	-	-	+	-	-	-	-	1
Coronilla glauca	2	-	-	-	-	-	-	-	-	-	-	1
Rhamnus myrtifolius	-	-	-	-	-	-	-	-	-	-	+	1
Companions												
Rosmarinus officinalis	-	+	1	1	1	-	1	-	1	1	-	7
Cistus albidus	+	+	-	+	1	-	-	1	+	1	-	7
Rubus ulmifolius	+	1	+	-	-	+	+	-	-	-	-	5
Thymus orospedanus	+	-	-	-	+	-	-	1	+	+	-	5
Aphyllantes monspeliensis	-	-	-	+	-	-	-	+	+	+	-	4
Brachypodium retusum	-	-	-	-	+	-	-	-	-	+	1	3
Clematis vitalba	+	-	-	-	-	-	1	+	-	-	-	3
Halimium atriplicifolium	-	-	-	-	-	-	-	-	2	1	-	2
Thymus zygis subsp. *gracilis*	-	+	1	-	-	-	-	-	-	-	-	2
Asphodelus albus	-	-	-	-	-	-	-	+	+	-	-	2
Thymus mastichina	-	-	-	-	-	-	-	1	-	-	1	2
Rosa canina	-	-	-	-	-	1	+	-	-	-	-	2
Lotus corniculatus	-	-	-	-	-	-	-	-	+	+	-	2
Euphorbia characias	+	-	+	-	-	-	-	-	-	-	-	2
Staehelina dubia	-	+	-	+	-	-	-	-	-	-	-	2
Lithodora fruticosa	-	-	-	-	-	-	-	-	+	+	-	2

Other species: *Polygala rupestris* TP11(+), *Melica minuta* TP11(1), *Sedum sediforme* TP11(+), *Dactylis hispanica* TP8(+), *Crataegus laciniata* TP3(+), *Phlomis lychnitis* TP4(+), *Urginea maritima* TP11(+), *Helleborus foetidus* TP11(+), *Geranium purpureum* TP3(+), *Asplenium ceterach* TP11(+), *Vitis vinifera* subsp. *sylvestris* TP2(+), *Ficus carica* TP2(+), *Cardamine hirsuta* TP3(+), *Vincetoxicum nigrum* TP3(+), *Genista cinerea* subsp. *speciosa* TP4(1), *Melica magnolii* TP5(+), *Fraxinus angustifolia* TP6(+), *Dorycnium pentaphyllum* TP7(+), *Linum narbonense* TP10(+), *Sedum brevifolium* TP11(+), *Mucizonia hispida* TP11(+), *Asplenium trichomanes* TP11(+), *Biscutella valentina* TP11(1), *Rubus caesius* TP11(+), *Ruta chalepensis* TP11(+).

P = number of Presences; **-** = absent. **Localities:** 1 and 2.—Near Presa del Tranco. 3.—Puntal del Poyo Gonzalo. 4.—Cerro de los Cabezones. 5.—Ravine of the Obispo. 6.—Los Blancores. 7.—Near Finca de Mihí. 8.—Aguascebas Reservoir. 9.—Mount of Solegas Anchas. 10.—Cañada de los Caballeros. 11.—Rise to the birth of the Guadalquivir.

3.2. Synthetic Vegetation Analysis

The synthetic table (Appendix A) reveals a differential floristic composition between all the associations studied, with a predominance of species of *Pistacio lentisci-Rhamnetalia alaterni* Rivas-Martínez such as *J. oxycedrus* subsp. *oxycedrus*, *J. oxycedrus* subsp. *badia*, *Pistacia lentiscus*, *P. terebinthus*, *Quercus coccifera*, *Phillyrea latifolia*, *P. angustifolia*, *Rhamnus alaternus*, *R. lycioides*, *R. oleoides*, *Pinus halepensis*, *Arbutus unedo* and *Asparagus albus*. The floristic composition of the associations allows us to include them in the alliance *Juniperion badiae*, a thermo- to supramediterranean dry juniper scrub found in the Luso-Extremaduran province in the central Iberian Peninsula [19,38].

3.3. Catenal Analysis of the Landscape Evolution

Territories behave differently in response to the general climate, the type of substrate and the topography of the terrain. For this reason, areas on rocky crests-even though they may be in rainy environments and surrounded by climactic forests-behave differently from the territories around them. In these circumstances, islands evolve which may contain edaphoseries, minoriseries, and permaseries [46–48]. All the plant communities growing on rocky crests and in steeply sloping areas are very significantly influenced by the soil, which allows their existence. All territories have a substrate and an orography which determines whether they have a greater or lesser capacity to retain water. There are special substrates such as ultramafic rocks (serpentines) that are rich in heavy cations and have a high content of ferromagnesium minerals [49]. The Betic mountains (southern Spain) comprise marble limestone, gypsum, and serpentines [50]. The rainfall values for the serpentine territories (Sierra Bermeja) indicate a wet ombrotype, very like the precipitations for the mountains in northwestern Serbia [51]. The xericity of serpentines often gives rise to forests and scrublands that do not correspond to the ombrotype in the territory: plants living here develop ecophysiological and morpho-anatomical adaptations to withstand the limitations [52]. In ideal situations with good soil texture and structure and without slopes, we can assume that the water retention (WR) is maximum (100%). Otherwise there are losses due to run-off and drainage, and the WR may therefore vary. Water is also lost through potential evapotranspiration (ETP). However, as plants have the capacity to self-regulate their losses, it can be assumed that the residual evapotranspiration e = 0.2ETP. So two parameters (i.e., e and WR) are implicated in the development of a vegetation that is essentially conditioned by rainfall. The Ombroclimatic Index (IO) does not therefore explain the presence of plant communities that are influenced by the substrate, and we propose the new Ombroedaphoxeric Index (Ioex) to explain the presence of communities of *Juniperus* in territories with a thermo- to supramediterranean thermotype.

$$\mathrm{Ioex} = \mathrm{P_p} - \mathrm{e}/\mathrm{T_p} * \mathrm{WR},$$

P_p = Annual positive precipitation; T_p = Annual positive temperature [25]; e = residual evapotranspiration whose value is 0.2 ETP [43]; WR = water retention in parts per unit, whose values may be 0.25, 0.50, 0.75, and 1.

Table 5 shows the values for PP, TP, and IO according to the criterion established by Reference [52]. The value of ETP is obtained by applying Thornthwaite's formula, $ETP_{monthly} = 16(10.T/I)^a$, where "T" is the mean monthly temperature, "I" is the annual heat index, and "a" is a parameter that depends on the values taken by "I".

Table 5. Comparative value of indices IO and Ioex in some localities in the Southern Iberian Peninsula.

Weather Station	PP	TP	IO	Ombrotype	ETP	e	Ioex1	Ioex2 *	Ioex3	Ombroclimatic Behaviour of the Locality
Almadén-Minas (CR)	625.2	194.4	3.21	dry	808.54	161.7	0.59	1.19	1.78	Semiarid
Cabezas Rubias (H)	993.4	177.6	5.59	subhumid	702.14	140.42	1.2	2.4	3.6	dry
Aracena (H)	1025.8	175.2	5.85	subhumid	703.46	140.69	1.26	2.52	3.78	dry
Santiago Pontones (J)	1148.7	164.4	6.98	subhumid	675.23	135.04	1.54	3.08	4.62	dry
Vadillo Castril (J)	1182.2	140.4	8.42	humid	488.88	97.72	1.93	3.86	5.79	subhumid
Grazalema (Ca)	1962.2	183.6	10.7	humid	726.22	145.24	2.47	4.94	7.42	subhumid
Montoro (Co)	522.4	210	2.48	dry	903.15	180.63	0.4	0.81	1.22	arid
Pozoblanco (Co)	514.4	193.2	2.66	dry	805.45	161.09	0.45	0.91	1.37	arid
Villanueva del Arzobispo (J)	698.2	196.8	3.54	dry	915.7	183.14	0.65	1.3	1.96	semiarid

PP = Positive precipitation of the year [25]; TP = Positive temperature of the year [25]; e = residual evapotranspiration whose value is 0.2 ETP [43]; ETP = potential evapotranspiration; Ioex1, Ioex2, Ioex3= values of Ioex when WR is 0.25, 0.50, and 0.75; * = most representative value of Ioex.

If we apply the formula Ioex for the assumptions that WR is 0.25, 0.50 and 0.75, we obtain three values, of which the most representative is Ioex2. Table 5 establishes the equivalence values in such a way that although the territorial bioclimate allows the existence of climactic forests, in wild areas with WR = 50% the humid ombrotype becomes dry or subhumid depending on whether the value of WR = 25% or 50%. The subhumid becomes dry and the dry becomes semiarid or arid. Therefore, areas with IO > 8 have Ioex2 values of 3.86 and 4.94, which is equivalent to subhumid. This allows the presence of an edaphoxerophilous community of *Quercus faginea* s.l. or *Abies pinsapo* in rocky areas, as occurs in Grazalema (Cadiz), and a value of Ioex1 = 2.47 in the case that WR = 25%. There is an edaphoxerophilous community of *Quercus ilex* subsp. *ballota* in this situation in Cazorla (Jaén) and in Grazalema (Cadiz). When the underlying ombrotype is subhumid, the equivalence value of Ioex2 is dry; an underlying dry IO gives semiarid and even arid values of Ioex2 if the underlying horizon is less than dry. This does not allow the development of *Quercus* tree species, but does allow the genus *Juniperus*. The value of Ioex is affected by climate change, as evidenced by Del Río et al. [53]. According to these authors, this change in annual rainfall redistribution is taking place heterogeneously, and decreasing in most of the mountainous areas of Grazalema, Ronda, Cazorla, Segura, Sierra Nevada and a large part of the Sierra Morena. However, they have detected an increase in rainfall on the Andalusian coast and particularly in Almería. This affects forest stands, and-together with human activity [23]-favours a redistribution of the current forests due to a decline in the forests of *Quercus* and an increase in the microforests of *Juniperus*.

4. Discussion

J. oxycedrus L. subsp. *badia* (H. Gay) Debeaux and *J. oxycedrus* L. subsp. *lagunae* (Pau ex Vicioso) Rivas-Martínez have been used indistinctly as a result of accumulated and persistent errors [19,38,54]. According to Cano-Ortiz et al. [53], the name *J. oxycedrus* L. subsp. *lagunae* (Pau ex Vicioso) Rivas-Martínez is invalid, and its correct name is *J. oxycedrus* L. subsp. *badia* (H. Gay) Debeaux. For this reason, we rectify here the association names of: *Echinosparto iberici-Juniperetum lagunae* with *Echinosparto iberici-Juniperetum badiae*, *Cytiso eriocarpi-Juniperetum lagunae* with *Cytiso eriocarpi-Juniperetum badiae* and *Stipo tenacissimae-Juniperetum lagunae* with *Stipo tenacissimae-Juniperetum badiae* (see the syntaxonomical scheme below).

The following figures show the catenal contacts and reveal the coexistence of plant communities with different ombroclimatic demands. In the catenas in Figures 5 and 6 (Sierra Morena) with opposing orientations and on a siliceous substrate, there is an ombroclimatic gradient from dry to humid from the base of the mountain to the summit. In this case the presence of microforests of *Juniperus* is only possible due to the influence of the substrate; this is repeated in the catenas in Figures 7 and 8 (Cazorla and Mágina), which have calcareous substrates and a northern orientation, implying higher rainfall than in Sierra Morena. We therefore find edaphoxerophilous copses of *Quercus ilex* subsp. *ballota* and juniper ("sabinares"), and holm oak forests ("enebrales") of *Juniperetum phoeniceae-badiae*, along with forests of Portuguese oak ("quejigares") and "acerales" of *Viburno tini-Quercetum alpestris*, *Berberido hispanicae-Quercetum alpestris* and *Daphno latifoliae-Aceretum granatensis*.

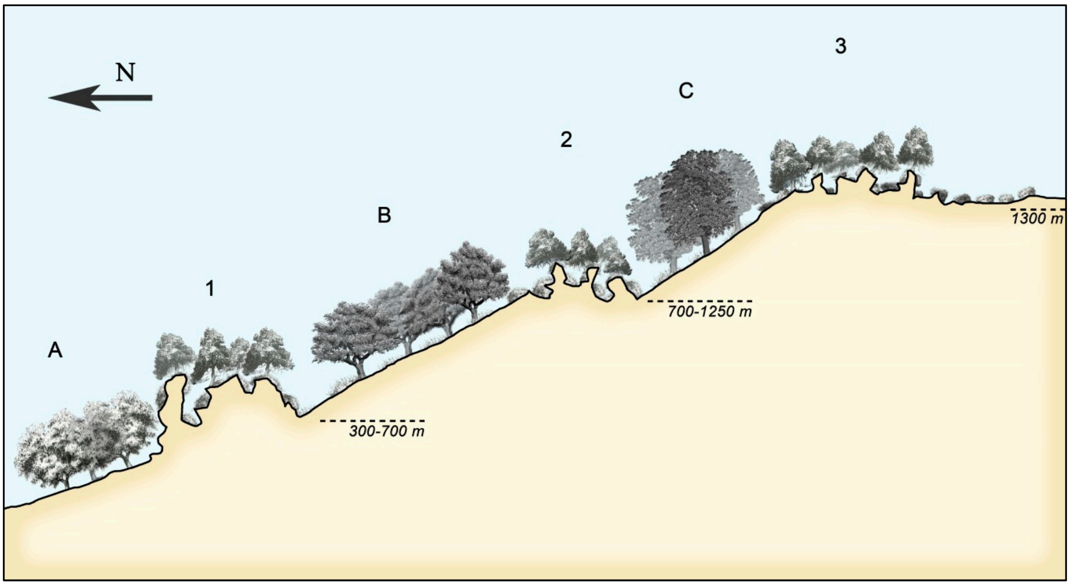


Figure 5. A, B, and C: climatic forests of **A**) *Myrto communis-Quercetum rotundifoliae*; **B**) *Poterio agrimonioidis-Quercetum suberis*; **C**) *Arbuto unedonis-Quercetum pyrenaicae*. 1, 2, and 3: edaphoxerophilous microforests of *Juniperus sp.* **1**) *Myrto communis-Juniperetum badiae*; **2**) *Genisto polianthi-Juniperetum badiae*; **3**) *Echinosparto iberici-Juniperetum badiae*.

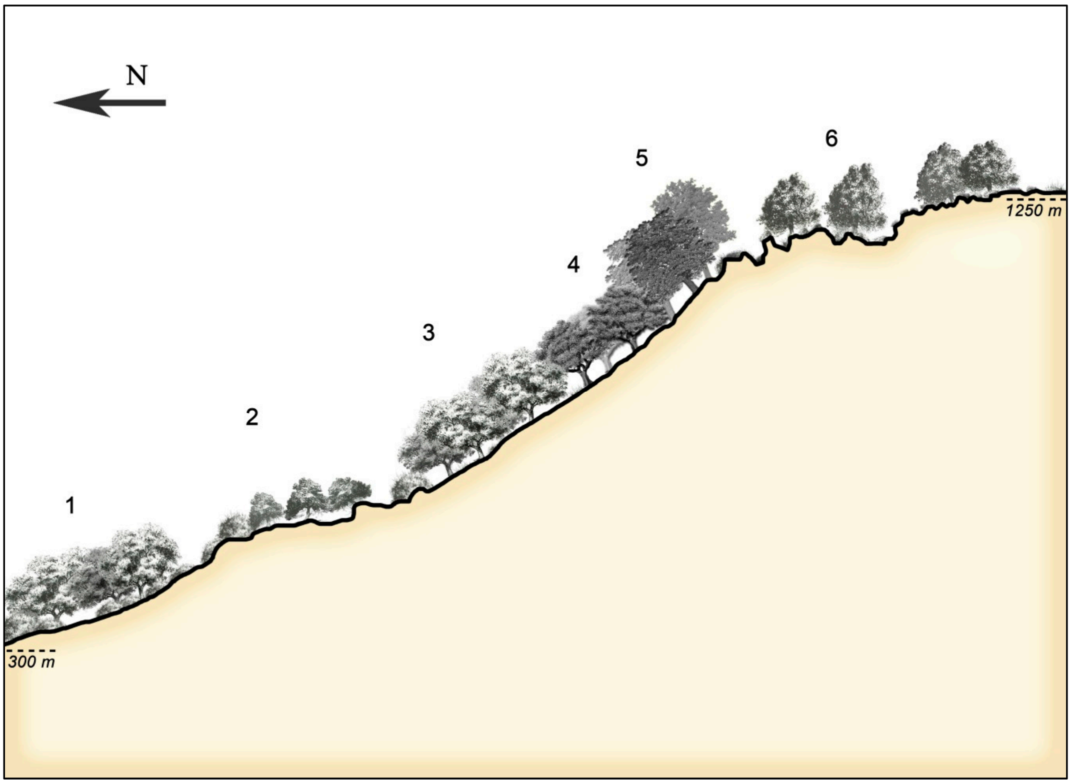


Figure 6. **1**. *Myrto communis-Quercetum rotundifoliae*. **2**. *Myrto communis-Juniperetum badiae*. **3**. *Pyro bourgaeanae-Querctum rotundifoliae*. **4**. *Poterio agrimonioidis-Quercetum suberis*. **5**. *Arbuto unedonis-Quercetum pyrenaicae*. **6**. *Echinosparto iberici-Juniperetum badiae*.

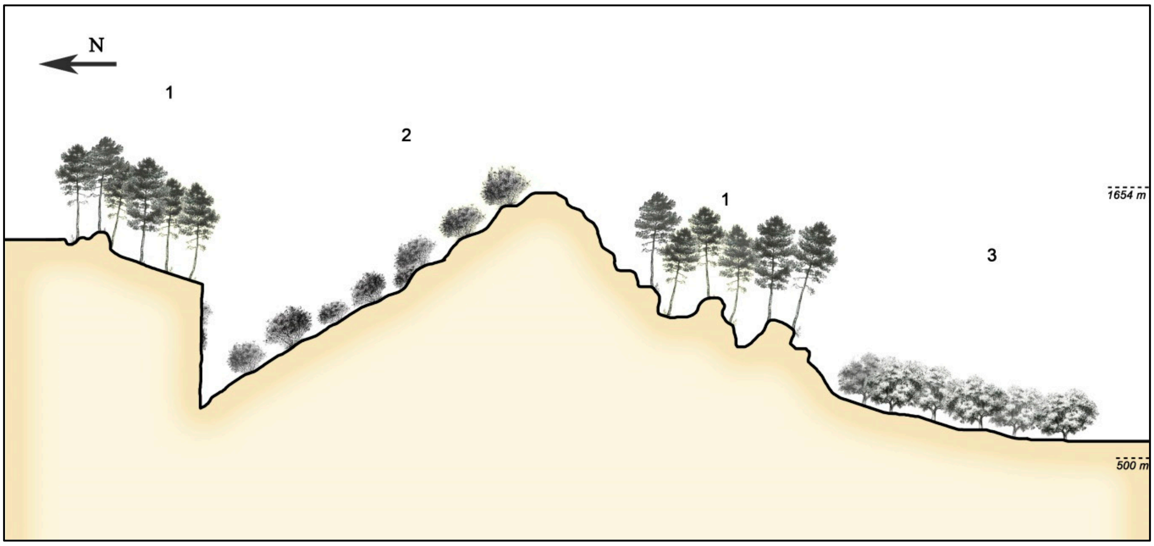


Figure 7. **1**) Pinewood of *Rhamno lycioidis-Pinetum halepensis*. **2**) Communities of *Teline patentis-Pistacietum terebinthi*. **3**) Holm oak forest of *Paeonio-Quercetum rotundifoliae* (Cazorla, Mágina).

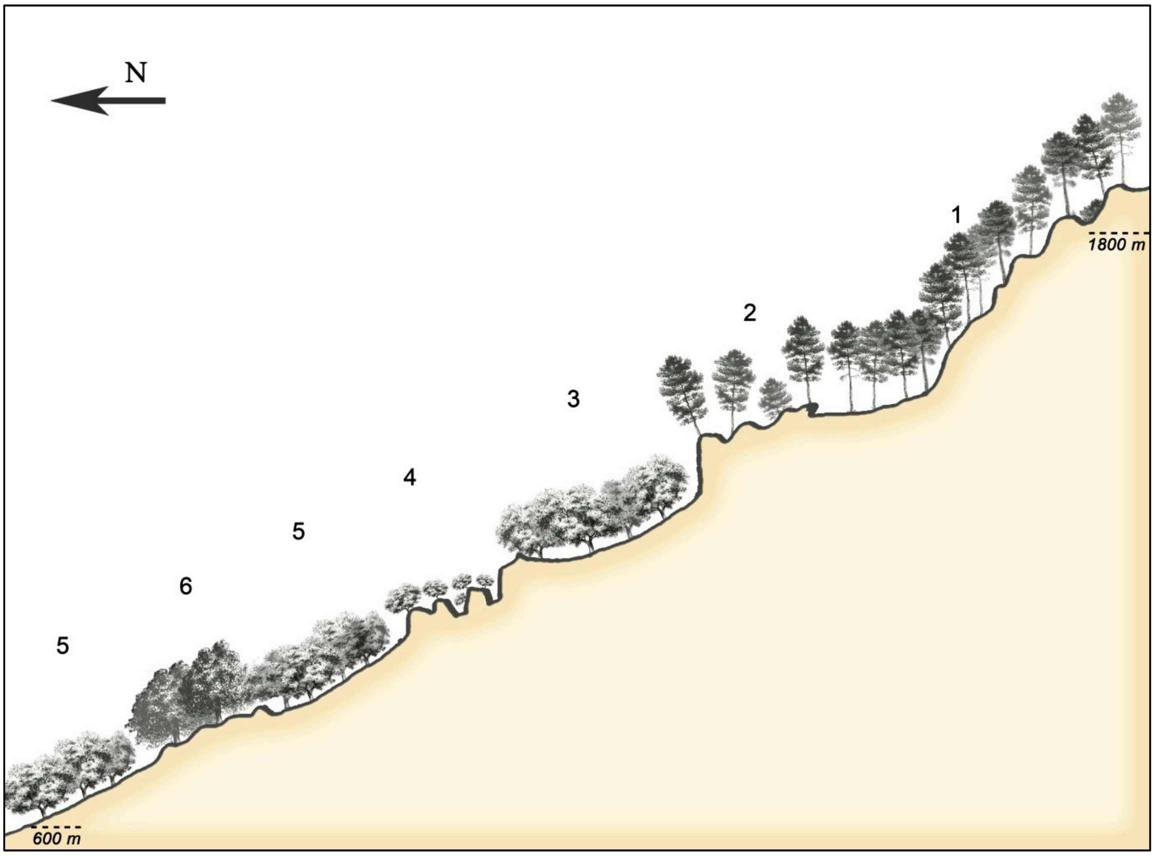


Figure 8. **1**) and **2**) Pine forest of *Junipero phoeniceae-Pinetum clusianae*. **3**) Forests of *Viburno tini-Quercetum alpestris*, *Berberido hispanicae-Quercetum alpestris*, and *Daphno latifoliae-Aceretum granatensi*. **4**) Edaphoxerophilous holm oak forest of *Junipero phoeniceae-Quercetum rotundifoliae*. **5**) Holm oak forest of *Paeonio coriaceae-Quercetum rotundifoliae*. **6**) Holm oak and juniper forest of *Juniperetum phoeniceae-badiae* (Cazorla).

5. Conclusions

The different groups of communities proposed for the Luso-Extremaduran province occupy areas whose dominant ecological factor is the xericity of the substrate. These are edaphoxerophilous formations with a permanent character that occupy restricted areas, but are currently in expansion, as frequent fires and the deforestation and clearing of the scrub layer have led to an extension of eroded areas due to soil loss: indeed, the absence or presence of fire is the main agent of vegetation change in areas with low anthropic influence [55]. These biotopes do not tend to be occupied by *Fagaceae*, and the forests of *Quercus ilex* subsp. *ballota* are relegated to less inhospitable territories. If the factors that condition this dynamic persist, we will continue to see an exponential rise in the area occupied by species from the genus *Juniperus*. We can therefore predict a change in the landscape in the future, with a strong predominance of gymnosperms over angiosperms, as the former are better adapted to extreme conditions. These areas in expansion do not present a serious threat unless there is excessive pressure from livestock farming, which could lead to an alteration in these habitats that are rich in endemic species; endemics have a rate of 12 and account for 60% of their flora. As a result of the study of these wild areas we have detected a total of ten plant associations, of which we propose four as new. In all cases, these are Sites of Community Interest (SCI), as they include habitats with a high richness in endemic species. The recommendation is thus to implement conservation measures by applying a protection status to allow control over the management of the territory, for example by establishing micro-reserves for the conservation of flora and habitats, according to Spampinato et al. [56].

Soil water in semiarid areas plays an important role in evapotranspiration [57]. The significance of evapotranspiration is confirmed as a tool for improving our understanding of environmental changes, and according to Liu et al. [58], has a direct connection with society. Another important aspect is that the phytosociological approach and statistical analysis are fundamental for the study and greater knowledge of plant communities; several authors consider all these data (plus others such as phytotoponims) to be crucial to their conservation and/or restoration [20,56,59–63]. It is worth noting that vegetation is a key element for society in general and for communities that share neighbouring geographical territories. The increase in pollution, and particularly in CO_2 emissions, can be mitigated by the absorption of this greenhouse gas by plants that convert it into organic matter [64]. In many cases. this organic matter can be used in a variety of forms for building the cities of the future, i.e., the cork of *Quercus suber* L. [65–69]. Forest management is known to be a good tool for removing atmospheric CO_2 [70]. In particular, this study highlights the importance of planning actions for the efficient management of Habitat 5210 "Arborescent matorral with *Juniperus ssp.*" present in Portugal and Spain. In fact, this kind of habitat-among others-could also sequester a substantial amount of CO_2, as in the case of the juniper forest in Central Spain, which is characterised by other species of *Juniperus* such as *J. thurifera* L. and *J. communis* L. [71]. It is today essential to develop a modern forest management system in protected areas, and to promote the importance of forests and their extensions as a means of protecting and improving the natural environment, according to Rădulescu et al. [72]. In view of this, and since vegetation knows no political borders, it is desirable to plan actions involving cross-border-cooperation projects based on other experiences in this field to ensure sustainable development and territorial cohesion between Spain and Portugal [73,74].

Syntaxonomical scheme

QUERCETEA ILICIS Br.-Bl. ex A. O. Bolòs 1950
Pistacio lentisci-Rhamnetalia alaterni Rivas-Martínez 1975
Juniperion badiae Cano, Rodríguez Torres, Pinto Gomes, García Fuentes, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 ex Mucina et al. 2016 *nom. corr. hoc loco*
Festuco merinoi-Juniperetum badiae (Rivas-Martínez & Sánchez Mata 1989) Sánchez Mata 1999 corr. Rivas-Martínez & Sánchez Mata 2011 *nom. corr. hoc loco*
Cytiso tribracteolati-Juniperetum oxycedri Pérez Latorre, Galán & Cabezudo in Pérez Latorre, Galán, Navas P., Gil & Cabezudo 1999
Echinosparto iberici-Juniperetum badiae Rodríguez Torres & Cano in Cano, Rodríguez Torres, Pinto Gomes, García Fuentes, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 *nom. corr. hoc loco*
Cytiso eriocarpi-Juniperetum badiae Pinto & Cano in Cano, Rodríguez Torres, Pinto Gomes, García Fuentes, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 *nom. corr. hoc loco*
Pistacio terebinthi-Juniperetum badiae Cano, Rodríguez Torres, Pinto Gomes, García, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 *nom. corr. hoc loco*
Stipo tenacissimae-Juniperetum badiae Cano, Rodríguez Torres, Pinto Gomes, García Fuentes, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 *nom. corr. hoc loco*
Juniperetum phoeniceae-badiae ass. nova hoc loco
Teline patentis-Pistacietum terebinthi ass. nova hoc loco
Myrto communis-Juniperetum badiae ass. nova hoc loco
Genisto polyanthi-Juniperetum badiae ass. nova hoc loco

Author Contributions: Conceptualization: E.C.; data curation: C.M.M., A.C.-O., S.D.R.G. and G.S.; formal analysis: C.M.M., A.C.-O., J.C.P.F. and S.D.R.G.; research: E.C., C.M.M., A.C.-O., J.C.P.F., A.R.T., C.J.P.G. and R.Q.-C.; methodology: E.C.; software: A.C.-O., J.C.P.F. and S.D.R.G.; supervision: E.C. and C.M.M.; writing (original draft): E.C., C.M.M. and A.C.-O.; writing (review and editing): E.C., C.M.M., A.C.-O., J.C.P.F., A.R.T., S.D.R.G., C.J.P.G., R.Q.-C. and G.S.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Synthetic table of relevés: *Juniperetum phoeniceae-badiae* (JPB) *nova*; *Teline patentis-Pistacietum terebinthi* (TP) *nova*; *Myrto communis-Juniperetum badiae* (MJ) *nova*; *Echinosparto iberici-Juniperetum badiae* (Cano et al. 2007) (EJ) *nom. corr. hoc loco*; *Festuco merinoi-Juniperetum badiae* (Rivas-Martínez & Sánchez-Mata in Sánchez-Mata 1989) (FJ) *nom. corr. hoc loco*; *Cytiso eriocarpi-Juniperetum badiae* (Pinto & Cano in Cano et al. 2007) (CJ) *nom. corr. hoc loco*; *Pistacio terebinthi-Juniperetum badiae* (Rodríguez Torres & Cano in Cano et al. 2007) (PJ) *nom. corr. hoc loco*; *Stipo tenacissimae-Juniperetum badiae* (Cano et al. 2007) (SJ) *nom. corr. hoc loco*; *Genisto polyanthi-Juniperetum badiae* (GJ) *nova*.

Table A1. Synthetic table of relevés.

Characteristic	JPB	TP	MJ	EJ	FJ	CJ	PJ	SJ	GJ
Juniperus oxycedrus subsp. *badia*	V	V	V	V	V	V	V	V	V
Quercus rotundifolia	IV	IV	III	III	V	-	V	V	V
Asparagus acutifolius	I	I	I	-	-	-	II	II	I
Pistacia lentiscus	I	III	II	-	-	III	-	-	I
Juniperus oxycedrus subsp. *oxycedrus*	IV	-	I	-	-	V	I	-	I
Quercus coccifera	I	III	I	-	-	-	I	III	-
Daphne gnidium	III	-	I	-	-	II	V	III	-
Thapsia villosa	I	I	I	-	-	-	III	I	-
Pistacia terebinthus	I	V	II	-	-	I	IV	-	-
Jasminum fruticans	I	II	I	-	-	-	III	-	-
Quercus faginea	I	I	-	-	-	-	I	-	-
Rubia peregrina	I	I	I	-	-	-	I	-	-
Phillyrea latifolia	I	I	I	-	-	I	-	-	-
Rhamnus alaternus	I	I	I	-	-	I	-	-	-
Smilax aspera	I	I	I	-	-	-	-	-	-
Carex hallerana	I	-	-	-	-	-	-	I	-
Juniperus phoenicea	V	I	-	-	-	-	-	-	-
Crataegus laciniata	I	I	-	-	-	-	-	-	-
Paeonia broteroi	I	-	-	-	-	-	-	-	-
Pinus halepensis	I	-	-	-	-	-	-	-	-
Teline patens	-	III	-	-	-	-	-	-	-
Rhamnus myrtifolius	-	I	-	-	-	-	-	-	-
Coronilla glauca	-	I	-	-	-	-	-	-	-
Phillyrea angustifolia	-	I	III	I	-	V	-	-	I
Olea europea var. *sylvestris*	-	I	II	-	-	II	II	I	-
Viburnum tinus	-	I	I	-	-	I	-	-	-
Arbutus unedo	-	II	II	I	-	-	-	-	-
Ruscus aculeatus	-	I	-	-	-	I	-	-	-
Pinus pinaster	-	I	-	I	-	-	-	-	-
Erica arborea	-	-	I	I	IV	V	-	-	I
Rhamnus lycioides	-	-	I	-	-	-	II	I	-
Osyris alba	-	-	I	-	-	-	III	I	-
Quercus suber	-	-	I	I	-	-	I	-	-
Quercus broteroi	-	-	I	-	-	-	I	-	-
Pyrus bourgaeana	-	-	I	-	-	-	I	-	-
Myrtus communis	-	-	II	-	-	III	-	-	-
Asparagus aphyllus	-	-	I	-	-	I	-	-	-
Rhamnus oleoides	-	-	I	-	-	II	-	-	-
Pistacia x saportae	-	-	I	-	-	I	-	-	-
Asparagus albus	-	-	I	-	-	-	-	-	-
Teucrium fruticans	-	-	I	-	-	-	-	-	-
Quercus marianica	-	-	I	-	-	-	-	-	-
Quercus canariensis	-	-	I	-	-	-	-	-	-
Phlomis purpurea	-	-	I	-	-	-	-	-	-
Crataegus monogyna	-	-	I	-	-	-	-	-	-
Genista polyanthos	-	-	-	-	-	-	-	-	V
Companions									
Urginea maritima	I	I	II	I	-	-	I	I	I
Thymus mastichina	II	I	I	-	-	-	V	II	I
Rosmarinus officinalis	III	III	III	-	-	-	I	-	II
Asphodelus albus	III	I	I	II	-	-	-	-	II

Table A1. *Cont.*

Characteristic	JPB	TP	MJ	EJ	FJ	CJ	PJ	SJ	GJ
Cistus albidus	III	III	II	-	-	-	-	III	I
Dactylis hispanica	I	I	I	-	IV	-	I	IV	-
Retama sphaerocarpa	I	-	I	-	-	-	V	II	I
Asplenium ceterach	I	I	I	-	-	-	I	I	-
Rubus ulmifolius	I	II	III	-	-	-	I	-	-
Phagnalon saxatile	I	-	-	-	-	-	I	III	-
Geranium purpureum	I	I	-	-	-	-	-	-	I
Phlomis lychnitis	II	I	-	-	-	-	-	III	-
Lonicera periclymenum subsp. *hispanica*	I	I	-	-	-	-	I	-	-
Staehelina dubia	I	I	-	-	-	-	-	I	-
Santolina canescens	I	-	-	-	-	-	I	-	-
Halimium atriplicifolium	I	I	I	-	-	-	-	-	-
Melica minuta	I	I	I	-	-	-	-	-	-
Sanguisorba minor	I	-	I	-	-	-	-	-	-
Thymus zygis subsp. *gracilis*	I	I	-	-	-	-	-	-	-
Thymus orospedanus	III	II	-	-	-	-	-	-	-
Aphyllantes monspeliensis	I	II	-	-	-	-	-	-	-
Rosa canina	I	I	-	-	-	-	-	-	-
Brachypodium retusum	II	I	-	-	-	-	-	-	-
Hedera ibernica	I	I	-	-	-	-	-	-	-
Helleborus foetidus	I	I	-	-	-	-	-	-	-
Lavandula latifolia	I	-	-	-	-	-	-	-	-
Cistus monspeliensis	I	-	-	-	-	-	-	-	-
Teucrium capitatum	I	-	-	-	-	-	-	-	-
Teucrium rotundifolium	I	-	-	-	-	-	-	-	-
Helianthemum ledifolium	I	-	-	-	-	-	-	-	-
Clematis flammula	I	-	-	-	-	-	-	-	-
Linum suffruticosum	I	-	-	-	-	-	-	-	-
Bupleurum rigidum	I	-	-	-	-	-	-	-	-
Ilex aquifolium	I	-	-	-	-	-	-	-	-
Fumana thymifolia	I	-	-	-	-	-	-	-	-
Lonicera splendida	I	-	-	-	-	-	-	-	-
Leuzea conifera	I	-	-	-	-	-	-	-	-
Berberis hispanica	I	-	-	-	-	-	-	-	-
Buxus sempervirens	I	-	-	-	-	-	-	-	-
Pinus salzmannii	I	-	-	-	-	-	-	-	-
Helianthemum syriacum	I	-	-	-	-	-	-	-	-
Filipendula vulgaris	I	-	-	-	-	-	-	-	-
Polygala monspeliaca	I	-	-	-	-	-	-	-	-
Ophrys tenthrediniferfa	I	-	-	-	-	-	-	-	-
Helianthemum cinereum subsp. *rotundifolium*	I	-	-	-	-	-	-	-	-
Ptilostemon hispanicus	I	-	-	-	-	-	-	-	-
Anthyllis vulneraria subsp. *maura*	I	-	-	-	-	-	-	-	-
Arrhenatherum album	I	-	-	-	-	-	-	-	-
Erinacea anthyllis	I	-	-	-	-	-	-	-	-

Table A1. *Cont.*

Characteristic	JPB	TP	MJ	EJ	FJ	CJ	PJ	SJ	GJ
Fumana paradoxa	I	-	-	-	-	-	-	-	-
Helictotrichon filifolium	I	-	-	-	-	-	-	-	-
Crupina crupinastrum	I	-	-	-	-	-	-	-	-
Narcissus assoanus	I	-	-	-	-	-	-	-	-
Medicago rigidula	I	-	-	-	-	-	-	-	-
Genista scorpius	I	-	-	-	-	-	-	-	-
Crocus serotinus subsp. *salzmannii*	I	-	-	-	-	-	-	-	-
Prunus spinosa	I	-	-	-	-	-	-	-	-
Cytisus scoparius subsp. *reverchonii*	I	-	-	-	-	-	-	-	-
Fumana laevipes	I	-	-	-	-	-	-	-	-
Genista boissieri	I	-	-	-	-	-	-	-	-
Amelanchier ovalis	I	-	-	-	-	-	-	-	-
Muscari giennense	I	-	-	-	-	-	-	-	-
Thymus granatensis	I	-	-	-	-	-	-	-	-
Biscutella sempervirens	I	-	-	-	-	-	-	-	-
Sedum brevifolium	-	I	I	I	-	IV	-	I	II
Mucizonia hispida	-	I	I	I	-	-	-	-	II
Tamus communis	-	II	I	-	-	-	II	-	-
Fraxinus angustifolia	-	I	I	-	-	-	-	-	I
Polygala rupestris	-	I	I	-	-	-	-	-	-
Sedum sediforme	-	I	I	-	-	-	-	-	-
Vitis vinifera subsp. *sylvestris*	-	I	I	-	-	-	-	-	-
Lithodora fruticosa	-	I	-	-	-	-	-	-	-
Biscutella valentina	-	I	-	-	-	-	-	-	-
Rubus caesius	-	I	-	-	-	-	-	-	-
Clematis vitalba	-	I	-	-	-	-	-	-	-
Euphorbia characias	-	I	-	-	-	-	-	-	-
Genista cinerea subsp. *speciosa*	-	I	-	-	-	-	-	-	-
Dianthus lusitanus	-	-	II	III	IV	IV	I	II	IV
Cistus ladanifer	-	-	III	III	-	III	I	I	III
Halimium umbellatum subsp. *viscosum*		-	I	I	-	III	I	I	I
Arrhenatherum bulbosum	-	-	I	I	-	II	II	-	III
Halimium ocymoides	-	-	I	II	-	III	-	-	II
Lavandula sampaiana	-	-	II	II	-	III	IV	III	-
Sedum dasyphyllum	-	-	I	I	-	-	-	-	I
Coincya longirrostra	-	-	I	I	-	-	-	-	I
Digitalis mariana	-	-	I	II	-	-	-	-	I
Jasione mariana	-	-	I	II	-	-	-	-	III
Linaria saxatilis	-	-	I	II	-	-	-	-	II
Lavandula luisieri	-	-	I	I	-	-	-	-	I
Elymus caninus	-	-	I	I	-	-	-	-	I
Nerium oleander	-	-	I	-	-	-	-	-	I
Anogramma leptophylla	-	-	I	-	-	-	-	-	I
Adenocarpus telonensis	-	-	II	-	-	-	I	I	-
Cytisuss striatus subsp. *eriocarpus*	-	-	I	-	V	IV	I	-	-
Cistus salvifolius	-	-	I	-	-	III	-	III	-
Bryonia cretica	-	-	I	-	-	-	I	-	-

Table A1. *Cont.*

Characteristic	JPB	TP	MJ	EJ	FJ	CJ	PJ	SJ	GJ
Flueggea tinctoria	-	-	I	-	-	-	-	-	I
Genista hirsuta	-	-	I	-	-	-	I	-	-
Teucrium gnaphalodes	-	-	I	-	-	-	-	I	-
Teucrium pseudochamaepytis	-	-	I	-	-	-	-	III	-
Cheilanthes tinaei	-	-	I	-	-	-	-	I	-
Calluna vulgaris	-	-	I	I	-	II	-	-	-
Cheilanthes hispanica	-	-	I	-	-	II	-	-	-
Adenocarpus argyrophyllus	-	-	I	II	-	-	-	-	-
Ericca scoparia	-	-	I	I	-	-	-	-	-
Astragalus lusitanicus	-	-	I	I	-	-	-	-	-
Jasione tomentosa	-	-	I	I	-	-	-	-	-
Cheilanthes maderensis	-	-	II	-	-	-	-	-	-
Arisarum simorhinum	-	-	I	-	-	-	-	-	-
Sedum album	-	-	I	-	-	-	-	-	-
Stipa capensis	-	-	I	-	-	-	-	-	-
Hyacinthoides hispanica	-	-	I	-	-	-	-	-	-
Pterocepalus diandrus	-	-	I	-	-	-	-	-	-
Digitalis heywoodii var. *albicans*	-	-	I	-	-	-	-	-	-
Antirrhinum graniticum subsp. *onubensis*		-	I	-	-	-	-	-	-
Cytisus scoparius subsp. *bourgaei*	-	-	I	-	-	-	-	-	-
Aristolochia baetica	-	-	I	-	-	-	-	-	-
Micromeria graeca	-	-	I	-	-	-	-	-	-
Dianthus crassipes	-	-	I	-	-	-	-	-	-
Jasonia glutinosa	-	-	I	-	-	-	-	-	-
Helianthemum croceum	-	-	I	-	-	-	-	-	-
Stipa gigantea	-	-	-	II	-	-	I	II	II
Conopodium capillifolium	-	-	-	I	-	I	-	-	I
Festuca elegans	-	-	-	II	V	-	-	-	I
Armeria capitella	-	-	-	I	-	-	-	-	I
Narcissus rupicola	-	-	-	I	-	-	-	-	I
Digitalis thapsi	-	-	-	I	-	II	II	-	-
Lavandula pedunculata	-	-	-	-	IV	-	I	-	-
Erica australis	-	-	-	I	-	II	-	-	-
Gladiolus illyricus	-	-	-	I	-	I	-	-	-
Echinospartum ibericum	-	-	-	II	-	-	-	-	-
Quercus pyrenaica	-	-	-	I	-	-	-	-	-
Arenaria querioides	-	-	-	I	-	-	-	-	-
Armeria arenaria subsp. *segoviensis*	-	-	-	I	-	-	-	-	-
Erica scoparia	-	-	-	I	-	-	-	-	-
Leucanthemopsis flaveola	-	-	-	I	-	-	-	-	-
Festuca summilusitanica	-	-	-	-	V	-	-	-	-
Cytisus oromediterraneus	-	-	-	-	IV	-	-	-	-
Juniperus hemisphaerica	-	-	-	-	IV	-	-	-	-
Arenaria grandiflora	-	-	-	-	V	-	-	-	-
Thymus x bractichina	-	-	-	-	V	-	-	-	-
Pteridium aquilinum	-	-	-	-	V	-	-	-	-
Sorbus aucuparia	-	-	-	-	II	-	-	-	-
Jasione sessiliflora	-	-	-	-	IV	-	-	-	-

Table A1. *Cont.*

Characteristic	JPB	TP	MJ	EJ	FJ	CJ	PJ	SJ	GJ
Genista cinerascens	-	-	-	-	I	-	-	-	-
Sedum hirsutum	-	-	-	-	IV	IV	-	-	-
Simethis planifolia	-	-	-	-	-	II	-	-	-
Polypodium cambricum	-	-	-	-	-	I	-	-	-
Adenocarpus anisochilus	-	-	-	-	-	I	-	-	-
Hypericum linearifolium	-	-	-	-	-	I	-	-	-
Thymus zygis	-	-	-	-	-	-	I	III	-
Helichrysum stoechas	-	-	-	-	-	-	I	IV	-
Cynosurus echinatus	-	-	-	-	-	-	I	I	-
Santolina rosmarinifolia	-	-	-	-	-	-	I	I	-
Hyparrhenia hirta	-	-	-	-	-	-	I	I	-
Cytisus scoparius subsp. *scoparius*	-	-	-	-	-	-	III	-	-
Helianthemum appeninum	-	-	-	-	-	-	I	-	-
Hedera helix	-	-	-	-	-	-	I	-	-
Lonicera implexa	-	-	-	-	-	-	I	-	-
Thapsia maxima	-	-	-	-	-	-	I	-	-
Antirrhinum graniticum	-	-	-	-	-	-	I	-	-
Stipa tenacissima	-	-	-	-	-	-	-	III	-
Cytisus multiflorus	-	-	-	-	-	-	-	I	-
Cistus populifolius x C. salvifolius	-	-	-	-	-	-	-	-	I
Festuca rothmaleri	-	-	-	-	-	-	-	-	I
Conopodium bourgaei	-	-	-	-	-	-	-	-	I
Asplenium billotii	-	-	-	-	-	-	-	-	I
Scrophularia canina	-	-	-	-	-	-	-	-	I
Genista florida	-	-	-	-	-	-	-	-	I

The values from I to V represent the degree of presence of a species in an association. V = presence between 80 and 100%; IV = between 60 and 80%; III = between 40 and 60%; II = between 20 and 40%; I = <20%; "-" indicates its absence [75]. The floristic groups differentiating the plant associations are highlighted in grey.

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