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*Article*

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

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**Abstract:** We have studied *Juniperus oxycedrus* subsp. *badia* in the central and southern Iberian Peninsula. Here, the macrobioclimate ranges from Mediterranean-pluviseasonal-oceanic and Mediterranean-pluviseasonal-continental, thermotype from thermomediterranean and 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 of the genus *Quercus*, we applied the formula of Thornthwaite to calculate potential evapotranspiration.
The general cluster analysis clearly separates two groups of plant communities and separates the different associations in each group. All plant communities growing on rocky crests and in steeply extreme sloping areas are significantly influenced by the soil. The Ombroclimatic Index does not explain the presence of plant communities influenced by substrate: so, we propose a new Ombroedaphoxeric Index which explains the presence of the *Juniperus* communities in territories with a thermotype ranging from the thermo to the supramediterranean belt. The areas of distribution of *Juniperus* species are expanding due to the spread of rocky areas: this phenomenon causes a rise in edaphoxerophilous areas and a decrease in climatophilous one.

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We propose four new plant associations and with this update on their structures and floristic compositions, it is possible to make an efficient form of conservation in both territories studied (Spain and Portugal) with 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

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## 1. Introduction

*Juniperus oxycedrus* is distributed throughout the Mediterranean region, eastern Portugal, Morocco, even extending as far as northern Iran [1]. According to this author, the species has three clearly differentiated subspecies.

*J. oxycedrus* subsp. *macrocarpa* is typical of dunes and coastal sand flats, and may occasionally occupy rocky areas. The formations of this taxon present on the Iberian Peninsula are described and included in the alliance *Juniperion turbinatae* Rivas-Martínez 1975 corr. 1987 [2], along with other communities presided by *Juniperus navicularis* Grand (= *J. oxycedrus* 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 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 [1] 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 [3] include the var. *lagunae* Pau–which has the same characters as the subspecies *badia*– within the subspecies *oxycedrus*. Rivas-Martínez et al. [4], based on the work of Vicioso [5], formulated the new combination *Juniperus oxycedrus* subsp. *lagunae* [=*Juniperus oxycedrus* subsp. *badia*]. Unfortunately, this last name was not validly published and for this reason the correct name actually is *Juniperus oxycedrus* subsp. *badia*.

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 areas, it grows in formations with a broad extension, generally on rocky areas and biotopes with shallow soils where *Quercus ilex* L. subsp. *ballota* (Desf.) Samp. (=*Quercus rotundifolia* Lam.) cease to be dominant or simply cannot exist because do not occur the ecological and/or soil conditions necessary to develop these taxa [6].

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These are also phytocoenoses of considerable ecological interest due to the presence of the companion endemics in these plant communities, forming small islands of vegetation: these act as species reservoirs as they are used neither for either agriculture or livestock farming, and have thus avoided destruction by human action. A similar condition can occur in forest fringe communities, as evidenced by Quinto-Canas et al. [7], where can refuge endemic species. 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 polyanthos, Dianthus crassipes, Dianthus lusitanus, Digitalis thapsi, Digitalis purpurea* subsp. *heywoodii*, *D. purpurea* subsp. *mariana, Securinega tinctoria, Lavandula stoechas* subsp. *luisieri*, *L. stoechas* subsp. *sampaiana*, *Genista hirsuta*, *Thymus mastichina*, *Thymus granatensis* subsp. *micranthus, Thymus zygis* subsp. *gracilis, Antirrhinum graniticum* subsp. *onubensis* [8]. These species live in sites of community interest (SCI) due to the presence of habitats such as 8220: "Siliceous rocky slopes with chasmophytic vegetation", and contain the plant associations *Digitali thapsi-Dianthetum lusitani* Rivas-Martínez ex Fuente 1986, *Jasiono marianae-Dianthetum lusitani* Rivas Goday (1955) 1964, *Coincyo longirostraae-Dianthetum lusitani* Melendo in Cano, Melendo & F. Valle 1997 [9], all of which are reason for the conservation of these areas. However, the dominant species in these environments is *Juniperus oxycedrus* subsp. *badia*, in whose surroundings are located the rest of the species, most of them endemics. These areas can therefore be classified as hotspots of interest for conservation. All these associations are included in the Habitats-2000 directive, which highlights the ecological importance of these areas, and the need to study them for their subsequent conservation [10].

The areas dominated by *Juniperus* are currently in a process of expansion due to the rise in rocky areas, which are spreading every year due to deforestation and forest fire. Fire is a widespread problem for the conservation of several comunities plants in Iberian Peninsula [11]. This phenomenon causes an increase in edaphoxerophilous zones and a decrease in climatophilous ones. There are therefore more potential areas that can act as a refuge for endemic species.

The aim of this work is to study the communities of *J. oxycedrus* subsp. *badia* present in the central and southern Iberian Peninsula and included in the Habitat Directive 5210: "Arborescent matorral with *Juniperus ssp*.". With this update on their structures and floristic compositions, it is possible to make an efficient form of conservation of these communities.

## 2. Materials and Methods

### Study Area

*Location, climate, geomorphology and soils*

Juniper communities are well represented in several biogeographic units, and can be found both in the more continentalised central and eastern areas and in the

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more oceanic Portuguese territories in both siliceous and limestone areas. For this reason, we carried out this research in the central and southern Iberian Peninsula (Figure 1).

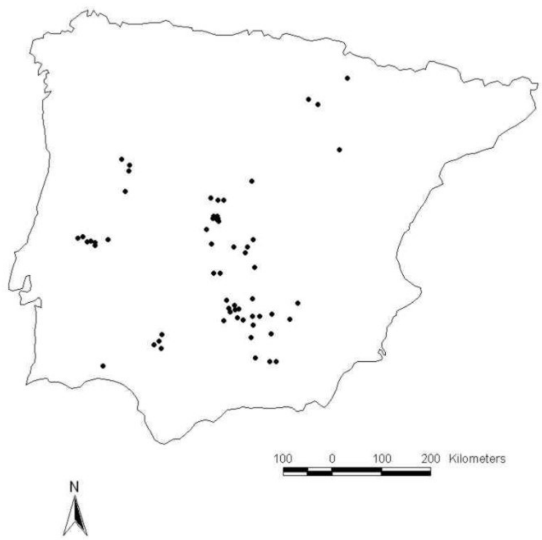


**Figure 1.** Study area and distribution of *Juniperus oxycedrus* subsp. *badia* on the Iberian Peninsula [6].

We studied 100 weater stations in the central-south of the Iberian Peninsula, 29 of which have an Ombrothermic Index (Io) of between 3.6 and 6.3, implying that this territory has a subhumid-humid ombrotype [12]. The 71 remaining meteorological 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 (18.54) and Itc (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 [10].

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 280-1,500 m.

For the nomenclature we followed: [4,5,8,13-23] for vascular plants and [6,24] for plant communities.

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**Methods**

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 *Juniperus oxycedrus* subsp. *oxycedrus* and subsp. *badia*. Specifically, nine plant communities were studied. Among these, there are five published previously [6,25] and four new for the science.

The relevés were taken following the Braun-Blanquet phytosociological methodology, as described in works such as Braun-Blanquet [26] and Géhu & Rivas-Martínez [27]. A statistical treatment was applied to establish a separation among *Juniperus* communities. We compiled an Excel© table with 134 relevés x 294 species, and applied a Ward's distance cluster analysis and a DECORANA and DCA analysis. To understand the presence of *Juniperus* communities in territories dominated by species of the genus *Quercus*, we applied the formula of Thornthwaite $ETP_{monthly} = 16(10.T/I)^a$ to calculate potential evapotranspiration, and 0.2ETP of Montero Burgos & González Rebollar [28]. With these data, we prepared a new Ombroedaphoxeric Index ($I_{oex}$), which, in a comparative analysis with the Ombrothermic Index ($I_o$) proposed by Rivas-Martínez & Loidi [29], justifies the presence of microforests of *Juniperus*.

## 3. Results

*3.1. Phytosociological classification derived from the numerical analyses*

All the communities of *Juniperus oxycedrus* subsp. *badia* share the fact that they are permanent communities with an edaphoxerophilous character, which is imposed by the rocky substrate, due to soil lost. Thus, although the territorial ombrotype could allow the survival of *Quercus* species, only *Quercus coccifera* can do it so in warmer territories.

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

The general cluster analysis clearly separates 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 various 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 statistical treatments DCA clearly separated the three associations in the subgroup MJ, SJ and CJ. CJ was described by its authors 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, and shows significant floristic differences with CJ. The new association we propose in this work –MJ– is in areas of the Sierra Morena on siliceous substrates and in dry-subhumid environments (Figure 3).

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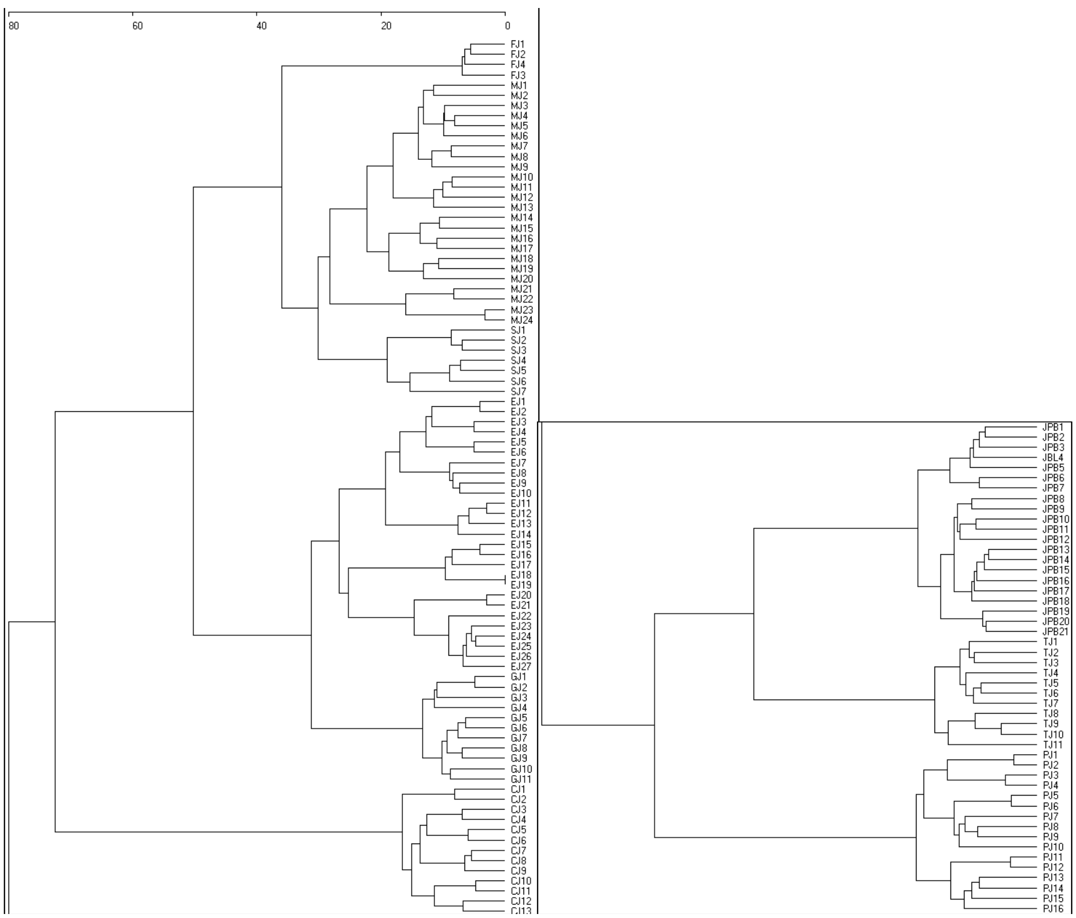
The subgroup of associations EJ and GJ grows in the Mariánico-Monchiquense sector on siliceous substrates (Paleozoic slate and quartzite), with an ombroclimate ranging between dry and humid; EJ was described by Cano et al. [6] for the supramediterranean belt. The new association we propose is found in 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 *Echinospartum ibericum* explains the sole dominance of *Juniperus oxycedrus* subsp. *badia*. The low floristic differentiation between EJ and GJ is due to the fact that the main differentiating floristic elements, *Echinospartum ibericum* and *Genista polyanthos*, are infrequent in their respective plant communities; whereas *Echinospartum ibericum* is exclusive to the supramediterranean thermotype, *Genista 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*.



**(a)** **(b)**

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

In contrast, the new association GJ contains species of interest such as *Genista polianthos*, which acts as a differential species from the exclusively

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supramediterranean association of *Echinosparto iberici-Juniperetum badiae*. We therefore propose the new syntaxon *Genisto polyanthi-Juniperetum badiae* (Table 1 rel. 1 to 11 typus rel. 1), located in the Marianico-Monchiquense sector. The juniper forest of *Juniperus oxycedrus* subsp. *badia* in the eastern territories of the Iberian Peninsula (Portugal) is present in small mountain ranges with a quartzite character with frequent mesophytic flora, as the mesomediterranean thermotype, and subhumid-humid ombrotype continue to prevail. 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. [30].

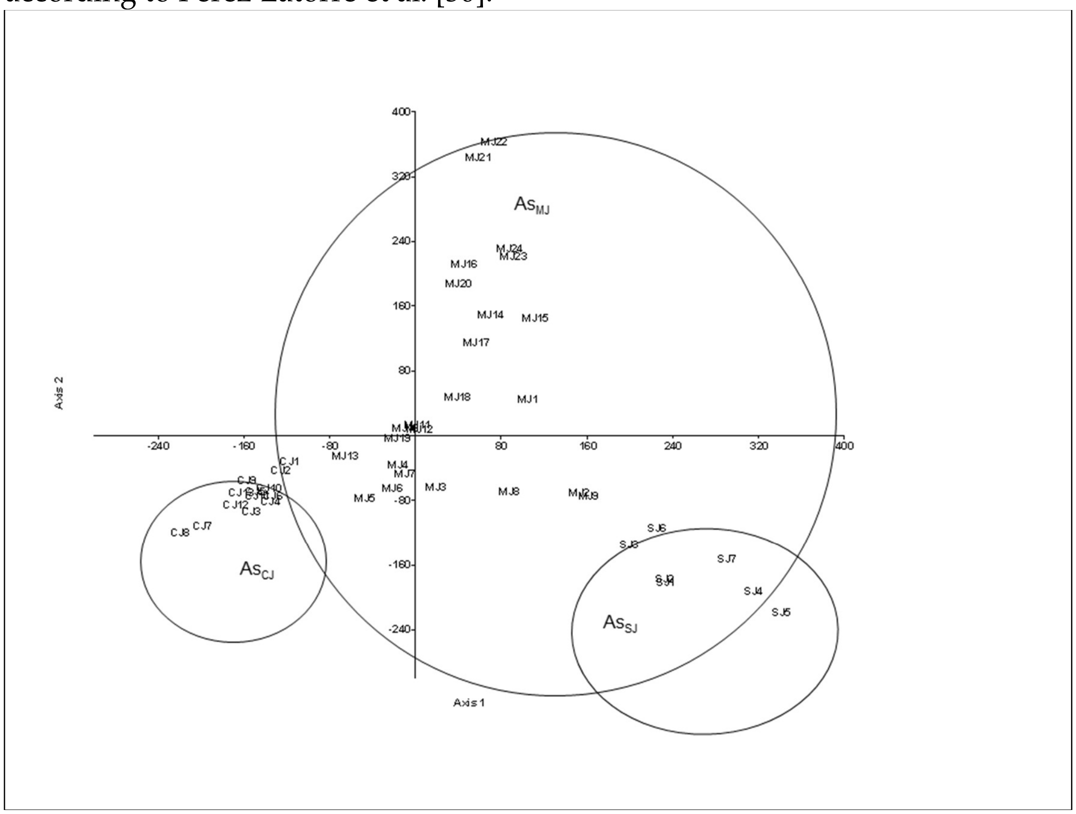


**Figure 3.** DCA ordination analysis of associations MJ, SJ and CJ in GI group.

**Table 1: Ass. *Genisto polyanthi-Juniperetum badiae* nova GJ**

| Nº order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area m² | 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 height of veg.(m.) | 1,2 | 0,5 | 0,9 | 1,5 | 1,3 | 1,8 | 1,4 | 1,5 | 1,5 | 1,3 | 1,5 | |
| Nº Cluster | GJ1 | GJ2 | GJ3 | GJ4 | GJ5 | GJ6 | GJ7 | GJ8 | GJ9 | GJ10 | GJ11 | |
| **Characteristic of association and higher units** | | | | | | | | | | | | P |
| *Juniperus oxycedrus* subsp. *badia* | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 11 |

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| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *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 |
| *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).

**Localities:** GJ1. Monte Manzano. Prox. Torre Castañarejo (30S0449835/4256709); GJ2. Collado Grande. Torre Vigilancia (30S0443300/4257119); GJ3. Desembocadura del Río Montoro (30S0417604/4253109); GJ4. Pico Estrella. Finca Ruichoto (30S0448476/4250771); GJ5. Monte Manzano. Peñón de Atilano (30S0447322/4255301); GJ6. Abulagoso (30S0385725/4258301); GJ7. Cañada Real (30S0450280/4256964); GJ8. Piedrallana (30S0450483/4256122); GJ9. Monte 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 *Juniperus 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 *Juniperus oxycedrus* subsp. *badia*, *Pistacia terebinthus*, *Pistacia lentiscus*, *Phlomis purpurea*, *Myrtus communis*, *Aristolochia baetica*, *Asparagus aphyllus*, *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). This association is close to *Stipo tenacissimae-Juniperetum badiae*, but is differentiated from it by the type of substrate, thermocline, floristic composition

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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.

GII Group is formed by JPB, TJ and PJ. In this case, a DECORANA 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 TJ– 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).

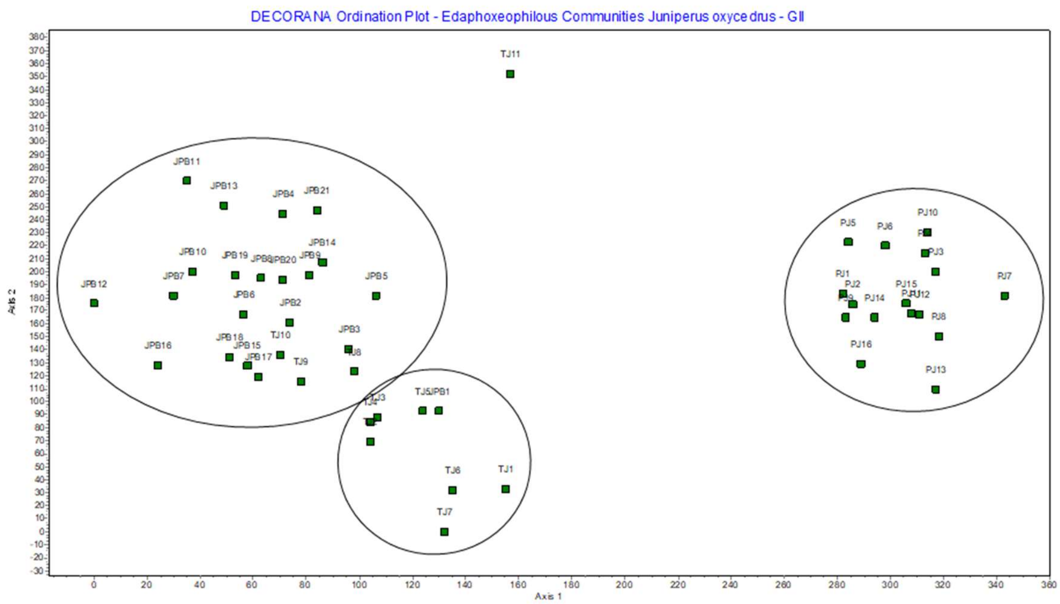


**Figure 4.** DECORANA ordination analysis of the associations JPB, TJ and PJ in GII group.

The GII$_{JPB}$ subgroup *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 *Juniperus oxycedrus* subsp. *badia*, *J. oxycedrus* subsp. *oxycedrus* and *J. phoenicea* (Table 3 rel. 1 to 21 typus rel. 17).

This GII group includes GII$_{PJ}$ *Pistacio terebinthi-Juniperetum badiae* for Toledan territories and in the north of the province of Ciudad Real. Particularly significant are the olive groves in the Subbético mountain ranges that grow in the subhumid-humid meso- and supramediterranean in rocky areas or debris fields on mountainsides. This community is physiognomically dominated by *Pistacia terebintus*, with other floristic elements such as *Juniperus oxycedrus* subsp. *badia*, *J. phoenicea* and *Teline patens*. We propose the association *Teline patentis-Pistacietum terebinthi* nova (Table 4 rel. 1 to 11 typus rel. 2). This association is differentiated from *Phillyreo latifoliae-Pistacietum terebinthi* Pavón Núñez et al. 2013 [31] due to the

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absence of the thermophilous elements *Clematis cirrhosa*, *Aristolochia baetica*, *Rhamnus oleoides*, *Rhamnus 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, in Table 1 relevés 3, 4 and 5 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 ones in the Bétic biogeographic province.

*3.2. Synthetic analysis of vegetation*

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 1975 as *Juniperus oxycedrus* subsp. *oxycedrus, J. oxycedrus* subsp. *badia, Pistacia lentiscus, Quercus coccifera, Pistacia terebinthus, Phillyrea latifolia, P. angustifolia, Rhamnus alaternus, R. lycioides, R. oleoides, Pinus halepensis, Arbutus unedo, Asparagus albus.* The floristic composition of the associations allows us to include them in the alliance *Juniperion badiae*, that is a thermo- to supramediterranean dry juniper scrub of the Luso-Extremadurean Province of the Central Iberian Peninsula [6, 24].

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**Table 2: Ass. *Myrto communis-Juniperetum badiae* nova MJ**

| Nº order | 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 m² | 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 height of veg.(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 | |
| Nº Cluster | MJ1 | MJ2 | MJ3 | MJ4 | MJ5 | MJ6 | MJ7 | MJ8 | MJ9 | MJ10 | MJ11 | MJ12 | MJ13 | MJ14 | MJ15 | MJ16 | MJ17 | MJ18 | MJ19 | MJ20 | MJ21 | MJ22 | MJ23 | MJ24 | |
| **Characteristic 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 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Rhamnus alaternus* | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 1 | . | . | . | 1 | . | . | . | 3 |
| *Quercus broteroi* | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | + | . | . | . | . | . | . | . | 3 |
| *Asparagus acutifolius* | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | 2 |
| *Thapsia villosa* | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | 2 |
| *Phillyrea latifolia* | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | 1 | . | . | . | 2 |
| *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 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *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 |
| *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(+).

**Localities:** MJ1. Mora de Toledo (Toledo) (Cano et al. 2007), (*Stipo tenacissimae-Juniperetum lagunae*); MJ2. Mora de Toledo (Toledo) (Cano et al. 2007), (*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) (Cano et al. 2007), (*Stipo tenacissimae-Juniperetum lagunae*); MJ9. Marjaliza (Toledo) (Cano et al. 2007), (*Stipo tenacissimae-Juniperetum lagunae*); MJ10. Sierrra Madrona (30S04067709/4250513); MJ11. Sierra Quintana (oeste) (30S0391176/4250840); MJ12. Pantano de la 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. Prox.

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San Benito (30S0352613/4271155); MJ19. Extremo oriental sierra Almadén (30S0346378/4291566); MJ20. Desembocadura del Río Montoro (30S0417854/4253846); MJ21. Garganta del Río Viar (Sevilla) (Cano et al. 2007), (Community of *Phlomis purpurea*); MJ22. Garganta del Río Viar (Sevilla) (Cano et al. 2007), (Community of *Phlomis purpurea*); MJ23. Garganta del Río Viar (Sevilla) (Cano et al. 2007), (Community of *Phlomis purpurea*); MJ24. Garganta del Río Viar (Sevilla) (Cano et al. 2007), (Community of *Phlomis purpurea*).

**Table 3: Ass. *Juniperetum phoeniceo-badiae* nova JPB**

| Nº order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area $m^2$ | 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 height of veg.(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 | |
| Nº Cluster | JPB1 | JPB2 | JPB3 | JPB4 | JPB5 | JPB6 | JPB7 | JPB8 | JPB9 | JPB10 | JPB11 | JPB12 | JPB13 | JPB14 | JPB15 | JPB16 | JPB17 | JPB18 | JPB19 | JPB20 | JPB21 | |
| **Characteristic 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 |

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| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *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 |
| *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(+), Cuprina 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. reverchoniiJPB16(+), 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(+).*

Localities: JPB1.- Casilla de los Rajones. JPB2 and JPB5.- Alto de las Muelas. JPB3.- Los Yegüerizos. JPB4.- Bujaraiza.JPB 6.- 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.- Embalse de Aguascebas. JPB16.- San Antón. JPB19.- Subida al Nacimiento del Guadalquivir. JPB20 and JPB21.- Carretera Quesada-Pozo Alcón.

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**Table 4: Ass. *Teline patentis-Pistacietum terebinthi* nova TP**

| Nº order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area 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 height of veg.(m.) | 3.0 | 2.0 | 2.0 | 8.0 | 2.5 | 4.0 | 4.5 | 3.5 | 2.0 | 3.0 | 3.0 | |
| Nº Cluster | TP1 | TP2 | TP3 | TP4 | TP5 | TP6 | TP7 | TP8 | TP9 | TP10 | TP11 | |
| **Characteristic 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 |

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| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *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(+).

**Localities:** 1 and 2.- Prox. Presa del Tranco. 3.- Puntal del Poyo Gonzalo. 4.- Cerro de los Cabezones. 5.- Barranco del Obispo. 6.- Los Blancores. 7.- Prox, Finca de Mihí. 8.- Embalse del Aguascebas. 9.- Monte de Solegas Anchas. 10.- Cañada de los Caballeros. 11.- Subida al Nacimiento del Guadalquivir.

### *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 [32,33]. All the plant communities growing on rocky crests and in steeply sloping areas are very significantly influenced by the soil, which conditions 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), rich in heavy cations, with a high content of ferromagnesium minerals [34]. In the Betic mountains (southern Spain) there are with some frequency marble limestone, gypsum and serpentines [35]. The rainfall values for the territories of serpentines (Sierra Bermeja) influence a wet ombrotype, very like the values precipitations of the mountains in northwestern Serbia [36] and, due to the xericity of serpentines, often appear forests and scrublands not in accordance with the ombrotype of the territory: plants living here, present ecophysiological and morpho-anatomical adaptations to support the limitations [37]. 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 evapotranspiration (ETP). However, as plants have the capacity to self-regulate their losses, it can be accepted that the residual evapotranspiration e = 0.2ETP. There are therefore two parameters (e and WR) implicated in the development of a vegetation that is essentially conditioned by rainfall. The ombroclimatic index (Io) therefore does not explain the presence of plant communities that are influenced by the substrate, and we propose the new

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Ombroedaphoxeric Index ($I_{oex}$) which explains the presence of the communities of *Juniperus* in territories with a thermotype ranging from the thermo to the supramediterranean belt.

$I_{oex} = P_p\text{-}e/T_p \times WR$

$P_p$ = mean annual precipitation; $T_p$ = mean annual temperature [29]; e = residual evapotranspiration whose value is 0.2. ETP [28]; WR = retention capacity 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 [38]. The value of ETP is obtained by applying the formula of Thornthwaite $ETP_{monthly} = 16(10.T/I)^a$, 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 $I_o$ and $I_{oex}$ in some localities in the southern Iberian Peninsula.**

| Estación meteorológica | $P_p$ | $T_p$ | $I_o$ | Ombrotype | ETP | e | $I_{oex1}$ | $I_{oex2}$* | $I_{oex3}$ | Ombroclimático behavior of the locality |
|---|---|---|---|---|---|---|---|---|---|---|
| Almadén-Minas (CR) | 625,2 | 194,4 | 3,2 | dry | 808,54 | 161,7 | 0,59 | 1,19 | 1,78 | semiarid |
| Cabezas Rubias (H) | 993,4 | 177,6 | 5,6 | subhumid | 702,14 | 140,42 | 1,2 | 2,4 | 3,6 | dry |
| Aracena (H) | 1025,8 | 175,2 | 5,9 | subhumid | 703,46 | 140,69 | 1,26 | 2,52 | 3,78 | dry |
| Santiago Pontones (J) | 1148,7 | 164,4 | 7 | subhumid | 675,23 | 135,04 | 1,54 | 3,08 | 4,62 | dry |
| Vadillo Castril (J) | 1182,2 | 140,4 | 8,4 | humid | 488,88 | 97,72 | 1,93 | 3,86 | 5,79 | subhumid |
| Grazalema (Ca) | 1962,2 | 183,6 | 11 | humid | 726,22 | 145,24 | 2,47 | 4,94 | 7,42 | subhumid |
| Montoro (Co) | 522,4 | 210 | 2,5 | dry | 903,15 | 180,63 | 0,4 | 0,81 | 1,22 | arid |
| Pozoblanco (Co) | 514,4 | 193,2 | 2,7 | dry | 805,45 | 161,09 | 0,45 | 0,91 | 1,37 | arid |
| Villanueva del Arzobispo | 698,2 | 196,8 | 3,5 | dry | 915,7 | 183,14 | 0,65 | 1,3 | 1,96 | semiarid |

Applying the formula $I_{oex}$ for the assumptions that WR is 0.25, 0.50 and 0.75, we obtain three values, of which the most representative is $I_{oex2}$. 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 values of $I_{oex2}$ of 3.86 and 4.94, which is equivalent to subhumid. This allows the existence in rocky areas of an edaphoxerophilous community of *Quercus faginea* s. l. or *Abies pinsapo*, as occurs in Grazalema (Cadiz), and a value of $I_{oex1}$ = 2.47 in the case that WR = 25%. In this situation, there is a presence of an edaphoxerophilous community of *Quercus ilex* subsp. *ballota* in Cazorla (Jaén) and in Grazalema (Cádiz). When the underlying ombrotype is subhumid, the equivalence value of $I_{oex2}$ corresponds to dry; an underlying dry "Io" gives semiarid, and even arid values of $I_{oex2}$ if the underlying horizon is lower than dry.

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This does not allow the development of *Quercus* tree species, but does allow the genus *Juniperus.* The value of $I_{oex}$ is affected by climate change, as evidenced by Del Río et al. [39]. According to the authors, this change is taking place with a heterogeneous pattern in terms of annual rainfall redistribution, which is decreasing in most of the mountainous areas of Grazalema, Ronda, Cazorla, Segura, Sierra Nevada and a large part of the Sierra Morena. However, these authors have detected an increase in rainfall on the Andalusian coast and particularly in Almería. This affects forest stands, and –together with human activity [10]– favours a redistribution of the current forests in the form of a decline in the forests of *Quercus* and an increase in the microforests of *Juniperus*.

## 4. Discussion

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*.

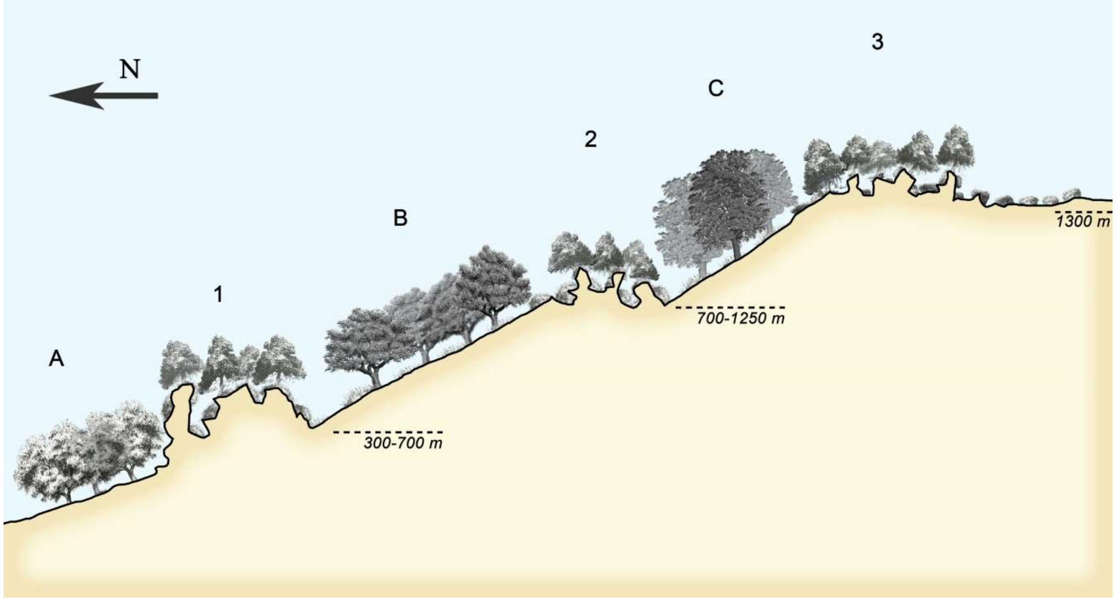


Figure 5. A, B and C climatic forests of: A) *Myrto communis-Quercetum rotundifoliae*; B) *Poterio agrimonioidis-Quercetum suberis*; C) *Arbuto unedonis-Quercetum pyrenaicae.*

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1, 2 and 3 edaphoxerophilous microforests of *Juniperus sp.*: 1) *Myrto communis-Juniperetum badiae*; 2) *Genisto polianthi-Juniperetum badiae*; 3) *Echinosparto iberici-Juniperetum badiae*.

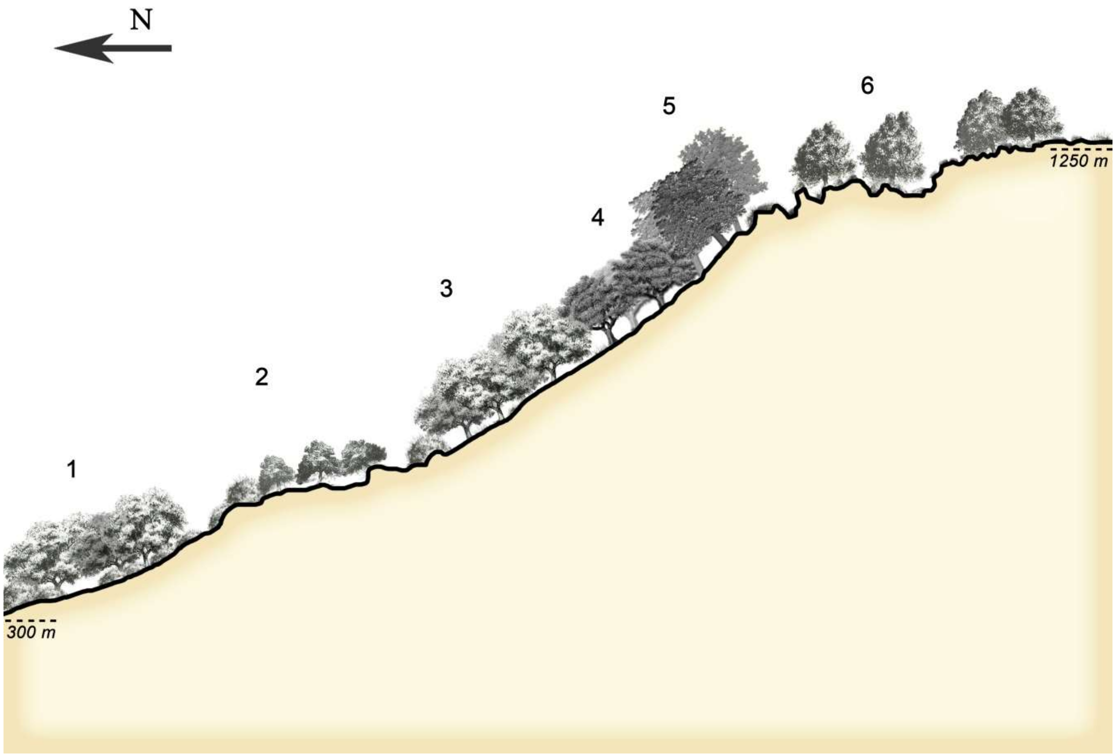


**Figure 6.** 1. *Myrto communis-Quercetum rotundifoliae*. 2. *Myrto communis-Juniperetum badiae*. 3. *Pyro bourgaeanae-Querctum rotundifoliae.* 4. *Poterio agrimonioidis-Quercetum suberis*. 5. *Arbuto unedonis-Quercetum pyrenaicae.* 6. *Echinosparto iberici-Juniperetum badiae.*

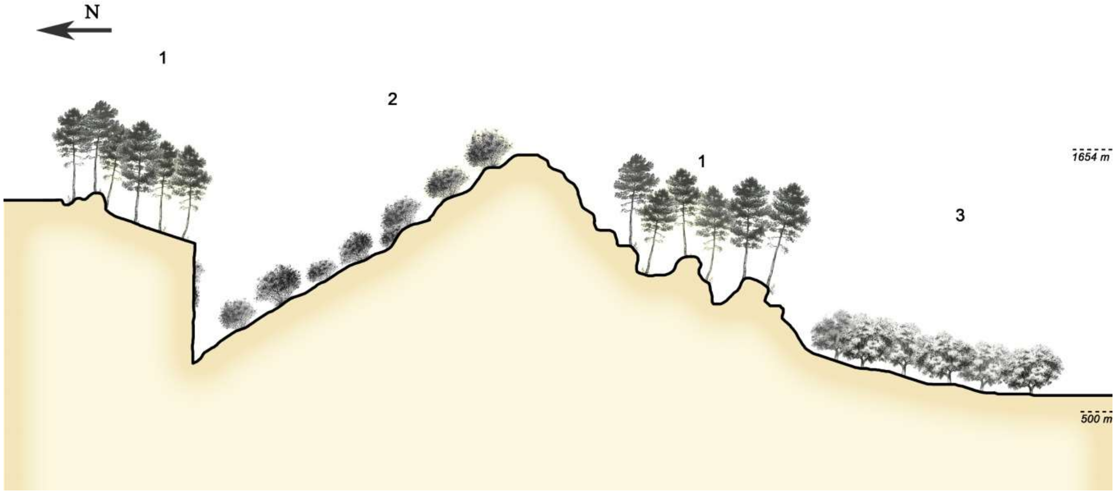


**Figure 7.** 1 Pinewood of *Rhamno lycioidis-Pinetum halepensis.* 2 Olive grove of *Teline*

*patentis-Pistacietum terebinthi*. 3 Holm oak forest of *Paeonio-Quercetum rotundifoliae* (Cazorla, Mágina).

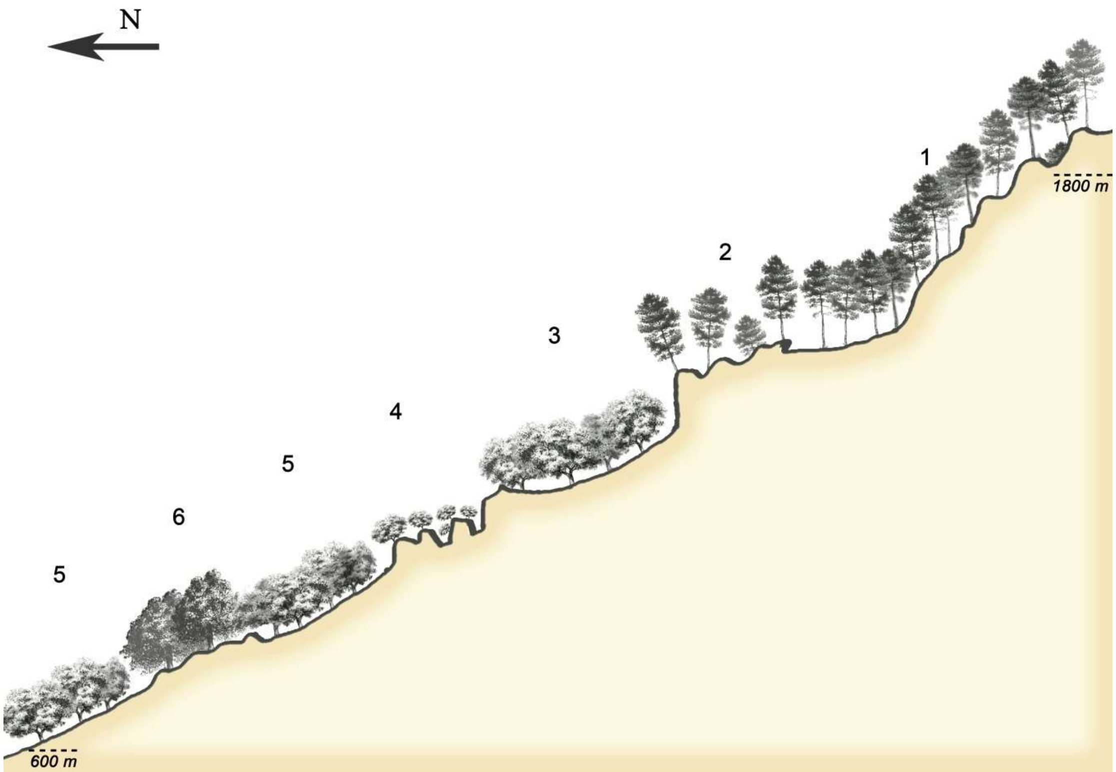


**Figure 8.** 1 and 2 Pine forest of *Junipero phoeniceae-Pinetum clusianae*. 3. Forests of *Viburno tini-Quercetum alpestris*, *Berberido hispanicae-Quercetum alpestris* and *Daphno latifoliae-Aceretum granatensi*. 4 Edaphoxerophilous holm oak forest. 5 Holm oak forest of *Paeonio coriaceae-Quercetum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

## 5. Conclusions

In conclusion, 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 therefore edaphoxerophilous formations with a permanent character that occupy restricted areas, but which 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. 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 which are rich in endemic species; the rate of endemics is 12 and accounts for 60% of their flora.

With the study of these wild areas, we have detected 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. For all these reasons, it is recommended to think conservation measures by applying a protection status to allow control over the management of the territory, for example establishing micro-reserves for the conservation of flora and habitats, according to [40]: all this can allow a sustainable development of these territories.

Finally, we want to highlight that the phytosociological approach and a statistical analysis are everytime fundamental for the study and the better knowledge of plant communities: all these data (more others such as phytotoponims) are very important to their conservation and/or restoration as considered by several authors [7,40-45]. And more, we consider also important to planning actions for an efficient management of the habitat 5210: "Arborescent matorral with *Juniperus ssp*." present in Portugal and Spain. Based on all these informations, for a sustainable development and a territorial cohesion between these two nations, it is desiderable planning actions with cross-border-cooperation projects, basing on other experiences in this field [46,47].

**Syntaxonomic 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 corr.

*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 Fuentes, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 *nom. corr. hoc loco*

*Stipo tenacissimae-Juniperetum* Cano, Rodríguez Torres, Pinto Gomes, García Fuentes, Torres, Salazar, Ruiz, Cano-Ortiz & Montilla 2007 *nom. corr. hoc loco*

*Juniperetum phoeniceae-badiae* nova hoc loco
*Teline patentis-Pistacietum terebinthi* nova hoc loco
*Myrto communis-Juniperetum badiae* nova hoc loco
*Genisto polyanthi-Juniperetum badiae* nova hoc loco

**Author Contributions:** Conceptualization, Eusebio Cano; Data curation, Carmelo Maria Musarella, Ana Cano-Ortiz, Sara Del Rio González and Giovanni Spampinato; Formal analysis, Carmelo Maria Musarella, Ana Cano-Ortiz, José Carlos Piñar Fuentes and Sara Del Rio González; Investigation, Eusebio Cano, Carmelo Maria Musarella, Ana Cano-Ortiz, José Carlos Piñar Fuentes, Alfonso Rodríguez Torres, Carlos Pinto Gomes and Ricardo Quinto-Canas; Methodology, Eusebio Cano; Software, Ana Cano-Ortiz, José Carlos Piñar Fuentes and Sara Del Rio González; Supervision, Eusebio Cano and Carmelo Maria Musarella; Writing – original draft, Eusebio Cano, Carmelo Maria Musarella and Ana Cano-Ortiz; Writing – review & editing, Eusebio Cano, Carmelo Maria Musarella, Ana Cano-Ortiz, José Carlos Piñar Fuentes, Alfonso Rodríguez Torres, Sara Del Rio González, Carlos Pinto Gomes, Ricardo Quinto-Canas and Giovanni Spampinato.

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

## Appendix A

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

**Appendix A:** Synthetic table of relevés

| Characteristic | JPB | TJ | MJ | EJ | FJ | CJ | PJ | SJ | GJ |
|---|---|---|---|---|---|---|---|---|---|
| *Juniperus oxycedrus* subsp. *badiae* | 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 | . |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *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 |
| *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 | . |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *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 | . | . | . | . | . | . | . | . |
| *Fumana paradoxa* | I | . | . | . | . | . | . | . | . |
| *Helictotrichon filifolium* | I | . | . | . | . | . | . | . | . |
| *Cuprina 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 | . | . | . | . | . | . | . | . |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *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 | . | . |
| *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 | . | . | . | . | . |

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|---|---|---|---|---|---|---|---|---|---|
| *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 | . | . | . | . |
| *Genista cinerascens* | . | . | . | . | I | . | . | . | . |
| *Sedum hirsutum* | . | . | . | . | IV | IV | . | . | . |
| *Simethis planifolia* | . | . | . | . | . | II | . | . | . |
| *Polypodium cambricum* | . | . | . | . | . | I | . | . | . |
| *Adenocarpus anisochilus* | . | . | . | . | . | I | . | . | . |

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| *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 |

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