Chapter

Intensive Habitat Loss in South Spain: Arborescent Scrubs with *Ziziphus* (5220*)

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Abstract

The habitat arborescent matorral with *Ziziphus* (5220*) was included in the Habitats Directive of the European Commission. These plant formations represent the maximum potential vegetation in a very restrictive arid environment, since it encompasses endemic, tropical, or Maghrebian floristic elements, and from other areas of the ancient Thetis Sea. In fact, the version of this community with *Gymnosporia senegalensis* (Lam.) Loes. [=*Maytenus senegalensis* (Lam.) Exell] constitutes extraordinarily singular flora formations in the Iberian southeast. These are unique communities in Europe and ecologically extremely valuable and, however, have been included among the Europe's most endangered habitats. The vast economic development experienced in South Spain based on the remarkable transformation of traditional farming patterns into a highly profitable agriculture that uses industrial production methods and the groundwater intensively (agriculture intensification and land-use change), in addition to urbanization without sustainable land planning, determines that European *G. senegalensis* populations are seriously threatened by severe habitat destruction and fragmentation.

Keywords: habitat fragmentation, Mediterranean Basin, priority coastal habitat, semiarid ecosystems, *Ziziphus lotus*

1. Introduction

Mediterranean arborescent scrubs with *Ziziphus* Mill. species have been coded as habitat 5220* (arborescent matorral with *Ziziphus*) and included in the Habitats Directive of the European Commission since 1992 [1], which lists Europe's most endangered and vulnerable habitats. These plant communities, recognized in the Iberian Southeast, Cyprus, Sicily, and surrounding islands, are composed mainly by pre-desert deciduous scrub with *Ziziphus lotus* (L.) Lam. or *Gymnosporia senegalensis* (Lam.) Loes. [=*Maytenus senegalensis* (Lam.) Exell; =*Maytenus senegalensis* subsp. *europaeus* (Boiss.) Rivas Mart. ex Güemes & M.B. Crespo] and smaller specimens of *Periploca laevigata* Aiton subsp. *angustifolia* (Labill.) Markgraf, *Lycium intricatum* Boiss., *Asparagus horridus* L., *A. albus* L., *Withania frutescens* (Sims) Sweet, etc. The largest patches of these communities are distributed in the arid Iberian southeast under a xerophytic thermomediterranean bioclimate and correspond to the mature phase or climax of the climatophilous and edapho-xero-psammophilous vegetation series [2–4].

The Mediterranean Basin, and specifically the eastern region of Andalucia (Spain) and some islands as Sicily (Italy), accumulates a group of environmental conditions which result in the existence of these variety of habitats that have given shelter to paleoendemic species and favored specialization processes [5, 6]. This habitat, which is represented by the communities of arborescent scrub with *Ziziphus*, forms the type of vegetation that can produce the maximum of biomass in relation to the prevailing climatic conditions. These conditions include an arid and warm summer, typical of the Mediterranean climate, with low or no water availability for plants. In addition, the arrangement of this type of vegetation in hemispherical clusters is very impressive from the landscape point of view, and it has elicited various interpretations about the community dynamics [7].

2. Diagnosis

Typical scrub formations of the pre-desert climate are characterized by the presence of thorny, intricate species with leaves of small size and that are often deciduous. These types of vegetation are controlled by climatological factors such as the absence of frost, the water deficit during the dry season (high temperatures and absence of precipitation), mild annual average temperatures, and high solar radiation throughout the year [8]. The cases with greater development correspond to communities characterized by several strata of shrubs, bushes, and herbaceous species, dominated by shrubs up to 3 m high, thorny and impenetrable, which are often aggregated forming islands of vegetation (**Figure 1**). Taxa of tropical-subtropical origin or relicts of past climatic conditions, such as *Z. lotus*, *G. senegalensis*, *P. laevigata* subsp. *angustifolia*, etc., dominate them.

They develop below 300 m elevation, in semiarid and frost-free environments, on various types of substrates, although with preference for limestone, occupying depressions, riverbeds, and sporadic water flow zones, where the roots of these large shrubs could get water [9, 10].

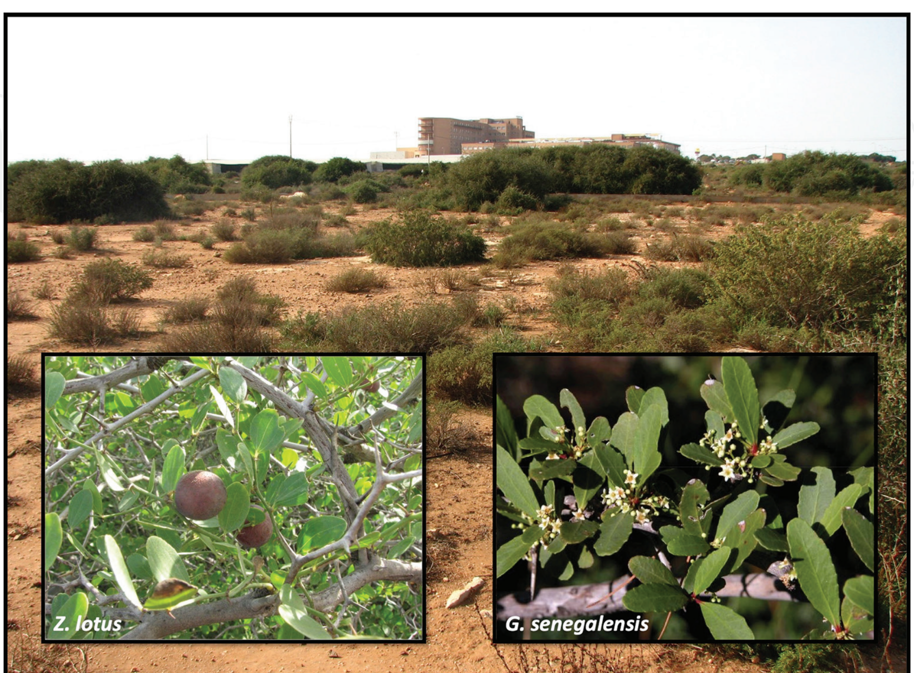

Figure 1.
General view of the habitat 5220 and zoom on Z. lotus and G. senegalensis.*

These plant communities are very interesting for the surrounding fauna and flora, since they can create in their interior a microenvironment that contrasts with the dry and torrid conditions of the external environment, providing refuge and food to reptiles, rodents, and birds, among other groups, as well as favorable nursing processes for a number of plant species [11]. This nursing effect could be due the protection that larger plants provide against browsing of livestock or the favorable microclimatic and edaphic conditions that they promote, as it has been documented to happen in other plant communities of arid and semiarid ecosystems [11–13].

3. Distribution

This habitat is distributed through the Mediterranean Basin. In the European context, it has been inventoried in 55 Natura 2000 sites from three countries, where there are populations of species that characterize it [2]. In Cyprus, it covers an area larger than 113 ha distributed in 11 natural areas, and worthy of note is the presence of this habitat in Italy [14], which appears very locally (1.56 ha) and exclusively in three areas of Sicily, and in some surrounding smaller islands. On the contrary, in Spain, the habitat is more widely distributed and occupies more than 12,900 ha (**Table 1**). It presents in Andalucia, mainly to the south and east of the province of Almeria [15], and in more or less specific zones of the coast of the provinces of Granada and Malaga [4]. In addition, this habitat occupies the southern part of the Region of Murcia and the Valencian Community, in locations clearly exposed to marine influence and other inland territories (**Figure 2**) [16].

Site code	Country	Natura 2000 site	Cover [ha]
CY2000002	Cyprus	Alykos Potamos—Agios Sozomenos	2.78
CY2000003	Cyprus	Periochi Mitserou—Agrokipias	4.65
CY2000006	Cyprus	Dasos Pafou	0.36
CY2000008	Cyprus	Koilada Kedron—Kampos	91.29
CY2000010	Cyprus	Koilada Potamou Maroullenas	0.36
CY2000011	Cyprus	Potamos Peristeronas	0.19
CY3000002	Cyprus	Spa Kavo Gkreko	0.01
CY3000005	Cyprus	Kavo Gkreko	9.38
CY4000013	Cyprus	Faros Kato Pafou	0.43
CY6000003	Cyprus	Periochi Lympion—Agias Annas	2.58
CY6000006	Cyprus	Ethniko Dasiko Parko Rizoelias	1.29
ES0000045	Spain	Sierra Alhamilla	111.00
ES0000046	Spain	Cabo de Gata-Níjar	4024.27
ES0000047	Spain	Desierto de Tabernas	429.00
ES0000048	Spain	Punta Entinas-Sabinar	2.62
ES0000199	Spain	Sierra de la Fausilla	46.54
ES0000200	Spain	Isla Grosa	0.15
ES0000260	Spain	Mar Menor	12.44
ES0000261	Spain	Almenara-Moreras-Cabo Cope	525.31
ES0000262	Spain	Sierras del Gigante-Pericay, Lomas del Buitre-Río Luchena y Sierra de la Torrecilla	5.82

Site code	Country	Natura 2000 site	Cover [ha]
ES0000264	Spain	La Muela-Cabo Tiñoso	329.22
ES0000461	Spain	Serres del Sud d'Alacant	86.36
ES5213023	Spain	Sierra de Callosa de Segura	6.64
ES5213026	Spain	Sierra de Orihuela	33.55
ES6110002	Spain	Karst en Yesos de Sorbas	49.00
ES6110005	Spain	Sierra de Cabrera-Bédar	49.00
ES6110006	Spain	Ramblas de Gérgal, Tabernas y Sur de Sierra Alhamilla	2547.00
ES6110007	Spain	La Serrata de Cabo de Gata	57.53
ES6110008	Spain	Sierras de Gádor y Enix	616.01
ES6110011	Spain	Sierra del Alto de Almagro	1142.50
ES6110012	Spain	Sierras Almagrera, de Los Pinos y El Aguilón	1315.31
ES6110014	Spain	Artos de El Ejido	25.01
ES6110016	Spain	Rambla de Arejos	0.82
ES6110017	Spain	Río Antas	0.06
ES6140011	Spain	Sierra de Castell de Ferro	190.29
ES6140013	Spain	Acantilados y Fondos Marinos Tesorillo-Salobreña	7.22
ES6170002	Spain	Acantilados de Maro-Cerro Gordo	57.38
ES6200001	Spain	Calblanque, Monte de las Cenizas y Peña del Águila	69.33
ES6200006	Spain	Espacios Abiertos e Islas del Mar Menor	16.09
ES6200007	Spain	Islas e Islotes del Litoral Mediterráneo	2.69
ES6200010	Spain	Cuatro Calas	1.86
ES6200011	Spain	Sierra de las Moreras	133.42
ES6200012	Spain	Calnegre	184.97
ES6200013	Spain	Cabezo Gordo	18.69
ES6200015	Spain	La Muela y Cabo Tiñoso	271.82
ES6200024	Spain	Cabezo de Roldán	61.46
ES6200025	Spain	Sierra de la Fausilla	45.08
ES6200031	Spain	Cabo Cope	13.82
ES6200035	Spain	Sierra de Almenara	427.67
ES6200040	Spain	Cabezos del Pericón	3.29
ES6200044	Spain	Sierra de los Victorias	20.54
ES6200046	Spain	Sierra de En Medio	3.91
ITA010014	Italy	Sciare di Marsala	0.10
ITA020014	Italy	Monte Pellegrino	1.44
ITA090013	Italy	Saline di Priolo	0.02
Total habitat 5220* cover			13059.56

Table 1.
Natura 2000 sites where the habitat type 5220 is registered.*

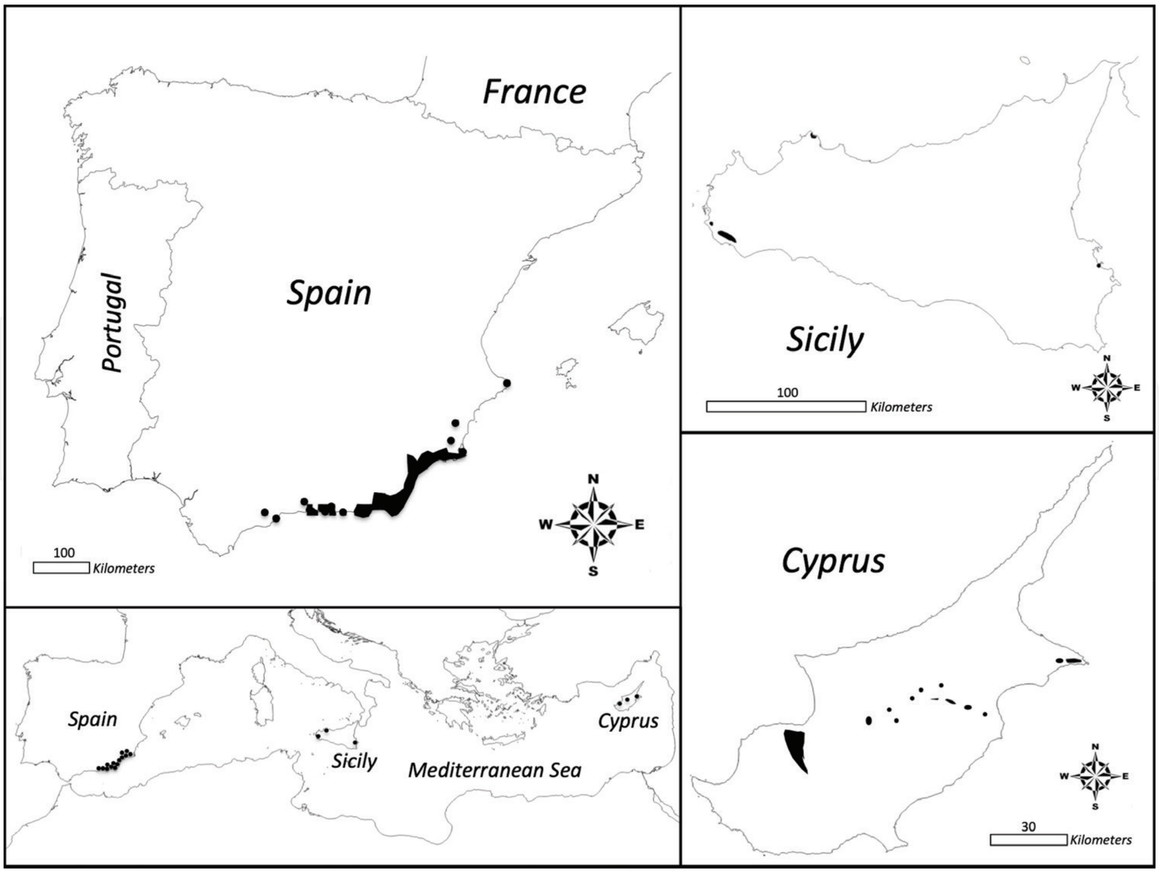

Figure 2.
Inventoried distribution of the habitat type 5220.*

4. Phytosociological associations related to habitat 5220*

The plant communities that constitute the habitat 5220* correspond to different phytosociological associations integrated in the syntaxnomic scheme of the *Quercetea ilicis* Br.-Bl. ex A. & O. Bolòs 1950 class [17–19]. Considering the geographical distribution, the general characteristics of the associations included in the habitat arborescent matorral with *Ziziphus* are listed and detailed below (**Table 2**).

In Italy, the *Z. lotus* communities are included within the alliance *Oleo sylvestris-Ceratonion siliquae*. Particularly, the association *Asparago acutifolii-Ziziphetum loti* defines the vegetation with *Z. lotus* that conserves some specimens of thorny scrubs, settled on white organogenic calcarenites, at altitudes between 5 and 75 m above sea level, in a short band of the northwest coast of Sicily. Communities nowadays relegated to disturbed or even semirural environments, near the towns and the edges of the road, are often in contact with some herbaceous or halophytic formations arranged toward localities of marine influence [20].

Otherwise, the communities of the alliance *Periplocion angustifoliae* are endemic associations with a particular phytosociological and phytogeographic interest. These communities are distributed in bioclimatic areas between the upper inframediterranean semiarid and the lower thermomediterranean dry thermotypes. *Calicotomo infestae-Rhoetum tripartitae* is an association from Sicily, composed of a xerophilous scrub dominated by *Calicotome infesta* (C.Presl) Guss. and linked to particularly arid habitats on calcareous substrates. Interesting elements of North African origin are found, such as *Rhus tripartita* (Ucria) Grande and *R. pentaphylla* (Jacq.) Desf., quite rarely in Sicily. This peculiar vegetation, now reduced to a few patches almost destroyed and fragmented, is found along the coastal strip of the

- *QUERCETEA ILICIS* Br.-Bl. ex A. & O. Bolòs 1950
  - *Pistacio lentisci-Rhamnetalia alaterni* Rivas-Martínez 1975
    - *Oleo sylvestris-Ceratonion siliquae* Br.-Bl. ex Guinochet & Drouineau 1944
      - *Asparago acutifolii-Ziziphetum loti* Gianguzzi, Ilardi & Raimondo 1996
    - *Periplocion angustifoliae* Rivas-Martínez 1975
      - *Calicotomo infestae-Rhoetum tripartitae Bartolo, Brullo et Marcenò 1982*
      - *Periploco angustifoliae-Euphorbietum dendroidis Brullo, Di Martino & Marcenò 1977*
      - *Ziziphetum loti Rivas Goday & Bellot 1944*
      - *Gymnosporio europaei-Ziziphetum loti F. Casas 1970*
      - *Mayteno europaei-Periplocetum angustifoliae Rivas Goday in Rivas Goday, Borja, Esteve, Galiano, Rigual & Rivas-*Martínez 1960
    - *Asparago albi-Rhamnion oleoidis* Rivas Goday ex Rivas-Martínez 1975
      - *Calicotomo intermediae-Maytenetum senegalensis Cabezudo & Pérez Latorre 2001*
      - *Oleo sylvestris-Maytenetum europaei* Díez Garretas, Asensi & Rivas-Martínez 2005

Table 2.
Syntaxonomic scheme of the phytosociological associations that characterize the habitat 5220.*

southeast, in particular, in the area of Sampieri (Ragusa) in contact with formations of the *Crithmo-Limonietea* Molinier 1934 class. The vegetal community *Periploco angustifoliae-Euphorbietum dendroidis* (Sicily and surrounding islands: Pantelleria, Favignana, Levanzo, Marettimo, and Lampedusa [21–24]) characterizes a thermo-xerophilous scrub with *P. laevigata* subsp. *angustifolia* and *Euphorbia dendroides* L., of climatic sort, settled in insular coastal environments on volcanic, calcarenite, calcareous, dolomitic substrates, etc. Sometimes, the same formation can also acquire connotations of extra xericity, linked to the stoniness of the substrate in rocky or subrupicolous environments.

In Spain, several communities that are part of the habitat 5220* also integrate the same alliance (*Periplocion angustifoliae*). The *Ziziphetum loti* association defines a vegetation type composed of intricate spiny shrubs of *Z. lotus* from 1 to 3 m height, among which other species such as *Asparagus albus* and *Ballota hirsuta* (Willd.) Benth. frequently occur, as well as *Ephedra fragilis* Desf. and *Rhamnus lycioides L. subsp. oleoides* (L.) Jahand. & Maire more sporadically. The most striking aspect of the community is the mass of thorny branches, in a very apparent zigzag, that interlace with each other forming almost insurmountable barriers. During the winter, *Z. lotus* loses its leaves, while in late spring they turn in a light green shade, so the community has two highly contrasted aspects of physiognomy [9, 10, 16]. The community seems to be well settled in dry riverbeds; however the plains, which are often widely cultivated, are really its optimum. So *Z. lotus* is relegated to very strong slopes and abandoned crops.

A similar conservation concern happens in the association *Gimnosporio europaei-Ziziphetum loti*, which represents prickly scrubs up to 3 m high, dominated by *G. senegalensis* and usually accompanied by *Z. lotus* [3–5]. This is an endemic plant community of enormous uniqueness and ecological valuableness that is not found in any other part of Europe. Geographically it can be found in the southern area of the province of Almeria (Andalucia), in semiarid thermomediterranean territories with coastal influence.

The community *Mayteno europaei-Periplocetum angustifoliae* represents deciduous by drought shrub formations up to 1.5 m high, dominated by the species *P. laevigata* subsp. *angustifolia* and accompanied by sclerophyllous plants such as *Chamaerops humilis* L., *Pistacia lentiscus* L., *Rhamnus lycioides* subsp. *oleoides*, *Rubia peregrina* L., etc. It is the potential vegetation of the arid inframediterranean strip of southeastern Spain [2, 17, 25, 26]. The abundance of these formations varies from limestone soils where is high, to medium sloped silicate areas where a more open structure is usual, especially in sunny exposures. The dynamic that is related to related to the moist conditions is also remarkable, showing more typical tropical adaptations than Mediterranean ones [9, 10].

Furthermore, habitat 5220* presents in Spain a variation within the alliance *Asparago albi-Rhamnio oleidis*, where the species *Z. lotus* is not found, being the prickly species that characterizes the community is *G. senegalensis*. Two different associations have been described for this vegetation type. On the one hand, *Calicotomo intermediae-Maytenetum senegalensis* [17, 25, 26], which is a medium coverage community characterized by *G. senegalensis*, *Calicotome intermedia* C. Presl, and sporadically *Cytisus malacitanus* Boiss., developed in the thermomediterranean bioclimatic belt with a low-dry ombrotype, on calcareous soils, even of strong slopes. On the other hand, the association *Oleo sylvestris-Maytenetum europaei* represents the *G. senegalensis* thermomediterranean communities that grow in a semiarid ombrotype and are located on coastal limestone walls more or less exposed to the coastal influence or on dry riverbeds inland [3, 4].

5. Conservation of the priority habitat 5220*

This is one of the most outstanding ecosystems in Europe, whose extension of presence has been drastically reduced since the mid-twentieth century. Will the European Union be able to preserve this natural heritage? This is a priority habitat since it represents the potential natural vegetation of the territory (the expected state of mature vegetation in the absence of human intervention), that is, as the forests in other rainy territories, the Mediterranean distributions of species such as *G. senegalensis*, *Z. lotus*, and *P. laevigata* subsp. *angustifolia* indicate the maximum vegetation that the exiguous rainfall allows (**Figure 3**).

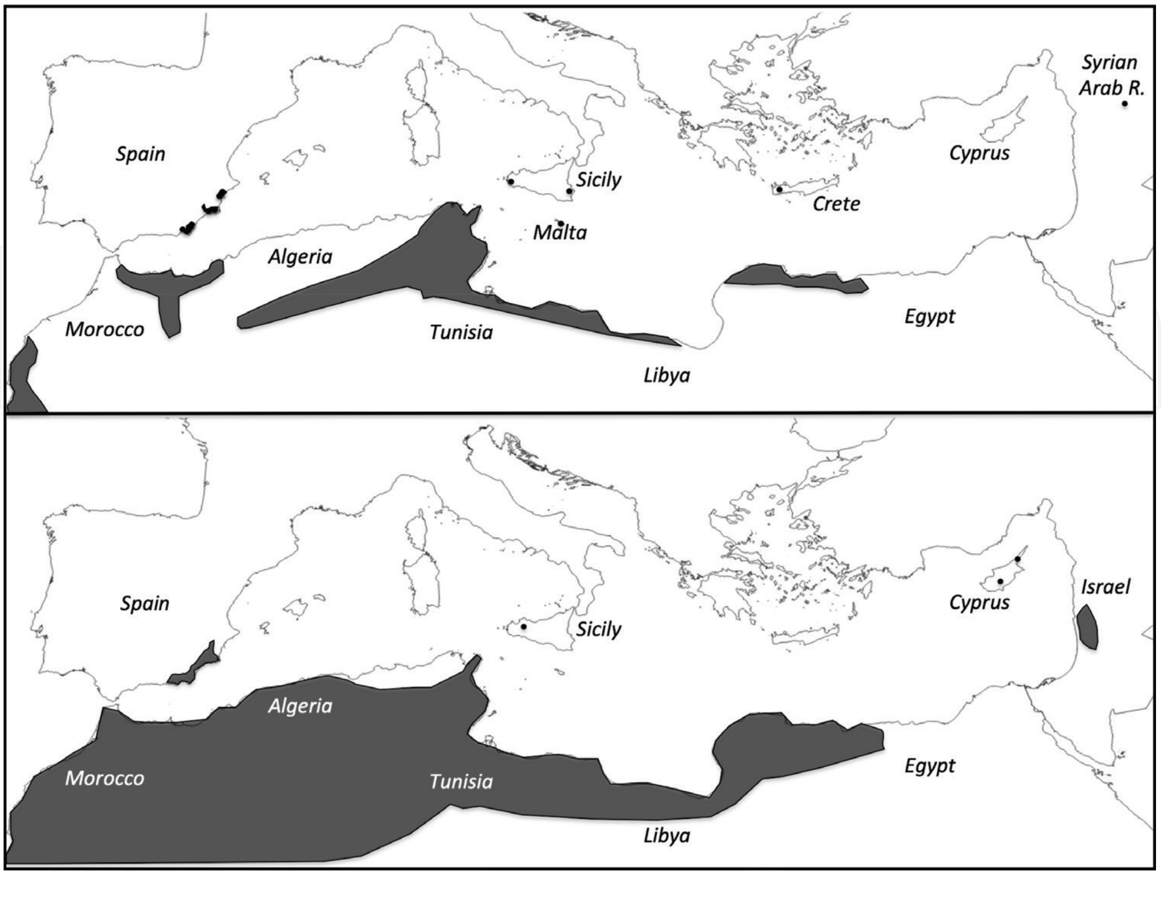

Figure 3.
Distribution of P. laevigata subsp. angustifolia (top) and Z. lotus (bottom) in the Mediterranean Basin [27, 28].

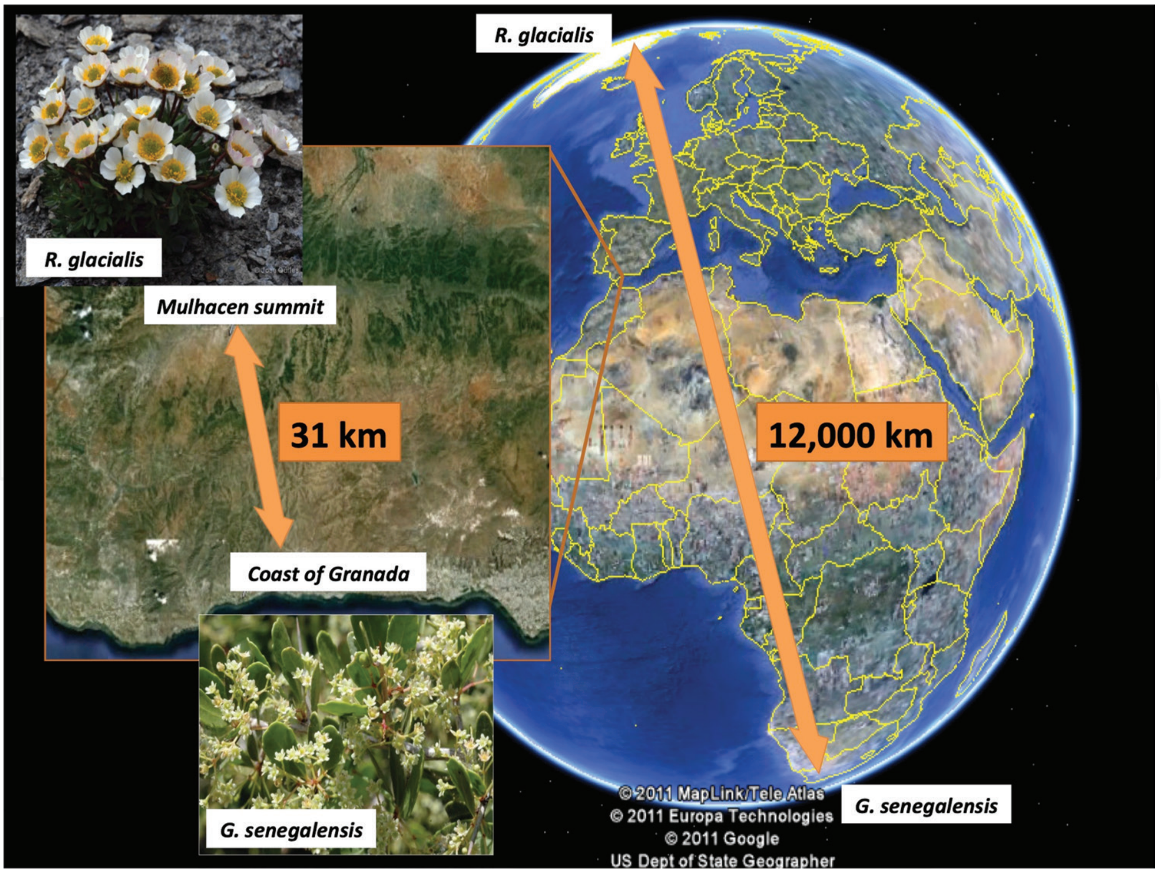

Figure 4.
Global distance between R. glacialis and G. senegalensis most remote populations and documented distance between them in southern Spain.

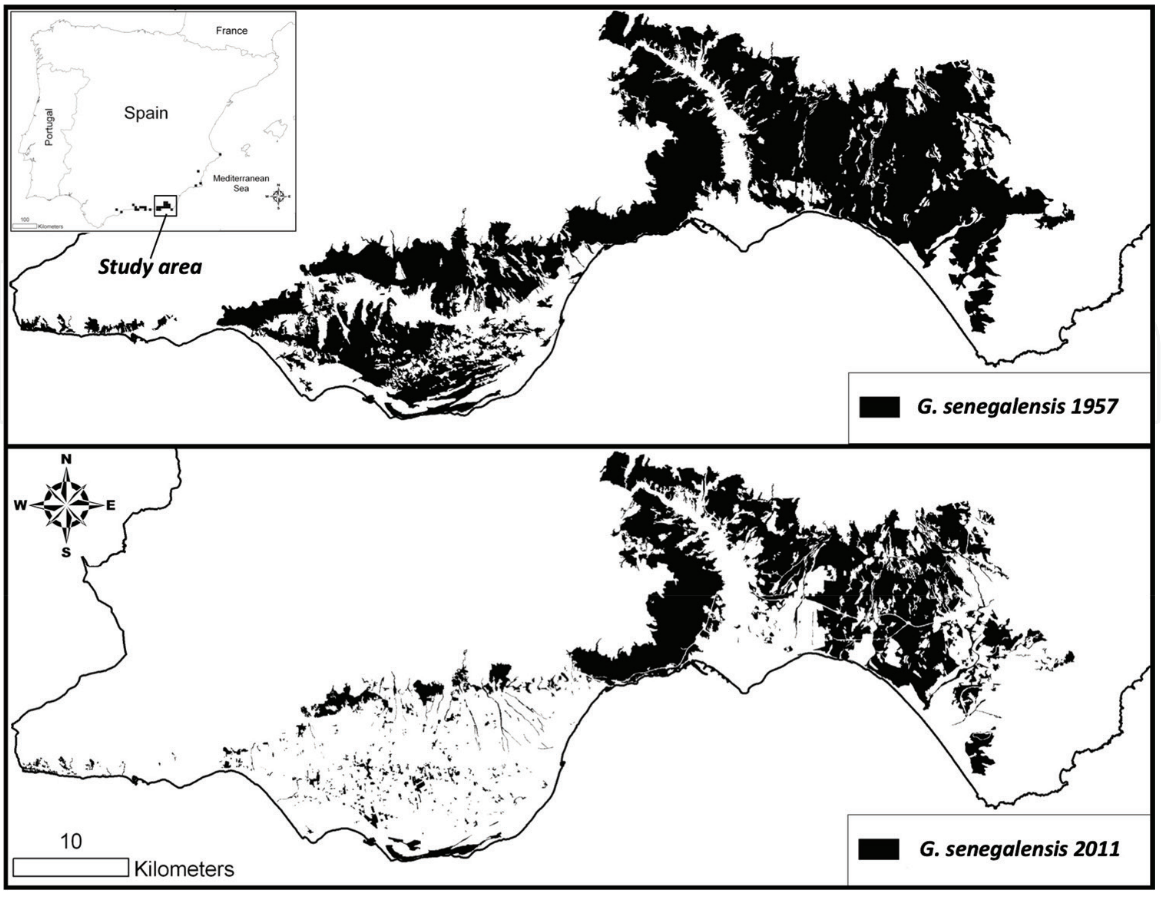

Figure 5.
Distribution area of the G. senegalensis plant formations in 1957 and 2011 in Almeria (Spain) [38].

This habitat is so peculiar that in the south of Spain, there are native flora and vegetation communities that range from *G. senegalensis* formations on the coast to alpine communities of *Ranunculus glacialis* L. The latter species, with populations on the Mulhacen summit at 3400 m,, is the vascular plant that reaches the highest northern latitude, while *G. senegalensis* reaches the coasts of South Africa (**Figure 4**). Their Spanish populations are separated by just 30 km in a straight line; and their most remote populations are separated by almost 12,000 km [29, 30].

In addition, the threat level of each species is very important [1, 31–35], but even more so is that of the communities. In fact, European *Z. lotus* habitats are seriously threatened by severe environmental destruction and fragmentation due to several risk factors such as urbanization, infrastructures, as well as agriculture intensification and land-use change [36, 38].

Some studies carried out in the southeastern of the Iberian Peninsula by combined modeling methods of environmental variables, diachronic study based in the historical photointerpretation of the area and fieldwork, showed the strong habitat regression of these communities [36–38]. Only in the province of Almeria (Andalucia, Spain), more than 26,000 ha of potential area have been lost (extension of presence) for the survival of habitat characteristic species (**Figure 5**).

6. Genetic study of the species *G. senegalensis* in Spain

Reduction in population size, so accentuated in *G. senegalensis* as a consequence of the habitat fragmentation, raises genetic barriers, since the remaining individuals are only a sample of the total number of genes present in the population [39]. Small populations may exhibit an increase in gene drift, inbreeding or outbreeding depression, and a reduction in gene flow [40–43]. The loss of genetic variability as a consequence of habitat fragmentation can have long-term evolutionary consequences and even short-term effects that involve changes at the genetic level that alter suitability and viability of the remaining populations.

Genetic structure of plant populations can be determined by a wide range of factors that interact with each other simultaneously. These factors include short- and long-term processes, such as migration, diversification, habitat fragmentation, and selection, that act at local, regional, and global range and that, when interacting with historical factors, determine geographical patterns of genetic diversity [44].

In addition to habitat loss, and due to the decrease in effective size of populations, local risks are increased by the environmental, demographic, and genetic stochasticity. Therefore, genetic variability erodes due to the random loss of alleles because of the effects of genetic drift, decreasing heterozygosity as a consequence of the increase of endogamic mating [43].

In order to clarify those questions related to the genetic structure of the populations of *G. senegalensis* that could help to establish conservation measures for this species, with the aid of the information generated by Pérez-Salmerón [44], DNA sequences have been used to detect diversity levels, in different localities through species distribution in the Iberian Peninsula (**Table 3**; **Figure 6**). With this information, we will be able to set up the basis for a next design of conservation strategies for this species.

Plant material was collected through the distribution of the species in the Iberian Peninsula (10 populations). Once in laboratory, plant material was dried in silica gel and stored at room temperature. To perform the phylogeographic analysis, DNA sequences of the ITS and trnL-trnF plastid regions were amplified from two individuals of each population, according to previous phylogenetic studies performed in *Celastraceae* family [45, 46]. Ribotype and haplotype networks obtained

Loc.	Cod.	Coord.	Alt.	H	R
El Alquián	ALQ	36°51′N 2°19'W	38	1	2
Baños de Sierra Alhamilla	BAÑ	36°57'N 2°24'W	470	1	1
Cabo de Gata	CAB	36°44'N 2°11'W	55	2	4
El Ejido	EJI	36°45'N 2°48'W	81	2	5
Melicena	MEL	36°45'N 3°14'W	17	2	2,4
Rincón de la Victoria	MSR	36°42'N 4°19'W	58	3	1,6
Cabo de la Nao	NAO	38°44'N 0°13′E	71	2	2,3
Nerja	NER	36°45'N 3°50'W	148	2	2
Velilla	MSM	36°45'N 3°38'W	116	3	2
Portman	POR	37°35'N 0°51'W	58	2	1

Table 3.
Sampled localities in the work developed by Pérez-Salmerón [44], detailing locality (Loc.), locality code (Cod.), coordinates (Coord.), altitude (Alt.), haplotypes (H), and ribotypes (R).

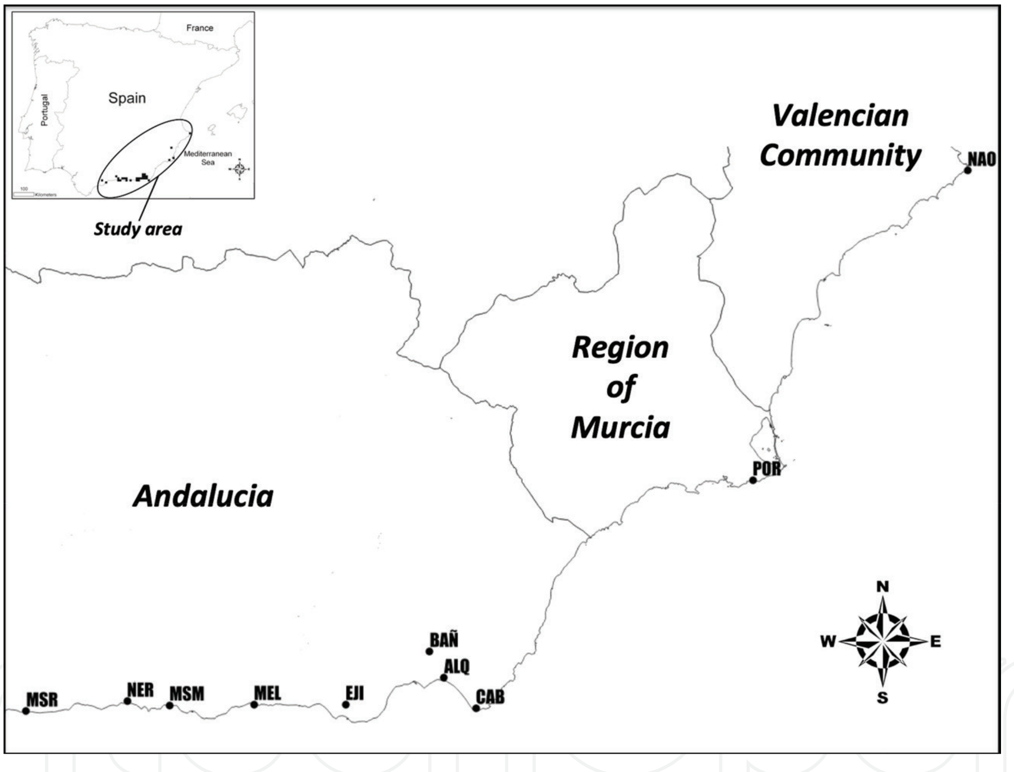

Figure 6.
Distribution of the sampled localities in the population genetic study of G. senegalensis [44].

are shown in **Figure 7**. In the case of the ribosomal sequences, among the 20 samples analyzed, it was possible to detect a total of 7 ribotypes (see **Table 3**). The highest distance between ribotypes occurred between R6 and R3, with a distance of six mutational steps. Ribotypes R2, R4, R5, and R6 were found one step away from each other. The most frequent ribotype was R2 (present throughout the distribution of the species, from NAO to MSR), followed by R1 (also of distribution in POR, MSR, and NAO) and R4 (MEL and CAB); the rest of ribotypes were present in a single locality (CAB, EJI, MSR, and NAO). With respect to plastid sequences, it was possible to detect three haplotypes. The most frequent (H2) was present in central and eastern localities (CAB, EJI, MEL, NAO, NER, and POR), whereas the remainder was present in two localities. The highest distance between the most distant haplotypes was four mutational steps.

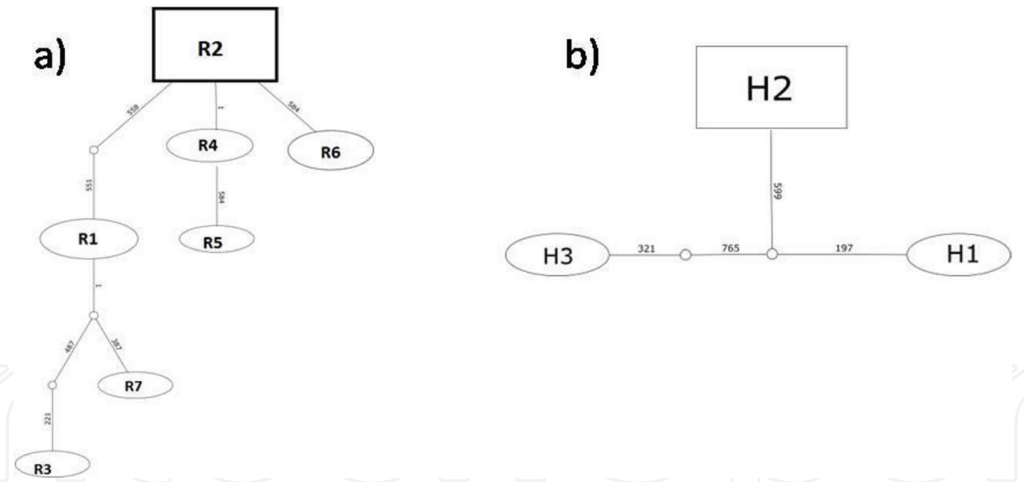

Figure 7.
Ribotype (a) and haplotype (b) networks generated by mean of the maximum parsimony algorithm as implemented in TCS software, by using nuclear (ITS1-5.8S-ITS2) and plastidial (trnL-F) sequences.

Ribotype and haplotype networks showed a low intrapopulation genetic diversity, as well as a lack of differentiation among haplotypes according to its geographical distribution. Thus, for example, R2 ribotype is present throughout the distribution of the species (ALQ, MEL, NAO, NER, MSM), while some of the haplotypes were distributed according to their distribution geographic (H1 and H3), and others not (H2). The underrepresentation of haplotypes and ribotypes in the eastern area is in line with the small area and fragmentation of these localities.

In order to maintain an in situ representation of the found lineages, it would be necessary to adopt conservation measures in at least half of the sampled populations. These populations would be BAÑ, EJI, MEL, MSR, and NAO.

7. Conclusions

This habitat is seriously threatened. The patches where this type of vegetation can be found are disappearing at a huge rate in Spain, and its presence is very scarce in Italy and Cyprus. For this reason it is consider as priority and fits in the main purpose of the Habitats Directive, which aims not only to conserve species but also entire ecosystems. The philosophy is as simple as powerful: only by protecting the community (biocenosis), all its members will be preserved indefinitely. Nowadays, to conserve implies the protection of the ecosystem, and to achieve this it is necessary to include the ecological processes and the biological components (species) that make them possible.

The lists of "Sites of Community Importance" for the conservation of the Natura 2000 Network, and the designation as "Special Areas of Conservation," have proved to be the most important initiatives for the conservation of the priority habitats. In addition, the elaboration of a checklist of characteristic species is a decisive work for the determination of these sites [47]. The management or restoration measures to ensure the favorable conservation status of the priority habitats are constituted by diverse actions implemented within the framework of LIFE+ program of the European Union (EU), among which can be mentioned, for instance, in Cyprus, the project entitled "Improving the conservation status of the priority habitat types 1520* and 5220* at the Rizoelia National Forest Park" (LIFE12 NAT/CY/000758) in which the primary aim has been to promote and enable the long-term conservation of gypsum steppes (*Gypsophiletalia*) and arborescent matorrals with *Ziziphus* in Cyprus, by quantifying and halting natural and anthropogenic pressure and threats that contribute to the long-term degradation of these habitats. In Spain, the Conhabit project 'Preservation and improvement in priority habitats on the Andalusian coast' (LIFE+13/ES/000586) is currently advancing the improvement and preservation of priority habitats found in 15 areas of the Natura 2000 Network on the Andalusian coast, and promoting social awareness of the need to protect these spaces, habitats, and species, some of which are under threat.

It is necessary to continue the elaboration of a precise cartography and the monitoring plans that help to identify the changes in the conservation status [48, 49]. The research on the plant communities should be kept open to better understand its distribution, structure, successional dynamics, and ecological requirements, especially in peripheral population patterns [44, 50]. For instance, genetic studies of *G. senegalensis* populations in Spain conclude that habitat 5220* fragmentation is associated with a progressive and drastic reduction in the size of their populations that could lead to their definitive loss. This fragmentation degree is alarming since it could have some implication with the low levels of genetic variability found (higher in the eastern region, where fragmentation and isolation are greater). These levels of genetic diversity possibly are also associated with paleoclimatic events that have contracted the area of occurrence of the species. The outcomes are worrisome considering the rate of reduction of the populations during the last decades, the adoption of measures being necessary intended for their effective protection.

Acknowledgements

This study has been made possible through the projects "Assessment, Monitoring and Applied Scientific Research for Ecological Restoration of Gypsum Mining Concessions (Majadas Viejas and Marylen) and Spreading of Results (ECORESGYP)" sponsored by the company EXPLOTACIONES RÍO DE AGUAS S.L. (TORRALBA GROUP) and "Integrated study of coastal sands vegetation (AREVEG)" sponsored by CEI·MAR.

Conflict of interest

There are no conflicts of interest.

Thanks

We want to express our gratitude to E. Pérez-Salmerón, B. J. Teruel Giménez, and J. M. López Martos, for the work produced in their final degree projects.

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