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Plant Species Protection in S Spain

Abstract

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Andalusian endangered plant protection is achieved through four diferent actions. Protected natural areas which cover more than 21% of the Andalusian territory and include from National Parks to concerted natural reserves; species protection, with 191 endangered species, protected by law; the establishment of a network of 11 botanic gardens for nature conservation, and the establishment of an Andalusian Germplasm Bank.

Introduction

Andalusia is a region in S Spain which covers aproximately 15% of the total territory of the country (Hernández Bermejo & Clemente 1994).

The orography is very complex, as the results of the Alpine deformation which started in the Cretaceous and had a very intense phase during the Miocene. At this period, a small continental plate, the microplate of Alboran, was forced to drift westwards and collided with the S ridge of the Iberian Peninsula plate which was moving southeastwards and with the N ridge of the African plate which was moving towards the Northwest (Brell 1989). This gave origing to the most intense Alpine folding phase in the area, which arose the internal Betic mountains formed by highly metamorphised materials and with an important vulcanic component. The result has been the formation of several systems of mountains with the maximal altitude at Sierra Nevada, with the Mulhacén (3478 m) and the Veleta (3392 m) picks.

Besides, there is a great diversity of geological materials, including sandstones, limestones, dolomites, schistos, granites, peridotites, marls, gypsum, etc., and many different types of rocks and soils resulting from their breackdown, together with sedimentary and litoral salty and sandy areas, which form all a complex mosaic of very different substrates.

In these conditions, it could be expected that speciation processes, which have played a very important role in the production of an increase of floristic diversity in Andalusia during the end of the Tertiary and along the Quaternary, were especially intense, mainly through the existence of strong geographical and ecological isolation barriers.

Floristic richness of Vascular Plants in Andalusia has been estimated in c. 4000 taxa (Blanca & al. 1999), although this number is probably understimated and the exact figure will only be known with certainty when Flora Iberica (Castroviejo & al. 1986-2005) or project BIOGEO, of which one of the main aims is to produce a floristic checklist of vascular plants of Andalusia and N Morocco, are completed.

Castroviejo (2003) estimates in c. 8000 the number of vascular plant species which occur in the Iberian Peninsula, and this means that in Andalusia, a territory which covers c. 15% Peninsular Spain, grow about half the species which occur in the Iberian Peninsula.

The high botanical singularity of Andalusia can easily be understood if it is considered that of these c. 4000 taxa, 463, this is 11'6% are strictly Andalusian endemics and that 466, this is, another 11'6%, are either Iberian endemics (Blanca & al. 1999), this is, which also occur in other Iberian Peninsula areas, or Ibero-Maghrebian endemics, which occur in the Iberian Peninsula and NW African countries.

Much of this variability concentrates in the mountains, especially Sierra Nevada, Serranía de Ronda, Macizo de Mágina, Sierra de Cazorla, etc., where the percentage of endemicity may be very high, as in Sierra Nevada, where about 30-40% of the taxa which grow in high altitudes are endemic (Blanca 2002).

Some of these endemic taxa are more or less widespread, while other occupy rather small areas, and are sometimes reduced to a single population. Many Andalusian species, especially those growing in mountainous areas are not endangered, but others, especially those growing on the coasts or on wet areas are endangered and sometimes have the risk to become extinct.

The Consejería de Medio Ambiente (formerly Environment Agency or Agencia de Medio Ambiente) of the Andalusian Government (Junta de Andalucía) has allways been very sensitive to the problem of diversity loss and this is why it has developed a wide programme to protect plant species which aim is to guaranty to the maximum possible extent *in situ* and *ex situ* protection, especially to those endangered of extinction or vulnerable.

This programme has been undertaken through four actions: protection of natural areas, protection of taxa, development of a network of botanic gardens for nature protection and the establishment of an Andalusian plant germplasm bank.

1. Protected areas

The only two Andalusian protected areas existing in 1982, National Park of Doñana and Natural Park of Torcal de Antequera, scarcely covered 0'6% of the National Territory (Anonimous 1990). In 1989 a regional law established a Network of Andalusian Protected Natural Areas (La Red de Espacios Naturales Protegidos de Andalucía, RENPA), which includes 152 areas covering over 21% of the total area of Andalusia, which are consequently protected by law. Protected areas include two National Parks: Doñana and Sierra Nevada, 24 Natural Parks, 32 Natural Areas, 28 Natural Reserves and several Concerted Natural Reserves, Forestal Parks and Periurban Protected parks (RENPA 2001) (Fig. 1).

Surface covered by these protected areas varies from 5 ha (Concerted Natural Reserve "Cañada de los Pájaros" near Sevilla) to 209.418 ha (Natural Park of Cazorla-Segura-Las Villas). The widest protected areas which follow in extention to the former Natural Park

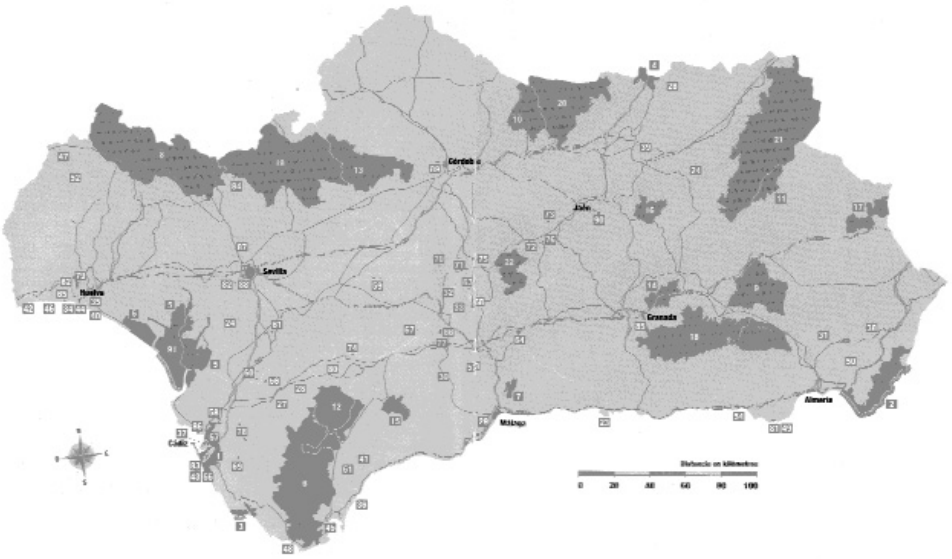

Fig. 1. The protected areas in S Spain.

are the Natural Park of Sierra de Aracena (186.909 ha), the National and Natural Parks of Sierra Nevada, which altogether cover 171.984 ha, the Natural Park of Alcornocales (168.639 ha) and the Natural Park of Sierra Norte, Sevilla (167.439 ha) (RENPA 2001).

Each protected area is provided with a series of facilities which may include a visitors centre, centres for nature interpretation, an exhibit area, a lecture theater to develop courses, seminars, lectures and video-projections, marked itineraries, recreative areas, camping areas, etc. (Anonimous 1998).

2. Species protection

In 1994 the Andalusian Parliament approved an Andalusian Checklist of Endangered Plant Species which includes 70 endangered and 121 vulnerable species which are from then protected by law (see Blanca & al. 1999; Rodríguez Hiraldo & al. 1997). This resulted from the elaboration of a document on plant protection in Andalusia which prepared two years earlier was published almost simultaneously (Hernández Bermejo & Clemente 1994).

Agreements between the Andalusian Consejería de Medio Ambiente and six Andalusian research teams allowed the detailled study of all species listed in the Checklist. Between 1992 an 1999 a total of 59 botanists from the Universities of Córdoba, Granada, Málaga y Sevilla, Córdoba's Botanic Garden and Estación Biológica de Doñana, Sevilla (C.S.I.C.) undertook a series of studies covering the 191 endangered species.

For the 70 endangered species these studies have covered: nomenclature and taxonomic position; morphological variation; geographical distribution; plant community or com-

munities where each species occurs including autoecology, topography, soil types and ecological gradients; demography refered to several populations and including number of specimens, population density and age structure; fenology including growing, flowering and fruit ripening periods; reproductive biology including reproductive systems, pollinators, fruit and seed dispersal, seed germination capacity and fertility; economic and ethnobotanical interest; risks and disturbing factors; proposals for protection measurements at shot, mean and long terms (see Valdés & al. 1999).

For vulnerable species all those aspects but reproductive biology have been studied.

These studies have allowed to know exactly the actual situation of the 191 endangered species. A summary of these studies has been published as a Red Book of Endangered Andalusian Plants in two volumes (Blanca & al. 1999, 2000, with a CD edition in 2002).

A new Law (Ley de la Flora y Fauna Silvestre) was approved by the Andalusian Parliament in October 2003 (Anonimous 2003). This includes the reclassification of those 191 indicated above, considering the following IUCN protection figures:

1. Extinct, or extinct in Nature, such as *Marsilea batardae* Launert, species endemic of Spain and Portugal now extinct in Andalusia, or *Diplotaxis siettiana* Maire, endemic of Island of Alboran (Málaga province) and now extinct, although its reintroduction by the use of seeds which were stored in the Seed Bank of the School of Agronomic Engeneering of Madrid seems to be successful.

2. Endangered species, such as *Lithodora nitida* (Ern) R. Fernandes, endemic of Sierra de Mágina (Jaén province).

3. Vulnerable, such as, by instance, *Nepeta boissieri* Willk., endemic of Sierra Nevada (Granada province).

4. Species of special interest, as it is the case of *Juniperus oxycedrus* subsp. *macrocarpa* (Sm.) Ball, which has a wide Circum-Mediterranean area but it is the most characteristic floristic component of several Andalusian coastal communities.

A revision of the Andalusian checklist of Endangered Plant Species was recently published (Cabezudo & al. 2005).

3. Network of botanic gardens for plant conservation.

A network of 11 botanic gardens for conservation has been established, one within the limits of the each of the 11 chorological sectors recognised by Rivas Martínez (1982) which are represented in Andalusia.

Seven of these gardens are currently on duty and four in a more or less advanced phase of building (Anonimous 2001).

The seven open to the public are: El Robledo, which is representative of the Marianico-Monchiquense Chorological Sector which covers Sierra Morena. Torre del Vingre, which represents the Subbetic Sector. Umbría de la Virgen, representative of Manchego and Guadiciano-Bacense Sectors. El Albardinal, within Almeriense Chorological Sector. La Cortijuela, which in Sierra Nevada represents the flora of the calcareous parts of these mountains. El Castillejo, within the limits of Sector Rondeño. San Fernando, which represent the chorological sectors Hispalense, Aljibico and Gaditano-Onubo-Algarviense.

The other four botanic gardens, still being built or in project are: Dunas del Odiel, which

willl more specifically represent the coastal flora of sector Gaditano-Onubo-Algarviense. El Picacho, which will cover the mountain flora of Aljibico Sector. Sierra Tejada-Alhama-Almijara, which will represent the flora of Malacitano-Almijarense sector. And a second botanic garden in Sierra Nevada which will represent the acidophilous flora of Nevadense Sector and the flora of Alpujarreño-Gadorense Sector.

The main aims of this network of botanic gardens are (Anonimous 2002):
1. To develop basic and applied research on wild plants, vegetation, ethnobotany and traditional crops.
2. To recover, preserve and manage the Andalusian protected plant species.
3. To preserve plant genetic diversity.

These gardens develop a series of activities covering:
1. Programmes on conservation, research and recovering of endangered plant species.
2. Educational programmes at all levels.
3. Programmes on divulgation of Plant Sciences.

There is a responsible for the garden, usually a biologists and one or more guardians with a good knowledge on local flora, specially on local endangered plants.

4. The Andalusian Germplasm Bank

The Andalusian Germplasm Bank was established in 1994 in the Botanic Garden of Córdoba which is mainly engaged with flora protection. The Germplasm Bank was opened in 1997. It hold seed conservation chambers, with facilities for crioconservation. Seed collecting, plant propagation, and preparation and conservation of plant propagules are developed in the laboratories of the Germplasm Bank.

5. Conclusions

Through the four actions, natural areas protection, species protection, network of botanic gardens and Germplasm Bank, the conservation *in situ* and *ex situ* of endangered Andalusian plants is achieved to a high level of eficiency. In this context, Andalucía is quite more advanced than any other Spanish regions and some of the actions can be used as a model for nature conservation.

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