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BIOGEO, a Biogeographichal study of Andalusian flora in relation to that of N Morocco

Abstract

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Project BIOGEO, financed by the Spanish Ministery of Sciences and Technology has the aim of organising, co-ordinate and make available information on plants of Andalusia (S Spain) and N Morocco. It will be developed by tree teams of taxonomists, ecologist and biogeographers centered in Sevilla, Barcelona and Jaén. A checklist of the vascular plants which occur in the territory, a chorological atlas and the establishment of biogeographical areas will be the main results of the project. Floristical affinities amongst these areas will be established and analysed.

Introduction

Project BIOGEO, financed by the Spanish Ministery of Science and Technology (project REN2002-04478-C03-03) covers Andalusia (S Spain) and N Morocco, which are separated by a geographical barrier, the Gibraltar straight, which although not too wide (only 12 km wide at its narrower point) is an effective isolation barrier as proved by the many species which have not been able to colonize the other part of the Straight (Valdés & Parra 1999: 112).

But this has not always been the situation. In fact, until the Cretaceous, the two subcontinents then existing: Laurasia and Gondwana were connected by the Iberian plate. Then, they separated and during much of the Cretaceous, for about 50 million years Europe was separate from Africa. But at the end of the Cretaceous the situation in the area changed. The Alpine folding, which affected the area was not very intense at the beginning. But during the Palaeocene a small continental plate (the microplate of Alborán) was forced to move westwards; it collided with the southern ridge of the Iberian plate which was moving to the southeast and with the northern ridge of the African plate which was moving to the northwest and gave origin to a very intense phase of the Alpine folding which extended along the Miocene and formed the internal Betic and Rifian mountains constituted by intensely metamorphized materials with an important plutonic activity (Brell 1989; Fontboté & al. 1972a, 1972b).

As a consequence of the alpine folding which operated in this area, during the Miocene the Mediterranean resulted completely closed, and for a period of almost 20 million years the Iberian Peninsula and NW Africa remained connected. Then, at the end of the Tertiary, when most important climatic changes in W Mediterranean occurred, which produced the main syndromes which characterise the Mediterranean plants, this region formed a single geographycal unit. Plants could migrate Northwards or Southwards according to climatic changes and this unit shared a same flora.

The situation changed in the Pliocene, about five million years ago, when Gibraltar Straight opened for a second time aproximately with the limits it has today. The floras of S Spain and N Morocco evolved independently during the Pliocene and the Quaternary and a series of taxa which characterise both areas, including many vicariants, were formed.

The Andalusian flora was better known that that of N Morocco, as there is a complete flora of W Andalusia (Valdés & al. 1987) and Flora Iberica (Castroviejo & al. 1987-2002), still in progress, constitute a detailled study of the variability of the Iberian Peninsula vascular plants. But a checklist of vascular plants of N Morocco has been recently published (Valdés & al. 2002). The conditions are consequently appropriate to project a study to compare both regions.

Floristic richness

The number of Vascular plants which occurs in Andalusia is estimated in about 4.000 taxa, of which 463 are endemic (Hernández-Bermejo & Clemente 1994). The Vascular flora of N Morocco includes 3168 taxa (2.907 species, 231 subspecies, 21 varieties and 30 hybrids; Valdés & al. 2006) of which 96 are endemic (Valdés & Montserrat 2003).

Altogether floristic richness of Andalusia and N Morocco is estimated in c. 4700 taxa, of which over 15% are endemic.

A rough comparison indicates that the flora of N Morocco shows a higher similarity with that of Andalusia than with the rest of Morocco, and that there are very similar floristic areas in both territories.

A first very rough attempt to compare the flora of Andalusia and N Morocco (excluding the Forêt de la Mamora and the Beni-Snassen mountains) was proposed by Valdés (1991) 15 years ago (Fig. 1). But to establish floristic links has to be done by a precise comparison at a species by species distribution base and by the study of the distribution of the different biogeographical elements which occur in both areas.

This is why project BIOGEO is being developed.

The territory

For this project, which structure and composition will be given bellow, Andalusia has been considered as the political region which includes the provinces of Jaén, Córdoba, Sevilla, Huelva, Cádiz, Málaga, Granada and Almería, and N Morocco as delimited by the Catalogue des Plantes Vasculaires du Nord du Maroc (Valdés & al. 2002), this is, including all Moroccan territories north of a line which extends from Sale-Rabat to Oujda and the Algerian frontier (Fig. 2).

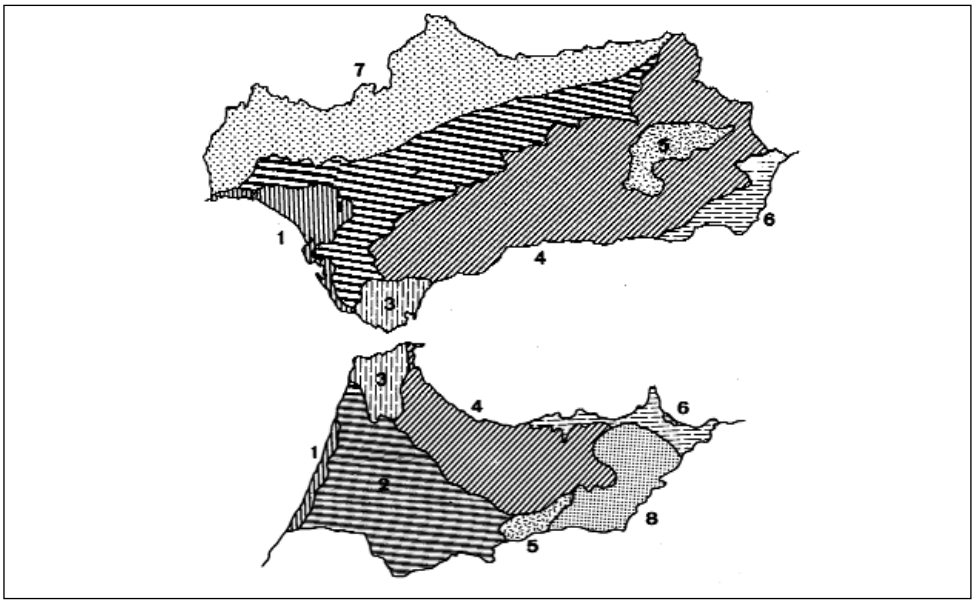

Fig. 1. Floristic correspondence between areas of Andalusia and the Rif (Based on Sauvage & Vindt 1952; Sauvage 1961; Valdés & al. 1987, Rivas Martínez 1987). 1. Atlantic littoral; 2. Guadalquivir, Loukkos and Sebou valleys; 3. Algeciras-Tanger; 4. Betic-Rifean mountains; 5. Guadix-Baza-Isoul; 6. Cabo de Gata-Knor-Nador; 7. Sierra Morena; 8. Saka-Guercif (from Valdés 1991).

For chorological purposes Andalusia has been divided into 26 units and Morocco in 20 units (Fig. 2). These are provisional units based in biogeography, traditional uses, geology, etc.

Project organisation

The organisation of the project is shown in Fig. 3. There are three teams centered in Sevilla, Barcelona and Jaén. The team of Jaén will deal mainly with the biogeographical aspects of the project; the team of Barcelona covers computing and part of the taxonomical aspects, and the team of Sevilla part of the taxonomical and computing aspects and coordination. There are a total of 35 botanists directly involved in the project, as indicated in Fig. 4. But there are also several experts on particular groups which will collaborate at least with the preparation of one of the products of the project: a checklist of vascular plants of the area.

The organisation (Fig. 3) includes an executive group (B. Valdés, Sevilla; J. M. Montserrat, Barcelona and E. Cano, Jaén) and three working groups one on biogeography, one on computing and another on taxonomy.

X. Font, as responsible for the computer working group has developed three computing programmes: one for data management (incorporation of herbarium and bibliographical data into the database: Programme Fagus), another for incorporation of data from phytosociological tables (Programme Quercus) and another for statistical data analysis (Programme Ginkgo).

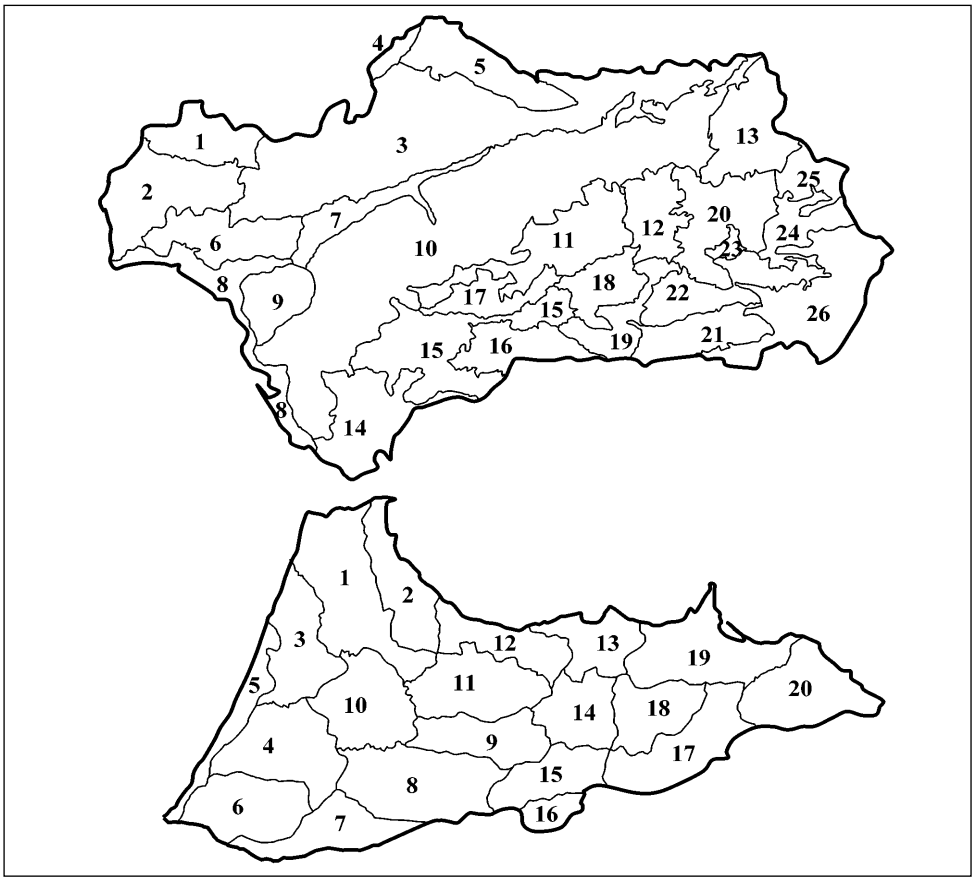

Fig. 2. Geographical limits and natural areas. Andalusia: 1, Aracena Mountains; 2, Andévalo; 3, Sierra Morena; 4, Zújar; 5, Pedroches; 6, Campiña de Huelva and Condado-Aljarafe; 7, Guadalquivir plain; 8, W Littoral; 9, Guadalquivir Marshes; 10, Guadalquivir valley; 11, W Subbetic Mountains; 12, Mágina; 13, E Subbetic Mountains: Cazorla, Segura, Las Villas; 14, Aljibe Mountains; 15, Serranía de Ronda; 16, Axarquía; 17, Antequera depression; 18, Granada depression; 19, Almijara-Trevenque; 20 Guadix-Baza and Guadiana Menor depression; 21, Lower Alpujarras, Contraviesa, Lújar and Gádor Mountains; 22, Sierra Nevada and Filabres Mountains; 23, Sierra de Baza; 24, María-Orce and Estancias Mountains; 25, The Altiplanos; 26, Almería. Morocco: 1, Tanger area; 2, W Rif; 3, Loukkos; 4, Gharb; 5, Atlantic Coast; 6, Forêt de la Mamora; 7, Zerhoun; 8, Central Pre-Rif; 9, High Ouerrha; 10, Ouezanne; 11, Central Rif; 12, Taguist area, 13, Imzorène; 14, Aknoul; 15, Tsoul; 16, Tazzeka; 17, Guercif area; 18, Kert Ganc; 19, Gareb area; 20, Beni-Snassen Mountains.

Taxonomic activities are developed under five main programmes (see Fig. 3):

1. Literature. A group is responsible for selecting bibiographical references which data have to be directly included into the database.
2. T. Navarro (Málaga) coordinates the preparation of sample taxonomic revisions (*Teucrium, Asphodelus, Euphorbia, Lithospermeae and Buxaceae*).

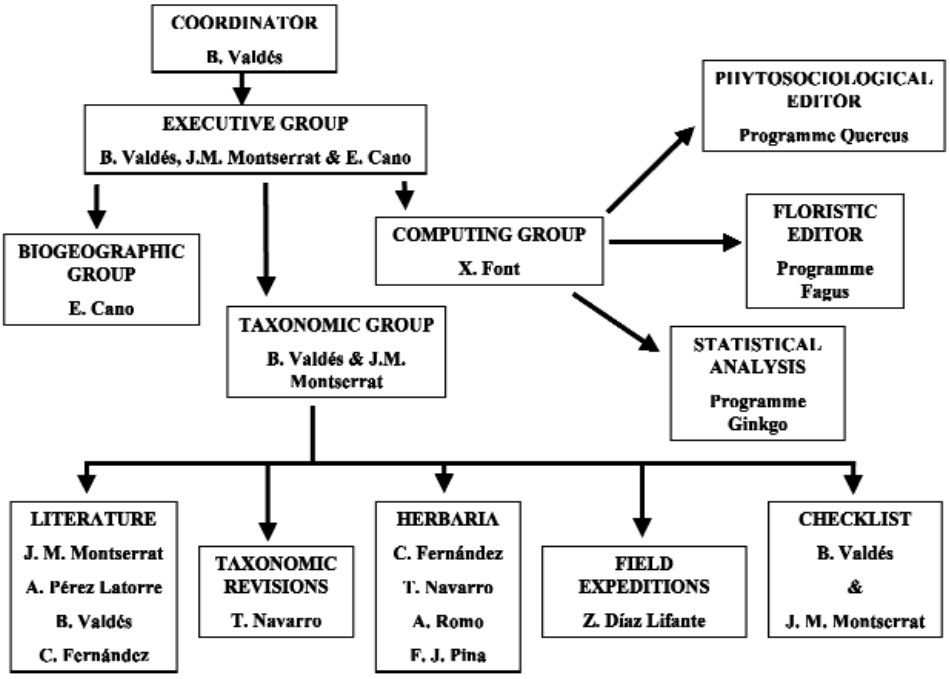

Fig. 3. Project management and working groups.

3. Herbaria management, including preparation and sending herbarium material to authors is the responsibility of a person in each of the four main herbaria to use for the project.
4. Field expeditions to complete the floristical knowledge of those areas still poorly represented in the herbaria are co-ordinated by Z. Díaz Lifante.
5. The preparation of a checklist of vascular plants which occur in the territory is co-ordinated by B. Valdés & J. M. Montserrat.

Aims of the project

The main aims of the project is to organise, co-ordinate and make available information on the plants of Andalusia and N Morocco. This includes:

1. To form an initial database of floristic, taxonomic and biogeographycal data based on available bibliographycal information. The starting point are: the Flora Vascular of Andalucía Occidental (Valdés & al. 1987), the Catalogue des Plantes Vasculaires du Nord du Maroc (Valdés & al. 2002) and the published checklists of different E Andalusian areas. This initial database will be updated by the incorporation of new reliable literature.
2. Critical identification of the bulk ammount of plant material still to be studied at Barcelona, Sevilla and other Andalusian herbaria.

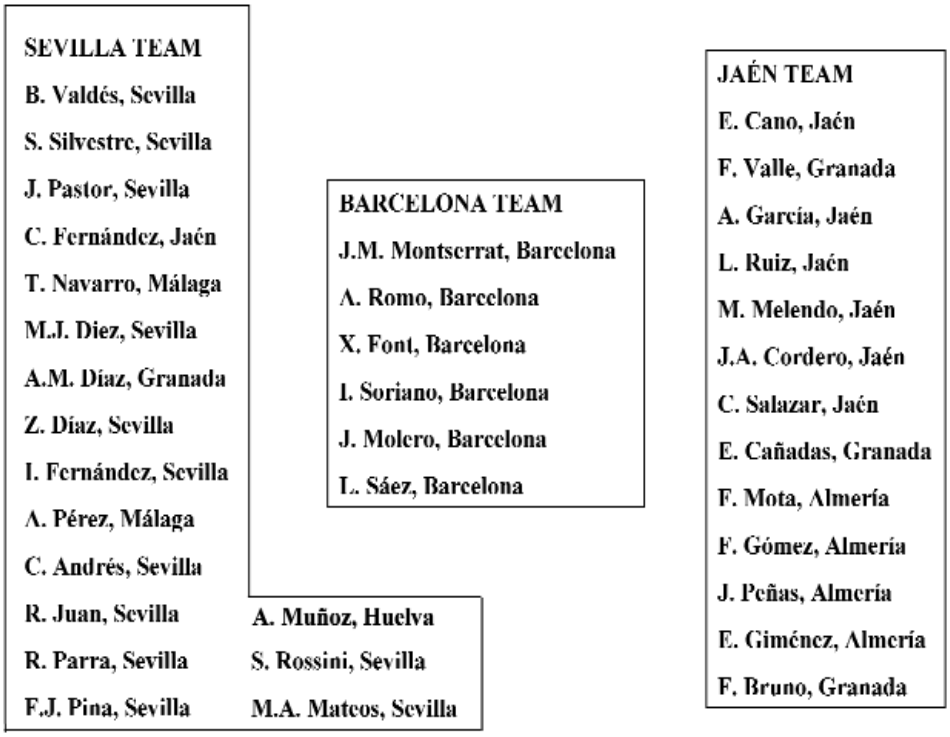

Fig. 4. The teams.

3. To incorporate to the herbaria BC, GDA, JAEN, MA and SEV the studied plant material.
4. To collect and identify new herbarium material from poorly known areas.
5. To incorporate to the database at a locality by locality bases the data resulting from the studied plant material.
6. To establish a subdivision of the study area in working chorological units.
7. To assign the recognised taxa to the working chorological units.
8. To elaborate a checklist of vascular plants of Andalusia and N Morocco with identification keys.
9. To elaborate a chorological atlas of vascular plants of Andalusia and N Morocco.
10 . To propose a biogeographical sectorization of the study area.
11. To establish the floristic affinities amongst the different biogeographical sectors of Andalusia and N Morocco.
12. To establish floristic affinities amongst the biogeographical sectors within Andalusia and within N Morocco.
13. To study taxonomically several genera to check the fiability of the biogeographycal sectors and to establish a model of taxonomic traitment for a future preparation of a vascular flora of Andalusia and N Morocco.

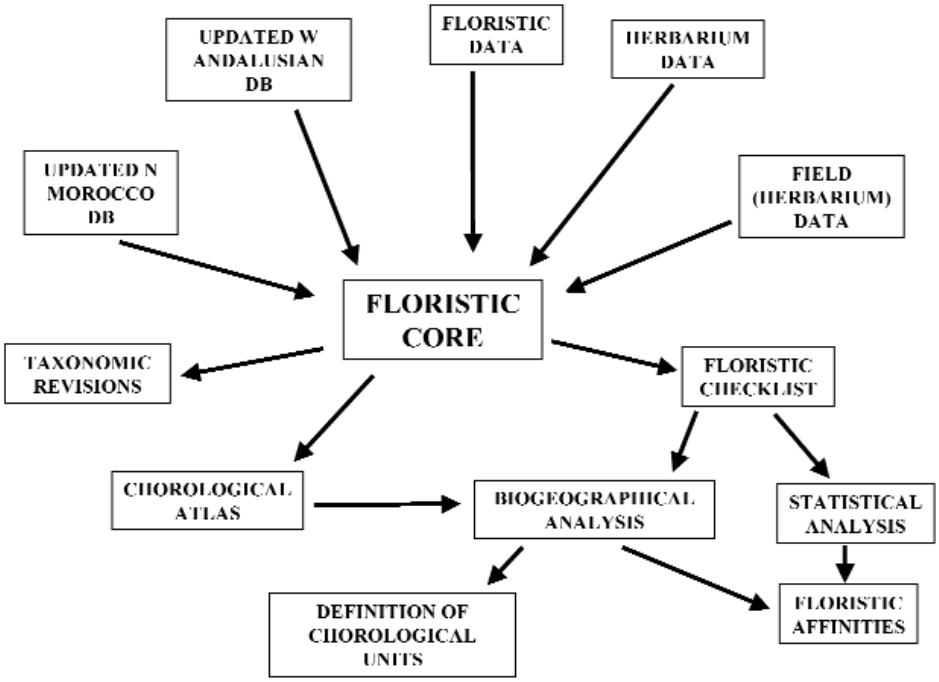

Fig. 5. Project structure. Inputs and outputs.

Project structure

Information flow is summarised in fig. 5. Inputs include the data used to form the project database, which is basically a floristic core from which a series of products will be extracted.

The floristic core includes:

1. Accepted name, authority and place of publication for genera, species and subspecies.
2. Selected synonyms with authority and place of publication.
3. General distribution referred to worldwide distribution and within the study area indicated by the initial chorological sectors shown in Fig. 2.
4. Assignation of taxa to floristic elements.
5. Distribution of taxa at a locality by locality base, based mainly on herbarium material.
6. Habitat, both the macrohabitat (general habitat) and microhabitat, substrate and altitude.
7. Growth form.
8. Phenology.

The main products will be:

1. A floristic checklist of vascular plants for the whole territory.
2. A chorological atlas for species and subspecies of the area.

3. A biogeographical analysis which will result in the proposal of new chorological units for the territory based on biogeography.
4. The establishment of floristic affinities amongst the different chorological units.

Discussion

This is a cooperative project which will be developed mainly by the components of the three teams involved in the project which have the responsibility to drown the project to a successful end. But a number of specialists from different institutions within and outside Spain will co-operate and will be responsible for the study of particular genera or groups of genera. According to the programme, the project will be completed by July-August 2006.

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