



## Pleistocene and Holocene Iberian flora: a complete picture and review

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A detailed analysis of the location and composition of Iberian vegetation types during the whole Pleistocene and Holocene periods shows a complex patched landscape with persistence of different types of ecosystems, even during glacial times. In addition, recent, high-resolution palaeoecological records are changing the traditional picture of post-glacial vegetation succession in the Iberian Peninsula.

The main available charcoal and pollen sequences include, coniferous and deciduous forest, steppes, shrublands, savannahs and glacial refugia during the Pleistocene for Meso-thermophytes (phytodiversity reservoirs), in different proportions. This panorama suggests an environmental complexity that relates biotic responses to climate changes forced by Milankovitch cycles, suborbital forcings and by the latitudinal and physiographic particularities of the Iberian Peninsula. Thus, many factors are critical in the course of vegetational developments and strong regional differences are observed since the Early Pleistocene.

Currently, the flora of Iberia is located in two biogeographical/climatic regions: the Eurosiberian and the Mediterranean.

The first one includes northern and northwestern areas of the peninsula, where post-glacial responses of vegetation are very similar to Central Europe, although with some particularities due to its proximity to both the Atlantic Ocean and the Mediterranean region. The second one comprises the main territory of Iberia and shows more complex patterns and singularities, now and in the past.

Steppe landscapes dominated extensive areas over all the territory during the cold spells of the Quaternary, especially during the Late Pleistocene up to the Last Glacial Maximum, but differences in composition of the dominant taxa (Compositae versus Artemisia) are observed since the Early Pleistocene, probably related to moisture regional gradients. Coastal shelves and intramountainous valleys, even in continental areas, are spots of floristic diversity and nuclei of population expansion during climatic ameliorations of the Pleistocene. The floristic composition, location and structure of glacial tree populations and communities may have been a primary control on these developments and on the origin and composition of Holocene scenarios. Refugial populations would have been a source, but not the only one, for the early Lateglacial oak expansions for example. From Middle to Late Holocene, inertial, resilient, and rapid responses of vegetation to climatic change are described, any time with regional and local differences. The role of fire, pastoralism, agriculture and other anthropogenic disturbances such as mining during the Copper, Bronze, Iberic, and Roman times must be also considered as an important factor of the current vegetation distribution. In fact, the Iberian Peninsula constitutes a territory where climatic, geological, biogeographical and historical conditions have converged to produce environmental heterogeneity, large biological diversity and ecosystem richness.

A note of singularity: in comparison with other Mediterranean peninsulas, Iberia was, doubtless, particularly suitable for the survival and permanence of sclerophyllous elements of any kind (including Ibero-Maghrebian scrubs such as *Maytenus*, *Periploca*, *Ziziphus*, *Withania*, *Lycium*, and *Calicotome*), currently, during the Holocene, and even during glacial stages of the Pleistocene. However, no macro-remains of these taxa have been documented until Late Holocene chronologies, but the survival of other thermophilous species, such as *Olea*, reveals the existence of glacial refugia in the southernmost areas of Iberia. Over all, and dealing with plant species, the Iberian

Peninsula is a land of survival.