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ORIGINAL ARTICLE

Differences in fine-scale genetic structure and dispersal in *Quercus ilex* L. and *Q. suber* L.: consequences for regeneration of mediterranean open woods

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Cork oak *(Quercus suber L.)* and holm oak (Q. *ilex L.)* are among the most important tree species (economically and ecologically) in the Western Mediterranean region, where they define unique open woods (created and maintained by man) known as 'dehesas' in Spain. However, these formations are under increasing threat due to the lack of regeneration. We have analysed spatial genetic structure in a mixed parkland; inferences about gene dispersal have also been performed, according to the isolation by distance model. Noticeable differences have been detected between the species, despite their similar ecological roles. Restricted effective dispersal leads to kin structures in cork oak, up to 70 m, while no genetic structure is observed in holm oak. Our results suggest a very effective dispersal for the latter, with a local historical gene flow estimated between 55 and 95m. This is the first time regeneration of Mediterranean oak parklands has been assessed from a genetic perspective. Effective gene flow detected for holm oaks allows us to discount the risk of inbreeding over successive generations. Thus, regeneration of *Q. ilex* dehesas will just require action directed to help the settlement of the saplings (such as limiting grazing). However, in those cases where densities are too low, more intense forestation (such as plantation and/or establishment of appropriate shelter) will be needed. The 'density threshold' for initiating regeneration will probably be higher for cork oak, due to its more limited dispersal and minor full-light tolerance. *Heredity(2007) 99,* 601-607; doi:10.1038/sj.hdy.6801007; published online 31 October 2007

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Introduction

The abundance of evergreen broad-leaved trees such as *Quercus suber L.* (cork oak) and *Quercus ilex L.* (holm oak) characterizes European schlerophyllous forests. Both tree species are among the most important from an ecological point of view in the Western Mediterranean basin, and dominate formations in extended areas along the region. Open wooded landscapes of these species are particularly abundant in Spain and Portugal, where they are known as 'dehesas' and 'montados' respectively, and can also be found in France, Italy and Greece (in this case, just *Q. ilex).* These are formations created and maintained for the activities carried out in the clearings and under the canopies, such as cropping and grazing; remaining trees provide acorns, highly regarded as pig food. The oldest dehesas, still existing, were created in the Middle Ages and are named 'dehesas boyales' in Spain. Since the nineteenth century, cork exploitation became an additional key factor in their economic value; these agro-silvipastoral systems developed extensively in those years and are named 'majadales' (see Martin-Vicente and Fernandez-Ales (2006), for a review of the history of Spanish dehesas). In recent years, there has been increasing recognition of the important contribution made by these systems to the preservation of semi-natural habitats and landscapes in Europe. High levels of species richness have been reported (Blondel and Aaronson, 1999), leading to their inclusion as special areas of conservation in EU directive 92/43; they are considered as the paradigm of sustainable agrosilvicultural equilibrium (Council of Europe, UNEP & ECNC 1996; Joffre *et al.,* 1999). However, Iberian dehesas are currently threatened by the lack of regeneration (mainly due to the excess of grazing and insolation) and they cannot rely exclusively on the decreasing resprouting ability of decaying, aged adult trees (Pulido and Diaz, 2005). Thus, their admired sustainability is jeopardized, and these formations may become 'fossil forests'. In this sense, the outlook is more favourable for *Q. ilex.* This is a more euryoic species than *Q. suber* (whose presence is limited by cold, drought and soil type). *Q. ilex is* also a more resilient species, with a better tolerance for direct insolation and with very effective asexual reproduction through stump and root shooting. Recently, several

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