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## Geographic variation in cork oak and its implications for expected impacts of climate change

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Cork oak (Quercus suber L.) is a protected tree species in Portugal, being also the source of raw material for the cork industry, a major player in Portuguese economy (representing 3% of GDP in 2010). The future climatic scenarios for Portugal point to an increase in average summer temperatures from 0.3 to 0.7ºC between 2016 and 2035, and up to 4.6ºC until 2100. In addition, precipitation estimates suggest a reduction of annual rainfall from 20 to 40%, especially in southern Portugal. Water stress will, therefore, be a leading constraint to primary production. The combined effects of drought and high temperatures will lead to decreases in carbon assimilation and increases in tree mortality, and consequently current reforestation efforts will need to account for these expected adverse outcomes through the sustainable use of suitable genetic material.

There are several reasons that can be highlighted to emphasize the need for an efficient management of cork oak genetic resources in Portugal, namely: i) to avoid cork import, and thus to increase cork production to meet the industry demands; ii) to overcome a generally poor area of natural regeneration, which does not help to ensure an *in situ* conservation of genetic resources; iii) to deploy adapted genetic material for afforestation/reforestation; and iv) to develop a gene resources conservation program, as cork oak is a vital component of agro-silvopastoral systems in the Mediterranean region.

Given the broad native range of the species, involving significant environmental and geographic gradients, a high level of genetic variation can be expected. It is possible that disruptive selection has caused a large differentiation in adaptive traits among populations, namely in the ability to tolerate different environmental stress events (e.g. drought and frost) and to cope with pests and diseases. Between 1998 and 2011, we have collected data involving survival, growth, phenology and water-use efficiency traits from five common-garden provenance trials (including family structure in two of the trials), that were established in Portugal under a concerted action launched by the EUFORGEN's network. These multi-site field experiments are based on up to 35 tested provenances covering the entire natural distribution of cork oak, and results obtained from the genetic evaluation of the trials have indicated significant differences among populations for all the measured traits at all observed ages. Four of the tested provenances (Alpujarras – Haza de Lino, Puglia – Lucci - S. Teresa, Landes - Soustons, Rif Occidental – Ain Rami) were then chosen according to their contrasting field performance for growth, phenology and water-use efficiency (WUE), and were further evaluated under controlled-environment conditions where drought stress was induced. In this context, the main drivers of drought adaptation appeared to be early stomatal closure and root investment, which also showed significant differences among the selected provenances. The responses to drought over time also varied among these studied populations, and seemed to be related to their differences in growth rhythm.

The Ain Rami population seemed to be most prone population to endure drought conditions. Facing a water deficit scenario this population, with highest growth, showed a higher investment on roots compared to the Haza de Lino population, that even under optimal hydration status, had lower biomass values, more reduced transpiration area (smallest size, with lowest Specific Leaf Area), leading to a lower water consumption. This population showed a delay in onset of stress when compared to other populations, only revealed no stomatal limitations with high stress levels. Furthermore, Ain Rami showed higher WUE under drought conditions both in the field trials and under controlled conditions, but average WUE in wet conditions.

The results from the field and controlled-environment experiments were consistent in that geographic origin had an important influence on the performance of fitness surrogates and functional traits, and thus providing a strong indication that seed origin must be considered in cork oak reforestation programs.