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Climatic sensitivity in co-occurring Quercus species: analysis of spatial and temporal gradients under Mediterranean conditions

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The study of the relative abundance of stable isotopes in plant tissues provides valuable information regarding temporal and spatial interactions between plant communities and environmental factors. Stable isotopes show how plants can respond to different environmental conditions such as aridity, altitudinal or rainfall gradients. These conditions remain partially recorded in the isotopic signal and express the circumstances of the time in which vegetal tissue was formed. Traditionally, dendrochronology has focused on the reconstruction of past climate, based on the ability of tree-ring growth to characterize climatic fluctuations. In recent years both isotopic and dendrochronological analyses have been applied together to obtain more detailed information about climate and plants relationships. In the Mediterranean region, fully adapted Mediterranean vegetation coexists with temperate species that are either on the driest extreme of their distribution limit or remain as relict species limited to relatively wet environments. Most likely, warming temperature, as a consequence of a changing climate, can affect significantly those temperate species and this response may affect the future distribution of European flora. In this regard, the aim of this study was to identify how co-existing species with different distributions and climate optima respond to climate and what climatic factors are limiting to their growth.

We evaluated carbon and oxygen isotope composition in wood cellulose, and growth of four co-occurring *Quercus* species growing along a rainfall gradient in Northern Spain. We selected 21 points in the Catalonia region where the evergreen *Q. ilex* (L.) was accompanied by different deciduous oak species along an aridity gradient, from the continental, mesomediterranean *Q. faginea* (Lam.) to the temperate *Q. petraea* (Liebl.) and going through the submediterranean *Q. humilis* (Mill). Along the gradient, annual rainfall varied from 586 mm to 845 mm, while summer precipitation range was 138 mm to 225 mm. We extracted cores from 10 dominant trees of each sampling point (5 pairs of neighbour trees including the two oak species present on each site). After measuring a time period of twenty years (1989-2008), we pooled and milled wood material to a fine powder. For three out of the 21 sampling points (one point representing each pair of oaks), we used ten cores to analyze also tree rings with annual resolution for the same period. A 20-yr. wood pool and individual rings were subjected to alpha-cellulose extraction and this fraction subjected to isotopic analysis. We applied simple correlations between isotopic values and climatic factors to evaluate the relationship between these two sets of variables. In order to determine variation between species, points and tree pairs, data were subjected to analysis of variance.

Q. humilis showed similar responses to those of *Q. ilex*. The other two deciduous species, in the extremes of the rainfall gradient, showed either strong growth limitations (*Q. faginea*) or near-optimal conditions (*Q. petraea*). Inter-specific differences in the response to environmental factors could be explained on the light of their current distribution and habitat preferences. Based on their performance in relatively warm and dry sites, potential implications of global warming for oak species currently growing in wetter and colder areas will be discussed.

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