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Drought-induced decline in oak Mediterranean forests: insights from wood anatomical traits

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Increased forest vulnerability to drought and heat spells is being reflected as more widespread and severe dieback events. In this regard, the Mediterranean Basin is revealing a high susceptibility to these phenomena across several tree taxa with a high ecological and socio-economic importance, particularly pines and oaks. For instance, oaks are particularly vulnerable to spring-summer droughts with important losses in term of growth and productivity accompanied by rising mortality rates and declining growth rates, despite some of these species are theoretically considered well-adapted to tolerate drought stress. Dendroecological studies using retrospective analysis of wood anatomical traits and tree-rings have demonstrated their potential to supply useful information on the long-term patterns of forest dieback in several oak species.

In this study, we explored the xylem anatomical plasticity through time by performing a long-term (1980-2017) reconstruction of wood anatomical traits, aiming at investigate the drought stress effects on dieback of oak species.To this aim, we carried out some field experiments in Italy on four oak species differing in drought tolerance, i.e. Quercus robur, Quercus cerris, Quercus frainetto and Quercus pubescens, considered to have low to high tolerance, respectively, but showing recent decline phenomena. We cored asymptomatic (ND) and symptomatic (D) coexisting trees showing low and high defoliation levels, respectively, and for all sampled species we measured the following anatomical traits in the xylem: vessel area, Dh, vessel density.

Climate-traits relationships over the last century explained the recent growth divergence observed between D and ND trees because D trees were more sensitive[U1] to drought stress and summer warm temperatures leading to high evapotranspiration rates. Here, we discuss: i) the relationships between radial growth, changes in wood anatomy and hydraulic functioning of trees to highlight the triggers of oak dieback; ii) the associations between climate, growth and anatomy data to explain likely the differences in acclimation/plasticity to short/long-term changes in environmental conditions.