Genetic, environmental and ontogenetic effects on cone serotiny in Aleppo pine (*Pinus halepensis Mill*.)

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In the Mediterranean basin, the dramatic increase of catastrophic wildfires combined with heat waves and severe droughts has raised concern about whether the high colonizing ability of Mediterranean pines will be enough to cope with these challenges. As a fire-related trait, (the adaptive role of) serotiny has recently attracted an important scientific interest, with researches focusing on different genera and species, both conifers and angiosperms in different Mediterranean climate zones worldwide. Aleppo pine is one of the most studied species in this regard, probably because it shows a rather complex variation of cone serotiny affecting the dynamics of aerial seed banks.

The variation of cone serotiny in Aleppo pine has been postulated to derive either from ontogeny (young or small individuals tend to retain more closed cones), environment (dry and warm episodes triggers cone opening) and -still poorly known- genetic effects among and within populations. Our objective was to separate these three main causes of variation of cone serotiny in Aleppo pine. According to literature, we expected higher serotiny in small, young trees but at the same time higher serotiny under less stressful environmental conditions.

We measured serotiny at a large Aleppo pine common garden experiment replicated at three contrasted sites, with a comprehensive representation of the natural distribution range. This allowed us to separate population differentiation from phenotypic plasticity of cone serotiny, estimated through the percentage of closed cones. Also, micro-environmental variation within the sites allowed us to account for ontogenetic size effects, even when all trees were coetaneous. We also searched for correlations between serotiny and other adaptive traits, namely female fecundity (estimated through cone counts) and bark thickness.

Preliminary analysis showed that tree size has indeed a key influence on serotiny, as, as predicted, serotiny decreased with tree size, but this effect it is not easily detached from site and provenance effects affecting tree size as well. When tree size is accounted for, site effect is barely significant or not significant, but the pattern we found also fulfills predictions: higher serotiny under more favorable conditions. However, the interactions between provenance x size and site x size seemed highly significant, suggesting that an inherent allometric effect is altered by both the population of origin and the environment. These findings underline that serotiny in Aleppo pine is actually a complex trait and confirm that genotype, environment and ontogeny must be considered jointly to improve our understanding of its adaptive implications.