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Quantifying genetic variations and phenotypic plasticity of leaf phenology and growth for two temperate Fagaceae species (sessile oak and european beech)

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Under current climate change, research on inherent adaptive capacities of organisms is crucial to assess future evolutionary changes of natural populations. Genetic diversity and phenotypic plasticity constitute adaptative capacities that could allow populations to respond to new environmental conditions. The aim of the present study was (i) to determine whether there are genetic variations among populations from altitudinal gradients using a lowland common garden experiment and (ii) to assess the magnitude of phenotypic plasticity using a reciprocal transplant experiment (5 elevations from 100 to 1600 m asl.) for leaf phenology (flushing and senescence) and growth of two fagaceae species (Fagus sylvatica and Quercus petraea).
We found significant differences in phenology among provenances for most species, and evidenced that these among-population differences in phenology were related to annual temperature of the provenance sites for both species. It's noteworthy that, along the same climatic gradient, the species exhibited opposite genetic clines: beech populations from high elevation flushed earlier than those of low elevation, whereas we observed an opposite trend for oak. Finally, we highlighted that both phenology timing and growth rate were highly consistent year to year. The results demonstrated that in spite of the proximity of the populations in their natural area, altitude led to genetic differentiations in their phenology and growth.
Moreover, a high phenological plasticity was found for both species. We evidenced that reaction norms of flushing timing to temperature followed linear clinal trends for both species with an average shift of 5.7 days per degree increase. Timing of leaf senescence exhibited hyperbolic trends for beech and no or slight trends for oak. Furthermore, within species, there was no difference in magnitude of phenological plasticity among populations neither for flushing, nor for senescence. Consequently, for both species, the growing season length increased to reach maximum values for annual temperature ranging from 10°C to 13°C according to the population.
These adaptive capacities (genetic differentiations and high magnitude of plasticity) could allow populations to respond immediately to temperature variations in term of leaf phenology and then to cope with current climate change. Finally, we also highlight that current populations tend to occupy suboptimal environments, i.e, populations inhabit climates colder that their optimum.