Microgeographic adaptation and the effect of pollen flow on the adaptive potential of a temperate tree species

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ORAL PRESENTATION: Microgeographic adaptation and the effect of pollen flow on the adaptive potential of a temperate tree species.

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Abstract :

Recent interest for microgeographic adaptation, *i.e.* adaptation at spatial scales compatible with substantial amount of gene dispersal, offers to reconsider the scale at which evolution occurs (Richardson *et al*. 2014). Whether gene flow is constraining or facilitating local adaptation at this fine spatial scale remains an unresolved question. Too important gene flow would overwhelm the effects of natural selection and decrease local adaptation along environmental gradients. Conversely, gene flow, and particularly long-distance dispersal events, could play a major role in resupplying the genetic variation of populations and favouring the spread of beneficial alleles (Kremer *et al*. 2012). Hence, the high dispersal capacities of trees are often assumed to be the main process maintaining the large levels of genetic variation measured in their natural populations. However, evidences for microgeographic adaptation and the quantitative assessment of the impact of gene flow on adaptive genetic variation are still limited in most temperate trees.

Here, we sampled 60 open-pollinated families of European beech (*Fagus sylvatica* L.) from three natural plots, spreading along a short elevation gradient (~1.5 km) at the warm margin of this species distribution. We analysed the phenotypic and genotypic data of ~2,300 seedlings grown in a common garden. We focused on 11 potentially adaptive traits with significant heritabilities (Gauzere *et al*. 2016) and tested for signature of local selection on quantitative trait differentiation. We then identified the offspring likely originating from local or distant pollen immigration events and quantified the role of gene flow in increasing locally the additive variance of traits under selection.

We found a significant signal of adaptive differentiation among plots separated by less than one kilometre, with local selection acting on growth and phenological traits. We found that trees in the plots at high elevation, experiencing the lowest temperature conditions, flushed earlier and had a higher height and diameter growth in our common garden than trees from the plot at low elevation. Beech populations originating from higher longitude or elevation have also been shown to be genetically earlier in provenance tests, suggesting that these populations evolved phenological traits promoting a longer vegetation period. At this southern margin of the species, the reduced allocation to stem growth at the low elevation plot

is likely an adaptive response to drought, which has previously been described by comparing marginal vs central beech populations. Consistently with theoretical expectations, our results suggest a beneficial effect of pollen dispersal by increasing the genetic diversity for these locally differentiated traits. These effects were quantitatively high, with more than twice higher genetic variance for immigrant than local offspring, although with large standard errors around estimates.

Our results highlight that local selection is an important evolutionary force in natural tree populations, and provide a strong evidence that adaptive genetic differentiation can occur despite high gene flow. For the two genetically differentiated traits, our analyses suggested a beneficial effect of pollen dispersal by increasing genetic diversity after one episode of reproduction. The findings suggest that conservation and management interventions to facilitate movement of gametes along short ecological gradients would boost genetic diversity of individual tree populations, and thereby enhance their adaptive potential.

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