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Elevational adaptation and plasticity in bud burst and budset timing in seedlings of major temperate tree species in the Swiss Alps

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Phenological events such as the initiation and the end of seasonal growth are expected to be under high evolutionary pressure due to their strong influence on tree fitness. A good synchronisation of these two phenological events with climate is crucial to prevent frost damages on leaves or flowers in spring and to be cold-hardened in autumn, while optimizing the length of the growing season. Although numerous studies highlighted genetic differentiation in phenology among populations from contrasting climate, it remains unclear whether local adaptation could obstruct phenological plasticity in response to current rapid warming. Seedling populations of seven broad-leaved tree species from high and low elevation in the Swiss Alps were investigated in eight common gardens located along two elevational gradients from 400 to 1700 m. The study design allowed (i) to assess genetic differentiation among populations from low and high elevation and (ii) to characterize the phenological plasticity of each seedling population to changing temperature as well as to quantify the plasticity that is genetically induced. Genetic variation of leaf unfolding date between low and high populations was detected in six out of seven tree species. Except for European beech, populations from high elevation tended to flush later than populations from low elevations, irrespective of the elevation of the common garden. In contrast, the opposite cline was found for beech. This result emphasizes that leaf phenology is under strong evolutionary pressure, but this selective pressure differs among tree species. This discrepancy of genetic differentiations among species could be due to their differences in frost sensitivity before and during bud break. Furthermore, we found strong plasticity in timing of leaf unfolding in all species with only a small part explained by genetically induced plasticity (interactions between populations and environment). Thus, in spite of their genetic differentiation, populations possess similar abilities for shifting their phenology in response to temperature variation, which suggests that populations from the leading edge of the species distribution could respond similarly than populations from the middle of the species distribution range to current climate warming. These results await scaling to the adult life stages.