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Leaf morphology and phenology of Beech (Fagus sylvatica L.) are linked to environmental conditions depending on the altitudinal origin

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One of the principal responses of temperate climate trees to climate warming, besides migration, will be in-situ adaptation/evolution. For both, germination and growth rates can have a strong impact on survival and long-term recruitment and establishment of a species. Leaf morphology traits, together with phenology, are relevant to the study of inherent capacities of plants to adapt to an ever changing climate, especially in alpine regions, where a rapid warming has been observed in the last decades. The aim of this study was to evaluate the changes in possible adaptive traits (e.g. leaf morphology and phenology) of Beech (Fagus sylvatica L.) and to asses a decisive component of the survival strategy of this important broadly distributed Central European tree species. We collected beech seeds at six sites along two transects of a south- (900, 1000 and 1100-1400 m.a.s.l.) and a north-facing slope (800, 900 and 1100 m.a.s.l.) in 2011 (mast year) near Garmisch-Partenkirchen, Germany. All the seeds were stratified before sowing; 150 seeds were selected from each site and sowed (at the beginning of the spring) in square containers in a greenhouse under the same climatic conditions; seven phenological stages were defined following a modified beech germination key and the phenology of every seed was recorded three times a week. Harvesting took place 38/42 days after sowing and the specific leaf area (SLA), biomass, and leaf morphology (lamina length and width) were recorded for each seedling. Seeds from lower sites of the two transects presented a poorer germination rates (e.g. 30% for the south 900 m.a.s.l. site) and (75% for the north 800 m.a.s.l. site) when compared to seeds originating from higher elevations within the same transect. The highest germination percentages (98 and 85%) were observed in seeds originating from the highest elevations (e.g. 1100-1400 m.a.s.l. of the south site and 1100 m.a.s.l. of the north site, respectively). Although no significant differences in SLA were found among the altitudinal levels in any of the transects, significant differences were found in biomass among the two highest sites of the two transects. The length of the lamina differed significantly between 900 to 1100-1400 m.a.s.l. in the south facing transect, while in the north facing transect the lamina width showed significant differences between the highest and the lower sites. A higher percentage of germination of seeds originating from higher altitudinal sites may points to a developed sensitivity to environmental changes and a rapid and more favorable response. Our results suggest, contrary to what has been reported, (leaf size differentiation among altitudinal sites under natural conditions), that the altitude of origin doesn′t have an overriding impact on leaf morphological responses when growing under the same conditions, indicating that leaf morphology and phenology may have an adaptive significance linked to climate.