

Biodiversity conservation is crucial for the sustainable management of forests. However, climate change and industry-driven transformations towards increased forest plantation areas pose a serious threat to numerous forest-related species. These factors lead to an increased risk of extinction for various species, which negatively affects the functional biodiversity of forest ecosystems. While human impact can be mitigated through changes in forest management, addressing the challenge of rapid climate change requires populations to have the ability to adapt, relying on their so-called evolutionary potential. Major forest trees are characterized by high levels of genetic variability due to large population sizes and significant gene flow, exhibiting high heterozygosity, phenotypic plasticity, and adaptive capacity. In contrast, rare tree species, especially those characterized by fragmented distributions and adverse demographics, may struggle to adapt to changing conditions due to insufficient adaptive genetic variation. This project aims to contribute to the ongoing debate on the adaptive potential of forests. However, instead of focusing on the economically important canopy trees, we aim to fill the knowledge gap regarding the adaptive potential of rare tree species that occupy the lower forest layers.

This project focuses on determining the evolutionary potential of natural populations of European yew (*Taxus baccata*), a species currently threatened by climate change and habitat loss. The scattered yew populations are often characterized by small numbers of individuals, low genetic diversity, and limited gene flow. These conditions may hinder the species' ability to adapt to rapidly changing environmental conditions. However, the actual evolutionary potential of yew populations remains largely unknown. Using yew as a model, we will investigate whether early-stage traits, such as seed germination success and seedling early growth, shape the evolutionary value of individuals (i.e., fitness). Our goal is to assess whether early-stage traits exhibit heritability and whether they influence adult-stage fitness. Additionally, we aim to evaluate whether mating between relatives (inbreeding) negatively affects early development and adaptation in the mature phase. We hypothesize that genetic factors significantly shape variation in seed germination and early seedling growth, and that these traits correlate with fitness in the adult phase. Confirmation of these expectations will provide evidence that natural yew populations exhibit evolutionary potential in key fitness components. We also hypothesize that both adult-phase fitness and early development traits are negatively influenced by inbreeding, i.e., that natural yew populations still exhibit masked genetic load despite significant genetic drift and bottleneck effects. In this project, we focus on early development traits because: 1) the strongest reduction in population size occurs during the early phase of the plant life cycle – this stage is an excellent opportunity for natural selection to act; 2) for rare mixed-species trees in the lower forest layers, which face strong competition for environmental resources, traits related to growth may be an important component of adaptation.

To achieve the aforementioned goals, we will collect seeds from natural yew populations to assess their germination ability and early seedling growth. Using genetic methods, we will first reconstruct the parentage of the offspring individuals, then estimate the kinship among offspring based on genomic data obtained for the parent trees. These data will be used to assess the heritability of the measured offspring traits and (retrospectively) genetic values of the parents in relation to germination and early growth. We will determine adult fitness in the field using genetic parentage analysis of naturally recruited seedlings. This will allow us to assess both the heritability of fitness and test the relationship between adult-stage fitness and the genetic component of early-stage traits that characterize adult individuals. Finally, we will examine the relationship between inbreeding and adult fitness, as well as early development traits, such as seed germination and seedling growth.

Our results will enrich the knowledge of the evolutionary potential of understory tree species whose populations face the effects of genetic isolation and adverse demographics. In addition to filling an important knowledge gap, our research will provide information crucial for sustainable forest management and biodiversity conservation efforts. The knowledge gained from this project will also create a solid foundation for future research on the adaptive potential of yew and other taxa facing similar challenges.