SNSF CoG proposal Christoph Schwörer

ARIaDNA

Assessing the **R**esponse of mountain forests to past climate change **I**mpacts using **a**ncient **DNA**

Abstract

The climate and biodiversity crises are the most pressing environmental challenges of our generation, potentially leading to drastic changes in ecosystems and associated services that threaten the livelihood and well-being of billions of people. To make accurate projections of future ecosystem trajectories and develop management strategies that can maintain ecosystem services, long-term records documenting ecosystem responses to past environmental changes are urgently needed. This is particularly important for long-lived organisms, such as trees, that have a life span vastly exceeding the duration of normal research projects. To study past ecosystem responses to rapid climate change and demographic shifts, I propose a novel research approach that takes advantage of recent revolutions in paleogenetics by combining the analysis of ancient DNA (aDNA) with established paleoecological methods and dynamic vegetation modelling. Specifically, the project will focus on the effect of past climatic and demographic changes since the last Ice Age on four key tree species of European mountain forests i.e., *Abies alba* (silver fir), *Larix decidua* (European larch), *Picea abies* (Norway spruce), and *Pinus cembra* (Swiss stone pine). I will first apply classical paleoecologial methods such as pollen, macrofossil and charcoal analysis to identify periods of rapid demographic changes and link them to shifts in the climate system or anthropogenic disturbance. By analyzing the genetic information from ancient plant macrofossils preserved in natural archives, I will then be able to study the response of tree populations to past environmental changes at different spatial and temporal scales. I am particularly interested in 1) tracking postglacial range shifts of these four tree species across the Alps in unprecedented detail, 2) reconstruct changes in genetic and haplotype diversity in response to demographic changes, and 3) test whether trees were able to adapt to rapid climatic changes by studying putatively adaptive loci from populations living before and after climate transitions. I will also use key results from these analyses to simulate future vegetation trajectories under different climate scenarios using a dynamic vegetation model. The project will also open new research avenues in paleoecology and population genetics, by expanding and applying an individual-based approach of plant aDNA analysis that has the potential to lead to similar paradigm shifts in plant ecology, as paleogenomic approaches on human or animal remains have caused in such different fields as archaeology, anthropology, ecology and evolution. The results from this ambitious research project will ultimately provide a thread to ecosystem managers and conservation biologists navigating the maze of future ecosystem responses and help deciding which management strategies are best suited to protect multi-level biodiversity and maintain fragile alpine ecosystems and their services for future generations.