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Physiological responses of herbaceous plants to climate change: a century long assessment based on the stable isotope analysis of herbaria specimens

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It is important to understand plant physiological responses to climate change, as these responses could influence global carbon and water cycles and could ultimately drive changes in plant communities' distribution and biodiversity. Some studies have already related drifts in species' distribution to climate change and manipulative experiments found short-term plant physiological responses to variations in climate. However, plant physiological responses may be species specific and their magnitude was found to decrease with time in these experimental studies. This indicates possible long-term processes of acclimation and adaptation in plants and urges the need to assess the long-term responses of plants to climate change.

The isotopic analysis of archived plant material offers the exceptional opportunity to reconstruct the physiological activity of plants over long time periods. The carbon isotopic composition of plants is a good proxy of leaf-level intrinsic water use efficiency and leaf oxygen isotopic composition can provide a time-integrated indication of leaf stomatal conductance during the growing season. Previous studies analysing the physiological activity of plants over long time periods have largely focused on the stable isotope analyses of tree ring chronosequences. Trees represent, however, less than 2% of plant species found in Switzerland. The stable isotope analysis of herbarium samples offers the opportunity to reconstruct the physiological processes of a large range of different plant species from different environments.

The objective of this study is to assess the long-term physiological responses of herbaceous plant species from diverse environments and functional groups to changes in climate occurred during the past centuries in Switzerland. In order to do so, leaf herbarium samples from a large number of herbaceous plants species are analysed for their stable oxygen and carbon isotope ratios. Samples are collected from the unique herbaria hold at the University of Basel which cover 600'000 specimens collected mostly in Switzerland since the 18^{th} century for a wide range of species and environments in Switzerland.