PhD position in plant evolutionary biology.

University of Zurich, Dept. of Systematic and Evolutionary Botany

Biophysical carbon concentrating mechanisms (CCMs) operating at the single-cell level have evolved independently in some eukaryotic algae and a single lineage of land plants, the hornworts. An essential component for an efficient biophysical CCM is a pyrenoid, which represents a specialized compartment inside chloroplasts that mainly comprise the CO_2-fixing enzyme RuBisCO. Hornworts with pyrenoids fix significantly more carbon than their relatives without pyrenoids. Given the repeated gains and losses of pyrenoids in hornworts during the last 50 million years, we may assume that their assembly is potentially controlled by a few master regulators of eco-evolutionary relevance.

In a joint effort, we will combine comparative -omics with reverse genetics tools to study the genetics, function, and molecular basis of pyrenoid-based CCM in hornwort plastids under different environmental conditions. Guided by ultrastructure-based monitoring of the pyrenoid assembly in hornworts, we aim to identify the genetic toolkit of biophysical CCM in hornworts through two interdependent approaches: First, we aim to predict candidate CCM components in silico though a set of homology searches that compare the hornwort gene set with algal CCM component. Second, we employ an exploratory gene and protein (co)expression profiling of isolated plastids collected under low vs. high CO_2 concentrations and under flooding. A strength of our experimental design is that we contrast up to three pairs of pyrenoid bearing and pyrenoid lacking hornwort species. Finally, we will investigate pyrenoid functionality under various environmental conditions.

Specifically, we aim to conduct localization and functional validation analyses for a core set of genes discovered in our CCM gene prediction approaches. These experiments are possible through our recent advances to establish *Anthoceros agrestis* and other hornwort species as a tractable model system. Together, our collaborative project will not only allow a comparison of the mechanisms of pyrenoid assembly between algae and hornworts, but also reveal general principles and species-specific innovations in the evolution of carbon-concentrating plastids. Above that, focusing on and understanding the basis of land plant CCM instead of only the algal form could eventually contribute to efficiently engineer pyrenoid assembly and boost photosynthetic efficiency of crops. Relevant publications: https://www.nature.com/articles/s41477-020-0618-2, https://doi.org/10.1016/j.tplants.2017.02.002.

This project is founded by the German National Science Foundation (DFG) MadLand (https://madland.science/) program to Peter Szovenyi and Susann Wicke. The project requires collaborative work including frequent visits to Germany and to the USA (Fay-Wei Li`s lab at Cornell).

The Dept. of Systematic Botany hosts research groups working on the evolutionary and ecological drivers of biodiversity, on the macroevolution of plants, on plant-insect interactions/pollination, on the evolution of mating systems, hybridization and speciation. The Dept. of Plant and Microbial Biology hosts many groups working on plant molecular and

developmental biology, epigenetics, community genomics and plant adaptation. Both institutes are housed in the beautiful Botanical Gardens and host a diverse community of researchers in plant biology.

The ideal candidate will have an MSc in biology with a specialization in evolution, developmental genetics and/or bioinformatics. This position primarily involves reverse genetic, microscopy, gas exchange measurements and bioinformatic work and requires advanced skills in handling, analyzing and interpreting high-throughput next-generation sequencing data. Good skills in assembling vectors, carrying out genetic transformations and microscopy are also required. Previous experience with *Chlamydomonas* pyrenoids is a plus but not necessary. In case not all these skills are covered, the willingness to quickly acquire them is absolutely necessary.

The student will closely work together with the second PhD student/postdoctoral associate in Germany on this grant. Students should be willing to work both in the wet lab and in the office doing computational work. The position is initially for three years. Selected candidates will be enrolled in one of the two affiliated PhD schools in evolution or plant sciences.

CLOSING DATE: The position is opened until filled, but all application material including **CV**, a summary of **research experience**, a **letter of motivation**, **copies of relevant publications** (published or submitted) and **names and contact information of three reference persons** sent **as a single pdf file** should be received by 18th June. 2020 to ensure full consideration. The position will start at the earliest possible date, but it is negotiable (at the latest in August 2020). Candidates should indicate in a cover letter when they could take up the position.

Please send all application material with the following subject line "PhD_hornwort_pyrenoid" to: Peter Szovenyi, peter.szoevenyi@uzh.ch, as a single pdf document. For enquiries please contact Peter Szovenyi (peter.szoevenyi@uzh.ch).