Universität Basel

Research Project

Algal Dynamics And Productivity through Time (ADAPT)

Third-party funded project

Project title Algal Dynamics And Productivity through Time (ADAPT)
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Although individually small, algae have the collective power to change the composition of Earth's atmosphere, oceans, and climate, thereby influencing virtually all other forms of life. Human disruptions to the carbon and nitrogen cycles impact waters in which algae live and cause changes to phytoplankton distributions and productivity. These changes can drive feedback loops with unforeseen consequences for Earth's oceans and atmosphere, thereby impacting the environment and resources needed for the continued human prosperity. Understanding algal community dynamics and responses to environmental change is therefore key for constraining their feedbacks to climatic and biogeochemical perturbations. One of the best ways to understand these dynamics is to analyze the ways in which algae have responded to the diverse conditions that have existed over geologic time. However, our ability to gain information from past changes is only as good as the tools we have to detect these changes because direct observations are limited to the tiniest sliver of Earth's history. As a consequence, we must rely on indirect indicators – proxies – of past ecologic and environmental change.

The proposed ADAPT project will lead to a comprehensive, innovative, multi-proxy toolkit that can be applied to resolve outstanding questions about phytoplankton dynamics on diverse geographic and temporal scales. This will allow us to reconstruct phytoplankton community dynamics and interactions with nutrient cycling in the geologic past, and better predict feedbacks between phytoplankton and climate in the future. In this context, ADAPT will focus on developing and applying three organic geochemical proxies: relative distributions of diagnostic lipid biomarkers, the difference in nitrogen isotope ratios between bulk organic matter and chlorophyll degradation products, and the difference in hydrogen isotope ratios among different classes of algal lipids. The organic geochemical proxies will be integrated with, and calibrated through, sedimentary ancient DNA (*seda*DNA) analyses. *Seda*DNA is another emerging tool to reconstruct past ecological changes, but is limited to more recent timescales than the organic geochemical proxies.

The underlying goals of ADAPT are to reconstruct phytoplankton community dynamics and interactions with nutrient cycling in the geologic past, and to develop the tools needed to better understand how they impact the atmosphere, global ecosystems, and climate system. In order to achieve these goals I have developed a five-year plan divided into three phases. In the first phase of ADAPT, I will validate and cross-calibrate proxies for phytoplankton ecology using samples collected every second week from the water column of a small lake in Switzerland with large seasonal variability in the distribution of different types of algae. In the second phase, I will determine how lacustrine phytoplankton communities responded to known anthropogenic forcings in the modern era (20^{th} and 21^{st} centuries) and in antiquity (ancient Romans). In the third phase of ADAPT, I will reconstruct the composition of phytoplankton communities over the Holocene in temperate lakes in order to establish baseline values for natural rates of change and frequency of harmful algal blooms. I choose to focus on lakes because in contrast to oceans their relatively small size means they can react quickly to perturbations, facilitating the development of a mechanistic understanding of how algal populations respond to changing conditions, and how those signals are transferred to sedimentary proxy indicators.

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