A Pond-Scale Experimental Test of How Community Composition Affects Lipid Hydrogen Isotopes

S. NEMIAH LADD*[1,2], BLAKE MATTHEWS[1], DANIEL B. NELSON[1,3], NATHALIE DUBOIS[1,2], CARSTEN SCHUBERT[1]

[1] Swiss Federal Institute of Aquatic Science and Technology (Eawag), Kastanienbaum, Switzerland (*nemiah.ladd@eawag.ch, blake.matthews@eawag.ch, nathalie.dubois@eawag.ch, carsten.schubert@eawag.ch)

[2] Swiss Federal Institute of Technology in Zürich (ETHZ), Zürich, Switzerland

[3]University of Basel, Basel, Switzerland (danielnelson@unibas.ch)

Earth's past contains information critical to understanding climate dymanics and assessing the likelihood of future climate trajectories. Instrumental records of climatic variables are short, necessitating the use of paleoclimate proxies. Useful organic geochemical proxies have been developed based on the distributions of lipid biomarkers in sediments, and the isotopic compositions of these compounds. These proxies are typically calibrated against the target climate variable in surface sediment transects, and refined by cultures of individual lipid producers. Although both approaches are important steps, neither provides a good means to experimentally test how changes in community structure and shifts in relative production sources influence the net signal exported to sediments.

We demonstrate the utility of experimental ponds for assessing the impact of community structure on lipid-based proxies by measuring the hydrogen (H) isotope composition of diverse lipids (fatty acids, phytol, sterols, stanols) collected from the water columns of 20 large-volume (15,000 L) outdoor ponds. The phytoplankton community in the ponds was manipulated by the presence/absense of keystone species (macrophytes and/or mussels) and then perturbed by sequential nutrient additions. We found that changes in fatty acid H isotope fractionation in response to nutrient loading were three times as large and of the opposite sign as observed in single species grown in culture. One possible explanation for this surprising result is that the ponds became dominated by green algae, which we subsequently confirmed fractionate H significantly less when producing fatty acids in batch culture than other taxa (e.g. diatoms and cyanobacteria). We also found that H isotope fractionation associated with 4-methyl-sterols and stanols, compounds produced almost exclusively by dinoflagellates, was insensitive to nutrient loading, indicating that these compounds are more robust hydroclimate tracers.