Shedding Light on Phytoplankton in Antarctic Lakes

Halie M. Seifert, Lehua D. Hoops, Gejla Toromani, Tareen R. Haque, Rochelle Pereira, Kaylie Wheeless, Devon Popson, and Rachael M. Morgan-Kiss
Department of Microbiology, Miami University. 700 E. High Street Oxford, OH 45056. Email: seiferhm@miamioh.edu, hoopsld@miamioh.edu, toromag@miamioh.edu, haquetr@miamioh.edu, morganr2@miamioh.edu

Like all aquatic ecosystems, phytoplankton are essential to polar ecosystems as foundational primary producers and as vital contributors to nutrient cycling. Polar phytoplankton conduct photosynthesis under extreme conditions (e.g., low temperatures, hypersalinity, nutrient limitation). These polar phytoplankton are also adapted to seasonal extremes in light availability, from 24-hour daylight (summer) to total darkness (winter). The McMurdo Dry Valleys (MDV), located within the valleys of the Transantarctic mountain range (Victorialand, East Antarctica) harbor numerous ice-covered lakes and ponds, each supporting unique phytoplankton communities. The MDV lakes are genomic reservoirs for novel extremophilic microorganisms and pristine models of simplified food webs. The McMurdo Long Term Ecological Research program (mcmlter.org) has monitored several MCM lakes for more than 3 decades. Two MDV lakes, Lakes Bonney and Fryxell, are representative of the extremes in water column chemistry: Bonney is highly oligotrophic and hypersaline, while Fryxell is mesotrophic and relatively freshwater. Both lakes exhibit permanent chemical stratification through the water columns.

The Morgan-Kiss laboratory is undertaking a large effort to monitor temporal and spatial trends in MDV lake phytoplankton communities over decadal and seasonal time scales. A diving spectral fluorometer, the bbe FluoroProbe (Moldaenke, Germany), represents a major tool for this project. Since 2005, depth profiles of four MDV lakes have been collected throughout the short austral summer. Additionally, moored instruments have been autonomously deployed year-round to collect annual trends in phytoplankton. The FluoroProbe utilizes several excitation wavelengths to convert chlorophyll a fluorescence to determination of four spectral algal groups (chlorophytes, cyanobacteria, cryptophytes, and 'mixed'). Here we present four research questions utilizing the long-term FluoroProbe dataset to explore questions about drivers of phytoplankton dynamics: 1) How will different algal classes respond to drastic environmental changes such as temperature and nutrient levels over time? This project could provide an understanding of which phytoplankton will be most impacted by climate change within an Antarctic ecosystem. 2) Does metabolic flexibility allow for greater survivability of cryptophytes over chlorophytes in a changing environment? This will increase understanding of how diverse lifestyles can impact survivability in response to environmental shifts. 3) How do changes in temperature, and as a result, ice thickness, influence the distribution of green algae within Lake Bonney? The findings are expected to elucidate the ecological impacts of climate change on a key group of primary producers. 4) How do seasonal changes in phytoplankton biomass in Antarctic Lakes Bonney, Fryxell, and Hoare correlate with environmental factors such as temperature and photosynthetically active radiation (PAR) during the transition from polar night to austral summer? The analysis aims to clarify the interactions between phytoplankton dynamics and climatic variables, providing insights into the potential impacts of climate change on these remote ecosystems. Students representing all four projects will present a joint poster to highlight this robust long-term dataset representing phytoplankton dynamics from this isolated and unique environment.