Eco-evolutionary responses of phytoplankton to global change

Mentors: **Danny O'Donnell** (PhD Candidate, Kellogg Biological Station) and **Dr. Elena Litchman** (Faculty – MSU Dept. of Integrative Biology and Kellogg Biological Station.

Introduction

Take a long, deep breath. Now slowly let it out and take another. That second breath was brought to you by phytoplankton, the microscopic photosynthesizers found in almost all open water on Earth. In addition to producing nearly half of the oxygen you breathe, phytoplankton are the foundation of most open ocean food webs; they are essentially the trees of the seas.

Recent studies, including some from the Litchman lab at KBS, have projected massive changes in phytoplankton communities in the world's oceans over the next century, due to climate change. However, some phytoplankton may have one last trick up their sleeves: massive population sizes and extremely high reproductive rates allow phytoplankton to adapt evolutionarily to rising temperatures at rates unattainable to larger, slower-growing organisms.

In the Litchman lab, we are currently evolving replicate populations of the marine diatom (a type of phytoplankton) *Thalassiosira pseudonana* at temperatures below and above its optimal temperature for growth. After ~450 generations, we have observed exciting trends (see Danny's website (www.msu.edu/~odonn146) for some details). While we have observed evolutionary change in several key traits in *T. pseudonana* (population growth rates at a given temperature, nitrate-dependent growth kinetics, cell size), there are a practically limitless number of traits and genetic and ecological comparisons that one might explore, both between temperature-selection groups and among replicates within each group. For example, we have yet to sequence and compare the genomes of our populations; we have not explored the thermodynamic properties of our populations' intracellular biochemistry; we have not thoroughly explored short-term physiological acclimation (phenotypic plasticity) to high or low temperatures; and, perhaps most importantly, we have yet to conduct successful ecological competitions between selection lines.

With some luck, next summer will be an exciting period of rapid advancement on this project. An REU in our lab should be open-minded, as we are not yet sure which project(s) we will be focusing on next summer. The REU will likely have some freedom to choose which project they will undertake, though this will depend on a number of factors (primarily the success/failure of various projects between now and next summer).

The successful applicant should demonstrate focus, responsibility, self-motivation, independence, and enthusiasm for learning new things. There will be ample opportunity to develop technical lab skills (e.g. nutrient analysis, spectroscopy, algal culture), and (optionally) some experimental design, math, and programming skills as well! Depending on the success of the project, we encourage students to maintain collaborations with our lab after the summer is over. We look forward to reading your application!