Characterizing the phytoplankton community of Harpswell Sound by size class using high performance liquid chromatography

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Phytoplankton, microscopic single-celled organisms that photosynthesize, make up the foundation of the trophic chain in the global ocean. In recent years, Harpswell Sound (HS) and the greater Gulf of Maine have experienced an increase in harmful algal blooms (HABs), commonly known as "red tides." These blooms are composed of certain phytoplankton species that release toxins, which are then bioaccumulated by grazing shellfish and which cause shellfish poisoning in humans who consume those fish. As a result, fisheries located near HABs are required to close, which significantly impacts Maine's coastal economy. Dr. Collin Roesler has been studying the dynamics of phytoplankton in coastal Maine for multiple decades to better understand when and why these HABs occur. One of the methods she employs (and that summer fellow Emma Barker worked with) is the use of an Imaging Flow CytoBot (IFCB) to continuously capture images of the phytoplankton that are collected from HS and flow through the marine lab at Bowdoin's Schiller Coastal Studies Center. This instrument allows for the genus- and sometimes species-level quantification of the phytoplankton that appear in each water sample, making it a powerful tool for community analysis.

However, the IFCB can only reliably photograph and identify phytoplankton down to ~10 microns, which omits a significant population of smaller nanno- and picoplankton. My project uses high performance liquid chromatography (HPLC) to perform pigment analysis on fractionated water samples to characterize this smaller population. Each week, our lab collected water samples at 5 locations in HS to be used in IFCB and HPLC analyses. The research goals were threefold: (1) to determine which phytoplankton taxonomic groups were present at each of our sampling locations in HS; (2) to determine which, if any, taxa smaller than 10 µm were missed by the IFCB; and (3) to track how the populations of ≤10 µm taxa and >10 µm taxa shifted over the course of the summer.

HPLC analysis uses a multitude of field and lab techniques to take a water sample from field collection all the way through data collection and processing on the HPLC instrument. To conduct HPLC analysis, water samples were collected in the field, then size fractioned using vacuum filtration into the desired size classes, which in this case were a "total" sample and a ≤10 µm sample. The phytoplankton in these samples were then filtered onto glass microfiber filters and stored in liquid nitrogen until ready for extraction. Samples were run alongside pigment standards to allow for pigment identification in a reversed-phase HPLC system.

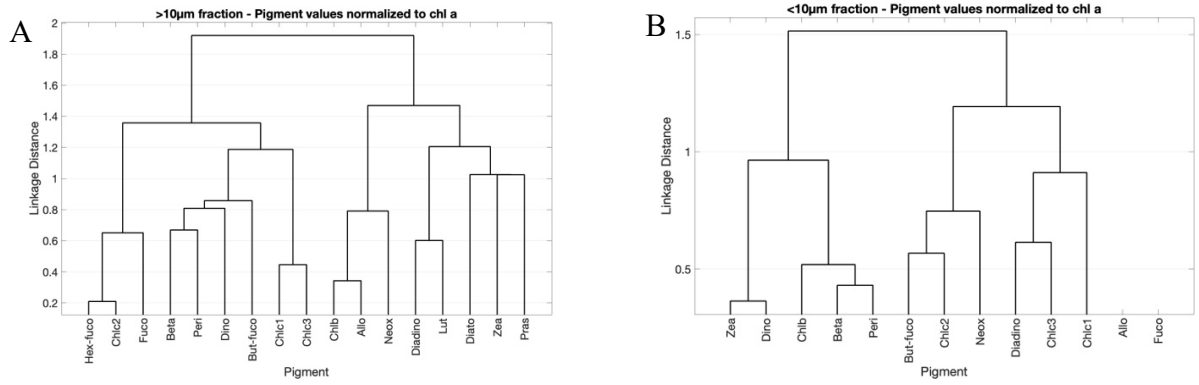

Figure 1. Hierarchical cluster analysis showing pigment values normalized to chlorophyll a (i.e., normalized to biomass) for A. the >10µm size fraction and B. the ≤10 µm size fraction.

While research goal 3 is still ongoing, goals 1 and 2 elucidated interesting preliminary results. A hierarchical cluster analysis (HCA) was performed in MATLAB on both the >10 µm and ≤10 µm phytoplankton fractions for June 2024. HCA is a statistical test that considers how two or more objects—in this case, pigments—covary, elucidating which phytoplankton taxa were appearing together in the samples. The HCA showed that the pigments were distributed differently in the >10 µm and ≤10 µm fractions, showing the presence of multiple distinct populations separated by size (Figure 1). Moreover, the HCA indicated that even if a certain group, such as dinoflagellates, appeared in both size fractions, it may not covary with the same other taxa in both size fractions (Figure 1). These preliminary findings suggest that different sized phytoplankton within a given taxonomic group may cycle differently over the course of a season in HS, setting the stage for further exploration of the dynamics of different size classes in HS over time.

Faculty Mentor: Dr. Collin Roesler

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References

Kramer, S.J. and D.A. Siegel (2019). How can phytoplankton pigments be best used to characterize surface ocean phytoplankton groups for ocean color remote sensing algorithms? Journal of Geophysical Research: Oceans, 124(11), 7557-7574, https://doi.org/10.1029/2019JC015604.