Allelopathic and Antigrazing Compounds in Marine Cyanobacteria and Dinoflagellates: Characterization, Community Effects, and Mode of Action

Matthew D. Johnson and Tracy Mincer

The aim of our project was to characterize the ecological role of toxins and allelopathic (inhibitory to other species) compounds produced by marine microbes, and to describe their biochemical effect on other organisms. In most cases, toxins that are produce by microbes are poorly understood in regard to their toxicity to other microorganisms. Total small molecule extracts (molecules of 2000 Dalton or less) were obtained from various cyanobacteria and proteobacteria. Toxicity of crude small molecule extracts to phytoplankton cultures were assessed through bioassays against key bloom-forming phytoplankton. We found that extracts from cyanobacteria *Trichodesmium erythraeum* strain K-11 #131 and *Microcoleus* sp., as well as the heterotrophic bacterium *Rheinheimera aquimaris* strain A500, generated the greatest cytotoxicity towards a model oceanic phytoplankter, *Emiliania huxleyi* (371) (Figure 1). Toxicity of extracts towards *E. huxleyi* was manifested by dramatic declines in photosynthetic efficiency (Fv/Fm) and mortality within 24h (Figure 2, 3), with K11-131 having an immediate acute toxicity and A500 producing a more gradual lethal effect. Other cyanobacterial extracts from *Crocosphaera* (8501p), *Lyngbya*, *Nostoc*, *Synechococcus*, and *Cyanothece*, induced slight but significant declines in Fv/Fm for *E. huxleyi* after 7 days, with little or no mortality (Figure 4).

Extracts from K-11 #131 and 8501p caused acute mortality in a cryptophyte alga, *Rhodomonas* sp., but had little affect on the marine diatom *Phaeodactylum tricornutum*, while extracts from A500 revealed little or no negative responses in either phytoplankter. Our results show that small molecules produced by bacteria can be significant in influencing photosystem health, growth, and mortality of major bloom-forming phytoplankton, and thus may play a role in structuring phytoplankton diversity. Future work will focus on structural elucidation of the active molecules in our assays and determining their mode of action, with the ultimate goal of testing these compounds in mesocosm and field-based studies. We plan to use these results to seek additional funding support from NSF to study the role of these molecules in marine microbial food webs. This research supported an undergraduate summer research student, Paige Roberts (University of Colorado), during the summer of 2010.