CMOP Undergraduate Intern Mentoring Opportunity

Project Title: Nitrification Potential and Niche Diversification of Ammonia Oxidizing Archaea in Columbia River sediments

Context for project:

Research in the Simon lab covers several topics in microbial ecology, including the study of microorganisms involved in carbon and nitrogen biogeochemical cycles, and monitoring of biological changes with the changing environment. The proposed summer intern project will be a part of our ongoing research to study the metabolic properties and ecological functions of archaea involved in global nitrogen and carbon cycles. General approaches used include classical cultivation, biomolecular techniques and geochemical characterization.

Brief Description:

Microbes are by far the most abundant and diverse life forms on planet Earth. They are essential for recycling nutrients through global biogeochemical cycles, which ultimately impacts our lives. An example is ammonia oxidation, the first and rate-limiting step in nitrification (which links the mineralization of organic matter to the recycling of nitrogen to the atmosphere). Ammonia oxidation is solely mediated by autotrophic ammonia oxidizing bacteria (AOB) and the recently-discovered ammonia oxidizing archaea (AOA). Recent findings in AOA research indicate that archaea have very significant roles in global nitrification. AOA are abundant and widely distributed in almost every habitat, and they often outnumber their counterpart AOB in marine and soil environments. Nevertheless, their metabolic properties and ecological functions are not well understood due to the lack of cultivated strains. To study nitrification potential and niche diversification of AOA in terrestrial environments, the intern will help analyze both environmental samples (freshwater sediments) and lab-maintained enrichment cultures using a combination of microanalytic and molecular genetic approaches, as well as correlate geochemical and molecular data. Freshwater sediments cores will be taken at selected sites in Columbia River. Biogeochemical and molecular variables will be characterized at fine vertical resolution in intact or fractionated cores. Furthermore, cultivation-based approach will be used to enrich for archaea and study their metabolisms using defined medium. The project, developed for summer intern, will focus on studying the nitrification potential of AOA using microcosms and enrichment cultures inoculated from freshwater sediments. Cultures with the addition of diverse substrates will be set up and maintained under different conditions. We will quantify both AOA and AOB gene abundance using quantitative PCR, and monitor ammonia oxidation activity by measuring ammonium and nitrite+nitrate. In addition, multivariate analysis will be used to assess the correlation between ecological data and complex environment factors.

Proposed Outcomes/Broader Impact:

This project, developed for a CMOP undergraduate summer intern, will train the student in microbiological and molecular biological techniques. The intern will learn molecular techniques by

performing nucleic acid extraction and purification, and quantitative PCR. He or she will also learn cultivation techniques by setting up and maintaining different cultures. Furthermore, the student will learn to take scientific notes, organize and analyze data, and communicate scientific results through written reports and oral presentations. Results from this project will contribute to our overall goals for understanding niche diversification of AOA in freshwater sediments.

The final report will summarize the result of enrichment cultivation, biomolecular characterization of AOA and data analysis. The student will present a verbal and written report, and produce laboratory notes that may be useful for future studies.

Proposed timeline (within a 10 week span):

From early of June until the mid of August.

First week: Literature review

Second-ninth weeks: Laboratory work

Last week: Presentation