2004-05 TWRI Mills Fellowship Program Application

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The Microbial Response to Stressors Across Watershed System Boundaries

Nature of the Problem

Human activities have generated a wide variety of stress from local to regional scales that have had major effects on ecosystems (Frost et al., 1999). The source of such stressors can include population increases and land-use changes which can stimulate run-off and pollution to associated watersheds. One of the most integral consumers of such pollution includes the microbial communities that reside in both the terrestrial and aquatic ecosystems. Microbial communities are fundamental components of a wide-range of ecological processes including cycling of nutrients, carbon storage, production of greenhouse gasses, degradation of pollutants, and maintenance of soil structure (Jones and Bradford, 2001). However, these microbial populations are constantly confronted by variable and stressful environments (Kivisaar, 2003). Common stressors to microbial communities include nutrients (C,N,P), H_2O, pH, and temperature; wide variations in these components can cause a variety of genetic mutations to occur, altering the structure of microbial populations and affecting biodiversity and ecosystem function (Kivisaar, 2003). In the proposed research, we aim to study the effect of the common stressor-H_2O and the associated microbial response within the terrestrial-aquatic interface. Interfaces are significant to study because these complex regions can dictate the fate and transport of pollutants across system boundaries; where the dominating biogeochemical processes are of primary importance in carbon cycling. Understanding the biogeochemical processes that occur in these areas provides insights to the complexity of the natural world. The current hypothesis states that the microbial activity, community structure and function at the terrestrial-marine interface are uniquely different than those of the individual systems.

Research Objectives

The proposed methodology includes the measurement of volatile organic carbons (VOCs) as a means to monitor the dynamical behavior of microbial systems under stress. Volatile organic carbons are an indicator of microbial activity and may prove to be the best currently known way to monitor it. In this work we aspire to design a methodology to easily measure produced VOCs in a laboratory microcosm study where sediment from a Texas watershed would be examined. The experimental design would mimic the response of the natural environment and associated water stress where the incorporation of traditional methods would include tracer techniques, measurement of microbial community structure (BioLogs), and measurement of redox potential (Eh). The specific objectives are to perturb a soil microcosm with water; isotope labeled nutrients and deuterated water will be used to trace microcosm response to water stress. Microbial metabolites in the form of volatile organic compounds will be measured as indicators of microcosm stress; deuterated water vapor will be concurrently measured to determine the state of water stress. In order to asses the impact of the water stressor, microcosm treatments would include flooding and purging to simulate field conditions of various water concentrations. Further the redox couples utilized during microbial respiration would be identified along with the associated microbial communities present.

Upon effective completion of the laboratory design, plans for in-situ applications to multiple field stations within a Texas watershed are anticipated. Field studies would allow for a watershed scale approach to the measurement of microbial activity and response to potential stressors, where ecological connections could be investigated. Transects of various water quantities would be established and measurements made along each transect in order to asses the impact of the stressor to microbial activity. In addition to microbial metabolism measurements, the soil and water properties of each station will be identified and characterized as well. Furthermore, exploration of geochemical data bases and geographical information system (GIS) mapping techniques would enable the complete execution of the research where a modeling approach to the watershed under study would enable future microbial response predictions to be made. This research is innovative because it integrates multiple methods to measure microbial activity within the land-water interface of a Texas watershed and it highlights the potential for a new application of VOC detection.

References

Frost et al. (1999). Multiple Stressors from a single agent: Diverse responses to the experimental acidification of Little Rock Lake, Wisconsin. Limnology and Oceanography 44(3): 784-794.

Jones T.H. and Bradford M.A. (2001). Assessing the functional implications of soil biodiversity in ecosystems. Ecological Research 16: 845-858.

Kivisaar M. (2003). Stationary phase mutagenesis: mechanisms that accelerate adaptation of microbial populations under environmental stress. Environmental Microbiology 5(10): 814-827

Karen S. Sell

Education

Ph.D., Geology, Dr. B. Herbert, Chair. Expected graduation May 2006, Texas A&M University, College Station, Texas, **GPR 3.53, HRS 92** (42 MS HRS)
M.S., Oceanography, 2003, Dr. J. Morse, Chair. Thesis title: *Temporal influences of seasonal hypoxia on sediment biogeochemistry*. Texas A&M University, College Station, Texas
B.S., Marine Science, 2000, Eckerd College, St. Petersburg, Florida, **GPA 3.61 GREV - 420, GREA - 540, GREQ - 540**

Professional Experience

2003-Present	Graduate Assistant, Information Technology in Science (ITS) Center for Teaching and Learning, Texas A&M University. Research focused on student development of rich, mental models of complex, environmental systems, including the coastal margin and sediment biogeochemical processes.
2000-03	Research Assistant in Oceanography, Texas A&M University. Research focused on sediment biogeochemical cycling and measurement of redox-reactive species in porewater and solid phase pools underlying bottom water hypoxia in estuarine environments.

Academic Honors

2004	Awarded the $300 Research Paper Award in the “Cognitive & Instructional Technologies Laboratory” category. 9th Annual Educational Research Exchange, Texas A&M University, Jan. 30, 2004.
2004	Student presenter at NSF- Teaching and Learning Center PI meeting, Washington DC
2003	“Honorable mention” of student research presented at TOS meeting
2000-02	Awarded Texas A&M University Scherck Fellowship in Oceanography
2000	Undergraduate research project evaluated as “honored” work, Eckerd College
2000	Sponsored as undergraduate Sigma XI and Omicron Delta Kappa member
1997-98	Dean’s List - Eckerd College
1997	National Dean’s List
1996-00	Awarded Eckerd College academic scholarship (1/4-time)

Publications

Sell K.S. and Herbert B.H. 2004. Student cognitive difficulties in their mental model development of complex earth and environmental systems, in prep.

Sell K.S. and Morse J.W. 2004. Influences of seasonal Hypoxia on iron and sulfur biogeochemistry in Corpus Christi Bay sediments, submitted to Limnology and Oceanography.

Gardner W.S., McCarthy M.J., Sobolev D., Soonmo A., and Sell K.S. 2004. Nitrogen fixation and dissimilatory nitrate reduction to ammonium (DNRA) support nitrogen dynamics in Texas estuaries, submitted to Limnology and Oceanography.

Morse J.W., DiMarco S.F., Hebert A.B., Sell K.S. 2003. A scaling approach to spatial variability in early diagenetic processes. Hydrobiologia. 494: 25-29.

Morse J.W., DiMarco S.F., Sell K.S. and Herbert A.B. 2003. Determination of the optimum sampling intervals in sediment pore waters using the autocovariance function. Aquatic Geochemistry. 9: 41-57.

Morse J.W., Gledhill D.K., Sell K.S., and Arvidson R.S. 2002. Pyritization of iron in sediments from the continental slope of the northern Gulf of Mexico. Aquatic Geochemistry. 8: 3-13.

Byrne R.H., Liu Xuewu, Kaltenbacher E.A., Sell K., 2002. Spectrophotometric measurement of total inorganic carbon in aqueous solutions using liquid core waveguide. Analytica Chimica. 451: 221-229.

Hopkins A.E., Sell K.S., Soli A.L., and Byrne R.H. 2000. In-situ spectrophotometric pH measurements: the effect of pressure on thymol blue protonation and absorbance characteristics. Marine Chemistry. 71: 103-109.

Proposed use of funds

The funds will be allocated for the main purpose of conducting research. Needed supplies to perform field and laboratory work will be purchased including a redox probe to measure Eh/pH in both microcosm and in-situ studies, materials to build a microcosm, and for the purchase of microbial growth wells plates (BIOLOGS). Further, additional funds will be allocated to general laboratory supplies and field travel expenses.

Budget Breakdown

Redox probe	$300
Microbial BIOLOGS	$100
Microcosm materials	$300
Laboratory supplies	$100
Field Travel	$200
Total	**$1000**

Intended Career Path

The student's aim in her anticipated career is academia, where she hopes to achieve employment at a 4-year teaching/research institute. The student has modeled her career on studying water quality issues (e.g. eutrophication, hypoxia, biogeochemistry) and she anticipates continuing her research in the arena. The student has also achieved synergy in her Ph.D. research where she has coupled environmental geochemical science research with science education research in evaluating student learning of the environmental sciences. By coupling these research paths she hopes to continue to educate future students on the many water quality issues, while simultaneously conducting research on such phenomena. She envisions her professional career including components of both research and teaching where her 5-year plan would include establishing a competitive research group composed of both undergraduate and graduate students and publishing in both the environmental sciences and education fields.