Annual Report – ACES

Period Covered by the Report: February 1, 1999 - March 30, 2002
Date of Report: March 30, 2002
Title: Effects of salinity stress on natural and anthropogenically-derived bacteria in estuarine environments
Investigators: Ronald P. Kiene, Principal Investigator

Institution: University of South Alabama and Dauphin Island Sea Lab
Research Category:
Project Period: February 1, 1999 - March 30, 2002

Objective(s) of the Research Project: Bacteria are among the most important components of ecosystems because they carry out most of the heterotrophic metabolism and nutrient regeneration. Knowledge of what controls the growth of specific bacterial groups in estuaries is presently very limited, but of great concern from a management standpoint. Aquatic bacteria are the first line of defense in coastal ecosystems because they have the potential to mitigate the detrimental effects of certain anthropogenic pollutants, through degradation and transformation. This project is examining how salinity stress affects both natural and introduced bacteria in the Mobile Bay Estuary. The effects of salinity stress on bacterial metabolic activities, especially degradation of organic matter (natural and pollutant) are being tested. The physiological responses of bacteria to osmotic stress are being examined, particularly with regard to uptake of osmotic solutes from the water. I hypothesize that bacteria experiencing salinity (osmotic) stress will be able to mitigate that stress by taking up exogenous osmolytes such as glycine betaine and DMSP. A long term goal of this study is to characterize the microbial community structure and function,in different salinity regimes of the Bay, using classical and modern molecular techniques.

Progress Summary/Accomplishments: The relationship between bacterial activity and salinity in Mobile Bay is not strightforward. However, some sampling transects along the main axis of the Bay showed markedly decreasing rates of bacterial biomass production as salinity increased. In laboratory experiments we found that acute salinity stress of +5 or +10 parts per thousand, decreased bacterial biomass production, as measured by 3H-leucine incorporation. These sample experiments showed that simultaneous supplements of low concentrations (20 nM) of the osmolyte glycine betaine relieved the imposed salinity stress. This suggests that native estuarine bacteria can take up exogenous osmolytes for the purposes of compensating for hyperosmolarity, in such a way that allows them to maintain growth rates similar to non-stressed cells. The inhibition of bacterial production caused by experimental increases in salinity stress was more or less directly dependent on the magnitude of salinity increase. We also examined the time dependence of the inhibition. Results from some of these experiment suggested a rapid inhibition upon increases in salinity, followed by a rapid recovery. For these experiments the bacteria may have recovered because they took up naturally-occuring extracellular osmolytes (as oour other experiments indicated they could), or they rapidly synthesized intracellular osmolytes that compensated for the stress. In other experiments we found acute salinity stress to inhibit bacterial production with no observed recovery during periods of up to 6 h after the stress.

Either exogenous osmolytes were not available during these experiments or different populations of bacteria were present that were more susceptible to the stress. Future experiments will be directed at understanding why these differences were observed. Key to these analyses will be genetic analysis of bacterial population structure. With help from this ACES funding we have acquired the necessary equipment to address these questions.

Publications/Presentations:

Publications:

Kiene, R. P. and M. Axell. Response of estuarine bacterioplankton to acute osmotic stress. In preparation for Applied and Environmental Microbiology.

Presentations:

Future Activities: We still have some unmet goals on this project which will be addressed during summer and fall 2002. In particular, we want to examine the genetic structure of bacterial populations in different salinity regimes and during different seasons in Mobile Bay. This work will help greatly in understanding the function of the bacterioplankton community in the Bay ecosystem, and also enable a better understanding of how they respond to environmental stresses.

Supplemental Keywords:

Relevant Web Sites: General information about the PI's research programs and this ACES project can be found at http://mas.usouthal.edu/ and www.disl.org.

Acknowledgments and disclaimers

This research has been supported by a grant from the U.S. Environmental Protection Agency's Science to Achieve Results (STAR) program.

Although the research described in the article has been funded wholly or in part by the U.S. Environmental Protection Agency's STAR program through grant (number), it has not been subjected to any EPA review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.