Microbial Ecology of Sediments and Pore Waters of Tampa Bay

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Tampa Bay, located on the subtropical west coast of Florida, is one of the largest estuaries in the Gulf of Mexico. The Tampa Bay watershed supports recreational, agricultural, and industrial activities, and unique and sensitive coastal environments. Recreational, agricultural and industrial activities, in addition to the commercial and residential development that has taken place during the past 25 years, put increasing degrees of environmental stress on the natural resources and ecosystems within the bay. All of the activities have collectively contributed to an overall decrease in the water quality of the bay.

A central charge of the Tampa Bay Integrated Science Project is to develop baseline data that will assist in the modeling of changes in chemical, physical, and biological parameters within Tampa Bay. Bacteria have been shown to play a central role in the cycling of nutrients and minerals and in the mineralization of pollutants in all aquatic systems that have been studied to date. However, there are no data on even the most basic aspect of the microbial ecology of bacteria in the water column or sediment systems of Tampa Bay. The purpose of this talk is to present the results of a study to provide baseline data on the abundance and productivity of bacteria on sediments and within the pore waters of sediments in Tampa Bay.

Three sites were selected to collect baseline data: (1) an area impacted by a spill of acidic process water ($50\text{-}56\times10^6$ gallons) from a phosphoric acid and fertilizer production facility in 1997 and still devoid of vegetation, (2) an area impacted by stream effluent from urban and agricultural regions, and (3) an area not impacted by human activities and minimally impacted by runoff and stream discharges. Samples were collected from the sediment surface and at 2.5-cm intervals to a depth of 7.5-cm in March and August, 2003. Temperature, pH, salinity, and redox potential were measured in the field. Laboratory analyses included total direct counts, secondary productivity (^{3}H-leucine incorporation), community-level physiological profiles (CLPP), and analyses for manganese and iron.

Bacterial abundance in the pore water was relatively consistent at all sites and depths, averaging 2.10×10^6 cells ml^{-1} of pore water and 2.50×10^6 cells gr^{-1} dry weight of sediment. However, there were significant differences in porewater bacterial productivities at the acid and urban discharge-impacted sites (161.9 μg C L^{-1}d^{-1}) when compared to the non-impacted site (7.6 μg C L^{-1}d^{-1}). The bacterial productivity values for the sediments from the same areas were not significantly different (5.0 μg C kg^{-1}d^{-1} and 4.0 μg C kg^{-1}d^{-}1, respectively). There was also a general trend of increasing Mn and Fe concentrations with depth at all sites, with greater concentrations of both metals at the impacted sites. Both metals were significantly correlated with redox potential. The relationship between the two impacted sites and the non-impacted site, as determined by bacterial-community activities, is also supported by the CLPP analyses, with both impacted sites being closely related but significantly different from the non-impacted site.

In summary: 1) the sediment systems of Tampa Bay become anoxic and reduced < 2.5 cm from the surface, 2) the pore waters of the Tampa Bay sediment system have bacterial abundances and productivities that are greater than those associated with the sediments, 3) there is a significant difference in the data trends between the non-impacted site and the other two sample sites. The differences are presumed to be the result of higher organic loads (i.e., higher and more complex food sources for bacteria) at the urban-runoff site and alterations in the bacterial community at the site impacted by the acid spill that have adapted those communities to the extreme conditions, 4) the CLPP analyses indicated that there were significant differences among each site and vertically within each site during the time of both sample events. There was a general shift in preferential substrate utilization from the carboxylic acid to the carbohydrate group in the August samples, 5) bacterial productivity in the sediment systems of Tampa Bay is relatively high year round, with greater productivity during August when water temperatures are higher, 6) based on redox potential and Mn and Fe concentrations in the pore waters, there is a general trend of increasing cycling and utilization of these metals for bacterial metabolism during August when water temperatures are warmer and bacterial abundances and productivities are greatest.

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