Bacterial mineralization and incorporation of 2,4,6-Trinitrotoluene (TNT), RDX, and HMX in the coastal waters and sediments (ER-1431).

Michael T. Montgomery, Thomas J. Boyd, Joseph P. Smith (Naval Research Laboratory), Shelby E. Walker (National Science Foundation), and Christopher L. Osburn (North Carolina State University).

**Abstract**

Our original hypothesis was that nitrogenous compounds (like TNT, HMX, and RDX) would be transient in coastal ecosystems. This was based primarily on the understanding that microbial growth in coastal waters and sediments is typically nitrogen limited and there are few examples of nitrogen based organic compounds that are not rapidly metabolized in these systems. During 14 sampling events in coastal waterways from 2002 to 2007, we measured TNT mineralization rates in surface sediment and water samples that were often the same as, or within one order of magnitude, of the rate of total heterotrophic bacterial metabolism. Measured rates were similar to those of other organic compounds, such as petrochemical hydrocarbons and amino acids, which are transient in natural ecosystems due to their use in bacterial metabolism. Our findings appear to conflict with those that are widely reported in the literature based on the study of natural microbial consortia and groundwater systems. However, the apparent incapacity may be more associated with the nature of predominant metabolic systems of the microbial assemblage in the specific systems studied.

Rates measured over salinity transect may be the result of three processes of TNT transformation originally described in the literature. In the freshwater-endmember, TNT is mineralized directly and not as a carbon or nitrogen source. The high incorporation efficiencies may be an artifact of binding of amino acids to particulate matter (or even the bacteria themselves). The low TNT mineralization rates measured are consistent with this hypothesis. Some areas of exceptionally high mineralization rates may be the result of rapid lignin metabolism. These areas include the Puyer River mouth and the zones of convergence between water masses in Kahana Bay. Bacterial assemblages in much of the estuarine and marine ecosystems may be accumulating TNT in a manner similar to other common organic nitrogen sources, like amino acids. This would explain the occurrence between TNT mineralization and bacterial production (which is measured by amino acid incorporation). If TNT is primarily intramurally mineralized into bacterial proteins rather than metabolized for energy, as an amino acid, then the mineralization rates measured actually underestimate the mineralization of bacterial macromolecules by perssion-grown bacteria. Rates of remineralization would likely correlate with bacterial production rates needed to support growth of the protocyan gran population.

**Hypothesis**

NEC are metabolized faster in marine environments than in terrestrial/groundwater systems because marine microbial assemblages are N-limited and not limited.

**Sampling**

Eleven sampling cruises were performed in communities from 2002 to 2007.

**Material & Methods**

All experiments were performed in accordance with protocols approved by the Office of Naval Research (ORNL) and Environmental Protection Agency (EPA). Statistical analyses were performed using commercially available software.

**Acknowledgements**

The authors wish to thank the crew of the R/V Cape Henlopen and R/V Point Sur for assistance in sampling the Chesapeake Bay and San Francisco Bay. Thanks to the Maryland and California State government for providing financial support. The authors also wish to acknowledge the support provided by the Naval Research Laboratory.

**Results**

**Conclusions**

- TNT mineralizations observed in large areas of marine ecosystems are likely to have been exposed to TNT (Kahana Bay, San Diego Bay, San Francisco Bay, Chesapeake Bay, Elizabeth & York Rivers, Delaware Bay & Gulf of Mexico).
- Incorporation and mineralization rates of TNT, RDX, and HMX by free natural bacterial assemblies are related to the environmental conditions and the nature of predominant metabolic systems of the microbial assemblages in the specific systems studied.
- The incorporation efficiencies may be higher at the freshwater-endmember than in areas where there is likely to be the natural degradation of non-fermentable lignocellulose materials.
- These findings are consistent with the assumption that natural bacterial communities are similar across coastal water systems and are not subject to large environmental changes.
- It is likely that these field and laboratory results need to be reconciled prior to acceptance of the SERDP research by EPA.

**Future Studies**

- To further test the hypothesis that coastal ecosystems are capable of rapidly metabolizing the carbon component of TNT, RDX, and HMX, we propose to study the natural bacterial assemblages in a variety of coastal ecosystems and to investigate the role of microbial assemblages in the degradation of these compounds.
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