Final Report Summary

New Approaches for Assessing Mutagenic Risk of Contaminants in the Long Island Sound Environment

Urban sediments represent a reservoir of persistent contaminants that may pose a threat to the ecosystem and human health. To help evaluate these risks, testing approaches are needed to assess acute mortality as well as potential chronic effects that may reduce the fitness of affected populations. In this study we utilized a relatively new technique, a transgenic fish mutation frequency assay primarily developed for biomedical research, to directly evaluate the genotoxic (able to cause harmful damage to DNA) potential of coastal sediments from New York City and around Long Island Sound (LIS). Several national surveys characterizing chemical contamination in sediment and biota in US estuarine waters have identified a number of sites in this area as being among the most contaminated in country.

The primary goal of this study was to investigate the utility of using embryos of a recently developed strain of the Japanese medaka (Oryzias latipes) carrying a lambda cII transgene to directly test the mutation potential of environmental samples. Sites to be evaluated with the embryos were picked to represent toxic sites from New York Harbor and the lower Hudson River and sites along both the Connecticut and New York shores of Long Island Sound. Medaka embryos were incubated directly on sample sediments for 10 days and then hatched and reared in clean water for 60 days. Mutation frequency was assessed in the target transgene recovered from liver samples of these fish using selective plating techniques, and DNA from mutant plaques sequenced to determine mutation spectrum. Sediments from only one site near Rikers Island caused significant elevations in mutation frequency. The sediment sample from this site exhibited extremely high levels of polycyclic aromatic hydrocarbons (PAHs). The spectrum or type of mutations observed in these fish were similar to those produced by exposure to PAHs in laboratory tests. Fractionation experiments designed to test the mutagenicity of different groups of contaminants found in the Rikers Island sediment sample confirmed that PAHs contributed significantly to the mutations observed. However, these studies also indicated that unidentified polar contaminants also contributed.

This project was the first to our knowledge to use transgenic fish embryos to directly evaluate the mutagenicity of mixtures of contaminants in sediment samples, and the approach was found to be successful. The medaka embryos survived well on the sediment and provided conclusive and repeatable data quantifying both the magnitude and type of mutations caused by exposure to mutatoxic sediments. With modifications, this test could be used relatively efficiently to evaluate environmental samples. The results illustrate the utility of transgenic embryos to quantify and characterize mutations induced by exposure to environmental mutagens, providing more valuable information than can be obtained by the bacterial screening tests. That only one of six toxic sites evaluated in LIS led to increased mutation frequency in the medaka embryo test indicates that the mutagenic risk of sediment contaminants to vertebrate organisms is generally low in LIS, although the risk at more contaminated urban sites should be further evaluated.