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Woods Hole Sea Grant: 1996-1998 Projects

Molecular Biomarkers of Chemical Sensitivity in Protected Species: A New Approach to Environmental Risk Assessment

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Planar halogenated aromatic hydrocarbons (PHAH), including PCBs and dioxins, are ubiquitous and persistent contaminants of the global environment. Certain species of seals and whales have some of the highest levels of these pollutants documented in any animal group due, in part, to their position at the top of the food chain, and because PHAH tend to accumulate in the blubber of these animals. These compounds have been suggested as contributing to marine mammal mortality and morbidity, but the magnitude of the risk that PHAH pose to the health of marine mammals is controversial. The sensitivity of these animals to PHAH is not easily measured, since legal and ethical concerns preclude the direct testing of toxic chemicals on protected animals such as marine mammals. In this Sea Grant-supported project, researchers will determine the dioxin and PCB sensitivity of whales (including the beluga, Delphinapterus leucas) by characterizing a protein that is critical to PHAH effects. Through DNA cloning and in vitro analysis of the aryl hydrocarbon receptor protein, investigators hope to better understand the sensitivity of beluga and other whales to these pollutants. This state-of-the-art technique, commonly used to study human sensitivity to toxics, will aid the evaluation of the beluga's risk to PHAH and will serve as a model for a new method for assessing protected animals' risk to environmental contaminants. (R/B-137)

Development of Species-Specific and Stage Specific Immunofluorescent Markers for Bivalve Larvae with an Application to Fisheries Management

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Waters surrounding Nantucket Island, MA are known sinks for late-stage larvae of commercially-important bivalves such as Argopecten irradians (bay scallop), Mya arenaria (soft shell clam), and Spisula solidissima (surf clam). The planktonic larval stage is an important part of the life history of a benthic invertebrate as it is only during this stage that the organisms disperse, and thus exchange genes among populations, colonize new habitats or replenish old ones. However, limitations in sampling and identification of these planktonic organisms often hamper research and management practices. In this study, larvae will be sampled using a newly designed, automated sampling tool--the MASZP (moored, automated, serial zooplankton pump). Employing a cutting-edge molecular technique, the collected larvae will then be marked with fluorescent antibody tags to facilitate detection, identification, and enumeration in the samples. Identifying and enumerating previously indistinguishable planktonic larvae at early stages of their life cycle will be invaluable in studies of factors controlling population distributions, and of fisheries and aquaculture management. (R/B-139)

The following four projects are part of a 7-project, multi-institutional initiative supported by the National Sea Grant College Program titled "Chemical/Biological Interactions: Receptor-Mediated Effects on Reproduction and Development in Aquatic Species."

Fish Cytochrome P450 Genes Involved in Chemical Effects

John Stegeman, Woods Hole Oceanographic Institution

In this study, researchers will establish a molecular basis for explaining and monitoring effects of anthropogenic or natural chemicals on endocrine and developmental processes in fish. Through studying the salt marsh minnow, Fundulus heteroclitus, investigators will clone and sequence genes for cytochrome P450 that may metabolize and activate or inactivate chemical compounds. These studies will provide a molecular foundation for understanding the mechanisms and monitoring the effects of diverse chemical pollutants. The results will have implications for and applications in ecology, toxicology and pharmacology of fish, and could provide new approaches for screening effluents and new chemicals for biological reactivity. (R/P-60)

Molecular Biological Approaches for Non-Destructive Assessment of Chemical Effects on Marine Mammals

John J. Stegeman and Michael J. Moore, Woods Hole Oceanographic Institution

Pollutants in the marine environment, such as polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins, and furans, are believed to have adverse affects on marine populations, including marine mammals. Exposure to such pollutants may effect the physiology of marine mammals, including reproduction, immune defense, endocrine system functions, and, possibly, neural systems that control social and migratory behavior. Using molecular biological techniques, researchers in this study will focus on the pilot whale, studying biopsy samples of free-ranging populations as well as archived samples taken from stranded whales to evaluate the exposure of marine mammals to harmful chemical compounds. By quantifying expression of the cytochrome CYP1A gene, a sensitive biomarker of hydrocarbon effects, in the livers and other organs of the pilot whale, investigators will be able to characterize metabolic activity. The methods established in this study will provide a non-destructive means to study compounds that may pose a threat to fragile marine mammal populations. (R/P-61)

Impact of Environmental Contaminants on an Aquatic Bird Population

Mark E. Hahn and Connie Hart, Woods Hole Oceanographic Institution and Ian Nisbet, I.C.T. Nisbet and Co.

Many questions surround the extent to which dioxin-like compounds and chlorinated pesticides disrupt endocrine functions--such as reproductive and developmental processes--in humans and aquatic animals, including birds. This project seeks to examine abnormalities, including gonadal feminization, in common tern embryos from two coastal Massachusetts sites with different levels of environmental contamination. Using chemical, biochemical, and immunohistochemical methods as well as cell-culture bioassays, researchers will measure exposure of the birds to a variety of environmental pollutants. Through a combination of field and laboratory-based studies, investigators hope to assess possible relationships between health effects and specific contaminants, including dioxin-like compounds

and environmental estrogens. (R/P-58)

Identification of Bioactive Marine Natural Products Using a Fish Culture Bioassay

Mark Hahn, Woods Hole Oceanographic Institution

Marine organisms produce a variety of organic compounds, some of which display useful biological activities. Many of these products are structurally related to dioxins, PCBs and other anthropogenic compounds that act through specific receptor-mediated mechanisms. Investigators in this study will use a newly-devised cell culture bioassay system to determine marine natural products that stimulate or inhibit the same biochemical systems that respond to dioxins. Exploring the mimicking effects of natural marine compounds will be important in understanding the biochemical and physiological changes that have been observed in animals living in contaminated environments. In addition, identification of these compounds may be useful as future research tools or as pharmaceutical agents. (R/B-124)

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