Woods Hole Sea Grant: 2002-2004 Projects

Ligand Screen for Orphan Receptors in Marine Animals

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The oceans are a sink for many types of chemical pollutants, including numerous highly toxic compounds such as polynuclear aromatic hydrocarbons (PAH), halogenated aromatic hydrocarbons (HAH), and planar HAH (PHAH). These chemicals are found at high concentrations in sediments at many coastal sites, and can accumulate to extremely high levels in marine animals inhabiting those sites. The toxicity of many such pollutants occurs wholly or in part through interference with receptor-dependent signaling pathways. While much is known about such receptors in vertebrate animals, knowledge of toxicologically relevant receptors in invertebrates is extremely limited. Investigators will establish an assay that can be used to characterize the ligand (or chemical)-binding specificity of receptors in invertebrates and early vertebrates. The assay will be established initially using the aryl hydrocarbon receptor (AHR). A screening assay for receptor ligands would serve two functions: to identify toxicologically important ligands among known environmental contaminants, and to identify novel receptor-active compounds, including those of natural origin, in sediments and other environmental matrices. Identifying compounds that act as receptor ligands is important for understanding the impact of organic contaminants on marine invertebrates. Accurate ecological risk assessment for contaminated marine sites depends on the selection of appropriate “sentinel” species that are most at risk. While data from toxicity testing in selected species can provide some guidance for the choice of target species, the most accurate risk assessments will require a fundamental understanding of molecular mechanisms in various taxa, allowing prediction of the most sensitive species at contaminated sites. This project will contribute to such an understanding. (R/P-66)

Contaminants and Aquatic Animals: A Biomarker to Assess Species Differences in Susceptibility to Dioxin-like Chemicals

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Planar halogenated aromatic hydrocarbons (PHAHs) are widespread contaminants of the marine environment. This group of chemicals, which includes chlorinated dioxins, certain chlorinated biphenyls, and certain other halogenated compounds, is highly toxic to most vertebrate animals. Certain marine mammals contain some of the highest levels of PHAHs reported in any wildlife species, but the magnitude of that risk is controversial because there is little information on the sensitivity of these animals to PHAH. Despite numerous studies about PHAH accumulation in marine mammals and circumstantial evidence for adverse effects of contaminants, a cause-and-effect relationship between PHAH contamination and reproductive abnormalities or other effects in most marine mammals remains speculative. PHAHs are thought to produce toxicity through changes in the expression of genes involved in the control of cell growth and differentiation. These changes are initiated by the binding to the aryl hydrocarbon receptor (AHR), a ligand-dependent transcription factor. Researchers will investigate the mechanistic basis for PHAH toxicity in three species of marine mammals that either are known to accumulate high levels of PHAHs or are highly sensitive to the toxic effects of these compounds: harbor seals, mink, and polar bears. To do this, they will clone and characterize the AHR, an intracellular protein that is responsible for dioxin effects. These will test the hypothesis that the characteristics or expression of the AHR can be used as a biomarker of susceptibility to dioxin toxicity in marine mammals. This research builds on the investigator’s previous Sea Grant work on the comparative biochemistry and molecular biology of the AHR in marine species including beluga whales by expanding this work to other groups of marine mammals for which effects of contaminants are better known. The work in marine mammals will complement another study to examine the AHR in several species of birds and past work in fish to allow a broader comparative perspective concerning the characteristics of the AHR and its role in determining PHAH sensitivity. (R/P-67)

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