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Environmental Analysis of Endocrine Disrupting Effects from Hydrocarbon Contaminants in the Ecosystem

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Research Objective

The objective of this project is to determine how environmental contaminants, namely hydrocarbons, can act as hormones or anti-hormones (i.e., environmental hormones) in different species present in aquatic ecosystems. Species of particular focus are those which can serve as sentinel species (e.g., amphibians) and, thus, provide early warning signals for more widespread impacts on an ecosystem and its wildlife and human inhabitants.

Research Progress and Implications

This reports the progress of 1.5 years of a three-year grant awarded to the Tulane/Xavier Center for Bioenvironmental Research (CBR).

A growing body of evidence suggests that chemicals in the environment can disrupt the endocrine system of animals (i.e., wildlife and humans) and adversely impact the development of these species. Because of the multitude of known endocrine-disrupting chemicals and the numerous industrial and government sectors producing these chemicals, almost every federal agency has initiated research on the endocrine effects of chemicals relevant to their operations. This study represents the Department of Energy (DOE) Basic Energy Sciences' only research on the impacts of endocrine-disrupting chemicals. The activities employed by this project to determine these impacts include development of biotechnology screens (in vitro), animal screens (in vivo), and other analyses of aquatic ecosystem biomarkers of exposure. The results from this study can elucidate how chemicals in the environment, including those from DOE activities, can signal (and alter) the development of a number of species in aquatic ecosystems. These signals can have detrimental impacts not only on an organismal level, but also on community, population, and entire ecosystem levels, including humans.

Biotechnology Screening System

Three biotechnology screens have been developed and tested through this grant: 1) the Yeast Expression System (YES), 2) an *in vitro* screen for thyroid hormone disruption, and 3) an *in vitro* screen for the Arthropod ecdysone receptor. These screens allow us to test the ability of PAHs and other environmental hormones on hormone receptors of humans, amphibians, and invertebrates (e.g., shrimp). Development of all of these screens is completed and all have demonstrated success in identifying numerous compounds, including PAHs, which interact with these important receptors.

Animal Screening

Three animal screen studies have been funded through this grant and include the effects of environmental hormones on: 1) the African clawed frog (*Xenopus laevis*), 2) the leopard frog (*Rana pipiens*), and grass shrimp (*Palaeomonetes* spp.). Frogs were chosen as species of concern since unusual frequencies of frogs with morphological abnormalities have been observed recently in western North America; environmental hormones are capable of disrupting reproductive physiology in amphibians; amphibians are often the most susceptible species for adverse environmental impacts (and, thus, can serve as sentinel species for ecosystem inhabitants); and many are threatened and endangered. Grass shrimp were chosen as species of concern because of their economic and ecological value and because of the many industrial impacts on their aquatic habitats.

Since frog metamorphosis is primarily controlled by thyroid hormones, we used metamorphosis as a model for environmental hormone interaction with the thyroid axis. We exposed premetamorphic tadpoles of the African clawed and leopard frogs to a variety environmental hormones and measured growth and rate of metamorphosis. For both frog species, metamorphosis was affected (either delaying or accelerating metamorphosis) by these environmental chemicals. For the African clawed frog, in particular, biomarker analyses suggest that the endocrine neuroimmune systems could be adversely impacted by various hydrocarbons and organometals.

The impact of PAH contamination on grass shrimp was investigated in a contaminated bayou and in the lab. Grass shrimp caught in the bayou showed a contaminant-gradient increase in heat shock protein 63 and cytochrome P450 1A (as measured by ECOD metabolism). Grass shrimp exposed to contaminated sediment in the laboratory showed a trend for elevated ECOD metabolism, however individual variation was too large for statistical significance. Heat shock proteins were also not significantly elevated in laboratory exposed shrimp. This lack of significant increase in these two biomarkers could be due to the short exposure regime.

Planned Activities

During the remainder of this grant period (approximately 1.5 years), the investigators intend to continue development of animal screen and biomarker analyses for environmental hormones. The shrimp screening has recently been initiated and will, therefore, continue for at least one more year. Animal screens with fish will possibly initiate in Summer or Fall, 1998.

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