



WATER RESOURCES RESEARCH GRANT PROPOSAL

(1) Project No:

(2) Title: Assessment of Environmental Estrogens in Wastewater: Potential for Developmental and Reproductive Toxicity in Fish

(3) Focus Categories: TS, WW, WQL

(4) Keywords: Animal Waste, Health Effects, Toxic Substances, Reproductive Effects, Wastewater, Water Quality

(5) Duration: November 1, 1998 to October 31, 1999

(6) Federal Funds: 32,650 (32,650)

(Total) Direct

(7) Non-Federal Funds: 67,655 (53,920) (13,735)

(Total) Direct Indirect

(8) Co-Principal Investigators, University and City:

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(9) Congressional District No: District No. 1 (UM) and District No. 2 (UT)

(10) Water Problem, Need for Research:

Environmental estrogens refer to substances in the environment that mimic the effects of the endogenous hormone estrogen. A number of environmental contaminants possess estrogenic activity including chlorinated hydrocarbon pesticides, degradation products of high-use industrial surfactants and by-products of industrial processes such as pulp and paper mill production. Included in this list are potent natural and synthetic estrogens which find their way to the aquatic environment through animal waste or municipal sewage effluent. In mammals, exposure to environmental estrogens has been linked to reproductive disorder and disruption of developmental processes. In fish and wildlife, reproductive disorders resulting from exposure to environmental estrogens may include reductions in fertility and decreased viability, as well as alterations in hormone levels or adult sexual behaviors. Each of the preceding adverse effects may have further implications, particularly in wildlife population dynamics.

The overall goals of the present research are to assess wastewater effluents for the presence of environmental estrogens as well as to evaluate the potential for microbial degradation of steroid hormones in activated sludge. Further, the research design seeks to explore the underlying mechanisms of developmental and reproductive toxicity due to compounds present in wastewater effluents which may disrupt the fish endocrine system. This proposal addresses Mississippi and Tennessee Water Research as well as South Atlantic-Gulf Region priorities related to water quality, particularly surface waters, and agricultural and municipal wastewater.

(11) Expected Results, Benefits, Information:

The survival of a species depends on successful development and reproduction. The proposed research strategy is designed to test the hypothesis that natural and synthetic hormones as well as other environmental estrogens are present in wastewater effluent at concentrations sufficient to result in endocrine disrupting activity and reproductive toxicity. Environmental estrogens may compete with the effect of endogenous estradiol either by competitive binding at the receptor or through negative feedback pathways in the hypothalamic-pituitary-gonadal axis. As such, environmental estrogens have the potential to perturb delicate hormone pathways which may result in decreased fertility and egg production. Also, because the germ cells of developing fish are bipotential and the inducers of gonadal development are most likely the sex steroid hormones, estrogenic compounds have the potential to skew the gender ratio to female. Genetic males which have been phenotypically reversed to female may not have the same reproductive competence as their genetic female counterparts. Reproductive toxicity may occur during larval development, or, because many of these compounds are designed to be resistant to degradation and metabolism, they can be bioaccumulated and may compromise the successful maturation of the gonads in a later stage. The reproductive role of adult female fish is to produce viable eggs and offspring. The process of producing such eggs is dependent upon hormonal communication between the brain, ovary and liver. Estrogen receptors present in the involved organs coordinate the delicate timing of the vitellogenesis/maturing/ovulating sequence. If something goes awry, eggs are not spawned or developing embryos do not have an adequate nutrition source for development.

The present investigation has been designed to assess wastewater effluents for the presence of environmental estrogens and the potential for microbial degradation of steroid hormones in activated sludge as well as explore the underlying mechanisms of developmental and reproductive toxicity due to compounds which disrupt the endocrine system. Several classes of anthropogenic compounds have demonstrated estrogenic activity in mammals, fish and wildlife. As indicated above, the majority of research has focused on chemical classes such as chlorinated hydrocarbon pesticides, degradation products of high-use industrial surfactants, by-products of industrial processes such as pulp and paper mill production. Another important class of compounds with which little is known with regard to their ecological impact is the natural and synthetic estrogens used in estrogen-replacement therapy, oral contraceptive formulations, and growth promoters in feed livestock. It is also recognized that estrogens naturally excreted from females find

their way into aquatic systems through municipal sewage effluent. By far, the majority of environmental research concerning environmental estrogens has focused on pesticides and industrial by-products with very few published studies examining natural and synthetic estrogens. Results of the present investigation will demonstrate whether natural and synthetic estrogens used in pharmaceutical products or natural estrogens discharged through municipal sewage effluent pose a "real world" hazard to the environment. Accordingly, this project is directly applicable to Mississippi, Tennessee and other states within the South Atlantic-Gulf because of the importance of accurately assessing the impact of chemicals in the environment.