The Effects of Estrogenic Endocrine Disruptors on the Osmoregulatory Functions in Euryhaline Fish

Submitted by Noura Jalal Al-Jandal, to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Biological Sciences in January 2011

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Signature

Noura Al-Jandal
Osmoregulation is an essential process to maintain water and ionic balance and when euryhaline fish move between freshwater and seawater environments as part of their life cycle this presents additional osmoregulatory challenges. Migrating fish can be exposed in both environments to pollutants such as endocrine disrupting chemicals (EDCs) that include natural hormones (e.g. 17β-estradiol; E2), synthetic hormones (e.g. 17α-ethinylestradiol; EE2), and industrial chemicals (e.g. nonylphenol). The focus of this thesis was to study the effects of different categories of EDCs on the osmoregulatory functions of euryhaline fish such as three-spined sticklebacks (Gasterosteus aculeatus) and rainbow trout (Oncorhynchus mykiss). Osmoregulatory variables (such as osmolality, water and ionic content) were compared in plasma and tissues (white muscle and carcass) of rainbow trout. This validated the use of specific tissue parameters as a surrogate of plasma responses to various osmoregulatory challenges. Waterborne exposure to 17α-ethinylestradiol revealed differential sensitivity of vitellogenesis in the three-spined sticklebacks (no induction) and rainbow trout, but had a significant effect on calcium homeostasis in both species. Intraperitoneal implants of 17β-estradiol reduced CaCO₃ production and apparent water absorption in the intestine and increased in tissue calcium stores of seawater-acclimated trout, but fish were able to compensate and showed no overall osmoregulatory disturbance. Waterborne exposure to nonylphenol in freshwater trout was also investigated, but no effects on osmoregulation were found up to 2 ng/l. Overall, estrogens can affect osmoregulation differentially in euryhaline fish species, and sometimes at EDC levels lower than the threshold for reproductive effects (i.e. vitellogenin induction).
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