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The Effects of Xenoestrogens on Mate Choice and Offspring Fitness in the Gulf Pipefish

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Introduction

Endocrine disruptors possess the potential to have a major impact on the reproductive fitness of a number of aquatic organisms. Studies in inhabiting contaminated areas have been shown to have decreased sperm production, increased liver weights, and increased vitellogenin levels (Allen et al., 2003). In female and male lab reared zebrafish exposed to xenoestrogens as larvae had delayed gonadal and behavioral development compared to unexposed larvae (Hill Janz, 2003).

Previous studies have examined the impact of xenoestrogens in relation to sexual signaling and selection. The reason for this gap in knowledge is that many of the organisms used in endocrine disruption studies do not have sexual traits that regulate pre-mating competition.

Exposure of male Gulf pipefish to 17 α -ethinylestradiol (EE2), a synthetic estrogen, induces the expression of display colors normally only found in females (Figure 1). Mimicking the sex-role reversal in the Gulf pipefish, sexual selection acts on traits exhibited by the female causing extreme sexual dimorphism, thereby allowing for the manipulation of perceived female quality by exposure to synthetic estrogens. The goal of this study is to determine if exposure to estrogenic mimics can effect expression of sexually selected traits in males and females and to determine how false signals affect mate choice and offspring fitness.

Specific Aims

- What are the effects of estrogen mimics on the expression of female display coloration and can these effects lead to false dominance recognition?
- What is the effect on offspring fitness if males mate with false dominant females?
- What genes regulate the secondary sexual characteristics observed in females?

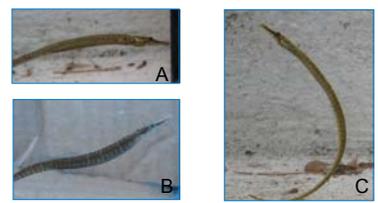


Figure 1: (A) Female pipefish, (B) Male pipefish after exposure to EE2, (C) Non-exposed male pipefish

Scientific Approach

Phase I: Determine the effect of EE2 on mate choice and offspring fitness

- Male Mate Choice Experiments**
 - Female pipefish will be exposed to one of three treatments (1) Control, (95% ethanol), (2) 1.0 ng/L EE2 or (3) 1.0 μ g/L EE2 for 10 days and the intensity of induced female secondary sexual traits will be scored.
 - The effect of each treatment on male mate choice will be determined by standard mate choice experiments (Figure 2), which evaluate the amount of time the male spends courting each female and the female chosen by the male for mating.
 - The effects of exposure on reproductive success and offspring viability will be assessed by observing embryonic development time after impregnation, offspring growth rates, and overall offspring survival.

- Female Mate Choice Experiments**
 - Male pipefish will be exposed to one of three treatments (1) Control, (95% ethanol), (2) 1.0 ng/L EE2 or (3) 1 μ g/L EE2 for 10 days and the intensity of induced secondary sexual traits will be scored.
 - The effect of each treatment on female mate choice will be determined by standard mate choice experiments, which evaluate the amount of time the female spends courting each male and the male chosen by the female for mating.
 - The effects of exposure on reproductive success and offspring viability will be assessed by observing embryonic development time after impregnation, offspring growth rates, and overall offspring survival.



Figure 2: (A) Frontal view of mate choice tanks, (B) Top view of mate choice tanks

Phase II: Determine the genes that regulate mating display color patterns and determine if gene expression is affected after exposure to xenoestrogens

- Treatment**
 - Gulf pipefish will be exposed to one of three treatments (1) Control (95% Ethanol), (2) 1.0 ng/L EE2, or (3) 1.0 μ g/L EE2, for 10 days. Preliminary studies show that this is a significant concentration and time to induce female secondary sexual characteristics, i.e., lateral stripes, in male Gulf pipefish (Figure 3).
 - After exposure, cross sections through the abdomen and brain tissue samples will be taken from each male fish and processed for mRNA analysis.

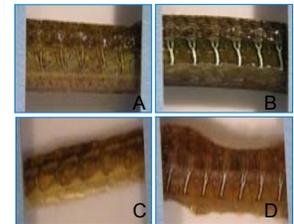


Figure 3: (A) Lateral stripes of a non-dominant female Gulf pipefish, (B) Lateral stripes of a dominant female, (C) Abdomen of a control male pipefish, (D) Lateral stripes of a male pipefish exposed to EE2

Impact

- Reproductive Fitness of Natural Populations**
 - Estrogen mimicking compounds have the potential to **disrupt normal mating behavior** by altering sexual traits that are used to determine mate quality.
 - Choosing low quality mates has been shown to produce **offspring with lower survival rates** than offspring produced by mating with high quality individuals, **thus potentially affecting the overall fitness of the entire population**.
 - This is the first study to combine the effects of estrogenic contaminants on pre-reproductive mechanisms and to examine the potential for decreased offspring fitness if mate selecting signals become disrupted.
 - Additionally, this is the first time the effects of estrogen mimicking compounds have been assessed in an organism that is sex-role reversed.

References
 Allen, Y., Scott, A., Matthiessen, P., Hawthorn, S., Thain, J., and Feist, S., 1999. *Environmental Toxicology and Chemistry*. 18(9): 1793 – 1800.
 Hill, R. and Janz, D. 2003. *Aquatic Toxicology*. 63: 417 – 429.

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