The impact of antidepressants on hypoxia tolerance in Gulf toadfish, *Opsanus beta*

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**Background**

- Severe hypoxic or anoxic aquatic environments are found worldwide and have been on the rise.
- In August 2020, due to a hypoxia event in Biscayne Bay, Fl, fish died, and most were Gulf toadfish.
- This was unexpected as toadfish are believed to be able to withstand hypoxia.
- The neurochemical serotonin (5-HT, 5-hydroxytryptamine) plays a role in the cardiovascular response to hypoxia.

**Objectives & Hypotheses**

**Objective 1:** Determine the time it takes for toadfish to lose equilibrium (tLOE) when in severe hypoxia and compare them to sheepshead minnow, *Cyprinodon variegatus variegatus*.

- **Hypothesis 1:** Toadfish will have a significantly higher tLOE than the sheepshead minnow.

**Objective 2:** Assess if tLOE in toadfish is affected by blocking 5-HT uptake or degradation.

- **Hypothesis 2:** Toadfish will have a significantly shorter tLOE when 5-HT uptake or degradation is inhibited.

**Methods**

- A tLOE apparatus was built that minimized movement.
- Oxygen saturation was maintained at 0.4% throughout trials.
- tLOE was recorded when the fish was unable to maintain dorsoventral orientation.
- Sheepshead minnow: tLOE was reported for male and female minnows as males are easily distinguishable.

**Gulf toadfish:** 24 h before tLOE trials, toadfish were intraperitoneally injected with coconut oil (control), coconut oil overlaid with fluoxetine, bupropion and deoxynucle-2 (FBD-treated), or coconut oil overlaid with clorgyline (M-treated).

- **Statistics:** Welch’s t-tests and one-way ANOVAs were used to determine significant differences for data analysis in R (*p*<0.05 considered statistically significant).

**Results**

- Figure 1: Bar graph demonstrating mean ± standard deviation of tLOE in female, male, and total sheepshead minnow. There was no significant difference between males and females (*p*=0.19).
- Figure 2: Scatter plot of weight versus tLOE in sheepshead minnow females and males. A polynomial trendline to the second order revealed an *R*^2^ value of 0.82. When standardizing for weight, female and male tLOE per gram were not significantly different (*p*=0.76).
- Figure 3: Bar graphs comparing mean ± standard deviation of tLOE between total sheepshead minnow and control toadfish. * indicates significant difference (*p*=0.05). Control toadfish tLOE was 81.5 times greater than sheepshead minnow tLOE (*p*=2.7x10^-7). The difference between sheepshead minnow and control toadfish tLOE after standardising for weight was also statistically significant (*p*=0.04).
- Figure 4: Bar graphs comparing mean ± standard deviation of tLOE in control, FBD-, and M-treated toadfish. There was no significant difference in tLOE between control and treatment groups (*p*=0.74). No comparisons of tLOE with standardized weight were significantly different (*p*=0.24).

**Discussion**

- **Hypothesis 1 was supported**
  - Toadfish are more hypoxia tolerant independent of size.
  - tLOE presents the toadfish as being highly tolerant to hypoxic conditions.
  - Further investigation of the physiological mechanisms conferring hypoxia tolerance in both species is needed.

- **Hypothesis 2 was not supported**
  - Hypothesized that the medications were metabolized during the trials.
  - A single intraperitoneal injection may not be sufficient in hindering the hypoxia responses mediated by 5-HT.

Sheepshead minnow sex and weight investigation

- Average tLOE was lower than expected.
- Fish were lab-reared while the previous study collected their fish from a tidal pond.
- Potential implications of using lab-reared versus wild-caught.
- No change in hypoxia tolerance due to sex.
- Likely a species-specific trait as other species exhibit superior hypoxia tolerance in one sex.

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**References**