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

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Filming Florida

Background

- Severely hypoxic or anoxic aquatic environments are found worldwide and have been on the rise[1]
- In August 2020, due to a hypoxia event in Biscayne Bay, FL, fish died, and most were Gulf toadfish[2]
- This was unexpected as toadfish are believed to be able to withstand hypoxia[3,4]
- The neurochemical serotonin (5-HT, 5-hydroxytryptamine) plays a role in the cardiovascular response to hypoxia[4,5]

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.*[6]

- ***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

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- **Gulf toadfish**: 24 h before tLOE trials, toadfish were intraperitoneally injected with coconut oil (control), coconut oil overlaid with fluoxetine, bupropion and decynium-22 (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

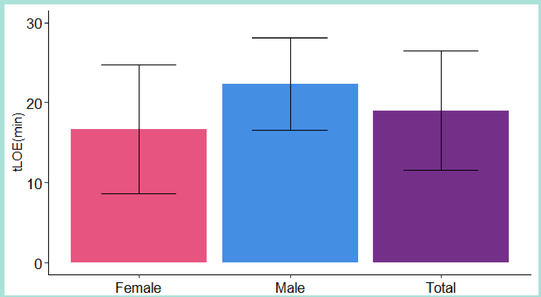

Figure 1. Bar graph demonstrating mean ± standard deviation of tLOE in female, male, and total sheepshead minnow. There was no significant difference between males and females (p=0.19).

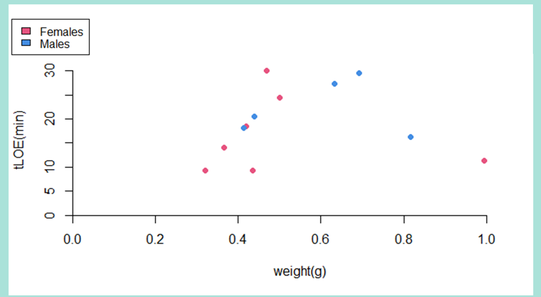

Figure 2. Scatter plot of weight versus tLOE in sheepshead minnow females and males. A polynomial trendline to the second order revealed an R^2 value of 0.62. When standardizing for weight, female and male tLOE per gram were not significantly different (p=0.76).

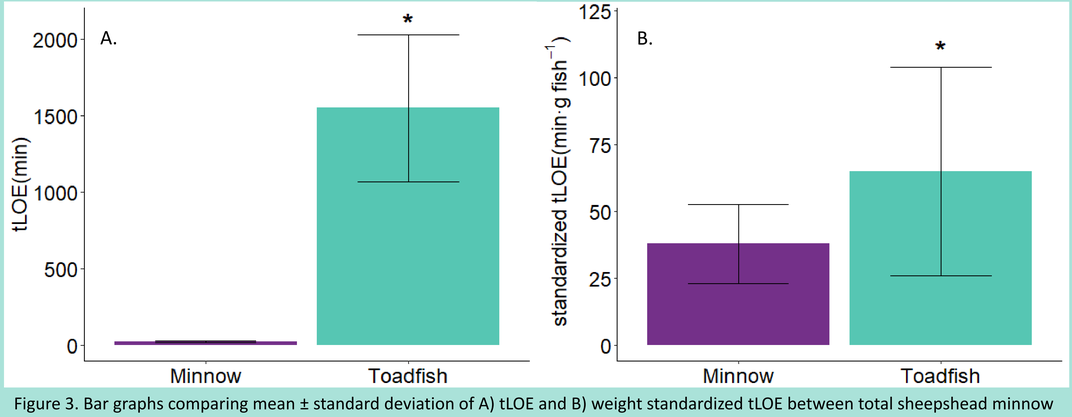

Figure 3. Bar graphs comparing mean ± standard deviation of A) tLOE and B) weight standardized tLOE between total sheepshead minnow and control toadfish. * indicates significant difference (p<0.05). Control toadfish tLOE was 81.5 times greater than sheepshead minnow tLOE ($p=2.7x10^{-7}$). The difference between sheepshead minnow and control toadfish tLOE after standardizing for weight was also statistically significant (p=0.04).

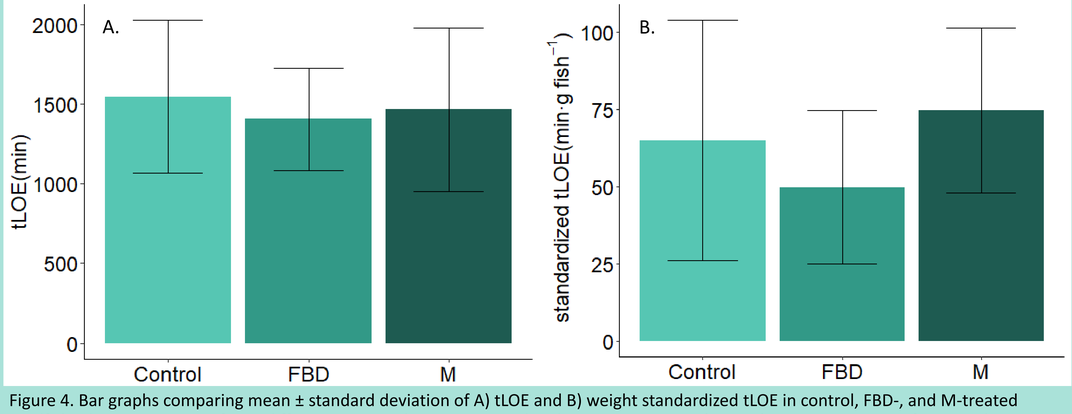

Figure 4. Bar graphs comparing mean ± standard deviation of A) tLOE and B) weight standardized tLOE in control, FBD-, and M-treated toadfish. There was no significant difference in tLOE between control and treatment groups (p=0.74). No comparisons of tLOE with standardized weight were significantly different (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[6]
- 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[7,8]

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