The experimental animals were obtained from the Rosenstiel School. Ventilation changes were measured by mantle cavity pressure using a transducer. A photo was taken to evaluate physical response to injection. The experimental animal was left for 30 min while the Biopac System recorded heart rate. A 30 sec baseline of heart rate using an ultrasound machine was taken. Pressure transducers were connected to a Biopac System at the end of the 30-min trial. A final photograph was taken.

Aplysia californica are marine mollusks that are exposed to low environmental oxygen levels. The acute response to hypoxia involves changes in both heart rate and ventilation. Cardiac contraction in Aplysia is controlled through pressure gradients resulting in blood flow through the gill into the cardiac atrium. Fluctuations in ventilation (FLX) block the reuptake of 5-HT by the 5-HT transporter, increasing the extracellular concentrations of circulating 5-HT.

Heart rate and ventilation response to 5-HT and FLX will provide understanding of 5-HT and the 5-HT transporter on the control of heart rate and ventilation, providing insights into the role of serotonin in the control of heart rate and ventilation in Aplysia californica.

Materials and Methods
- The experimental animals were obtained from the Rosenstiel School National Resource for Aplysia californica (n = 32; 128.6 ± 5.46 g). A photo was taken to evaluate physical response to injection. A 30 sec baseline of heart rate using an ultrasound machine was taken 10 min after weighing (t = 0 min).
- Immediately after (30 sec), a dose of either 100 mL·g⁻¹ Aplysia saline (control), 3 µg·100 mL⁻¹ 5-HT (5-HT-treated), or 0.1 µg·100 mL⁻¹ FLX was injected into the hemocoel. A 30 sec heart rate was immediately recorded after injection at (t = 2 min) (t = 7 min) (t = 32 min).
- After ultrasound recording a final picture of the Aplysia was taken.
- Ventilation changes were measured by mantle cavity pressure using a parapodial catheter attached through surgery 24 hours prior.
- Pressure transducers were connected to a Biopac System.
- Aplysia was then connected to the pressure transducer by the parapodial catheter.
- Aplysia were then injected with either NaCl, 5-HT, or FLX and a photo was taken to evaluate injection response.
- The experimental animal was left for 30 min while the Biopac System tracked the ventilation.
- At the end of the 30-min trial a final photograph was taken.

Objective and Hypothesis
Objective
To determine the acute response of heart rate and ventilation to the hemocoel injection of 5-HT or FLX.

Hypothesis
Heart rate and ventilation will be unchanged in Aplysia injected with NaCl and will increase in Aplysia injected with 5-HT or FLX.

Results

![Graph showing heart rate changes over time](image)

Figure 1: Mean heart beat per second over 30 min after NaCl (control), 5-HT, or FLX injection into the hemocoel. Values are means ± SEM. Different letters denote significant difference (p < 0.05).

![Graph showing mantle cavity pressure changes over time](image)

Figure 2: Mantle cavity pressure over 30 min after NaCl (control), 5-HT, or FLX injection into the hemocoel. Values are means ± SEM.

Discussion
Our data supported the hypothesis in 5-HT-injected Aplysia heart rate experiments as the heart rate increased. Our FLX injection experiments did not support the original hypothesis, as heart rate decreased in response to FLX.

5-HT and FLX had no effect on ventilation.

The NaCl injected animals acted as a control, so their heart rates and ventilation remained the same after the baseline reading. 89% of the animals that exhibited scrunching were the FLX-injected Aplysia compared to only 11% that were 5-HT injected Aplysia.

- Ventilatory amplitude and respiratory pumping are major components in Aplysia and could be analyzed in response to 5-HT and FLX injection.
- The physical reaction could indicate that the heart rate and ventilation response was because of the injection.
- More studies understanding what the scrunching behavior means would need to be conducted.

Broader Impacts
There is an increase in hypoxic dead zones occurring with climate change. The 5-HT ability to regulate heart rate and ventilation could function as a strategy for hypoxic resistant organisms. Fluoxetine is metabolized and excreted into many wastewater systems resulting in increased levels in fish in the areas nearby.

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References