STG response to co-application of synaptically released modulators and hemolymph in *C. borealis*
Ahmed Albayaty, 2025

This past summer, my research focused on exploring how neural circuit modulation occurs, particularly in the Jonah Crab model organism. I aimed to answer the question: How does the co-application of synaptically released modulators and hemolymph affect the neural output of a specific circuit?

Neuromodulation refers to the process by which the output of a neuron or neural circuit is altered by compounds called modulators. These compounds, which include hormones, neurotransmitters, and peptides, can either increase or decrease the activity of the neurons. While previous research has outlined the compounds involved in neuromodulation, the interaction between externally applied neuromodulators and those found in crab hemolymph, particularly their combined effect on a motor circuit, has yet to be clearly defined.

I used the Jonah Crab because it contains a central pattern generator (CPG)—a rhythmically active circuit that functions without rhythmic input. CPGs are useful because they produce fictive outputs in experiments that mimic what is observed in the live animal, allowing us to study behavioral patterns without actively applying modulators.

In a live crab, the pyloric rhythm, a specific motor pattern, remains active and robust even under the influence of hemolymph. However, when I isolated the neurons and then applied hemolymph, the pyloric rhythm was significantly dampened. This suggests that the live crab must use modulators that counteract the hemolymph's inhibitory effects to maintain the rhythm. This finding was central to my research this summer: something in the hemolymph suppresses this rhythm, and I aimed to see if I could restore the pyloric rhythm by applying known synaptically released neurotransmitters.

The circuit I studied contains only motor neurons, all of which express receptors known as metabotropic acetylcholine (ACh) receptors. To test whether the rhythm could be recovered under the damping effect of hemolymph, I applied a compound that would bind to these receptors, oxotremorine. As expected, the motor neurons responded well to oxotremorine, restoring the rhythm and proving that the rhythm could be restored by modulation. However, oxotremorine is not native to the crab's system, so I tested other modulators like proctolin and serotonin, which are native to the crab. While they excited the neurons, they failed to restore the rhythmic output.

My findings suggest that a combination of synaptically released modulators may be required to fully restore the rhythm. To expand on this, during the school year, I plan to identify this combination and explore stimulating the neurons responsible for releasing these modulators. This is crucial because there is a difference in effect between directly applying modulators and having them synaptically released in specific localized areas.

Faculty Mentor: Daniel Powell
Funded by the Henry L. and Grace Doherty Charitable Foundation Coastal Studies Research Fellowship