The role of behavioral diversity in determining the extent to which neuronal patterns are modulated

Grace Bukowski-Thall, 2020

Central pattern generators (CPGs) are neural networks that control the rhythmic outputs necessary for movement and flexibility. CPGs can be modulated so that organisms have the behavior flexibility necessary to adapt to changes in both their internal and external environments: for instance, to go from a walk to a run, or to digest different kinds of food. The neuromodulators that act on CPGs are typically peptides or amines that can either increase or decrease electrical output or modify action potential firing patterns.

Considerable work has been done in Professor Patsy Dickinson's lab to better understand the role of modulators in the crustacean stomatogastric nervous system (STNS). The STNS is composed of multiple ganglia that control the movement of the foregut. The STNS is modulated by neurohormones and modulators that are released locally or hormonally. Modulation of the foregut regulates the rhythmic behaviors that are responsible for foregut motion and flexibility. In another crustacean system, the neurogenic heart, modulators act on the cardiac ganglion to regulate the amplitude and frequency of contractions.

Upwards of seventy different types of neuromodulators have been identified in the STNS of decapod crustaceans. However, the specific roles of these neuromodulators as well as the reason for their abundance is undetermined. We have hypothesized that since a system is modulated according to its need for movement and flexibility, decapods that must digest a greater variety of food types will have more neuromodulation in the STNS than those with a specialized diet. This hypothesis has been supported by preliminary data that show that the opportunist-feeding crabs, *Chionocetes opilio* and *Libinia emarginata,* have higher STNS modulatory capacity than their majoid superfamily member, *pugettia producta,* which has a highly-specialized kelp diet.

Because *Pugettia* and *Labinia* are very closely related, they should not have many differences in biological function due to phylogeny; their primary distinctions are their feeding habits. For this reason, we predicted that opportunist and specialized feeders would have equal amounts of cardiac modulation. This would suggest that the lack of modulatory capacity observed in the STNS of *Pugettia* relative to *Labinia* and *Chionocetes* is specific to evolved foregut function.

For my summer research project, I recorded cardiac neuromuscular patterns from *Pugettia* and *Chionocetes.* This was done by removing the heart from the specimens and keeping it beating by perfusing temperature controlled physiological saline through the posterior artery. I then perfused the same modulators tested in the STNS through the heart. These included proctolin, dopamine, CabTRP, CCAP, RPCH, and oxotremorine the muscarinic acetylcholine agonist. I noted the various cardiac patterns caused by the perfusion of the different neuropeptides by measuring the amplitude and frequency of the heartbeats with a force transducer connected to the five anterior arteries.

Preliminary data that I have collected support the hypothesis that the cardiac ganglia of specialist and opportunist feeders are more similarly modulated than the STNS. During the school year I will be continuing this project for my honors project. I will be increasing my sample size in order to have more conclusive results, and I will also start collecting cardiac pattern recordings from *Libinia.*

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