**Does the need for flexibility in movements drive neuromodulatory capacity?**

**Ricky Tsang, Class of 2021**

Central pattern generators (CPGs) are small neural networks that generate rhythmic outputs, which control rhythmic behaviors such as locomotion and respiration (Dickinson 2006). The rhythmic outputs of CPGs need to be able to adapt to changes in the internal and external environment (e.g. a giraffe changing from a walk to a run when it sees a lion). Neuromodulation can allow for these changes in rhythmic output, thus allowing behavioral flexibility (Dickinson 2006).

The crab stomatogastric nervous system (STNS) is one model that can be used to study CPGs. Bursts of action potentials (nerve impulses) from the neurons in the STNS control the muscle movements of the stomach. The CPG that I focused on is the pyloric pattern, which controls the movements of the pylorus (the portion of the stomach that filters food). The core pyloric pattern is made up of bursts of action potentials from LP, PY, and PD neurons. For simplicity purposes, the names of neurons have been abbreviated. The left portion of the figure below illustrates this bursting pattern. Each vertical line is an action potential and a collection of them is considered a burst.

Previous research found that crabs with a low need for flexibility in diet have a low neuromodulatory capacity, while crabs with a high need for flexibility in diet have a high neuromodulatory capacity (Dickinson et al. 2008). Neuromodulatory capacity is the number of neuromodulators that a CPG responds to. It is hypothesized that STNS neuromodulatory capacity will differ across crabs as a function of diet. My research compares two closely related crab species that the Dickinson lab has been studying: *Pugettia producta* and *Libinia emarginata*. *Pugettia* is a dietary specialist that primarily eats kelp (Hines 1982). *Libinia* is a dietary generalist, meaning it has a large ranging diet.

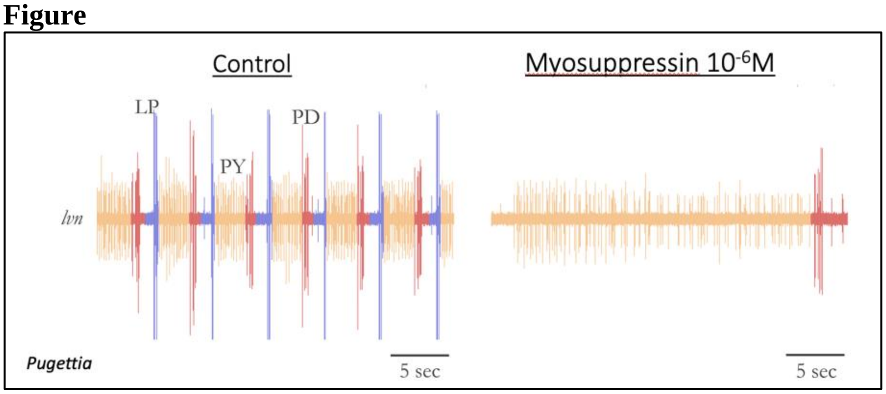
I worked mostly with *Pugettia* and tested several neuromodulators, one of which is myosuppressin. Myosuppressin has been shown to modulate the pyloric pattern of *Libinia* and other generalists. Previous research on *Pugettia* has shown that only a few neuromodulators have an effect on the pyloric pattern. It was predicted that myosuppressin would not have an effect on *Pugettia.*

The neuromodulator myosuppressin exhibited modulatory effects on the pyloric pattern of *Pugettia* as shown in the figure below. At control, there was a fast pattern of LP, PY, and PD. The pattern repeats five full times in this time scale. Once the neuromodulator myosuppressin was applied, LP stopped firing. Furthermore, PY fired for a longer duration and PD was still present. Only two neurons (PY and PD) of the core pattern remained after myosuppressin was applied. Also, the neurons PY and PD did not repeat as frequently as before. The pyloric pattern was modulated by myosuppressin.

*Pugettia* responding to myosuppressin does not support the prediction, but it does not necessarily dismiss the broader hypothesis of neuromodulatory capacity. Myosuppressin just happens to be one of the select neuromodulators that have an effect on *Pugettia.* Another neuromodulator that was tested on *Pugettia* was SGRN. The neuromodulator SGRN did not have a modulatory effect on the pyloric pattern of *Pugettia but* did have an inhibitory effect on *Libinia.* Lastly, the neuromodulator AST-C I exhibited inhibitory effects similar to myosuppressin on both species.

The three neuromodulators tested on *Pugettia* support the larger hypothesis of neuromodulatory capacity as a function of diet. *Pugettia* did not respond to one out of three neuromodulators meaning it has some limited capacity.

**Figure**




The figure to the left is an extracellular recording done on *Pugettia producta.* At control, the core pyloric pattern is present. The neurons LP, PY, and PD are bursting. When the neuromodulator myosuppressin is applied, LP stops firing and PY fires for a longer duration. The neuron PD is still present. This figure is a 30 second section of the experiment.

**Faculty Mentor: Patsy Dickinson**

**Funded by the Henry L. and Grace Doherty Charitable Foundation Coastal Studies Research Fellowship**

**References:**

Dickinson PS. 2006. Neuromodulation of central pattern generators in invertebrates and vertebrates. Curr Opin Neurobiol. 16(6)6: 04-614.
Dickinson PS, Stemmler EA, Christie AE. 2008. The pyloric neural circuit of the herbivorous crab *Pugettia producta* shows limited sensitivity to several neuromodulators that elicit robust effects in more opportunistically feeding decapods. J Exp Biol. 211(9): 1434-1447.
Hines AH. 1982. Coexistence in a kelp forest: size, population dynamics, and resource partitioning in a guild of spider crabs (Brachyura, Majidae). Ecol Monogr. 52(2): 179-198.