Determining the peripheral site at which myosuppressin modulates cardiac contractions in the American lobster, *Homarus americanus*

Isabel Petropoulos, Class 2023

Central pattern generators (CPGs) are neural circuits that, when activated, generate rhythmic behaviors and patterns. These complex circuits have the capacity to send outputs that control behaviors such as swimming, walking, and breathing (Marder & Bucher 2001). In the absence of other inputs, CPGs produce consistent patterns as the networks are relatively fixed. However, modulation of CPGs creates variations in motor patterns, which gives organisms behavioral flexibility. Neurohormones and neurotransmitters such as amines and neuropeptides are molecules that can modulate CPGs, thereby enabling organisms to respond to changes in the environment (Brezina et al., 2010). It has been shown that neuromodulators not only have effects on CPGs, but also alter muscle contractions by acting directly on the neuromuscular junction or muscle itself. The neurogenic lobster heart requires neural impulses to contract, and these impulses are controlled by a CPG called the cardiac ganglion (CG) (Cooke, 2002).

Myosuppressin is a peptide that has been shown to exert modulatory effects on the cardiac neuromuscular system. In the isolated cardiac ganglion, myosuppressin increased burst duration and decreased cycle frequency and thus, the duty cycle of the action potential bursts. In a whole heart preparation, myosuppressin increased contraction force (Stevens et al., 2009). A previous student in the Dickinson lab investigated whether myosuppressin exerted its effects at the neuromuscular junction (NMJ) and did not find any significant effects, which suggests that myosuppressin exerts its peripheral effects at the cardiac muscle. Thus, this summer I asked whether myosuppressin affects tred the resultant muscle contractio

. L-glutamate (5×10^{-4} M) was administered using a syringe pump, which was connected to a micropipette that was positioned to puff glutamate onto one of the lateral muscles on the heart (the left or right muscle across a few muscle fibers). Two hooks were glued perpendicularly to either side of the muscle to stabilize the muscle and give a slight amount of stretch. A force transducer was placed between the two hooks to record the muscle contractions. Saline was continuously perfused across the heart while control puffs of glutamate were administered. Once the glutamate-evoked muscle contractions stabilized in size, myosuppressin (10^{-6} M) was perfused over the muscle for 30 minutes while glutamate was puffed at regular intervals. Subsequently, the preparation was washed with lobster saline to ensure responses returned to baseline. My data suggests that myosuppressin caused significant increases in the amplitude of glutamate-evoked contractions in the isolated cardiac muscle relative to those evoked by glutamate while lobster saline was perfused (one sample t-test, $p=0.0111$; $N=7$). The width of contractions and baseline did not change significantly when myosuppressin was applied (compared to control in lobster saline) (one sample t-test, $p=0.5769$; $N=7$) (one sample t-test, $p=0.8381$; $N=7$).

I am extremely grateful to Professor Dickinson, Dan Powell, the student faculty research fellowship, and Bowdoin's resources for the opportunity to be part of this exciting project.

Faculty Mentor: Patsy S. Dickinson
Funded by the

References

Brezina V. Beyond the wiring diagram: signaling through complex neuromodulator networks. Philos Trans R Soc Lond B Biol Sci. 2010;365(1551):2363-74. Epub 2010/07/07. doi: 365/1551/2363 [pii]10.1098/rstb.2010.0105. PubMed PMID: 20603357; PubMed Central PMCID: PMC2894954.

Cooke, I. M. (2002). Reliable, responsive pacemaking and pattern generation with minimal cell numbers: The crustacean cardiac ganglion. Biological Bulletin, *202*(2), 108-136. doi:10.2307/1543649

Marder E, Bucher D. Central pattern generators and the control of rhythmic movements. Curr Biol. 2001;11(23):R986-96. Epub 2001/12/01. doi: S0960-9822(01)00581-4 [pii]. PubMed PMID: 11728329.

Stevens, J. S., et al. "The peptide hormone pQDLDHVFLRFamide (crustacean myosuppressin) modulates the Homarus americanus cardiac neuromuscular system at multiple sites." Journal of Experimental Biology 212.24 (2009): 3961-3976.