Luminescence plays a vital role in the marine environment, occurring in the vast majority of midwater organisms ranging from bacteria to vertebrates (Lee 2008). As sunlight penetrates very little of the ocean’s depth, bioluminescence acts as the primary source of light and, therefore, influences communication among organisms (Haddock et al. 2010). Aiding in camouflage, predation, defense, and mating, luminescence comes in many forms, with glows thought to act as lures and flashes as deterrents (Haddock et al. 2010). While much is known about the chemical mechanisms of bioluminescence, few in-depth studies have been conducted on the behavioral aspect: why organisms bioluminesce.

In the previous two years, Doherty Marine Postdoctoral Scholar Trevor Rivers and his honors students Tamara Perreault and Julia Livermore have been studying the luminescent behavior of the intertidal polychaete polynoid worm Harmothoe imbricata and the responses of its arthropod predators, especially Homarus americanus (American lobster) and Carcinus maenas (European green crab), to luminescence. Initial experiments were aimed to simply describe the displays of H. imbricata, which were hypothesized to startle predators or distract them using autotomized luminescing elytra (scales) or body segments as decoys (Rivers and Perreault 2012). After characterizing the bioluminescent displays of H. imbricata, research has been focused on the behavior of predators in response to the displays, specifically how light affects their behavior. By isolating various sensory modalities, such as vision, chemosensing, and touch, in predators, we can determine how the bioluminescent displays of H. imbricata affect survivorship. In their studies, Rivers, Livermore, and Perreault removed vision by temporarily blinding some of the predators with black nail polish and comparing predator-prey interactions of blinded and unimpaired predators with the scale worms (2013). Predators that could not see the bioluminescent displays were more successful in attacking the worms, suggesting that light plays a role in the response of predators to these displays. However, how light alone affects the behavior of predators is still unknown. My goal for the summer was to further investigate how light affects predator behavior and, thus, worm survivorship.

Scale worms and arthropod predators were collected in intertidal areas around the marine lab at the Coastal Studies Center. As European green crabs and American lobsters are nocturnal predators, worms and predators were put on a reverse daylight schedule so that experiments could be conducted during the day. After acclimating, scale worms and predators were placed in a clear 10x10cm acrylic tank, and their behavior was recorded. Three infra-red (IR) low-light cameras were used for viewing movement, a night vision camera with an IR barrier filter was used to capture only the worm’s luminescent display, and two photomultipliers along with a DATAQ data acquisition device and Windaq software were used to measure the relative intensity and pattern of the luminescent display.

This summer I conducted two experiments focusing on light and predator behavior. Experiments begun by Livermore and Rivers were continued, blinding predators to observe their behavior in the presence of every sensory modality except vision. Some predators were painted with black nail polish or clear nail polish, while others were left unpainted. Worm survivorship from attacks by the three predator treatments were compared. Worms attacked by blind predators had the lowest survival rate, while worms attacked by clear polish and unpainted lobsters had higher survival rates. This indicates that vision plays a definite role in predator success. To further observe how predators react to the light of bioluminescent displays, I created LED mimic displays using Arduino programming software and boards. Displays were programmed to mimic both the flashing and scale autotomization displays. These LED mimics allow us to observe the role of light alone on predator behavior by removing all other sensory modalities. We have only started conducted trials using the LED mimics, too early to observe a trend in predator behavior, but we have observed “freezing” behavior in some crabs exposed to the displays. More trials will be conducted during the 2013-2014 school year.

**Faculty Mentor:** Trevor Rivers
References:


