PaV1 Avoidance in *Panulirus argus*

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Anderson JR, Behringer DC. 2013. Spatial dynamics in the social lobster *Panulirus argus* in defense to diseased conspecifics. *Marine Ecology Progress Series* 474: 191-200.

The spread of disease among cohabitating/social invertebrate populations is continually a concern for those who depend on such populations economically. In the past, there has been significant research on the behavior of infected individuals. In some cases, hosts isolate themselves from the rest of the group in a form of altruistic suicide, as seen in the honeybee *Apis mellifera* (Dolan et. al, 2014). This behavior is most commonly seen in stationary populations, whereas migratory populations differ in behavior and spatial dynamics.

The Caribbean spiny lobster, *Panulirus argus,* is a typically "gregarious" organism that behaves based on chemosensory and visual cues. The most common disease to infect populations of the spiny lobster, known as *Panulirus argus* virus 1 (PaV1), is for unknown reasons only symptomatic or harmful in juveniles. Generally, 2-8% of juveniles are infected, but that number has also spiked as high as 60% (Dolan et. al, 2014). Also, this disease has approximately a 90% mortality rate in juvenile spiny lobsters, and it is unknown by what means the disease functions. Visually, non-infected members identify disease hosts by the presence of a milky white hemolymph and a reddening of the upper region of the exoskeleton. Hosts also distribute chemosensory cues by means of a different urine content that is indicative of infection. PaV1 avoidance has been documented in spiny lobster populations as a viable means of stopping the spread of the virus, but this avoidance of dens where disease hosts are present can have numerous effects on the healthy population. It is unclear whether the preference in PaV1 hosts is determined by visual or chemoreceptive factors, and if so, to what extent?

Individuals that avoid PaV1 hosts by exiling them from migration groups along with avoiding disease dens have a number of risks heightened. Although the likelihood of disease transmission is decreased, the amount of viable shelter is also decreased, potentially affecting predation due to the need to spatially redistribute the healthy lobsters.

Anderson and Behringer (2013) analyzed this potential for change in arrangement when viable habitats are decreased due to infected inhabitants. The researcher conducted three laboratory experiments and a field experiment to determine preference and if these animals change their spatial arrangement based on either visual or chemoreceptive cues of PaV1 infection. The three laboratory experiments made use of a Y-maze, testing for a preference in the location of a community that exhibits the chemical makeup of pure seawater, uninfected, or infected. In all lab chemical testing, there was found a specific preference away from active chemical in the urine of infected lobsters, as 86% of uninfected lobsters chose an alternative environment. A significant result was not found when investigating preference over visual cues ($p = 0.4049, 1.00, 0.855$).

In the field experiment, 258 spiny lobsters were caught and tagged. It is also of note that the visibly uninfected lobsters were 7.1 cm longer on average than the infected lobsters, suggesting that PaV1 stunts growth as well. Uninfected lobsters were found to congregate significantly less around a shelter with a tethered infected lobster ($p = 0.009$). Uninfected lobsters were found to move 0.5 m or more away from shelters that contained an infected lobster in a low flow environment ($p = 0.0010$), but not in a high flow environment ($p = 0.7408$).

The results of this experiment lead to several important conclusions regarding disease avoidance in social marine organisms. First, lab experiments determined that chemoreception is clearly the primary form of disease recognition by spiny lobsters, as visual testing did not result in significant behavior consistent with the presence of an infected lobster. This result suggests that there may be a decreased need in visual detection, but this claim requires further research. With chemoreception determined to be the means by which spiny lobsters spatially organize themselves in relation to PaV1 infection, field tests determined a diluted population near sites containing an infected lobster. This finding was neutralized when flow strength appeared in the equation though, as there was no significant difference in population density or dispersal in a high flow environment. The need to fight ocean current or the reduced likelihood of interacting with an infected individual appears to offset the preference of the uninfected lobsters to avoid PaV1 hosts. Still, several questions are left unanswered. Has chemoreception entirely overtaken the need to abide by visual cues? Are these behaviors consistent in other social marine crustaceans? Also, what is the estimated economic/political impact if this disease continues to proliferate through spiny lobster population?

Other Literature Cited:

Dolan III, T.W., Butler IV, M.J., and J.D. Shields. 2014. Host behavior alters spiny lobster-viral disease dynamics: a simulation study. *Ecology* 95(8): 2346- 2361.

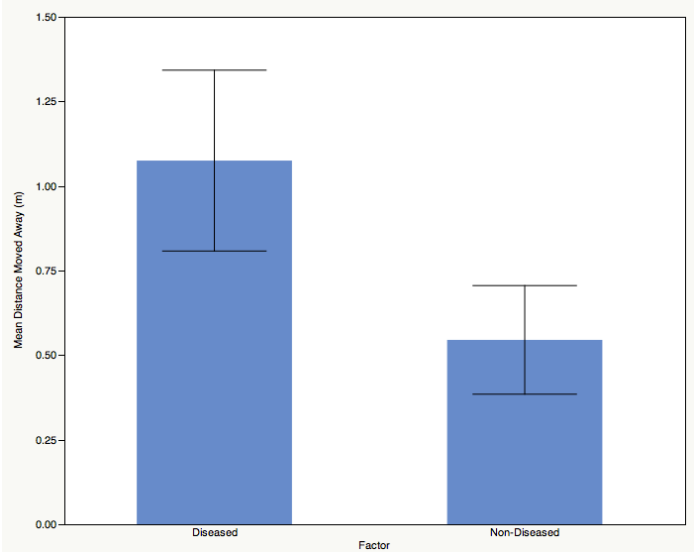

Fig. 1. 258 healthy spiny lobsters were put in a habitat in which half contained an infected lobster tethered to the center of the shelter. The lobsters were significantly more likely to more greatly disperse in an environment in which a diseased lobster was present ($p < 0.001$).