Mechanisms For Prey Identification in Cnidarians

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Biol 337, Fall 2005

Cnidarians are efficient predators that use nematocysts within cnidocytes for prey capture. Nematocysts involve different mechanisms of prey capture, including the use of paralyzing toxins and spiked harpoons that can ejected forcible into prey. However, this method of capture requires cnidarians to differentiate between prey and non-prey to prevent wasting nematocysts. Lacking image-forming eyes, cnidarians must rely on mechanoreceptors to recognize the pressure and vibration of prey and chemoreceptors to recognize the smell and taste of prey. Furthermore, it appears that the chemoreceptors play a large part it affecting which vibration the mechanoreceptors react to. Watson and Hessinger (1989) demonstrate that the chemicals associated with prey stimulate the chemoreceptors located on support cells surrounding the cnidocytes, which in turn "tune" the mechanoreceptors to the frequencies of the prey's movement.

The mechanism though which the chemoreceptors tune the mechanoreceptors involve the interaction between the stereocilia of the supporting cells and the single cilia of the cnidocyte. The chemosensitizer, in this case bovine mutin, activates the chemoreceptors on the cell membrane, starting an intercellular reaction leading to the lengthening of the stereocilia. (The stereocilia are similar to those on the hair cells in the inner ear of mammals that are used in hearing and balance. However mammal stereocilia are static, while in cnidarians they are capable of becoming longer.) The stereocilia touch the mechanoreceptor cilia of the cnidocytes, thereby affecting which frequencies of vibrations trigger the cnidocyte to eject its nematocyst.

In order to establish the effect of chemoreceptors on mechanoreceptors, the researchers first had to demonstrate that cnidocytes react differentially to different frequencies of vibration, then explore the effects of chemosensitizers on this reaction, and finally correlate the frequencies that elicit response to the frequencies of prey movement. Monoclonal sea anemones (*Haliepanella lucie*), fed solely on brine shrimp nauplius larvae, reacted most strongly when touched by a probe that was vibrating at 55 hertz, and to a less extent when the probe was vibrating at 30 or 65 to 75 hertz if they were not exposed to mucin. However when mucin was present in the water, the anemone discharged the maximum number of nematocysts when exposed to 5, 15, 30 and 40 Hz. Furthermore, the amount of mucin present determined the strength of the response until the maximum response with the maximum number of nematocyst fired was reached. The researchers then recorded the frequencies of the brine shrimp *Artemia salina*'s nauplius larva's as it moved though water. The larva's movement produced power spectra that had maxima at 2, 7, 12, 19, 30, 38, and 60 Hz, although the maximum at 60 Hz was discarded as electrical noise. The adult brine shrimp's movements were also recorded and had maxima at 2, 12, 19, 30, and 38 Hz. Both sets of frequencies are very similar to the frequencies that the mucin-stimulated cnidocytes respond to, but much lower than the frequencies that the non-stimulated cnidocytes respond to, indicating that the mucin does in fact "tune" the mechanoreceptors to the vibrations of the prey.

From their experiments, Watson and Hessinger (1989) conclude that chemicals associated with prey items are used by the cnidarians not only to identify them as prey but also to tune the mechanoreceptors of their cnidocytes to the frequencies of the prey's movements increasing the chance that the object it injects its nematocysts into is actually edible. By using a combination of stimuli to identify prey the cnidarian avoids wasting nematocysts on disbursed chemicals in the water or objects that are not moving. However this lead to the question why the cnidarians fire their nematocysts at all when not stimulated by chemosensitizers and why they prefer to do so at objects vibrating at 55 Hz. Answering these questions would aid our understanding of the mechanisms by which cnidocytes fire.

This study has interesting implications in human safety, suggesting a possible investigation to minimize harm done to humans by dangerous cnidarians, although much more research would have to be done. This research was fairly limited, dealing with only with one species of cnidarians that consumed one type of prey alone. Furthermore, it does not explore whether this reaction is learned or predetermined. Some other possible studies could include testing a variety of prey, determining whether or not different prey have different frequencies of movement, and if so whether the anemones can differentiate between them. Studies on how jellyfish and sea wasps use chemo- and mechanoreceptors to identify targets to sting could help understand why these cnidarians sting humans, even though we are too large for them to ingest. Certainly the fact that the researchers could substitute bovine mutin in place of the chemosensitizer associated with the natural prey of the anemone, suggests that mammals and crustaceans and, presumably, fish all have similar chemical signature. If all three also generate the same frequency of movement it would explain why cnidarians see, or rather taste and feel, humans as prey.   Another line of study would be investigating chemicals that confuse or interfere with the chemoreceptors. Such chemicals could potentially be used as a sort of jellyfish spray to be used by beach goers to prevent stings. Clearly any research that further explores the mechanism of cnidarian stings would help prevent further injuries to humans.

Literature Cited:

Watson, Glen M. and David A Hessinger. 1989. Cnidocyte Mechanoreceptors are Tuned to the Movements of Swimming Prey by Chemoreceptors. *Science*, 243:4898. pp. 1589-1591.