

How can a squid teach us about detecting bacteria?

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The Hawaiian bobtail squid is a nocturnal animal that has a myriad of mechanisms to hide from predators. One of them involves a symbiotic interaction with “glowing” bacteria (an effect called bioluminescence). See the [video by HHMI](#) (Ed Yong) for more info on the squid and pioneering work by Margaret McFall-Ngai and Edward Ruby at the University of Hawaii.



Images courtesy of McFall Ngai lab ([photo by M. Ormestad](#))

In summary, the juvenile animal spends its’ day buried in the sand, taking in bacteria through a small valve and filtering material in the sand to find one particular type of bacteria (symbiont competent *Vibrio fischerii*). McFall-Ngai and her colleagues have studied this symbiotic interaction for 30 years and have deciphered much of the underlying biology.

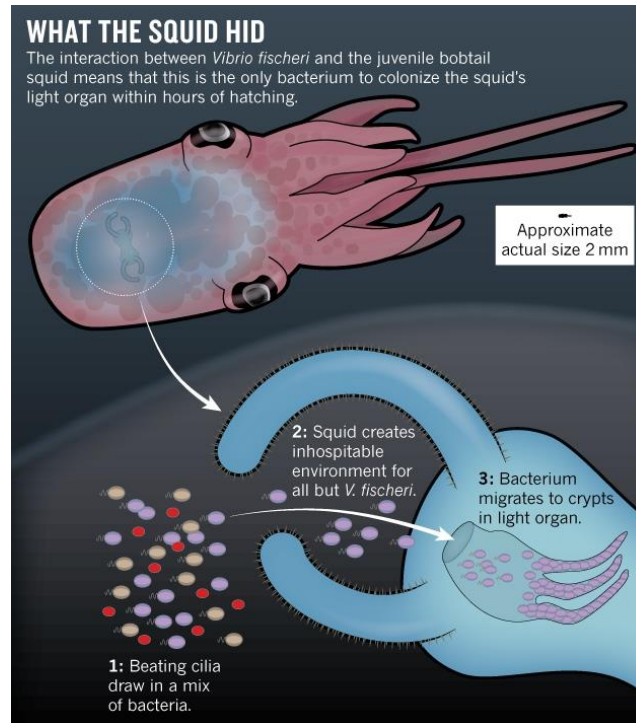
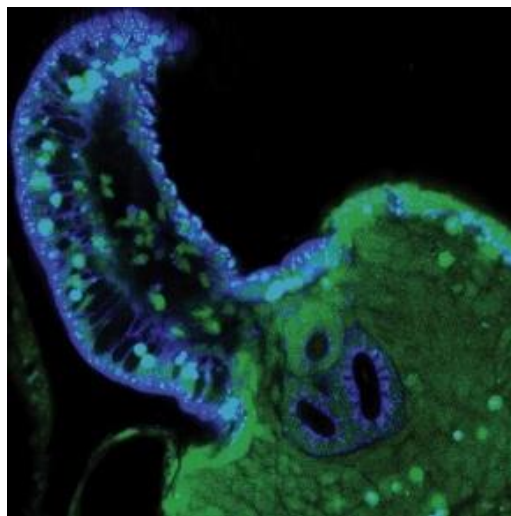


Image courtesy of [Yong et al \(2015\), Nature News Feature, 517\(7534\)](#)

The filtering is an effort to make sure the right bacteria attach to the “light organ”, which is the structure responsible for producing chemiluminescence. This symbiotic interaction is paramount for understanding evolutionary biology and the microbiome that is central to life. Some of the important mechanisms that the squid uses to filter the bacteria are to alter the local microenvironment by producing particular chemicals and also altering the flow of water using small structures called “brush borders”, among others. But why does the squid go through all of this effort to catch a bacteria?



Images courtesy of [McFall-Ngai \(2008\) Current Biology, 18\(22\): PR1043-1044](#) (left) and

When the squid leaves the sand (as sun sets), it begins to search and feed. If a predatory approaches, the squid activates the fluorescent bacteria and “poof”! It disappears and looks like moon ripples to the approaching predator. To find out more about the biology, visit the full story by Dr. McFall-Ngai et al:

How can engineers mimic this process?

To start, we can recreate some aspects of the brush border structure.

Inspired by this biological system, researchers at UF and ISU are developing biomimetic nanobrush coatings that can actuate (move) in a controlled manner. The nanopolymer coating material is used to create sensors for detecting dangerous bacteria in food (we are focused on *Listeria monocytogenes*). During the first stage of development we have combined the ability to control local fluid movement with the addition of sticky receptors onto the nanobrush (we have tested DNA aptamers, RNA aptamers, antibodies, and lectins).

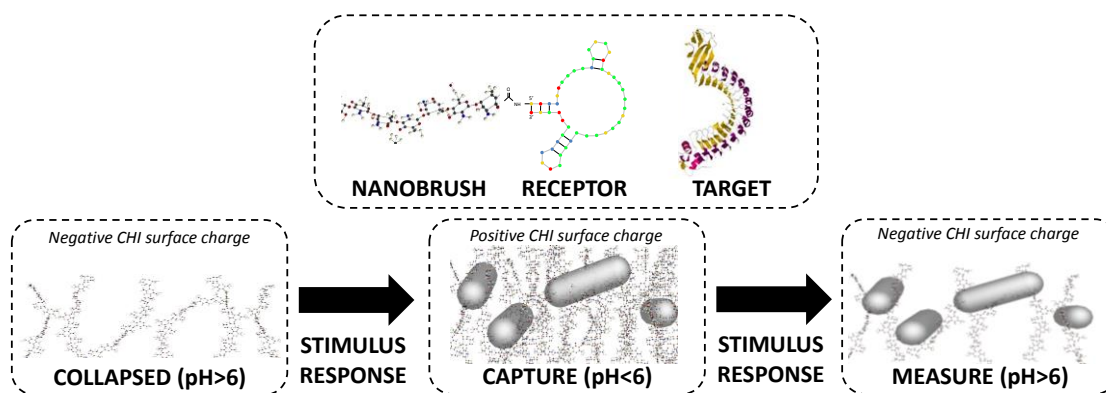


Image courtesy of [Hills et al \(2018\), Analyst](#), 143(7): 1650-1661.

Our work shows that the biomimetic approach is an excellent, and simple, mechanism for capturing one type of bacteria amongst a crowd of others. We have tested this system for capturing *Escherichia coli* O157:H7, *Listeria innocua*, and *Listeria monocytogenes*.

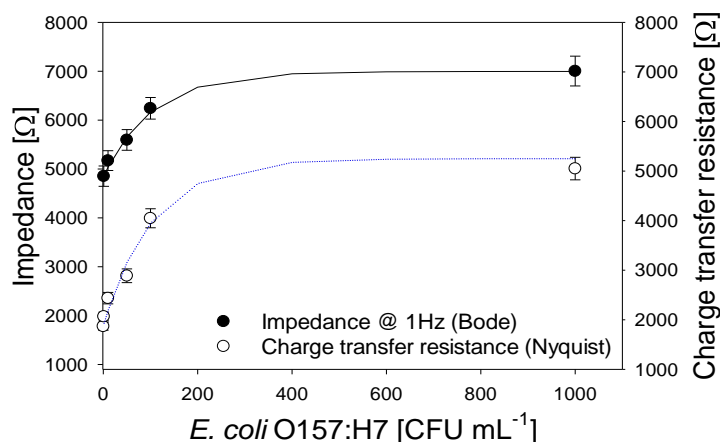


Image courtesy of [Burrs et al \(2016\) Biosensors and Bioelectronics](#), 85:479-487

In 2017 we filed a provisional patent on a technique for enhancing the selectivity of capture by controlling the chemistry of the surrounding fluid, and we are continuing to work on this process.

Finally, we are currently testing new microfluidic devices and flexible electronics for scaling this system up for use in agricultural and food applications. Regardless of our final design, the heart of the interaction will be based on what we have learned from the Hawaiian bobtail squid and the researchers who study these important interactions.

