Understanding sound production and hearing in clawed lobsters, *Homarus americanus* and *Homarus gammarus*

ASK THE LOBSTER DOC

by Diane Cowan

Ever wonder what lobsters hear, "say," and how they do it?

Early science papers on Homarid (clawed) lobster sounds appeared in the 1950's. Sometime during the 1980's, I tried to figure out what American lobsters were trying to say. And in 2000, I wrote in this space about *The Mystery of Lobster Vibrations* (CFN May).

Finally, we have some provocative answers – thanks to Dr. Youenn Jézéquel and a team of scientists from around the world.

If you're a lobsterman or lobster field biologist you've no doubt handled a lobster that vibrated or "buzzed" in your hand. To us, the lobster's low frequency noise feels like a vibrating cellphone and sounds like a buzz.

Have you ever wondered if other lobsters hear the buzz?

The answer is yes.

Have you ever wondered how lobsters hear?

The answer is hairfans. No kidding.

Instead of localized ear organs, lobsters hear using cuticular "hairfans" prevalent along the entire length of their bodies. Although the shell itself is made up of dead tissues, sensory hairs stick out of the tiny holes in the lobster exoskeleton. Receptors at the base of hair-fan organs sense stimuli – including particle motion that lobsters detect as low frequency sound.

Here's how sending and receiving the buzz sound signal works in American lobster. (Spiny lobster do some things differently).

The lobster sends the buzz by contracting muscles in the head region. The sound signal vibrates the lobster's entire body sending particle waves through the water.

Lobsters hear these sounds by listening with hairfan organs located in tiny, shallow pit-like depressions from end to end of the entire body. Way different, obviously from we humans, who talk with localized mouths and hear with ears.

Another big difference between our hearing and that of a lobster is the type of sound signal we hear.

We – like other mammals including whales and dolphins – are sensitive to pressure waves; while lobsters – like fish and invertebrates – decode particle motion.

Lobsters making and hearing noises may seem like stating the obvious, but it's not.

How lobsters hear and why lobsters produce sound was previously unknown.

Previous attempts to characterize lobster sounds in laboratory tanks failed, partly because of the way sound attenuates (bounces off the walls). New understanding and use of new ways to record sound underwater provides solutions to how the size and shape of the container presented obstacles to data accuracy.

Once sounds could be properly characterized and recorded, Jézéquel staged lobster boxing matches to ascertain how sounds might be used in agonistic encounters.

Buzzing was recorded – most notably when

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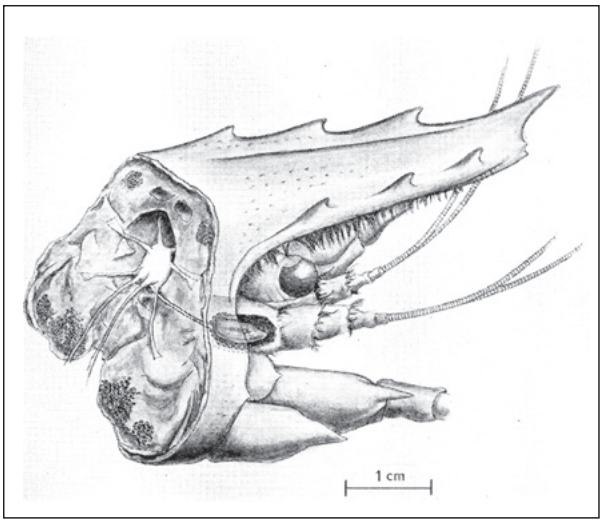

Fig. 1. A drawing of the dissected anterior cephalo-thoracic region of the lobster (Homarus Americanus). This type of preparation was used in all experiments. For this drawing the statocyst is exposed in the basal segment of the right antennule. The nerve seen coursing from the brain to the statocyst is the combined statocyst and antennular nerve.

Credit: Cohen 1955.

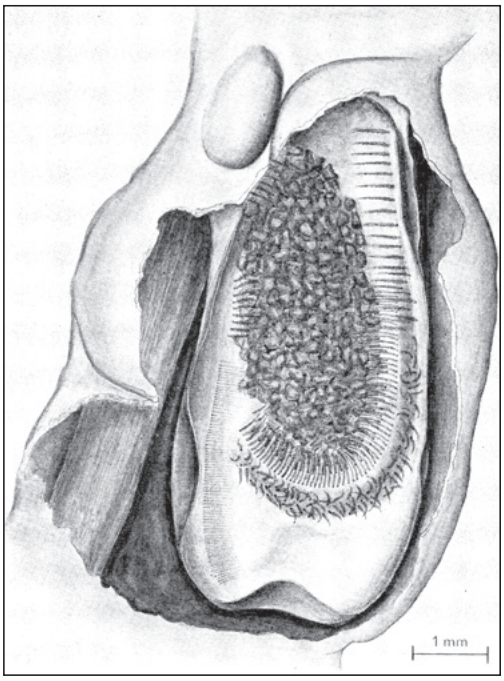

Fig. 2. Drawing of the right statocyst as seen from above. The dorsal region of the basal antennular segment and the dorsal statocyst wall have been removed, thereby exposing the lumen contents. Anterior is toward the top, lateral is to the right. Note the crescentic sensory cushion with its four hair rows. The statolith mass is seen in contact with the inner three rows. The fine medial thread hairs project horizontally into the lumen from the posterior region of the medial wall. The large antero-lateral hairs are visible and the opening into the cyst can be discerned at the antero-medial boundary between the cyst and antennular chitin.

Credit: Cohen 1955.

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one of the two males managed to establish dominance. In such a case, the dominant male buzzed after the subordinate lobster conceded the fight. Perhaps he is saying touché?

Finding out that lobsters do indeed hear the buzzes of other lobsters and learning that the receptors for hearing the buzz involve hairfans is big news, frankly.

Demonstrating that lobsters also buzz in social context by appearing to use acoustic signals to communicate during the boxing match is extraordinary. This makes me wonder what else lobsters are buzzing about.

In addition to being just plain interesting, the basic research conducted by the lobster bioacoustians brings timely news for the lobster industry.

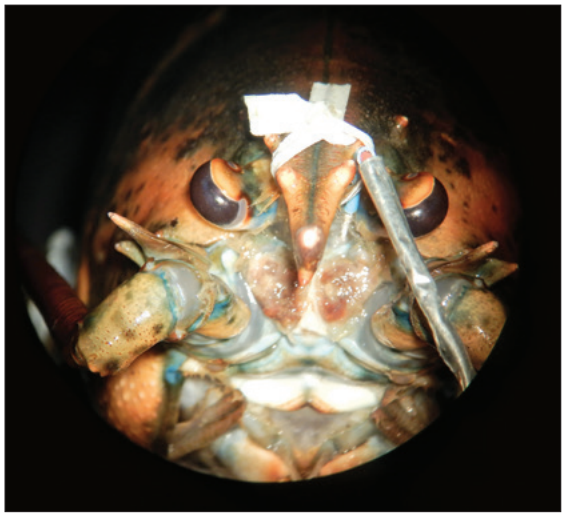
Now that we know lobsters use acoustic signals to talk to each other, it's time to find out what they are saying.

It's time to hear what the lobsters have to tell us about how they respond to and are impacted by us and other external factors.

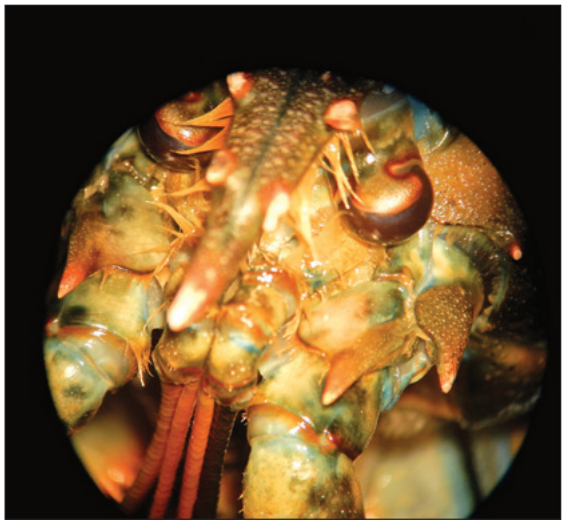
To paraphrase Dr. Jézéquel:

While we've known for decades that marine mammals and fish are impacted by anthropogenic noise, impacts on marine invertebrates, including lobsters, are not yet established.

Considering what we know now: that lobsters detect sounds in the same frequency band as anthropogenic noise (i.e. low frequencies), we are able to target clear concerns and crucial needs to understand and assess the impacts of underwater man-made noise on the economically and ecologically important lobster.



WHOI photos



- Read about lobster sound detection and find more references at: https://journals.biologists.com/jeb/article/224/6/jeb240747/237913/Sound-detection-by-the-American-lobster-Homarus
- Read more about particle motion and underwater acoustic ecology at: https://besjournals.onlinelibrary.wiley.com/doi/10.1111/2041-210X.12544

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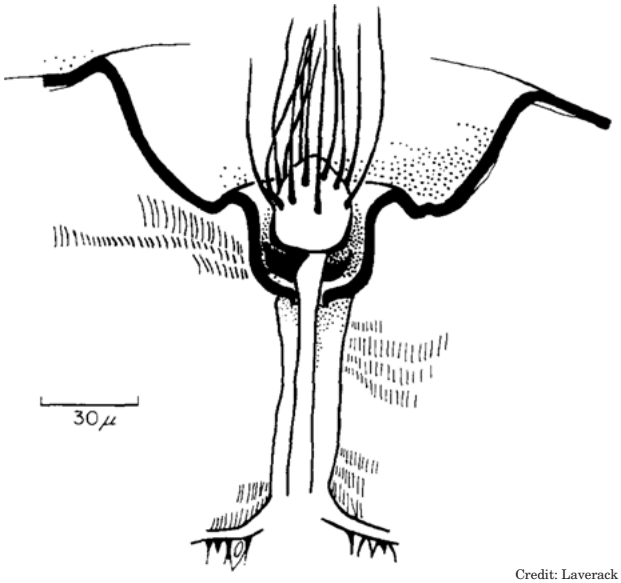

Credit: Laverack 1962.

Fig. 3. Illustration of hairfan organ, basically a shallow pit-like depression with hairs sticking out and nerve fibers running in; not sure exactly sure what receptors inside look like or how they work. A piece of the cuticle is shown as a shallow depression in which the hairfan is situated. The base of the organ is innervated, the nerve fibers passing from the peripheral nervous system through a small pore in the cuticle.

Acknowledgements

Illustrations borrowed from:

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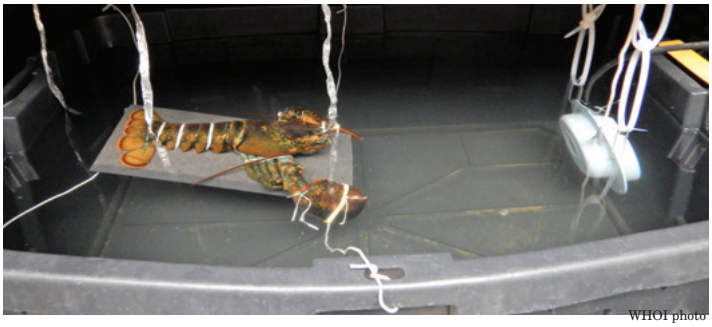

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