Mucus may play vital role in dolphin echolocation

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A dolphin chasing a tasty fish will produce a stream of rapid-fire echolocation clicks that help it track the speed, direction and distance to its prey. Now researchers have developed a model that could yield new insights into how the charismatic marine mammals make these clicks - and it turns out snot may play an important role.

The researchers will present their model at the 171st meeting of the Acoustical Society of America, held May 23-27 in Salt Lake City.

"It's harder than you might think to make loud, high frequency sounds," said Aaron Thode, a research scientist at the Scripps Institution of Oceanography in San Diego. "Wet, sticky surfaces could serve a purpose in this."

Most scientists believe dolphins create sound by forcing air through nasal passages located just beneath their blowholes. Within the nasal passage are lumps of tissue, called dorsal bursae, that collide and vibrate, producing the dolphin's repertoire of clicks, chirps and whistles. Yet the finer details of what happens in the nasal passages remain murky.

It's difficult to film a dolphin's working nasal passages, Thode said, and many of the motions happen as quickly as a thousand times per second, making it hard to measure them. In place of direct observation, Thode turned to a lumped element model - commonly used by engineers and scientists to simplify complicated systems.

While looking through the scientific literature on the human voice, Thode found a lumped element model for vocal cords. The model represents the vocal cords as discrete masses connected by springs, which store and release energy, and dampers, which dissipate energy. The model captures essential characteristics of the system, like the frequency at which it vibrates, while remaining simple enough to easily solve.

Thode worked with his father, Lester Thode, a retired physicist from Los Alamos National Laboratory, to adapt the vocal cord model to dolphin nasal passages. The researchers compared their model's simulated clicks to recordings of real dolphin clicks that had been gathered by their colleagues at the Hawaii Institute of Marine Biology and the Navy Marine Mammal Program.

The model accurately reproduced two distinct parts of a dolphin click: an initial loud thump, followed by an extended ring. It suggests the thump is caused when the dorsal bursae collide and then pull apart, and the ring develops from the lingering vibrations of the tissue.

What's more, the bursae must stick slightly to each other before separating in order to produce the loudest, highest frequency parts of the call.

Thode describes the required motion as "kind of like pulling apart silly putty - if you pull it hard it will resist, but then snap apart." The researchers think the mucus coating of the nasal passage could provide this stick-and-snap motion.

The model can produce whistles, click trains and individual clicks. It can also reproduce "weird" clicks, where the thump and ring seem to occur at the same time, and shows a similar statistical correlation between peak frequency and power as observed in real click data.

The agreement between real and simulated clicks is encouraging, but the researchers caution the model is still under development.

"Others could create a different model that also matches the data," Lester Thode said.

Going forward, the father and son team hope to get more dolphin recordings so they can see if additional predictions made by the model - such as the timing patterns of click bursts - also show up in real life.

The model could potentially inspire human engineers looking for clever new ways to create high-frequency sounds. It could also yield insights into how other animals, such as whales, vocalize, Aaron Thode said.

More information: Presentation 2pABa3, "There must be mucus: Using a lumped-parameter model to simulate the "thump" and "ring" of a bottlenose dolphin echolocation click," by Lester Thode will take place at 1:30 p.m. MDT on Tuesday, May 24 in Salon 1. The abstract can be found by searching for the presentation number here: http://acousticalsociety.org/content/spring-meeting-itinerary-planner

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