Scientists Reveal Secrets of Whales

THAR SHE BLOWS!

by Erin Koenig

Using drones to fly into the misty "blows" of exhaling humpback whales, scientists have found for the first time that the whales had a common set of microorganisms—a respiratory microbiome that may help maintain their health.

In recent years, scientists have learned that vast communities of symbiotic microbes live in and on humans and play crucial roles in supporting people's immune systems and metabolisms. The discovery of a shared respiratory "microbiome" in whales could help scientists monitor the health of whales.

In turn, "whales can be sentinels of ocean health," said Amy Apprill, a scientist at Woods Hole Oceanographic Institution. "The more we understand about their health and the causes of decline in their health, the more we can understand about the health of the ocean."

Apprill and her colleagues wanted a new way to collect samples of whales' blow—the moist breath that whales spray out of their blowholes. Traditionally, scientists tracked whales in a small boat, getting close enough to hold a long pole with a large petri dish at its tip as close as possible to the blowholes. The method works, but it can potentially stress the whales and change their behavior.

Seeking a less intrusive approach, the researchers turned to the skies and some high-tech equipment—a custom-made, remotely controlled hexacopter. The research team also included scientists from the National Oceanic and Atmospheric Administration (NOAA), SR3 (Sealife Response, Rehabilitation and Research), and the Vancouver Aquarium.

The scientists were using a camera on the hexacopter to take high-resolution aerial images of whales to assess their body conditions and overall health, NOAA scientist John Durban said. "Because of the stable flight performance of our hexacopter, we quickly learned that we could reliably fly through whale blow without disturbing the animals."

Durban, WHOI biologist Michael Moore, and SR3's Holly Fearnbach collected their first samples using a drone off Patagonia in early 2015. They brought the technique back to sample the blows from 17 humpback whales off Cape Cod and nine humpbacks off Vancouver Island, Canada, collaborating with Lance G. Barrett-Lennard of the Vancouver Aquarium.

Fearnbach called positioning directions at a rapid pace that would rival that of a veteran auctioneer, and Durban piloted the hexacopter several feet above the blowhole. Some of the blow landed on a sterilized petri dish on top of the drone.

"The whales don't seem to know the aircraft is there," Moore said. "We want to study whale health, but not affect their behavior. The drone helps us do just that."

Apprill and WHOI laboratory colleague Carolyn Miller identified 25 bacterial groups present in all of the whale samples. "This strongly suggests that regardless of where the animals live, or even their age or sex, they have a shared blow microbiome," Apprill said.

Next, the researchers will take samples from whales with poor body conditions that possibly indicate illness.

"From this study, we have a good idea of what a normal, healthy whale microbiome looks like," Apprill said. "Now we need to understand what the microbiome of an unhealthy whale looks like."

The new study was published in October 2017 in mSystems, *a journal of the American Society for Microbiology. The research was funded by the Ocean Life Institute at WHOI.*

Véronique LaCapra, WHOI. Research approach of whales using the hexacopter was authorized by NMFS permit #17355 and flights were authorized under an MOU between NOAA and the FAA (Class G MOU #2016-ESA-3-NOAA)

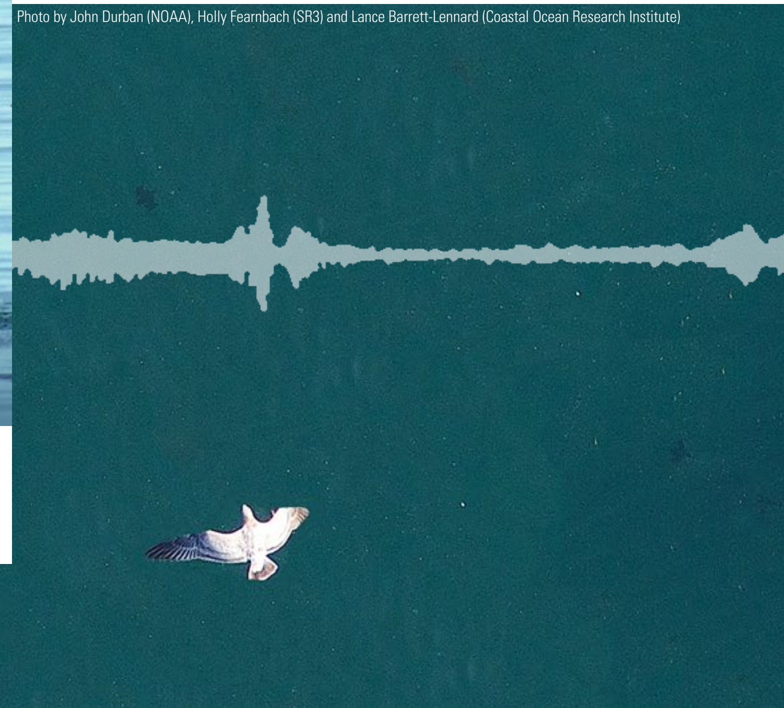

Photo by John Durban (NOAA), Holly Fearnbach (SR3) and Lance Barrett-Lennard (Coastal Ocean Research Institute)

Top: A drone captures a sample of whale's breath. Right: A humpback whale opens its mouth wide to gulp a huge amount of food-filled water, a mechanism known as "lunge feeding."

THAR SHE SINGS! *by David Levin*

Researchers have known for decades that whales create elaborate songs. But a new study has revealed a component of whale songs that has long been overlooked—sort of a booming baseline to go along with the treble.

Aboard a small research boat, a research team measured two elements of songs from a group of humpback whales off the coast of the Hawaiian island of Maui—pressure waves (the type of sound waves that push on human eardrums, allowing us to hear), and particle motion (the physical vibration of a substance as sound moves through it).

"Imagine pulling up next to a car blasting loud music," said Aran Mooney, a biologist at Woods Hole Oceanographic Institution. "The stuff you hear is pressure waves; the stuff you feel vibrating your seat is particle motion."

To the scientists' surprise, they found that particle motion in the water was detectable much farther than expected.

"We threw our gear over the side and let ourselves drift away from whales while measuring both particle motion and sound pressure," Mooney said. "We didn't expect particle motion to be detectable much at all—just a few meters away at most. But as we got progressively farther away, the particle motion stayed loud and clear."

Mooney and his colleagues—WHOI graduate student Maxwell Kaplan and Marc Lammers of the Hawaii Institute of Marine Biology—measured only as far as about 655 feet (200 meters) from the whales, but their data show that particle motion from the whale songs, especially in lower frequencies of sound, could travel much farther.

"It's a whole other avenue of sound that we never knew whales could use," Mooney said. "When it comes to whale songs, particle motion hasn't really been studied much. It's a lot more complex to measure than pressure waves, so we don't have a great sense of how it propagates in water or air."

Pressure waves are relatively simple to detect using common underwater microphones called hydrophones. Detecting particle motion, however, requires sensitive underwater instruments such as accelerometers, which until recently have not been widely used by researchers to measure sound. Mooney and his team had both sensors on hand, allowing them to collect their unexpected recordings.

Mooney is quick to note that his team didn't gather enough data to say definitively whether these whales could sense the particle motion present, but the anatomy of whale ear bones suggests that low-frequency vibrations could play a major role in whale hearing. Unlike those in dolphins and toothed whales, humpback whale ear bones are fused to the animals' skull, providing a direct link to conduct vibrations in the water through their bones to their ears.

"It raises the question: Does a whale's lower jaw act like a tuning fork to direct vibrations to their ears?" Mooney said. "Previous studies have shown this bone conduction might be a viable mode of hearing."

There's also some evolutionary precedence. Whales' closest living relatives—hippopotamuses—can sense sound under water using their bodies, even while their ears remain above the surface. Elephants, another close relative of whales, can pick up ultralow-frequency vibrations through their feet, a trait that may help them locate their herd from miles away.

The new findings also raise another concern: Increasing human activity—from shipping, seismic exploration for oil and gas, and construction using pile-driving machinery—probably increases low-frequency particle motion that might propagate for miles under water and might interfere with whale communication.

"We humans don't hear well in water, so we overlook noise in the ocean," Mooney said, "but this could be a major concern for whales." ▲

The study was published in November 2016 in the journal Biology Letters. *It was funded by a WHOI Independent Study Award.*