Migrating animals' pee affects ocean chemistry

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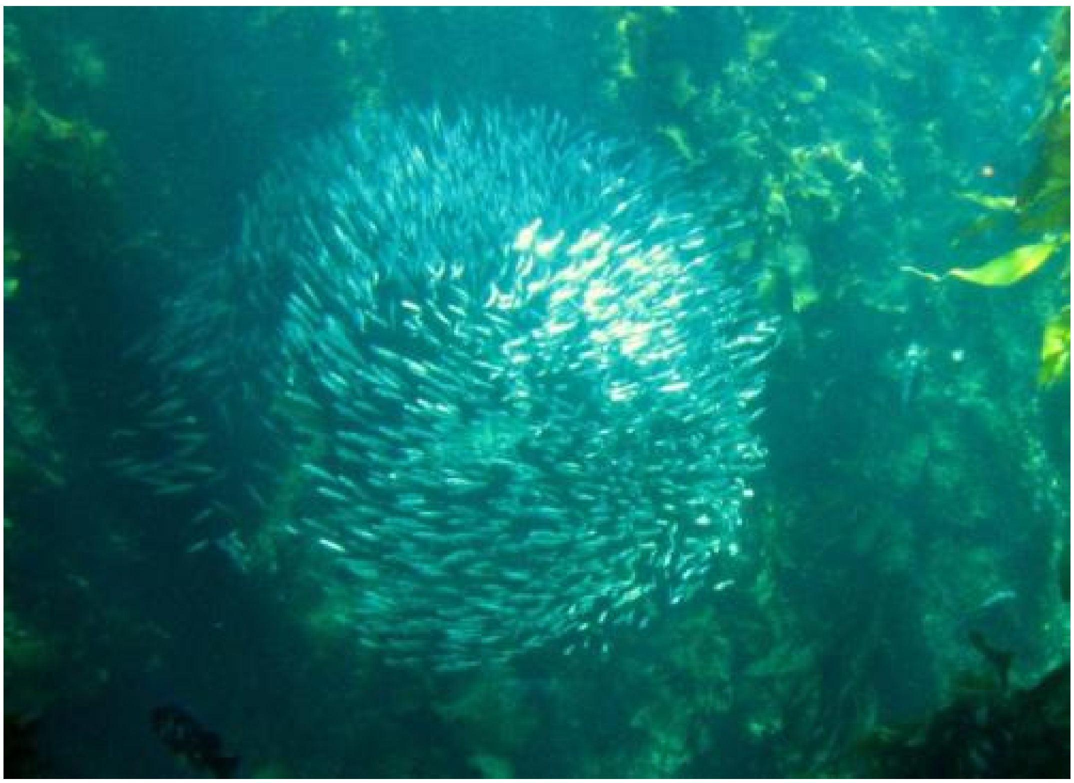

A school of small fish in the Monterey Bay Aquarium. Credit: Jared Zimmerman / Flickr

The largest migration on the planet is the movement of small animals from the surface of the open ocean, where they feed on plants under cover of darkness, to the sunless depths where they hide from predators during the day.

University of Washington researchers have found that this regular migration helps shape our oceans. During the daylight hours below the surface the animals release ammonia, the equivalent of our urine, that turns out to play a significant role in marine chemistry, particularly in low-oxygen zones. Results are published online this week in the *Proceedings of the National Academy of Sciences*.

"I'm very fascinated by these massive migrations," said lead author Daniele Bianchi, a postdoctoral researcher in the UW School of Oceanography. "To me, it's exciting to think about the effects of animal behavior on a large scale in the ocean."

One might not think that peeing into the vastness of the oceans could have an effect. But the animals – which include tiny zooplankton, crustaceans such as krill, and fish such as lanternfish up to a few inches long – compensate for their small size with huge abundance throughout the world's oceans.

After a nighttime feast near the surface, these small creatures take a couple of hours to swim about 650 to 2,000 feet (200 to 600 meters) deep. Solid waste falls as pellets. The liquid waste is emitted more gradually.

In earlier work, Bianchi made the surprising finding that the animals spend most of their day in low-oxygen water. Marine bacteria consume oxygen as they decompose sinking dead material, creating low-oxygen zones a few hundred feet below the surface.

"The animals really seem to stop in low-oxygen regions, which is sort of puzzling," Bianchi said. Some speculated these zones might protect them from larger predators.

The earlier study also showed that animals actually contribute to these low-oxygen zones by using the little remaining oxygen to breathe.

Researchers next wondered about their other bodily functions.

For the new study, authors mined data from underwater sonar surveys to calculate how many animals are migrating to which depths, and where. Next they gauged the combined effect of their daytime digestion.

Results show that in certain parts of the ocean, ammonia released from animals drives a big part of the oxygen-free conversion of ammonium and other molecules to nitrogen gas, a key chemical transition.

"We still think bacteria do most of the job, but the effect of animals is enough to alter the rates of these reactions and maybe help explain some of the measurements," Bianchi said.

Inside low-oxygen zones, it's still mysterious how bacteria turn so much nitrogen-based ammonia into tight pairs of nitrogen atoms, like those found in air, which cannot be used by plants or animals. The conversion is important because it determines how much nitrogen-based fertilizer remains to support life in the world's oceans.

Researchers typically model low-oxygen zones using factors such as ocean currents, weather and bacterial growth. The new paper, Bianchi said, shows that diving animals, though more difficult to model, also play a role in marine chemistry.

The ocean's low-oxygen zones are projected to expand under climate change, as warmer waters hold less oxygen and decrease oxygen content below the surface. Understanding these zones is thus important for predicting what might happen to the oceans under climate change.

More information: www.pnas.org/content/early/201 …

/1410790111.abstract

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