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News

Fish are crucial in oceanic carbon cycle

Chemistry models need to incorporate new discovery.

Roberta Kwok

Fish may play a more important role in the marine carbon cycle than previously thought, a new study shows. Researchers have found that fish excrete prodigious amounts of a mineral, calcium carbonate, that had been thought to come almost exclusively from marine plankton such as shelled algae.

Fish ingest calcium from seawater and excrete it as calcium carbonate.

P. Mumby/Exeter U.

Biologists knew that bony fish — a group that includes most fish apart from cartilaginous ones such as sharks and rays — produced calcium carbonate in their guts to rid themselves of excess calcium ingested from seawater. But this process hadn't been factored into models of ocean chemistry.

"This is the first study that has even tried to link carbonate production by fish to global carbon cycles," says Rod Wilson, a fish physiologist at the University of Exeter, UK.

Wilson and his colleagues from the United Kingdom, the United States and Canada set about estimating the contribution of fish to global marine carbonate production. They took X-rays to observe carbonate formation in fish intestines and measured the amount excreted by the European flounder (*Platichthys flesus*) and the Gulf toadfish (*Opsanus beta*), model species studied previously in the authors' labs. Then, they used two independent computer models to calculate the total mass of fish in the world's oceans.

The models suggested that there are between 0.8 billion tonnes and 2 billion tonnes of fish biomass in the oceans. And this indicates that bony fish produce 40 million–110 million tonnes of calcium carbonate per year, the study says. The range accounts for 3%–15% of the estimated total.

Below the surface

The lab results can be extrapolated to global fish populations, says Wilson, because the predictions are based on well-studied relationships between fish metabolism, mass, activity level and temperature. The estimate is conservative and could be as high as 45% of total calcium-carbonate production under more liberal assumptions, he says. The study appears in *Science*.[1]

"They hit on an important but, before this, unrecognized source of calcium carbonate in the ocean," says Victoria Fabry, an oceanographer at California State University, San Marcos.

And this might elucidate why ocean surface waters are more alkaline, or less acidic, than models have predicted. The carbonate coming from plankton doesn't dissolve until it sinks to depths greater than 1000 metres. But carbonate produced by fish contains more magnesium, an impurity that causes the mineral to dissolve more readily and reduce the acidity of the water.

"It helps explain a dilemma we had with the calcium-carbonate budget," says Richard Feely, an oceanographer at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory in Seattle, Washington, who has worked with one of the study's co-authors. "There is a much better chance now that we can balance the marine carbon cycle."

Changing with the climate

Fish may boost their carbonate production rate in response to increased carbon-dioxide levels, the researchers suggest. Ocean scientists have warned that plankton and corals will produce less calcium carbonate as the amount of CO_2 in the atmosphere rises, but "what's a bit peculiar is we think fish go in the other direction", Wilson says. Fish make calcium carbonate by combining calcium from seawater with carbonate ions generated from CO_2 in their bodies. If the amount of atmospheric CO_2 goes up as expected — leading to a CO_2 increase in the oceans — the fish may produce more carbonate ions and thus more calcium carbonate.

Learning how other processes affect fish carbonate production could be complex. For example, overfishing may lower the number of fish producing calcium carbonate, but it could also reduce the average size of fish in the oceans. Smaller fish, which are less likely to be harvested,

produce more calcium carbonate per body mass unit because of their higher metabolism. Preliminary modelling suggests carbonate production will go down, says Wilson, but not by as much as you might expect.

The researchers plan to study more fish species and get firmer estimates of the dissolving rates of magnesium-rich carbonates. The results will also need to be verified by checking the amount of fish-produced calcium carbonate in coastal sediments, where the mineral is likely to be preserved, says Feely.

References

1. Wilson, R. W. *et al. Science* **323**, 359–362 (2009). | **Article** | **ChemPort** |

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