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The Fish Did It! Mystery solved

An international team of scientists has solved a mystery that has puzzled marine chemists for decades. They have discovered that fish contribute a significant fraction of the oceans' calcium carbonate production, which affects the delicate pH balance of seawater. The study gives a conservative estimate of three to 15 percent of marine calcium carbonate being produced by fish, but the researchers believe it could be up to three times higher.

Published January 16th in Science, their findings highlight how little is known about some aspects of the marine carbon cycle, which is undergoing rapid change as a result of global CO2 emissions.

Until now, scientists believed that the oceans' calcium carbonate, which dissolves in deep waters making seawater more alkaline, came from marine plankton. The recent findings published in Science explain how up to 15 percent of these carbonates are, in fact, excreted by fish that continuously drink calcium-rich seawater. The ocean becomes more alkaline at much shallower depths than prior knowledge of carbonate chemistry would suggest which has puzzled oceanographers for decades. The new findings of fish-produced calcium carbonate provides an explanation: fish produce more soluble forms of calcium carbonate, which probably dissolve more rapidly, before they sink into the deep ocean.

Corresponding authors Drs. Frank Millero and Martin Grosell at the University of Miami's Rosenstiel School of Marine and Atmospheric Science and Dr. Rod Wilson of the University of Exeter note that given current concerns about the acidification of our seas through global CO2 emissions, it is more important than ever that we understand how the pH balance of the sea is maintained. Although we know that fish carbonates differ considerably in their chemical make-up, the team has really only just scratched the surface regarding their chemical nature and ultimate fate in the ocean. Scientists clearly need to investigate this further to understand what this means for the future health of the world's oceans.

Millero, Grosell and Wilson, who was the recipient of the University of Miami's prestigious 2005 Rosenstiel Award, along with Rosenstiel School Marine Biology and Fisheries graduate student Josi Taylor collaborated with other British and Canadian scientists to reach the conclusion published in the current issue of Science.

The researchers suggest that fish carbonates dissolve much faster than those produced by plankton, and at depths of less than 1,000 m. Less soluble carbonates, produced by plankton, are more likely to sink further and become locked up in sediments and rocks for tens or hundreds of millions of years before being released. Fish carbonates, on the other hand, are likely to form part of the 'fast' carbonate system by more rapidly dissolving into seawater.

"As a marine chemist who has been studying the global carbon cycle and its impacts on the pH of the water and marine ecosystems for 40+ years, these results offer an important piece of the equation," said Millero, professor of Marine and Atmospheric Chemistry at the Rosenstiel School. "By working with scientists in several disciplines we were able to come at this from different perspectives and combine data sets that hadn't been previously used together, to solve this problem. We can now employ the knowledge gained from this study to examine how ocean acidification due to the adsorption of CO2 from the burning of fossil fuels affects the ocean carbon system."

The combination of future increases in sea temperature and rising CO2 will cause fish to produce even more calcium carbonate, which is in sharp contrast to the response by most other calcium carbonate producing organisms. Fish's metabolic rates are known to increase in warmer waters, and this study explains how this will also accelerate the rate of carbonate excretion. In addition, our existing knowledge of fish biology shows that blood CO2 levels rise as CO2 increases in seawater and that this in turn will further stimulate fish calcium carbonate production.

"Depletion of fish stocks due to overfishing will obviously influence global calcium carbonate production attributable to fish, but the prediction of the impact of overexploitation is complex. Smaller fish which often result from exploitation produce more calcium carbonate for the same unit of biomass than bigger fish, a simple consequence of higher mass-specific metabolic rates in the smaller animals. In addition, the

chemical nature of the calcium carbonate produced by fish, which determines solubility, almost certainly will depend on temperature, fish species, ambient pH and CO2 levels among other factors. The influence of such factors on this newly recognized and significant contribution to oceanic carbon cycling offers an exciting challenge for further study" said Grosell, associate professor of Marine Biology and Fisheries at the Rosenstiel School.

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