Scientists discover biological mechanism for enhanced carbon consumption in the ocean

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Experiments for the future: Mesocosms in the Raunefjord, Norway.

The world oceans are by far the largest sink of anthropogenic CO_2 on our planet. Until now, they have swallowed almost half of the CO_2 emitted through the burning of fossil fuels. However, can the oceans continue to alleviate the steady rise in atmospheric CO_2 in the future?

Current models for the development of the global climate system do not incorporate the reaction of marine organisms nor the processes that they influence.

Professor Ulf Riebesell, marine biologist at IFM-GEOMAR in Kiel and the first author of the study, gives insight into the motivation for the research: “We need to learn a lot more about the biology of the oceans,

because the organisms play a decisive role in the carbon cycle. How do they affect the chemical balance and what are their responses to the enormous environmental changes we are currently experiencing?" The *Nature* publication provides new insights into these effects and their dimension.

To investigate the biological processes and their potential changes with time, the scientists made use of an unusual experimental set up in the Raunefjord in Norway. Here, a series of nine mesocosms, enclosures manufactured from a specialized synthetic material and measuring 10 meters in depth, were used to isolate 27 cubic meters of natural fjord water.

In the experimental design, Ulf Riebesell and his team maintained three enclosures at current CO_2 conditions as a control, while they infused CO_2 in the remaining mesocosms to simulate predicted concentrations for the year 2100 and the year 2150. The critters in the mesocosms responded quickly to the extra serving of CO_2. The higher the concentration of dissolved carbon dioxide, the faster the microalgae incorporated the greenhouse gas via photosynthesis. Can CO_2 act as a fertilizer in the ocean?

The scientists measured an increased uptake of up to 39% compared to current rates. Ulf Riebesell describes the reaction of his team: "We expected the organisms to show distinct reactions to changing CO_2 conditions. What really surprised us, however, was the dimension of this effect. Basically, we can now say that the biology in the oceans is significantly affecting the global climate system." In the final step of the experiment, the scientists wanted to find out what happens with the rapidly proliferating biomass. Again the experiments in the Raunefjord provided insights: the extra CO_2 bound in organic matter sank to depth after the peak of the algal bloom.

The CO_2 fertilization of marine plankton can have a positive effect on climate change in the future. The greenhouse gas consumed by plankton and removed from the surface ocean when the dying cells sink to depth makes way for the uptake of more CO_2. In a way, the tiny organisms act as a biological conveyer belt for the transport of carbon dioxide out of the surface and into the deep ocean. What appears to be a blessing for the atmospheric greenhouse effect may prove to be a curse for deep ocean ecosystems. Decomposition of the increased biomass will consume more oxygen, a major problem for marine animals that occupy deep habitats. Another consequence of the biological conveyer belt is the accelerated rate of ocean acidification in the deep ocean due to more rapid transport of CO_2 to depth. The authors also expect direct affects on marine organisms based on previous observations. Planktonic crustaceans that were fed with CO_2-enriched microalgae displayed slower growth rates and were less proliferous.

Ulf Riebesell remarks on the consequences of the study: „Our results probably represent only the tip of the iceberg. I am certain that scientists will discover further biological feedback mechanisms in the near future. It is essential not only to identify and to understand these mechanisms, but also to quantify their effect on the global climate system, now and in the future. “

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