# Ocean acidification: First demonstration that ocean's CO2 uptake can impair digestion in a marine animal

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This shows green sea urchins (*Strongylocentrotus droebachiensis*) at the lab. Credit: GEOMAR

Ocean acidification impairs digestion in marine organisms, according to a new study published in the journal *Nature Climate Change*. Researchers from Sweden and Germany have studied the larval stage of green sea urchins *Strongylocentrotus droebachiensis*. The results show that the animals have problems digesting food in acidified water.

Carbon dioxide ($CO_2$) emissions do not only affect the climate but also our seas and oceans. One-quarter of all $CO_2$ released into the atmosphere is absorbed by the oceans. Once there, the $CO_2$ is converted to carbonic acid, making the water more acidic. Previous studies showed that marine species and ecosystems can suffer in an acidified environment. Although the reason for the sensitivity was seen in physiological processes, mechanisms remained unclear. Scientists from the universities of Gothenburg (GU) and Kiel (CAU), as well as GEOMAR Helmholtz Centre for Ocean Research Kiel and Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) found that ocean acidification leads to reduced rates of digestion in larvae of the ecologically important green sea urchin *Strongylocentrotus droebachiensis*. The findings are published in the international journal *Nature Climate Change*.

Dr. Meike Stumpp, former PhD student at GEOMAR and Kiel University and first author of the study, used novel pH micro-electrode techniques and designed new assay methods during her postdoc at the University of Gothenburg to investigate digestion and digestive enzymes in the larvae. She showed that when larvae are exposed to acidified seawater, the digestion takes longer and is less effective. "My measurements demonstrated a very strong pH dependency", Stumpp explains. "The enzymes in the sea urchins' stomachs are optimized to function at very high pH – which is different from the situation in mammals, where stomach pH is acidic and enzymes work best at low pH."

Exposed to simulated ocean acidification, the larvae work hard to maintain the high stomach pH values. "The energetic demands to maintain the stomach pH increase', says Dr. Marian Hu, co-first author of the study. Using antibody staining techniques, Hu discovered a high concentration of pH regulatory cells that cover the inner surface of the stomach. Such cells typically consume a lot of energy. Culturing

experiments and feeding trials revealed that in order to compensate for the decreased efficiency of digestion, the larvae feed more.

"While earlier studies mainly focused on understanding calcification under acidified conditions, other vital processes, such as digestion and gastric pH regulation, were neglected", says Meike Stumpp. "We can now demonstrate that they deserve much more attention." "All living processes are run or controlled by enzymes. They are the key in understanding the functions and reactions of organisms, and finally ecosystems, in a changing world", AWI-scientist Dr. Reinhard Saborowski adds.

"If the organisms are unable to compensate for extra costs caused by ocean acidification, by eating more, they suffer negative consequences in the form of reduced growth and fertility and in extreme cases death", Dr. Sam Dupont points out. The researcher from the University of Gothenburg is senior author of the study.

The researchers in Germany and Sweden have spent several years developing their techniques. "Studying digestion in larvae is not easy since they are only about a fifth of a millimeter in length", Dupont admits. "But now we are able to analyze this important process and get an impression of how sea urchin larvae might react to future living conditions."

**More information:** "Digestion in sea urchin larvae impaired under ocean acidification" *Nature Climate Change* 2013. DOI: 10.1038/nclimate2028

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