Press Release

GEOMAR
Helmholtz Centre for Ocean Research Kiel

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Ocean acidification: Herring could benefit from an altered food chain
New studies show complex effects of carbon dioxide on fish population

19 March 2018 / Kiel. **Many studies have shown that larvae of various fish species can be negatively affected by ocean acidification. Acidification is caused by large amounts of carbon dioxide (CO_2) entering the seawater from the atmosphere. But CO_2 can also influence the food supply for the fish larvae. Researchers from the GEOMAR Helmholtz Centre for Ocean Research Kiel investigated how the combination of these effects influences herring larvae. Their results have been published today in the international journal *Nature Ecology and Evolution*.**

As soon as they start life, it's all about survival for juvenile young fish. They must learn to catch prey and to escape enemies. Additionally, at this stage of their lives they are highly sensitive to environmental factors such as temperature, oxygen and the pH of the water. Exactly these factors are currently changing on a global scale: temperature is rising, the oxygen content of the ocean is decreasing and more and more carbon dioxide (CO_2) from the atmosphere dissolves in the seawater, where it forms carbonic acid and lowers the pH level. But not only directly, also indirectly elevated CO_2 affects the survival of fish larvae, because it can change their food supply.

Scientists from Germany, Sweden and Norway, led by the GEOMAR Helmholtz Centre for Ocean Research Kiel, have now investigated how the combination of these two effects of ocean acidification can affect the survival and growth of herring larvae. As they have published today in the international journal *Nature Ecology and Evolution*, the experiment revealed that herring could benefit from an ocean acidification induced change in the food web. “It appears that the herring will have an advantage over other more sensitive species in a future acidified ocean,” states Dr. Michael Sswat from GEOMAR, lead author of the study.

The scientists tested the response of young herring to ocean acidification by rearing them in a complete food web under present and future CO_2 conditions. For this purpose, they used the Kiel KOSMOS pelagic mesocosms, which were moored for a long-term experiment in the Swedish Gullmarsfjord in 2013. “The mesocosms enclose 50 cubic meters of seawater including all planktonic organisms naturally occurring at the deployment site, just like in a huge test tube floating in the sea,” explains Prof. Dr. Ulf Riebesell from GEOMAR, co-author of the study. Five of the mesocosms were set to elevated CO_2 concentrations as projected for the end of the century, while the remaining five mesocosms were left as untreated controls at current CO_2 levels.

Mesocosms with elevated CO_2 concentrations showed a more intense algal bloom compared to those with lower CO_2 levels. “As a result, the zooplankton also flourished and the herring larvae profited from this increased food supply,” explains Dr. Sswat. Six weeks after hatching, survival of herring larvae was higher by almost 20 percent under future compared to present day CO_2 conditions. “This overall positive effect of ocean acidification on herring larvae was initially surprising, as previous studies have shown negative direct effects of acidification on larval survival for many other fish species,” says Dr. Catriona Clemmesen from GEOMAR, also co-author of the study.

An explanation for the unexpected result emerged from a parallel laboratory study, which showed herring larvae had also been found to be tolerant to pH changes. “Siblings of the herring larvae in

the mesocosms were raised in the laboratory at comparable pH and CO_2 levels, excluding CO_2-induced changes in food supply. Thereby we were able to separate the direct effect of acidification on the herring larvae from the indirect influence via the food chain", explains Dr. Sswat. He is also the lead author of the laboratory study, which appeared in late January in the journal *PLOS ONE*.

The tolerance of herring larvae to pH changes could be due to their life history strategy. "Herring spawn mostly near the ground, where naturally high CO_2 levels prevail. They are therefore probably better adapted to ocean acidification than other fish species such as the cod that spawns near the surface," explains Dr. Clemmesen.

How the survival of the fish larvae and thereby entire populations will change in the future depends on many factors. In addition to ocean acidification, rising temperature and overfishing are also affecting marine communities around the world, and the consequences are far from being predictable. "But changes in the ecosystem are very likely. Hence, there is a high risk that the direct and indirect consequences of unabated CO_2 emissions will have a negative impact on fish", concludes Ulf Riebesell.

Reference:

Sswat, M., M.H. Stiasny, J. Taucher, M. Alguero-Muñiz, L.T. Bach, F. Jutfelt, U. Riebesell, C. Clemmesen (2018): Food web changes under ocean acidification promote herring larvae survival. *Nature Ecology & Evolution*. http://dx.doi.org/10.1038/s41559-018-0514-6

Sswat, M., M.H. Stiasny, F. Jutfelt, U. Riebesell, C. Clemmesen (2018): Growth and survival of larval Atlantic herring, under the combined effects of elevated temperatures and CO2. *PLOS ONE*, https://doi.org/10.1371/journal.pone.0191947

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www.geomar.de The GEOMAR Helmholtz Center for Ocean Research Kiel

Images:

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