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Impact of ocean acidification and elevated temperatures on early juveniles of the sub-polar shelled pteropod \textit{Limacina helicina} (Thecosomata): mortality, shell growth and shell degradation

Silke Lischka, Jan Büdenbender, Tim Boxhammer, and Ulf Riebesell
IFM-GEOMAR, Marine Biogeochemistry, Kiel, Germany (slischka@ifm-geomar.de)

Due to their aragonitic shell thecosome pteropods may be particularly vulnerable to ocean acidification driven by anthropogenic CO_2 emissions. This applies specifically to species inhabiting Arctic surface waters that are projected to become locally undersaturated with respect to aragonite as early as 2020. Because of the high solubility of CO_2 in cold waters, undersaturation will first occur during winter when the water is coldest.

The thecosome pteropod *Limacina helicina* contributes significantly to the Arctic zooplankton biomass at times and has a key function in the Arctic epipelagic food web. Due to their aragonitic shell, pteropods are expected to be among the first major group of calcifying organisms to be adversely effected by undersaturation in $CaCO_3$.

This study investigated the effects of rising pCO$_2$ partial pressures and elevated temperature on pre-winter juveniles of the polar pteropod *Limacina helicina* in the Arctic Kongsfjord (Svalbard). In September/October 2009 a 29 days experiment was carried out at three different temperatures and under pCO$_2$ scenarios projected for this century. Mortality, shell diameter, shell increment and shell degradation were investigated.

Temperature and pCO$_2$ were shown to have a significant effect on mortality, but temperature was the overriding factor. Shell diameter, shell increment and shell degradation were significantly impacted by pCO$_2$ but not by temperature. Mortality was 46% higher at 8°C compared to 3°C (*in situ*), and 14% higher at 1100 μatm CO_2 as compared to 230 μatm CO_2. Shell diameter and increment were reduced by 10% and 12% at 1100 μatm CO_2 as compared to 230 μatm CO_2, respectively, and shell degradation was 41% higher at elevated compared to ambient pCO$_2$ partial pressures. We conclude that pre-winter juveniles will be negatively affected by both rising temperature and pCO2 which may result in a possible abundance decline of the overwintering population, the basis for next year's reproduction.