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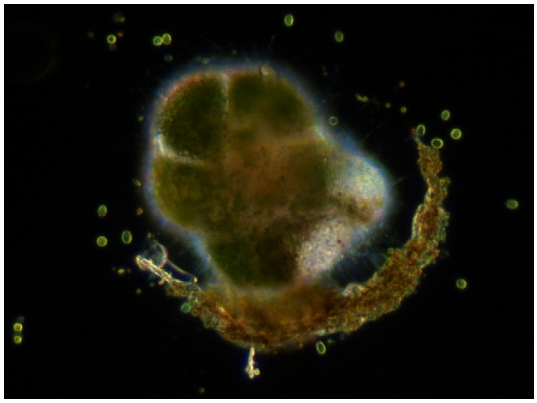
Master Thesis

Impact of Mg^{2+} and Ca^{2+} concentrations on calcification in the benthic foraminifer *Ammonia tepida*



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Abstract

Seawater Mg/Ca ratios have varied in the geological past due to different rates of seafloor spreading and weathering. Presently, this ratio is ~ 5, with a high enough Mg^{2+} concentration to inhibit inorganic calcification, even though surface sea waters are supersaturated with respect to $CaCO_3$. In order to precipitate calcium carbonate, foraminifers evolved cellular mechanisms to cope with these high environmental Mg^{2+} concentrations. Because foraminiferal tests are widely used in paleoceanographic and paleoclimatic studies, understanding these mechanisms is necessary - on the one hand to reliably reconstruct past changes in ocean chemistry - but also to predict the impact of future changes (e.g. ocean acidification) on calcification.

The benthic foraminifer *Ammonia tepida* was cultured under different Mg^{2+} and Ca^{2+} concentrations. Subsequently, morphological (test size, weight, deformities and coiling direction) and chemical test parameters (calcite Mg/Ca ratio, crystal structure) were analyzed.

The study revealed highest growth rates of *A. tepida* at today's seawater Mg/Ca ratios. Higher Mg^{2+} concentrations do not influence growth rates or test deformities, but possibly affect test thickness and shape. On the other hand, lower Mg^{2+} concentrations lead to low growth rates and high percentages of deformities. If Ca^{2+} concentrations are below a certain threshold, growth of *A. tepida* is disrupted. Tests are composed of calcite. Calcite Mg/Ca positively correlates with seawater Mg/Ca whereby tests show a very low partition coefficient D_{Mg}. Further studies are necessary to clarify whether D_{Mg} varies between chambers and whether it is influenced by seawater Mg/Ca ratios.

Results reflect the strong biological control of the calcification process in *A. tepida* as their adaptation to the high Mg^{2+} concentrations of today's seawater. It is suggested that Ca^{2+}, instead of Mg^{2+}, is pumped out of endocytosed seawater vacuoles and subsequently concentrated for calcification, while the vacuolized seawater with residual Mg^{2+} is exocytosed. An influence of ontogeny and seawater Mg/Ca ratio on D_{Mg} still needs to be confirmed, but would have an enormous impact on paleo-reconstruction.