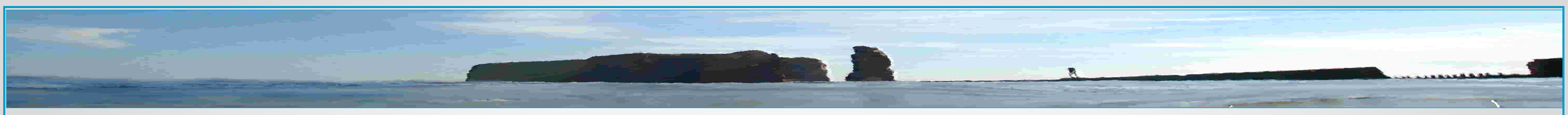

Ocean acidification: direct and indirect effects on the growth of *Cyanea capillata* and *Chrysaora hysoscella* polyps

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Introduction

Anthropogenically elevated atmospheric CO_2 levels are an increasing threat to our global oceans. Direct CO_2 induced decreases in pH, as well as indirect changes via trophic pathways both affect marine ecosystem functioning. High CO_2 levels increase the availability of carbon for primary producers relative to other nutrients, and consequently change the nutrient stoichiometry in the tissue of these producers. Obviously, most of the Ocean Acidification (OA) research has focused on pH effects on calcifying organisms, but recently also other organisms have come under investigation. One of the prominent exceptions is gelatinous zooplankton, where very few published reports exist on the impact of OA on life history parameters. Hence, we set out to investigate the direct and indirect effects of OA (through CO_2 induced changes in food quality) on the growth of polyps of two scyphozoans ecologically relevant in the North Sea.

Material & Methods

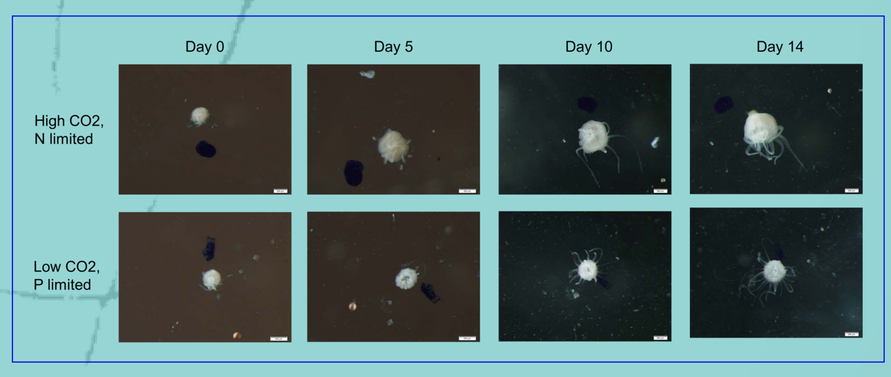
Adult *Cyanea capillata* and *Chrysaora hysoscella* were harvested from the field, induced to release larvae in the laboratory, and these were left to settle on plates and develop into polyps. Polyps were exposed to two different CO_2 environments (200 and 800 ppm) and two food qualities, which differed in their elemental composition (N limited, P limited), mimicking the indirect effects of high CO_2 availability. Subsequently, radial growth over an experimental period of 27 days was measured, as well as the carbon content of the polyps at the end of the experiment.

The experimental food chain. The Redfield ratio (106C:16N:1P) should provide a balanced diet for consumers.

Malzahn *et al.*, 2007

	R. salina		*A. tonsa*	
	N limited	P limited	N limited	P limited
molar C:N	10	8	7	9
molar C:P	180	580	186	280

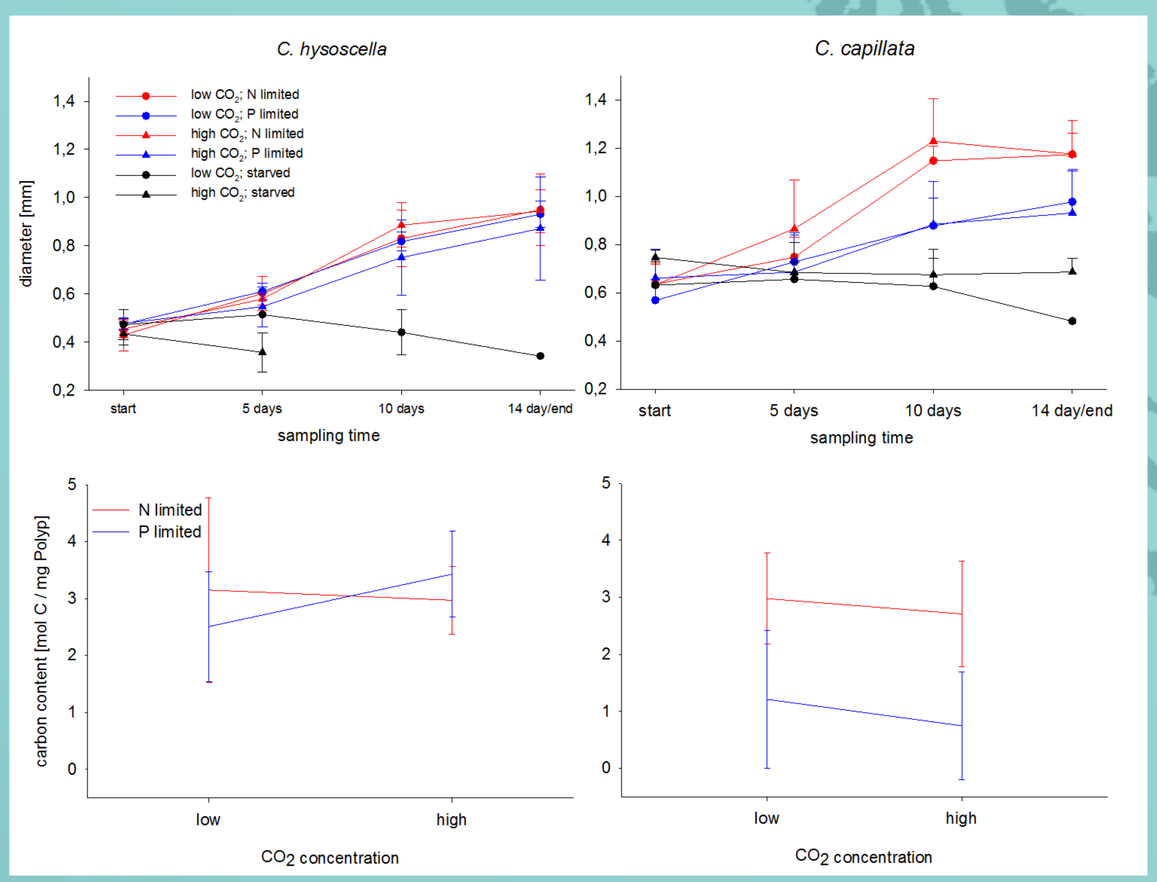
C.capillata polyps



Size of the polyps was established after inducing them to contract, and subsequently measuring them within 5 minutes.

Results

The CO_2 content of the water had no effect on the growth of the polyps, despite a difference in pH of 0.3 (8.23 and 7.96 as mean values for low and high CO_2 pressure, respectively), whereas we observed a clear impact of food quality, especially for *C. capillata*, with phosphorus limited (high CO_2) algae clearly representing a food of inferior quality. No significant effects were observed for *C.hysoscella*. Thus, at least for this life stage, indirect effects of OA are more important than direct pH effects.



Differential growth of the polyps under the different treatments, with above the diameter of the different species and below the carbon content.

Conclusions & Outlook

Other life stages, especially those building statoliths may be more vulnerable to pH effects, but the literature indicates that this is also might not be the case under realistic CO_2 scenarios. Future research will have to incorporate all life stages of gelatinous zooplankton to generate a comprehensive understanding of direct and indirect effects of OA, alone and in combination with other stressors such as increasing temperature or eutrophication.

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