Biogeosciences Discuss., 7, C2532–C2535, 2010
www.biogeosciences-discuss.net/7/C2532/2010/

Biogeosciences
Discussions

Interactive comment on "Calcifying invertebrates succeed in a naturally CO_2 enriched coastal habitat but are threatened by high levels of future acidification" *by* J. Thomsen et al.

Anonymous Referee #2

Received and published: 27 August 2010

General Comments: Thomsen and collaborators have undertaken and interesting and comprehensive study that investigates the temporally dynamic carbonate chemistry of Kiel Fjord. Additionally they study the effects of elevated pCO2 on the growth, calcification, and physiology of the mussel, Mytilus edulis, an ecologically dominant member of the benthic community and an economically important fishery species. Their willingness to address both the environmental chemistry of the Fjord and the biology of one of its dominant species demonstrates the growing need for interdisciplinary studies of ocean acidification and its effects on the biotic and abiotic environments. This research highlights important differences between the open ocean, where the carbonate chemical environment has been relatively constant and at equilibrium with the atmosphere

for millennia, and a much more variable coastal ecosystem, in this case the mesohaline Kiel Fjord, where seasonal upwelling is predictable, and the air and water are rarely in equilibrium. Indeed, the authors could, and perhaps should, stress further that coastal ecosystems are generally more complicated with respect to carbon flux than is the open ocean, even beyond upwelling and riverine inputs. Furthermore, biological and ecological impacts may be expected to be quite different in rate and outcome in the two settings due to acclimation and adaptation over ecological and evolutionary time scales. The investigators use field studies and laboratory analyses to characterize the dynamic carbonate speciation of Kiel Fjord and then use the information to inform their simulated elevated CO2 conditions to which M. edulis were 1) exposed in a 2 week lab experiment aimed at understanding how elevated pCO2 influences ion concentrations in extracellular acid – base chemistry of haemolymph and extrapallial fluids inside the animals; 2) exposed for 8 weeks to differential pCO2 in the lab to test for differences in calcification and growth rates; these rates were then compared to those of wild mussels found in the Fjord and shown to be similar, suggesting that M. edulis is able to grow and calcify normally, if not somewhat more slowly, in high pCO2 settings versus conditions that are at equilibrium with the atmosphere. This paper is innovative and addresses interesting questions in a scientifically and technically sophisticated way. The results are compelling and add to the growing body of literature which suggests that predicting the effects of elevated CO2 will be variable with species and setting. I recommend this article for publication in Biogeosciences, but provide some comments and suggested edits that may strengthen it further.

Specific Comments: P5122 lines 15-22: The term "upwelling" is used at two scales but should be more clearly delineated: 1) deep water upwelling on the N. American Pacific coast where acidic abyssal water upwells and influences carbonate chemistry at surface and 2) shallow upwelling on the scale of a meters to tens of meters depth that occurs in Kiel Fjord, where carbonate chemistry at the surface is influenced by hypoxia/anoxia/respiration from below. A slight revision would clarify the two separate phenomena - the first driven by long term geochemistry of deep ocean and the second driven by seasonal biological perturbation in shallow waters. A description of the bathymetry of the Kiel Fjord would be helpful to readers unfamiliar with this body of water.

P5125 lines 10-13: "Each replicate contained eight mussels of 5.5mm ("small") and 13mm ("medium") shell length. . ." indicates that the experimental design was a split-plot design rather than a fully randomized design. In the split-plot, "size" is a subplot factor rather than a whole plot factor; which affects the associated experimental error. The data for analyses in Table 4 (shell length growth, dry mass growth, shell mass growth) should be re-run according to the split-plot design of the experiment, using proper error terms. Further, the number formatting in Table 4 is inconsistent and actually very confusing (e.g., sometimes spaces are used as thousands dividers, other times periods, introducing confusion with decimal points). The table should be reformatted using a consistent convention.

P5128 section 2.6 is not clearly written and is confusing. It is not immediately obvious how many plates were used to sample settlement. Indicate the number of settling plates deployed per time period, the length of the soak period (4 wks), and the number separate deployments so that the reader can more easily see how many plates were in the water at a time and over how many months settlement was assessed.

P5129 line 11: How many mussels were there to start? What was the mortality rate?

P5131 Section 2.9 – Statistical Analyses: This section needs more detail relating specific analyses to particular experiments. When reporting means, standard errors of the mean are more appropriate than standard deviations.

P5132: "Given the particular carbonate system variability of the habitat it is surprising that blue mussel (Mytilus edulis) beds and associated calcifying benthic species (e.g. the barnacle Amphibalanus improvisus, the echinoderm Asterias rubens) are common features in Kiel Fjord and the Western Baltic." This is indeed surprising if one approaches from the invariant carbonate chemistry of the open ocean point of view

(i.e., environmental constancy is the norm). To those who work in coastal systems, variability is the rule (tidal, diel, seasonal). Although less well characterized, there are estuaries throughout the world in which the carbonate chemistry is quite variable and under-saturating conditions, with respect to aragonite and calcite, are common for much of the year, yet calcifying organisms can thrive. Indeed, many freshwater lakes and streams support calcifiers, despite extremely unfavorable carbonate chemistry. The variable backdrop of coastal ecosystems provides the ecological and evolutionary settings for the animals and plants that inhabit them. This notion hints at an evolutionary basis for why we might expect different biological responses in coastal versus non-coastal systems and may be worthy of a line or two in the Discussion.

Technical Comments: P5121 line16: "Keystone species" carries particular ecological meaning and although M. edulis is a dominant species, it is not evident that it is a true keystone species.

P5124 line 15: "Juny" should be "June".

Carefully revise all table and figure captions such that a reader can fully grasp the results without having to extensively refer to information in the text. Many of the captions in this article could be improved substantially with minor revisions.

Interactive comment on Biogeosciences Discuss., 7, 5119, 2010.