

Interactive comment on “Chronic exposure of the North Atlantic copepod *Calanus finmarchicus* (Gunnerus, 1770) to CO₂-acidified seawater; effects on survival, growth and development” by S. A. Pedersen et al.

Anonymous Referee #2

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Chronic exposure of the North Atlantic copepod *Calanus finmarchicus* (Gunnerus, 1770) to CO₂-acidified seawater; effects on survival and development S. A. Pedersen, B. H. Hansen, D. Altin, and A. J. Olsen

General comments:

This paper presents results from a laboratory study of CO₂ acidification effects on the copepod *Calanus finmarchicus* over almost one complete life cycle (excluding reproduction). The levels of CO₂ acidification used are very high compared to realistic end of century predictions but may be relevant to concentrations that could be experienced

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by animals overwintering at depth if exposed to leaks from sub-seabed carbon storage. Significant increased mortality and decreased development rates were seen at the higher experimental CO₂ concentrations, whilst results at the lowest experimental CO₂ concentration suggest that this copepod will not be affected by predicted end of century CO₂ concentrations in the ocean.

This manuscript contains useful and scientifically sound data. The study fits in with the scope of this journal, and is sufficiently novel and interesting to deserve publication. Although similar studies have been carried out on other species of copepod, the effects of CO₂ acidification are highly variable and require species specific experiments. As far as I am aware, this is the first study that has looked at CO₂ acidification effects on all stages of *Calanus finmarchicus*. I would have been concerned over the omission of a more realistic CO₂ concentration, had it not been for the absence of effects seen at the lowest CO₂ concentration used in this study.

Specific Comments:

Introduction: There are quite a lot of grey literature references in the introduction, one of which is a literature review (Turley 2004). Could any of them be replaced by relevant peer review publications?

Page 5276, line 19: It seems odd to choose Shek and Liu 2010 as a single reference to highlight the role that copepods play in marine food webs as it is only concerned with one aspect of their importance, i.e. faecal pellets. Could you add more references, e.g. concerned with their grazing, importance as fish food, or a more inclusive reference.

Page 5276, line 25: You state that Kurihara & Ishimatsu 2008 found negative effects of CO₂ on *Acartia tsuensis* but they found no significant effects. Their text states that egg hatching was significantly lower overall in the CO₂ incubations but this significant difference did not hold when the different generations were considered separately.

Page 5278, line 10: You state that Zhang et al 2011 found no effect on egg production

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rate of *Calanus sinicus* up to 10000ppm CO₂, however there were negative effects at 10000ppm. Did you meant no effects at less than 10000ppm?

Methods: Page 5279, line 1: I don't understand what is meant by 'mature water'.

Page 5279, line 8: How many females were incubated in order to collect eggs?

Page 5281, line 7: Was the 'stable density of algae' measured or checked for stability? Is this combination of algae the same as is fed to the culture animals?

Page 5282, line 16: Did you do any checks to see how stable the pH/ carbonate chemistry were, and if weekly checks were sufficient?

Results: Page 5284, line 3 (and Figure 4): It would be useful to know how many of each stage were measured.

Discussion: Page 5285, line25: You state that 2000ppm is the worst case scenario predicted for the year 2300 but don't add a reference (Caldeira & Wickett 2003?). Caldeira & Wickett 2005 use 8000ppm as a worst case scenario.

Page 5286, line 2: You give Pascal et al 2010 as a reference for adult copepods being more resistant to elevated CO₂ than eggs and nauplii, however that study only looked at nonovigerous females.

Page 5286, line 13: The Kurihara et al 2004 reference that is relevant here is not listed in the reference section (Kurihara, H. et al. Effects of raised CO₂ concentration on the egg production rate and early development of two marine copepods (*Acartia steueri* and *Acartia erythraea*). Marine Pollution Bulletin 49, 721-727, 2004.

Page 5286, line 29: You have only listed one species/reference for effects of CO₂ on fertilisation when there are several others in the literature. Listing a couple more would add weight to the argument.

Page 5287, line 1: You again state that Kurihara & Ishimatsu 2008 found negative effects of CO₂ on *Acartia tsuensis* survival but they found no significant effects.

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Page 5287, line 13: The reference should be Kurihara & Ishimatsu 2008, not Kurihara et al 2008.

Tables & Figures: Table 1: This table needs units.

Technical corrections: Species names have the taxonomic authorities but not the dates. Fat content of animals is referred to throughout the manuscript, but lipid content may be a better term. Page 5274, line 20: Suggest change 'raise' to 'a rise in'. Page 5275, line 1: Change 'middle' to 'mean' or average? Page 5275, line 5: Is 'A1FI' supposed to be there? Page 5275, line 7: Suggest change 'Even up to 8000ppm has been' to '8000ppm has even been'. Page 5276, line 1: Suggest change 'raised on' to 'regarding'. Page 5276, line 28: Change 'revealed negative' to 'revealed a negative'. Page 5277, line 1: Suggest change the word 'nuancing' to 'contradicting'. Page 5277, line 29: Suggest change 'at the same time as' to 'although'. Page 5279, line 22: Define ID on first use. Page 5280, line 6: Define AGA on first use. Page 5280, line 13: Define OD on first use Page 5280, lines 20 & 21: Change 'basis' to 'base'. Page 5281, line 1: Change 'feed' to 'fed'. Page 5283, line 17: Suggest remove the word 'single'. Page 5284, line 27: Suggest change 'of what' to 'that'. Page 5285, line 3: Suggest change 'is likely to' 'may' as it is only animals overwintering in CCS areas and only in case of a leak that may be affected. Page 5285, line 18: Suggest change 'of what' to 'that'. Page 5285, line 21: Change 'in light of this the' to 'in light of the'. Page 5285, line 29: Change 'retards' to 'regards'. Page 5286, line 8: Suggest change 'for the successful' to 'for successful'. Page 5287, line 26: Suggest change 'potentiated' to 'intensified'. Page 5288, line 17: Change 'Zooplanktons' to 'Zooplankters'. Page 5289, line 17: Suggest change 'reservations' to 'caution'. Table 1: S and T need to be defined. Fig 1: Change 'inlet' to 'inlet' and 'entiched' to 'enriched'. Fig. 4 Change 'lenght' to 'length'

Interactive comment on Biogeosciences Discuss., 10, 5273, 2013.

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