Biogeosciences

Discussions

Interactive comment on "Larval development and settling of *Macoma balthica* in a large-scale mesocosm experiment at different fCO$_2$ levels" *by* A. Jansson et al.

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Received and published: 15 March 2016

Response to comments by Referee #1

We thank the reviewer for the helpful and constructive comments, which helped to clarify a number of points in our manuscript. Our responses including the potential modifications to the manuscript are detailed below

REVIEWER COMMENT 1 by Referee #1 General issue: Based on the abstract, I expected to read results on changes in the community, not a single species. My general feeling form the manuscript was that the authors used importance of the larger project,

KOSMOS, was one of the main selling points of this article. The results are interesting enough in themselves, particularly the difference in response from the laboratory study to field/mesocosm study. The references to KOSMOS and other publications resulting from that project detracted from the results in this study. In particular, this study only reports the response of a single organism and not a community response. For example, in the abstract, "The response of organisms to future ocean acidification has primarily been studied in single-species experiments, whereas the knowledge of community-wide responses is still limited. To study responses of the Baltic Sea pelagic community to a range of future CO2- scenarios, six âʹLij 55 m3 pelagic mesocosms were deployed in the northern Baltic Sea in June 2012. In this specific study we focused on the tolerance, development and subsequent settlement process of the larvae of the benthic key-species Macoma balthica when exposed to different levels of future CO2." The authors state that the majority of studies report single-species experiments, that the mesocosms were used to study the community response, but that this study focuses on a single species. This can easily be addressed.

Author response: It is clear that the original abstract lead to some misunderstanding and the sentence that seems to have caused most of the confusion here ("The response of organisms to future ocean acidification has primarily been studied in single-species experiments, whereas the knowledge of community-wide responses is still limited") should indeed be MOVED to the discussion, highlighting needs for future studies.

The point that needs to be clarified is that most experiments have been single-species experiments in the LAB, with only that one particular species included in the experimental setup (often even with filtered seawater), while in this study the response of a single species was studied while the species was still in its natural community. To highlight this point, we would CHANGE the following two sentences: "To study responses of the Baltic Sea pelagic community to a range of future CO2-scenarios, six âĹij 55 m3 pelagic mesocosms were deployed in the northern Baltic Sea in June 2012. In this speciïňĄc study we focused on the tolerance, development and subsequent settlement

process of the larvae of the benthic key-species Macoma balthica when exposed to diïňãerent levels of future CO2." NEW VERSION: "We studied the responses of larvae of the benthic key-species Macoma balthica to a range of future CO2-scenarios using six âĹij 55 m3 mesocosms encompassing the entire pelagic community. The mesocosms were deployed in the northern Baltic Sea in June 2012. We focused on the survival, growth and subsequent settlement process of Macoma balthica when exposed to diïňãerent levels of future CO2". Also, "Tolerance and development" are changed to "survival and growth" to accommodate comments from the second reviewer.

REVIEWER COMMENT 2 by Referee #1 The decline in abundance in the control mesocosms is not accounted for. Do the authors have a suggestion as to why this occurred? Further, were samples taken from within the bay, outside of the mesocosms to control for the mesocosms themselves? These data become particularly relevant when the control mesocosms behave unexpectedly.

Author response: The decline in the control mesocosm M5 is considered to be within normal mortality patterns, and is discussed e.g. on page 20421 lines 11-13. What remained unexplained is the pattern in the control mesocosm M1 during days -3 to -1, where unaccounted for variation was found. We hypothesize this to be a sampling issue or an artifact caused by a mesocosm maintenance method (bubbling to destroy the halocline on day -3). This discussion will be added to the manuscript.

Samples taken from the bay have unfortunately not been analysed. However, we do not think these data would provide a reliable control setting as in the bay the larvae are part of a dynamic open system (predation, transport, production of new larvae occurring), whereas in the mesocosms the community is fixed at the start of the experiment.

REVIEWER COMMENT 3 by Referee #1 I found the use of M1-8 confusing, as it was not stated (outside of table 1), which mesocosm had which fCO2 value. I suggest referring to the mesocosms not by Mx but by CO2 level.

Author response: We will change the way of referring to the mesocosms as suggested

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by the reviewer.

REVIEWER COMMENT 4 by Referee #1 P20422 L 4-5: Is it possible from the samples collected to determine if shell thickness was reduced, resulting in an animal that is too light to settle? The delayed development/lengthened time to settlement is an interesting result and should be investigated in more detail, ideally in this publication. This would then rule in or out a lighter shell as the cause of the animal not being able to settle.

Author response: The shells (average size < 300 μm) are unfortunately too small and fragile to handle (remove, weigh) with the methods we have access to. We fully agree that this is a topic that should be investigated in more detail.

REVIEWER COMMENT 5 by Referee #1 It is really interesting that the M. balthica responded differently to elevated CO2 compared to the previous laboratory experiments. The authors should include a discussion as to why this may have occurred.

Author response: On page 20422 we wrote "In a previous experiment conducted with newly hatched larvae (ca. 150 μm) from the same bay (Jansson et al., 2013), both the growth and survival of the larvae were found to be negatively impacted by decreasing pH." In this mesocosm experiment survival was, however, not affected, while it was not possible to study growth in the same level of detail as in the laboratory experiment Nevertheless, we still maintain that increased fCO2 had severe negative effects on the larvae also in this experiment.

REVIEWER COMMENT 6 by Referee #1 From your data, the "performance" of M. balthica was not actually reduced with increasing CO2. Mortality was not increased, at least the number of settling individuals was the same, an increase in deformities was not reported or abnormal development other than the delay in settlement, the cause of which is also unknown. The final comments on p20424, are therefore not valid based on the current results. The negative comments should be toned down. The delay in settlement could very well have negative impacts, either on the individuals or on the community. If the authors believe this to be the case, then the potential impacts should

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be discussed in more detail during the discussion.

Author response: The negative conclusions will be toned down and we will expand the discussion on potential consequences for communities. However, we still maintain that increased fCO2 had a negative effect on the larvae.

REVIEWER COMMENT 7 by Referee #1 Technical comments: 1. P20412 L5: ": : :the system is already at present". Remove "at present" from the sentence. 2. P20412 L13-15. We found that the settling of M. balthica was delayed along the increasing CO2 gradient of the mesocosms. Also, when exposed to increasing CO2 levels larvae settled at a larger size, indicating a developmental delay. These two sentences are unclear. At first reading, they express the same result. These could be combined eg: The size and time to settlement of M. balthica increased along the CO2, suggesting a developmental delay. 3. P20412 l 25: "before" is not needed in this sentence as it is implied by "geological past". 4. P20413l3: Similar to above "already" and "at present" suggest the same thing. Pick one. 5. 20413 l 15: "of post-larvae are" 6. 20416 l 18: Please write CTD in full, at least for the first use. 7. 20419 L4: Word reversal "total alkalinity measured on: : :" 8. 20421 L7 "an indication that M. balthica: : :" This result was observed; therefore the word indication should be removed. 9. P20422 L2: Replace "is" with "does" 10. P20423 L26: "Already at present: : :". As previously in the introduction, only one of these is necessary.

Author response: These details were corrected according to the suggestions of the reviewer.

Interactive comment on Biogeosciences Discuss., 12, 20411, 2015.