

Biogeosciences Discussions

RC: Referee comment

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Micro- and mesozooplankton community response to increasing CO₂ levels in the Baltic Sea: insights from a large-scale mesocosm experiment

General comments

The ms. is interesting since it is one of the few studies where CO₂ effects on whole plankton communities have been studied in ca. 55 m³ mesocosms. This provides a more realistic setting than single species experiments in smaller experimental units and allows for community effects to be realized.

At the same time, the large mesocosm approach used provides some interpretation problems. With no replicate mesocosms in each of the manipulations, statistical analysis is difficult. The fact that the temporal variability of most species during the experiment greatly exceeds the minor differences between the CO₂ manipulations makes difficult to detect any patterns caused by CO₂. This problem has been partly but not wholly circumvented by using GAMM and GLM models. Also, as with many community studies, it is very difficult to distinguish between direct and indirect (food web) effects, and many of the conclusions remain speculations.

The strongest evidence is found for (statistically significant) effects of temperature on microzooplankton abundance, and CO₂ effects on certain microzooplankton taxa. Indirect effects on cladocerans, instead, remain on a weak ground. Also, the suggested changes in the food web efficiency (enhanced carbon transfer to higher trophic levels) due to increase of cladocerans are not fully warranted and are not supported by data (see detailed comments).

Detailed comments

Abstract

The abstract is clear, but some of the conclusions are speculative and probably do not merit mentioning in the abstract (see below).

1. Introduction

The Introduction is generally well laid out and informative. It gives a proper justification for the study.

Where is "Storfjorden" and "Tvarminne"? (page 20029 / line 2, line 6)

2. Methods

The field, laboratory and statistical methods are generally valid. Lack of replicates however creates difficulties in statistical analysis of data.

3. Results

The results are presented in a clear manner, but are a bit too exhaustive. The most interesting phenomena are swamped under a load of detailed descriptions of population variations, many of which are impossible to explain.

To clarify the temporal patterns, and relate them to the minor differences between CO₂ manipulations, it would be useful to show the CO₂ development in each of the mesocosms.

3.1.4: It would also like to see the temporal development in the Shannon index H.

3.1.5: Please add a short written summary of the most important findings of the statistical tests. At least those that you will also deal with in Discussion and mention in the Abstract.

4. Discussion

4.1.1: Page 20044, lines 16-20. (“While... respectively”) - An unclear sentence.

4.1.1: Page 20045, lines 2-3. Mentioning that “significant relations were determined for all factors” is not very helpful. rather pinpoint the most significant and meaningful findings.

4.1.2: May Myrionecta... This chapter is very speculative. I would condense this to minimum – or reject it totally.

4.2: mesozooplankton. There is not much relevant discussion on the cause-effect relationships in this chapter. If no significant relations were found, I would not expand the discussion by adding a chapter on each of the Results chapters. E.g., you can easily delete chapter 4.2.2 Mollusks.

4.2.3: The long speculation on the “Cladocera-OA effect” is also far too stretched. The data do not show any effect of chl a on cladoceran abundance. Finding evidence in some imaginary phenomena (“missed peaks between samplings”) is not a good strategy either. (Page 20052, lines 6-9).

4.2.3: The finding of correlation between empty-filled brood chamber ratio and CO₂ and chl a is interesting, but, again, too many variables covary. All in all, if all phenomena on cladocerans are mediated through food, it is very speculative to say that CO₂ will have any effect. There are simply too many open issues between the relationship between CO₂ increase and *Bosmina* food conditions in the Baltic Sea.

5. Conclusions

The authors suggest that an increasing amount of filter feeding cladocerans (*Bosmina*) enhances carbon transfer to higher trophic levels due to enhanced usage of organisms of the microbial loop. Yes, filter feeders, like *Daphnia*, use bacteria and nanoflagellates for food, but *Bosmina* are not non-selective filter feeders, and many copepods also feed on flagellates. This complicates the picture. Also, Wikner & Andersson (2012, *Global Change Biology* 18: 2509-2519) claim that channeling more energy through microbial loop *decreases* the food web efficiency, and, hence, transfer of energy towards the higher trophic levels, including fish. If the authors want to retain this part, they should at least back up their conclusions with references, and include a description of the food web, clarifying who is eating whom, and how carbon will be channeled in each case. Actually, it is not obvious that *Bosmina* are much eaten by fish. Instead, it is possible that small cladocerans are suitable food for mysids and predatory cladocerans, like *Cercopagis pengoi*. Studies exist for the Baltic Sea for such interactions. How does this affect the conclusions on the trophic efficiency?

However, despite some shortcomings, there are valuable parts in this ms. If nothing else, the study shows that some CO₂ effects can be seen at community level, but that the effects are complex and difficult to study in any type of experiment. This is useful information as such.