

## **Summary**

This paper aims at investigating the influence of trophic interactions between zooplankton and phytoplankton taxa on their spatial distribution in lakes at the landscape level. The authors hypothesized that regarding biogeographical distribution of plankton taxa and plankton functional traits, the major and determining trophic interaction would be between primary producers (phytoplankton) and consumers (zooplankton), which seems reasonable and coherent. However, in overall, the results point out that the initially supposed most important trophic interaction between zooplankton and phytoplankton does not significantly explain the observed distribution of taxa and traits, or at least not after accounting for the effects of environmental drivers. Instead, they conclude that it seems more likely that the directly upper (predators on zooplankton) and directly lower (resources on phytoplankton) interactions are the essential drivers of the biogeographical distribution of the studied taxa. Nevertheless, this result represents an interesting input to better understand trophic interactions within lake food webs, and is likely to contribute to better apprehend the cascading influence of global changes (e.g. species invasions or water warming) on these ecosystems.

## **General appraisal**

First, I must acknowledge that I have only limited knowledge about zoo/phytoplankton ecology, so I won't be of much help/expertise on this specific aspect of the paper. I have however tried to focus on aspects I am more comfortable with such as community ecology and functional biogeography.

Overall, I enjoyed reading this paper. Despite a perhaps too quick focus on the present subject of the study (see comment #4), the introduction is very well constructed, the issue raised pedagogically and the hypotheses clearly set. The reader should thus well understand the interests and challenges of the study in the broader context of species trophic interactions in lake ecosystems. The authors analyzed a large dataset of lake plankton communities (>100 lakes) at a pretty large spatial scale (Québec, CA). A set of analysis methods have been used to test the formulated hypotheses, which to me represents one possibility of analytical approach among others, but the authors have made choices, and I found that these choices make sense. The results presented here are rather descriptive but remain both concise and comprehensive. The discussion is interesting and, to me, well covered the main aspects of the study. Overall, the manuscript is very well written and of good quality. This study indeed provides interesting new inputs to our knowledge of trophic interactions between plankton taxa in boreal lakes, and more broadly of interactions in lake food webs.

Given those elements, I would recommend this manuscript for further consideration by PCI Ecology recommenders. I have provided more detailed comments below. The main comments that specifically requires clarifications or attention are comments #2, #4 and #11.

## **Detailed comments**

### *Overall*

#1: Please add line numbering to make the reviewing easier.

### *Abstract*

#2: p.2 second sentence - I doubt that this is globally true (e.g. some of the references listed in comment #3), but it is perhaps true for plankton in lakes. I may be wrong, but in this case it would mean that the sentence is not accurate enough since I am almost sure that a pretty large number of studies have investigated the influence of trophic interactions on the spatial distribution or co-existence of species, and probably also on their ecological traits. Please modify this sentence to either specify in which context (environment, taxa, ...) the influence of such interactions have never been tested or detail more

what aspect of such interactions you focused on has never been tested. For instance as it is stated in the last sentence of the 1<sup>st</sup> paragraph of the introduction.

#3: p.2 sentence “The lack of support for the role of trophic interactions as a driver coupling the distribution of plankton communities across boreal lakes indicates that taxon-specific and functional trait driven ecological interactions do not modulate large-scale spatial patterns of phytoplankton and zooplankton in a coordinated way.” - Careful here, it is not because you did not find any significant coupling residuals that could be attributed to trophic interactions that it does not exist. You can only say, and have to stick to it, that the data considered and the analyses performed, which both seem quite robust, did not bring evidence of such phenomenon. Consequently, I would suggest to at least qualify/nuance this statement, for instance as follows: “[...] across boreal lakes suggests that taxon-specific and functional trait driven ecological interactions may not modulate large-scale spatial patterns [...]”

### *Introduction*

#4: The introduction seems to me too precise too quickly (i.e. lakes are the topic of the first sentence of the introduction). It may be fine for a journal specialized in limnology, but it might not be appropriate for a generalist journal in ecology. Thus, a slight widening (through a new first paragraph) of the context of trophic interaction between different levels of food webs in other ecosystems than lakes would make the article more suitable for a wider panel of scientists, which does not seem very challenging given the large number of studies dealing with this topic in terrestrial, marine and freshwater environments (here some possible references I found after a quick bibliographic research, which are probably not all relevant and would deserve a more serious inventory: Holt 1996; Srivastava 2006; Gotelli et al. 2010; Gravel et al. 2011).

#5: p.6 last paragraph, first sentence - Perhaps ‘the relative importance of trophic interactions between planktonic organisms compared to the effects of environment and dispersal’ is more correct?

#6: p.6 last paragraph, last sentence - “Our study covers a large biogeographical scale (1 228 km)” Should not it be in km<sup>2</sup> for an area measurement? Please correct or specify what this figure corresponds to.

### *Material and Methods*

#7: You did not specify why only a subset of the 104 lakes was sampled for phytoplankton. Are the reasons for this only practical (cost, opportunity, data initially sampled to address another research question, ...), or are there other reasons? Behind my curiosity, I would like to make sure that there are no confounding reasons (e.g. absence or scarcity of phytoplankton, lake situation, unsuitable environmental features, ...) which have prevented the sampling of phytoplankton in these lakes. This would possibly have a strong effect on the results and on their interpretation.

#8: p.7 middle of the second paragraph - “We used a multiparameter sonde (YSI, Yellow Springs Instruments, OH, USA) to measure pH (at 0.5m) and temperature (at 0.5m, then averaged over the water column). Water samples were collected at 0.5m to measure [...]” Specify at 0.5m depth, because it can also be the distance to the shoreline.

#9: p.8 lines 4-5 - I find it odd to ‘interpolate’ (inputted using a random forest procedure) the missing values of some environmental variables, given the low number of lakes concerned (5 lakes max, 2 lakes min depending on co-missing values for the same lake). Usually, elements (here lakes) without available data are discarded for the part of the analysis in which these data are used. I fully concede that this probably has a negligible impact on the results, but yet it seems more likely to lead to additional biases rather than additional ecological sense. Please explain why you chose to proceed this way.

#10: p.8 and Figure 1 caption - Please move the sentence “Catchment slope was estimated using a Digital Elevation Model (Canadian Digital Elevation Data)” from the caption of Figure 1 to the Materials and Methods section. ‘was estimated’ was also written twice. Please also specify how you calculated the lake maximum depth (Zmax) or from where you retrieved this variable (+ reference).

#11: An information is missing about the repartition and representativeness of the 48 lakes for which both zooplankton and phytoplankton samples were done. Especially regarding the 3 subsets of lakes (regions). I strongly encourage to make appear in the text or with an additional table the number of lakes sampled for zooplankton and/or for phytoplankton. A table like the one below would do the job and would let the reader assess whether the subsampling of phytoplankton was representative of the whole studied set of 104 lakes. This would also lead to fewer questions about the comparison between the patterns observed for zooplankton on the 104 lakes and for phytoplankton on the subset of 48 lakes.

Region/subset	N lakes zooplankton	N lakes phytoplankton
<i>Abitibi</i>		
<i>Chicoutimi</i>		
<i>Schefferville</i>		
Total	104	48

#12 p.10 end of the first paragraph - “space (using latitude and longitude coordinates).” Would “space (using ***between lake distance based on*** latitude and longitude coordinates).” be more accurate? Since you wrote in the first part of the Materials and Methods section that you used the “Euclidean distance between lakes to characterize the effect of dispersal limitation”. Please change it accordingly or provide additional details.

### Results

#13 p.13 6<sup>th</sup> line of the ‘Factors related to community composition’ section - “[...] spatial factors indicating that the water quality variables driving the distribution [...]” variables plural.

### Discussion

#14 p.16 9<sup>th</sup> line of the ‘Divergent responses of phytoplankton and zooplankton to their environment’ section - “However, **water some** quality effects were also [...]” please correct the word order.

#15 p.19 last 4 lines- I think this part would benefit from adding supporting references regarding the statements made (e.g. main pathway for matter and energy transfer in aquatic environments)

### Figures

#16: Figure 1 caption - Please remove the sentence “Zooplankton samples were collected in all lakes (n=108), while phytoplankton samples were collected in a subset of lakes (n=48).” that has no relevance to understand the figure, and this information is already given in the text. See also comment #10 for the sentence regarding Catchment slope.

#17: Table 2 - a horizontal line seems missing between the two variables ‘Biovolume’ and ‘Colonial’

#18: Table 3 caption - add “ns = non-significant”.

#19: Figure 6 - Please revise this figure and its caption, especially regarding 1) the absence of arrow on the figures for environmental variables while this is written in the caption, 2) the crosses and the corresponding names of taxa or traits are often poorly positioned, and 3) the color of the name of the variable: “The RDA was constrained by variables related to water quality (***in blue***) and by variables related to lake morphometry (***in yellow***).”

References cited:

- Gotelli, N. J., Graves, G. R., & Rahbek, C. (2010). Macroecological signals of species interactions in the Danish avifauna. *Proceedings of the National Academy of Sciences*, **107**, 5030-5035.
- Gravel, D., Massol, F., Canard, E., Mouillot, D., & Mouquet, N. (2011). Trophic theory of island biogeography. *Ecology letters*, **14**, 1010-1016.
- Holt, R. D. (1996). Food webs in space: an island biogeographic perspective. In *Food webs* (pp. 313-323). Springer, Boston, MA.
- Srivastava, D. S. (2006). Habitat structure, trophic structure and ecosystem function: interactive effects in a bromeliad–insect community. *Oecologia*, **149**, 493-504.