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Biogeosciences Discussions

Interactive comment on "Temperature dependence of Arctic zooplankton metabolism and excretion stoichiometry" *by* M. Alcaraz et al.

Anonymous Referee #2

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General comments

The paper addresses a very interesting and current issue in plankton ecology; that is how zooplankton metabolism may react to climate warming and influence community structure and food-webs through its products. To tackle this question Alcaraz et al. investigate zooplankton respiration rate, N and P excretion and their stochiometric ratios in relation to latitudinal changes in temperature in the Arctic environment. They found that temperature increase affects zooplankton metabolism of P and N more than respiration and predict that in a scenario of global temperature increase these stoichiometric differences will contribute to modify the pool of nutrients available to phytoplankton and possibly result in quantitative and qualitative shift within arctic food webs. Overall, the scientific question presented by this paper is timely and important. Nevertheless, I

have several concerns regarding the method adopted and consequently the conclusions arrived at by the study.

Specific comments

One of the major concerns I have with this study is that temperature is not the only variables affecting the metabolism and stoichiometry of zooplankton, particularly under in situ conditions. Hence, the relationships reported by this paper between respiration, N, P vs temperature may be distorted by the influence of other ambient factors which could not be controlled during the experiment. For instance, both respiration and the excretion products of metabolism are deeply affected by food quantity, quality and the body substrate metabolised by the organism. The microplankton composition and quantity is very likely to vary between sampling stations particularly along a latitudinal gradient such as that sampled in the present paper. This problem is further complicated by the "black-box" approach adopted by the authors who measured the zooplankton community overall, rather than looking at individual taxa. The zooplankton community will, in fact, also vary along the latitudinal gradient investigated by this study. Since zooplankton species are characterised by very different physiology, body composition, behaviour and ecology, they will also respire and excrete at different rates and release different metabolic products depending on their physiological state and substrate metabolised. The substrate metabolised will also vary whether zooplankton are well fed or staved and whether they are carnivorous, herbivorous and omnivorous. For instance, large arctic herbivorous calanoid copepods are active swimmers and can store substantial amount of lipids (and use these as substrate) and therefore, their respiration rate, excretion of P and N will be very different compared to carnivorous zooplankton such as Chaetognaths and jelly-fish, which overall consume less energy for swimming and do not store large amount of lipid reserves. Therefore another main concern is that, in this study, the authors derived body carbon from a published equation rather than measuring it directly. Moreover, the authors provide no information on how community composition varied along the latitudinal gradients they have sampled and whether this might have affected their results. Another, point to keep in mind is that both carnivores and omnivores will be present in the same experimental container and this will have important implications for the results as it may results in changes in community composition, the amount of biomass respiring and excreting over the time of the incubation. Therefore, it is not surprising that the metabolic data shown in presented in figure 2 and Figure 3 are characterised by very high variability even when standardised by body mass, as the data points in each plot are not really comparable to each other. High variability in the response (y-axis) and narrow temperature range (x-axis) contribute to uncertainty in the estimation of regression coefficients. Reported values for the temperature coefficient Q10 in the literature generally vary between 2 and 3, which are considerably lower than those reported by the present paper (i.e. Q10 = 6.5-15.7). However, one cannot help notice that the very high Q10 values reported in Table 2 are usually associated with a poor regression fit (i.e. the low R2 values). Figures 2 and 3 show that, despite the relatively high number of data points (N= 40-44) the majority of the observations are concentrated in the middle and few at the extreme of the temperature range with numerous replicate made at the same temperature. This lack of homogeneity in the scatter of data along the x-axis, which is a serious violation of the assumptions of regression analysis, can easily bias the slope (in this case the Q10) of the regression line. To conclude, I think the authors have proposed a very interesting scientific question. Nevertheless, their conclusions on the effect of temperature change on zooplankton metabolism and excretion stoichiometry may be biased by the methodological approach they have used. A solution to this may be a more controlled experimental approach which also takes into account the physiological plasticity and adaptation of zooplankton taxa under different environmental conditions.

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