Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-440-RC1, 2019

Biogeosciences Discussions
Open Access
EGU

Interactive comment on "A meta-analysis on environmental drivers of marine phytoplankton C : N : P" *by* Tatsuro Tanioka and Katsumi Matsumoto

Anonymous Referee #1

Received and published: 6 December 2019

The manuscript by Tanioka & Matsumoto is a well written and informative examination of the driving environmental factors of marine phytoplankton major element stoichiometry. The meta-analysis and use of the 's-factor' provides interesting new insights into the variability of different elemental ratios in the context of changing resource availability.

Thought the article is well written and likely the subject of considerable interest, there are a number of serious issues that need to be addressed before it can be recommended for publication. These include: problems with the taxonomic affiliation of some 'diatoms' in the data analysis; a lack of discussion of the limitations, confounding fac-

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tors and more basic details of the database; and the use of functional groups, which directly influences the conclusions.

Looking through the figures it was clear that a number of non-diatoms were included in the meta-analysis for the diatom group. These include: the dinoflagellate Alexandrium minutum (diatom N:C and N:P, Fig. 2), the green algae Chlorella sp (diatom N:C and irradiance, Fig. 3), and the prymnesiophyte Phaeocystis antarctica (diatom P:C and temperature, Fig. 4). These taxa will need to be removed from the diatom grouping, leading to the need to re-run some of the statistical analysis.

On discovering these mis-classifications, this reviewer began looking further into the taxonomy and ecology of the other species included in the functional groupings. This highlighted that in contrast to the diatom grouping, the eukaryotes included members of a huge range of taxonomic groups, with diverse ecologies (e.g. motility, biomineralisation), distributions (marine, estuarine) and likely physiologies. The cyanobacteria are another example of this issue, where single-celled oceanic and coastal species are simply grouped together with colonial species which are prominent nitrogen-fixing taxa. Simple traits within all the functional groups assessed, such as cell size or motility, cover a large range, despite their implications on nutrient uptake, cell metabolism and light harvesting (and hence likely elemental content). Using these groupings, with the assumption that such diverse taxa should confirm to a joint response to environmental variability, and then concluding that diatoms showed a more consistent response than the other functional groupings, is highly questionable. A more refined approach to the non-diatoms is needed, either in terms of sub-groupings to an appropriate taxonomic or functional level, or rephrasing the conclusions so that the lack of taxonomic diversity in the diatoms is recognized as allowing this group to show a consistent response.

Any data analysis is only as good as the quality of data it includes. Within the manuscript there is no examination, exploration or discussion of potential issues with the input data. Some analysis of the nutrient ranges (how replete or deplete where the experimental conditions?), irradiance gradients (where low light cultures light-limited?

where high light cultures photo-inhibited?), or basic details of the growth conditions (temperature, salinity, light-dark cycle, light level) needs including. Were all cultures acclimated to experimental conditions for (e.g.) 10 generations? Did studies use natural seawater or artificial seawater? Where cultures grown under optimum temperature or salinity conditions? Are any of the species included in the eukaryote grouping euryhaline and were they grown under low (or high) salinity conditions? Such key details would have needed to be included and justified in the original studies, so why not in a meta-analysis of all the data? Could some of the strong responses that were distinct from other species be due to the growth conditions or other confounding factors (e.g. sub-optimal salinity, temperature, light-limitation)?

Ln 6: 'The elemental stoichiometry of marine phytoplankton plays a critical role in the global carbon cycle through carbon export'. Surely elemental stoichiometry plays other critical roles in ocean biogeochemistry, such as differential nutrient cycling and subsequent nutrient limitation, or dictating the quantity and quality of organic matter formed through primary and secondary production?

Ln 31-32: What about supply of nitrate from nitrification? What about the loss terms? The balance of N:P will depend on the supply and loss terms over geological time scales.

Ln 157: Meta-analysis within 3 plankton functional types (diatoms, eukaryotes excluding diatoms, cyanobacteria) as a categorical moderator – not three functional types (i.e. eukaryotes not functional type and contain diverse taxa with distinct ecology and physiology). Also cyanobacteria grouping contains both nitrogen-fixing taxa and non-nitrogen fixing taxa, with highly differential impacts on the N:C and P:C ratios and the impact of N, P and Fe availability on their stoichiometry.

Ln 186: 'NO3 is one of the primary drivers of N:C'. What about the availability of other N sources?

Ln 186-187: So the s-factor for NO3 and N:C is 0.22 $\pm$ 0.04 for diatoms and 0.17 $\pm$

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0.04 for eukaryotes, are these statistically different enough to support the statement that 'diatoms are the most sensitive PFT'?

Ln 243-244: How often does nutrient toxicity impact natural communities of phytoplankton? The phrasing of this statement should be modified to reflect just how high nutrient concentrations need to be to induce nutrient toxicity – i.e. nutrient concentrations are in excess of requirements during early spring prior to the spring bloom when phytoplankton biomass is low.

Ln 250-253: What about fundamental taxonomic differences?

Ln 357-358: Is it the length of the light period per se or the total daily light dose that is important in terms of the effects of different light regimes? Does the data base not contain this information (i.e. light-dark cycle and irradiance level)?

Ln 362-364: Surely N availability has a stronger influence on N:C in light-replete low latitudes (i.e. the subtropical gyres)?

Ln 377-378: Is 'temperature arguably the most important environmental factor affecting growth and survival' of phytoplankton?

Ln 419-422: The authors state that differences in the overall conclusions in their meta-analysis with previous ones (e.g. Yvon-Durocher et al., 2015) is due to the two analyses assessing different sets of studies (over different time-scales). If this is true as the only reason for the divergence of conclusions, can we expect a different conclusion from a future study done in another (e.g.) 20 years?

Ln 432-434: The use of 'that' early in the sentence skews the meaning and interpretation of the statement: 'This suggests <that> an increase in the carbon assimilation via photosynthesis and/or a reduction in the formation of nitrogen rich compounds such as porphyrin and phycobiliproteins that are essential for light harvesting..'.

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