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## ***Interactive comment on “Calcification in the planktonic foraminifera *Globigerina bulloides* linked to phosphate concentrations in surface waters of the North Atlantic Ocean” by D. Aldridge et al.***

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The manuscript addresses calcification in the planktonic foraminifer *G. bulloides*. This is a very timely topic with regard to factors driving calcification, which is of interest not only for the “ocean acidification community” in general but also for “paleo-scientists” working around the pitfalls of the “size normalized weight” (SNW) methodology. It is well written but the conclusion is not very satisfying. . . .as the authors state themselves, their results: “. . . .do not necessarily imply causality“. I think they could have done a better job by digging a bit deeper. The first thing that comes to my mind is a possible

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relationship to temperature (and salinity or density but also chlorophyll as *G. bulloides* feeds mainly on algae). Temperature has been suggested before as a control on SNW and Andy Moy (PhD thesis) has found a remarkable relationship between SNW and  $\delta^{18}\text{O}$  in *G. bulloides* from the Tasman Rise. This should be explored. In addition, it should be noted in the case of *G. bulloides*, weight increase may be more than simple shell thickening (e.g. glacial specimens showed more “crusting” than Holocene ones) and there are several genotypes or sister species that may have different SNW under similar conditions. I further suggest that the authors have a look at “Bijma et al. (2002). Impact of the ocean carbonate chemistry on living foraminiferal shell weight: Comment on “Carbonate ion concentration in glacial-age deep waters of the Caribbean Sea“ by W. S. Broecker and E. Clark, *Geochemistry geophysics geosystems*, 3(11), 1064, 7 pp”. Last but not least, the authors should discuss the fact that, in view of the potential variability in SNW, a  $34\mu\text{M}/\text{kg}$  range in  $[\text{CO}_3^{2-}]$  is very narrow in comparison to the magnitude range in  $[\text{PO}_4^{3-}]$ .

Below are some specific comments: P. 6448; Line 21-22: “While  $\text{CaCO}_3$  transferred to the seafloor represents a long-term sink of carbon dioxide ( $\text{CO}_2$ ). . . . .”. This is not correct: What the authors mean is the  $\text{CaCO}_3$  that is permanently buried and becomes part of the fossil archive. . . .not the flux (those “transferred to the seafloor”).

P. 6449; Line 16-17: Here and in several other places throughout the manuscript, the authors talk about “calcification rate”. . . This is not correct: calcification rate infers a time scale. Planktonic foraminifera build their chambers intermittently. We do not know if each of these calcification events take longer or shorter. Maybe the use of “calcification potential” or “intensity” is better suited.

P. 6450-6451; 2.1 Sample collection: The authors should make clear that there is a potential bias in using plankton nets compared to e.g. sediment traps or surface sediments: The last chamber upon collection is not necessarily completely calcified, i.e. it may not reflect the final weight at its respective ontogenetic stage (12-chambered; 13-chambered, etc.) and thus bias SNW.

P. 6452; 2.3 Calculation of *G. bulloides* abundance: 30% of the flowmeter readings were obviously wrong; what makes you sure the other readings are correct?

P. 6453; Line 24-25: “Specimens less than 25  $\mu\text{m}$  outside the desired size range were included in the final analysis in order to maintain as large a sample size as possible”; Depending on the size range (especially in the 150-200 $\mu\text{m}$  range), a  $\pm 25\mu\text{m}$  slop may include or exclude an additional chamber, i.e. the final population may include different ontogentic stages (e.g 10-chambered and 11-chambered).

P. 6454; 2.5 [CO32- ] measurements: add more information: Choice of constants; choice of pH scale; temperature corrected, etc.

P. 6456; Line 23-24:”The suggestion that SNWs decrease with increasing nutrient concentrations raises the question of how nutrient concentrations impact *G. bulloides* abundance.”: Bijma et al., 1999 write: . “Contrary to most spinose species, an important part of its diet consists of algae as evidenced by the olive green to brownish coloration of the cytoplasm of freshly collected specimens.” Hence, their food (energy) may be related to nutrient concentration and it is not a coincidence either that this species is associated with upwelling events. Also, consult the papers by Fraile et al., 2008 (BG) and 2009 (Marine Micropal.) for information on factors controlling the abundance of *G. bulloides*.

P. 6457; Line 9 and 12: “calcification rate” again. . .see above.

P. 6458; Line 14-15: “*G. bulloides* is a non-symbiont bearing species. Foraminifera species which harbor algal symbionts may be better able to withstand changes in [CO32-]. . . .” . . . .Should this be “. . . .decrease [CO32-]. . . .”

P. 6461; Line 2-5:” While this is by no means proof that phosphate is a major factor influencing calcification rates in planktonic foraminifera in the ocean, it would possibly explain the occurrence of heavier tests during non-upwelling periods (de Moel et al., 2009)”. I don’t understand. . . . during non-upwelling periods [CO32-] is also higher!

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P. 6467; Table 1: add Russel et al., 2004. "Effects of seawater carbonate ion concentration and temperature on shell U, Mg, and Sr in cultured planktonic foraminifera." *Geochimica et Cosmochimica Acta*, Vol. 68, No. 21, pp. 4347–4361. to this table (wall thickness data.)

P. 6470; Fig. 3: if the upper left point in panel is omitted both size fractions increase with increasing [CO<sub>3</sub><sup>2-</sup>]. I'm not suggesting to leave this data point out but considering the small range in [CO<sub>3</sub><sup>2-</sup>], it is something to note.

P. 6470; Fig. 4 shows a good correlation between sfc. phosphate and nitrate, yet the authors suggest phosphate as a controlling factor. This makes me curious about a correlation with primary productivity (chlorophyll).

Overall, I suggest that the authors put a little bit more work into the manuscript before publishing it in BG.

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