

General comments:

This culture study thoughtfully explores some important questions behind the widely-used Mg/Ca temperature proxy and proposes transmembrane transport as a primary mechanism controlling foraminiferal calcite Mg/Ca. It concludes that seawater vacuolization is less important than previous studies suggested, and modifies and updates an existing Mg incorporation model, providing appropriate mathematical derivations to support this. The study is well-designed and carefully executed, and its conclusions represent a valuable contribution to our understanding of how the Mg/Ca temperature proxy works.

I am concerned that the conclusion that an optimal Mg/Cas_w and not [Ca] drives faster growth rates is reached too quickly and with not enough justification (p. 17471-2). While this may be the correct conclusion, it needs to be clearly shown and explained why increasing [Ca] (up to a point) does not drive higher growth rates (until a certain, too-high level of [Ca] is reached). This could be shown with the addition of a figure showing [Ca] vs. size, SNW or growth rate and better justification in the discussion.

The style of writing in the later part of the discussion section is unclear at several points, mentioning previously discussed concepts or cited sources and referring to phenomena, mechanisms and models without explaining clearly what idea is being referred to. See specific comments below for pages 17473-17475.

All figure captions should explain the figure content and the authors' interpretation more (the captions should summarize what the key message of each figure is), and the message(s) derived from the figures should be stated more explicitly in the text when the figures are cited (e.g. 17472, L 29, where the figure interpretation is not well-stated).

Specific comments:

17465, line 10-12: This sentence has problems. Impacts is the wrong word: variables covary in the natural environment, but impacts do not covary. The second phrase is grammatically incorrect: instead, it could be "as well as allowing *seawater conditions more extreme than natural conditions*."

17466, line 9-10: Sampling living foraminifera from a zoo aquarium instead of the natural environment seems not ideal, as the forams here are already not living in natural conditions and naturally varying seawater. Can you provide some justification for this choice?

17467, line 10-11: This sentence should make more clear that the forams used in this experiment were not the zoo-derived forams, but rather their culture-grown offspring (assuming that is the case). It is explained later, but should be made clear earlier.

17470, line 16-21: These described results are quite difficult to see on Fig. 1A (see technical comments below for suggested improvements to Fig. 1A).

17470, line 23: Mistake – the largest test size is in fact at SW [Ca]= 17.9 (not 7) and SW Mg/Ca 2.9, which can be seen when comparing Table 1 and Fig. 1b. However, it's very hard to figure this out, as neither the table or the figure shows both seawater [Ca] and final test size. I suggest including average final shell weights, SNW and growth rate for each treatment in Table 1.

17471, line 20: Please state briefly the findings of Mewes et al. 2014 so the reader can understand how this study agrees with it.

17471, line 20-21: The statement “suggesting that the calcium concentration itself may not be the primary driver of growth rate” strongly needs further explanation - why can you exclude [Ca] as a driver of growth rate? These data so far could also be interpreted to mean that increasing [Ca] causes faster growth until a certain toxic level of [Ca] between 18 and 34. If this is not the case, the discussion section needs to more explicitly address why this can be ruled out.

17471, line 23: The choice to use a “linear regression curve fitted to the size data of the first 30 days” instead of simply the size data needs to be explained and justified better. Currently, it leaves the question why you can't just compare size or the actual calculated growth rate instead of doing a regression to size (which, lacking an explanation, seems unnecessary). Please clarify/justify.

17472, L 3-4: Please clarify what it is that reaches an optimum in the Mewes et al. 2014 study (growth rate? SNW? Something else?)

17472, L 6-7: Grammatical problem (incomplete sentence), awkwardly phrased.

17472, L 6-8: This conclusion has not been adequately explained and justified in this paper – as the data is presented currently, it is not made clear that this dataset suggests that. A figure showing [Ca] vs. growth rate would be quite helpful, but lacking that, you cannot exclude the possibility that perhaps increasing [Ca] could also explain faster growth. Please justify this interpretation more.

17472, L 12-13: The Segev and Erez 2006 optimal Mg/Ca_{sw} value is very different than your optimal value - how do you explain this? Please propose some explanations for the difference.

17472, L 21-22: This sentence is unclear – I think what you mean is that at low Mg/Ca, lowering [Mg] produced a higher growth rate than raising [Ca].

17472, L 28, 17473 L1: “foraminiferal SNW, which is correlated to the change in growth rates as a function of Mg=Ca_{sw}.” This relationship is not shown in this or the other figures (or if so, it's quite obscured). If this is discussed, it needs to be shown.

17473 L6: What phenomenon is being discussed in this sentence and the ones before/after? This is unclear, and the paragraph is hard to make sense of for that reason.

17473, L19-21: This sentence is hard to understand – please clarify it.

17474, L10: Please briefly restate this mixing model (Nehrke et al. 2013) so that it's clear what you mean when you say that your relationship agrees with it.

17474, L13: Please succinctly summarize the discussion in Mewes et al. 2014 that addresses this difference with the mixing model and cite it so that the point of that discussion is clear here.

17475, eqn. 3: Please define Rsw before/after equation. This term is defined only in the appendix.

17475, L 16-17: Please restate the physiological mechanism you have presented – the reader is left wondering, “What was the mechanism?”

17475, L 17-19: Please elaborate on/restate what the “promising new way of interpreting foraminiferal element to calcium ratios” you have presented is – it has gotten somewhat lost in the previous part.

17486, Fig. 4: I would like to see a figure/pair of figures showing different [Ca] and [Mg] vs. shell size or growth rate (like Fig. 1a or Fig. 4). These figures alone do not rule out that higher [Ca] does not drive faster growth.

17488, Fig. 6a, b: The caption here (and in all figures) should explain the figures more. In figures 6a, 6b, is the grey line a fit to the stable [Ca] data, the stable [Mg] data, or both combined? Need to also cite the Mewes et al. 2014 data source for Mg.

Purely technical comments

17482, Table 1: I suggest including mean final shell weights, size normalized weight and growth rate for each treatment in this table to make it easier to compare the culture environment with the results. The table title can be modified accordingly.

17483, Fig. 1A: the figure is very hard to read because the symbols are small, overlapping, and the error bars obscure their shape. I would recommend either using color, or drawing lines between each type of symbols so the reader can follow each [Ca] trend. Also use error bars without end caps so the symbols are more distinguishable.

17483, Fig. 1B, 1A and table 1 conflict with the text (presumably the mistake was in the text, as noted above): 1A and table 1 show the largest final tests were in the [Ca]=17.9 and [Ca]=9 sizes, but the text (pg. 17470, line 23) shows the largest final tests were in [Ca]=7 and [Ca]=9.

17487, Fig. 5: y-axis title is redundant – SNW already contains the word “normalized”, so the axis title should not contain the word and the acronym.

17489: Fig. 7b is not referenced in the text.