

Interactive comment on “A culture-based calibration of benthic foraminiferal paleotemperature proxies: $\delta^{18}\text{O}$ and Mg/Ca results” by H. L. Filipsson et al.

H. L. Filipsson et al.

helena.filipsson@geol.lu.se

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We thank both reviewers for their constructive comments and positive feed back. Both reviewers suggest minor revisions. We here address only the major points; we have followed most of their suggestions regarding grammar and technical details and feel no need to discuss those further.

Reviewer 1

Major comments: R1: Were foraminifera cleaned at all after retrieval from the culture vessels? Specimens that were alive at the end of the experiments likely contained cytoplasm that may have influenced the elemental and isotope analysis.

C579

Reply: The specimens were rinsed in MilliQ water after finishing the experiment. From our prior culture experience (e.g., McCorkle et al. 2008), we don't believe that the stable isotope analyses were affected by the lack of more rigorous cleaning. However we recognize that there is Mg in the chlorophyll from the algae and it is a possibility that it could contribute to the high Mg values. We have added a short paragraph about this possibility in the discussion section.

R1: Why do the authors focus on the culturing conditions from Feb to May? Variability in T, sal, etc was not high in the excluded timespan (Dec – Feb), compared to the rest of the experimental period. Besides, the cultured specimens may well have grown most of their calcite in the first half of the experiment and died during as the incubation progressed.

Reply: As far as we could tell the specimens were alive, and eating algae at the end of the experiment, and then the mass calcified presumably will be dominated by the final few months. We have added a paragraph about this under the result section. In addition the two sets of averages were not significantly different – i.e., this will not alter any of our conclusions. We have chosen to keep the averages calculated between Feb and May.

R1: Whatever happened to the Sr/Ca ratios? Since Sr counts were also recorded, it would be interesting to present these data along with the Mg/Ca ratios.

Reply: We chose to focus on Mg/Ca because of its established utility as a paleotemperature proxy. We do not want to complicate and lengthen the manuscript by including Sr/Ca as well.

R1: To compare their data with published Mg-T relationships, the authors plotted their Mg/Ca data twice: in the second figure (no 8), a core-top calibration is included from Lear et al. (2002). The calibration curve reproduced by Lear and others, however, is based on results from different species than that of Filipsson et al. (namely *Cibicidoides* spp.). Is there a special reason why the authors chose this particular calibration curve?

C580

The same reference also gives curves for other genera (e.g. *Uvigerina* spp.; figure 9b) and the references named by Filipsson et al. all list results for genera other than *Bulimina*. I don't think there is a published calibration for *Bulimina*'s so far and therefore, I suggest that either the authors either do not plot and discuss their results in relation to the *Cibicides*-curve of Lear et al. (2002) or that they include other calibrations in their figure 8 as well. Also, figures 5 and 8 may better be combined into one.

Reply: We believe it is important to compare our results with core-top data, and the Lear et al (2002) curve is currently the best and most widely used. We also note that the few available core-top *Bulimina* Mg/Ca data (Lear et al, Groeneveld & Filipsson unpub) are consistent with the Lear et al *Cibicides* curve. We also chose to keep the two figures since we want to present the data first in the Results section and then discuss in relation to the Lear et al. (2002) calibration curve.

R1: There are some references missing in the discussion on the relatively high variability of Mg/Ca ratios (section 4.4). Anand and Elderfield (2005) and Sadekov et al. (2005) show that Mg/Ca ratios display much higher variabilities than other trace elements (e.g. Sr) between and within specimens. In the latter's figure 3, high values of Mg can easily be 10x higher than minimum values. Could this be an explanation for the high Mg/Ca values at 4_C? If not, please discuss in the light of 'natural' Mg-variability. There is also a paper on Mg/Ca from cultured benthic foraminifera (Dissard et al., 2010) showing that there is no significant difference in the Mg/Ca from calcite grown at 10 and 20 °C. Please include in the discussion.

Reply: We added the missing references and included them in the discussion.

R1: Since the Introduction starts with the application of foraminiferal calcite in paleoceanography: could the authors discuss the implication of their results for the use of calcitic Mg/Ca and $\delta^{18}\text{O}$? Do the ontogenetic trend in $\delta^{18}\text{O}$ and the large overall variability in Mg/Ca from this study change the way benthic foraminifera are used as proxies?

C581

Reply: As we state in the conclusions this study points towards the need to consider ontogenetic variations in $\delta^{18}\text{O}$ analyses and the need to use adult specimens, a pattern also consistent with other culturing and field-based studies. Our results (also stated in the conclusions) indicate that the best fit paleotemperature equation at least for *Bulimina aculeata/marginata* is the one of Bemis et al. (1998).

R1: Perhaps tables 2, 4 and 5 could be added to the paper as appendices.

Reply: We have chosen to keep them as tables and not have them as separate online supporting material since the tables are fairly short and should be easy accessible for a potential reader.

Literature Anand P, Elderfield H, 2005. Variability of Mg/Ca and Sr/Ca between and within the planktonic foraminifers *Globigerina bulloides* and *Globorotalia truncatulinoides*. *Geochemistry, Geophysics, Geosystems* 6(11). Dissard D, Nehrke G, Reichert GJ, Bijma J, 2010. Impact of seawater pCO₂ on calcification and Mg/Ca and Sr/Ca ratios in benthic foraminifera calcite: results from culturing experiments with *Ammonia tepida*. *Biogeosciences* 7: 81-93. Sadekov AY, Eggins SM, deDecker P, 2005. Characterization of Mg/Ca distributions in planktonic foraminifera species by electron microprobe mapping. *Geochemistry, Geophysics, Geosystems* 6(12): Q12P06, doi:10.1029/2005GC000973.

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