

Interactive comment on “Effect of carbonate ion concentration and irradiance on calcification in foraminifera” by F. Lombard et al.

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The authors present a careful numerical analysis of the effect of seawater carbonate ion concentration on two species of symbiont-bearing planktonic foraminifera, *Orbulina universa* and *Globigerinoides sacculifer*, based on compiled data from published laboratory experiments. Given that species of these calcifying marine protozoans are found throughout the world's oceans, the insight obtained from these experiments has the potential to provide a baseline for the impact of anthropogenic CO₂ invasion and acidification of the ocean during the next century.

My primary recommendations are based on the way these data were analyzed in light of the foraminiferal calcification process. It is now well-known that the microenvironment of dinoflagellate-bearing species such as *O. universa* and *G. sacculifer* undergo

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large diurnal shifts in pH as the physiological effects of respiration (night) and photosynthesis (day) modify [CO₃=] in the calcifying environment against the shell. Given that day time pH can rise to >8.6, it is hard to understand how a small reduction in ambient pH could dramatically shift the calcite saturation state very much during periods of illumination. In contrast, calcite added at night is precipitated under reduced pH conditions (relative to ambient) due to the contribution of respired CO₂ to Σ CO₂. We also know that *G. sacculifer* and *O. universa* add ~10% and 30%, respectively of their shell mass at night. I recommend that the authors consider the potential impact on their calculations if day-precipitated calcite was not influenced significantly by changes in ambient pH, and that the dominant effect was on the amount of calcite precipitated at night. Given that *O. universa* adds much more calcite at night than *G. sacculifer*, such a rationale could explain why the data analysis indicates a much larger decrease in shell mass for *O. universa* vs *G. sacculifer* by the end of the century. If indeed the primary impact of ocean acidification is on night calcite, I wonder if a reanalysis of these data would help reconcile the magnitude of the effect of seawater pH change on the non-symbiotic species *Globigerina bulloides* that has appeared in the literature recently.

My second issue is a question for the authors. A part of the analysis is a presentation of the data in terms of foraminifera organic carbon content. This calculation is based on an assumption that the cytoplasm volume is the same as the cumulative chamber volume within a shell. From observations on many living foraminifera, we know that cytoplasm does not instantly fill a chamber, but requires ~1 day for *G. sacculifer* and 3-5 days to fill the sphere of *O. universa*. In both species, the shells do not completely fill with cytoplasm until just before gametogenesis when the foraminifera has ceased ontogenetic calcification. How does this issue affect the calculations?

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