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Interactive comment on "Mass extinctions past and present: a unifying hypothesis" *by* S. A. Wooldridge

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Wooldridge (2008) proposes that the inactivation of a single enzyme, urease, by low pH was the kill-mechanism for at least four mass extinctions during the past 560 million years. As he rightly indicates, this hypothesis remains to be tested, including for a reason which is not mentioned in the discussion paper. The "urease" hypothesis entirely rests on a paper by Barnes & Crossland (1976) which provides a graph of urease activity as a function of pH. The reproduction of these results in Wooldridge (2008; Fig. 2) is not adequate because it is oversimplified and does not mention that Barnes and Crossland actually conducted three distinct experiments in three different buffers. It is critical to demonstrate that urease activity also decreases in seawater at pH values of about 7.9 (see below).

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Another problem is that the scale of the pH values is not reported. I assume that Barnes Crossland (1976) have used the N.B.S. scale but the scale used by Wooldridge (2008) is not mentioned, nor are temperature, salinity and total alkalinity. pCO2 is 560 ppm at pH_T=7.91, total alkalinity=2.2 mEq kg^{-1}, temperature=20C and S=35. The point is that a pH of 7.9 on the total scale corresponds to a larger pH value on the N.B.S. scale (about 0.1 unit), hence a pH_{NBS} higher than 7.9.

I agree with S. A. Wooldridge that coral reef communities sometimes exhibit calcium carbonate dissolution at night but I disagree that there is strong and persuasive evidence to support the fact that scleractinian corals typically undergo net decalcification (i.e. dissolution) during the night-time period. A review of the literature does not support this statement (Gattuso et al., 1999). The analysis of 108 data compiled from 26 publications provides overwhelming evidence that calcification in the light is significantly higher than calcification in the dark. Only 4% of the observations report negative light:dark ratios indicating net $CaCO_3$ dissolution at night; all of them were reported by Kawaguti & Sakumoto (1948). The experiments by Horani et al. (2005) estimate the flux of calcium between the polyps and seawater and cannot be scaled to rates of calcification.

There is no doubt that $CaCO_3$ dissolution can occur in corals. For example in colonies exhibiting a significant area of skeleton not covered by live tissue or in massive species. However, this is not related to a physiological response to elevated pCO_2. It is merely a biological or chemical dissolution process. Likewise, $CaCO_3$ dissolution at community level is mostly controlled by sedimentary processes, not by a physiological response of coral colonies (Leclercq et al., 2002). I therefore conclude that $CaCO_3$ dissolution data do not indicate that the negative outcome of the urease hypothesis for marine organisms is already partially activated as S. C. Wooldridge mentions in one of his short comments.

References cited

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Al-Horani, F. A.: Effects of changing seawater temperature on photosynthesis and calcification in the scleractinian coral *Galaxea fascicularis*, measured with O_2, Ca^{2+} and pH microsensors, *Scientia Marina*, 69, 2005.

Barnes, D. J. and Crossland, C. J.: Urease activity in the staghorn coral, *Acropora acuminata*, *Comparative Biochemistry and Physiology B*, 1976.

Gattuso, J.-P., Allemand, D. and Frankignoulle, M.: Photosynthesis and calcification at cellular, organismal and community levels in coral reefs: a review on interactions and control by carbonate chemistry, *American Zoologist* , 39(1), 160-183, 1999.

Kawaguti, S. and Sakumoto, D.: The effects of light on the calcium deposition of corals, *Bulletin of the Oceanographic Institute of Taiwan*, 4, 65-70, 1948.

Leclercq, N., Gattuso, J.-P. and Jaubert, J.: Primary production, respiration, and calcification of a coral reef mesocosm under increased CO_2 partial pressure, *Limnology and Oceanography* , 47(2), 558-564, 2002.

Wooldridge, S. A.: Mass extinctions past and present: a unifying hypothesis, *Biogeosciences Discussions*, 5, 2401-2423, 2008.

Interactive comment on Biogeosciences Discuss., 5, 2401, 2008.