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Biogeosciences Discussions

Interactive comment on "A hypothesis linking sub-optimal seawater pCO$_2$ conditions for cnidarian-*Symbiodinium* symbioses with the exceedence of the interglacial threshold ($>$ 260 ppmv)" *by* S. A. Wooldridge

Anonymous Referee #2

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The basic claim here is that an ATP dependent CCM is essential for co2 supply to the Algae and that the algae will become co2 limited under high co2 concentrations due to proliferation of the symbiotic algae:

"The linkage of these CCMs to the receipt of photosynthate ensures that the zooxanthellae indirectly play a role in generating the CO2(aq)20 that they themselves require for photosynthesis; thus representing a strong disincentive for zooxanthellae to shift towards parasitism (cheating). In essence, stability is maintained because 'defectors' (exploiters) become victims of their own success. If the zooxanthellae fail to invest in

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the host, they will generate local selection, i.e., CO_2-limitation → expulsion → replacement."

this assumption is not supported in this work. if fact it ignores massive arrays of active hco3 transporters that are not diffusion based in both host and symbiont. and indeed most of the DIC in sea water is in the form of HCO_3 that is not of short supply. in the case of increasing Pco2 due to pH changes, the active CCM based diffusion of co2(aq) will increase as the delta in concentration between the internal and external will increase and again - I see no limitation there.

this claim is that the limiting factor of the symbionts is co2 limitation:

"potentially disruptive influence of this enhanced 'passive' supply of CO_2(aq) on the stable functioning of cnidarian symbioses should not be understated, since it provides the opportunity for an increasing ('excess') proportion of the zooxanthellae population to exist outside the strict host sanctioning implicit with the 15 photosynthate-feedback operation of the CCMs."

this is probably not the case as these dinos posses a CCM (Badger 2000) and are perfectly able to survive in low co2 conditions. adding more co2 (aq) will not really matter

the claim that corals are more sensitive to elevated co2 concentration :" Experimental observations confirm the potential sensitivity of the in hospite symbiont population to rising seawater pCO_2. For example, increasing pCO_2 from 400 to 700 ppmv during low ambient irradiance (winter) conditions resulted in a doubling of the number of zooxanthellae within the temperate coral Cladocora caespitosa (Rodolfo-Metalpa et al., 20 2010)."

a report from Fine Tchernov 2007 shows that symbiosis did not break due to even extremely low pH condition (which meant high co2 aq)

since I am not convinced that limiting co2 is the basis for bleaching - in fact, it might just be a balancing factor as you increase the external CO2 aq and thus lower energy demand for the basic active (CA LIKE) diffusion of co2 into the cells (higher co2 outside)

this claim: "As alluded, this paradox is ultimately linked to the increased permitted size of the ‘excess’ zooxanthellae fraction that functions on the passive supply route of seawater CO2(aq), and which is extremely vulnerable to CO2-limitation during periods of excessive (irradiance-driven) CO2(aq) demand; particularly when coupled with a flow-mediated reduction in passive CO2(aq) supply, which is a characteristic feature of the 15 ‘doldrum’ conditions that normally precede mass bleaching events (Gleason and Wellington, 1993)." is in contrast to the fact that if a high demand for co2 arises due to enhanced photosynthesis will just increase the active pathways of hco uptake (very visible in isotopic evidence) and you will have more ATP at your disposal as the authors leans heavily on this relationship.

"Passive supply of co2" is used here a lot - there is no such thing in an organism with a rubisco km of 150 micro M,. in order to photosynthesis they ALL require an active CCM.

" Reduced calcification (= reduced activity of host CCMs)" makes no sense to me : sea anemones, corallimorpharians hydra and more taxa are without skeleton altogether, that does not impair their DIC uptake in any way. the fact that most of your respiratory carbon is designated to calcification (Furla) is in direct contrast to that assumption a you free more co2 for photosynthesis.

then the author refers to Fine Tchernov 2007 paper and claims that calcification was stopped to permit the symbiosis, while lower carbonate levels are now known to cause the reduction in calcification (Caldera 2005, Schneider EREZ 2006 and many more.

‘Drowned’ reefs at interglacial climate terminations- the simple explanation is sea level rise that was rapid Fairbanks,1989 Camoin 2004) .in addition, during the LGM these is no recorded reef gap McCulloch 1999 although co2 was much higher then 260ppm much higher then 260ppm

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8, C5518–C5521, 2012

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8, C5518–C5521, 2012