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Interactive comment on "Physiological basis for high CO_2 tolerance in marine ectothermic animals: pre-adaptation through lifestyle and ontogeny?" *by* F. Melzner et al.

J.-C. Massabuau (Referee)

jc.massabuau@epoc.u-bordeaux1.fr

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This is a well written review that can be helpful for numerous people who do not belong to the past or present field of 'respiration in aquatic animals'. All the described mechanisms do exist and non-specialists must be aware of the complexity described here. However, the authors faced two difficulties. For unspecialized people, the underlying concepts are probably not explained simply enough, although a great effort was made (but the underlying concepts are not so simple). For specialized people, it is essentially one more review (we have already had a lot during the past 2-3 decades). But it is clear that these specialized readers were not the target people here.

Evidently, nobody knows what will happen in the context of the future ocean acidification that is predicted. We speculate. What is really required is new experimental data but the problem is such that we should expect from this kind of specialized review some key directions.

It is probably true that in the present ocean acidification context, possibly nobody stressed, by writing it, that extracellular CO2 partial pressures are living with much higher CO2 values than in the open ocean. But besides that, I am surprised by the absence of a statement recalling that in freshwaters, most partial pressures of CO2 are significantly higher than in the present, and possibly the future, ocean. In freshwaters, the average excess is 8 times above air values (0.3 kPa, 3200 μatm, Rebsdorf et al. 1991), with a maximum well above 30 (12 000 μatm. Massabuau and Fritz, 1984). Yet everybody knows that numerous aquatic animals and aquatic plants are living there quite well. To discuss that point is evidently an open question. What is the difference between respiratory physiology in freshwater and seawater species if there is one? An interesting recent paper about the CO2 range found in freshwaters, and the limiting putative role of CO2 excess for aquatic plants, can be found in Demars and Trémolières (2009).

In addition of this first and basic observation, a few more physiological observations could have been added by the authors. For example, another simple piece of information that we did not find in this review is that any increase in CO2 partial pressure in water will result basically in the same increase in aquatic organisms, from blood to intracellular levels. The bulk of evidence, that is well reviewed here, is that most aquatic animals are well equipped to face these chronic CO2 overloads and maintain a proper internal pH. The authors however failed to recall that we know for a long time about the existence of compensatory mechanisms, not only at the organismic level but also at cellular levels (Busa and Nuccittelli, 1984). Cells can possess either ion exchange mechanisms to actively regulate their intracellular acid-base balance or various intracellular buffer capacities. Whether all unicellular, or small pluricellular, organisms (the most important from an ecological point of view) are able to do this is an open question. Another point is that blood, as well as intracellular, CO2 partial pressure and pH are not fixed values. They are variable set points used by the cells to manipulate and regulate their metabolic needs at different rates (Busa and Nuccittelli, 1983; Malan, 1999). Aquatic animals are also known for their ability to adjust their blood pH at different set points before and after a meal (Legeay and Massabuau, 1999) as well as following a circadian rhythm (Sakakibara et al., 1987), dependently or independently of the water oxygenation status. What will happen to some key ocean species as we all know that the occurrence of hypoxic events will be increasing in the coastal areas? Finally, the existence of ventilatory responses to CO2 changes (hyperventilation in response to CO2 induced acidosis) has been demonstrated in water breathing animals (Massabuau and Burtin, 1985) and it can be an efficient way to regulate blood pH (Burtin and Massabuau, 1988). It has often been a missed point in numerous previous reviews where the emphasis was on relatively large water CO2 changes. Based on what is expected today, these ventilatory adjustments could be efficient. However, an increase in ventilatory activity should be associated with changes in internal O2 partial pressures as most water breathers aim at maintaining their ventilatory activity at minimal values (Massabuau, 2001). What could be the consequence of these hyperventilatory responses in a CO2 enriched ocean remains again an open question.

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