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Interactive comment on “The real limits to marine life: a further critique of the Respiration Index” by B. A. Seibel and J. J. Childress

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Author response: Interactive comment on “The real limits to marine life: a further critique of the Respiration Index” by B. A. Seibel and J. J. Childress

Both reviewers were generally quite positive about our manuscript and we thank them for their thoughtful contributions.

Referee #2 (H. O. Pörtner): p. 16526, l.25: Intracellular PO₂ being brought to higher than ambient values sounds like a very unlikely and rare situation. That statement must be backed by data and a reference.

Reply: We had in mind the high PO₂ achieved inside fish swim bladders by kinetic manipulation of the oxygen gradient in the blood. Although the majority of fishes possess

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swim bladders containing pure oxygen, this could certainly be considered an unusual example. We have modified the text to clarify this example and added a citation.

Referee #2 (H. O. Pörtner): Also to say that cellular PO₂ is independent of ambient values is overstated and not backed by evidence.

Reply: We meant that, above the P_{crit}, intracellular PO₂ is independent of ambient oxygen. More correctly, at oxygen partial pressures sufficient to fully saturate the blood (in those species with respirator proteins), intracellular PO₂ will be independent of ambient oxygen. We have modified this statement.

Referee #2 (H. O. Pörtner): p. 16527: That any predictions by use of the RI are inappropriate is clear but the word “dangerous” is not the right one to use here.

Reply: We have substituted “misleading” for “dangerous”.

Referee #2 (H. O. Pörtner): p. 16528: The authors rightly discuss the critical PO₂ as the relevant oxygen threshold which is species and life stage specific. Here they should include further literature that goes beyond their own and broaden their statement to one valid for all animals. P_{crit} being defined as “the oxygen partial pressure below which metabolism cannot be regulated independently of PO₂” is the classical definition dating back to the pioneers of comparative physiology (this should be said) but this definition is only valid for oxyregulators and not encompassing oxyconformers among invertebrates. Progress made in the early nineties in the Grieshaber lab and elsewhere has shown in all cases tested that the P_{crit} is also characterized by transition to anaerobic metabolism, in oxyconformers and oxyregulators. This transition is a more reliable component in quantifying limiting oxygen conditions. Metabolic depression may occur above P_{crit} but is not per se indicative of an oxygen limitation threshold.

Reply: We have broadened our definition of P_{crit} to include the anaerobic threshold (and citations below) as suggested. However we emphasize that anaerobic capacity is highly variable and for many OMZ animals that live permanently at low oxygen, the

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capacity to live (anaerobically) below the P_{crit} is not important as the oxygen levels are quite stable. As such many such species have very low anaerobic capacities and the accumulation of anaerobic metabolites is difficult to measure. The break in aerobic metabolism is, we believe, the important point.

Grieshaber, M.K., I. Hardewig, U. Kreutzer, H.O. Pörtner (1994) Physiological and metabolic responses to hypoxia in invertebrates. *Rev. Physiol. Biochem. Pharmacol.* 125: 43-147.

Pörtner, H.O., M.K. Grieshaber (1993) Critical $PO_2(s)$ in oxyconforming and oxyregulating animals: gas exchange, metabolic rate and the mode of energy production. In: *The vertebrate gas transport cascade: adaptations to environment and mode of life* (ed. Bicudo, J.E.P.W.). CRC Press Inc., Boca Raton FL, U.S

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