

Peer Review

Review of: "Atmospheric CO₂ as a Biophysical Driver of Mesozoic–Cenozoic Biodiversity"

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I'll begin by saying I am not an expert on the thermodynamics of the metabolic processes that are discussed in this work, however, the central thesis of the work is interesting and something for which I was unaware. Therefore, while I can critique aspects of the evolutionary processes, I cannot offer a thorough dissection of the underlying biological principle the author discusses.

Firstly, I would approach this work as a hypothesis and I would suggest that the author approaches journals, like *Astrobiology*, with this in mind.

The central focus is on the positive correlation between oxygen and carbon dioxide concentration and the metabolic constraint on encephalisation. It's certainly an interesting idea and the correlations appear strong. A mechanism is proposed (referenced) to link atmospheric carbon dioxide concentration and respiratory output in terms of ATP. One issue that might arise, is whether increases in vascular carbon dioxide, would increase the ventilation rate to compensate and I was not absolutely sure that the typical change in atmospheric carbon dioxide concentration would affect that in the blood. Again, this is not an area of strength on my part.

An area of research I referenced about a decade ago, in my book, *Exo-Weather Report*, was an observation that mammal size repeatedly decreased when atmospheric carbon dioxide concentrations increased. The work is by Philip Gingerich of the University of Michigan, though I cannot find my original reference. The suggestion Gingerich made was that increased carbon dioxide led to plants "bulking up" on carbohydrates rather than maintaining a higher ratio of protein to carbohydrate. Animals, that then consume this fill up on carbs but cannot consume sufficient protein, thereby limiting growth.

I wasn't completely convinced by the argument about continental fragmentation, because there is more to landscape diversification and speciation. There is a clear relationship between landscape diversity (entropy) and species diversity ("Biogeographical modeling.." Stevenson and Wallace, *Astrobiology*, 2021 - and others, such as Walz, 2011). Therefore, it might be worth considering a broader measure of landscape diversity than simply increases in coastline. For example, in the Cenozoic there is a significant uptick in orogeny across the Americas, Europe and Asia.

In the conclusion, I would rephrase the first sentence, as it comes across as rather negative about the work! Something along the lines of, "This work aims to identify additional factors that might affect encephalisation..."

Overall, an interesting article and well worth pursuing.

Declarations

Potential competing interests: No potential competing interests to declare.