Authors response to referee comment 2

Dear editor, Dr. Adrian Immenhauser, and EGU sphere.

First we would like to thank Adrian Immenhauser for the time he invested reviewing this paper and his comments and suggestions that will help improve the paper.
In this response, we will pass on the language suggestions, which we take into account for the revised version of the paper, to focus on the scientific discussion.

Abstract:

Ln. 20. I am not sure what a `growing temperature' is (also referred to as `living temperature' elsewhere)? I did google the term to make sure I did not miss something. The only paper that matched is yours (this discussion version) on the EGU sphere webpage. Do you mean the ambient seawater's temperature during the brachiopod's lifetime? Use `ambient seawater temperature', I suggest. Other than that, please use proper terminology: seawater d18O `values' or similar.

'Growing temperature' which may be corrected as 'growth temperature' or 'shell growth temperature', refers to the ambient temperature when the animal grows its shell. This formulation aims to point that the temperature that may be registered in the carbonate archive, will correspond to the temperature of the environment when the carbonate formed. This exclude the periods during which the animal live but does not grow its shell. We acknowledge that in this specific occurrence the use of 'seawater temperature' is better suited.

Ln. 34. What do you mean by `relatively good´. In agreement with the measured temperatures within xy degree Celsius?

'good' should be here replaced by 'strong' relative to the strength of the correlation between the geochemical parameters and the temperature, which is illustrated by the regression coefficient.

Introduction:

Ln. 42. What are past seas, and what is the difference to oceans? Do you mean epeiric seas as opposed to genuine oceanic bluewater?

That is what we mean. This difference is here to imply that the $\delta^{18}O$ values of the seas that may be more or less restricted, can deviate substantially from that of the open ocean. Especially as while $\delta^{18}O$ values of the open ocean mostly reflect global processes (Amount of continental ice, oceanic circulation, global climate), the $\delta^{18}O$ values of the seas are also influenced by more local processes (runoff, evaporation).

Ln. 91. That is a scientific criticism. The authors argue about the question of whether shell carbon (DIC) and oxygen isotope values are in equilibrium with the seawater from which the shell carbonate precipitated or not. Please allow me to clarify that brachiopod biominerals are secreted from bodily fluids, NOT seawater. The problem is threefold: (i) What is the isotopic value of the bodily fluid relative to that of the ambient seawater? (ii) Does the

isotopic value of the bodily fluid change during active versus passive cycles in the brachiopod metabolism cycle and during the brachiopods life span? Juvenile brachiopods grow rapidly, mature slow down. (iii) What is the fractionation factor between bodily fluid and brachiopod biomineral, and is it constant during the lifetime of a brachiopod? In some cases, brachiopod bodily fluids are isotopically close to the ambient seawater; in others not. In short, it is complicated. The authors provide text about thermodynamics and kinetics but less so about these metabolic effects and biomineralization pathways. In my oppinion, that is a weakness of the paper. Please see the discussion and references cited in:

Immenhauser, A., Schöne, B., Hoffmann, R. and Niedermayr, A. (2016) Mollusc and brachiopod skeletal hard parts: Intricate archives of their marine environment. Sedimentology 63, 1-59.

Chapter 4.2 Here, we need much more emphasis on metabolism and biomineral secretion from bodily fluids. The authors deal with the topic as if brachiopod biomineralization pathways were an inorganic precipitation experiment. These are super complicated little `bio-machines', and they are fascinating since each individual is a case on its own. Please see papers from the marine biology community (mainly aquaria monitoring experiments but also field observations).

We fully agree that rynchonelliform brachiopods shells are not the result of an inorganic precipitation experiments from the seawater, but that they result from biological processes promoting carbonate precipitation from a biologically controlled fluid, forming a structured carbonate shells where calcite crystals are embedded in an organic matrix (Williams, 1968; Curry et al., 1991; Gaspard et al., 2008; Simonet Roda et al., 2019, 2022). We acknowledge that these aspects are not very present in the paper, mostly as the scope of this paper is the use of brachiopod shell geochemistry for paleo-environment reconstruction. But we are fully aware of the differences between biogenic and inorganic carbonate precipitation and will put more emphasis on these aspects in the revised version. From a more methodological point of view, the comparison between the brachiopod shell mineralisation and inorganic calcite precipitation is an approach to highlight the effect of biological processes on shell geochemistry, especially when the chemistry of the mineralizing fluids for brachiopods, remains for now largely unknown (We do not know of any study reporting isotopic values of ionic concentration from the brachiopod body fluids).
Indeed, if the data can be explained by what is known of inorganic precipitation, then we do not need to invoke any biological processes. On the contrary if the data diverge from what we expect from inorganic precipitation, then biological processes may explain these differences.
Regarding the discussion around kinetic effects, we clearly state (ln 549-554) that we expect the extent of the kinetic effects to be directly linked to shell growth rates, which is biologically controlled.

Ln. 282. What are `independent´ brachiopods? Please explain.

Obviously here we do not refer to brachiopods that are independent from anyone or anything. 'Independent' here qualifies the dataset chose to test the fractionation equations. The adjectives associated with dataset here are numerous so we will rephrase it to make it clearer.

Chapter 4.1.4 All good science but very longwinded. Could you streamline that? This is not easy to follow and this is not something you want to hear from the readers.

We will rework the construction of this section to make it easier to follow and more concise.

Conclusion(s):

Please use the plural, I suggest that you list more than one conclusion here. This chapter is very much written in a discussion style. Please consider coming up with genuine conclusions style text rather than a short (renewed) discussion. The last statement is an anti-climax. First, you present all of these data and text. Then you tell the reader that you advise considering the variability in brachiopod live habitats, environmental conditions, metabolic effects, seasonal effects etc.? I must admit, have read very similar concluding statement in many papers published a decade or more years ago. Please consider.

The conclusions will be reworked in their style.

References

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