

Biogeosciences Discuss., referee comment RC2  
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## Comment on bg-2022-10

Anonymous Referee #2

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Referee comment on "Intra-skeletal variability in phosphate oxygen isotope composition reveals regional heterothermies in marine vertebrates" by Nicolas Séon et al.,  
Biogeosciences Discuss., <https://doi.org/10.5194/bg-2022-10-RC2>, 2022

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The manuscript „Intra-skeletal variability in phosphate oxygen isotope composition reveals regional heterothermies in marine vertebrates“ by Séon et al. is an interesting new contribution demonstrating that substantial differences in  $d_{18}O_p$  values of different skeletal parts exist within ectotherm and endotherm marine vertebrates, which has implications both for temperature and/or salinity reconstructions based on bioapatite phosphate oxygen isotope analysis.

The manuscript thus provides notes of caution for such palaeoceanographic seawater temperature and salinity reconstructions which may have a larger error range than previously thought. To support this claim the manuscript presents a convincing and substantial  $d_{18}O_p$  dataset on modern cetaceans and osteichthyans, it is concise and well written therefore I have only several minor suggestions/corrections to propose.

I miss some information on the salinity and water temperature differences in the method section for the regions from which the marine vertebrates were captured.

In the results section you must provide ranges for  $d_{18}O_p$  values for intra- and inter-bone variability and state that the variability is higher for poikilothermic versus homeothermic endotherms.

I think it could be useful to provide a graph and/or text to quantify the influence (error range) of intra-skeletal  $d_{18}O_p$  variability on water temperature and  $d_{18}O_{water}$  reconstructions. A comparison of measured body temperature differences versus calculated body temperature differences from  $d_{18}O_p$  values and estimated versus measured  $d_{18}O_{sw}$  (when available) might be instructive.

## Minor comments

Line 21, 238, 459: hydroxylapatite is the correct terminology according to the IMA (International Mineralogical Association)

Line 31: I assume there is also more recent pertinent literature to cite here than only Rodbard 1955. Same for line 35 Scholander 1955

Line 36: do you mean core body temperature (instead of deep) here?

Line 52: inhaled air oxygen also contributes to the body water pool of lung breathing marine mammals

Line 56: may be add at the end: in isotope equilibrium

Line 58: organisms is too unspecific. Use vertebrates

Line 60: paleontological (as you use American English)

Line 60: in Vennemann et al. 2001 also intra jaw tooth enameloid  $\delta^{18}O_p$  variability of modern sharks is presented

Line 66-68: Would it not be informative to provide a plot at least in the supplements to compare measured and calculated body temperatures (based on  $\delta^{18}O_p$ )?

Line 71: four extant fully marine species

Line 73: not four authors but Robineau et al. Furthermore, this reference is missing in the reference list

Line 76: All three dolphin specimens

Line 79: some more provenance information should be provided. Are those specimens from the fish shop from the Mediterranean Sea? Which area?

Line 80: may be you could refer here to one of the figures demonstrating which skeletal parts were sampled

Line 94, 95, 97: the current terminology for these international standard reference materials is NIST SRM plus the according number

Line 97: why did you choose a non-matrix matched reference material (BaSO<sub>4</sub>) and not another isotopically distinct silverphosphate? This is not ideal because of different combustion properties of different mineral phases.

Line 100: you should state the analytical error of d18Op analysis for samples too or at least mention that it is the same as for NIST SRM 120c.

Line 104: intra-skeletal

Line 117, 118: Fig. 1A; Fig. 2A (space missing before nr.)

Line 119: you mean variability instead of homogeneity here?

Line 119: why not providing the Fig. S1 in the main text?

Line 120: please provide values for d18Op ranges here

Line 123: any ideas why the teeth have higher d18Op values? Are the snout regions where they mineralize cooler? The 1.5 permil difference seem to suggest a 6 °C body temperature difference in dolphins. Is this to be expected and in line with instrumental body temperature measurements?

Line 141: result (singular not plural)

Lines 141-142: what do you mean with oxygen sources of the body: body water, inhaled oxygen? Can migration to different seawater masses with different  $\delta^{18}\text{O}_{\text{sw}}$  values play a role here too? What about any mother milk consumption effects? For early ontogenetically forming teeth this could play also a role. Furthermore, could also tissue specific differences in oxygen isotope fractionation (i.e. between dentin and enamel) play any role? Enamel of dolphin teeth is very thin. Thus may be you sampled a mixture between some dentin and enamel.

Line 144, 145, 151, 164: space after Fig. missing

Line 149: are not also the teeth of other osteichthyans (not only the tuna) replaced continuously? Can you add a reference for this?

Line 151: Besides, all studied vertebrates...

Line 151: are different rates of air oxygen inhalation (marine mammals versus fish) not a significant factor for different  $\delta^{18}\text{O}_{\text{p}}$  values?

Line 154: you must quote a reference for the statement that food is the main water source for dolphins.

Line 155: marine vertebrates (instead of organisms)

Line 159: is there an estimate possible of how much of the inter-bone variance in  $\delta^{18}\text{O}_{\text{p}}$  is possible to attribute to temperature differences (based on modelled  $\delta^{18}\text{O}_{\text{p}}$  from measured temperatures versus measured  $\delta^{18}\text{O}_{\text{p}}$ )?

Line 164: Intra-skeletal

Line 167 and elsewhere in the text: should there not be a space between value and  $^{\circ}\text{C}$  ? According to SI unit use guidelines.

Line 167: Is the  $\pm 2$  °C for cetaceans (i.e. dolphins) in line with a  $\pm 0.5$  permil 1 SD variance in measured  $d_{18}O_p$ ? Then worth mentioning this here?

Line 173-174: no additional, newer references for dolphin body temperature available? What is the constant trunc body temperature, can you provide a value and 1 SD?

Line 174: Assuming only slight changes...

Line 180-181: could you back this statement up with values how large the differences between reconstructed and measured temperatures are?

Line 183: ... represent a long-term average value...

Line 197-200: Is it not possible to compare the temperature variance of measured and calculated temperatures (from  $d_{18}O_p$ )? Why is the range of core body temperature and ambient water so large (4 to 20 °C)? Because some tuna were caught in cold water settings? I think it would be useful to point this here out as the differences given here based on measured  $d_{18}O_p$  values are at the lower end of the huge range up to 20 °C quoted.

Line 205: Eq. (1), you can refer to Fig. 3A here for the body temperatures.

Line 206: what do you mean with global trend? Reword for clarification?

Line 212: ...loggers are difficult...

Line 217: Well, you need to kill the animal to get bones or teeth for analysis, hence the method is lethal or at least invasive (except for collection of shed teeth or museum specimens). This should be acknowledged. You can add may be... that are difficult to monitor otherwise. Again replace the too unspecific organisms by marine vertebrates for which only skeletal remains are available...

Line 218: ... and marine reptiles such as.. you may additionally mention megatooth sharks.

Line 225: Similarly or Along the same lines, seem more appropriate than the phrasing in the same idea.

Line 227: can you please provide the equation you quote here so that the reader is not forced to access the Ciner et al. (2016) reference.

Line 231: would it not be helpful to use the current published equations and illustrate the effects of intra-body  $\delta^{18}O_p$  variability on differences in reconstructed  $\delta^{18}O_{sw}$  and body temperature, in supplementary figure(s) for instance?

Line 239: ... chemical alteration processes that take place during postmortem taphonomy and fossilization.

Note that this especially applies for enamel, less so for dentin and bone, which are more liable for alteration (e.g., Ayliffe et al., 1994). Furthermore, it is typically not common practice to quote studies in the conclusion section. I do not know how the Biogeosciences policy is concerning this. If considered ok you can leave as is.

Line 241, 441, 449: correct formatting of  $\delta^{18}O_p$  (super-, respectively, subscript)

## Figures

Fig. 1B: may be you can provide a typical analytical error bar here?

Fig. 2 may be use same font size as in Fig. 1. May be use same scale for  $\delta^{18}O_p$  in A and B? The star symbols in B are rather small and difficult to see may be enlarge and fill the stars white to enhance visibility? May be add a note that absolute  $\delta^{18}O_p$  differences between the two fish is due to capture in different seawater bodies and mention those.

Fig. 3: use same symbol size in A and B. Are mean values and 1SD potted in the figures? Please specify.

Line 461: equal (without s)

Fig. 3B: may be plot real  $\delta^{18}\text{O}_{\text{sw}}$  ranges as shaded bars for comparison if there are such values available from the literature or NOAA or other seawater  $\delta^{18}\text{O}$  database for the regions of vertebrate capture?

Is there any reference to support the assumption that osteichthyans have  $\delta^{18}\text{O}_{\text{bw}} = \delta^{18}\text{O}_{\text{sw}}$  that could be cited here?

Are tooth values dentin and enamel mixtures or pur enamel? Not clear. As dolphin enamel is very thing may be the former?

Line 463: fractionation equation for cetaceans by Ciner et al.... Mediterranean Sea

Table 1

Replace global by all skeletal remains

References

There are still several formatting errors in the reference list that you need to correct.

For instance, comma missing in author, and autor references

Line 284: O'Neil

Line 295: I-Fan; is this correct?

Line 318: Antarctic (capital A)

Line 336: subscript 2 in  $\text{SO}_2$

Line 351: journal, volume page number missing

Line 353: journal name not abbreviated

Line 356: Arctic (capital A)

Line 361, 362: words in article title not with capital letters

Line 367: degree sign for temperature missing

Line 381: incomplete reference: missing journal, volume, page numbers

Line 397: page numbers missing

Line 426: Science (capital S)

Line 429: book title words longer than three letters starting with capital letters

You did not cite the Barrick et al. 1992 whale d18Op paper that also contains cetacean d18Op data of modern whales, why not?