

# ***Interactive comment on “Environmental and taxonomic controls of carbon and oxygen stable isotope composition in *Sphagnum* across broad climatic and geographic ranges” by Gustaf Granath et al.***

## **Anonymous Referee #3**

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This paper addresses important questions about how the isotope composition of *Sphagnum* is controlled by environmental conditions: which is key to using peat bogs as palaeoenvironmental archives. The authors have chosen two cosmopolitan species, which allows the important subject of species specificity of signals to be addressed, and have a good distribution of sample locations from around the Holarctic, the regions where using *Sphagnum* as a paleoclimate archive is potentially feasible. The differential sensitivity of the two *Sphagnum* species to the environmental variables is an important result, even when growing in close proximity. The relationship between

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18O and the annual precipitation is interesting and an important result that has wide ranging relevance. The relationships with 13C are much more complicated! I think that to make the most of the data set, the results section needs to be expanded, with more description of the raw data, which will give the reader a better understanding of the data. The impact of the many environmental variables is very complex, hence several of the relationships have very low explanatory power: there needs to be more critical analysis of the statistics teasing out those that have clear biological relevance. One aspect on which there is no comment is any regional variation in values / relationships, which would be interesting. Specific comments:

Line 72: I think it would be better to replace “elements” with “compounds”, as although it is isotopic composition of C and O being analysed, they are not abstracted from the atmosphere in their elemental form, and are analysed within compounds.

Line 73: compositions (rather than composition)

Line 74: Can be difficult to determine if the material is dead, some may spontaneously start to regrow if exposed to light.

Line 83: Holarctic spelling

Line 83: Were the differences significant in  $\delta^{13}\text{C}$  between species

Line 85: Where  $R^2$  is only 6%, I'm doubtful of its importance as a significant predictor: I think this needs expansion and may be easier to leave out of the abstract

Line 90: Expand HWT and NPP at first use Introduction

Line 97: forcings (rather than forcing), responses (rather than response)

Line 101: replace “is” with “are”

Line 106-113: This paragraph is a bit unclear. It is the isotopic composition of the  $\text{CO}_2$  that is in the chloroplast, rather than purely its concentration that is important for the extent of carbon isotope composition. Thus, if the rate of diffusion is slow,

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and assimilation continues by the moss, the carbon concentration will decrease, but what is more important is that the proportion of  $^{13}\text{CO}_2$  will increase and consequently discrimination against  $^{13}\text{CO}_2$  will decrease.

Line 113: remove “consequently”.

Line 113: Respiratory  $\text{CO}_2$  can be fixed when the mosses are not submerged: particularly close to the ground the isotopic composition of the source  $\text{CO}_2$  may vary in space and time depending on the extent of mixing between any respired  $\text{CO}_2$  at the bog surface, and the well mixed atmosphere above.

Line 147:  $\text{CO}_2$ : subscript rather than superscript

Line 155: compositions (rather than composition) Methods

Line 187: How was the end of the growing season identified?

Table S1: mark which / both species were collected from each site

Line 204: space between and and are

Line 215: However, cellulose may be more applicable for a comparison to palaeo studies, in which case the differential breakdown of different components means analysing a single component can increase the accuracy. Furthermore, may be a significant contributor to species specific differences. Furthermore, whilst trying to pin down influencing factors which previous studies have shown to be very complex, whilst there is a strong relationship between the composition of organic matter and cellulose, particularly for 18 O, 30-50% variation in cellulose-OM relationship is not explained using OM, and the mean annual modelled water leaves 24% to be explained. ...cellulose maybe could have been measured and precip collected to facilitate explanations

Line 234: when were the HWT measurements made? Depending when most of the growth occurred, this could have a significant impact on both isotope relationships

Line 240: how long a period were the pins in place? The calculations for NPP need

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more detail both for the amount of vertical growth, and the bulk density measurements as that can be very difficult to do accurately on loose sphagnum

Line 251: built rather than build Results: Need more details in the results section – the results need to be described at the beginning. What are the ranges of the raw data for the isotope values, what are the growth rates, bulk densities, water table depths etc.

Line 272: Table 1 is unclear: need means of both  $^{13}\text{C}$  and  $^{18}\text{O}$  values rather than just the variation. Add per mille sign to SD values. Unclear what the proportion of variance is referring to: is this the variance explained by the mixed effect model?

Line 268-272: Are the relationships between  $\text{d}^{13}\text{C}$  and HWT significant?

Fig 2: How many samples per site into each line? If its only two per site ( $N_{\text{site}} = 80$ ,  $N = c. 160$ ), is that enough info for a valid calculation: I'm not convinced the site lines are meaningful. Plot confidence interval on pooled regression lines. The individual site lines make it hard to see the overall averages.

Fig 3: Plot confidence interval on regression lines.

## Discussion

Line 324: This overstates the influence that you measured on  $\text{d}^{13}\text{C}$ , especially of ET, which had “weak evidence” for *S. magellanicum*.

Line 335 “influenced by many unknown factors”: could this be expanded and made a little more specific?

Line 345: Do you mean precipitation amount?

Line 373: Sphagnum doesn't actively control the water availability: it is a passive process, influenced by growth form etc. I think that “control” implies that it is an active process.

Line 391: May not be generalisable across moss species: sphagnums are generally

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wet so tightly coupled to the source water, mosses which rapidly hydrate and desiccate repeatedly may be less tightly coupled to the source water and more dependent on evaporative processes.

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