Corrigendum: Leaf Waxes and Hemicelluloses in Topsoils Reflect the $\delta^2$H and $\delta^{18}$O Isotopic Composition of Precipitation in Mongolia

Julian Struck1*, Marcel Bliedtner1, Paul Strobel1, Lucas Bittner2,3, Enkhtuya Bazarradnaa4, Darima Andreeva5, Wolfgang Zech6, Bruno Glaser3, Michael Zech2 and Roland Zech1

1Institute of Geography, Friedrich Schiller University Jena, Jena, Germany, 2Heisenberg Chair of Physical Geography with Focus on Paleoenvironmental Research, Institute of Geography, Technical University of Dresden, Dresden, Germany, 3Institute of Agronomy and Nutritional Sciences, Soil Biogeochemistry, Martin Luther University Halle-Wittenberg, Halle (Saale), Germany, 4Institute of Plant and Agricultural Sciences, Mongolian University of Life Sciences, Ulaanbaatar, Mongolia, 5Institute of General and Experimental Biology, Russian Academy of Science (RAS), Ulan-Ude, Russia, 6Institute of Soil Science and Soil Geography, University of Bayreuth, Bayreuth, Germany

Keywords: biomarkers, n-alkanes, sugars, compound-specific isotopes, apparent fractionation

A Corrigendum on

Leaf Waxes and Hemicelluloses in Topsoils Reflect the $\delta^2$H and $\delta^{18}$O Isotopic Composition of Precipitation in Mongolia
by Struck, J., Bliedtner, M., Strobel, P., Bittner, L., Bazarradnaa, E., Andreeva, D., Zech, W., Glaser, B., Zech, M., and Zech, R. (2020). Front. Earth Sci. 8:343. doi: 10.3389/feart.2020.00343

In the original article, the presented $\delta^{18}$Oara values were accidentally not corrected for the oxygen introduced during hydrolysis. The necessary correction results in slightly more positive $\delta^{18}$Oara values.

The authors apologize for this mistake, and state that this does not change the scientific conclusions of the article in any way, particularly the fact that the calculated apparent fractionation ($E_{18O \text{ ara/p}}$) is constant along the Mongolian transect. However, as the apparent fractionation is $44 \pm 2\%$ (not $41 \pm 2\%$) and this would affect future data compilations and comparisons, we have corrected all $\delta^{18}$Oara and $E_{18O \text{ ara/p}}$ values in the text, the figures, and the supplementary material. We delete our hypothesis stated in the Supplementary Material that a decreasing partial CO2 pressure might cause enhanced $18O_{\text{ara}}$ enrichment, because the correlation between $E_{18O \text{ ara/p}}$ and altitude is not significant anymore ($R^2 = 0.09, p = 0.14$). All changes are highlighted in bold.

A correction has been made to the Abstract. The corrected version is as follows:

“The apparent fractionation $E_{\text{app}}$, i.e., the isotopic difference between precipitation and the investigated compounds, shows no strong correlation with climate along the transect ($E_{2H-n-C29/p} = -129 \pm 14\%$, $E_{2H-n-C31/p} = -146 \pm 14\%$, and $E_{18O \text{ ara/p}} = +44 \pm 2\%$). Our results suggest that $\delta^{2}$H$_{\text{malkane}}$ and $\delta^{18}$O$_{\text{ara}}$ in topsoils from Mongolia reflect the isotopic composition of precipitation and are not strongly modulated by climate. Correlation with the isotopic composition of precipitation has root-mean-square errors of 13.4% for $\delta^{2}$H$_{\text{n-C29}}$, 12.6 for $\delta^{2}$H$_{\text{n-C31}}$, and 2.2% for $\delta^{18}$O$_{\text{ara}}$, so our findings corroborate the great potential of compound-specific $\delta^{2}$H$_{\text{malkane}}$ and $\delta^{18}$O$_{\text{ara}}$ analyzes for paleohydrological research in Mongolia”.

Edited and reviewed by: Moritz Felix Lehmann, University of Basel, Switzerland

*Correspondence: Julian Struck
julian.struck@uni-jena.de

Specialty section: This article was submitted to Biogeoscience, a section of the journal Frontiers in Earth Science

Received: 19 October 2020
Accepted: 27 October 2020
Published: 11 January 2021

Citation: Struck J, Bliedtner M, Strobel P, Bittner L, Bazarradnaa E, Andreeva D, Zech W, Glaser B, Zech M, and Zech R (2021) Corrigendum: Leaf Waxes and Hemicelluloses in Topsoils Reflect the $\delta^2$H and $\delta^{18}$O Isotopic Composition of Precipitation in Mongolia. Front. Earth Sci. 8:619100. doi: 10.3389/feart.2020.619100
A correction has been made to the Results. The corrected version is as follows:

“The $\delta^{18}$O$_{ara}$ values range from $+31\%$ to $+41\%$ with an average of $+35 \pm 3\%$ (Figure 2B). All compounds show the same trend as the isotopic composition of precipitation (Figures 2E,F), and are significantly more positive in the arid part of the transect (ID: 34–42) compared to the rest ($\delta^{2}H_{n-C_{29}}$: $p = 0.017$, $\delta^{2}H_{n-C_{31}}$: $p = 7.08e^{-4}$, $\delta^{18}$O$_{ara}$: $p = 2.95e^{-5}$).
A correction has been made to Discussion, $\delta^{2}H_{n\text{-alkane}}$ and $\delta^{18}O_{\text{ara}}$ Against the Isotopic Composition of Precipitation. The corrected version is as follows:

“The $\delta^{2}H_{n\text{-alkane}}$ and $\delta^{18}O_{\text{ara}}$ values correlate significantly with the $\delta^{2}H_{p\text{-WM}}$ and $\delta^{18}O_{p\text{-WM}}$ values (Figure 3, $R^2 = 0.30$, $p = 3.22 \times 10^{-4}$ for $\delta^{2}H_{n\text{-C29}}$, 0.11 and 0.03 for $\delta^{2}H_{n\text{-C31}}$; and 0.36 and $1.60 \times 10^{-3}$ for $\delta^{18}O_{\text{ara}}$).

The RMSE is $13.4\%$ for $\delta^{2}H_{n\text{-C29}}$, $12.6\%$ for $\delta^{2}H_{n\text{-C31}}$ and $2.2\%$ for $\delta^{18}O_{\text{ara}}$ (Figure 3) and thus indicates that the biomarkers accurately record the isotopic composition of precipitation along our transect”.

A correction has been made to Discussion, Apparent Fractionation Against Climate. The corrected version is as follows:

“Thus, this correlation should not be over interpreted. We conclude that $\varepsilon_{\text{app}}$ is nearly constant with $\varepsilon_{\text{app}} = -129 \pm 14\%$, $\varepsilon_{\text{app}} = -146 \pm 14\%$, and $\varepsilon_{\text{app}} = +44 \pm 2\%$.

Assuming a constant $\varepsilon_{\text{app}}$ factor of $+27\%$ for arabinose (Lehmann et al., 2017; Hepp et al., 2020) evapotranspirative enrichment would be $-17\%$ for $\delta^{18}O_{\text{ara}}$.

A correction has been made to Discussion, Comparison With Other Studies. The corrected version is as follows:

“The $\varepsilon_{\text{app}}$ values for Mongolia ($44 \pm 2\%$) are similar to values reported by Strobel et al. (2020) for relatively arid regions in South Africa. There, the more humid regions have a significantly lower $\varepsilon_{\text{app}}$ values ($-37\%$), quite similar to the C3 grass sites in Europe (Hepp et al., 2020). The deciduous tree sites in Europe, however, are again characterized by more enriched $\delta^{18}O_{\text{sugar}}$ values ($\varepsilon_{\text{app}} = -43\%$). This indicates that $\delta^{18}O$ is more sensitive to evapotranspirative enrichment than $\delta^{2}H$, so that climate can more strongly modulate $\delta^{18}O_{\text{sugar}}$, and again that grasses show the signal dampening much more pronounced than dicotyledons”.

A correction has been made to the Conclusion. The corrected version is as follows:

- “Leaf wax-derived n-alkanes and the hemicellulose-derived sugar arabinose are significantly more enriched in $^{2}H$ and $^{18}O$ in the more arid southern and eastern parts of the transect. This reflects the changes in the isotopic composition of precipitation along the transect, and the correlations with $\delta^{2}H_{p\text{-WM}}$ and $\delta^{18}O_{p\text{-WM}}$ have RMSE of $13.4\%$ for $\delta^{2}H_{n\text{-alkane}}$ and $2.2\%$ for $\delta^{18}O_{\text{ara}}$.
- The apparent fractionation remains mostly constant at $-129 \pm 14\%$, $-146 \pm 14\%$, and at $+44 \pm 2\%$ for $\varepsilon_{\text{app}}$ (Figure 3).
- There are no significant differences along the transect, nor strong correlations with climate”.

A correction has been made to the Supplementary Material, Apparent Fractionation Against Climate. The corrected version is as follows:

$\varepsilon_{\text{app}}$ ranges from $+39\%$ to $+48\%$ with an average of $+44 \pm 2\%$ (Figure 2D). $\varepsilon_{\text{app}}$ is not statistically different in the arid part of the transect ($\varepsilon_{\text{app}} = -129 \pm 14\%$, $\varepsilon_{\text{app}} = -146 \pm 14\%$, and at $+44 \pm 2\%$ for $\varepsilon_{\text{app}}$).
In addition to climate, we correlated the \( \varepsilon_{\text{app}} \) values against altitude, to test for altitude-controlled evapotranspirative enrichment. In contrast to a previous study by Polissar and Freeman (2010), no impact could be observed for \( \delta^{2}H_{\text{n-alkane}} \) and \( \delta^{18}O_{\text{ara}} \), with \( \varepsilon^{2}H_{\text{n-alkane}} \), \( \varepsilon^{2}H_{\text{n-C31/p}} \) and \( \varepsilon^{18}O_{\text{ara/p}} \) being constant along our investigated transect (Supplementary Figure 1).

The corrected caption for Supplementary Figure 1 is as follows:

“The corrected \( \delta^{18}O_{\text{ara}} \) values affect the presented data in Figures 2–4, and the Supplementary Figure 1.”

The authors apologize for these errors and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

REFERENCES

Bowen, G. J. (2019). Version 3.1. The online isotopes in precipitation calculator. Available at: http://www.waterisotopes.org. (Accessed January 31, 2020).

Bowen, G. J., Wassenaar, L. I., and Hobson, K. A. (2005). Global application of stable hydrogen and oxygen isotopes to wildlife forensics. Oecologia 143, 337–348. doi:10.1007/s00442-004-1813-3

Fick, S. E. and Hijmans, R. J. (2017). WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. Int. J. Climatol. 37, 4302–4315. doi:10.1002/joc.5086

Hepp, J., Schäfer, I. K., Lanny, V., Franke, J., Bleidtner, M., Rozanski, K., et al. (2020). Evaluation of bacterial glycerol dialkyl glycerol tetraether and \( ^{1}H-^{18}O \) biomarker proxies along a central European topsoil transect. Biogeosciences 17, 741–756. doi:10.5194/bg-17-741-2020

AUTHOR CONTRIBUTIONS

JS, MB, PS, MZ, and RZ designed the study. MB and RZ collected the samples along transect I in 2016. JS and RZ collected the samples along transect II in 2017. JS carried out the major part of the laboratory analyzes in the laboratory of RZ and BG, assisted by LB, PS, and MB. EB, DA, and WZ organized the sample logistics in 2016 and 2017. JS wrote the manuscript with contributions of all coauthors. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feart.2020.619100/full#supplementary-material.

Jarvis, A., Reuter, H. I., Nelson, A., and Guevara, E. (2008). Hole-filled seamless SRTM data V4, international centre for tropical agriculture (CIAT). Available at: http://srtm.cgiar.org. (Accessed January 31, 2020).

Lehmann, M. M., Gambarra, B., Kahmen, A., Siegwolf, R. T. W., and Saurer, M. (2017). Oxygen isotope fractionations across individual leaf carbohydrates in grass and tree species. Plant Cell Environ. 40, 1658–1670. doi:10.1111/pce.12974

Polissar, P. J. and Freeman, K. H. (2010). Effects of aridity and vegetation on plant-wax \( ^{18}O_{\text{true}} \) in modern lake sediments. Geochem. Cosmochim. Acta 74, 5785–5797. doi:10.1016/j.gca.2010.06.018

Strobel, P., Haberzettl, T., Bleidtner, M., Struck, J., Glaser, B., Zech, M., et al. (2020). The potential of \( ^{3}H_{\text{true}} \) and \( ^{2}H_{\text{true}} \) for paleoclimate reconstruction—a regional calibration study for South Africa. Sci. Total Environ. 716, 137045. doi:10.1016/j.scitotenv.2020.137045
Trabucco, A. and Zomer, R. (2019). Global aridity index and potential evapotranspiration (ET0) climate database v2. Figshare. Available at: https://doi.org/10.6084/m9.figshare.7504448.v3 (Accessed January 24, 2019).

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.