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Phylogenetic patterns in leaf wax *n*-alkane hydrogen isotope composition can be observed in spatially separated parts of the biosynthetic pathway

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Background

The hydrogen stable isotope composition (δ^2H) of plant derived leaf wax *n*-alkanes (δ^2H_{alkane}) is used to reconstruct past climate, as δ^2H_{alkane} reflects environmentally driven source- and leaf-water δ^2H values. However, δ^2H_{alkane} values can strongly vary among species at a single geographic location suggesting strong variation in species-specific biosynthetic ^2H-fractionation. Thus, species-specific variation in δ^2H_{alkane} values may cloud the interpretation of δ^2H_{alkane} in climate reconstructions.

Objectives

1) Determine variation in δ^2H_{alkane} values across species grown in a single location, and test if this is related to phylogeny (**Fig. 1**).
2) Distinguish sources of variation in species-specific δ^2H_{alkane} values between chloroplast and cytosol along the biosynthetic pathway (**Fig. 2**).

Conclusions

1) Large species-specific variation in δ^2H_{alkane} values needs to be accounted for in palaeoclimatological reconstructions.
2) Species-specific δ^2H_{alkane} values are shaped in both chloroplast and cytosol, but the extent of this depends on phylogeny.

❖ Potential new tool for understanding evolution of plant lipid metabolism?

Results & Discussion

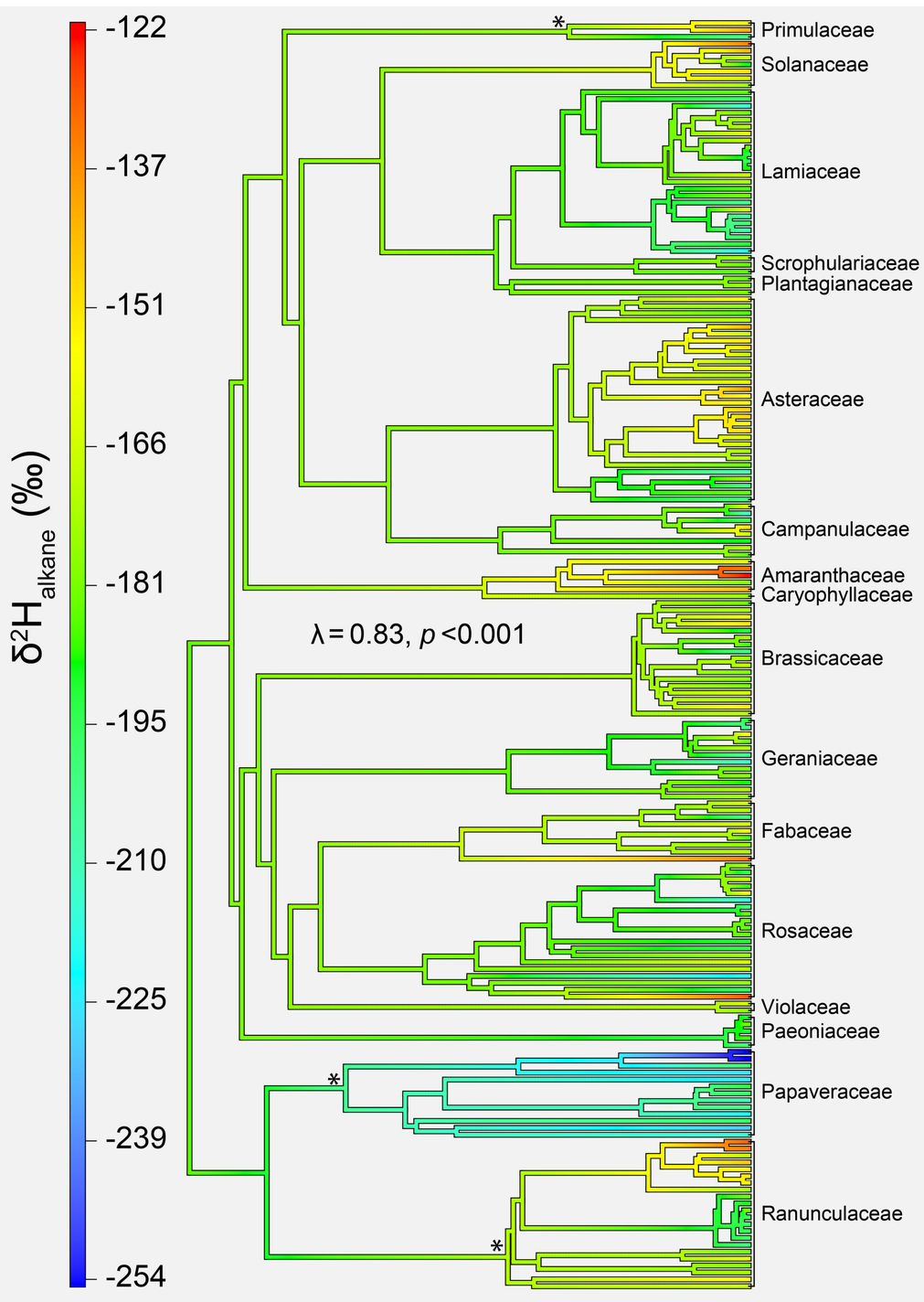

Figure 1: δ^2H_{alkane} values mapped as color gradient along branches of eudicot phylogeny. *Branches where species were sampled more densely in 2020.

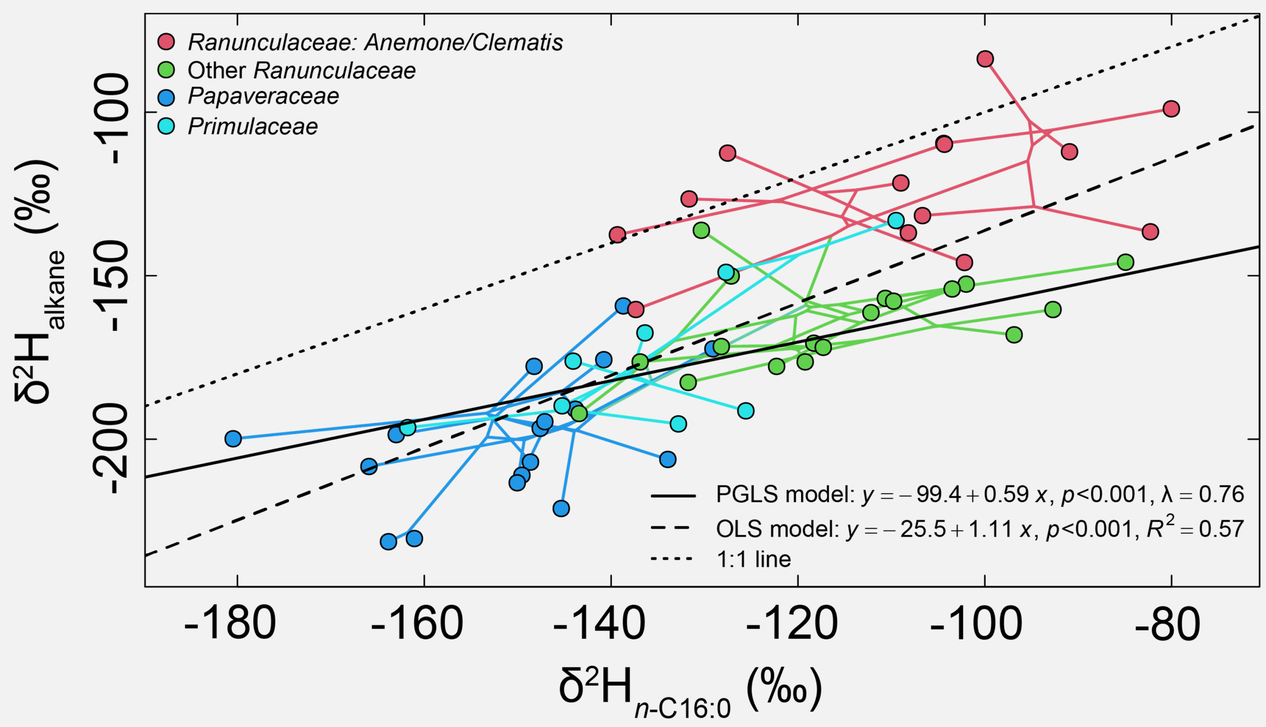

Figure 2: δ^2H_{alkane} values plotted against chloroplast produced precursor $\delta^2H_{n\text{-}C16:0}$ values. Each point is a single species and lines between points are branches of the phylogenetic tree. Abbreviations: PGLS, phylogenetic generalized least squares; OLS, ordinary least squares.

1) δ^2H_{alkane} values significantly evolved along the phylogeny and can vary up to 130 ‰ across eudicot species (**Fig. 1**), while leaf water δ^2H values varied only up to 35 ‰ across species (data not shown).
2) Chloroplast produced precursor, $\delta^2H_{n\text{-}C16:0}$ values can explain a large part of the variation in δ^2H_{alkane}, but additional variation is introduced in the cytosolic part of the biosynthetic pathway, which is dependent on phylogeny (**Fig. 2**).

Methods

All plants were sampled from the University of Basel botanical garden.

1) δ^2H_{alkane} values measured in leaves of 184 eudicot plant species in 2019.
2) δ^2H_{alkane} values and δ^2H values of chloroplast produced precursor (palmitic acid; $\delta^2H_{n\text{-}C16:0}$) measured in leaves of 58 species in 2020.

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