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Hydrogen isotope composition of leaf wax n-alkanes in Arabidopsis lines with different transpiration rates

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Stable isotopic compositions of oxygen and hydrogen are used widely to investigate modern and ancient water cycles. The D/H composition of organic compounds derived from terrestrial plants has recently attracted significant attention as a proxy for palaeohydrology. However, the role of various plant physiological and biochemical factors in controlling the D/H signature of leaf wax lipids in extant plants remains unclear. The focus of this study is to investigate the effect of plant transpiration on the D/H composition of n-alkanes in terrestrial plants.

This experiment includes 4 varieties of Arabidopsis thaliana that differ with respect to stomatal density and stomatal geometry. All 4 varieties were grown indoors under identical temperature, relative humidity, light and watering regimes and then sampled for leaf wax and leaf water stable isotopic measurements. During growth, stomatal conductance to carbon dioxide and water vapour were also determined.

We found that the plants varied significantly in terms of their transpiration rates. Transpiration rates were significantly higher in Arabidopsis ost1 and ost1-1 varieties (2.4 and 3.2 mmol m-2 s-1, respectively) than in Arabidopsis RbohD and Col-0 (1.5 and 1.4). However, hydrogen isotope measurements of n-alkanes extracted from leaf waxes revealed a very different pattern. Varieties ost1, ost1-1, and RbohD have very similar deltaD values of n-C29 alkane (-125, -128, and -127 per mil), whereas the deltaD value of Col-0 is more negative (-137 per mil).

The initial results of this work suggest that plant transpiration is decoupled from the D/H composition of n-alkanes. In other words, physical processes that affect water vapour movement between the plant and its environment apparently cannot account for the stable hydrogen isotope composition of organic compounds that comprise leaf waxes. Additional, perhaps biochemical, processes that affect hydrogen isotope fractionation during photosynthesis might need to be invoked to explain the reason for this decoupling. Our current work that also includes leaf water isotopic measurements will provide further details regarding the role of transpiration in controlling the deltaD values of leaf lipids.