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Hydrogen Apparent Fractionation between Precipitation and Leaf Wax n-Alkanes from Conifers and Deciduous Angiosperms along a Longitudinal Transect in Eurasia

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D/H composition of individual organic compounds derived from leaf wax may provide a wealth of information regarding plant-water relations in studies of plant ecology and climate change. Extracting that information from the organic D/H signal requires a thorough understanding of hydrogen isotope fractionation between environmental water and organic compounds. The purpose of this project is to investigate the importance of plant types and local climatic conditions on hydrogen apparent fractionation in higher terrestrial plants.

We determined D/H composition of n-alkanes derived from leaf wax extracted from several extant plants representing common evergreen and deciduous conifer (Pinus and Larix) and deciduous angiosperm (Betula, Salix, and Sorbus) genera along a longitudinal transect from the UK to central Siberia at 10 different locations. These data were used to calculate the apparent fractionation factor (epsilon) between source water, estimated using the Online Isotopes in Precipitation Calculator, and n-alkanes. Our initial results show the following.

First, we found large differences in the epsilon values among different genera at each location, e.g. Betula -63%■ vs. Salix -115%■ in Norwich, UK, and Betula -86%■ vs. Salix -146%■ in Novosibirsk, Russia. Assuming the plants at individual locations utilized soil water of very similar deltaD values, variations in the epsilon values are likely to be explained by differences in plant physiology and biochemistry.

Second, we identified extensive shifts in the epsilon values in individual species along the transect from the UK to central Siberia, e.g. Betula -63%■ in Norwich vs. -104%■ in Zotino, Krasnoyarsk Krai, central Siberia and Salix -115%■ in Norwich vs. -164%■ in Sodankyla, Finland. With the exception of Sorbus, there is a positive relationship between the MAT (mean annual temperature) and epsilon values at locations above 2 °C MAT, suggesting a possible climatic effect on isotopic fractionation. However, this relation between the MAT and epsilon values collapses at locations with MAT below that temperature. For example, epsilon in Betula varies between -61 and -104%■ among Sodankyla, Novosibirsk and Zotino, all of which are characterized by 1 °C MAT. The nature of this observation is currently not clear. Because all 3 locations do not differ substantially in terms of the amount of precipitation and relative humidity, we suggest that the Online Isotope Calculator may not be sufficiently accurate for estimating the deltaD values of source water in Sodankyla, Novosibirsk and Zotino. For example, significant differences in the contribution of D-depleted snowmelt to soil water utilized by plants during the growing season may not necessarily be captured by estimating annual deltaD of precipitation for epsilon calculations.

Further research involving deltaD of soil and leaf water as well as modeling of leaf water evaporation at individual locations will clarify which factors and to what extent control hydrogen isotope fractionation in various higher terrestrial plants growing in different climatic conditions.