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Influence of plant growth form, habitat and season on leaf-wax n-alkane hydrogen-isotopic signatures in equatorial East Africa

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Leaf-wax n-alkanes are produced by terrestrial plants, and through long-term preservation in sediments their stable hydrogen-isotopic signature (δ^2H_{wax}) provides useful information on past hydrological variation for paleoclimate reconstructions. However, gaps remain in our understanding of the isotopic relationships between the leaf waxes and the plants' source water. In this study, we investigated the influence of plant growth form, habitat and season on the distribution patterns and δ^2H_{wax} values of 14 plant species (among which are two grasses, five trees and seven shrubs) sampled during four successive dry and wet seasons in three distinct habitats around Lake Chala in equatorial East Africa. Variation in δ^2H_{wax} was analyzed with linear mixed-effect models and compared with the associated values of xylem water (δ^2H_{xylem}), leaf water (δ^2H_{leaf}) and biosynthetic hydrogen fractionation (ε_{bio}). Our results show that plant growth form was the most important driver of modern-day δ^2H_{wax} variability in the study area, and that differences in δ^2H_{wax} between habitats to a large extent reflect the representation of the three major growth forms in those habitats. Individual plant species appear to express substantial species-specific isotopic fractionation that cannot be attributed to the tested external factors but rather seem to depend on intrinsic (e.g., plant phenological and biosynthesis-related) factors. For the purpose of calibrating δ^2H_{wax} signatures against vegetation types, it is thus crucial to analyze representative samples of the plant communities present in the study area. Our results further indicate that paleohydrological studies in regions receiving rain from multiple moisture sources must take into account possible seasonal bias in the δ^2H_{wax} signature relative to annual rainfall, due to unequal use of those moisture sources by the plants. Finally, the strong influence of plant growth form on δ^2H_{wax} values argues for systematic evaluation of δ^2H_{wax} variation in paleo-records in conjunction with independent proxy data on changes in vegetation composition. Differences in n-alkane distribution patterns (average chain length, carbon preference index and $C_{31}/(C_{29}+C_{31})$ ratio) among trees, shrubs and grasses may provide such a proxy, and can be produced from the same leaf-wax n-alkane dataset used to determine δ^2H_{wax}.