

¹³C discrimination related to phylogeny and leaf habit in modern woody plant types: Implications for ecological controls on bulk, n-alkane, and terpenoid carbon isotope records preserved in Paleocene-Eocene terrestrial sediments

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Changes in plant ecology may be a significant—but often understated—factor controlling carbon isotope values of terrestrial organic carbon in the geologic past. For example, paleofloristic data in the Bighorn Basin (WY, USA) document a mixed angiosperm-conifer flora in the late Paleocene, which shifts to an angiosperm-dominated flora during the Paleocene-Eocene Thermal Maximum (PETM). This event correlates with a 2-3 permil increase in carbon isotope fractionation inferred from plant n-alkanes and bulk organic matter (Smith et al., 2007). An improved understanding of plant leaf ¹³C patterns has potential to provide insights to climatic and botanical factors underlying the large variability typically observed in ancient terrestrial organic carbon. We have compiled a large data set comprised of ¹³C discrimination values for 249 species of woody plants (48 publications, 80 sites, 7 biomes, 57 Families, 151 Genera) delineated by leaf habit and phylogeny, and by climate, biome, and geography. We observe positive linear relationships between ¹³C discrimination values and mean annual precipitation across all biomes, latitudinal zones and within plant functional groups. We also observe statistically significant differences between leaf habit and phylogeny in our global dataset across biomes where 1) deciduous angiosperms have higher ¹³C discrimination than evergreen conifers and 2) deciduous conifers have higher discrimination than evergreen conifers. When comparing differences between leaf habit and phylogeny at individual sites, we observe larger ¹³C discrimination differences between plant functional types. Comparisons within a given site help to limit variation in canopy effects, respiration, humidity, and precipitation and thus may have better specificity with regard to geologic samples. Paleocene and Eocene (60 to 52.6 Ma) sediments from the Bighorn Basin (WY, USA) document large changes in the ratio of conifers to angiosperm floras derived from leaf fossil evidence as well as from terpenoid biomarkers (tricyclic diterpenoids and pentacyclic triterpenoids specific for conifers and angiosperms, respectively). End members defined by biomarker analyses are consistent in magnitude with differences found for modern plants, and observed floral shifts. These findings highlight a need to constrain ecological and precipitation effects prior to paleoclimate reconstruction or chemostratigraphy based on bulk carbon isotope records.