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Should alkane biomarker results be corrected for degradation effects when reconstructing vegetation changes?

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N-alkanes with 25 to 33 carbon atoms are important constituents of plant leaf waxes and thereby typically reveal a strong odd over even predominance (OEP). The homologues C27 and C29 are characteristically dominant in most trees and shrubs, whereas C31 and C33 are dominant in grasses and herbs. With the litter-fall the cuticular alkanes are also deposited in sediments and soils, where they are regarded to be relatively resistant to degradation and therefore may serve as plant-derived biomarkers. Hence, alkane ratios like C31/C27 have been used in Quaternary studies to reconstruct vegetation changes.

But in fact a change of alkane patterns has been reported when comparing fresh litter and the soil organic matter developing from it. This can be either attributed to a selective removal of alkanes during degradation, to the input of root or microbial biomass or to thermal degradation. On the one hand, the alkane patterns are getting more balanced, i.e. dominances of C27 in trees and C31 in grasses, respectively, are reduced and the ratios C31/C27 are approximating the value 1. Hence, reconstructed vegetation changes neglecting this effect may be invalid. On the other hand, it has been shown for several litter types that the OEP values, being high in fresh plant material, are becoming lower during organic matter degradation.

Aiming at reconstructing vegetation changes in loess-palaeosol sequences of the Vojvodina, Serbia, we did not only sample the Quaternary sequence, but additionally analysed modern litter and topsoils from natural forests and grasslands. We propose to use the OEP as proxy for degradation and plot the alkane ratios in percent against the OEP in order to obtain ‘degradation lines’ for grassland- versus forest- derived organic matter (Zech et al., 2009, Eiszeitalter und Gegenwart – Quaternary Science Journal, submitted). Accordingly, for a given loess or palaeosol sample, an improved (corrected for the degradation effect) estimation of the percentage contribution of tree- versus grass-derived alkanes can be determined in two steps. Firstly, using the OEP of a sample, the respective alkane ratio end-members for grassland and forest are calculated by means of the functions describing the degradation lines. Secondly, using the end members obtained for a certain sample, the percent contribution of the two vegetation types is estimated by means of a two component mixing equation.

Modelling results for the alkane ratios C31/C27, C31/C29, C33/C27 and (C31+C33)/(C27+C29) from the investigated loess-palaeosol sequence in Serbia are very similar. Although they question the traditional and palynologically derived paradigm of treeless full-glacial palaeoenvironments, they are in apparent agreement with charcoal and malacological findings from the Carpathian Basin.