

$\delta^{13}\text{C}$ values of aquatic macrophyte-derived mid-chain n-alkanes as a proxy for carbon limitation in Tibetan lakes

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With a set of surface sediment samples and corresponding plants from the Tibetan Plateau we show that aquatic macrophytes significantly influence the the lipid composition as well as the $\delta^{13}\text{C}$ values (bulk and compound specific) of sedimentary organic matter in this region. Submerged macrophyte species like *Potamogeton pectinatus* turned out to show wide ranges of $\delta^{13}\text{C}$ values in bulk organic matter (-23.3‰ to -6.0‰) and in n-alkanes (e.g. -28.0‰ to -16.6‰ for nC23) due to bicarbonate metabolism in the alkaline and shallow lakes, containing dense macrophyte populations. In a sediment core from Lake Koucha, the strong correlation between TOC contents, total amounts mid-chain n-alkanes and $\delta^{13}\text{C}$ values of TOC and nC23 suggest that the lake was aquatic macrophyte-dominated before 8 cal ka BP. At 7.2 cal ka BP, a variety of algal and bacterial markers like hopanoids, sterenes and isoprenoids occur, of which especially phytane, pentamethylcosene (PMI), moretene and diploptene are highly abundant. Phytane and PMI show different isotopic signals (\approx -18‰ and \approx -28‰) which indicates that they originate from different sources. The isotopic depletion of diploptene (\approx -60‰) gives evidence for the presence of methanotrophs. From 6.1 cal ka BP on the high abundance of C20 and C25 highly branched isoprenoids (HBIs) suggest that the lake shifted to a phytoplankton dominated system. $\delta^{13}\text{C}$ values of nC23 range from -23.5‰ to -12.6‰ throughout the core, with maxima at the peak of macrophyte abundance at ca 11 cal ka BP and during the phytoplankton maximum between 5 and 2 cal ka BP. Thus, aquatic macrophyte-derived mid-chain n-alkanes turn out to be excellent recorders of carbon-limiting conditions which lead to the assimilation of isotopically enriched carbon species. The limitation of carbon sources could either be a local phenomenon at dense plant stands (as in the older section of the core) or induced by high primary productivity (as in the younger section). Since the $\delta^{13}\text{C}$ value of the inorganic carbon source can vary, the offset between the $\delta^{13}\text{C}$ values of nC23 and TIC might serve as a more precise proxy for carbon-limiting conditions in lacustrine environments which in turn can be interpreted with respect to lake paleo-productivity.