Investigation of organic-rich fossil material from Eocene Lake Messel, Germany using C and N stable isotopes

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Carbon and nitrogen stable isotopic compositions of autolithified soft tissues from Messel (49Ma) vertebrate fossils are used to investigate fossil ecosystem dynamics. Messel's fossil flora and fauna are diverse and exquisitely preserved. Insects and plants are preserved with original material intact. Stable isotope results are compared to previous trophic reconstructions based on gut contents and coprolites, and also to related modern organisms. Different tissues within fish specimens are isotopically distinct, with intraorganism fractionations similar to those observed in modern organisms. Stable isotope signatures also clearly reflect the feeding patterns of fossil organisms. Primary producers are associated with low $\delta^{15}N$ values and consumers are enriched +2‰ $\delta^{15}N$ or more relative to these values depending on their diets. Messel fossil organisms represent several trophic levels in each of two trophic webs, one aquatic and one terrestrial. Both trophic systems include primary producers (terrigenous and aquatic plants), primary consumers (insects), and higher consumers (carnivores such as fish, crocodiles, and frogs). $\delta^{13}C$ values for these organisms trace carbon sources and indicate widespread omnivory in both low and high trophic level consumers. A thorough understanding of trophic structure in Lake Messel contributes to the global databank of ecological history.