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East African Hominid Paleoecology: Isotopic Evidence from Paleosols

The carbon isotopic composition of soil carbonate can be used to reconstruct the proportion of C₃ (trees and shrubs) to C₄ biomass (grasses) in the past. The main sources of uncertainty in these estimates arise from (1) the variability $\delta^{13}\text{C}$ values of plants, (2) uncertainties in soil respiration rates, and (3) uncertainty in the mean depth of production in soil CO₂. The combined records from eleven studies in East Africa show that C₄ grasses expanded unevenly from area to area. The critical period 9 to 7 Ma—when C₄ grasses began to expand in other areas of the world—is only covered in Africa by a few data points from Lothagam. The Lothagam record shows that C₄ grasses appear to have expanded sharply sometime between 9 and 8.4 Ma, and a savanna ecosystem was present by 6 to 7 Ma. Somewhat younger deposits at Baringo and Kanapoi in Kenya, and Gona in Ethiopia also record the substantial presence of C₄ grasses (up to 50%) by no later than 4.5 Ma. This was the paleovegetational context of *Ardipithecus ramidus* at Gona. In most areas, however, savanna ecosystems (up to 80% grass cover) developed unevenly and much later than at Lothagam, at Gona by 2.71 Ma and later at Turkana, by 2.0 Ma. The savanna expansion in most areas overlaps the rise of *Homo* across East Africa and the earliest documented stone-toolmaking at Gona.

The oxygen isotopic record in soil carbonates also contains valuable information. Two important conclusions from the East African record are that: 1) there is large regional variation in oxygen isotopic values across East Africa; and 2) the minimum oxygen isotopic values from almost all soil carbonate records in East Africa are too low to have formed in equilibrium with modern meteoric waters. These observations imply considerable regional heterogeneity in the climatic and topographic variables that determine oxygen isotopic compositions, as well as significant climatic differences between today and the past. At Gona, it is clear that soil carbonates with low $\delta^{18}\text{O}$ values formed during a wetter time period when circulation patterns in East Africa were different from today. Full interpretation of the soil carbonate oxygen isotopic record

requires careful use of multiple proxies and understanding of modern local and regional isotopic system.

The isotopic record from paleosols in East Africa is seriously hampered by undersampling. The period 18 to 7 Ma has been barely touched, and the few studies from that period are confined to western Kenya. Much more data from the 1-3 Ma period is needed to examine the antiquity of savannas in East Africa and their temporal relationship to the rise of *Homo*.