The Pleistocene expansion of C_4 grasses in eastern Africa and the role of atmospheric pCO_2

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Grasses play a critical role in views of the environmental context for human evolution. $\delta^{13}C$ records of fossil teeth, soil carbonates, and leaf waxes indicate that C_4 grasses were prevalent in eastern Africa since the late Miocene but only became consistently dominant parts of landscapes during the Pleistocene. The more recent C_4 expansion is important for human evolution as it coincides with the appearance of hominin omnivory, bigger brains, and bodies adapted to long-distance travel.

The Pleistocene success of C_4 grasses is recorded by multiple proxies but soil carbonate $\delta^{13}C$ records are particularly telling as they indicate the dominance of C_4 plants in one of the least likely places: large floodplain soils where C_3 trees, shrubs, and herbs should be abundant. This dominance is traditionally attributed to increased aridity [1], but recent foraminiferal $\delta^{11}B$ records of atmospheric pCO_2 below 350 ppm in the Pleistocene [2, 3], a threshold in the quantum yield of C_3 and C_4 plants in warm environments [4], should revitalize arguments for the importance of pCO_2 levels on distributions of C_4 plants. The dominance of C_4 grasses during the Pleistocene in eastern Africa and elsewhere likely represents an ecological shift that involves the interplay between pCO_2, fire, grazing, and aridity [5]. The ecological significance of the emergence of *Homo* should be considered in terms of a low pCO_2 world.

[1] deMenocal (2004) *EPSL* **220**, 3-24. [2] Hönisch *et al* (2009) *Science* **324**, 1551-1554. [3] Bartoli *et al* (2011) *Paleoceanography* **26**, PA4313. [4] Ehleringer *et al* (1997) *Oecologia* **112**, 285–99. [5] Bond & Midgley (2012) Phil. *Trans. R. Soc. B* **367**, 601-612.