Origin of the C_4 grass savannah in South-Western Africa

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Modern tropical savannah grasslands are dominated by grasses using the C_4 photosynthetic pathway. The Mio-/Pliocene expansion of C_4 grasses in tropical savannahs, however, remains enigmatic since regional differences in timing rule out a common forcing by atmospheric CO_2 levels. Other environmental factors have been suggested as potential driving factors but conclusive evidence is missing. Here, we present organic-geochemical and palynological data from ODP cores offshore southwestern (SW) Africa recording the regionally integrated history of SW African drylands by wind-blown terrigenous signals. Organic proxy parameters for ocean temperatures were analysed in parallel to document the evolution of the Benguela upwelling system and unravel land-ocean climate linkages. Surface and subsurface ocean temperature estimates indicate an upwelling intensification from 10 million years (Ma) onward triggered by Antarctic ice-sheet expansion and intensification of Southern Hemisphere southeasterly trade winds [1]. An increased summer drought in southernmost SW Africa led to the disappearance of Afromontane forests and development of semi-arid succulent vegetation in the Cape flora [2]. From 8 Ma onward, tropical grass savannah expanded in the Kalahari [3]. Compound-specific stable carbon analyses of plant waxes indicate a dominance by C_3 plants [3]. Hydrogen isotope analyses reveal concurrent large-scale aridification and an inferred shift from Atlantic to Indian Ocean moisture sources at around 7 Ma [4]. At this time, elevated contents of micro-charcoal in the sediments indicate increased fire occurrence and first expansion of C_4 grasslands [3]. The intensified fire regime ended around 6 Ma when the coastal desert expanded [3]. The C_4 plant fraction in the vegetation, however, continued to increase upon further aridification [3]. We infer a crucial sequence of events from aridification leading to initial grass expansion and increased fire disturbance as ultimate trigger for establishment of the modern C_4 dominated grass savannah in SW Africa.

[1] Rommerskirchen *et al* (2011) *Paleoceanography* **26**, PA3216. [2] Dupont *et al* (2011) *J. Biogeogr.* **38**, 1059-1068. [3] Hoetzel *et al* (2013) *Nature Geoscience* **6**, 1027-1013. [4] Dupont *et al* (2013) *EPSL* **375**, 408-417.