A 25 M.Y. ISOTOPIC RECORD OF PALEODIET AND ENVIRONMENTAL CHANGE FROM FOSSIL MAMMALS AND PALEOSOLS FROM THE NE MARGIN OF THE TIBETAN PLATEAU

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Introduction

Late Cenozoic vegetation and climate records from China are crucial to understanding the effects of the uplift of the Himalaya and the Tibetan plateau on regional and global climate as well as to understanding of the evolution of hominids. However, direct paleoenvironmental information is lacking in many parts of China. In this study, we use the carbon and oxygen isotopic compositions of fossil tooth enamel and paleosols to reconstruct the late Cenozoic history of vegetation and environmental change in the Linxia Basin at the northeastern margin of the Tibetan Plateau.

Results and Discussion

The $\delta^{13}C$ values of fossil enamel from a diverse group of herbivores and of paleosol carbonate and organic matter indicate that C4 grasses were either absent or insignificant in the Linxia Basin prior to ~2–3 Ma and only became a significant component of local ecosystems in the Quaternary (Figure 1). This is in striking contrast to what was observed in Pakistan, Nepal, Africa and the Americas where C4 plants expanded rapidly at about 7–5 Ma as indicated by a positive $\delta^{13}C$ shift in mammalian tooth enamel and paleosols. The $\delta^{18}O$ results from the same herbivore species show several significant shifts in climate in the late Cenozoic. Most notably, a positive $\delta^{18}O$ shift after ~7 Ma indicates a shift to warmer and/or drier conditions and is comparable in timing and direction to the $\delta^{18}O$ shift observed in paleosol carbonates in Pakistan and Nepal. This late Miocene climate change observed in the Indian sub-continent and in the Linxia Basin, however, seems to be a regional manifestation of a global climate change. The lack of evidence for C4 plants in the Linxia basin prior to ~2–3 Ma suggests that the East Asian summer monsoon, which brings precipitation into northern China during the summer and creates optimal conditions for the growth of C4 grasses, was probably not strong enough to affect this part of China throughout much of the Neogene. This implies that the Himalayan-Tibetan Plateau may not have reached the present-day elevation and extent to support a strong East Asian monsoon system before ~ 2–3 Ma and that significant uplift occurred more recently in the Plio-Pleistocene. Our data also suggest that regional climatic conditions played an important role in controlling the expansion of C4 plants.

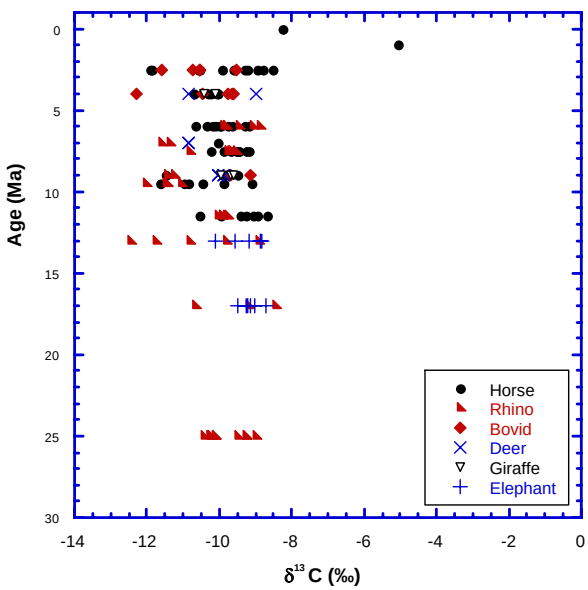

Figure 1. The $\delta^{13}C$ of herbivore tooth enamel and paleosol carbonate from the Linxia Basin.

Conclusions

The landscape in the Linxia Basin was dominated by C3 plants prior to ~2-3 Ma. C4 plants became an important component of local ecosystems in the Quaternary. The late expansion of C4 plants into the Linxia Basin implies that the present-day elevation of much of the Tibetan Plateau was reached after ~ 2-3 Ma although significant uplift had occurred much earlier.