ANCIENT DIETS INDICATE SIGNIFICANT UPLIFT OF SOUTHERN TIBET AFTER 7 MILLION YEARS AGO

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Introduction

The Tibetan Plateau is important for driving the modern Asian monsoons, with profound effects on global atmospheric circulation, climate, and erosion, as well as biological and ecological migration. However, the timing of the surface uplift of the Tibetan Plateau and how it was distributed both spatially and temporally are still hotly debated. Here we present a stable carbon isotopic record of paleodiet and paleoenvironment in the high Himalayas that is preserved in bioapatite of fossil mammalian tooth enamel. Our carbon isotope data provide independent evidence that sheds new light on the debate concerning the timing of the uplift of the Tibetan Plateau.

Results and Discussion

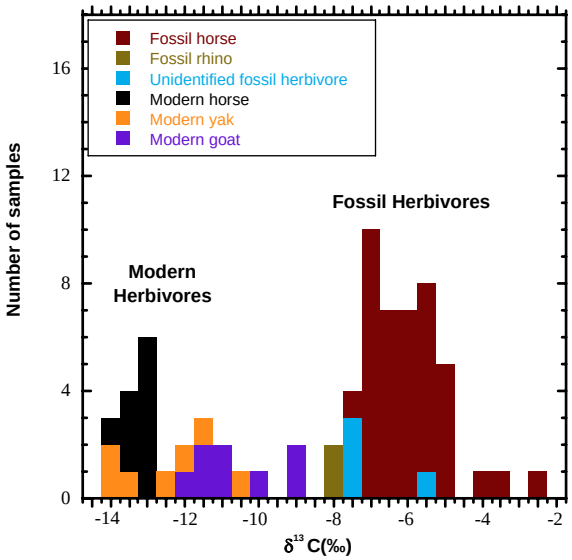

Figure 1. Stable carbon isotopic composition of tooth enamel from both modern and ancient herbivores in the Gyirong Basin in the high Himalayas

We analyzed 46 fossil enamel samples from primarily horses and rhinos and few unidentified herbivores collected from the Gyirong Basin (28°46.13N, 85°17.84E) in the high Himalayas. In addition, we analyzed 26 modern herbivore teeth from the area. The $\delta^{13}C$ values of tooth enamel samples from modern domesticated horses (*Equus caballus*), yaks (*Bos mutus*) and goats (*Capra hircus*) in the Gyirong Basin range from –9.0 to –14.2‰ (Figure 1), with a mean value of –12.2±1.5‰ (n=26), indicating a pure C_3 diet consistent with the current dominance of C_3 vegetation in the area. Fossil tooth enamel from horses in the Gyirong Basin, on the other hand, have $\delta^{13}C$ values ranging from –2.4‰ to –8.0‰ (Figure 1), with a mean of –6.0±1.1‰, indicating that these ancient horses were feeding on both C_3 and C_4 vegetation with about 30 to 70% C_4 grasses in their diets, assuming pure C_3 and C_4 end-member enamel $\delta^{13}C$ values of –12‰ and +2‰, respectively. Fossil rhino enamel samples have a mean $\delta^{13}C$ value of -7.9±0.1‰, also indicating a mixed C_3-C_4 diet with about 30% C_4 plants. The presence of significant amounts of warm-climate C_4 grasses in the diets of these 7 million-year-old mammals indicates that C_4 grasses were an important component of local ecosystems in the area at that time. The local ecosystems in the Gyirong Basin in the latest Miocene likely included grasslands and/or wooded grasslands that had significant amounts of C_4 grasses, which is consistent with forested grassy plain and shrubby grassland habitats represented in pollen analyses. Our finding that C_4 grasses were an important component of local ecosystems in the latest Miocene in the Gyirong Basin is significant, indicating that the area had a much warmer climate and a much lower elevation during the late Miocene than today.

Conclusions

Carbon isotopic evidence, preserved in tooth enamel from 7 million year old horses and rhinos from the high Himalayas, indicates that, unlike modern herbivores in the area, these ancient mammals ate substantial amounts of C_4 grasses. The presence of significant amounts of C_4 grasses in the diets of these ancient mammals indicates that the climate in the area was much warmer and the elevation was much lower in the late Miocene than today. The carbon isotope data from the high Himalayas, after accounting for late Cenozoic global cooling and paleo-atmospheric CO_2 levels, indicate that this part of southern Tibet was less than 2900-3400 m above sea level in the latest Miocene. This implies that the present elevation of the area must have been attained after 7 million years ago, much later than generally believed.