

## Stable isotope analysis of middle Miocene mammals from the Siwalik sub-Group of Pakistan

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Stable isotope analysis is pivotal for investigating the paleodiet and paleoecology of past mammals. In this paper, we analyzed thirty fossil enamel samples belonging to the families Suidae, Rhinocerotidae, and Deinotheriidae for  $\delta^{13}\text{C}_{\text{enamel}}$  and  $\delta^{18}\text{O}_{\text{enamel}}$  composition to investigate paleodiet and paleoecology of middle Miocene mammals of the Siwalik sub-Group of Pakistan. The three mammalian groups, when combined together, yielded an average  $\delta^{13}\text{C}_{\text{enamel}}$  value of  $-12.2 \pm 2\text{‰}$ , indicating a pure to nearly pure C<sub>3</sub> diet. Suids show slightly higher  $\delta^{13}\text{C}_{\text{enamel}}$  values of  $-11.2 \pm 1.4\text{‰}$  when compared to rhinocerotids and deinotheres ( $-12.3 \pm 0.8\text{‰}$  and  $-12.5 \pm 1.3\text{‰}$ , respectively), which could be explained by selective foraging on new leaf shoots or feeding from open spaces. Alternatively, the differences in  $\delta^{13}\text{C}_{\text{enamel}}$  could be due to different digestive physiologies and different enamel-diet enrichment factors. Members of all three families showed significant differences in  $\delta^{18}\text{O}_{\text{enamel}}$  values, where suids yielded higher  $\delta^{18}\text{O}$  values of  $-8.2 \pm 1.2\text{‰}$  compared to rhinocerotids and deinotheres ( $-11.4 \pm 1.8\text{‰}$  and  $-10.4 \pm 1.7\text{‰}$ , respectively). Based upon these results, we assume that these mammals inhabited subtropical forests similar that of mid-Miocene of the Siwalik Group, India and Nepal. The modern analogues of such vegetation system are present in East and South of Myanmar, Nepal, and Malaya where precipitation is enough to support evergreen C<sub>3</sub> forests. By contrast, today's floodplain environments in Pakistan are dominated by C<sub>4</sub> grasses, and C<sub>3</sub> vegetation is only present in non-floodplain settings.

**Key words:** Mammalia, paleoclimate, paleodiet, Miocene, Chinji Formation, Pakistan.

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