THE THERMAL PHYSIOLOGY OF THE DINOSAURIA: DIRECT EVIDENCE FROM OXYGEN ISOTOPES

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The thermal physiology of extinct reptiles has been a hotly debated topic for the last two decades, with no direct evidence available to help solve the debate. Oxygen isotopes are fractionated with respect to temperature between an animal's body water and bone phosphate, thus providing avenues for deriving the first direct evidence of dinosaur thermal physiology.

Multiple samples from both cortical and cancellous areas from individual bones were sampled in order to determine the heterogeneity of $\delta^{18}O$ values within single bones. Bones from both the body core (ribs and vertebrae) and the extremities (limbs and caudal vertebrae) of known individual dinosaurs were sampled in this method. This allows for a comparison of isotopic heterogeneity from bones of all body regions. In ectothermic heterotherms or mass homeotherms the $\delta^{18}O$ values from the extremities are expected to generally be heavier than those from ribs or dorsal vertebrae. It is also expected that there would be a greater degree of heterogeneity of $\delta^{18}O$ values from bones in the extremities than those in the body core for these individuals. This relationship would result from the greater degree of heat loss from the extremities than body cores due to greater surface areas and distance from the heart. This relationship has been seen in analyses on bones from the modern *Varanus komodoensis*. On the other hand, true endothermic homeotherms should show a very narrow range of hetergeneity of $\delta^{18}O$ values both within individual bones and between bones within single individuals as seen in modern mammals.

Dinosaurs analyzed indicate isotopic heterogeneities within individual bones intermediate between modern mammals and *Varanus*, with the *Tyrannosaurus* showing the greatest isotopic variability. However, this isotopic heterogeneity is relatively small and is not significantly different for bones from the body core and extremities. This indicates that heterogeneity of the $\delta^{18}O$ values is most likely the result of variations in drinking water $\delta^{18}O$ values throughout an individual's lifetime rather than daily or seasonal variations in body temperatures.

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