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Isotopic ordering in eggshells reflects body temperatures and suggests differing thermophysiology in two Cretaceous dinosaurs

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Our understanding of the evolutionary transitions leading to the modern endothermic state of birds and mammals is incomplete, partly because tools available to study the thermophysiology of extinct vertebrates are limited. Here we show that clumped isotope analysis of eggshells can be used to determine body temperatures of females during periods of ovulation. Late Cretaceous titanosaurid eggshells yield temperatures similar to large modern endotherms. In contrast, oviraptorid eggshells yield temperatures lower than most modern endotherms but $\sim 6^\circ\text{C}$ higher than co-occurring abiogenic carbonates, implying that this taxon did not have thermoregulation comparable to modern birds, but was able to elevate its body temperature above environmental temperatures. Therefore, we observe no strong evidence for end-member ectothermy or endothermy in the species examined. Body temperatures for these two species indicate that variable thermoregulation likely existed among the non-avian dinosaurs and that not all dinosaurs had body temperatures in the range of that seen in modern birds.

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