

EGGSHELL CLUMPED ISOTOPE TEMPERATURES: IMPLICATIONS FOR DINOSAUR THERMOREGULATION

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Carbonate clumped-isotope (Δ_{47}) paleothermometry has been used to estimate the body temperatures of extinct dinosaurs [Eagle *et al.*, 2011], giving results within the range of modern endotherms. However, only a single clade, the sauropods, was investigated and it is unclear whether this is due to endothermy or their size (i.e. gigantothermy). The evolutionary timing of endothermy within Dinosauria is still debated [Grady *et al.*, 2014], therefore we use Δ_{47} paleothermometry of well-preserved dinosaur eggshells to test if smaller dinosaurs also had warm body temperatures and if there is a difference in body temperatures between dinosaurs more closely (i.e. *Troodon*) and more distantly (i.e. *Maiasaura*) related to birds [Zelenitsky *et al.*, 2002].

Well preserved (based on SEM and trace element metal analysis) *Troodon* and *Maiasaura* eggshells from one locality give Δ_{47} temperatures within the range of modern endotherms (~ 37-42 °C). Poorly preserved hadrosaur eggshell from the same locality has a Δ_{47} temperature (~ 32 °C) closer to the Δ_{47} estimated paleoenvironmental temperature (~ 28 °C; based on a well preserved bivalve). A well preserved *Troodon* eggshell from another locality gives a Δ_{47} temperature ~ 27 °C, similar to a poorly preserved hadrosaur eggshell and a well preserved freshwater gastropod (~ 28 °C and ~ 26 °C, respectively) from the same locality. If our preservation interpretations are correct, dinosaur metabolism of those closely related to birds allowed for a range in body temperatures of at least ~ 10 °C. The variability in *Troodon* Δ_{47} estimated body temperatures may be due to different behavioral habits, as in modern ectotherms, or indicative of mesothermic metabolisms as in modern sharks and tuna [Grady *et al.*, 2014].

Eagle, R. A., et al. (2011) Dinosaur body temperatures determined from isotopic (¹³C-¹⁸O) ordering in fossil biominerals. *Science*, 333, 443-445.

Grady, J.J., et al. (2014) Evidence for mesothermy in dinosaurs. *Science*, 344, 1268-1272.

Zelenitsky, D. K., et al. (2002) *Cretaceous Research* 23, 297-305.