

## Using dual clumped isotope thermometry to better understand the dinosaur-bird transition.

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Birds have become one of the most widespread group of vertebrates on the planet following their evolution from dinosaurs during the Late Jurassic [1]. A precise and detailed reconstruction of all steps composing this transition is still missing, including information about changes in the reproductive process [2]. Modern reptiles are living representatives of the evolutionary line connecting reptiles-dinosaurs-birds, and thus they can be used to determine the ancestral conditions for both dinosaurs and birds. When the reproductive mode of reptiles and birds is compared several contrasts arise, spanning from behavioral differences (e.g. parental and nesting strategies) and structural differences (e.g. number of ovaries and oviducts).

With the advent of the  $\Delta_{47}$ -thermometer it became possible to reconstruct body temperatures of dinosaurs, through the analysis of teeth and eggshells. Now, the combined analysis of  $\Delta_{47}$  and  $\Delta_{48}$  (i.e., dual clumped isotope thermometry) [3] allows determination of the extent to which carbonate (bio)mineralization was controlled by kinetics in addition to temperature [4].

For this study, we analyzed the dual clumped isotopic composition of eggshells of modern reptiles and birds to investigate potential differences in eggshell biomineralization between ecto- and endotherms. In addition, we analyzed the dual clumped isotopic composition of eggshells of four different specimens of *Troodon*(Paraves), one of the last bird-like dinosaurs [1]. We will present the  $\Delta_{47}$  and  $\Delta_{48}$  patterns of these three groups and discuss the implications concerning the evolution of the reproductive system and thermophysiology.

[1] Brusatte, O'Connor & Jarvis (2015), The Origin and Diversification of Birds. *Current Biology* 25, R888-R898.

[2] Varricchio & Jackson (2016), Reproduction in Mesozoic birds and evolution of the modern avian reproductive mode. *The Auk* 133, 654-684.

[3] Fiebig *et al.* (2021), Calibration of the dual clumped isotope thermometer for carbonates. *Geochimica et Cosmochimica Acta*.

[4] Guo (2020), Kinetic clumped isotope fractionation in the DIC-H<sub>2</sub>O-CO<sub>2</sub> system: Patterns, controls, and implications. *Geochimica Et Cosmochimica Acta* 268, 230-257.