



## **Do brooding and polygamy behaviors exist on Cretaceous oviraptoroid dinosaurs of China: a paleobiological perspective**

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Brooding, parental care, and polygamy represent three different stages in bird's reproduction. The origin of these behaviors is still in debate. Several samples excavated from China strengthen the phylogenetic relationship between birds and dinosaurs, for example, feathered dinosaurs, paired-eggs in pelvic region of an oviraptorid dinosaur, and small theropod fossils. Previous studies in past two decades, including an oviraptor sitting on a clutch and comparison of the ratio of clutch-volume to adult-body-size between Aves and Mesozoic dinosaurs, proposed that these behaviors had appeared on some Cretaceous theropods (e.g., oviraptor and troodon). These researches also indicate the possibility of endothermy and male care first. In conclusion, this reproduction strategy might support females having more remnant energy to build a larger clutch contributed eggs from multiple females, and brooded by males only.

From our cluster analysis through paleoecological perspectives, the eggs in Cretaceous oviraptor's nest should not be corporately laid by multiple females. In morphological observation, the fossilized clutches from Ganzhou, Jiangxi, Mainland China, are 2-layered interbedded with matrix of reddish-brown siltstone or clays. The inner-layer eggs are hampered from directly contacting with adult dinosaurs body. Furthermore, the blunt ends of the eggs point to the center, and incline away forming a mound-shape nest, which is completely different from those of precocial and male-caring megapode. The ornamentation of eggshell surface and microstructures from thin sections of eggs from oviraptors and ostrich (*Struthioniformes*) are totally different. Comparison of thickness in different part of oviraptor's egg also reveal possible physiological structure in the egg and ecological behaviors. The detailed comparison implies that the Mesozoic oviraptoroid dinosaurs hold absolutely different incubation and caring behaviors from extant birds.

We propose an alternative hypothesis herein suggesting that the paternal care and brooding behaviors not originated from Mesozoic clade of dinosaurs, which didn't brood their clutch and show polygamy behaviors, either. The oviraptors dinosaurs adults laid pair eggs each time, arrange them toroidally, buried them in a substrate, and then superpose another layer of eggs. Oviraptoroid dinosaurs probably guard their exquisite nests without caring and egg-rotation behaviors, just alike to extant crocodylians which belong to the same clade of Archosaur Reptiles.