

A Pair of Shelled Eggs Inside A Female Dinosaur

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Reproductive biology is now an important topic in the study of dinosaur-bird relationships (1). Two immature eggs in *Sinosauropteryx* (2) and discoveries of paired eggs in maniraptoran nests (3–5) have been used to suggest that theropod dinosaurs had paired functional oviducts. Occurrences of paired eggs in the nests may also indicate a lack of egg rotation by the adults (5). Maniraptoran specimens found atop egg clutches might imply that entire egg clutches were laid in a single sitting (like crocodiles) or laid in multiple sittings (like birds) of the adult female (4–6). We present here a fossil that tests these ideas.

The specimen is a three-dimensional pelvis that contains a single pair of shelled eggs within its body cavity (Fig. 1). It was identified as an oviraptorosaurian on the basis of the pelvis morphology and a preliminary phylogenetic analysis (supporting online text). Aside from a shift to the left side during fossilization, we believe that the eggs retain their approximate original orientation and position within the oviducts. Compared with the immature eggs of *Sinosauropteryx* (2), these eggs are located more caudally in the body cavity and, on the basis of their position relative to the cloacal region, were likely in the uteri at death. The caudal end of the right egg is more pointed than the cranial end of the left egg (Fig. 1D),

suggesting a slightly asymmetrical profile of the eggs in life. The left egg has measurable diameters of 175 mm by 78 to 80 mm by 55 mm. The egg shape and surficial ornamentations indicate an affinity to elongatoolithids, and their microscopic structures resemble those of *Macroolithus yaotunensis* (supporting online text).

Two adult oviraptorid specimens have been found atop ring-shaped clutches that contain at

least 15 eggs (6). Given the relatively large egg size of our specimen, the position of the cloaca (estimated as ventral to the anteriormost caudal vertebra), and the inferred location for shell deposition in the uterus as in modern birds and crocodiles, it is unlikely that this specimen could have had multiple pairs of shelled eggs inside the body at one time. Unless sequential egg formation and shelling was very rapid and/or there was an extremely prolonged period of egg laying, the preservation of only two tightly juxtaposed eggs in the specimen strongly indicates that each of the paired oviducts simultaneously produced a single egg. This supports the theory that maniraptoran dinosaurs retained two functional oviducts like crocodiles but had reduced the number of eggs ovulated to one per oviduct, as in birds.

The pairedness of eggs in some oviraptorosaurian nests was therefore likely due to the oviposition of two eggs nearly simultaneously, rather than the result of egg manipulation by the parent(s). It is also evident that, as in birds, multiple ovipositions would have been required to lay an entire clutch. Furthermore, the slightly pointed end of each egg directing caudally inside the body and toward the periphery in the nests (4) suggests that the females came to the centers of the nests to lay neat, multilayered, ring-shaped clutches.

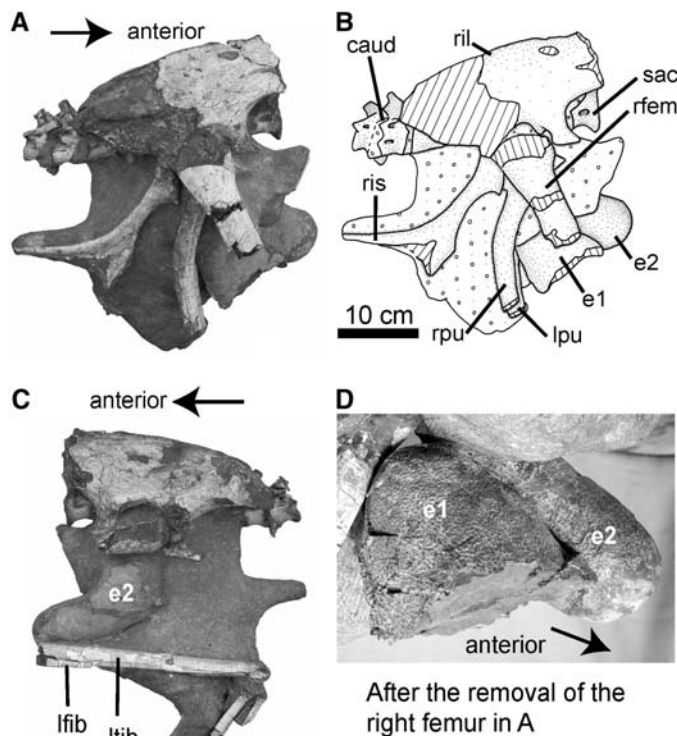


Fig. 1. The oviraptorosaurian specimen at the National Museum of Natural Science in Taiwan (specimen no. NMNS-VPDINO-2002-0901) was excavated from the Upper Cretaceous Nanxiong Formation of the Hongcheng Basin near the city of Ganzhou, in the southern Jiangxi Province, China. It consists of six sacral vertebrae; the first two caudal vertebrae; the ilia, pubes, ischia, and femora; the lower part of the left leg; and a pair of eggs inside the pelvis. The pubes and ischia are slightly disarticulated, but otherwise these bones retain their original anatomical relationships. The eggs are located dorsal to the pubic symphysis, about one egg length anterior to the cloacal region. They are side by side and closely apposed, although the right egg was slightly more ventrally positioned than the left egg. Y.-n.C. and Y.-f.H. supervised the preparation of NMNS-VPDINO-2002-0901, confirming that it is not a composite. (A and B) Right lateral view. (C) Left lateral view. (D) A right close-up view of the two eggs. Caud, caudal vertebrae; e, egg; lfib, left fibula; lpu, left pubis; ltib, left tibia; rfem, right femur; ril, right ilium; ris, right ischium; rpu, right pubis; sac, sacral.

References and Notes

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Supporting Online Material

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SOM Text

Fig. S1

References and Notes

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