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*Biol. Lett.* 2007 **3**, 81-82

doi: 10.1098/rsbl.2006.0580

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# A two-headed reptile from the Cretaceous of China

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**A malformed embryonic or neonate choristoderan reptile from the Lower Cretaceous Yixian Formation of northeastern China is described. The tiny skeleton exhibits two heads and two necks, with bifurcation at the level of the pectoral girdle. In a fossil, this is the first occurrence of the malformation known as axial bifurcation, which is well known in living reptiles.**

**Keywords:** Choristodera; fossil; malformation; axial bifurcation; Cretaceous; China

## 1. INTRODUCTION

The Yixian Formation of northeastern China, consisting of fine-grained lacustrine sediments interbedded with volcanic rocks of Early Cretaceous age (Swisher *et al.* 1999), is well known for its exquisitely preserved fossils, including ‘feathered dinosaurs’ and early birds, which form part of the famous ‘Jehol Biota’ (Chang *et al.* 2003). Here, we report an unusual fossil of a different kind from the Yixian Formation, *viz.* a very small, presumably embryonic or neonate, reptile skeleton with two heads and two sets of cervical vertebrae, which appears to be the first reported occurrence in the vertebrate fossil record of such a developmental malformation, known as axial bifurcation and well documented in various groups of living reptiles, especially among turtles and snakes (figure 1).

## 2. DESCRIPTION

The Shenzhen Paleontological Museum in Shenzhen, China contains a few specimens of tiny long-necked reptiles from the Yixian Formation at Wanfuotang (Yixian, Liaoning Province, northeastern China), which appear to be neonates or embryos. Besides their small size (total length up to 90 mm), the skeletons show various juvenile characters, including a head that is proportionally large, with very large orbits. The curled-up attitude of some of the specimens suggests that they were still in an embryonic position when they became fossilized. Their characters, in particular the remarkable elongation of the cervical part of the vertebral column and the relative shortness of the limbs, suggest that they are very young individuals of a long-necked aquatic diapsid that is common in the Yixian Formation and is known under the two

contending names of *Sinohydrosaurus lingyuanensis* Li *et al.* (1999) and *Hyphalosaurus lingyuanensis* Gao *et al.* (1999). This animal, which could exceed 1 m in length when adult, belongs to the choristoderes, a group of aquatic diapsids that is frequent and relatively diverse in the Yixian Formation, with both the above-mentioned long-necked form and the short-necked genera *Monjurosuchus* and *Ikechosaurus* (Liu & Wang 2003).

The approximately 70 mm long single teratological specimen (no. R10) is similar in every respect to the other embryonic or neonate skeletons, except that it possesses two heads and two necks, which are of the same size and placed close to each other in similar positions relative to the body from which they diverge, showing that they do belong to the same individual. Although faked fossils from the Yixian Formation have been reported (Rowe *et al.* 2001), the condition of the fossil and the surrounding matrix excludes any tampering (in particular, the slab bearing the fossil shows no cracks or evidence of gluing), and there is no doubt that the specimen is genuine. As is often the case with fossils from the Yixian Formation, the overall preservation of the specimen is good, but osteological details have been obscured by crushing. The specimen shows a single body with a long curled-up tail, the hind limbs, the dorsal vertebrae and the rib cage, and the pectoral girdle and fore limbs. Starting from the level of the pectoral girdle, the vertebral column divides into two cervical series, forming two long necks that end in two skulls. The total number of neck vertebrae cannot be precisely ascertained, but it is clear that most or all cervical vertebrae were duplicated (there are 19 cervical vertebrae in *Sinohydrosaurus lingyuanensis*, and the separate parts of the necks of the malformed specimen include at least 16 vertebrae). The exact condition at the confluence of the two necks is not clearly visible, because the two cervical columns have been pressed together by fossilization, thus obscuring details, and the small size and extreme fragility of the fossil preclude any further preparation.

## 3. DISCUSSION

This specimen clearly is an instance of a developmental malformation known as axial bifurcation (Cunningham 1937). When affecting the anterior part of the body, it results in two-headed abnormal specimens that may also exhibit a more or less complete duplication of the neck, depending on the number of cervical vertebrae involved. According to Matz (2001), axial duplication results from imperfect splitting of a single blastoderm, as a consequence of regeneration following an embryonic lesion. This kind of abnormality, which apparently was already known to Aristotle (Cunningham 1937), occurs relatively frequently in modern reptiles (Bellairs 1969), such as turtles (Barbour 1888; Derickson 1927; Hildebrandt 1930), crocodiles, lizards and snakes (Strohl 1925; Cunningham 1927, 1937); about 400 cases of dicephalic snakes have been recorded (Matz 2001). Two-headed turtles and snakes have lived for several years in captivity. To judge from its apparent extreme juvenility, the malformed diapsid from the Yixian Formation did not survive long, if at all.

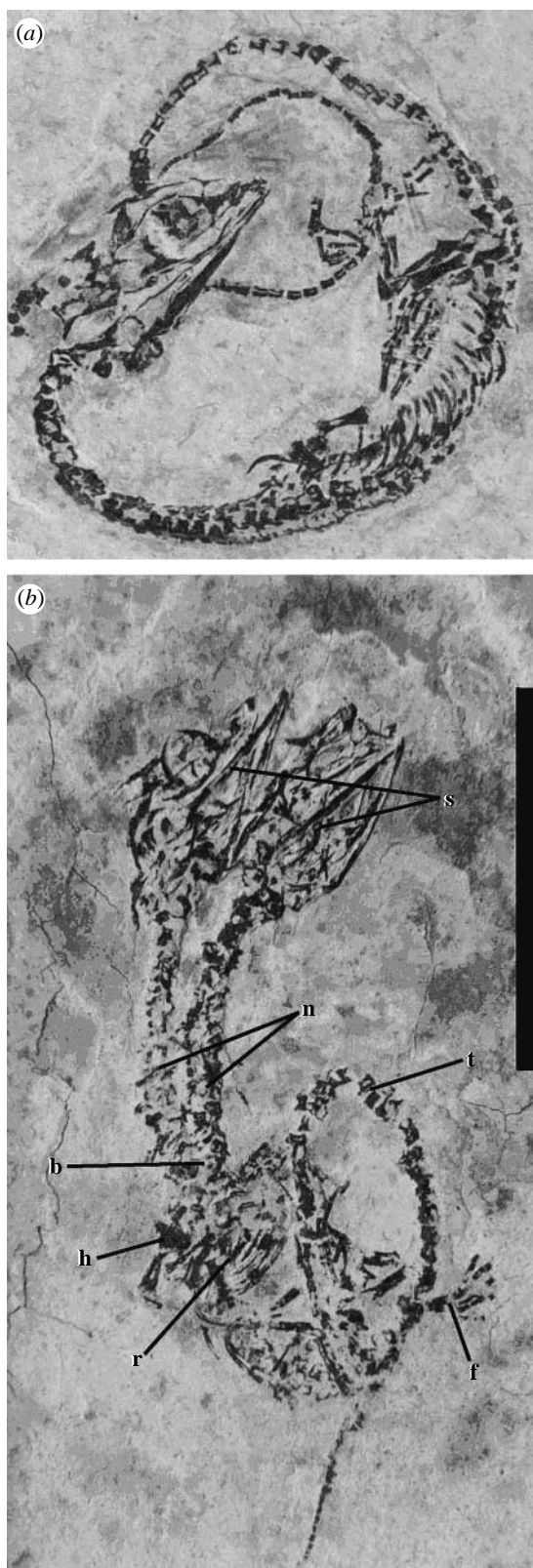


Figure 1. Embryos or neonates of a diapsid reptile (Choristodera) from the Yixian Formation of northeastern China, in Shenzhen Paleontological Museum. (a) Normal specimen (R13) in foetal position and (b) two-headed specimen (R10) showing anterior axial bifurcation. The very thin coating of sediment still partly covering some of the bones shows that the specimen has not been tampered with. Scale bar, 20 mm. b, bifurcation of vertebral column; f, foot; h, right humerus; n, necks; r, rib cage; s, skulls and t, tail.

Developmental abnormalities have been reported in fossil invertebrates (Tasnádi-Kubacska 1962), but very little is known about the teratology of extinct vertebrates, and this two-headed reptile seems to be unique in the fossil record.

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