

Additional Evidence

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16. Sun, Y., Ford, D. H. & Nishida, M. Evidence for avian-like skull and neck in the Mesozoic ornithomimid *Archaeopteryx lithuanica*. *Nature* **452**, 401–403 (2009).
17. Sun, Y., Gorbunov, D. H. & Ford, D. H. Middle Permian ornithomimid *Archaeopteryx lithuanica* from the Permian of Russia. *Nature* **452**, 401–403 (2009).
18. Sun, Y., Gorbunov, D. H. & Ford, D. H. Evidence for avian-like skull and neck in the Mesozoic ornithomimid *Archaeopteryx lithuanica*. *Nature* **452**, 401–403 (2009).
19. Sun, Y., Gorbunov, D. H. & Ford, D. H. Evidence for avian-like skull and neck in the Mesozoic ornithomimid *Archaeopteryx lithuanica*. *Nature* **452**, 401–403 (2009).
20. Sun, Y., Gorbunov, D. H. & Ford, D. H. Evidence for avian-like skull and neck in the Mesozoic ornithomimid *Archaeopteryx lithuanica*. *Nature* **452**, 401–403 (2009).
21. Sun, Y., Gorbunov, D. H. & Ford, D. H. Evidence for avian-like skull and neck in the Mesozoic ornithomimid *Archaeopteryx lithuanica*. *Nature* **452**, 401–403 (2009).

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A new troodontid dinosaur from China with avian-like sleeping posture

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Discovering evidence of behaviour in fossilized vertebrates is rare. Even rarer is evidence of behaviour in non-avian dinosaurs that directly relates to stereotypical behaviour seen in extant birds (such as) and not previously predicted in non-avian dinosaurs^{1,2}. Here we report the discovery of a new troodontid dinosaur from the Early Cretaceous Yixian Formation of western Liaoning, China. Numerous other three-dimensionally preserved vertebrate fossils have been recovered recently at this locality, including some specimens preserving behavioural information³. The new troodontid preserves several features that have been implicated in avian origins. Notably, the specimen is preserved in the stereotypical sleeping or resting posture found in extant birds⁴. Evidence of this behaviour outside of the crown group Aves further demonstrates that many bird features occurred early in dinosaurian evolution^{5,6}.

Theropods Marsh, 1881
Maniraptorans Garfield, 1986
Troodontidae Gilmore, 1924
Moi leg gen. et sp. nov.

Etymology. *Moi* from Chinese, meaning to sleep peacefully; *leg* from Chinese, meaning diapsid.

Holotype. IVPP (Institute of Vertebrate Palaeontology and Paleoanthropology, Beijing) V12733, a nearly complete, fully articulated skeleton (Fig. 1).

Locality and horizon. Lujiazui, Shuanggou, Beijing City, western Liaoning, China. Lived near Beiluo, volcanoclastic beds of Yixian Formation, older than 128 and younger than 129 million years⁷.

Diagnosis. *Moi leg* is distinguishable from all other troodontids in

the basis of extremely long toes extending posteriorly over one-half of the maxillary tooth row; closely packed middle maxillary teeth; maxillary teeth row extending posteriorly to the level of the preorbital; a robust, sub-V-shaped fenestra posterior of a lateral process on distal tibia IV; and the most proximal end of the pubic duct is significantly compressed anteroposteriorly, and extends laterally just ventral to the articulation with the ilium.

Moi leg is about 51-cm in length, similar in size to the basal dromaeosaurid *Microvenator chelonius* and the basal avian *Archaeopteryx lithuanica*^{8,9}. IVPP V12733 is not an adult, as several cranial sutures are unfused, and although fused, sutures between the nasal arches and orbits are still apparent on the dorsal vertebrae. However, the holotype is also not a hatching or cranial and neural vertebral sutures are not apparent, the parietal is formed from a single element and there is complete fusion of astragals and calcanei, indicating that the individual is approaching maturity.

As in *Sinovenator chengi* and basal dromaeosaurs⁸, the skull is proportionally small (about 60% of the femoral length), the trunk short and the hindlimbs very long. Long hindlimbs relative to the trunk is a feature correlated with a knee-based avian running mechanism¹⁰; it is also present in the basal troodontids *Sinovenator* and *Sinurotrodon*^{11,12}, the basal dromaeosaurid *Microvenator*, and the basal ornithomimid *Gaoligongosaurus*¹³. As in other troodontids^{14,15} the numerous maxillary teeth (approximately 24) are tightly packed anteriorly (Fig. 2a, b). Unlike other troodontids, over the middle teeth lack inter-crown space. Posteriorly, the teeth are more stout and recurved. As with other troodontids¹⁶, the intermaxillary bar is strap-like and T-shaped. Additionally, a pterygospine lies on the posterior quadrate surface; a prominent concavity lies lateral to the foramen magnum on the occipital/epithetic; and the distally expanded parietal paroccipital processes are vertical and appressed. The dentary anterior foramen lies in a horizontal groove on the labial surface of the dentary as in other troodontids^{17,18}.

As in *Sinovenator chengi* the dorsal vertebrae have fan-shaped neural spines and slender transverse processes, but lack pneumatic foramina¹⁹. The distal radius is elongate, with a reduced cotyloid and a sulcus on their dorsal surface as in other troodontids²⁰. The ilium is short and tapers posteriorly. The pubis is long and proximally thick, but is not medially compressed as in other troodontids including *Sinovenator chengi*. The ischium is fairly short with a distally positioned obturator process and two small processes on the dorsal edge. The tibia has an anteroposteriorly wide proximal end, and a distal end with a thick lateral margin. As in basal dromaeosaurids and *Sinovenator*^{21,22} the first metatarsometatarsal, and metatarsal III is reduced but still visible on the plantar surface (Fig. 1b). Metatarsal II bears a prominent medial flange and metatarsal IV a lateral one on the ventral surface, producing a longitudinal metatarsal pulvinate excavation. As in other dromaeosaurids, the second phalange is specialized with a hypertrophied distal, but is not developed to the same degree as seen in derived dromaeosaurids^{23,24}.

Moi leg differs with respect to a number of features compared with most other troodontids. Many of these differences are similar to conditions seen in avian and dromaeosaurids^{25–28}. Laterally, the skull has an antorbital fossa that is much smaller than that of other non-avian theropods (except for ornithomimids²⁹) and a large orbit that is apparently confluent with the infra-orbital foramen (Fig. 2a, b). No postorbital is preserved, but if present it was undoubtedly small, as in *Archaeopteryx*³⁰. As in avian³¹ and ornithomimid³², there is no corresponding ascending postorbital process of the tibia (used to form a complete postorbital bar); however, there is a small dorsal expansion of the jugal at its posterior end (as in *Archaeopteryx*³³), one where it contacts the quadrate, which is buttressed by an extremely small quadrangular (Fig. 2a, b). The squamosal is also reduced and does not contact the quadrate-

