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A new Mesozoic caudate (*Liaoxitriton daohugouensis* sp. nov.) from Inner Mongolia, China

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Fossil caudates are rare and mostly preserved by fragmentary material in the Mesozoic^[1]. The recent reports of five monotypic genera with articulated skeletons in China^[2] have thus drawn worldwide attention^[3]. These Chinese forms are yielded in the Lower Cretaceous Jehol Group or slightly lower horizon, and have relatively earlier geological age, better preservative condition and greater taxonomic diversity as compared globally; therefore they bear special significance for the study of caudate origin, early evolution and geographic dispersal. Among the known Mesozoic caudate localities in China, Daohugou of Inner Mongolia is richest in fossil material and has yielded *Jeholotriton paradoxus*^[4] and *Chunerpeton tianyiensis*^[5]; however, the geological age of the fossil-bearing strata has been hotly debated with three different opinions^[6–8]. A new caudate was recently found here, which differs from the above two taxa, and is similar to *Liaoxitriton zhongjiani* from the Jehol Group in southwestern Liaoning. The paper reports it as a new species of *Liaoxitriton*, and provides a revised diagnosis of the genus based on new material. The discovery of *Liaoxitriton* in Inner Mongolia has important implications on the correlation and age of the strata.

Order Urodela Duméril, 1806

Family incertae sedis

Genus *Liaoxitriton* Dong et Wang, 1998

Type species. *Liaoxitriton zhongjiani* Dong et Wang, 1998

Revised diagnosis. Mesozoic crown group salamander; skull bones with no sculpture; maxillae well developed, forming, with premaxillae, a complete maxillary arcade with closely arranged teeth; nasals abutted at the midline; frontals without, parietals with anterolateral extension; prefrontals and lacrimals retained; vomers connected at the midline, with a palatal fenestra anteromedially; vomerine tooth rows (VTRs) transverse and medi-

ally placed in the palate; anterior ramus of pterygoid (ARP) robust, directing to the end of maxilla; prearticular and articular present; hyobranchial apparatus with three ossifications: paired Hypobranchial II and Ceratobranchial II slender, single Basibranchial II anchor-shaped but without posterior projection; scapulocoracoid notably expanded at proximal end; presacrals 15—16 in number; transverse processes of vertebrae long, about half-length of centra; ribs with single, expanded head; postsacral ribs 2—3 pairs; mesopodials partially ossified.

***Liaoxitriton daohugouensis* sp. nov.**

Holotype. Clear ventral impression of an articulated skeleton preserved on a slab of silicified mudstone (Figs. 1 and 2). Institute of Vertebrate Paleontology and Paleoanthropology specimen number: IVPP V 13393.

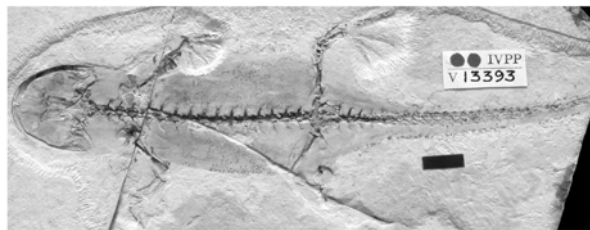


Fig. 1. Holotype of *Liaoxitriton daohugouensis* sp. nov. Scale bar equals 1 cm.

Included specimen. IVPP V 14062 (ventral skeletal impression).

Etymology. After the fossil locality.

Diagnosis. New species of *Liaoxitriton* differing from *L. zhongjiani* (Lz) in having wide and round rostrum (Lz: narrow), anterolaterally extended VTRs (Lz: posterolaterally extended), higher coronoid flange on prearticulars, larger articulars, more expanded proximal end and shorter distal bar of scapulocoracoid; more robust ribs with larger distal end on 2nd presacral, three pairs of postsacral ribs (Lz: two pairs), and non-expanded Metacarpal II (Lz: expanded).

Locality and horizon. Daohugou, Ningcheng, Inner Mongolia; Daohugou fossil bed, Lower Cretaceous (or Upper Jurassic).

Description. The holotype preserves clear ventral impression of a nearly complete articulated skeleton. The snout-pelvis length (snout tip to middle of pelvis) is 75 mm, and the total body length is slightly greater than 140 mm, the preserved length. The skull is 19 mm long and 21 mm wide. Mesopodial ossification suggests that it is a post-metamorphic individual. The rostrum is wide and round. The maxillae are well developed, forming a

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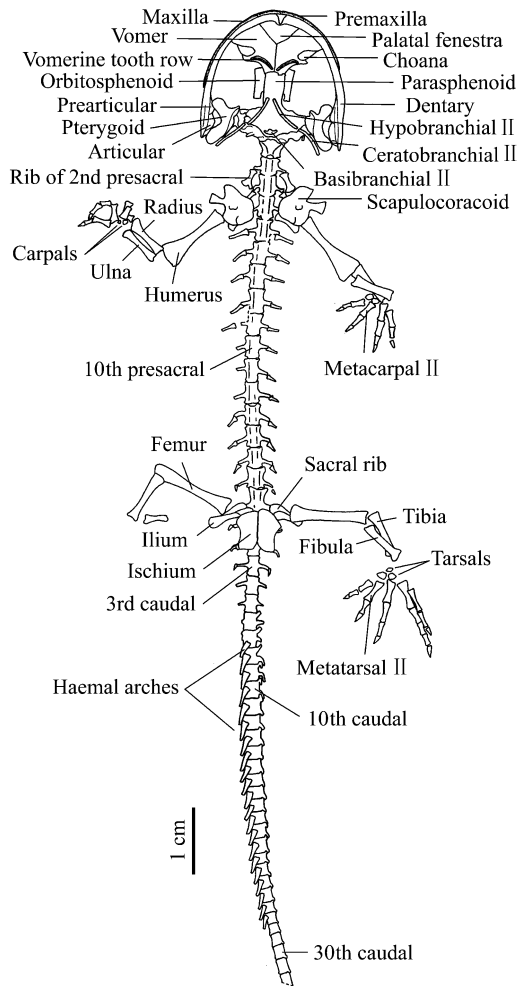


Fig. 2. Skeletal outline of *L. daohugouensis* sp. nov. (holotype) in ventral view.

closely-toothed complete arcade with the premaxillae. Two vomers are connected at the midline, bordering a large palatal fenestra with the premaxillae. Posteromedial to the choanae, the short, curved VTRs extend anterolaterally and bend backwards at the distal end. Hypobranchial II and Ceratobranchial II are ossified and slender, similar to those in the living hynobiid *Onychodactylus*^[9]. The pterygoids have robust ARPs that direct to the end of the maxillae. The coronoid flange on prearticulars is high, and the articulars are well developed. The scapulocoracoids have greatly expanded proximal end and short hatched-shaped distal end, with obvious anterior and posterior notches in the middle portion of the bone. The holotype has 16 presacrals, and preserves 32 caudals. The transverse processes of vertebrae are about half-length of the centra. All ribs are uncapitate and expanded proximally. The ribs of the 2nd presacral are robust and ex-

panded distally, and bifurcated on the right side as preserved. Three pairs of postsacral ribs are observed. Metacarpal II is not expanded. The phalangeal formula is 2-2-3-2 and 2-2-3-4-2 for the manus and pes, respectively.

Comparison and discussion. The new Daohugou caudate has *Liaoxitriton* characteristics, such as VTRs transverse and placed medially in the palate, Hypobranchial II, Ceratobranchial II and Basibranchial II ossified, ARP robust and directing to the end of maxilla, and mesopodials partially ossified. It differs notably from *Jeholotriton*^[4] (VTRs longitudinal; hyobranchial apparatus poorly ossified; ARP directing anteromedially to the nasal capsule; mesopodials unossified) and *Chunerpeton*^[5] (VTRs marginal, parallel to the maxillary arcade; Hypobranchial I, II and Basibranchial II ossified; gill rakers present; ARP anterolaterally directed and curved medially towards the distal end of vomer) of the same locality. It also differs from the small caudates *Laccotriton* (ceratobranchials absent, postsacral ribs five pairs) and *Sinerpeton*^[10] (proximal end of scapulocoracoid slightly expanded, 1st toe of limbs with only one phalange) from Fengshan of Hebei. The new Inner Mongolian taxon is differentiated from *L. zhongjiani* of Liaoning in rostral morphology, direction of VTRs, and number of postsacral ribs, etc., so a new species is justified. However, despite bearing many similarities that suggest close affinity with living hynobiids^[9], the genus is still unresolved at familial level, due to the lack of diagnosis of the family Hynobiidae based on derived character states^[11].

L. zhongjiani was yielded in dark lacustrine mudstone of the Jiufotang Formation in southwestern Liaoning^[11]. Recent work has proposed the fossil bed may belong to the Yixian Formation. The stratigraphic correlation of Daohugou fossil horizon is highly controversial, with the Middle^[8] or Upper Jurassic^[7] by entomologists and the lower part of the Yixian Formation (Lower Cretaceous)^[6] opinion by those working on vertebrate fossils such as pterosaurs. The discovery of *L. daohugouensis* relates, for the first time, the Daohugou bed in Inner Mongolia to the horizon of *L. zhongjiani* in Liaoning. The Daohugou caudates have a high taxonomic diversity, and may imply a rapid rate of caudate evolution at the time; in the meanwhile, the two species of *Liaoxitriton* is very similar, which, in combination with rapid evolution, might suggest a closer geological age of the two horizons. The holotype of *Sinerpeton* from Hebei is very similar to the juvenile material of *Liaoxitriton*. If it indeed is the synonym of the later genus, the new opinion that the Hebei caudate horizon is Lower Cretaceous Dadianzi Formation (comparable

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to the lower part of the Yixian Formation) will be further supported, contrary to the Upper Jurassic^[10] originally proposed. In the view of evolution of osteological characters, all the Chinese Mesozoic caudates (six species in five genera) have unicapitate ribs, a synapomorphy of living cryptobranchoids, indicating that they are of the same evolutionary stage, and might have similar geological age. Furthermore, these Chinese forms are all advanced over *Karaurus* (with heavy dermal sculpture and quadratojugals in the skull and double-headed ribs^[1]) from the Late Jurassic of Kazakhstan. With the above discussions, the age of Daohugou fossil horizon is probably Early Cretaceous or Late Jurassic, and not as early as Middle Jurassic.

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References

1. Estes, R., Gymnophiona, Caudata, Handb. Palaeoherp., 2. Stuttgart, New York: Gustav Fischer Verlag, 1981, 1—115.
2. Wang, Y., Gao, K., Amphibians (eds. Chang, M., Chen, P., Wang, Y. et al.), The Jehol Biota, Shanghai: Shanghai Scientific & Technical Publishers, 2003, 76—85.
3. Carroll, R. L., Chinese salamanders tell tales, *Nature*, 2001, 410: 534—536.
4. Wang, Y., A new salamander (Amphibia: Caudata) from the Early Cretaceous Jehol Biota, *Vert. PalAsiat.*, 2000, 38(2): 100—103.
5. Gao, K., Shubin, N., Earliest known crown-group salamanders, *Nature*, 2003, 422: 424—428.
6. Wang, X., Wang, Y., Zhang, F. et al., Biostratigraphy of vertebrates from the Lower Cretaceous Yixian Formation in Lingyuan, western Liaoning and the neighboring southern area of Nei Mongol, *Vert. PalAsiat.*, 2000, 38(2): 85—99.
7. Zhang, J., Discovery of Daohugou Biota (Pre-Jehol Biota) with a discussion on its geological age, *J. Stratig.*, 2002, 26(3): 173—177.
8. Ren, D., Gao, K., Guo, Z. et al., Stratigraphic division of the Jurassic in the Daohugou area, Ningcheng, Inner Mongolia, *Geol. Bull. Chin.*, 2002, 21(8-9): 584—588.
9. Rose, C. S., The developmental morphology of salamander skulls (eds. Heatwole, H., Davies, M.), *Amphibian Biology*, Vol. 5. Chipping Norton: Surrey Beatty & Sons, 2003, 1684—1781.
10. Gao, K., Shubin, N., Late Jurassic salamanders from northern China, *Nature*, 2001, 410: 574—577.
11. Dong, Z., Wang, Y., A new urodele (*Liaoxitriton zhongjiani* gen. et sp. nov.) from the Early Cretaceous of western Liaoning Province, China, *Vert. PalAsiat.*, 1998, 36(2): 159—172.

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