·基础地质·

A new gigantic sauropod dinosaur from the Cretaceous of Ruyang, Henan, China
记河南汝阳白垩纪一新的巨型蜥脚类恐龙

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Abstract: The new gigantic sauropod dinosaur *Ruyangosaurus giganteus* gen. et sp. nov. from the early Late Cretaceous Mangchuan Formation of Ruyang, Henan , China is described. It is characterized by a lower neural spine, lack of centroprezygapophyseal lamina, a large, irregularly triangular deep fossa on the lateral surface of the neural arch, the prezygodiapophyseal lamina oriented anteroposteriorly, and a robust tibia, some 127cm in length. The discovery of *Ruyangosaurus* indicates that a higher diversity of sauropod dinosaurs occurred during the early Late Cretaceous than previously thought.

Key words: *Ruyangosaurus*; Sauropoda; early Late Cretaceous; Ruyang,Henan, China

摘要:记述了产自河南汝阳地区晚白垩世早期莽川组一新的巨型蜥脚类恐龙——巨型汝阳龙(新属新种):*Ruyangosaurus giganteus* gen. et sp. nov.。它具有以下特征:神经棘低,缺少椎前关节突隔板,神经弓的侧面具有大的、不规则的三角形凹,前关节横突隔板前后伸展,胫骨粗壮,达 127 cm 等。汝阳龙的发现显示在晚白垩世早期蜥脚类恐龙发生的分异程度要比以前想象的高得多。

关键词:巨型汝阳龙;蜥脚亚目;晚白垩世早期;河南汝阳
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Most gigantic sauropod dinosaurs have been found from the Late Jurassic of North America, Africa and Asia[1-4]. The new gigantic sauropod dinosaur described here was found from early Late Cretaceous deposits of Liudian Town, Ruyang County of Henan Province (Fig.1), and is similar to that of *Argentinosaurus* [5] in the width of centrum of the dorsal vertebra. Although one large-sized sauropod *Huanghetti-*

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tian ruyangensis[6] was discovered from a site close to the new fossil locality, the structures of the dorsal vertebrae are significantly different. The dorsal vertebra of *Ruyangosaurus giganteus* gen. et sp. nov. is much larger than that of *Huanghetitan ruyangensis*, indicating that the new sauropod dinosaur is much larger than *Huanghetitan*. The new sauropod obviously represents a new and gigantic dinosaur, which can match *Argentinosaurus* in the size of its centrum, and represents the largest dinosaur found from Asia so far. The terminology for the vertebral laminal structures follows Wilson[7–8].

1 Systematic paleontology

Sauropodomorpha Huene, 1932[9]

Sauropoda Marsh, 1878[10]

Eusauropoda Salgado, Coria et Calvo, 1997[11]

Neosauropoda Bonaparte, 1986[12]

Camarasauromorpha Salgado, Coria et Calvo,1997[11]

Titanosauriformes Salgado, Coria et Calvo,1997 [11]

? Andesauridae Bonaparte and Coria, 1993[5]

Ruyangosaurus gen. nov.

Etymology: The generic name refers to the Ruyang County of Henan Province, which the holotype locality belongs to *sauros*, Greek for lizard, reptile.

Diagnosis: as for the only species.

Species: *Ruyangosaurus giganteus* (Figs. 2–4).

Etymology: giganteus, Greek, very large, huge, indicates that *Ruyangosaurus* is a huge sauropod dinosaur.

Holotype: One nearly complete posterior cervical vertebra, one nearly complete posterior dorsal vertebra, one posterior cervical rib and one anterior dorsal rib, proximal portion of right femur, one complete right tibia. The specimen (41HIII–0002) is housed in the Henan Geological Museum.

Locality and Horizon: Shengshuigou of Shaping Village, Liudian Town, Ruyang County of Henan Province. Mangchuan Formation, early Late Cretaceous [13–14].

Diagnosis: A gigantic sauropod dinosaur characterized by the following derived features: a relatively small neural canal and short neural spines; a large, irregularly triangular deep fossa on the lateral surface of the neural arch; lack of centroprezygapophyseal lamina; two spinodiapophyseal laminae and the diapophysis form a deep concavity on the lateral surface of the base of the neural spine; the posterior centrodiapophyseal lamina stoutest among the laminae; and the centropostzygapophyseal lamina weak and plate–like, together with the postzygodiapophyseal lamina and the posterior centrodiapophyseal lamina, forming a triangular concavity.

2 Description

A possible incomplete posterior cervical vertebra is preserved (Fig. 2). The width of the centrum is 51 cm, it is 18 cm long excluding the anterior articular end and 30 cm long with the anterior articular end. The anterior articular end is strongly convex and its posterior articular face is concave. The broken surface of the anterior articular end displays an internal honeycomb–like structure. The neural canal is small compared with the centrum. It is 7 cm wide and 6 cm high. The neural canal is larger in anterior view than in posterior view. The base of the short neural arch is plate–like.

The single posterior dorsal vertebra is nearly complete except for missing a small portion of neural arch. The anterior articular end is convex, whil its posterior articular end is strongly concave. The facet of the prezygapohysis is sub–oval and faces mediodorsally. A distinct ridge is present above the neural canal, connecting to the base of the prezygapophyses. There is a single large pleurocoel on the dorsal half of the lateral face of the centrum. Its anteroposterior length is 14cm, and height is 7 cm. The neural canal is relatively small and suboval. It is 6 cm wide and 8 cm high. The height ratio of the neural canal to the centrum is approximate 15.7%. There is a weak–developed hyposphene between the neural canal and the postzygapophyses. There are two laminae on the dorsal surface of the right postzygapophysis and one is on

The preserved proximal portion of the right femur is 120 cm long (Fig. 5). The femur is estimated about 200 cm long. The femoral shaft is compressed anteroposteriorly and has an elliptical horizontal cross section as in other sauropod dinosaurs[21]. The distance between the 4th trochanter and the proximal end of the femur is 90 cm. The fourth trochanter is reduced to a low, rounded ridge. The width of the proximal end is 60cm. The maximum anteroposterior width is 23cm.

The complete right tibia is 127 cm long. Its proximal end is greatly expanded anteroposteriorly and transversely relative to its main shaft. The proximal articular surface is shallowly concave. The outline of the proximal end is sub-oval (Fig.5d). The maximum anteroposterior diameter of the proximal end (excluding the cnemial crest) is 25 cm. The maximum transverse diameter of the proximal end (including the lateral expansion) is 51 cm. The transverse width of the distal end is 31cm and the anteroposterior width is 27 cm. The distal end of tibia broader transversely than anteroposteriorly is the synapomorphy of the unnamed clade including *Andesaurus*, *Argentinosaurs*, *Alamosaurus*, etc.[11]. A distinct notch is present at the distal end.

3 Comparison and Discussion

Ruyangosaurus may be assigned to Andesauridae based on its large size, the presence of hyposphene-hypantrum system[22,5], and two or three deep depressions on the lateral sides of neural arch[23]. However, *Ruyangosaurus* is not the typical andesaruids in the lower neural spine, weakly developed hyposphene-hypantra and large deep fossa present on the lateral surface of the neural arch. Thus, it is only tentatively assigned to the family Andesauridae and further finds may suggest an alternative systematic relationship.

The dorsal vertebra of *Ruyangosaurus* exhibits a relatively simple structure with low neural arches. The posterior centrodiapophyseal lamina bifurcates at its base, a similar condition is observed in at least some of the dorsal vertebrae of *Euhelopus*, *Argyrosaurus*, *Argentinosaurus*, the Peiropolis titanosaur, and *Alamosaurus sanjuanensis*[17] (Fig. 6).

Ruyangosaurus can match *Argentinosaurus*[5] in the size of dorsal centrum, and its centrum diameters of dorsal vertebrae are almost equal in both genera. The centrum diameter is 51 cm in *Ruyangosaurs*, whilst it is 50 cm in *Argentinosaurus*[21]. However, *Ruyangosaurus* differs from *Argentinosaurus* in that its neural spine is much shorter than that of *Argentinosaurus*.

Ruyangosaurus differs from the posterior dorsal vertebrae of *Andesaurus* in the high neural spine, almost vertical, with a prominent prespinal lamina, and a smaller, but well-developed postspinal lamina in *Andesaurus*[16], the reverse conditions present in *Ruyangosaurus*.

Ruyangosaurus differs from *Epachthosaurus* in that the neural canal and the pleurocoel are very large, a bridge connecting with the prezygapophyses is present, and the anterior centroparapophyseal lamina (acpl) is present too in *Epachthosaurus* (see plate 71 of [20]), however, the reverse conditions are present in *Ruyangosaurus* and a large concavity is present under the prezygapophyses and above the neural canal.

It is difficult to compare *Ruyangosaurus* with *Huanghetitan ruyangenis*[6], because of the lack of the corresponding elements between them. However, the centrum diameter of the dorsal vertebra of *Ruyangosaurus* is much larger than that of *Huanghetitan ruyangensis*, suggesting that even at adult, the animals were distinct in terms of body size.

Sauropod dinosaurs were thought to have reached a peak in abundance and diversity during the time interval represented by the Upper Jurassic and possible extending into the Lower Cretaceous, when they were the dominant large terrestrial herbivores[24]. *Ruyangosaurus* is the largest sauropod dinosaur found from Asia so far. The discovery of *Ruyangosaurus* and *Huanghetitan ruyangensis*[6] indicates that a higher diversity of sauropod dinosaurs occurred during the early Late Cretaceous. It may also indicate that titanosauriformes reached a peak in diversity during the time late Early Cretaceous-early Late Cretaceous interval.

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