中国广西晚白垩世一新的巨龙类恐龙1)

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摘要:记述了采自广西南宁市郊晚白垩世地层中一巨龙类恐龙新属种:右江清秀龙(*Qingxiusaurus youjiangensis* gen. et sp. nov.)。新属种正型标本包括以下不关联的头后骨骼:一段较完整的前部尾椎神经棘、左右胸骨板、左右肱骨。它以以下独特特征组合区别于其他巨龙类:前部尾椎神经棘板状结构不发育、相对较高并呈桨状;胸骨与肱骨最大长之比值较低(约0.65)。广西发现的新属种以及近年来报道的巨龙类恐龙材料表明,亚洲巨龙类恐龙的头后骨骼形态变异度高,白垩纪时期这类恐龙曾在亚洲广为分布。

关键词:广西南宁,晚白垩世,巨龙类
中图法分类号:Q915.864 **文献标识码**:A **文章编号**:1000-3118(2008)02-0147-10

1 前言

以往的化石材料表明(Hunt et al., 1994),侏罗纪时期亚洲地区的蜥脚类恐龙较为繁盛,但在白垩纪只有为数不多的几个属种(Wiman, 1929; Hoffet, 1942; Nowinski, 1971; Borsuk-Bialynicka, 1977; Kurzanov and Bannikov, 1983; Martin et al., 1994)。然而自1999年以来,亚洲地区白垩纪地层中相继发现了许多重要的蜥脚类恐龙化石新地点(Allain et al., 1999; Pang and Cheng, 2000; 唐烽等, 2001; Averianov et al., 2002; You et al., 2003, 2004, 2006; Xu et al., 2006; 吴文昊等, 2006; Tomida and Tsumura, 2006; Ksepka and Norell, 2006; Mo et al., 2006; 吕君昌等,2006, 2007),在早白垩世地层中产出了许多原始的巨龙类新属种(Barrett et al., 2002),有关研究工作显示,亚洲有可能是巨龙类恐龙的起源地区(You et al., 2003)。初步的形态分析表明,亚洲地区的巨龙形类恐龙呈现出较为复杂的形态特征分布(Xu et al., 2006)。在中国,已知大多数巨龙类恐龙化石地点分布于北方地区,在南方仅有浙江江山一个化石点(唐烽等, 2001)。

1991年,广西自然博物馆根据群众的报告,对广西壮族自治区南宁市西北48 km的那龙乡大石村石火岭地点进行了发掘,获得部分鸭嘴龙类和蜥脚类恐龙材料(莫进尤等, 1998)。蜥脚类恐龙材料主要包括以下不关联的头后骨骼:一段较完整的可能属于前部尾椎的神经棘、左右胸骨板、左右肱骨等。鉴于该发掘坑中的蜥脚类化石没有重复部分,且

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产出骨骼大小比例相配,我们推断这些材料应代表了同一个体的不同部位。从同一发掘坑采集的鸭嘴龙材料分析,含化石地层(紫红色泥质粉砂岩)时代应为晚白垩世(Mo et al., 2007),而不是此前认为的始新世(广西壮族自治区地质矿产局,1985)。本文将描述这一中国南方地区首次发现的晚白垩世巨龙类恐龙材料,并建立一新属种——右江清秀龙(*Qingxiusaurus youjiangensis*)。新材料的发现有助于进一步了解白垩纪晚期亚洲地区巨龙类恐龙的多样性及其头后骨骼形态特征复杂多变的现象。蜥脚类恐龙的系统分类学遵循 Wilson (2002)的系统。

2 系统描述

恐龙 Dinosauria Owen, 1842

蜥脚类 Sauropoda Marsh, 1878

巨龙类 Titanosauria Bonaparte & Coria, 1993

清秀龙(新属)*Qingxiusaurus* gen. nov.

属征 前部尾椎神经棘板状结构不发育、相对较高并呈桨状;胸骨与肱骨最大长之比值较低(约 0.65)。

属型种 *Q. youjiangensis* gen. et sp. nov.。

词源 “Qingxiu”为“清秀”的拼音,即“山清水秀”,意指美丽的广西山水;“saurus“(希腊语),指“蜥蜴”;种名“youjiang”指流经该区的右江,距化石产地约 300 m。

右江清秀龙(新属新种)*Qingxiusaurus youjiangensis* gen. et sp. nov.

(图 1;表 1)

种征 同属征。

正型标本 部分不关联的头后骨骼,包括一段较完整的前部尾椎神经棘、左右胸骨板、左右肱骨。广西自然博物馆标本编号:NHMG 8499。

产地与层位 广西壮族自治区南宁市郊那龙乡大石村石火岭;上白垩统红层。

标本描述 一段近乎完整的脊椎神经棘(图 1A–C),从神经棘较长、不分叉、板状结构较不发育等方面推测,这一神经棘应该来自尾椎序列的前部。从保存长度(27 cm)推断,神经棘较长。它的横向宽度远大于轴向长度(表 1),与 *Huabeisaurus*(Pang and Cheng, 2000)高而前后略压扁的前部尾椎神经棘形态类似,区别于一些巨龙类恐龙如 *Malawisaurus* (Jacobs et al., 1993)、*Phuwiangosaurus* (Martin et al., 1994, 1999)和 *Alamosaurus* (Gilmore, 1946)中前部尾椎神经棘较低和横向压扁的情形,也区别于 *Mendozasaurus* (González Riga, 2003)和 *Opisthocoelicaudia* (Borsuk-Bialynicka, 1977)中前部尾椎神经棘虽横向加宽但较为低矮的情形。神经棘基部的宽度略大于长度,宽度往上逐渐加大,接近顶点处的宽度达到了最大值。神经棘前视类似于桨状,与叉背龙科的 *Dicraeosaurus* (Janensch, 1929)和梁龙类的 *Amazonsaurus* (Carvalho et al., 2003)类似。相比之下,*Huabeisaurus* 的前部尾椎神经棘远端横向略膨大,*Camarasaurus* (McIntosh et al., 1996)的前部尾椎神经棘只在远

端横向急剧膨大，而大多数蜥脚类的前部尾椎神经棘表现为横向压扁（Upchurch et al., 2004）。神经棘的前缘发育了两条浅的纵向凹槽，并在中央形成了一个低而宽的脊状结构，前缘横切面呈拉长的“W”形。脊状结构向远端逐渐消失，在基部明显凹入。神经棘后缘大部分较为平坦，只在基部发育了一个缩小的棘后板。侧视，神经棘略向后倾斜，侧缘平直，不发育板状结构。一些巨龙类恐龙如 *Mendozasaurus* 和 *Opisthocoelicaudia* 的前部尾椎神经棘棘前板和棘后板等板状结构较为发育，*Amazonsaurus* 等梁龙类恐龙的神经棘侧面板状结构非常发育，明显不同于清秀龙。

左右胸骨板保存基本完整（图 1D，E）。胸骨板较平，外侧缘明显凹入，背腹视呈肾形，与 *Opisthocoelicaudia*、*Phuwiangosaurus*、*Erketu ellisoni*（Ksepka and Norell, 2006）和其他大多数巨龙类恐龙相似（Salgado et al., 1997; Wilson and Sereno, 1998; Wilson, 2002; Upchurch et al., 2004）。胸骨板后缘较为平直，类似于 *Malawisaurus*、*Mendozasaurus* 和 *Alamosaurus*。相比之下，*Opisthocoelicaudia* 和 *Saltasaurus*（Powell, 1992）的胸骨板后缘呈弧形凸出。清秀龙胸骨板前缘腹侧发育了粗壮的脊状结构，整块骨板脊状突起的地方最厚，为 5 cm。类似的脊状结构在其他巨龙类恐龙中较为发育（Sanz et al., 1999）。清秀龙的胸骨板与肱骨长度的比值约为 0.65，类似于非巨龙类恐龙；而在巨龙类恐龙中，这一比值一般大于 0.75（Upchurch, 1998），比如在 *Mendozasaurus* 中为 0.81，在 *Opisthocoelicaudia* 中为 0.75。

左右肱骨保存近乎完整，仅右肱骨的近外侧略有缺失（图 1F–J）。前视，肱骨的近端相对粗壮，其宽度可达整个肱骨长度的 41%，与 *Saltasaurus* 和 *Opisthocoelicaudia* 中近端宽度与最大长度之比大于 40% 的情形相似。肱骨的近外侧略呈方形的角状过渡，与 *Alamosaurus*（*Gilmore*, 1946; Lehman and Coulson, 2002）和 *Neuquensaurus*（Huene, 1929; Powell, 1986）类似。肱骨三角胸嵴在近侧较为低平，往下延伸至骨干 1/3 处时呈强烈的峰状突起，之后又逐渐降低一直伸展到骨干的中部，三角胸嵴侧视呈三角形，基部粗壮。与此相比，*Apatosaurus*（Gilmore, 1936）、*Camarasaurus*（Ostrom and McIntosh, 1966）、*Opisthocoelicaudia* 和其他大多数蜥脚类恐龙的肱骨三角胸嵴呈缓慢坡状突起。骨干外侧近端 1/3 处有一个显著的突起，该突起在 *Opisthocoelicaudia*、*Saltasaurus* 和其他进步的巨龙类恐龙中较为发育。肱骨前缘近端明显凹入，远端则较为平坦。骨干中部横切面呈椭圆形，椭圆长轴指向内外侧。后视，肱骨头向背内侧伸展，且向上伸展的程度明显大于三角胸嵴的近缘。肱骨远端后缘两侧分别发育了低矮粗壮的脊，该脊向上逐渐变低并最终消失，髁间槽（intercondylar groove）相对较深，与其他大多数巨龙类恐龙类似（Upchurch et al., 2004）。腹视，远端关节面平坦但较为粗糙，内髁近于方形，外髁向前发育了一个明显的小突起，向后急剧膨大，关节面外形接近于一拉长的字母“L”，与 *Alamosaurus*（Lehman and Coulson, 2002）类似，但后者的肱骨远端前缘发育小的凹槽。与此相比，大多数蜥脚类恐龙如 *Camarasaurus*（Ostrom and McIntosh, 1966）和 *Phuwiangosaurus* 的肱骨远端前缘发育两个小的突起，远端关节髁向后膨大的程度较弱。远端关节髁略向骨干前缘膨大，前视可见远端关节髁。

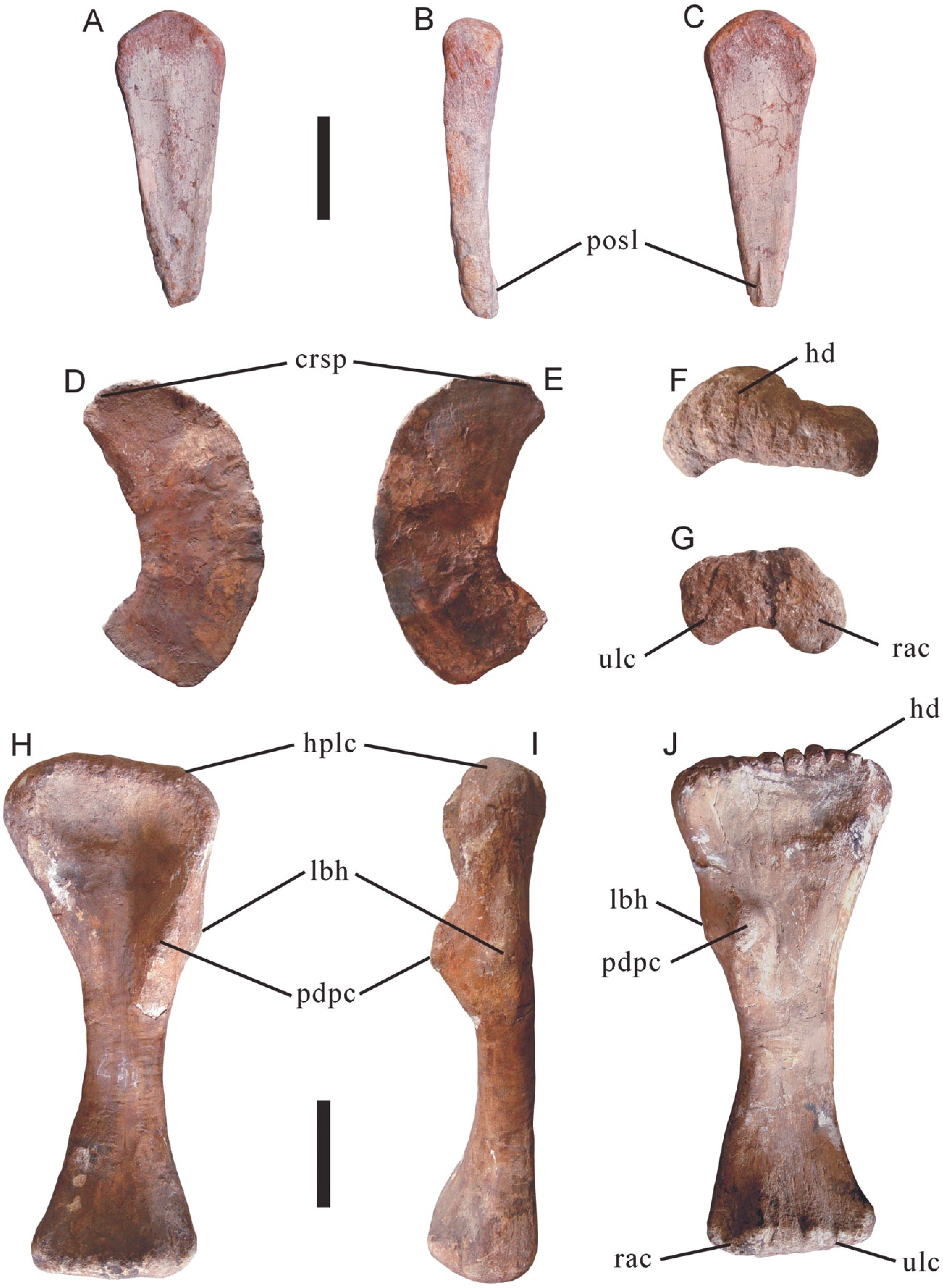

图 1 右江清秀龙(新属新种)正型标本(NHMG 8499)

Fig. 1 *Qingxiusaurus youjiangensis* gen. et sp. nov. (NHMG 8499, holotype)

A–C. 前部尾椎神经棘 cranial caudal neural spine, A. 前视 cranial view, B. 侧视 lateral view, C. 后视 caudal view; D. 右胸骨腹视 right sternal plate in ventral view; E. 左胸骨腹视 left sternal plate in ventral view; F–I. 左肱骨 left humerus, F. 近端视 proximal view, G. 远端视 distal view, H. 前视 cranial view, I. 外侧视 lateral view; J. 右肱骨前视 right humerus in cranial view; A–C 的比例尺 = 10 cm, D–J 的比例尺 = 20 cm, scale bar equals 10 cm in A–C, 20 cm in D–J

简字说明 Abbreviations: crsp. cranioventral ridge of sternal plate 胸骨腹前脊; hd. head 肱骨头; hplc. humeral proximolateral corner 肱骨近外侧角; lbh. lateral bulge of humerus 肱骨外隆凸; pdpc. peak of deltopectoral crest 三角胸嵴尖峰; posl. postspinal lamina 棘后板; rac. radial condyle 桡骨髁; ulc. ulnar condyle 尺骨髁

表 1 右江清秀龙(新属新种)正型标本测量

Table 1 Measurements of the holotype of *Qingxiusaurus youjiangensis* gen. et sp. nov. (mm)

标本 Specimen	最大长 Maximum length	近端最大宽(厚) Maximum proximal width (thickness)	远端最大宽(厚) Maximum distal width (thickness)	中部最小宽(厚) Minimum midshaft width (thickness)
神经棘 Neural spine	270	30(30)	100(50)	65(35)
左胸骨 Left sternal plate	560	(50)	?	?
右胸骨 Right sternal plate	580	(50)	210(12)	?
左肱骨 Left humerus	900	370(250)	300(200)	155(100)
右肱骨 Right humerus	890	?	300(200)	?

3 比较和讨论

尽管清秀龙已知的化石材料有限,但这些材料保存了许多有价值的形态特征,有助于我们探讨这一标本的系统位置。清秀龙具有巨龙形类或者巨龙形类中较进步类群的一些鉴定特征:肱骨的近外侧转角较为发育、胸骨板呈肾形、肱骨远端关节面前视可见、前部尾椎神经棘横向加宽以及肱骨三角胸嵴明显向远端扩张。这些特征不仅表明清秀龙属于巨龙形类恐龙,其中一些特征(前部尾椎神经棘横向加宽以及肱骨三角胸嵴明显向远端扩张)还表明清秀龙属于相对进步的巨龙类恐龙。肱骨三角胸嵴明显向远端扩张是巨龙类中进步的索塔龙科特征,这表明清秀龙有可能属于这一类群;然而,清秀龙的肱骨远端较平坦,不同于索塔龙科肱骨远端髁间槽在远端关节面发育的情形。综合以上分析,清秀龙有可能属于索塔龙科最原始的成员或者这一类群的姐妹群。但考虑到现有化石材料非常局限,清秀龙系统位置的最终确定还有待于更多材料的发现。

迄今为止,亚洲地区已发现了较多的巨龙类恐龙:*Opisthocoelicaudia*、*Huabeisaurus*、*Phuwiangosaurus*、*Tangvayosaurus*、*Borealosaurus*、*Jiangshanosaurus*、*Gobititan*、*Jiutaisaurus* 和 *Sonidosaurus*。与 *Opisthocoelicaudia* 相类似,清秀龙的胸骨板呈肾形,肱骨的外侧近端 1/3 处发育了一个突起,肱骨的三角胸嵴向远端膨大,前部尾椎神经棘横向宽度明显大于前后向长度。但清秀龙的前部尾椎神经棘较为拉长,神经棘前后视呈桨状,肱骨的近侧与外侧之间的角状过渡较弱,胸骨板后缘较为平直,胸骨与肱骨的最大长之比偏低(约为 0.65),这些特征又与 *Opisthocoelicaudia* 相区别。值得一提的是清秀龙的胸骨相对大小更接近于其他蜥脚类恐龙,而不同于其他巨龙类中相对较大的胸骨(胸骨与肱骨的最大长之比在巨龙类恐龙中一般超过 0.75)。考虑到清秀龙具有许多相对进步的巨龙类特征,我们认为清秀龙相对较小的胸骨代表一个反转。清秀龙和 *Phuwiangosaurus* 的胸骨板皆为肾形,但前者的胸骨板外缘向内侧的凹入更为显著。清秀龙的前部尾椎神经棘为横向扩张,而 *Phuwiangosaurus* 的前部尾椎神经棘为横向压扁。与清秀龙相类似,*Huabeisaurus* 的前部尾椎神经棘相对较高,神经棘横向略扩展,但扩展的程度没有清秀龙的强烈。与清秀龙不同,*Huabeisaurus* 的肱骨后侧中部发育了一条纵向的脊状结构突起,*Borealosaurus* 的肱骨近

外侧的突起相对不发育，且三角胸嵴向远端膨胀的程度没有清秀龙强烈。清秀龙和其他亚洲巨龙类恐龙由于缺乏相同的骨骼部位而很难进行比较。

清秀龙的前部尾椎神经棘结构简单，相对较长，前后向压缩呈桨状，这样的前部尾椎神经棘在蜥脚类尤其是巨龙类恐龙中尤为罕见。类似的神经棘在叉背龙科的 *Dicraeosaurus*（Janensch, 1929）和梁龙科的 *Amazonsaurus*（Carvalho et al., 2003）中亦可见到，但后两类恐龙除了前部尾椎神经棘较长和呈前后向压缩的桨状外，它们的棘前板和棘后板等板状结构远比清秀龙发育。相比之下，其他大多数蜥脚类恐龙的前部尾椎神经棘呈横向压缩的板状（Upchurch et al., 2004），明显区别于清秀龙的横向扩张的情形。清秀龙这一独特特征以及最近的相关发现似乎表明，亚洲巨龙类恐龙头后骨骼的形态特征变化非常复杂，正如亚洲的巨龙形类恐龙存在非常复杂的特征分布一样（Xu et al., 2006）。

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A NEW TITANOSAUR (DINOSAURIA: SAUROPODA) FROM THE LATE CRETACEOUS OF GUANGXI, CHINA

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Key words Guangxi, China; Late Cretaceous; Titanosauria

Summary

A new titanosaurian taxon, *Qingxiusaurus youjiangensis* gen. et sp. nov., from the Upper Cretaceous red beds of Nanning City, Guangxi, China is reported. It is represented by several postcranial elements including a cranial caudal neural spine, a pair of sternal plates, and a pair of humeri. The new taxon is diagnosed on the basis of a combination of following features: simply-built cranial caudal neural spine elongated and paddle-shaped and the length ratio between sternal plate and humerus low (about 0.65). The new form, as well as other recently recovered titanosaurian taxa from Asia, indicates a highly modified postcranial morphology and large diversity within this sauropod clade in the Cretaceous of Asia.

1 Systematic paleontology

Dinosauria Owen, 1842

Sauropoda Marsh, 1878

Titanosauria Bonaparte & Coria, 1993

***Qingxiusaurus* gen. nov.**

Diagnosis Distinguished from other titanosaurs in having a unique combination of following features: simply-built cranial caudal neural spine elongated and paddle-shaped and the length ratio between sternal plate and humerus low (about 0.65).

Type species *Q. youjiangensis* gen. et sp. nov.

Etymology "Qingxiu", for "shanqingshuixiu" (pinyin), means "a picturesque scenery of mountains and water in Guangxi"; "saurus", means "lizard" (Greek); "youjiang", after the name of the river near where the specimen is excavated.

Qingxiusaurus youjiangensis gen. et sp. nov.

(Fig. 1; Table 1)

Diagnosis Same as for genus.

Holotype A partial postcranial skeleton (NHMG 8499) including a cranial caudal neural spine, nearly complete paired sternal plates, and paired humeri.

Locality and horizon Dashi village, suburb of Nanning City, Guangxi Zhuang Autonomous Region; Upper Cretaceous red beds.

Remarks The cranial caudal neural spine is elongated and much broader transversely than craniocaudally. It is subsquare in cross-section at the base, but gradually broadens distally to subrectangular in cross-section with the cranial surface slightly broader than the caudal one. In cranial view, the neural spine is paddle-shaped, flaring distally through most of length and then tapering into a round summit. A low and broad ridge-like structure is present in the midline of the cranial surface of the spine. This structure fades into the summit of the spine and becomes markedly concave towards the basal part of the neural spine. The caudal surface of the spine is nearly flat with a greatly reduced post-spinal lamina near the base of the spine, just lateral to the midline. In lateral view, the surface of the spine is nearly flat, and the distal portion of the spine is inclined caudally. There is no indication that the lateral laminae are present on the lateral surface of the spine. The simply-built cranial caudal neural spine of *Qingxiusaurus* is quite different from some titanosaurs such as *Mendozasaurus* (González Riga, 2003) and *Opisthocoelicaudia* (Borsuk-Bialynicka, 1977) in which the cranial caudal neural spines are reinforced by prespinal and postspinal laminae, and from some Diplodocoidea such as *Amazonsaurus* (Carvalho et al., 2003) in which the cranial caudal neural spines bear well-developed lateral, pre-and postspinal laminae.

The left and right sternal plates are crescentic in shape, with a strongly concave lateral border, as seen in *Opisthocoelicaudia* and many other derived titanosaurids (Wilson, 2002). A stout ridge is present at the cranioventral margin where the greatest dorsoventral thickness of the plate is about 5 cm. This stout ridge is also developed in other titanosaurids (Sanz et al., 1999). The length ratio between the sternal plate and the humerus is about 0.65, while it is 0.75 in *Opisthocoelicaudia* and even larger in other titanosaurids (Upchurch, 1998).

The proximal end of the humerus is relatively wide, reaching 41% of the total length of the element. The proximolateral corner is somewhat square. The deltopectoral crest sharply projects cranially at the proximal one-third of the shaft, which extends ventromedially at about one-half of total length of the element. The base of the crest is robust. Caudal to the peak of the deltopectoral crest on the lateral side is a distinct bulge, which is seen on the humeri of *Opisthocoelicaudia*, *Saltasaurus* (Powell, 1992) and other derived titanosaurids. Viewed ventrally, the outline of the articular surface resembles a stretched letter "L", with the radial condyle bending caudally. The distal end of humerus is nearly flat, with the ulnar condyle more prominent than the radial one. The articular surface of the distal condyle is slightly expanded onto the cranial portion of the shaft.

2 Discussion

Qingxiusaurus displays many diagnostic features of the Titanosauriformes or its more exclusive clades: humerus with well developed proximolateral corner, crescentic sternal plate, humeral distal condyle exposed on cranial aspect of shaft, cranial caudal neural spine transversely broad, and humeral deltopectoral crest markedly expanded distally. These features not only establish the titanosaurian affinity of *Qingxiusaurus*, but also suggest a relatively derived systematic position within the group. Humeral deltopectoral crest markedly expanded distally is a diagnostic feature for the derived clade Saltasauridae, suggesting that *Qingxiusaurus* might be a member of this group, but *Qingxiusaurus* has a relatively flat distal end of the humerus, unlike in Saltasauridae the humeral distal end is divided. Therefore, *Qingxiusaurus* could either be a basal saltasaurid or a sister taxon with the Saltasauridae. Given that this systematic inference is based on limited information, this conclusion is tentative and more material is needed to confirm this assessment.

Qingxiusaurus possesses a simply-built, relatively elongated, paddle-shaped and axially compressed cranial caudal neural spine, which is uncommon among sauropods, especially titanosauria. Similar structures are also seen in some genera of Dicraeosauridae such as *Dicraeosaurus* (Janensch, 1929), Diplodocoidae such as *Amazonsaurus* (Carvalho et al., 2003) in which the cranial caudal neural spines are elongated and paddle-shaped, but bear a well-developed lamina system. In contrast, the cranial caudal neural spines in most other sauropod taxa are simple, laterally compressed plates (Upchurch et al., 2004). It seems that *Qingxiusaurus* reinforces previous assertions that Asian titanosaurian sauropods show a highly degree of variability in postcranial morphology and display a complex pattern of character distribution across the group (Xu et al., 2006).

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