第52卷 第5期
2006年9月

地 质 论 评 GEOLOGICAL REVIEW

Vol. 52 No. 5
Sept. 2006

刘家峡黄河巨龙:中国甘肃兰州盆地下白垩统河口群一新蜥脚类恐龙化石

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内容提要:本文记述了2004年发现于甘肃兰州盆地下白垩统河口群一个化石点的蜥脚类恐龙化石。新标本的荐椎独特,神经脊非常低并在其顶端横向扩展,代表蜥脚类恐龙一新属种:刘家峡黄河巨龙。分支系统分析发现黄河巨龙为一原始巨龙型类蜥脚类。

关键词:恐龙;巨龙型蜥脚类;河口群;兰州盆地

兰州盆地下白垩统河口群中的恐龙化石只是随着近年来甘肃省第三地质矿产勘查院古生物研究开发中心的大量野外工作才渐为人知,但其潜力巨大。自上世纪90年代末开始,在盆地西部发现了大量以恐龙足迹为主的遗迹化石群(Li et al., 2002; Zhang et al., 2006)。以此为基础建立的刘家峡恐龙国家地质公园也于2005年正式开园。2002年,首枚恐龙骨骼化石发现于盆地西部。随后2003年发掘的一具恐龙化石经研究是世界上牙齿最大的植食性恐龙,被命名为巨齿兰州龙(You et al., 2005)。大量野外工作还在继续,一个包括鱼类、龟鳖类和各类恐龙的脊椎动物化石群正展现给我们。

2004年发掘的2号化石点保存了一具不完整的蜥脚类恐龙骨骼化石。这批标本现已修理完毕,并具有一些独特的特征足以代表蜥脚类恐龙一新属种。本文即对这一新标本作简要记述并探讨其系统发育关系。

1 标本记述

恐龙 Dinosauria Owen, 1842

蜥臀类 Saurischia Seeley, 1887

蜥脚类 Sauropoda Marsh, 1878

巨龙型类 Titanosauriformes Salgado, Coria and Calvo, 1997

黄河巨龙(新属)*Huanghetitan* gen. nov.

属型种:*H. liujiaxiaensis* gen. et sp. nov.

词源:属名献给黄河,她流经化石产地所在兰州盆地。"Titan"(希腊语):希腊神话中的巨人,意指化石庞大的身躯。

属征:黄河巨龙为一较原始的巨龙型类蜥脚类恐龙。其荐椎神经脊非常低(低于椎体高度)并且神经脊顶端横向扩展(宽于神经脊高度)。

刘家峡黄河巨龙(新属、新种)*Huanghetitan liujiaxiaensis* gen. et sp. nov.

(图版 Ⅰ～Ⅲ;表 1)

正型标本:一具不完整骨架,包括近乎完整的荐椎,一个前部尾椎,一个中部尾椎,若干不完整颈肋,一个缺失远端的脉弧,左侧肩胛骨和乌喙骨。甘肃省第三地质矿产勘查院古生物研究开发中心标本号GSLTZP02-001。

产地与层位:甘肃省兰州盆地东部;下白垩统河口群(中国地层典编委会,2000)。

词源:刘家峡距化石产地不远,并以此纪念刘家峡恐龙国家地质公园的建立。

种征:同属征。

记述:荐椎保存近乎完整(图版Ⅰ)。愈合的荐椎体有5个,较 *Euhelopus* (Wiman, 1929)和其他进步的巨龙类少一个(Upchurch et al., 2004)。第一个荐椎体的前关节面平,并且宽远大于其高,而最后一个荐椎体的后关节面凹进。所有荐椎体侧面均没有凹槽发育。第一荐椎前关节突关节面指向背面。所有五个荐椎的椎弓像其椎体一样也彼此愈合。只有前

注:本文为国土资源部国际合作与科技司,中国地质调查局,国家科技部(973)和甘肃省地质矿产局项目的成果。

收稿日期:2006-07-10;改回日期:2006-7-28;责任编辑:章雨旭。

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表 1 刘家峡黄河巨龙正型标本(GSLTZP02-001)测量数据(单位:cm)

Table 1 Measurements (in centimeters) of holotype (GSLTZP02-001) of *Huanghetitan liujiaxiaensis* gen. et sp. now.

荐椎 Sacrum	荐椎体总长 Total centra length	90
	最大宽度 Maximum width	110
前部尾椎 Proximal caudal	椎体长 Centrum length	9
	椎体宽 Centrum width	13.5
	椎体高 Centrum height	12.5
	总高度 Total height	28
中部尾椎 Middle caudal	椎体长 Centrum length	11
	椎体宽 Centrum width	13
	椎体高 Centrum height	10
	总高度 Total height	20
肩胛骨 Scapula	总长度 Total length	123
	肩胛骨骨干长 Blade length	70
	肩胛骨骨干最大宽度 Maximum width of blade	45
	肩胛骨骨干最小宽度 Minimum width of blade	27
	肩胛骨肩峰突宽度 Plate width	83
乌喙骨 Coracoid	背腹长 Length (dorsoventral)	60
	横向宽 Width (transverse)	50
	肩臼窝长 Glenoid length	23
	肩臼窝最大厚度 Glenoid thickness (maximum)	20

四个神经脊愈合,长度约60 cm。这四个愈合的神经脊非常低并且在其顶端横向扩展,这是在其他蜥脚类中未曾报道过的。这四个神经脊的高度基本不变,约8cm;但其扩展的顶端的宽度却递减,从第一神经脊后缘的20cm 到第四神经脊后缘的8cm。

荐椎横突和其腹侧的荐肋彼此愈合。从背面看,荐椎横突向侧面伸展;但前两个荐椎的横突略向前倾,而后三个则微向后弯。每个横突的近端都有几个梁与神经脊相连,包括神经脊前关节突梁,神经脊横突梁和神经脊后关节突梁。不过,这些梁的发育程度却不尽相同。从腹面看,荐肋在其近端和远端膨大。前四个荐肋的近端通过副突连接到相应荐椎体侧面的前部,而第五个荐肋却连接到中部。除第一荐肋外,其余四个荐肋的远端彼此关联。

有两个孤立的尾椎保存(图版Ⅱ)。其中一个为前部尾椎,因其神经弓与椎体背缘大部分关节,并且远较另一尾椎高(图版Ⅱ-a—f)。另一个尾椎的神经弓仅与椎体背缘的前半部关节,是典型的巨龙型类的中部尾椎(图版Ⅱ-g—l)。

前部尾椎双平型,椎体关节面亚圆形。椎体的长度小于关节面的宽度。椎体腹面有一宽浅的轴向延伸的槽。神经孔较大,高约为椎体高度的一半。前关节突指向背前方,其最前端略超过椎体的前缘。后关节突仅为一短小的突起。神经脊侧视为长方形,向背后方伸展。神经脊四周未见梁状构造,表明这一尾椎为较靠后的前部尾椎。横突起于椎体与椎弓的缝合处,并向侧后方突出。

中部尾椎椎体也是双平型,具亚圆形的关节面。关节面的宽度与椎体的长度相当,并略长于前述前部尾椎的长度。与前部尾椎不同,它的前关节突和神经脊都较为低平。横突依然存在,表明这是一个较靠前的中部尾椎。

有几个保存不全的颈肋,其中较完整的一个有110cm 长。它的近端呈四射形,有一个短的前突。两肋骨关节突之间夹角小于90°,说明肋骨的位置应低于相应椎体的腹面。

有一个脉弧保存了其前端。根据大小,它很可能关联于前部尾椎。脉弧之间没有横梁相连,两分叉围成一较深的孔。

左肩胛骨仅其侧面被修复(图版Ⅲ-a)。与其他蜥脚类不同,黄河巨龙的盘状的肩峰突特别膨大,背腹向高达83cm,甚至长于肩胛骨骨干(70cm)。在肩峰突的背后缘发育一较低的斜脊,其前方肩峰突的大部则是一浅凹的区域。肩胛骨在肩臼窝处变得最厚。如在 *Euhelopus* 和其他巨龙类中一样,肩臼窝不仅面向前腹侧,而且向内侧倾斜。较短的肩胛骨骨干在其远端发育一向背前方的勾突。肩胛骨的骨干在其基部略微突起,使其截面呈 D 型。

左乌喙骨近圆盘型(图版Ⅲ-b)。其背缘和前缘较圆滑,而后缘和腹缘不规则。肩臼窝很厚且粗糙(图版Ⅲ-c)。在肩臼窝前方的腹面有一小凹槽。乌喙孔圆形,位于乌喙骨与肩胛骨关节面的中点的前方不远处。

2 讨论

为了探讨黄河巨龙的系统发育关系,我们进行了分支系统分析。性状矩阵根据 Wilson (2002),这一矩阵最近也被 Ksepka and Norell (2006)用来分析蒙古早白垩世新发现的 *Erketu ellisoni* 的系统发育关系。我们对第111个性状增加了一个性状状态(状态2:荐椎神经脊长度小于相应椎体长度),以反映正型标本这一近裔自性。刘家峡黄河巨龙的性状分布见表2。运用PAUP * 4.0b10(Swofford,

表 2　刘家峡黄河巨龙性状分布(根据 Wilson(2002)的性状矩阵)

Table 2　Coding of *Huanghetitan liujiaxiaensis* gen. et sp. now. for character matrix of Wilson (2002) used in phylogenetic analysis

				5					10					15					20
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				25					30					35					40
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				45					50					55					60
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				65					70					75					80
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				85					90					95					100
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				105					110					115					120
?	?	?	?	?	?	?	2	1	1	2	?	0	?	?	?	?	0	0	0
				125					130					135					140
0	0	?	?	?	0	1	0	0	0	0	1	0	0	?	?	?	?	1	0
				145					150					155					160
?	?	?	?	1	?	?	?	1	1	0	2	1	1	0	0	1	?	?	?
				165					170					175					180
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				185					190					195					200
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				205					210					215					220
?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
				225					230				234						
?	?	?	?	?	?	?	?	?	?	?	?	?	?						

2002)启发式搜索发现六个最简约树(树长=436;一致性指数=0.66;保留指数=0.80)。在所有六个树中,刘家峡黄河巨龙的位置不变,始终是 Somphospondyli 的姊妹群。由黄河巨龙和 Somphospondyli 构成的支系被两个无疑的近裔共性支持(前部和中部尾椎椎体腹面有一纵沟;肩胛骨肩臼窝向内倾斜)。同时,黄河巨龙也缺失 Somphospondyli 的两个无疑的近裔共性(6个荐椎;肩胛骨骨干基部截面较平呈长方形)。根据六个最简约树得到的一个严格一致树见图1。

黄河巨龙的发现为亚洲早白垩世巨龙型蜥脚类再添新成员。这之前的发现包括:*Euhelopus* (Wiman, 1929), *Phuwiangosaurus* (Martin et al., 1994, 1999), *Tangvayosaurus* (Allain et al., 1999), *Jiangshanosaurus* (Tang et al., 2001), *Gobititan* (You et al., 2003), *Erketu* (Ksepka and Norell, 2006), *Jiutaisaurus* (Wu et al., 2006), 和西西伯利亚一未命名标本(Averianov et al., 2002). 近年来对巨龙型蜥脚类的研究有很大进展(Upchurch et al., 2004; Wilson, 2005)。巨龙型蜥脚类不再局限在南半球,在北半球的早白垩世也有很多新发现。在亚洲也可能存在一独立单系类群(You et al., 2004)。同时,伴随着越来越多巨龙型蜥脚类的发现,传统的以鸭嘴龙和角龙为主导的白垩纪陆地植物生态系统也正受到挑战。

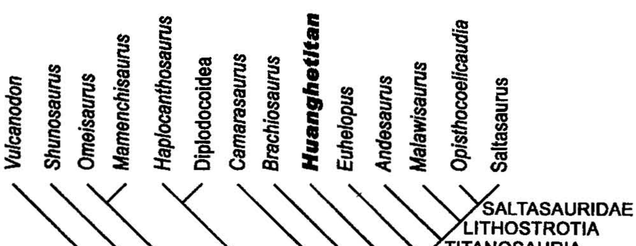

图 1　刘家峡黄河巨龙(新属、新种)系统发育关系

Fig. 1　Phylogenetic relationship of *Huanghetitan liujiaxiaensis* gen. et sp. nov.

分支图基于 PAUP * 4.0b10启发式搜索得到的六个最简约树(树长=436;一致性指数=0.66;保留指数=0.80)的一个严格一致树。各分类单元的定义根据 Curry Rogers (2005)和 Wilson (2005)。黄河巨龙是 Somphospondyli 的姊妹群

The topology is based on the strict consensus of six equally parsimonious and shortest trees from a PAUP * 4.0b10 heuristic search (436 steps; *CI*: 0.66; *RI*: 0.80). The definitions of taxa are based on Curry Rogers (2005) and Wilson (2005). *Huanghetitan* gen. now. is the sister taxon to Somphospondyli

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图版说明 / Plate Captions

图版 I / Plate I

刘家峡黄河巨龙(新属 新种)荐椎背视(a)和腹视(b)。比例尺10cm。

Sacrum of *Huanghetitan liujiaxiaensis*, gen. et sp. nov. in dorsal (a) and ventral (b) views. Scale bar equals 10 cm.

图版 Ⅱ / Plate Ⅱ

刘家峡黄河巨龙(新属 新种)前部尾椎(a—f)和中部尾椎(g—l)。前视(a, g),后视(b, h),左侧视(c, i),右侧视(d, j),背视(e, k)和腹视(f, l)。比例尺10cm。

Proximal (a—f) and middle (g—l) caudals of *Huanghetitan liujiaxiaensis*, gen. et sp. nov. in cranial (a, g), caudal (b, h), left lateral (c, i), right lateral (d, j), dorsal (e, k), and ventral (f, l) views. Scale bar equals 10 cm.

图版 Ⅲ / Plate Ⅲ

刘家峡黄河巨龙(新属 新种)左肩胛骨(a)和左乌喙骨 (b, c)。侧视(a, b)和腹视(c)。比例尺10cm。

Left scapula (a) and left coracoid (b, c) of *Huanghetitan liujiaxiaensis*, gen. et sp. nov. in lateral (a, b) and ventral (c) views. Scale bar equals 10 cm.

Huanghetitan liujiaxiaensis, a New Sauropod Dinosaur from the Lower Cretaceous Hekou Group of Lanzhou Basin, Gansu Province, China

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Abstract

Sauropod dinosaur material excavated from one quarry in the Lower Cretaceous Hekou Group of the

Lanzhou Basin, Gansu Province in 2004 pertain to a single, new taxon and are described. Unique features of its sacrum, including an extremely low neural spine with a remarkably transversely expanded distal end, support the attribution of this material to a new genus and species of sauropod, *Huanghetitan liujiaxiaensis* gen. et sp. nov. Cladistic analysis strongly supports *Huanghetitan* gen. now. as a basal member of the Titanosauriformes.

Dinosaurs have only recently been discovered in the Lower Cretaceous Hekou Group in the Lanzhou Basin, but the great promise of these strata for dinosaur research may now be recognized due largely to work by field crews from the Fossil Research and Development Center of the Third Geology and Mineral Resources Exploration Academy of Gansu Province. Beginning in the late 1990's (Li et al., 2002, Zhang et al., 2006), numerous dinosaur footprints were discovered in the western part of the basin, and their importance led to the establishment and opening of the Liujiaxia National Dinosaur Geopark in 2005. The first Hekou Group dinosaur body fossils were discovered in the southern part of the basin in 2002, and one quarry excavated in 2003 yielded the holotype of *Lanzhousaurus magnidens*, the largest-toothed herbivorous dinosaur in the world (You et al., 2005). Fieldwork has continued to the present, and a new vertebrate fossil assemblage, including fishes, turtles, and various dinosaurs, is being revealed.

Among the quarries excavated in 2004, Quarry 2 preserved partial sauropod skeletons. This material has since been prepared; the material exhibits some unique features that warrant the erection of a new taxon. Here we present some preliminary observations of this new taxon and discuss its phylogenetic relationships.

1 Description

Dinosauria Owen, 1842

Saurischia Seeley, 1887

Sauropoda Marsh, 1878

Titanosauriformes Salgado, Coria and Calvo, 1997

***Huanghetitan* gen. nov.**

Type Species: *H. liujiaxiaensis* gen. et sp. nov.

Etymology: "Huanghe" (Chinese): Yellow River, which flows along the Lanzhou Basin where the fossils were discovered. "Titan" (Greek): refers to Greek mythological giants, symbolic of great size.

Diagnosis: *Huanghetitan* gen. now. is a basal member of the Titanosauriformes distinguished from all others by its possession of extremely low sacral neural spines (lower than the height of the centrum) and transversely expanded distal ends of the neural spines (wider than neural spine height).

***Huanghetitan liujiaxiaensis* gen. et sp. nov.**

(Plates Ⅰ～Ⅲ, Table 1)

Holotype: GSLTZP02-001 (Quarry 2): nearly complete sacrum, one proximal caudal vertebra, one middle caudal vertebra, fragmentary cervical ribs, one chevron missing its distal end, left scapula, and left coracoid. Reposited in the Fossil Research and Development Center of the Third Geology and Mineral Resources Exploration Academy of Gansu Province in Lanzhou.

Type locality and horizon: Eastern part of the Lanzhou Basin, Gansu Province, P. R. China; Hekou Group, Lower Cretaceous (Editorial Committee of Chinese Stratigraphic Standard, 2000).

Etymology: "Liujiaxia" (Chinese): Liujia Gorge, which is part of the Yellow River in Lanzhou Basin, where the Liujiaxia National Dinosaur Geopark is located nearby.

Diagnosis: Same as for genus.

Description: An almost complete sacrum is preserved (Plate Ⅰ). The sacrum is composed of five coossified vertebrae, as in basal macronarians, but one fewer than in *Euhelopus* (Wiman, 1929) and more derived lithostrotians (Upchurch et al., 2004). The cylindrical sacral centra are fused; the first sacral has a flat cranial articular surface and the last a concave caudal articular surface. The cranial surface of the first centrum is much wider than tall. No pleurocoels are developed on the lateral surfaces. The articular surfaces of the prezygapophyses of the first sacral face dorsally. The neural arches of all five sacrals are, like their centra, fused, though the neural spines of only the first four sacrals are fused. Autapomorphic to these four fused neural spines (totaling 60 cm long) are their extremely short heights and markedly transversely expanded distal ends. The height of each neural spine is about 8 cm, but the widths of the expanded dorsal surfaces (along their caudal margins) begin at 20 cm on the first sacral and decrease caudally to 8 cm in the fourth sacral.

The sacral plate is composed of the transverse processes dorsally and the sacral ribs ventrally; these are fused to each other. In dorsal view, the transverse processes project laterally, but also slightly cranially in the first two sacrals and slightly caudally in the last three (Plate Ⅰ-a). The dorsal surface of the proximal end of each transverse process is craniocaudally expanded and braced against the neural spine by the spinoprezygapophyseal, spinodiapophyseal, and spinopostzygapophyseal laminae. However, the robustness of these laminae varies in each individual sacral. In ventral view, the sacral ribs expand at both the proximal and distal ends. The proximal ends of the first four ribs attach to the cranial portions of their respective centra via the parapophyses, while that of the fifth rib attaches to the midpoint of the centrum. Except for the first, the distal ends of all the sacral ribs connect to each other, forming a sacrocostal yoke.

Two isolated caudals are preserved (Plate Ⅱ). One, which has its neural arch occupying most of the length of the centrum, is much taller than the other. It is designated as a proximal caudal (Plate Ⅱ-a—f). In the other, the neural arch only occupies the proximal half of the length of the centrum, which is typical of the middle caudals of titanosauriforms (Plate Ⅱ-g—l).

The centrum of the proximal caudal is amphiplatyan, and has subcircular articular surfaces. The length of the centrum is shorter than the width of the articular surface. The ventral side of the centrum bears a wide but shallow longitudinal fossa that is more prominent at its distal end due to the enlargement of the chevron articular facets. The neural arch encompasses a relatively large neural canal that is about half as tall as the centrum. The medially facing prezygapophyses are transversely compressed, directed proximodorsally, and project slightly beyond the proximal end of the centrum. The postzygapophyses are mere facets, rather than processes. The neural spine is rectangular in lateral view, projecting more dorsally than distally. No clear laminae develop around the neural spine, as would be expected in a very proximal caudal vertebra, implying a relatively distal position for this element. The transverse processes are situated at the neurocentral suture, and seem to trend caudolaterally.

The centrum of the middle caudal is also amphiplatyan. Its articular surfaces have subcircular outlines, although diagenetic deformation may obscure its actual configuration. The width of each articular surface is about the same as the length of the centrum, which is slightly longer than that of the proximal centrum. Differing from the proximal caudal, its prezygapophyses and neural spine project more horizontally than dorsally. Transverse processes still exist, indicating a relatively proximal position for this middle caudal.

Several fragmentary cervical ribs are preserved. One cervical rib is relatively complete, and measures 1.1 m long. Its proximal end is tetraradiate, with a short cranial process. The angle between the capitulum and the tuberculum is well below 90°, indicating a ventral placement of the rib relative to the ventral edge of its centrum.

A single chevron is represented by its proximal end and part of its distal portion. Based on its large size, this chevron is probably articulated with proximal caudals. The proximal end has two rami that are not bridged. The hemal canal enclosed by the two rami is deep.

The lateral side of the left scapula is prepared (Plate Ⅲ-a). This scapula is unique among all sauropods in having an extremely dorsoventrally expanded, plate-like acromion (83 cm tall), longer than the blade itself (70 cm). The plate is elliptical in outline, with its dorsal portion far larger than the ventral one. A low deltoid ridge runs along the caudodorsal edge of the acromion, and defines the caudal margin of a shallow fossa that occupies the bulk of the dorsal portion of the plate. The acromion and scapular body become thicker ventrally, especially at the cranioventral edge of the glenoid. As in *Euhelopus* and titanosaurians, the scapular portion of the glenoid faces not only cranioventrally, but also medially. The short blade of the scapula expands caudally, with a pronounced hook at its caudodorsal corner. The lateral side of the blade is slightly convex, giving it a D-shaped cross-sectional morphology.

The left coracoid is a relatively flat plate, with round dorsal and cranial margins and sinuous caudal and ventral margins (Plate Ⅲ-b). The caudal margin is convex, with its apex at the midpoint, fitting a corresponding concavity on the cranial margin of the scapula. The coracoidal portion of the glenoid is transversely rugose and thick and bears a pronounced lip (Plate Ⅲ-c). Cranial to this, a notch embays the ventral margin of the element. A coracoid foramen is situated at mid-height, just cranial to the coracoid-scapula contact.

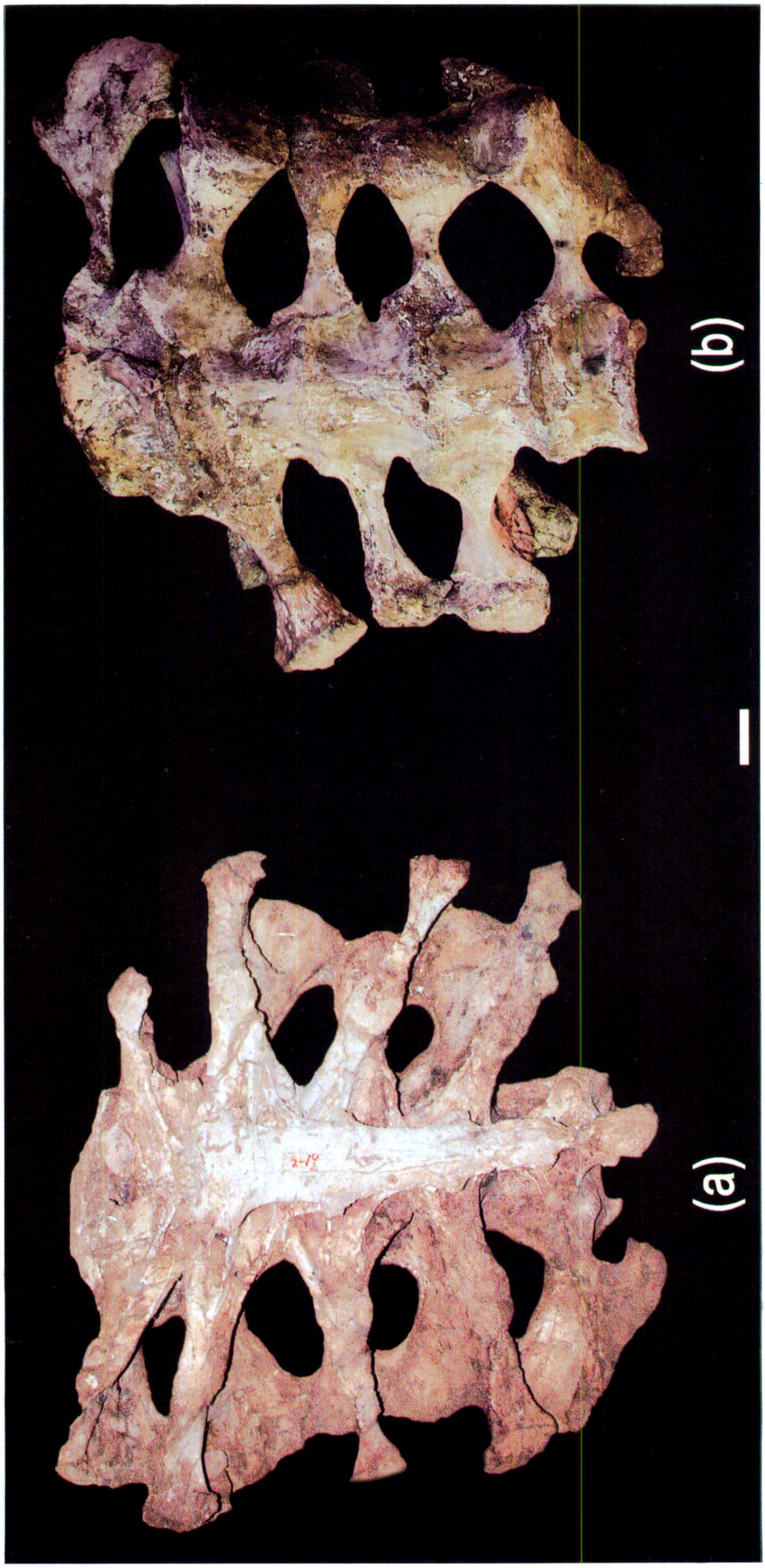
2 Discussion

In order to find the phylogenetic relationships of the new taxon, a cladistic analysis was performed using the data matrix of Wilson (2002). This data matrix was also used by Ksepka and Norell (2006) to find the phylogenetic relationships of the Early Cretaceous, Mongolian sauropod *Erketu ellisoni*. An additional character state (state 2) is added to character 111 to accommodate a sacral neural spine length that is less than the length of the centrum. This autapomorphic feature is only known in the holotype. The codings for *Huanghetitan liujiaxiaensis* gen. et sp. now. are listed in Table 2. A heuristic search in PAUP * 4.0b10 (Swofford, 2002) recovered six equally most parsimonious trees with lengths of 436 steps, $CI = 0.66$, and $RI = 0.80$. The position of *Huanghetitan liujiaxiaensis* gen. et sp. now., as the sister taxon of the Somphospondyli, remained constant across all six trees. This clade (*Huanghetitan* gen. now. + Somphospondyli) is supported by two unambiguous synapomorphies (132: 0>1; 153: 0>1). *Huanghetitan* gen. now. is less derived than other somphospondylians in its lack of two unambiguous synapomorphies (108: 2>3; 154: 1>0). A simplified, strict consensus of the six most parsimonious trees is presented in Figure 1. *Huanghetitan* gen. now. is more derived than *Brachiosaurus* in possessing a ventral, longitudinal hollow in proximal and middle caudal centra, and a strongly medially beveled scapular glenoid. *Huanghetitan* gen. now. is less derived than other members of the Somphospondyli in its lower sacral count (5), and the D-shaped cross-section of the base of the scapular blade.

The discovery of *Huanghetitan* gen. now. is yet another addition to the growing roster of basal titanosauriforms in the Early Cretaceous of Asia, following *Euhelopus* (Wiman, 1929), *Phuwiangosaurus* (Martin et al., 1994, 1999), *Tangvayosaurus* (Allain et al., 1999), *Jiangshanosaurus* (Tang et al., 2001), *Gobititan* (You et al., 2003), *Erketu* (Ksepka & Norell, 2006), *Jiutaisaurus* (Wu et al., 2006), and an unnamed taxon from western Siberia (Averianov et al., 2002). Research on titanosauriform sauropods has experienced great advances in recent years (Upchurch et al., 2004; Wilson, 2005). Titanosaurian dinosaurs are no longer restricted to the Southern Hemisphere, but were also common in Northern Hemisphere during the Early Cretaceous. The existence of an Asian monophyletic titanosaur group was raised on the opisthocoelous condition in their caudal centra (You et al., 2004). The increase in new discoveries of titanosaurian sauropods also challenges the traditional view that the Cretaceous terrestrial herbivorous world was dominated by duck-billed and horned dinosaurs.

Acknowledgements: We thank the crew of the Fossil Research and Development Center of the Third Geology and Mineral Resources Exploration Academy of Gansu Province for excavation and preparation of the specimens; Peter Dodson, Jerald Harris, and Matthew Lamanna for valuable discussions; Dong Zhiming and Tang Zhilu for their generous help. Funding was provided by the Chinese Geological Survey, the Department of International Cooperation of the Ministry of Land and Resources, and the Ministry of Science and Technology of China (973 Project) to Ji Qiang and You Hailu, and the Gansu Bureau of Geology and Mineral Resources to Li Daqing.

Key words: Dinosauria; Titanosauriformes; Hekou Group; Lanzhou Basin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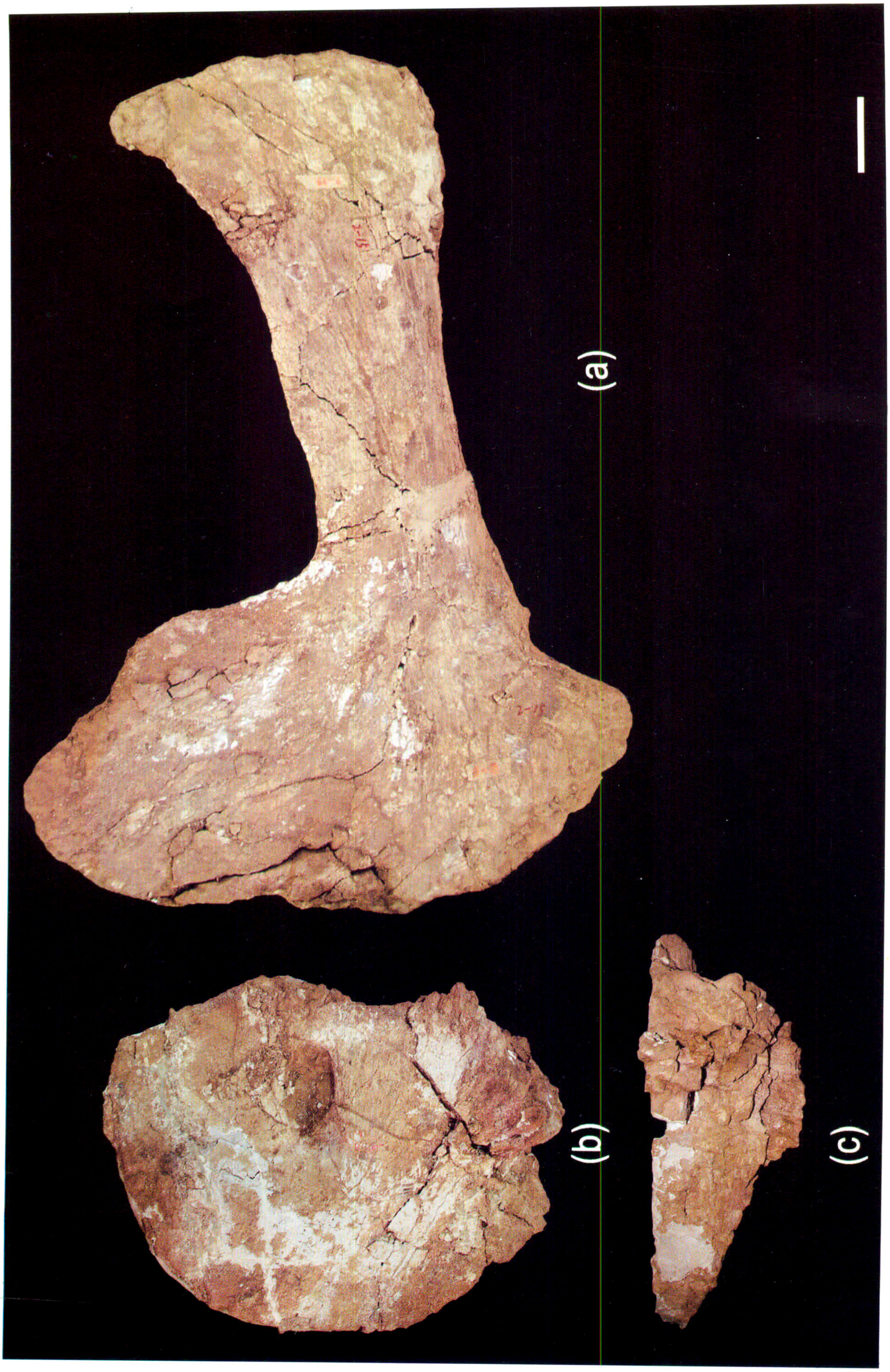
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