

内蒙古上白垩统二连组一长颈的镰刀龙类¹⁾

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摘要 镰刀龙类(又称“懒龙”)是一类奇特的植食性兽脚类恐龙,化石记录主要局限于亚洲白垩纪地层中。由于镰刀龙类极其特化的形态和化石材料的局限性,这类恐龙的系统位置存在较多的争议。最近的发现(Russell and Dong, 1994; Xu et al., 1999)表明这类恐龙属于虚骨龙类,但其更为具体的系统位置依然存在争议(Sues, 1997; Makovicky and Sues, 1998; Xu et al., 1999; Sereno, 1999)。

新发现于内蒙古苏尼特左旗赛罕高毕上白垩统二连组的镰刀龙类化石材料代表这类恐龙的一个新属种。杨氏内蒙古龙(*Neimongosaurus yangi* gen. et sp. nov.)的正型标本为一较为完整的骨架,是已知镰刀龙类当中第一件在同一个体中保存了大多数脊椎和几乎所有肢骨的标本。

依据以下特征将内蒙古龙归入镰刀龙超科:U形的下颌联合部、齿骨前端向下弯曲、齿骨前部没有牙齿、牙齿有一个收缩的基部、近圆形的齿根和叶形的齿冠、前部颈椎的神经脊低矮而轴向较长、后部颈椎背视呈X形、肱骨近端角状、肱骨有后转子、肱骨的尺骨髁和挠骨髁位于前部并为一狭窄槽分开、肠骨的耻骨柄细长而坐骨柄短以及跖部短。

内蒙古龙的以下特征区别于其他镰刀龙类:前部尾椎的横突下部有一圆形的窝,桡骨二头肌结节非常发育,后足趾节近端跟部非常发育,胫骨的腓骨嵴长,明显超过胫骨长度的一半,肠骨髁臼前支外侧面向背方,尾椎前关节突向两侧侧伸明显。

镰刀龙类有一些未见于其他手盗龙类的特征,表明这类恐龙较为原始,可能和似鸟龙类关系较近(Sereno, 1999),但其他一些证据表明镰刀龙类较为进步,可能和窃蛋龙类关系较近(Makovicky and Sues, 1998; Xu et al., 1999)。内蒙古龙高度气孔化的脊椎和进步的肩带形态表明镰刀龙类相当进步。其中加长的颈部和缩短的尾部等特征非常类似于窃蛋龙类。这些特征的发现支持了镰刀龙类和窃蛋龙类的系统关系较近的假说。

关键词 内蒙古苏尼特左旗,上白垩统,镰刀龙类

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A LONG NECKED THERIZINOSAUROID DINOSAUR FROM THE UPPER CRETACEOUS IREN DABASU FORMATION OF NEI MONGOL, PEOPLE'S REPUBLIC OF CHINA

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Abstract Two partial skeletons are described from the Upper Cretaceous Iren Dabasu Formation of Nei Mongol that represent a new therizinosauroid theropod. *Neimongosaurus yangi* gen. et sp. nov., is the first therizinosauroid to preserve most of the axial column and nearly all of the long bones of a single individual. Distinctive characteristics of the new species include anterior caudal vertebrae with a circular fossa under the transverse process, radius with a prominent biceps tuberosity, proximal pedal phalanges with well developed heels, tibia with an extremely long fibular crest that is much longer than the half length of the tibia, lateral surface of preacetabular process twisted to face dorsally, and caudal vertebrae with widely divergent prezygapophyses. *Neimongosaurus* displays a few characters that are not reported in other therizinosauroids but do occur in some advanced maniraptorians, such as highly pneumatized vertebra and derived shoulder girdle. Particularly the elongated neck and shortened tail provide further evidence for a close relationship between therizinosauroids and oviraptorosaurs.

Key words Sunitezuoqi, Nei Mongol, Upper Cretaceous, therizinosauroid

1 Introduction

Therizinosauroids comprise an unusual herbivorous group of theropod dinosaurs that have been recovered almost exclusively in deposits of Cretaceous age in Asia. The first remains were found in Mongolia and consisted of the enormous manual claws of one of the most specialized members of the group, *Therizinosaurus cheloniformis* (Maleev, 1954). Therizinosauroids are now represented by partial skeletons of basal taxa from the Early Cretaceous, such as *Beipiaosaurus inexpectus* (Xu et al., 1999) and *Alxasaurus elesitaiensis* (Russell and Dong, 1994), and generally less complete skeletal remains from more derived taxa of Late Cretaceous age, including *Nanshiungosaurus brevispinus* (Dong, 1979), *Segnosaurus galbinensis* (Perle, 1979), and *Erlikosaurus andrewsi* (Perle, 1980; Clark et al., 1994). A basal taxon is also known from the Early Jurassic South China (Zhao and Xu, 1998; Xu et al., 2001).

The group remains poorly known, as there is not yet a single species that preserved the skull in association with a reasonably complete skeleton, a skeleton that preserves all of the long bones of fore and hind limbs, or a skeleton that preserves all of the axial column.

We describe here skeletal materials of a new therizinosauroid that add important new information regarding the anatomy of these specialized theropods. The fossil was discovered in 1999 at Sanhangobi in Nei Mongol (Inner Mongolian) Autonomous Region by a team from the Department of Land and Resources, Hohhot. The fossil remains were collected in fluvial sandstones of the Upper Cretaceous Iren Dabasu Formation, which has yielded a diverse dinosaurian fauna, including the hadrosauroids *Bactrosaurus* and *Gilmoresaurus* and the theropods *Archaeornithomimus*, *Avimimus*, and *Alectrosaurus*. This formation is now regarded Late Cretaceous (Senonian) in age (Currie and Eberth, 1993).

Institutional abbreviations: LH, Long Hao Geologic Paleontological Research Center,

Department of Land and Resources, Hohhot.

2 Systematics

Theropoda Marsh, 1881

Coelurosauria Huene, 1914

Therizinosauroida (Maleev, 1954)

The superfamily Therizinosauroida had gained currency as the preferred higher taxon to encompass all species formerly referred to as "segnosaurs" or "therizinosaurids" (Russell and Dong, 1994). We suggest here that current widespread use of Therizinosauroida should be linked to a phylogenetic definition that recognizes its current uncertain position within Coelurosauria yet clearly unites all taxa that are more closely related to *Therizinosaurus* than to any other coelurosaurian subgroup. Therizinosauroida is defined here as: All coelurosaurs closer to *Therizinosaurus* than to either *Ornithomimus*, *Oviraptor*, *Velociraptor* or Neornithes. Therizinosauridae, on the other hand, is more usefully restricted to derived members of the clade than as formerly defined by Sereno (1998:65) to encompass the entire group. Therizinosauridae is redefined here as: *Segnosaurus*, *Erlikosaurus*, *Nanshiungosaurus*, *Therizinosaurus*, their common ancestor and all descendants.

Neimongosaurus yangi gen. et sp. nov.

(pls. I~III)

Etymology Neimongo, for Nei Mongol, the general location of the site of discovery; sauros, for reptile (Greek); yangi, in memory of the founder of vertebrate paleontology in China, Yang Zhongjian (C. C. Young)

Holotype Partial braincase, anterior end of right dentary, and most of the axial column except the atlas, some mid and posterior dorsal vertebrae, and the distalmost caudal vertebrae; pectoral girdle and forelimb elements include the left and partial right scapulocoracoids, furcula, both humeri, and the left radius; pelvic girdle and hindlimb elements include partial left and right ilia, both femora and tibiae, left distal tarsals 3 and 4, and most of the left pes (LH V0001). The axial column and pes were found in articulation; the remainder of the skeleton was partially disarticulated.

Referred specimen Sacrum composed of six coossified vertebrae articulated with both ilia (LH V0008).

Locality and horizon Sanhangobi, Sunitezuoqi, Nei Mongol (20 km southwest of Erlan city); Iren Dabusu Formation (Senonian).

Diagnosis Basal therizinosauroid reaches 2 to 3 meters in body length and differs from other therizinosauroids in having the following characters: anterior caudal vertebrae with a circular fossa under the transverse process, radius with a prominent biceps tuberosity, proximal pedal phalanges with well developed heels, tibia with an extremely long fibular crest that is much longer than the half length of the tibia, and lateral surface of preacetabular process twisted to face dorsally. Caudal vertebrae are characterized by widely divergent prezygapophyses (distribution poorly known among other therizinosauroids).

Description The skull includes the posterior part of the braincase and the anterior end of the right dentary. The width of the occipital condyle (12mm) is slightly less than that of the foramen magnum (approximately 15mm). The anterior end of the dentary ramus curves medially (pl. I, C), suggesting that the mandibles had a U-shaped, rather than V-shaped, symphyseal region, as also occurs in ornithomimids, oviraptorosaurs, and most troodontids. In lateral view (pl. I, A), the dentary ramus increases in depth toward the symphysis, and both dorsal and ventral margins curve ventrally. A large oval neurovascular foramen is located on the ventral half of the ramus about 1.5cm from the symphysis. In medial view, the

symphysis is restricted to the distal end of the ramus. The alveolar margin preserves sockets for the first five dentary teeth, anterior to which is a short edentulous margin. The thin edentulous margin is deflected slightly laterally before curving toward the symphysis, as seen in dorsal view (pl. I, C). The crowns of a replacement tooth in the second alveolus and a functioning tooth in the third alveolus are similar to that described for *Alxasaurus* (Russell and Dong, 1994) and other therizinosauroids. The crowns are fully enameled, transversely compressed, and have coarse marginal denticles fore and aft, which are best preserved on the unerupted tooth.

Axial column: A series of 17 vertebrae are preserved in articulation, beginning with the axis. We tentatively regard the first 13 as pertaining to the neck, representing cervicals 2 ~ 14 (pl. I, D ~ I). We base this identification on the ventral location of the parapophysis in these 13 vertebrae, its rather abrupt shift dorsally in the succeeding vertebra (identified as the first dorsal), and the abrupt shortening of the last cervical centrum, as compared to adjacent centra, fore and aft (pl. I, H ~ J). Our identification of as many as 14 cervical vertebrae needs confirmation in the future from material that also preserves the costal series. If our identification is correct, *Neimongosaurus* would have one of the longest cervical series ever recorded among nonavian theropods. The presence of a long neck with as many as 14 cervical vertebrae, however, may not characterize all therizinosauroids. Previous authors have suggested there may be 12 or fewer cervical vertebrae in the derived therizinosaurid *Nanshiungosaurus* (Dong, 1979, 1997). Some oviraptorosaurs may also have increased the number of cervical vertebrae, however, only twelve cervicals were reported in the basal oviraptorosaur *Caudipteryx* (Zhou et al., 2000).

The axis and succeeding nine vertebrae (C 2 ~ 11) have elongate centra with gently concave anterior faces and more strongly concave posterior faces (Table 1). In lateral view, the centra appear gently arched with broad pleurocoels occupying much of their sides (pl. I, D). In ventral or posterior view, the centra are narrow compared to their neural arches. The large flexed zygapophyseal facets on the neural arches are located entirely lateral to the centra (pl. I, F). The neural spine in C3 through C11 is low with length about half that of the centrum.

Table 1 Measurements of the holotypic specimen of *Neimongosaurus yangi* (LH V0001) (mm)

Furcula width	128	Radius distal anteroposterior depth	19
Furcula mid shaft anteroposterior width	7	Femur length (left)	366
Furcula mid shaft dorsoventral depth	11	Femur proximal transverse width	97
Furcula apex dorsoventral depth	17	Femur distal transverse width	87 *
Coracoid glenoid length	19	Femur proximal end to fourth trochanter	145
Coracoid anteroventral process length	65	Tibia length (left)	310
Humerus length (left)	222	Tibia distal transverse width	94
Humeral deltopectoral crest (head to apex)	82	Metatarsal I length (left pes)	57
Humeral head to posterior trochanter	102	Metatarsal I minimum shaft width	21
Humeral proximal end width	93	Metatarsal II length	116
Humeral distal end width	79	Metatarsal II minimum shaft width	19
Humeral minimum shaft diameter	29	Metatarsal III length	79
Radius length (right)	180	Metatarsal III minimum shaft width	10
Radius proximal anteroposterior depth	29	Phalanx I - 1 length (mid socket to condyle)	33
Radius mid shaft anteroposterior depth	14	Phalanx II - 1 length	30
Radius mid shaft transverse width	19	Phalanx III - 1 length	27
Radius distal transverse width	26	Phalanx IV - 1 length	27

续表

Axis	55 *	Cervical 12	47	Caudal 4	38	Caudal 14	31
Cervical 3	55	Cervical 13	47	Caudal 5	39	Caudal 15	31
Cervical 4	65	Cervical 14	31	Caudal 6	38	Caudal 16	28
Cervical 5	72	Dorsal 1	35 *	Caudal 7	38	Caudal 17	28
Cervical 6	72	Dorsal 2	35 *	Caudal 8	38	Caudal 18	26
Cervical 7	72	Dorsal 3	40	Caudal 9	36	Caudal 19	22
Cervical 8	72	Dorsal 4	40	Caudal 10	36	Caudal 20	22
Cervical 9	72	Caudal 1	39	Caudal 11	34	Caudal 21	18
Cervical 10	72	Caudal 2	38	Caudal 12	33	Caudal 22	13
Cervical 11	72	Caudal 3	35	Caudal 13	31		

* indicates estimation.

The last cervical (C14) is noticeably shorter than those preceding it, and it has a distinctive trapezoidal centrum (pl. I, H, D), which is often the case with centra at the base of the neck in dinosaurs. The parapophysis is still located on the anterior rim of the centrum.

The first four vertebrae in dorsal series (D1 ~ 4) are preserved in articulation posterior to the cervical vertebrae (pl. I, J ~ L). Their centra are spoon-shaped, the anterior rim lower than the posterior rim, and they have sizable pleurocoels to each side. The first two have a moderately developed hypapophysis on the anterior half of the ventral margin of the centrum (pl. I, J). In the fourth dorsal, the neural spine is tall and rectangular (pl. I, L). Four additional vertebrae that were not found in articulation are tentatively identified as D5-8 (pl. II, B).

The sacrum is composed of six coossified vertebrae with small pleurocoels, as preserved in a referred specimen found near the holotype (LH V0008). Sacral pleurocoels have also been reported in some dromaeosaurids and oviraptorosaurs, although they are absent in the basal oviraptorosaur *Caudipteryx*.

An articulated caudal series is composed of 22 vertebrae, some with associated chevrons. Judging from the size and form of the first and last caudal in the series, most of the tail is represented. This suggests that *Neimongosaurus* had a short tail composed of between 25 and 30 vertebrae, which is similar to the shortened caudal series in oviraptorosaurs. The first preserved caudal has transverse processes that are longer than the neural spine and have slightly expanded distal ends. The centra are subquadrate in shape in lateral view and have gently amphicoelous anterior and posterior faces. The dimensions of the centra decrease distally. The first few centra have small foramina on each side which appear to represent reduced pleurocoels.

The prezygapophyses are short throughout most of the caudal series. In the distalmost caudals, however, the prezygapophyses extend prominently anterodorsally, reaching forward across nearly 40% of the next anterior centrum. These lengthened prezygapophyses angle away from the midline at about 45 degrees, an unusually divergent orientation. The length of the prezygapophyses in the distalmost preserved caudals is reminiscent of the elongate prezygapophyses in other tetanurans that stiffen the distal portion of the tail. This is the first direct evidence in a therizinosauroid that the tail may have evolved from one more closely resembling that in most other tetanurans.

Several cervical ribs were found near the cervical series. One is a subtriangular bone that is shorter than many of the cervical centra. The very short and broad proportions of this rib closely resemble the anterior cervical ribs in *Alxasaurus* (Russell and Dong, 1994, fig. 6A, B).

Several chevrons are preserved, all of which have straight shafts. The longest come from the base of the tail and are more than twice the length of the neural spines of the anteriormost caudals. These chevrons, however, are shorter relative to the neural spines than in oviraptorosaurs. No boat-shaped chevrons are preserved.

Pectoral girdle: The pectoral girdle is represented by two partial scapulocoracoids, the left more complete than the right (pl. II, E ~ H), and a complete furcula (pl. II, C, D).

The scapula and coracoid are fused. The proximal half of the scapular blade is strap-shaped, with nearly parallel dorsal and ventral margins. The blade may well increase in depth slightly toward its distal end, but the distal blade is broken away on both sides. Proximally, the acromial region must have expanded to meet the coracoid, but this region of thinner bone is also broken away. The ventral margin curves gently toward the posterior rim of the glenoid (pl. II, G). The scapular glenoid fossa faces anteriorly and is about half the size of the remainder of the fossa on the coracoid.

The large plate-shaped coracoid is deflected medially at an angle of approximately 110 to 120 degrees from the axis of the scapular blade (pl. I, E, H). The hook-shaped anteroventral process projects a good distance from the lip of the glenoid fossa (pl. II, F), as in *Therizinosaurus* (Barsbold, 1976). The coracoid tubercle (biceps tubercle in many literature) is well developed and projects laterally as a pyramidal eminence. The acromial region of the coracoid is expanded with a broad lateral depression. The exact shape of the external margin, however, cannot be determined as a result of breakage.

The furcula is a robust V-shaped element, measuring 128mm across its rami, which diverge at an angle of approximately 135 degrees (pl. II, C, D). At mid length along each ramus, the height and depth of the bone are subequal (7mm). The depth of the furcula increases at the junction of the rami in the midline, but there is no development of a hypocleideum.

Forelimb: The preserved elements of the forelimb include both humeri and the left radius (pl. II, I~L; pl. III, E~G). The humerus shows many derived features common to other therizinosauroids, such as the hypertrophied medial tuberosity (pl. II, I), the deflection of the deltopectoral crest at approximately 90 degrees (pl. II, J, K), an anterior tuberosity on the distal end of the humerus proximal to the ectepicondyle (pl. II, J), the hypertrophied entepicondyle, the ventrolateral angle of the distal end of the humerus (pl. II, I), and the rotation of the distal condyles onto the anterior aspect of the distal end (pl. II, J, L).

The radius is approximately 80 percent the length of the humerus (Table 1). Both ends of the bone are moderately expanded. The proximal end is transversely flattened (pl. III, E~G). A prominent biceps tubercle is present on the shaft near the proximal end, as seen in lateral or medial views (pl. III, F, G).

Pelvic girdle: The left ilium is well preserved, lacking only the mid section of the blade. The preacetabular process is strongly deflected laterally (pl. III, A), but not to the extent that it becomes recurved, as in the most derived therizinosauroids (e. g., *Segnosaurus*, Perle, 1979; *Nanshiungosaurus*, Dong, 1979). Uniquely the lateral surface of the preacetabular process is re-oriented into facing dorally. The pubic peduncle is long and slightly arched (pl. III, D). In ventral view, the unusual anteroposterior compression of the process is visible, the articular end measuring 42mm across but only 27mm anteroposteriorly at its longest point. Other theropods have the reverse proportion, with the articular end of the peduncle often less than half as wide as long. The acetabular surface is broad, and the supraacetabular crest flares somewhat beyond the lateral margin of the blade (pl. III, B). There is no development of a cuppedicus fossa at the junction of the pubic peduncle and the preacetabular process. The postacetabular process has a moderately developed brevis shelf. An oval rugose scar is present on the dorsal margin of the blade at mid length along the postacetabular process. A similar attachment area is often developed as a raised welt in other therizinosauroids.

Hind limb: The hind limbs are represented by both femora and tibiae are preserved as well as the left distal tarsals and most of the left pes (pl. III, H~N). The femora have relatively straight shafts with the head projecting medially, the axis of the proximal end in line with that running through the distal condyles (pl. III, L). The proximal end is saddle-shaped, with the arched external rim of the greater trochanter elevated to match the most

prominent point on the head. A finger-shaped anterior trochanter is partially preserved on the anterolateral margin of the shaft, as in *Alxasaurus* (Russell and Dong, 1994). There is only a narrow slit between the trochanter and the shaft, and the tip of the trochanter did not reach the proximal articular end of the femur. A low crescentic fourth trochanter is present just proximal to mid shaft. The distal condyles are asymmetrical, the lateral much narrower than the medial (pl. III, L). An unusual deep fossa is present between the condyles, extending from the distal articular surface to a point proximal to the condyles. The distal articular surface of the femur, as a result, is U-shaped. In cross-sections of the shaft, a hollow central lumen typical of theropods is present.

The tibia is approximately 85 percent the length of the femur (Table 1). The proximal end is unusually broad with little anterior projection or elevation of the cnemial crest. As a result, the proximal end is nearly as broad as it is long anteroposteriorly (pl. III, J). The proximal end is also unusual in the anterior displacement of the lateral condyle, such that the proximal end takes on the shape of an equilateral triangle, rather than an acute triangle with the base across the condyles and the apex at the cnemial end (pl. III, J). The shaft of the tibia is characterized by an extremely long crest for the fibula (pl. III, H). The distal end of the tibia expands transversely with well developed medial and lateral malleoli (pl. III, H, K). The lateral malleolus backs the distal end of the fibula and extends farther distally than the medial malleolus.

Left distal tarsals 3 and 4 are preserved in articulation proximal to metatarsals III and IV (pl. III, N). As in many other dinosaurs, distal tarsal 3 is lozenge-shaped and thinner than distal tarsal 4. It caps most of the proximal end of metatarsal III except its dorsal margin and overlaps the ventrolateral corner of metatarsal II. Distal tarsal 4 is subrectangular with its long axis oriented transversely. The concave lateral margin appears to constitute an articular hollow for the base of metatarsal V, a portion of which is preserved more distally.

The left metatarsus exhibits many of the unusual features that characterize therizinosauroids and led to early speculation that they may lie outside the theropod radiation. Unlike other theropods and possibly also unlike the basal therizinosauroid *Beipiaosaurus* (Xu et al., 1999), the first metatarsal participates in the proximal articulation with the tarsus (pl. III, M). It does not form a significant portion of the articular area of the metatarsus and perhaps played no role in weight support. But it did reach the tarsus, as indicated by the smooth articular end of metatarsal I and rim for attachment of a synovial capsule. The proximal end of metatarsal I is beveled laterally for attachment to the medial aspect of the base of metatarsal II. The distal condyles of metatarsal I are bulbous. Metatarsal II has the broadest proximal articular area (pl. III, N), although it is shorter than both metatarsals III and IV. Metatarsal III is the longest and has an unusual proximal embayment to accommodate the expanded proximal end of metatarsal II. Metatarsal IV is stout and shows little of the lateral flare at its distal end that is commonly seen in other dinosaurs. Only a small portion of metatarsal V is preserved.

Most of the nonungual phalanges of the pes are preserved. The proximal phalanges display an unusually well developed heel, which is visible in dorsal view (pl. III, M). The interphalangeal articulations are very well formed, with prominent dorsal and ventral intercondylar processes and well developed distal condyles.

Discussions The therizinosauroid affinities of *Neimongosaurus* have been determined based on the following characters (some of them are also evolved in ornithomimosaurs and oviraptorosaurians): U-shaped mandibular symphyseal region; downturned mandibular symphysis; edentulous anterior dentary; tooth with a basal constriction, sub-circular tooth root, and lanceolate crown; neural spines of the anterior cervicals low and moderately long; posterior cervicals "X" shaped in dorsal view; angular proximal end of humerus; posterior

trochanter on humerus;cranially positioned ball-like ulnar and radial condyles separated by a narrow groove;a long and slender pubic peduncle and short ischial peduncle;a short metatarsus.

Neimongosaurus appears to represent a therizinosauroid more derived than *Beipiaosaurus* but less derived than members of the Therizinosauridae. Unlike *Beipiaosaurus* (Xu et al. , 1999) , the tibia is shorter than the femur (only 85 to 90 percent). Likewise , the metatarsus is shorter relative to the tibia (met III/tibia ratio is 39 percent in *Beipiaosaurus* and 34 percent in *Neimongosaurus*). The humerus appears to have a posterior trochanter in *Neimongosaurus* , whereas none appears to be present in *Beipiaosaurus* (Xu et al. , 1999). In addition , the strongly beveled base of metatarsal I and its participation in the articulation with the tarsus in *Neimongosaurus* appear to be more derived than in *Beipiaosaurus*.

Neimongosaurus is , however , clearly less derived than members of the family Therizinosauridae , as we have defined this taxon above. The very deep , laterally flared form of the ilium and the extreme narrow , blade-shaped form of the pedal unguals in *Erlikosaurus* (Perle , 1980) , *Segnosaurus* (Perle , 1979) , *Nanshiungosaurus* (Dong , 1979) and *Therizinosaurus* (Perle , 1982) unite this advanced group of therizinosauroids.

Neimongosaurus provides important information regarding diversity within Therizinosauroida and also important comparative data for determining the phylogenetic relationships of this derived subgroup within Coelurosauria.

The relationships of Therizinosauroida among other coelurosaurs has yet to be examined in detail. Some evidence supports a relationship with oviraptorosaurs (Sues , 1997;Makovicky and Sues , 1998 ;Xu et al. , 1999) whereas other data suggests that the group may have a more basal position in coelurosaurian phylogeny (Serenó , 1999). The straight shaft and strong olecranon process of the ulna , the subcylindrical distal end of the radius , the strength of manual digit III , the low position of the femoral anterior trochanter , the presence of discrete tibial malleoli , and the distal position of the condyles of the astragalus are features that are absent in maniraptoran theropods such as oviraptorosaurs , and may suggest a more basal position within Coelurosauria , perhaps in association with ornithomimids and alvarezsaurids (Serenó , 1999) .

Outstanding features with the potential to link therizinosauroids and oviraptorosaurs include an increase in the number of cervical vertebrae and a decrease in the number of caudal vertebrae , with concomitant loss of elongate prezygapophyses toward the distal end of the tail. As described above , the neck in *Neimongosaurus* appears to be composed of as many as 14 cervical vertebrae. Other therizinosauroids , such as *Nanshiungosaurus* (Dong , 1979 , 1997) , and the basal oviraptorosaur *Caudipteryx* (Ji et al. , 1998 ;Zhou et al. , 2000) have been reported with 12 or fewer vertebrae in the cervical series. Even so , twelve cervical vertebrae would constitute an increase over that seen in many other coelurosaurs. Additional articulated material and restudy of available specimens should clarify the grounds for this comparison.

The caudal series is clearly shortened in *Neimongosaurus* , which has no more than 25 or 30 vertebrae. This number or fewer caudals have also been reported in the therizinosauroid *Alxasaurus* (Russell and Dong , 1994) and in *Caudipteryx* (Ji et al. , 1998 ;Zhou et al. , 2000) and several oviraptorids (Barsbold et al. , 2000). Some features in the pectoral region are also derived with respect to basal coelurosaurs , such as ornithomimids. The hook-shaped coracoid posterior process , for example , is very well developed , more so than in ornithomimids or alvarezsaurids (Perle et al. , 1993). Likewise , the strength of the furcula is more reminiscent of that in oviraptorosaurs.

More detailed comparisons and even more complete remains will generate the critical

data needed for phylogenetic analysis. The discovery of *Neimongosaurus* takes us a step closer to understanding the diversity and relationships of Therizinosauroidae, one of the most intriguing subgroups of dinosaurs to have come to light in the last twenty years.

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Explanations of plates

Plate I

Neimongosaurus yangi (LH V0001), scale bar 1cm in A~C, 4cm in D~L
Right dentary in lateral (A), medial (B), and dorsal (C) views; cervical 5 in lateral (D), ventral (E), and posterior (F) views; cervicals 4 and 5 in dorsal view (G); presacral vertebrae 11~14 in lateral (H) and dorsal (I) views; anterior dorsal vertebrae (presacrals 15, 16) in lateral view (J); anterior dorsal vertebra (presacral 16) in lateral view (K); anterior dorsal vertebra (presacral 18) in lateral view (L)

Plate II

Neimongosaurus yangi (LH V0001), scale bar 4cm
Nearly complete series of caudal vertebrae in lateral view (A); mid dorsals (presacrals 17~22) in lateral view (B); furcula in anterior (C) and posterior (D) views; left scapulocoracoid in ventral (E), lateral (G), and dorsal (H) views; left coracoid in lateral view (F); right and left humeri in posterior (I), anterior (J), proximal (K), and distal (L) views

Plate III

Neimongosaurus yangi (LH V0001), scale bar 4cm
Left ilium in dorsomedial (A), ventral (B), lateral (C), and medial (D) views; left radius in anterior (E), lateral (F), and medial (G) views; left and right tibiae in posterior (H), anterior (I), proximal (J), and distal (K) views; right and left femur in posterior view (L); left pes in dorsal (M) and proximal (N) views
fc, fibular crest 腓骨嵴; pp, preacetabular process 髌臼前支; bt, biceps tuberosity 二头肌结节





