Vol. 80 No. 1 pp. 20–26 ACTA GEOLOGICA SINICA Feb. 2006

A New Titanosaurian Sauropod from Late Cretaceous of Nei Mongol, China

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Abstract: A specimen collected from the Upper Cretaceous Erlian Formation of Nei Mongol (Inner Mongolia), China, represents a new genus and species of titanosaurian sauropod. The new taxon is named and described on the basis of the holotype and the only known specimen, which comprises several dorsal, sacral, and caudal vertebrae, several dorsal ribs, one anterior chevron, and much of the pelvis. Diagnostic features of the new species include a thick ridge extending down from the postzygapophysis on the lateral surface of the neural arch of the posterior dorsal vertebrae, a transversely oriented accessory lamina present between the anterior centroparapophyseal limina and the lateral centraprezygapophyseal lamina of the posterior dorsal vertebrae, long, anteroventrally directed caudal rib that bears two distinctive fossae on its posterior margin on the anterior caudal vertebrae and a prominent vertical ridge above the pubic peduncle on the medial surface of the ilium, among others. The ilium is pneumatic, a feature not common among non-avian dinosaurs. The new taxon has an unusual combination of primitive and derived character states. Preliminary character analysis shows a complex character distribution within the Titanosauriformes. Recent titanosauriform discoveries suggest that a significant radiation occurred in Asia early in the titanosauriform evolution.

Key words: Nei Mongol (Inner Mongolia), Late Cretaceous, Erlian Formation, Titanosauriformes

1 Introduction

A new sauropod specimen was excavated from the Upper Cretaceous Erlian Formation of Saihangaobi, Sonid Zuoqi, Nei Mongol Autonomous Region in 2001 by an expedition team from the Department of Land and Resources of Nei Mongol. The specimen consists of several vertebrae and ribs, one chevron, and partial pelvis, which are associated with each other. Although these elements are not in articulation, we attribute the recovered material to a single individual based on their proportions and that no other bones were recovered nearby. In the present paper, we will describe this new specimen and erect a new sauropod taxon based on the information recovered. This new taxon, together with some other recent discoveries (You et al., 2003, 2004, 2005; You and Dong, 2003; You and Xu, 2005; Xu et al., 2003; Xu and Wang, 2004), has expanded our knowledge of dinosaurian diversity in the Cretaceous of China. For taxonomy, we follow Upchurch et al. (2004)'s phylogenetic definitions for sauropod dinosaurs. Terminology for the vertebral laminal structures follows Wilson (1999).

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2 Systematic Paleontology

Sauropoda Marsh, 1878
Titanosauriformes Salgado, Coria, et Calvo, 1997
Titanosauria Bonaparte and Coria 1993
Sonidosaurus saihangaobiensis gen et sp. nov.

Holotype: LH V 0010 (Long Hao Geologic and Paleontological Research Center), a partial skeleton preserving five dorsal vertebrae, the last sacral vertebra, one anterior caudal vertebra, several dorsal ribs, one anterior chevron, partial left and right ilia, partial left pubis, and both ischia (Fig. 1).

Type locality and horizon: Saihangaobi, Sonid Zuoqi, Nei Mongol (15 km southwest of Erenhot); Elian Formation. The specimen was collected from fluvial sandstones of the Upper Cretaceous Elian Formation, which is now regarded as Late Cretaceous (Senonian) in age (Currie and Eberth 1993). It was collected from beds that are slightly lower than the therizinosaroid-fossil-bearing beds (Zhang et al. 2001; Xu et al., 2002).

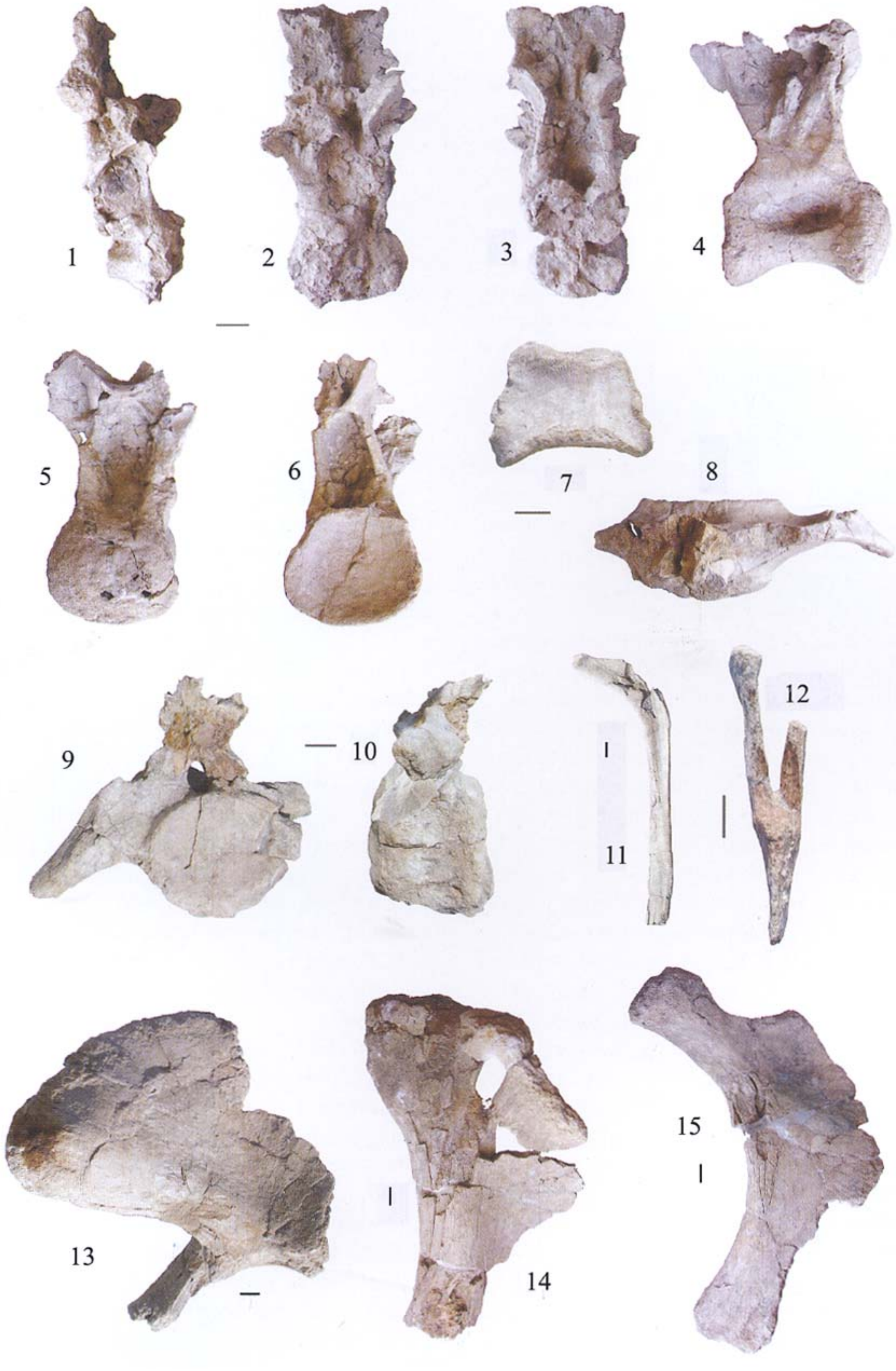

Fig. 1. *Sonidosaurus saihangaobiensis* holotype (LH V0010).
A middle-posterior dorsal vertebra in lateral (1), anterior (2) and posterior (3) views; A posterior dorsal vertebra in lateral (4), anterior (5) and posterior (6) views; The last sacral vertebra in ventral view (7); An anteromost caudal vertebra in dorsal (8), posterior (9) and lateral (10) views; A middle dorsal rib in posterior view (11); An anterior chevron in anterior view (12); Left ilium in lateral view (13); Left pubis in lateral view (14); Right ischium in medial view (15).
Scale bar = 3 cm for 1–6, 8–13; = 4 cm for 7; = 2 cm for 14 and 15.

Etymology: "Sonid", a large geographical area that includes the type locality; "saurus", meaning "lizard" (Greek); "saihangaobi", the type locality.

Diagnosis: A medium sized titianosaurian sauropod with the following autapomorphies: a thick ridge extending ventrally from the postzygapophysis on the lateral surface of the neural arch of the posterior dorsal vertebrae, a transversely oriented accessory lamina present between the anterior centroparapophyseal limina and the lateral centraprezygapophyseal lamina of the posterior dorsal vertebrae, anterior caudal vertebrae with long, anteroventrally directed caudal ribs bearing two distinctive fossae on posterior margin, and a prominent vertical ridge above the pubic peduncle on the medial surface of the ilium. Differentiated from all other titanosaurians in high neural arches on middle and posterior dorsal vertebrae (independently evolved in Diplodocoidea), divided centroprezygapophysis (independently evolved in some diplodocoids), and transversely widened, plate-like neural spines on middle and posterior dorsal vertebrae.

Description: The holotype of *Sonidosaurus saihangaobiensis* represents a mature animal as indicated by the complete closure of the neurocentral sutures of the preserved vertebrae. It is a relatively small-sized sauropod dinosaur, estimated to be about 9 m in total body length.

Five dorsal vertebrae are preserved. These most likely represent middle-posterior dorsal vertebrae as indicated by the relatively high position of the parapophyses. All preserved dorsal centra are strongly opisthocoelous, with a prominent hemispherical anterior articular surface and a deeply concave posterior one. The length of the centrum is evidently greater than its height and the centrum width is slightly greater than the height at the posterior margin. A large eye-shaped pleurocoel occupies much of the lateral surface of the centrum, and as in many other titanosauriforms such as *Alamosaurus sanguanensis* (Lehman and Coulson 2002) and *Opisthocoelicaudia skarzynskii* (Borsuk-Bialynicka, 1977), is relatively ventrally located. Large pleurocoels are reported in some juvenile sauropods including the North American *Pleurocoelus* (Wedel et al, 2000).

The neural arch is tall relative to the centrum, different from the proportionally lower neural arch in most other titanosaurs. The prezygapophyses are widely separated. The prezygapophyseal articular surface faces dorsomedially, forming a 45° angle to the horizontal level. The neural spine appears to be low, evidently shorter dorsoventrally than the neural arch. It is a plate-like structure, much wider transversely than anteroposteriorly. In anterior and posterior view, the neural spine appears to be saddle-shaped with the midline portion slightly lower than the axially-thickened lateral margins. A lateral flange is present on the lateral margin of the neural spine, though it is not prominent.

The lamina system is well-developed. Three parapophyseal laminae are present: the prezygoparapophyseal limina, the anterior centroparapophyseal lamina, and the posterior centroparapophyseal lamina. The last one is prominent. There are three prezygapophyseal laminae: the centroprezygapophyseal lamina, the spinoprezygapophyseal lamina and the intraprezygapophyseal lamina. Among them, the centroprezygapophyseal lamina is a compound structure comprising a medial and a lateral laminae which enclose a deep triangular cavity. An accessory lamina is present between the anterior centroparapophyseal limina and the lateral centraprezygapophyseal lamina and divides a large cavity enclosed by the two laminae into a larger dorsal and a smaller ventral cavity. The anterior centrodiapophyseal lamina is absent in all recovered dorsal vertebrae, but a prominent, relatively wide posterior centrodiapophyseal lamina is present parallel to the posterior centroparapophyseal lamina in one of the recovered dorsal vertebra. It extends posteroventrally close to the posterior margin of the centrum. Two short, nearly horizontally oriented paradiapophyseal and prezygodiapophyseal lamina are visible on one of the recovered dorsal vertebra, as is a postzygodiapophyseal lamina. The spinodiapophyseal limina is slightly obliquely oriented to support the lateral aspect of the neural spine. Three postzygapophyseal laminae are present: the centropostzygapophyseal lamina, the lateral spinopostzygapophyseal lamina and the medial spinopostzygapophyseal limina. The last one is short and wide, flooring a deep cavity laterally bounded by the lateral spinopostzygapophyseal lamina. Both prespinal and postspinal laminae are weakly developed, but extend ventrally close to the base of the neural spine. The prespinal lamina is intersected by a horizontally oriented lamina at the midheight of the neural spine. Below the prespinal lamina is a longitudinal groove at the base of the neural spine. The postspinal lamina is divided dorsally and a distinct groove is located immediately lateral to this bifurcation. The hyposphene-hypantrum articulations appear to be absent in all preserved dorsal vertebrae. One probable middle dorsal rib and several other rib fragments are preserved. The rib shaft is plank-like.

The last sacral vertebra is partially preserved. A large broken sacral rib surface, with the long axis nearly horizontally oriented, occupies most of the lateral surface of the centrum. The posterior articular surface of the centrum is strongly concave, indicating the first caudal centrum had a prominent hemispherical anterior condyle.

One anterior caudal vertebra is preserved. The centrum is opisthocoelous with a weakly convex anterior articular surface and a concave posterior one. The anterior condyle is rounded rather than somewhat pointed as in most other titanosaurs. The arch is tall, and the preserved part (lower than the zygapophyseal level) is close to the central depth at the posterior margin. The caudal rib is probably longer than the central width. The proximal half of the rib is strongly compressed anteroposteriorly and deep dorsoventrally; the distal half is somewhat rod-like, with a sub-triangular cross section. The distal half is deflected anteroventrally. Two fossae are present on the posterior margin of the caudal rib. The ventral margin of the centrum is mildly convex without a longitudinal hollow. A nearly complete anterior chevron lacks a dorsal bridge to enclose the hemal canal, which is about half of the chevron length.

Both iliums are partially preserved. The preacetabular blade flares laterally about 50° and its ventral margin is also twisted so that the external surface of the preacetabular blade faces dorsolaterally. It has a dorsoventrally deep but anteroposteriorly short preacetabular blade. The anteroventral corner of the blade extends ventrally. In medial view, there is a prominent ridge running posterodorsally from the base of the pubic peduncle. The broken dorsal margin of the ilium displays numerous internal chambers. Pneumatic ilium has also been reported in several other titanosaurs as well as a diplodocid (Carvaiho et al., 2003).

The left pubis is partially preserved. The preserved length is sub-equal to the ischial length, suggesting the pubis considerably longer than the ischium. The articular surface for the ischium is about 60% the preserved pubic length. The long axis of the pubic shaft passes through the posterior portion of the acetabulum.

Both ischia are nearly completely preserved. The ischium is a plate-like structure, with the distal ramus twisted about 50°. Immediately distal to the robust iliac articulation, a tuberosity arises on the lateral surface of the ischium. The articular facet for the pubis is large, about 60% the ischial length. The posterior margin of the ischium is relatively flat and thick for most of its length. The maximum width of the distal end surface is about three times its thickness. A distinct fossa is present on the ventral surface of the ischium near its midpoint, close to the distal corner of the pubic articulation.

3 Discussion

Sonidosaurus possesses numerous derived character states hierarchically distributed among the Macronaria and more exclusive ingroups (Salgado et al. 1997; Upchurch 2004; Wilson 2002; Wilson and Sereno 1998; Powell, 2003) and some other derived states which appear to have more complicated distribution among the Titianosauriformes. In this section, we will infer the possible systematic position of *Sonidosaurus* based on these features. A numerical cladistic analysis is beyond the scope of the present paper, though some of the following character states could be used in future in analyzing the interrelationship of the Titanosauriformes.

Macronarian features (Salgado et al. 1997; Upchurch 2004; Wilson 2002; Wilson and Sereno 1998). (1) Opisthocoelous posterior dorsal and sacral centra. (2) Width of Posterior dorsal centra slightly greater than height. This feature is seen in most macronarians but not in *Andesaurus* (Calvo and Bonaparte, 1991), which has much taller posterior dorsal centra. In *Brachiosaurus brancai* (Janensch 1950), *Opisthocoelicaudia* (Borsuk-Bialynicka, 1977) and *Argentinosaurus* (Bonaparte and Coria, 1993) the width of the posterior dorsal centra are much greater than height. (3) Dorsally open anterior haemal canals. (4) Deep ischial articulation of the pubis.

Titanosauriform features (Salgado et al. 1997; Upchurch 2004; Wilson 2002; Wilson and Sereno 1998). (5) Wide and prominent centrodiapophyseal lamina on posterior dorsal vertebrae. (6) Posterior centroparapophyseal lamina on posterior dorsal vertebrae. (7) Median prespinal lamina present in posterior dorsal vertebrae. (8) Dorsoventrally expanded preacetabular process of the ilium. (9) A distally located triangular ambiens process on the pubis. A triangular ambiens process is located distal to the proximal end of the iliac articulation in *Haplocanthosaurus* (Hatcher, 1903), *Brachiosaurus* (Janensch 1950) and some titanosaurs including *Sonidosaurus*. This feature might be a synapomorphy for the Titanosauriformes or slightly more inclusive group.

Titanosaurian features (Salgado et al. 1997; Upchurch 2004; Wilson 2002; Wilson and Sereno 1998). (10) Elongated middle and posterior dorsal centra. Primitive in neosauropods, the middle and posterior dorsal centra are about as long anteroposteriorly as tall dorsoventrally. This condition is present in *Dicraeosaurus* (Janensch 1929), *Camarasaurus* (Mcintosh et al., 1996), *Euhelopus*, and some titanosaurians. In most other titanosaurians (Salgado et al. 1997) and *Sonidosaurus*, the length of the middle and posterior dorsal centra are evidently greater than height at the posterior margin. *Brachisaurus* shows an intermediate condition, with most middle and posterior dorsal centra slightly elongated except the posteromost ones which are short axially. (11) Eye-shaped pleurocoels on dorsal centra. (12) Posteriorly strongly bowed ischial blade. In *Sonidosaurus*, the ischial blade is strongly curved posteriorly so that the upper corner of the pubic articulation lies posterior to the posterior margin of its shaft, a feature independently evolved in *Camarasaurus* (Wilson and Sereno 1998). Many titanosaurs also have relatively posteriorly directed ischial blade such that the long axis of its shaft passes through the pubic peduncle. (13) A short ischium relative to the pubis.

Derived titanosaurian features (Salgado et al. 1997; Upchurch 2004; Wilson 2002; Wilson and Sereno 1998). (14) Hyposphene-hypantrum articulation absent in posterior dorsal vertebrae. *Sonidosaurus* lacks a hyposphene-hypantrum articulation in preserved dorsal vertebrae, as in most titanosaurians except *Phiwangosaurus* (Martin et al., 1999), *Epachthosaurus sciutoi* and *Andesaurus delgadoi* (Calvo and Bonaparte, 1991; Salgado et al. 1997). (15) Median prespinal lamina extending down to the base of the neural spine in posterior dorsal vertebrae. The median prespinal lamina extends down to the base of the neural spine in posterior dorsal vertebrae of *Sonidosaurus*, a feature also known in *Argentinosurus*, *Opisthocoelicaudia*, *Aeolosaurus*, *Alamosaurus*, *Neuquensaurus*, and *Saltasaurus* (Salgado et al. 1997). (16) Anterior caudal centra relatively long. The height of the anterior caudal centra are moderately greater than the length in *Sonidosaurus*, as in *Saltasaurus* and *Alamosaurus*; whereas in most other sauropods the height of the anterior caudal centra are significantly greater than the length. (17) Anterior caudal neural arch relatively tall. Similar to *Saltasaurus* and *Alamosaurus*, the neural arch is subequal to or even taller than the centrum at the posterior margin whereas in most other macronarians it is proportionally much lower. (18) Broad ischial distal process. Some derived titanosaurs such as *Alamosaurus* and *Saltasaurus* have a broad ischial distal process, which is about half as wide as long . *Sonidosaurus* shares this derived condition. (19) Pubic articulation about half of the ischial length. In all macronarians, the pubic articulation is more than one-third the ischial length (measured from the upper corner of the pubic articulation to the distal end of the ischium). In some derived titanosaurs, it is more than half of the ischial length. *Sonidosaurus* has a ratio close to the more derived condition.

Features shared with Asian titanosauriforms. (20) Centrodiapophyseal lamina ventrally narrow. *Sonidosaurus* and *Opisthocoelicaudia* differ from most other titanosaurians in lacking a ventral widening and forking of the centrodiapophyseal lamina. (21) Centrodiapophyseal lamina on posterior dorsal vertebrae posteroventrally extended. In most neosauropods the centrodiapophyseal lamina on the posterior dorsal vertebrae are nearly vertically orientated. In *Sonidosaurus, Brachiosaurus*, and *Opisthocoelicaudia* it is posteroventrally orientated as the diapophysis in these taxa is relatively anteriorly located on the posterior dorsal vertebrae. Consequently the centrodiapophyseal and posterior centroparapophyseal laminae are sub-parallel to each other without an evident ventral connection. (22) Posterior centroparapophyseal lamina extending close to the posterior margin of the centrum. In most titanosaurs, the posterior centroparapophyseal lamina is located anterior to the midlength of the centrum whereas in *Sonidosaurus* and *Opisthocoelicaudia* it extends ventrally close to the posterior margin of the centrum, a feature also independently evolved in diplodocids. (23) Accessory lamina linking the prespinal lamina and the diapophysis on dorsal vertebrae. As in *Argentinosaurus* (Bonaparte and Coria, 1993) and *Opisthocoelicaudia* (Salgado et al. 1997), *Sonidosaurus* bears an accessory lamina connecting the prespinal lamina and the diapophysis on its dorsal vertebrae. (24) Neural spine low on middle and posterior dorsal vertebrae. In *Sonidosaurus* the neural spine is much lower than the central height at the posterior margin, as in *Opisthocoelicaudia*. In most other titanosauriforms, such as *Andesaurus*, *Argentinosaurus,* and *Saltasaurus loricatus*, the neural spine is relatively tall on posterior dorsal vertebrae, a primitive condition among macronarians. (25) Pubic peduncle of the ilium anteroventrally oriented. The pubic peduncle of the ilium is perpendicular to the long axis of the ilium in most titanosauriforms (Salgado et al., 1997) but anteroventrally oriented in *Sonidosaurus*, *Opisthocoelicaudia*, *Huabeisaurus* and a new titanosauriform from Guangxi (Mo et al., in submission), a feature similar to the condition in most other sauropods. (26) Relatively short preacetabular blade of the ilium. The preacetabular blade is much longer than the postacetabular process of the ilium in most other titanosauriforms including *Euhelopus* (but see Upchurch et al., 2004 for a different systematic hypothesis for *Euhelopus*). *Menmanchisaurus* independently evolved relatively long preacetabular blade. In *Sonidosaurus*, *Opisthocoelicaudia, Huabeisaurus*, and a new titanosauriform taxon from Guangxi, it is relatively short as in more primitive sauropods. (27) Anteroventral process of the ilium present. An anteroventral process of the ilium is absent in many titanosauriforms such that the preacetabular process is lobe-shaped in lateral view. In *Sonidosaurus, Opisthocoelicaudia* and two other basal titanosauriforms from China, this process is present. *Rapetosaurus krausei* has an extremely weak anteroventral process (Curry Rogers and Forster, 2001). (28) A lateral tubersity on the lateral surface of the iliac pedencle of the ischium. *Opisthocoelicaudia* and *Sonidosaurus* share this unique feature, though it is more developed in the former. (29) Neural spine weakly bifid on middle and posterior dorsal vertebrae. *Sonidosaurus* and *Argentinosaurus* appear to have a weakly bifid neural spine on the middle and posterior dorsal vertebrae as in some neosauropods such as *Camarasaurus* and *Apatosaurus*. In most titanosauriforms, exluding *Opisthocoelicaudia*, it is not bifid. (30) Opisthocoelous caudal vertebrae. The only preserved caudal centrum of *Sonidosaurus* is opisthocoelous, a feature seen in *Opisthocoelicaudia* and *Borealosaurus* (You et al., 2004), an unnamed taxon from Kazakhstan (Sues and Averianov, 2004), and *Rinconsaurus* (Calvo and Gonzalez Riga 2003).

As discussed above, the titanosaurian affinities of *Sonidosaurus* are strongly supported (Characters 1-13), but its systematic position within the Titanosauria is ambiguous in large part due to the unusual combination of primitive and derived character states in *Sonidosaurus* and also the relatively poorly known interrelationships of the Titanosauriformes. On one hand, *Sonidosaurus* lacks a few titanosaurian features, such as the ventral longitudinal hollows on caudal vertebrae and a dorsally-faced lateral surface of the preaectabular blade of the ilium (Salgado et al. 1997; Upchurch 2004; Wilson 2002; Wilson and Sereno 1998); on the other hand, it displays a few features seen in derived titanosaurians but absent in some basal forms (characters 14–19), suggesting a complex pattern of character distribution within this group. The evidence favoring a relatively derived position within the Titanosauria seems, however, to outweigh the evidence favoring a more basal position for *Sonidosaurus*. We thus suggest *Sonidosaurus* is a relatively derived titanosaurian, which is consistent with its geological age.

Interestingly *Sonidosaurus* shares many similarities with some Asian titanosauriforms, notably *Opisthocoelicaudia*. Some of these similarities are clearly derived and even uniquely shared by these taxa, such as characters 20, 22, 24, 28, and 30. Others are more ambiguous, as are present in *Sonidosaurus* and *Opisthocoelicaudia* as well as in some basal titanosauriforms and non-titanosauriform macronarians (Characters 21, 23, 25–27, and 29). It is premature to discuss the implications of these features before a thorough phylogenetic analysis is done, yet several possibilities exist for this distribution. One possibility is that most known Asian titanosauriforms might be basal forms and these features constitute the pleisomorphies for the group. A second possibility is that the Asian taxa or some of them, form a monophyletic group, representing an early divergence of the Titanosauriformes, which is supported by the numerous similarities including several salient ones shared by *Sonidosaurus*, *Opisthocoelicaudia* and other taxa. A last possibility is that these features are independently evolved. The increasing discoveries of basal titanosauriformes from Asia (Martin et al., 1999; Allain et al., 1999; Pang and Cheng, 2000; Tang et al., 2001; You et al, 2003, 2004; Ksepka and Norell, in press; Mo et al, in submission) seem to provide more evidence supporting an Asian origin for the group (You et al., 2003), though a thorough phylogenetic analysis is needed to confirm this. Nevertheless, the available fossil records strongly suggest that Asia is an important geographical area for the early evolution of titanosauriforms, a large sauropod radiation previously thought to occur mainly in southern continents.

Acknowledgements

We thank D.T. Ksepka for comments on and editing the manuscript, technicians of the Long Hao Geologic and Paleontological Research Center for their contributions in the field and for preparation of fossil materials. The fieldwork is supported by a grant from the Ministry of Land Resources of the People’s Republic of China (9501130). Xu Xing’ s work is supported by a grant from the National Natural Science Foundation of China (40125006).

Manuscript received Oct. 11, 2005
accepted Nov. 14, 2005
edited by Xie Guanglian

References

Allain, R., Taquet, P., Battail, B., Dejax, J., Richir, P., Veran, M., Linon-Duparcmeur, F., Vacant, R., Mateus, O., Sayarath, P., Khenthavong, B., and Phouyavong, S., 1999. Un nouveau genre de dinosaure sauropode de la formation des Gres superieurs (Aptien-Albien) du Laos. *Comptes Rendus de l’Academie des Sciences de Paris, Sciences de la Terres et des Planetes*, 329: 609–616.

Bonaparte, J.F., and Coria, R.A., 1993. Un Nuevo y gigantesco sauropodo titanosaurio de la Formacion Rio Limay (Albiano-Cenomaniano) de la Provincia del Neuquen, Argentina. *Ameghiniana*, 30: 271–282.

Borsuk-Bialynicka, M., 1977. A new camarasaurid sauropod Opisthocoelicaudia skarzynskii, gen. n. sp. n., from the Upper Cretaceous of Mongolia. *Palaeontological Polonica*, 37: 5–64.

Carvaiho, I., Avilla, L., and Salgado, L., 2003. Amazonsaurus maranhensis gen. et sp. nov. (Sauropoda, Diplodocoidea) from the Lower Cretaceous (Aptian–Albian) of Brazil. *Cretaceous Research*, 24(6): 697–713.

Calvo, J.O., and Bonaparte, J.F., 1991. Andesaurus delgadoi gen. et sp. nov. (Saurischia-Sauropoda), Dinosaurio Titanosauridae de la Formacion Rio Limay (Albiano-Cenomaniano), Neuquen, Argentina. *Ameghiniana*. 28: 303–330.

Calvo, J.O., and Gonzalez Riga, B.J., 2003. Rinconsaurus caudamirus gen et sp. nov., a new titanosaurid (Dinosauria, Sauropoda) from the Late Cretaceous of Patagonia, Argentina. *Revista Geologica de Chile*, 30: 333–353.

Currie, P.J., and D.A. Eberth, 1993. Palaeontology, sedimentology and palaeoecology of the Iren Dabasu formation (Upper Cretaceous), Nei Mongol, People's Republic of China. Cretaceous Research. 14(2): 127–144.

Curry Rogers, K., and Forster, C.A., 2001. The last of the dinosaur titans: A new sauropod from Madagascar. *Nature*, 412: 530–

534.

Hatcher, J.B., 1903. Osteology of Haplocanthosaurus, with description of a new species, and remarks on the probable habits of the Sauropoda and the age and origin of the Atlantosaurus Beds. *Memoir of Carnegie Museum*, 2: 1–72.

Janensch, W., 1929. Die Wirbelsaule der Gatttung Dicraeosaurus. *Palaeontographica* (Supplement 7), 2: 37–133.

Janensch, W., 1950. Die Wirbelsaule von Brachiosaurus brancai. *Palaeontographica* (Supplement 7), 3: 27–93.

Ksepka, D.T., and Norell, M.A.. *Erketu ellisoni*, a long-necked sauropod from Bor Guve (Dornogov Aimag, Mongolia). *American Museum Novitates* (in press).

Lehman, T.M., and Coulson, A.B., 2002. A juvenile specimen of the sauropod dinosaur Alamosaurus sanjuanensis from the Upper Cretaceous of Big Bend National Park, Texas. *J. Paleontol.*, 76: 156–172.

Martin, V., Suteethorn, V., and Buffetaut, V., 1999. Description of the type and referred material of Phuwiangosaurus sirindhornae Martin, Buffetaut and Suteethorn, 1994, a sauropod from the Lower Cretaceous of Thailand. *Oryctos*, 2: 39–91.

Marsh, O.C., 1978. Principal characters of American Jurassic dinosaurs. Part I. *Am. J. Sci.*, ser. 3, 16: 411–416.

Mcintosh, J.S., Miles, C.A., Cloward, K.C., and Parker, J.R., 1996. A newly complete skeleton of Camarasaurus. *Bulletin of Gunma Museum of Natural History*, 1: 1–87.

Mo Jinyou, Wang Wei, Huang Zitao, Huang Xin and Xu Xing. A basal titanosauriform from the Early Cretaceous of Guangxi, China. *Acta Geologica Sinica* (English edition) (in submission).

Pang Qiqing and Cheng Zhengwu, 2000. A new family of sauropod dinosaur from the Upper Cretaceous of Tianzhen Shanxi Province, China. *Acta Geologica Sinica* (English edition), 74: 117–125.

Powell, J.E., 2003. Revision of South American titanosaurid dinosaurs: palaeonbiological, palaeobiogeographical and phylogenetic aspects. *Records of the Queen Victoria Museum, Launceston*, 111: 1–173.

Salgado, L., Coria, R.A., and Heredia, S., 1997. Evolution of titanosaurid sauropods. In: phylogenetic analysis based on the postcranial evidence. *Ameghiniana* 34, 3–32.

Sues, H.-D., and Averianov, A., 2004. Dinosaurs from the Upper Cretaceous (Turonian) of Dzharakudud, Kyzylkum Desert, Uzbekistan. *J. Vertebrate Paleontol.*, 24: 119A–120A.

Tang Feng, Kang Ximin, Jin Xingsheng, Wei Feng and Wu Weitang, 2001. A new sauropod of Cretaceous from Jiangshan, Zhejiang Province. *Vertebrata PalAsiatica*, 39: 272–281 (in Chinese with English summary).

Upchurch, P., Barrett, P. M., and Dodson, P., 2004. Sauropoda. In: Weishampel, D. B., Dodson, P., and Osmolska, H. (eds.): *The Dinosauria* (second edition). Berkeley: University of California Press, 259–322.

Wedel, M.J., Gifelli, R.L., and Sanders, R.K., 2000. Sauroposeidon proteles, a new sauropod from the Early Cretaceous of Oklahoma. *J. Vertebrate Paleontol.*, 20: 109–114.

Wilson, J.A., and P.C. Sereno, 1998. Early evolution and higher-level phylogeny of sauropod dinosaurs. *Soc. Vertebrate Paleontol. Mem.*, 5: 1–68.

Wilson, J.A., 1999. A nomenclature for vertebral laminae in sauropods and other saurischian dinosaurs. *J. Vertebrate Paleontol.*, 19(4): 639–653.

Wilson, J.A., 2002. Sauropod dinosaur phylogeny: critique and cladistic analysis. *Zool. J. Linnean Soc.*, 136(2): 217–276.

Xu Xing, Cheng Yennien, Wang Xiaolin and Chang Chunhsiang, 2003. Pygostyle-like structure from Beipiaosaurus (Theropoda, Therizinosauroidea) from the Lower Cretaceous Yixian Formation of Liaoning, China. *Acta Geologica Sinica* (English edition), 77: 294–298.

Xu Xing and Wang Xiaolin, 2004. A new troodontid (Theropoda: Troodontidae) from the Lower Cretaceous Yixian Formation of western Liaoning, China. *Acta Geologica Sinica* (English edition), 78: 22–27.

Xu Xing, Zhang Xiaohong, Sereno, P., Zhao Xinjin, Kuang Xuewen, Han Jun, and Tan Lin, 2002. A new therizinosauroid (Dinosauria, Theropoda0 from the Upper Cretaceous Iren Dabasu Formation of Nei Mongol. *Vertebrata PalAsiatica*, 40: 228–240.

You Hailu and Dong Zhiming, 2003. A new protoceratopsid (Dinosauria: Neoceratopsia) from the Late Cretaceous of Inner Mongolia, China. *Acta Geologica Sinica* (English edition), 77: 299–303.

You Hailu, Ji Qiang, Lamanna, M.C., Li Jinglu , and Li Yinxian, 2004. A titanosaurian sauropod dinosaur with opisthocoelous caudal vertebrae from the early Late Cretaceous of Liaoning Province, China. *Acta Geologica Sinica* (English edition), 78: 907–911.

You Hailu, Tang Feng and Luo Zhexi, 2003. A new basal titanosaur (Dinosauria: Sauropoda) from the Early Cretaceous of China. *Acta Geologica Sinica* (English edition), 77: 424–429.

You Hailu and Xu Xing, 2005. An adult specimen of Hongshanosaurus houi (Dinosauria: Psittacosauridae) from the Lower Cretaceous of western Liaoning Province, China. *Acta Geologica Sinica* (English edition), 79: 168–173.

You Hailu, Li Daqing, Ji Qiang, Lamanna, M.C., and Dodson, P., 2005. On a new genus of basal neoceratopsian dinosaur from the Early Cretaceous of Gansus Province, China. *Acta Geologica Sinica* (English edition), 79: 593–597.

Zhang Xiaohong, Xu Xing, Zhao Xinjin, Sereno, P., Kuang Xuewen and Tan Lin, 2001. A long-necked therizinosauroid dinosaur from the Upper Cretraceous Iren Dabasu Formation of Nei Mongol, People’s Republic of China. *Vertebrata PalAsiatica*, 39: 282–290.