中国西北马鬃山地区早白垩世黎明角龙属(恐龙:新角龙类)一未定种[1)]

尤海鲁[1] Eric MORSCHHAUSER[2] Peter DODSON[3] 李大庆[4]
(1 中国地质科学院地质研究所 北京 100037)
(2 美国宾夕法尼亚大学地球与环境科学系 费城 19104－6316)
(3 美国宾夕法尼亚大学兽医学院 费城 19104－6045)
(4 甘肃地质博物馆 兰州 730010)

摘要:记述了基干新角龙类恐龙黎明角龙属一未定种。标本发现于中国西北马鬃山地区俞井子盆地下白垩统新民堡群,包括一关联的具有头骨带下颌的部分骨架。未定种与模式种(皱褶种)相比具有较长的吻部,较窄的鼻骨及其他一些特征。该未定种的发现使黎明角龙属的地理分布范围向南东延伸了约100 km,也使马鬃山地区的早白垩世成为世界上惟一保存大量基干新角龙类的区域。

关键词:马鬃山地区,俞井子盆地;早白垩世,新民堡群;恐龙,新角龙类
中图法分类号:Q915.864 **文献标识码**:A **文章编号**:1000－3118(2012)02－0170－11

AURORACERATOPS SP. (DINOSAURIA: NEOCERATOPSIA) FROM THE EARLY CRETACEOUS OF THE MAZONGSHAN AREA IN NORTHWESTERN CHINA

YOU Hai-Lu[1] Eric MORSCHHAUSER[2] Peter DODSON[3] LI Da-Qing[4]
(1 *Institute of Geology*, *Chinese Academy of Geological Sciences* Beijing 100037, China youhailu@gmail.com)
(2 *Department of Earth and Environmental Science*, *University of Pennsylvania* 240 S. 33rd Street, Philadelphia, PA 19104－6316, USA)
(3 *School of Veterinary Medicine*, *University of Pennsylvania* 3800 Spruce Street, Philadelphia, PA 19104－6045, USA)
(4 *Gansu Geological Museum* Lanzhou 730010, China)

Abstract A specifically indeterminate specimen of the basal neoceratopsian dinosaur *Auroraceratops* is described. *Auroraceratops* sp. is based on a partial articulated skeleton, including the skull and lower jaw, collected from the Lower Cretaceous Xinminpu Group in the Yujingzi Basin of the Mazongshan area, northwestern China. *A.* sp. differs from the type species *A. rugosus* in having a longer face and a narrower nasal, among other features. The finding of *A.* sp. extends the geographic distribution of this genus approximately 100 km southeast, and makes the Early Cretaceous Mazongshan area the richest single basal neoceratopsian locality in the world.

Key words Yujingzi Basin, Mazongshan area; Early Cretaceous, Xinminpu Group; Dinosauria, Neoceratopsia

1) 国家自然科学基金(批准号:40672007, 41072019)、科学技术部基本科研业务费(编号:J1003)、宾夕法尼亚大学夏季古生物研究奖学金、侏罗纪基金会、2009NSF/MOST东亚和太平洋夏季研究计划、美国国家科学基金(编号:EAR 1024671)和甘肃地质博物馆资助。
收稿日期:2010－11－30

Neoceratopsia, the horned and frilled dinosaurs, represents one of the few, but very successful, major dinosaur radiations in the Cretaceous. Alongside the duck-billed hadrosauriforms, neoceratopsians originated in the Early Cretaceous and quickly attained a dominance in the herbivorous terrestrial world, at least in the northern hemisphere, that continued until their extinction at the end of the Cretaceous (You and Dodson, 2004; Horner et al., 2004). Although three major groups of neoceratopsians (Protoceratopsidae, Leptoceratopsidae, and Ceratopsidae; collectively called Coronosauria) (Sereno, 1986; Sereno et al., 2005) have been documented in the Late Cretaceous, the origin and early evolution of these medium-large, quadrupedal derived forms are still not well understood (You and Dodson, 2004; Dodson et al., 2004; Kirkland and DeBlieux, 2010; Xu et al., 2010). In order to elucidate these missing chapters of ceratopsian history, we need to go slightly further back into the Early Cretaceous, and explore the close relatives or sister groups of coronosaurians.

Since 1997, three genera and four species of Early Cretaceous basal (non-coronosaurian) neoceratopsians have been described, all from northern China (*Archaeoceratops oshimai* Dong & Azuma, 1997, *Liaoceratops yanzigouensis* Xu et al., 2002, *Auroraceratops rugosus* You et al., 2005, and *Archaeoceratops yujingziensis* You et al., 2010), representing almost all the currently known basal neoceratopsian species worldwide. The other two reported basal neoceratopsians from eastern Asia are slightly younger (early Late Cretaceous), and their phylogenetic positions are questionable. *Yamaceratops* may be either a basal neoceratopsian (Makovicky and Norell, 2006) or the sister taxon of *Zuniceratops* + Ceratopsidae (Xu et al., 2010), and *Helioceratops* may be either a basal neoceratopsian (Jin et al., 2009) or a leptoceratopsid (personal observation). Here, we add a new undetermined species of basal neoceratopsian, belonging to the genus *Auroraceratops* and recently discovered in the late Early Cretaceous of northwestern China. We consider this new specimen to represent a distinct species of *Auroraceratops*, but do not have sufficient data to formally erect a new species at present. Although tens of specimens probably belonging to the same taxon have been found in a single small area, this preliminary description is based upon a single, completely prepared specimen to highlight some newly observable anatomical features. A detailed osteological description and phylogenetic analysis based on more specimens is in preparation.

The new specimen was recovered from the upper red beds of the Lower Cretaceous Xinminpu Group in the Yujingzi Basin of the Jiuquan area, northwestern Gansu Province (Li, 2008). The Yujingzi Basin, although relatively new to dinosaur research, has yieldeda rich dinosaur assemblage since 2007, including the therizinosauroid *Suzhousaurus megatherioides* (Li et al., 2007, 2008), the tyrannosauroid *Xiongguanlong baimoensis* (Li et al., 2009), the ornithomimosaur *Beishanlong grandis* (Makovicky et al., 2009), the titanosauriform *Qiaowanlong* (You and Li, 2009a) and the basal hadrosauriforms *Jintasaurus* (You and Li, 2009b) and *Xuwulong* (You et al., 2011), as well as numerous representatives of other vertebrate groups currently under study. The basin also yielded a new species of another basal neoceratopsian, *Archaeoceratops yujingziensis* from the middle gray beds of the Xinminpu Group (You et al., 2010). Together with dinosaurs from the similar-aged nearby Gongpoquan Basin, including the holotype of *Auroraceratops rugosus*, the greater Mazongshan Dinosaur Assemblage plays an important role in understanding faunal changes across the Early-Late Cretaceous boundary, especially the origin and early evolution of dominant Late Cretaceous dinosaur groups such as horned and duck-billed dinosaurs (You and Luo, 2008).

Dinosauria Owen, 1842

Ornithischia Seeley, 1887

Ceratopsia Marsh, 1890

Neoceratopsia Sereno, 1986

***Auroraceratops* You et al., 2005**

Type species *Auroraceratops rugosus* You et al., 2005.

Revised diagnosis for genus *Auroraceratops* is distinguishable from other basal neoceratopsians based on the presence of the following features: 1) rostrolateral process of the maxilla passes lateral to the premaxilla, extending to the rostral end of the caudalmost premaxillary alveolus, 2) fungiform expansion of the dorsal end of the lacrimal, 3) horizontal caudally directed processes of the pterygoid covering the basisphenoid-basipterygoid articulation ventrally, 4) three or four inflated striated premaxillary teeth, and 5) a surangular that bears a large tubercle lateral to the glenoid, without a ridge connecting this large tubercle and the caudodorsal tubercle on the dentary.

Auroraceratops sp.

Described specimen GSGM (Gansu Geological Museum)-FV-00500 (field number GSJB07-9-49). The specimen includes most of the skull, both mandibles, and a partial postcranium. Missing parts of the cranium include the rostral, left postorbital, squamosal, quadrate, quadrate wing of the pterygoid, quadratojugal, epijugal, caudal 1/3 of the left jugal, and predentary. The ascending process of the left jugal and most of the left paroccipital process are also missing, as are the left half of the parietal and most of the caudal margin of the parietal. The postcrania include seven dorsal vertebrae, a dorsosacral or first sacral, a free caudal vertebra, a series of four articulated caudal vertebrae, the left humerus, the partial right humerus, fragments of the right proximal ulna, two manual phalanges, left and right ilia, left and right ischia, the right pubis, the left femur and five pedal phalanges. The material was found disarticulated, but associated in an area of less than one square meter.

Locality and horizon Yujingzi Basin, Jiuquan area, Gansu Province, China. Xinminpu (= "Xinminbao") Group, Early Cretaceous, Aptian-Albian.

Institutional abbreviations GSGM, Gansu Geological Museum, Lanzhou, China; MOR, Museum of the Rockies, Bozeman, USA.

Description **Skull** The skull of *Auroraceratops* sp. has a basal length of 156 mm and a width at the jugals of 126 mm. Overall the skull combines a long and tapering face like that of *Archaeoceratops* with the rugosities and mandible morphology of *Auroraceratops rugosus* (Fig. 1A-G). This observation may be flawed, however, as both lacrimals show clear signs of dorsoventral buckling and shortening, so the snout is not as strongly tapering as it would appear. The bone is preserved with little diagenetic alteration. The color is white overall and the bone is very brittle. The preservation is comparable to that seen in specimens collected from other Central Asian localities (such as the AMNH *Protoceratops* locality Shabarakh Usu) (Brown and Schlaikjer, 1940).

The narial opening is ovate, elongate and slightly inclined at an angle of 15 – 20 degrees from the ventral margin of the maxilla. The orbits are large and ovate with the lacrimal forming a major portion of the rostral border. A spur of the jugal forms a distinct angle in the ventral orbital margin. This character is seen in many basal neoceratopsians (Dong and Azuma, 1997; Makovicky and Norell, 2006; Brown and Schlaikjer, 1940; Sternberg, 1951). The lateral temporal fenestra is bounded by the squamosals, quadrate, jugal and quadratojugal. The caudal margin is vertical, as in *Yinlong* (Xu et al., 2006) and *Auroraceratops*, and in contrast to the inclined caudal margin seen in *Archaeoceratops* (You and Dodson, 2003), *Yamaceratops* (Makovicky and Norell, 2006), and *Protoceratops* (Brown and Schlaikjer, 1940). The supratemporal fenestra is bounded by the frontal, squamosal, parietal and postorbital. It widens slightly caudally. The presence of parietal fenestrae in this taxon cannot be evaluated.

The rostral is missing, though the articular facets for it on the premaxilla show strongly developed buccal processes. The premaxillae bear three teeth and form much of the lateral surface of the most rostral portion of the snout. The teeth are conical, blunt, without serrations, covered by enamel on both sides and without wear facets. The premaxilla reaches its mediolaterally

Fig. 1　Skull (A-G) and right mandible (H) of *Auroraceratops* sp. (GSGM-FV-00500), skull in right lateral (A, B), dorsal (C, D), ventral (E, F), and left lateral (G) views; mandible in right lateral view (H)
Abbreviations: bo. basioccipital 基枕骨; f. frontal 额骨; j. jugal 颧骨; l. lacrimal 泪骨; m. maxilla 上颌骨; n. nasal 鼻骨; p. parietal 顶骨; pl. palatine 腭骨; pm. premaxilla 前颌骨; po. postorbital 眶后骨; prf. prefrontal 前额骨; pt. pterygoid 翼骨; q. quadrate 方骨; qj. quadratojugal 方颧骨; sq. squamosal 鳞骨

widest point in the region adjacent to the second premaxillary tooth. This flaring morphology is common in basal neoceratopsians (Makovicky and Norell, 2006; You et al., 2010). The palatal component of the premaxilla is vaulted.

The rostralmost portion of the maxilla is a forked process which embraces the premaxilla ventrally. The maxilla sends a rostral process medially between the palatal components of the premaxillae up to the level of the first premaxillary tooth. There is also a prominent rostrolateral process which extends to the level of the second premaxillary alveolus. After a very short diastema, the maxilla bears twelve teeth. As in other basal neoceratopsians the tooth rows are curved, diverging laterally towards the caudal margin (Tanoue et al., 2010). Dorsally the maxilla forms the ventral and lateral margins of the antorbital fossa. The sharp edge of the fossa is deeply incised into the maxilla. The tooth row is inset from the maximum lateral extent of the maxilla by 1.0 to 2.5 cm, with the distance increasing caudally as the facial crest of the maxilla extends laterally to meet the jugal. Caudally the maxilla joins with the pterygoid and ectopterygoid to form the elongate and pendant mandibular process.

The nasals are broad, with a length of 77 mm and a width of 22 mm on the right side, but are still narrower than those of *Auroraceratops rugosus*. The rostral ends of the nasals are separated medially by caudal projections of the premaxillae. The nasals are widest at midlength where they contact the prefrontals. The nasofrontal suture angles towards the midline, as in *A. rugosus* (You et al., 2005). The dorsal surface of the nasal is slightly vaulted lateral to the midline. The lacrimals are very similar to those of *A. rugosus*, with a fungiform dorsal expansion and very weak nasal-lacrimal contact. No palpebral was preserved with this skull, but the prefrontals do appear to bear facets for palpebral articulation. The lacrimals are telescoped in this specimen, so their full extent is not known. The caudoventral corner of the antorbital fossa is deep, while the rostral and dorsal margins are much shallower.

The frontals are similar in morphology to those of many other basal neoceratopsians. Most of the rostral margin of these elements has been lost to breakage, but the preserved lateral parts of the rostral margin indicate that it angled medially. The frontals form a flat, rostrally-sloping table between the orbits, which peaks caudal to the midpoint of the orbit. Caudally, the frontal is excavated by a broad, shallow frontal fossa. Shallow frontal fossae are seen in *Auroraceratops rugosus*, *Liaoceratops* and *Yinlong* (You et al., 2005; Xu et al., 2002, 2006).

The postorbital is triradiate and forms the entire caudal margin of the orbit. Caudally it fits into the bifurcated rostral process of the squamosal, as in *Auroraceratops rugosus* and most other ornithischians (Makovicky and Norell, 2006). The rostral process of the squamosal is horizontally oriented. The body of the squamosal does not project caudal to the quadrate, as in *A. rugosus*, but the medial process of the squamosal does angle slightly caudally. The ventral process of the squamosal is also bifurcated to accept the head of the quadrate. The parietal is primarily represented by the sagittal crest, which is strongly developed and narrow as in *Protoceratops*. The fragments of the right lateral portion of the parietal which are preserved indicate that it is less than 1 mm thick.

The jugal is one of the most distinctive bones of the ceratopsian skull. It tapers rostrally as in other basal neoceratopsians (Xu et al., 2002; You and Dodson, 2003; You et al., 2005; Makovicky and Norell, 2006), and forms the entire ventral margin of the orbit. Dorsally the jugal sends off a thin, tapering postorbital ramus which excludes the postorbital from participation in the infratemporal fenestra. As in *A. rugosus*, the jugal bears a patch of rounded ridges and knobs where the postorbital bar joins the main body of the jugal. This rugosity is less pronounced in *Auroraceratops* sp. than in *A. rugosus*, but is still located in the same region. The subtemporal part of the jugal is deeper than the suborbital portion of the jugal, though the difference is not as marked as in *Yamaceratops* (Makovicky and Norell, 2006). The subtemporal part of the jugal is truncated, exposing the quadratojugal laterally in *Auroraceratops* sp., as in *Liaoceratops* (Xu et al., 2002). The epijugal is small, ovate and securely fused to the jugal on the right side. It bears a sharp, laterally projecting jugal horn. The suture between the jugal, the epijugal and the quadratojugal has been obliterated.

The quadrate has a long shaft that curves caudally at its dorsal end. It forms most of the caudal border of the lateral temporal fenestra. Laterally it bears a caudoventrally angled ridge at midshaft that marks the dorsalmost extent of the facet for the articulation of the quadratojugal. Distally the articulation for the mandible includes two low condyles separated by a shallow sulcus.

The braincase is preserved within the skull, but the high degree of articulation and the current state of preparation prevent details of most of the braincase from being seen. The occipital condyle is well fused and the contributions of the basioccipital and the exoccipitals are not clear. The exoccipital sends off a thin, laterally flaring paroccipital process to meet the quadrate just ventral to its articulation with the squamosal. The foramen magnum is tall, narrow and subtriangular in outline. The basal tubera are angled caudoventrally compared to the vertical orientation of the supraoccipital.

The pterygoids form the caudal edge of the palate and a ventral plate on the braincase, and send wings towards the quadrate, the base of the braincase and the mandibular process. In ventral view, the pterygoids cover the basisphenoid as a horizontal plate. Caudally, the pterygoids bear elongate prongs which extend caudal to the basal tubera. While short basal processes are known for most basal neoceratopsians (Dodson et al., 2010), these elongate processes are an autapomorphy of *Auroraceratops* (You et al., 2005). The palatines sit between the more lateral maxilla and the more medial pterygoids. An L-shaped section of each palatine is preserved, though the dorsal portions of the palate, including the vomer, are not present. The ectopterygoid forms the caudal margin of the pterygo-palatine foramen.

Mandible The predentary is not preserved. The preserved facet for the predentary on the dentary indicates that the buccal processes were short.

The dentary is straight, and forms two-thirds to three-quarters of the total length of the mandible (Fig. 1H). It bears two tuberosities, one in the middle of the ventral margin in lateral view and a second rostroventral to the coronoid process. These tuberosities are in the same locations where rugosities were reported in *Auroraceratops rugosus*. The coronoid process is strongly developed, rounded dorsally and separated from the tooth row by a wide sulcus. The dentary contains 14 teeth. There is little separation between the predentary and the first dentary tooth position. The contact between the dentary and the surangular occurs caudal to the apex of the coronoid process. The coronoid and intercoronoid bones are not preserved in this specimen.

The surangular forms the caudodorsal portion of the mandible (Fig. 1H). It bears a large tubercle lateral to the glenoid. While there is a saddle-shaped area between this tubercle and the caudodorsal tubercle on the dentary, there is no ridge as seen in *Archaeoceratops* (You and Dodson, 2003) and *Protoceratops* (Brown and Schlaikjer, 1940; Tanoue et al., 2010). This morphology is uniquely shared between GSGM-FV-00500 and *A. rugosus*. The surangular forms more than half of the lateral cotyle of the glenoid and provides a lateral wall to the glenoid.

The articular is a stout rectangular bone in dorsal view, and forms more than half of the broad glenoid concavity. This articular surface is much wider than the cotyle of the quadrate that it is supposed to have enclosed. The articular also forms a short, rectangular retroarticular process. Rostral to the articular the prearticular is firmly articulated. The angular forms the caudoventral margin of a tall, narrow, reniform mandibular fenestra. This is in contrast to the more ovate mandibular fenestra seen in *A. rugosus*. Caudally the articular forms the ventral half of the retroarticular process.

Axial skeleton The skeleton preserves seven dorsal vertebrae in a series (Fig. 2A). Although the neural arches are firmly attached to the centra, lines of fusion are still visible, suggesting that this animal was not fully somatically mature. The dorsal centra are amphicoelous, with very slightly concave articular surfaces on both ends. The central articular faces are ovate with the long axis running dorsoventrally. The neural canal is sub-triangular on the cranialmost preserved dorsal and sub-circular on the remaining dorsal vertebrae. The neural spines are broken on the first two preserved dorsal vertebrae, but complete on the third to the fifth preserved vertebrae in the series. The spines are rectangular in outline, and strongly mediolaterally compressed. The base of each spine is caudally displaced such that one half sits dorsal to the following centrum and the intervertebral space. The fourth preserved vertebra has a triangular caudoventral projection off the spine, and an equivalent projection also occurs in the fifth preserved neural spine. The dorsal neural spines are more steeply caudally inclined than in *Montanoceratops* (Brown and Schlaikjer, 1942; Makovicky, 2010) and *Protoceratops* (Brown and Schlaikjer, 1940). The inclination is similar to that seen in *Leptoceratops* (Sternberg, 1951), although the spines are more similar in thickness to those of *Protoceratops*. The prezygapophyses have flat facets which extend only slightly cranial to the centra. Caudally the postzygapophyses extend approximately 0.5 mm beyond the caudal ends of the centra. The zygapophyseal facets are flat and angled dorsolaterally at approximately 30 degrees from the horizontal. The transverse processes sit high on the neural arches, which angle sharply dorsocaudally as in the cranial and mid-dorsal vertebrae of other basal neoceratopsians (Makovicky, 2010). The tubercular facet is distally located on the transverse process. The parapophyses (capitular facets) are oval to triangular in outline, with no particular pattern to their variation. The parapophysis lies on the neural arch just cranial to the transverse process.

The caudalmost dorsal centrum is wide and the transverse processes are capped by ovate, rugose areas representing the para-and diapophyses (Fig. 2B). The right side preserves the proximal end of a rib that tapers rapidly laterally from an oval fusion with the transverse process. This is similar to the condition noted in the 13^{th} dorsal vertebra of *Leptoceratops* (Sternberg, 1951). The pedicels are much thicker than those of the other preserved dorsals. The neural spine and postzygapophyses are not preserved.

The caudal vertebrae (Fig. 2C, D) have circular amphicoelous centra and taper rapidly. Ventrally the caudal centra bear hemal arch facets. The prezygapophyses are very widely placed to embrace the neural arch of the preceding vertebra. The postzygapophyses are very narrowly placed and inclined dorsomedially at a 45-degree angle. The neural spines are all broken off (Fig. 2C, D).

Appendicular skeleton The humerus measures 11.9 cm long, and is slender with a long, low and rectangular deltopectoral crest (Fig. 2E). Both the lesser trochanter of the humeral head and the distal end of the deltopectoral crest are broken in this specimen. A fairly strongly developed olecranon fossa extends one-fifth the length of the element. The humerus is not deflected medially, as in juvenile *Protoceratops* (Brown and Schlaikjer, 1940).

Two intermediate phalanges are preserved, from digit Ⅳ and/or digit Ⅴ. The shorter of the two bears distinct collateral ligament pits.

The ilium lacks the lateral V-shaped ridges seen in *Protoceratops*, but otherwise is quite similar; the preserved length of the left ilium is 16.6 cm (Fig. 2F). The preacetabular process is dorsoventrally narrow and triangular in cross section. The dorsal margin is only slightly everted at the cranial tip. The flat ventral margin of the preacetabular process curls gently medially towards the cranial end of the element. The dorsal margin is arched, but not so strongly as in *Archaeoceratops* (Dong and Azuma, 1997; You and Dodson, 2003). A thin, tall ridge is present medially on the preacetabular process of the ilium. The postacetabular process is much taller and smoother laterally than the preacetabular process. The lateral inclination of the ilium increases caudally along the postacetabular process. At the level of the acetabulum, the ilium arches laterally, giving the paired ilia an hourglass shape in dorsal view. The pubic peduncle is narrow and angled cranioventrally. The ischiadic peduncle is thick and bulbous (almost hemispherical in lateral aspect). It is comparable to that figured for a sub-adult *Protoceratops* (AMNH 6424), and not as expanded as in an adult specimen (AMNH 6466) (Brown and Schlaikjer, 1940, fig. 30). Medially, the right ilium preserves four articular scars for the sacral ribs. The caudalmost three scars are hourglass-shaped. The fusiform cranialmost scar on the medial crest of the preacetabular process lies approximately 1 cm cranial to the pubic peduncle.

Only the proximal portion of the right pubis is preserved (Fig. 2G). The cranial process of the pubis is elongate, dorsoventrally compressed and much thicker than the preserved portion of the caudal process. The elongate cranial process is much more pointed than in either *Protoceratops* (Brown and Schlaikjer, 1940) or *Montanoceratops* (Brown and Schlaikjer, 1942). The cranial process bears a dorsal midline ridge along its length. The medial surface is entirely composed of a sharp but low ridge. Only the proximalmost portion of the caudal process is preserved, but it suggests the caudal process was a long, rod-like element, as in the pubis associated with the basal neoceratopsian skeleton MOR 542 (Chinnery and Weishampel, 1998). As in *Archaeoceratops*, the pubis bears a medial facet on the acetabular rim for contact with the sacral ribs (Dong and Azuma, 1997).

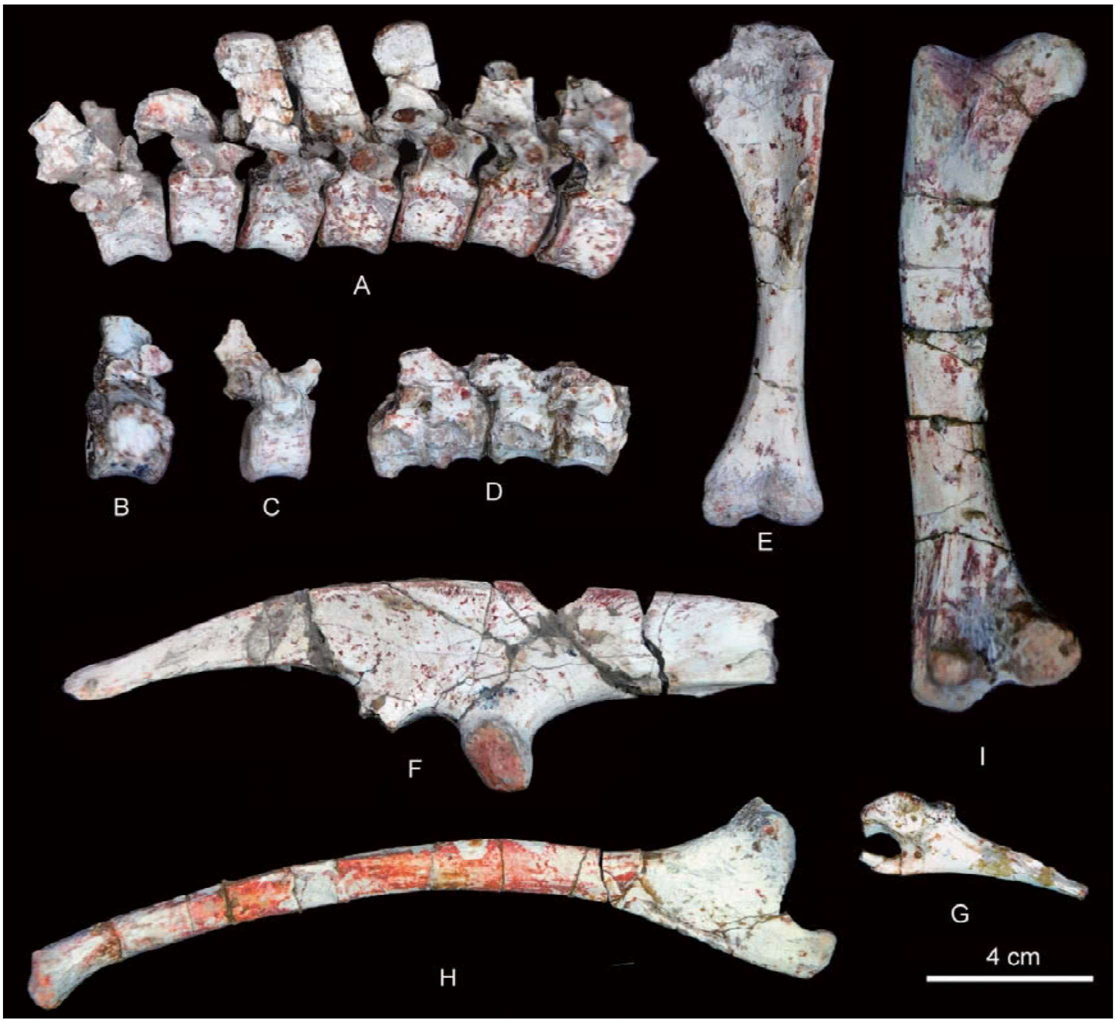

Fig. 2 Partial postcranial skeleton of *Auroraceratops* sp. (GSGM-FV-00500)
A. seven dorsal vertebrae in right lateral view; B. caudalmost dorsal vertebra in right lateral view; C. a free caudal vertebra in right lateral view; D. a series of four articulated caudal vertebrae in right lateral view; E. left humerus in cranial view; F. left ilium in lateral view; G. right pubis in lateral view; H. right ischium in lateral view; I. left femur in caudal view

The ischiumis 18.9 cm long. It has a fairly standard basal neoceratopsian morphology (Fig. 2H). It consists of a shaft that is slightly bowed, rather than strongly bowed as in *Leptoceratops* (Sternberg, 1951). It bears a stout iliac process and a rectangular pubic process. The iliac process appears more robust than in *Protoceratops*. In between the two processes, the ischiadic contribution to the acetabular wall is quite thin. The body of the ischium bears a strong ridge at the ventral margin, just ventral to the iliac process. The ischial shaft has a sharp, low but prominent ridge on the medial surface. This ridge lies slightly proximal to half way down the shaft and sits in the midline of the shaft. The distal tip of the ischial shaft is slightly downturned, as in *Protoceratops* (Brown and Schlaikjer, 1940).

The femur is 15.3 cm long, and is bowed cranially. The femoral head is strongly offset dorsomedially by a 1.25-cm-long neck (Fig. 2I). The femoral head sits above the level of the greater trochanter. The lesser trochanter is triangular in cross-section and set off from the greater trochanter by a distinct notch. It is also slightly shorter than the greater trochanter. The caudal surface of the femoral head shows a trough or notch trending along the axis of the head and giving the femoral head a caudally open U-shaped profile in proximal view, which appears to be homologous to the shallow tendon groove reported in *Archaeoceratops* by You and Dodson (2003). The fourth trochanter is present and thin in cross section, though it is broken in this specimen. Distally, the femoral condyles are broken craniomedially. The lateral condyle projects further caudally than the medial condyle, and constricts to a finger-like caudal projection. A low rounded ridge continues from this projection cranially, angling medially until it meets the fourth trochanter. A rounded sulcus separates the finger-like projection from the lateral femoral epicondyle.

The five pedal phalanges appear to come from the left pes and include phalanges II-1, III-1, IV-1, IV-2 and IV-3. All of the pedal phalanges have strongly developed collateral ligament pits. The distal articulation of each phalanx is strongly ginglymoid. The three proximal phalanges each have a dish-shaped proximal articulation and very faint dorsocaudal projections off the rim of the articulation. These proximal phalanges also have flattened surfaces at their ventrocaudal ends. The two more distal phalanges each have a very strong dorsocaudal projection and a strongly divided proximal articulation. These dorsocaudal projections are more strongly developed than in the subadult basal neoceratopsian MOR 542 (Chinnery and Weishampel, 1998). In general, the pes appears to be similar to those of other, closely related basal neoceratopsians (You and Dodson, 2003).

Discussion The new specimen (GSGM-FV-00500) shows several key features also present in *Auroraceratops rugosus*, a taxon based on an almost complete skull and lower jaw from the same late Early Cretaceous Xinminpu Group in the Mazongshan area (You et al., 2005). *A. rugosus* is a short-faced basal neoceratopsian previously distinguished by 1) great breadth of the nasals, 2) fungiform expansion of the dorsal end of the lacrimal, 3) highly developed rugosity of the jugal, dentary and surangular, 4) horizontal caudally directed processes of the pterygoid covering basisphenoid-basipterygoid articulation ventrally, and 5) inflated striated premaxillary teeth (You et al., 2005). Among these, features 2), 4), and 5) are also present in GSGM-FV-00500, while feature 3) may be subject to individual, sexual or ontogenetic variation. Moreover, the lower jaw of GSGM-FV-00500 is almost identical to that of *A. rugosus*, especially in having a surangular that bears a large tubercle lateral to the glenoid while lacking a ridge connecting this large tubercle to the caudodorsal tubercle on the dentary, a condition unique in all ceratopsians. Therefore, GSGM-FV-00500 is here assigned to the genus *Auroraceratops*.

However, GSGM-FV-00500 also possesses several features different from those in the type species of *Auroraceratops*: 1) it has a longer face than *A. rugosus* does, the ratio of preorbital length (without rostral)/orbital length being 1.5 (75 mm/50 mm) in GSGM-FV-00500 and 1.19 (6.5 mm/5.5 mm) in *A. rugosus*; 2) the nasal of GSGM-FV-00500 is not as wide as that of

A. rugosus, being 77 mm long and 22 mm wide compared to 66/61 mm (left/right) long and 24 mm wide in *A. rugosus*; 3) the epijugal is placed ventral to the caudal half of the infratemporal fenestra in GSGM-FV-00500, while it is ventral to the middle portion in *A. rugosus*; and 4) the supratemporal fenestra appears to widen caudally in GSGM-FV-00500, but to have a consistent width in *A. rugosus*. Even with these differences, we still feel we do not have sufficient data to formally erect a new species at present.

Auroraceratops sp. represents the second basal neoceratopsian from the Xinminpu Group in the Yujingzi Basin, the other being *Archaeoceratops yujingziensis* (You et al., 2010). Although only one specimen is described in this paper, tens of specimens tentatively assigned to the putative new species have been discovered from the upper red beds in a relatively small area (approximately several square kilometers); by contrast, only one partial skeleton of *Archaeoceratops yujingziensis* has been recovered from the middle gray beds, during the post-fieldwork preparation of a basal hadrosauriform. Alongside the two species from the Gongpoquan Basin approximately 100 km to the north (*Auroraceratops rugosus* and *Archaeoceratops oshimai*), two genera and species of basal neoceratopsians have been recovered from the late Early Cretaceous Xinminpu Group in the Mazongshan area of northwestern China, making it an important area for research into the early evolution of horned dinosaurs.

Acknowledgements We are grateful to the crew of the former Fossil Research and Development Center of the Third Geology and Mineral Resources Exploration Academy of the Gansu Provincial Bureau of Geo-Exploration and Mineral Development for discovering, excavating, and preparing the specimen. Thanks also go to Jennifer Hall for her skillful drawings in fig. 1B, D, and F. We also thank Drs. Andrew Farke and Michael Ryan for their critical and helpful reviews, and Corwin Sullivan and David Hone for editorial oversight.

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