新疆布尔津地区晚始新世哺乳动物化石的发现及其意义

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1995 年以来作者等人在新疆准噶尔盆地北缘乌伦古河地区开展了第三纪哺乳动物地层研究工作。在调查研究该区乌伦古河组地层同时（叶捷等，2001a，b），1999 年和 2001 年先后两次前往布尔津地区考察了那里的“乌伦古河组”。在布尔津县城西北 14km 处额尔齐斯河北岸的一片新生代露头，长期被视为乌伦古河组，因而时代也被定为始新世至渐新世，但一直没有确凿的化石依据。1999 年我们首次在该套地层中采集到哺乳动物化石（99027 地点），2001 年再次在同一地点、同一层位采集到化石并实测了地层剖面。布尔津的该乌伦古河组地层可大致分为两段，下段为富含铁质的砂岩与泥岩互层，上段为浅灰绿色砂岩与杂色泥岩互层，整套地层的风化表面呈黄棕色。在乌伦古河组建组的乌伦古河流域，乌伦古河组则由一套浅灰绿色砂岩与棕灰色含砂泥岩构成，整套地层风化表面呈灰白色（叶捷等，2001a）。两个地区的乌伦古河组的岩性显然是不同的。野外追索证明，这两个地区的两套不同岩性的地层是两个不同沉积盆地的堆积物，这两个盆地在乌伦古湖附近（E87°12′）被一由古生代地层构成的山岭隔开。作为地质体，这两套地层间没有联系，不应当归为同一岩石地层单位。因此，布尔津地区的乌伦古河组名称应该更改。在地形图上，布尔津地区似乎位于现代广义的斋桑盆地中，因而必须与斋桑盆地中的相应地层做详细对比后才能对布尔津地区的该套地层冠名。99027 地点的化石产自厚 1.2m 的黑色含锰质粉砂岩层（剖面第 21 层）中。

化石材料都为奇蹄类零星牙齿，共 6 种，分属 4 个科：两栖犀科 Cadurcodon cf. C. ardynensis，Amynodontidae gen. et sp. indet.，Gigantamynodon giganteus；Indricotheriinae gen. et sp. indet.，G. ardynensis，Amynodontidae gen. et sp. indet.，Gigantamynodon giganteus；跑犀科 Indricotheriinae gen. et sp. indet.；真犀科 Rhinocerotidae gen. et sp. indet. 和雷兽科 Brontotheriidae gen. et sp. indet.。

该奇蹄类组合与我国云南的蔡家冲动物群、内蒙古的乌兰戈楚动物群和乌尔丁鄂博动物群、蒙古的 Guateg 和 Khoer-Dzan 动物群以及哈萨克斯坦的 Kusto 动物群中的奇蹄类构成相似。众所周知，由于同位素测年手段的应用，近来这些动物群的时代已由早渐新世更改为晚始新世，因此布尔津的奇蹄类组合及产化石地层的时代也应为晚始新世。

1) 国家自然科学基金项目（编号：49928202）和国家科学技术部特别支持费（国科技字[1999]045 号）资助。
THE DISCOVERY OF LATE EOCENE MAMMAL FOSSILS FROM BURQIN OF XINJIANG

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Abstract The previously alleged “Ulunguhe Formation” in the Burqin region of Northern Xinjiang is lithologically different from the Ulunguhe Formation in its type region, the Ulungur River area. The two regions are separated by a mountain of Paleozoic rocks. Therefore the sediments in two areas belong to different geological body respectively. The name “Ulunguhe Formation” should not be applied to the deposits in the Burqin region, for which, however, it is premature to name a new rock unit.

A perissodactyl assemblage was collected from the sediments of Burqin. It consists of exclusively perissodactyls, including Cadurcodon cf. C. ardynensis, Gigantamynodon giganteus, Amynodontidae gen. et sp. indet., Indricotheriinae gen. et sp. indet., Rhinocerotidae gen. et sp. indet., and Brontotheriidae gen. et sp. indet., and is comparable with the late Eocene mammal faunas of Asia, such as Caijiachang fauna of Yunnan, Ulangochu fauna and Urtyn Ob fauna from Neimongol of China, Guateg and Khoer-Dzan fauna from Mongolia, and the Kusto fauna from Kazakhstan.

The discovery of the late Eocene mammals in North Xinjiang indicates that the terrestrial biogeographic division into south and north provinces in the Asian continent had not been achieved by the late Eocene.

Key words Burqin, Xinjiang, late Eocene, perissodactyls

Since 1995 the authors have been working on the Tertiary stratigraphy and faunas in the Ulungur River area of the north Junggar Basin, Xinjiang (Ye et al. 2001a). During the period of time we also investigated the Burqin area in 1999 and 2001. Mammal fossils were found in both years from sediments that were previously called “Ulunguhe Formation” on the north bank of the Irtysh River near the Burqin city (Fig. 1). The fossils were collected from two sections that are about 14 km apart and represent two assemblages of different ages. One section generated fragmentary specimens of large perissodactyls (locality 99027), whereas the other produced better material of primarily small mammals (99035) (Fig. 1). By correlations with other Asian Tertiary faunas, the perissodactyl assemblage indicates the age of late Eocene, whereas the assemblage of small mammals is of early Oligocene age. In this study, we report only the rock section that yields the perissodactyl fossils, describe the fossils, and discuss their implications.

1 Lithological stratigraphy

The measured section is located on the north bank of the Irtysh River, 14 km north of Burqin
The sketch geological map of northwestern part of Burqin, Xinjiang showing the location of the measured sections. The lithology from top downwards is as below:

- Grayish white conglomerates
- Grayish green mudstone 2m
- Variegated mudstone, dominantly grayish green with yellow spots, and becoming red with weathering 1.5m

Fig. 1: The sketch geological map of northwestern part of Burqin, Xinjiang showing the location of the measured sections.

City (N47°50.416', E86°40.837').

28. Grayish green mudstone
27. Variegated mudstone, dominantly grayish green with yellow spots, and becoming red with weathering 1.5m
The deposits in the section reported here can be divided into two parts: The lower part (1~11 layers) consists of alternate layers of ferruginous sandstone and mudstone, and the upper part is made of alternate layers of light grayish green sandstone and variegated mudstone. The weathered surface of the entire set of sediments looks yellowish brown. These deposits were previously considered to be "Ulunguhe Formation" by the local geological mapping team. Comparing the beds from Burqin region with those from Ulungur River areas, we found the sediments from the two areas are lithologically different. The typical Ulunguhe Fm. in the Ulungur river region is a set of light grayish green sandstone and brownish gray sandy mudstone, as a whole, grayish white in color on weathered surface (Ye et al., 2001a). We traced the rocks along the Irtysh River and found Paleozoic rocks near Ulungur lake at about E87°12' which makes up a natural barrier separating two deposit basins. The typical Ulunguhe Fm. sediments exist only in the east basin, and the deposits in Burqin region are accumulated in the west Basin (Burqin Basin). They are different geological bodies. Therefore the name Ulunguhe Fm. should not be used for the deposits of the Burqin Basin. Geographically Burqin is adjacent to the modern Zaisan Basin. Whether they were connected together in the relevant geological time remains a problem to be solved. It is premature to establish a new rock unit for the sediments described here before further investigation is carried on, particularly in correlation with the Tertiary beds of the Zaisan Basin, Kazakhstan.
2 Brief description of the mammalian fossils

*Amynodontidae* Scott et Osborn, 1883

Cadurcodon *cf. C. ardyensis* (Osborn, 1923)

(Fig. 2)

**Specimens**

Two upper right canines, V 13094. 1; one right and one left lower canine, V 13094. 3; four upper part (top part) of a right lower canine, V 13094. 5; two complete left p3, V 13094. 6; one complete left p4, V 13094. 8; a fragmentary right p4, V 13094. 9; a fragmentary left upper molar, V 13094. 10.

The upper canine (C1) is robust, curved posteriorly and is elliptical in cross-section. A weak ridge is on the posterior surface of the tooth. The tooth part labial to the ridge is wider than the part lingual to the ridge. The big smooth wear facet faces anteriorly and truncates the tooth obliquely (V 13094. 1). V 13094. 1 is 27 mm wide and 31 mm long at the base; V 13094. 2 is 23 mm wide, 30 mm long at the base.

The lower canine (c1) is slightly curved posteriorly. It is triangular in cross section with a sharp anterior ridge and two posterior ridges. The surface between the two posterior ridges is wide, depressed and longitudinally extended. The labial surface of the tooth is more or less flat and the lingual surface convex. V 13094. 3 is fresh and measured 51 mm high, 25, 5 mm wide and 33 mm long at the base.

Lower premolar (p3): triangular in occlusal view. The labial wall is flat. The protoconid is developed and connected with the metaconid, forming a short transverse ridge. The hypolophid is low and wide; the cingulum around the tooth is developed. The tooth has single root with a vertical groove on the inner side. V 13094. 6 is 23 mm long and 20 mm wide; V 13094. 7 is 25. 6 mm long and 26 mm wide.

p4: Trapezoid in occlusal view. The labial wall is more or less flat, but with a weak vertical groove in between the anterior and posterior lophs. The paralophid is slender, the metalophid is thick, the hypolophid is low and is the widest loph of the tooth; the cingulum around the tooth is developed. V 13094. 8 is 34. 1 mm long and 32 mm wide.

The described teeth are similar to those of *Cadurcodon ardyensis* (A. M. 19154, A. M. 20441) from the Ardyn Obo Formation of Mongolia (Osborn, 1924) and the p3 (V 13094. 6) and p4 (V 13094. 8) resemble the p3 and p4 (1397 - 3) of *Cadurcodon ardyensis* from Solonkure of Mongolia (Gromova, 1958) in morphology but with larger size.

*Amynodontidae* gen. et sp. indet.

The only specimen available is a fragmentary left lower canine, V 13097, damaged on the lower part. The preserved part is 71. 5 mm high, larger and much higher than that of *Cadurcodon ardyensis*. It possesses characters typical for amynodontids: triangular pyramid in shape with flat labial face, convex lingual face and slightly concave posterior face. It is referred to an open nomenclature (nomenclatura aperta) for lack of comparative material.
Gigantamynodon giganteus Xu, 1961

(Fig. 3)

A damaged right upper canine, V 13095.1; a damaged right m1/m2, V 13095.2 and 3 damaged m3, V 13095.3-5.

The upper canine (V 13095.1) is damaged in the top and base parts. It is robust, curved posteriorly, expanded from top to the base rapidly and with elliptical cross section. Specimen V 13095.2 is a damaged right m2 or m1, remaining only the posterior part with deep talonid basin and developed cingulum. It is 43 mm wide. A concaved posterior contact facet with m2 or m3 is present. Specimen V 13095.4 and V 13095.5 is the anterior part of a right m3 and the posterior part of a left m3 respectively. They came probably from one individual, judging from the same degree of wear. The m3 is probably rectangular in occlusal view with flat labial wall. The paralophid is low and widens downwards. The metaconid and entoconid are developed. The metalophid extends posteriorly, forming an angle of 65° with the labial wall. The cingulum around the tooth is distinct. The tooth is estimated 80 mm long and 41 mm wide.

Though damaged all the specimens characterize the Gigantamynodon giganteus. They resemble the specimens described by Xu (1961) from the type locality (Qujing, Yunnan) in 1) especially large size; 2) m1 and m2 having rather deep depression on the posterior wall, which is caused as Xu guessed by strong mutual squeeze between the cheek teeth; 3) the morphology and size of m3.

Hyracodontidae Cope, 1879

Indricotheriinae gen. et sp. indet.

(Fig. 4)

The only specimen is the left first lower incisor, V 13096. It resembles the corresponding tooth from Luoping, Yunnan (Chiu, 1962) in morphology but is smaller than the latter and displays subtle differences from the latter. Usually indricotheres lower incisors are situated at the front end of the lower jaw and extended forwards. The described i1 is worn at the top and its lower border curves upwards. Two ridges extended from the top to the base are present on the dorsal surface, the mesial one is higher than the distal one. The single tooth root is laterally flattened and slightly concave mesially. The tooth is 32.8 mm wide and 29 mm long at the base. This i1 differs from the Luoping specimen in 1) lack of the knobs at the base of lingual surface; 2) having contact facet on both mesial and distal side, which indicates the probable presence of at least one more incisor (or ? canine) and thus characterizes early indricotheres.

Rhinocerotidae gen. et sp. indet.

Among the fragmentary teeth only three specimens provide indicative information.

1) The nearly complete right M1 ?, V 13098.1 is medium high with long metacone and a cristal on the ectoloph. It is 38 mm wide.

2) The anterior part of a slightly worn M1 ?, V 13098.2. The paracone, parastyle and the anterior cingulum are developed. An incipient antecrochet is present. The protoloph is 36.5 mm wide (labial-lingual).

3) The anterior part of a left lower molar V 13098.3. The cingulum is developed and the metalophid
is 21mm wide.

Based on the presence of a crista and an antecrochet on M1?, these specimens may be temporarily referred to Rhinocerotidae.

**Brontotheriidae gen. et sp. indet.**

A damaged right lower molar, V13099, with only metaconid and talonid, the labial part of the latter is broken off. The metaconid is well-developed. The talonid is widely opened and about 34mm long.

### Discussion and conclusion

All the fossils from Burqin beds are perissodactyls. This perissodactyl assemblage is comparable with those from Caijia-chong fauna of Yunnan, Ulangochu fauna and Urtyn Obo fauna of Nei Mongol (Li and Ting, 1983), Guartege and Khoeer-Dzan faunas from Mongolia (Russell and Zhai, 1987), and Kusto fauna from Kazakhstan (Emry et al., 1998). Based on mammal faunas from 10 localities of Asia Savage and Russell (1983) listed 82 species of the then Asian" Early Oligocene" mammal fauna. Among them there are 42 species of perissodactyls:15 brontotheres, 10 amynodonts, 8 hyracodons and 3 rhinocerotids. The perissodactyls obviously occupied a predominant position among the macromammal world during that time. Because the North American mammal stage Chadronian has been shifted from early Oligocene to late Eocene as a result of new isotopic dating data (Swisher and Prothero, 1990; Berggren and Prothero, 1992), corresponding Asian "early Oligocene" mammal faunas were also compressed down to the late Eocene (Mckenna, 1995; Tong et al., 1995; Wang, 1997; Meng and McKenna, 1998).

Comparison of the late Eocene mammal faunas with those of older and younger ages shows that the late Eocene is the latest period when the perissodactyls were prosperous in Asia. Specifically, during this period of time, brontotheres remained abundant and became extinct at the Eocene-Oligocene boundary. Amynodonts continued to be diversified and specialized during late Eocene, and decline within early Oligocene. Indricotheres appeared in the late Eocene, and diverged in the Oligocene. Early rhinocerotoids began to radiate in the late Eocene and gradually replaced the hyracodonts in the Oligocene. This pattern is clearly reflected by the composition of the Burqin fauna. The amynodont *Cadurcodon* cf. *C. ardyensis* shows high-crowned tooth and reduced premolars, and *Gigantamynodon giganteus* is large and has lower molar with flat labial surface and more obliquely extended lophids. The only recovered specimen (i1) of indricotheres characterizes the early indricotheres, such as the incisor from Luoping, Yunnan (Chiu, 1962). The two fragmentary upper molars with incipient crista and antecrochet and the lower molar with developed cingula indicate the probable presence of early rhinocerotoids. By correlation with those late Eocene faunas of Asia, and morphological comparison of specimens of related taxa, the Burqin perissodactyl assemblage is undoubtedly of the late Eocene age. This is the first record of late Eocene mammal fauna in the Northern Xinjiang. Because of its similarity of faunal composition to those of southern and eastern areas of Asia, the Burqin assemblage further confirms that the biogeographic division of the south and north faunal provinces in Asian continent had not been formed in the late Eocene. In
addition, the composition of the Burqin fauna is also consistent with the “Mongolian Remodelling” (Meng and McKenna, 1998), in which Eocene faunas of central Asia are dominated by large perissodactyls, whereas the Oligocene faunas are represented primarily by small mammals. The transition of the terrestrial faunas probably reflects the change of global climates across the Eocene-Oligocene boundary. Future study of the Oligocene mammal assemblage found in nearby section (locality 99035) will provide additional evidence to testing of the “Mongolian Remodelling”.

Acknowledgments
We thank Prof. Qiu Zhanxiang and Wang Banyue for helpful discussion on the identification of relevant taxa. Thanks go to Messer Bi Shundong and Su Jianfeng for their efforts in 1999’s field work, to Mrs. Yang Mingwan for preparing the illustrations (figs. 2, 4). This work is supported by the National Natural Science Foundation of China (Grant No. 49928202) and the Special Funds of the Chinese Ministry of Technology and Sciences [1999] 045.

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