

## Research Advances

## First Report of Late Miocene Mammals Including *Chilotherium* in the Xining Basin, NE Tibetan Plateau, China

HAN Jianen<sup>1</sup>, SHAO Zhaogang<sup>1,\*</sup>, XU Biao<sup>1,2</sup>, ZHANG Qianqian<sup>1,3</sup>, YU Jia<sup>1</sup>, MENG Qingwei<sup>4</sup>, MENG Xiangang<sup>1</sup>, ZHU Dagang<sup>1</sup> and WANG Jin<sup>1</sup>

1 Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing 100081, China

2 China University of Geosciences (Beijing), Beijing 100083, China

3 Northeast Agricultural University, Harbin 150030, Heilongjiang, China

4 Chinese Academy of Geological Sciences, Beijing 100037, China

### Objective

Xining basin is located in the northeastern Qinghai-Tibetan Plateau, which tectonic location belongs to a junction of the Kunlun and Qilian mountains. The southern, northern and western parts of the basin are restricted by the Laji, Daban and Riyue mountains fault zones, and go eastward into the Longzhong basin in Gansu Province. A succession of Cenozoic lacustrine sedimentary strata has been well developed in the Xining basin, with sediments over 800 m thick. Deformation uplift, the history of weathering and denudation of the source area and the climate changes in the northeast part of the plateau have been recorded here. The Xiejia fauna dates the Early Miocene, the Danshuilu fauna dates the Middle Miocene, and the Diaogou fauna dates the late Middle Miocene, all of which have been found in the Xining basin; they provide important evidence for Cenozoic stratigraphic correlation. In recent decades, there were no reports of large mammal fossils in the Xining basin, especially data were insufficient for making assessments of Late Miocene faunas.

In 2015, however, *Hipparion dongxiangense* and *Parelasmotherium* fossil teeth were first reported, being found in Jiangjiagou, Huzhu County, Xining basin, and dated as early Late Miocene, which supplements earlier research on Late Cenozoic large mammals in the Xining basin. Because the biostratigraphy of Cenozoic mammal fossils plays an important role, based on the existing fossils a new Late Miocene fauna was established, which has become a key in the study of the sedimentary environment and regional stratigraphic correlation in the Xining basin during the Late Miocene. To this aim, we have continued fossil research in the Xining basin, with *Hipparion dongxiangense* and *Parelasmotherium* fossils being found in Linxia Formation, in order to further

accurately identify the fossil species and to establish the presence of the Late Miocene fauna in the Xining basin.

### Methods

A previously fossiliferous section found in 2015 exposed a nearly horizontal development of yellow compact calcareous mudstone, with gravel beds found in the upper and lower layers of the mudstone. We made a search for this formation and found a large number of mammal fossils in Banyan village, 1 km from Jiangjiagou village. The fossils are located in brownish yellow and yellow mudstone. The stratigraphic bedding is clear, and the upper strata of the fossil layers develop gravel layers, although the base of the whole stratigraphic section has not been seen. The fossils include two large mammal skulls, four teeth, one piece of mandible with teeth and a large number of small joints, bony plates and bone fragments. The coarse bones were crushed, but several were well preserved, in which visible crystalline calcite in rod-shaped cavities could be observed; small joints are relatively well preserved, with joint structure clearly visible. The fossil collection was prepared and identified at the Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Science, Beijing. The skulls were well preserved, teeth preservation complete, with obvious glossy enamel crowns. The large mammal fossils were identified on their tooth features.

### Results

In this study, one large mammal fossil skull is identified as the rhinocerotid *Chilotherium* sp. (Fig. 1a). The three teeth are identified as the equid, *Hipparion dongxiangense* (Fig. 1b). The mandible crown with teeth is identified as the cervid *Stephanocemas* sp. (Fig. 1c). One canine tooth is identified as the suid *Kubanochoerus* sp. (Fig. 1d).

\* Corresponding author. E-mail: shaozhaogang@sina.com



Fig. 1. Late Miocene mammal fauna found in the Xining basin, northeastern Qinghai-Tibetan Plateau: a, *Chilotherium* sp.; b, *Hipparion dongxiangense*; c, *Stephanocemas* sp.; d, *Kubanochoerus* sp.

## Conclusion

For now, fossils of *Hipparion dongxiangense*, *Chilotherium* sp., *Parelasmotherium* sp., *Stephanocemas* sp. and *Kubanochoerus* sp. have been found in the Xining basin in Late Cenozoic lacustrine sedimentary strata. The characteristics of the fossil assemblages are similar to the Xingjiawan fauna from Yongdeng County, Lanzhou basin and the fauna from Hezheng County, Linxia basin. It supports dating to the Late Miocene era.

During recent geological history, rhinoceroses developed strong vitality. Previous studies suggest that in the Early Miocene, the *Teleoceras* class dominated within Rhinocerotidae, and these indicated a cold and humid climate. During the Middle Miocene, rhinocerotids flourish, adapted to strong radiation, reflecting the warm climate and environment at that time. Within the early Late Miocene, rhinoceroses developed extremely high-crowned teeth and huge size in order to adapt to the hard grass-dominated temperate savanna environment. By the early Late Miocene, species were adapted to the grassland environment; Then in the late Late Miocene, the rhinoceros *Chilotherium* and the nasal horn rhinoceros are dominant, belonging to the typical type of grassland life. The discovery of *Chilotherium* teeth provides an opportunity to study the evolution, ecology, and environment of rhinoceroses in the Miocene.

This study has further enriched the species diversity of the local mammal fauna in the Xining basin during the Late Miocene, and laid the foundation for the establishment of the Late Miocene fauna in the Xining basin. At the same time, the establishment of this fauna also provides an opportunity to compare with the Longzhong basin, Gansu, for Miocene climate, environment, mammalian evolutionary history and regional stratigraphic correlation, and to consider the influence of the uplift of the Qinghai-Tibetan Plateau.

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