

The sequence of Cenozoic rhinocerotid fossils from the Linxia Basin (Gansu, China)

TAO DENG

Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences,
P. O. Box 643, Beijing 100044, China
dengtao@ivpp.ac.cn

The Linxia Basin is situated in the south-eastern part of Gansu Province, China. In this basin, the Cenozoic strata are very thick and well exposed. These deposits contain abundant mammalian fossils, in particular rhinocerotids.

Late Oligocene

Four rhinocerotids have been discovered in the Late Oligocene sandstones, including *Allacerops* sp., *Dzungariotherium orgosense*, *Ronzotherium* sp. and *Aprotodon* sp. *Dzungariotherium orgosense* was first recorded from the Junggar Basin in Xinjiang. It is characterised by its large body size, rudimental lower incisors, well-developed antecrochets and wide foot bones. In Xinjiang, *D. orgosense* co-occurs with *Lophimeryx*. The last record of the latter is from the middle Late Stampian in Europe. *Allacerops* was a rhinocerotid form that lived during the Oligocene in Asia, which has also been found in the Lanzhou Basin, adjacent to the Linxia Basin. *Aprotodon* was previously known only from Pakistan, Kazakhstan and Lanzhou. It coexisted with the giant rhinoceroses in all three regions. Previously, *Ronzotherium* has only been found from the Oligocene of Eurasia.

Middle Miocene

Two rhinocerotids, namely *Alicornops* sp. and *Hispanotherium matritense*, have been discovered in Middle Miocene conglomerates and sandstones. In Europe, *Alicornops* first appeared during MN3 (Wintershof-West, Germany) and had a wide distribution in Europe during MN6. *Hispanotherium matritense* has been found in Europe (Spain, Portugal and France) and Asia (Turkey, Pakistan, Mongolia and China). In China, *H. matritense* occurs in the Middle Miocene Dingjiaergou, Lengshuigou and Erlanggang (Fangxian, Hubei) faunas. It is smaller than *H. tungurensis* from the Tunggur fauna.

Late Miocene

The rich rhinocerotid material from the Late Miocene red clay includes *Acerorhinus hezhengensis*, *Chilotherium* sp., *C. wimani*, *Parelasmotherium simplym*, *P. linxiaense*, *Ningxiatherium* sp., *Iranotherium morgani* and *Dicerorhinus ringstroemi*. *Parelasmotherium* is more primitive than *Sinotherium* (the characteristic taxon of the Baode Fauna) and is the earliest of the huge elasmotheres to develop towards hypsodont teeth. *Ningxiatherium* has been found at Ganhegou in Zhongning, Ningxia, but the exact age of this locality is not yet known. *Chilotherium* sp., from the lower part of the Late Miocene red clay, is the earliest and most primitive representative of this genus. A Late Miocene Asian radiation is suggested for *Chilotherium*, beginning with a first appearance event in the Linxia Basin. *Acerorhinus hezhengensis* has a very narrow mandibular symphysis and narrowly separated parietal crests that form a high sagittal crest. It is, therefore, close to *A. tsaidamensis* of the Qaidam Fauna but different from *A. palaeosinensis* of the Baode Fauna. The primitive characters of *Chilotherium wimani* include the low position of orbit, well-developed supraorbital tubercle, weak postorbital process, concave dorsal skull profile, narrowly separate parietal crests, narrow braincase and strong paracone rib on premolars. Previously, *Iranotherium morgani* has only been discovered at Maragha and Kerjavol in Iran, such that its new discovery in the Linxia Basin expands its geographical distribution. *Dicerorhinus ringstroemi* is one of the representative members of the Baode Fauna. It has also been recorded from the Duodaoshi Formation in Jingmen, Hubei, which is the same age as the Baode Fauna.

Early Pliocene

Only one rhinoceros species, *Shansirhinus*

ringstroemi, been discovered in the Early Pliocene red clay. *S. ringstroemi* has previously been collected at Huangshigou in the Nihe district of the Yushe Basin, where mammal fossils mainly originate from the Gaozhuang formation (= Early Pliocene). Consequently, the presence of *S. ringstroemi* should indicate an Early Pliocene age.

Late Pliocene

The earliest woolly rhino, *Coelodonta nihowanensis*, has been discovered in the Wucheng Loess of the Linxia Basin, the oldest loess in China. Its characteristic features are the presence of an ossified nasal septum, the loss of the incisors and the peculiar fold on the labial wall of the cheek teeth. It is also characterised by a dolichocephalic skull and a strong occipital elevation, similar to the features seen in some later Eurasian forms. This occurrence of *C. nihowanensis* in the Linxia Basin confirms

that the woolly rhino, which was widespread across northern Eurasia during the Middle and Late Pleistocene, originated in northern China at around 2.5 Ma B.P.

TEILHARD DE CHARDIN & PIVETEAU (1930) described a milk tooth row from Nihewan (Hebei, China) as *Coelodonta* cf. *antiquitatis*, which was clearly recognised as a primitive species of woolly rhino, and implied that the woolly rhino actually originated in Asia. A new species, *Coelodonta nihowanensis*, was later defined for the Chinese Late Pliocene *Coelodonta* specimens (KAHLKE 1965, 1969). BELJAEVA (1966) described a new species, *Coelodonta tologoijensis*, from Tologoi (Ulan-Ude, Transbaikalia), which was the same age as *C. nihowanensis* from China. The distal limb bones of *C. tologoijensis* exhibit primitive features different from *C. antiquitatis*. In contrast to *C. nihowanensis*, however, *C. tologoijensis* has very wide nasals that are bent significantly downward.

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