Small mammal fauna of Early Pleistocene age from the Xiaochangliang site in the Nihewan Basin, Hebei, northern China

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A large amount of sediments was taken from the horizon stratigraphically equivalent to the artifact layer in the Xiaochangliang site, an important archaeological site of Early Pleistocene age. The sediments were washed with fine-mesh screens to collect small mammal remains. The layer is dated as 1.36 Ma by paleomagnetic measurements. Small mammal remains are important for biostratigraphic and paleoenvironmental studies, but they have been hardly collected from the site before the present study. A large number of the remains collected by the screen-washing have revealed the characteristics of the small mammal fauna of the site. The fauna is compared with those of the four well-dated localities in the adjacent area. On the basis of the faunal characteristics and comparisons, we discuss the biostratigraphy and faunal turnover in the Late Pliocene and Pleistocene. Furthermore, we reconstruct the paleoenvironment around the site in the Early Pleistocene.

Keywords : small mammal fauna, biostratigraphy, Early Pleistocene, Xiaochangliang site, Nihewan Basin, China

I. Introduction

The Nihewan Basin situated about 150 km west-north-west of Beijing (Fig. 1) has been well known for geologists and paleontologists since the discovery of abundant mammalian remains of Early Pleistocene age in the later 1920's. The remains have occurred from fluvio-lacustrine sediments called the Nihewan Formation. In spite of a piece of information on the occurrence of a "stone artifact" from the basin (Breuil, 1935), archaeologists had paid little attention to the sediments of the basin, until paleolithic artifacts were discovered at the Xiaochangliang site in 1978 (You *et al.*, 1980).

Since then, thousands of artifacts and more than 10 forms of mammals have been excavated from the site (Tang *et al.*, 1995 ; Chen *et al.*, 1999), but the knowledge on small mammals has been quite limited in previous works.

Because the site is important for considering human immigration into East Asia during the Early Pleistocene, Zhu *et al.* (2001) tried to determine the detailed numerical age of the artifact layer of the site by paleomagnetic measurements. They concluded that the layer was dated as 1.36 Ma. Their conclusion is more detailed and more reliable than the results of faunal dating by previous authors.

In order to obtain sufficient knowledge on

Received July 12, 2007. Accepted November 17, 2007.

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Fig. 1 Map showing the topography near the east-north-eastern end of the Nihewan Basin, where the Xiaochangliang site (X) is situated

AP : alluvial plain of the Sangganhe River, PS : plateau surface, M : another archaeological site at Majuangou ("new cultural layer" of Cai and Li, 2003).

small mammals of the paleomagnetically well-dated layer, a large amount of sediments was sampled from the layer, and was washed with fine-mesh screens. The screen-washing resulted in obtaining more than 200 remains of small mammals assignable to 10 forms, most of which were new to the mammalian fauna of this site. Small mammals are generally more important for biostratigraphy and paleoenvironmental reconstruction than large mammals. Thus in this paper, we describe the small mammal fauna of the site, compare it with other faunas, and discuss small mammal biostratigraphy, faunal turnover and paleoenvironment. The systematic descriptions for each form of small mammals will be given in subsequent papers.

II. Geological setting

The Xiaochangliang site is situated near the east-north-eastern end of the Nihewan Basin which shows a slender shape extending from this end toward west-south-west along the Sangganhe River into Shanxi Province. Around the site, Pliocene and Pleistocene sediments are well exposed in a hilly area between the alluvial plain of the Sangganhe River and a flat

plateau surface about 150 m higher than the plain (Fig. 1). Several paleolithic archaeological sites found after the Xiaochangliang site are also distributed in the hilly area (for example, the Donggutuo and Majuangou sites). Cai *et al.* (2004) divided the sediments in the area and in the neighbourhood with the same topography into such four units as 1) "*Hipparion* red clay" of early Pliocene age, 2) red, gray and grayish black fluvio-lacustrine silty clay of late Pliocene age, 3) brownish yellow to grayish yellow fluvio-lacustrine clay and gravel of Pleistocene age, and 4) overlying loess forming the plateau surface, in ascending order. The unit 3 is sometimes subdivided into the Nihewan Formation of Early Pleistocene age and the Xiaodukou Formation of Middle Pleistocene age (Yang *et al.*, 1996 ; Wei, 1997, etc.).

The Xiaochangliang site was found on a small ridge called Xiaochangliang which means a small but long hill ridge in Chinese (Fig. 2-A). The ridge extends north-westward from the plateau edge near Guanting (Fig. 1). The section of the sediments are observable along the ridge. In the section, the units 1 and 2 of Cai *et al.* (2004) are lacking, while the units 3 and 4 are

Fig. 2 Sampling site in "Location A" of the Xiaochangliang site

A : overall view from "Location B" showing the sampling site (arrow) on the western slope of the ridge extending from the plateau surface (PS), B : close-up photo of the sampling site showing the sampling horizon (SH).

present. The unit 3 overlies directly the Jurassic basement rocks with an unconformity and is covered by the unit 4. Zhu *et al.* (2001) showed a detailed stratigraphic sequence of the section with a thickness of 73 m, which was composed mainly of silt and/or clay (Fig. 3). They also described a thicker sequence of the "Donggou" section 1 km west-south-west of the Xiaochangliang site (outside the map of Fig. 1). Unfortunately, they did not show the exact position of this section, and "Donggou" by them is different in position from the same place-name used by other authors, as discussed in the subsequent chapter. The "Donggou" section is correlative with the Xiaochangliang section, because the sequences of the two sections are almost identical, and contain sedimentological marker layers. Zhu *et al.* (2001) carried out detailed paleomagnetic measurements, and determined two normal and two reversed magnetozones in the Xiaochangliang section (N1, N2 and R1, R2), and three normal and two reversed magnetozones in the "Donggou" section (N1, N2, N3 and R1, R2). They correlated the magnetozones with the standard geomagnetic time-scale, as shown in Figure 3. N3 correlative with the Olduvai Subchron is recognized only in the "Donggou" section, while N2 correlative with the Jaramillo Subchron is found in both of the sections. The sampling horizon of the present study (SH in Fig. 3) is identical with the artifact layer of the site as stated in the next

chapter. Zhu *et al.* (2001) estimated the age of the layer to be 1.36 Ma, because the average accumulation rate between the Jaramillo and Olduvai Subchrons was calculated at about 4.6 cm/ka in the "Donggou" section which intercalated a thin marker layer of black silty clay 13.4 m below the Jaramillo onset (1.07 Ma), and because the same layer was also found at the top of the artifact layer of the Xiaochangliang site.

In the present paper, we adopt 2.6 Ma as the boundary age of the Pliocene and Pleistocene instead of *ca.* 1.8 Ma, the end of the Olduvai Subchron, as generally done among Chinese scientists.

III. Sampling site and horizon

Since the first excavation, the Xiaochangliang site has been divided into Locations A and B (Fig. 4). The geographic coordinates are $114^{\circ}39.752'E$ and $40^{\circ}13.181'N$ for A, and $114^{\circ}39.692'E$ and $40^{\circ}13.188'N$ for B (Chen *et al.*, 1999). The excavations of the site have been conducted in many grids as shown in Figure 4. We decided the sampling site on the western slope near the most south-western grid of Location A (Figs. 2-A and 4), because each layer of the sediments are horizontal and the artifact layer is expected to expose in the sampling site. As a result of our excavation, the marker layer of black silty clay with a thickness of 2 cm was found in the lower part of the section of the sampling site.

Zhu *et al.* (2001) already described the marker layer lying just above the artifact layer of the Xiaochangliang site. Thus the sediments just below the marker layer in our section is stratigraphically equivalent to those of the artifact layer (SH in Fig. 2-B). They were sampled for

screen-washing.

IV. Screen-washing

The excavation, sampling and screen-washing were conducted by one of us (Zhang, Y.Q.) with assistance of two employed villagers in the summer of 2005. More than 1.6 tons of raw sediments taken from the sampling horizon were transported to the riverbed of the Sangganhe River near Xiaodukou (Fig. 1). A double-layered screen box was used for washing the sediments. The box comprises the upper part with 2.0 mm mesh screen and the lower part with 0.5 mm mesh screen. The upper part is removable, but nested into the lower part to prevent sample leakage. Before the screen-washing, the raw sediments were soaked in water to facilitate the following washing procedure. If necessary, large clods of the sediments were crumbled. Then the sediments were stirred in water, until they dissolved completely. The dissolved sediments were poured into the screen box, and then flushed with the box being swayed. After finer grains were completely washed away from the sediments, coarser grains as well as bones and teeth of small vertebrates remained on the screens. They were taken out from the screen box, and dried naturally. Then the bones and teeth were sorted by naked eyes from grains on the 2.0 mm mesh screen and by using a dissecting microscope from those on the 0.5 mm mesh screen.

V. Small mammal fauna

The previous papers on the Xiaochangliang site (You *et al.*, 1980 ; Tang *et al.*, 1995 ; Chen *et al.*, 1999) reported the occurrence of mammal remains, but most of them were large mammals (Table 1). Among the papers, Tang *et al.* (1995) is the only paper which describes small mammals, but the specimens described is only two, each of which is assigned to a different form of arvicolid rodents.

The screen-washing procedure mentioned in the preceding chapter has succeeded in collecting 233 specimens of small mammals identifiable at the generic or specific level with confidence. Almost all of the specimens are isolated teeth (Table 2). The specimens are allocated to 10 forms listed in Tables 1 and 2.

Fig. 3 Columnar section and paleomagnetic data of the Xiaochangliang site modified from Zhu *et al.* (2001)

The section shows the lithofacies of the sediments from the plateau surface (PS) to the sampling horizon (SH) which is equivalent to the artifact layer of the site. Zhu *et al.* (2001) dated the artifact layer as 1.36 Ma on the basis of the paleomagnetic data (VGP: vertical geomagnetic pole) from this section as well as the nearby "Donggou" section. Note that the age of the layer was determined by the average accumulation rate between the Jaramillo and Olduvai Subchrons in the "Donggou" section which intercalated the marker layer equivalent to that of the Xiaochangliang site (see text).

Among the forms, six are classified at the specific level, and comprise five extinct species (*Ochotona youngi*, *Yangia* cf. *tingi*, *Borsodia chinensis*, *Allophaiomys deucalion* and *Chardinomys*

nihowanicus) and one extant species (*Micromys minutus*). Thus in species number, the extinct species are considerably dominant in the small mammal fauna (more than 80%).

Fig. 4 Detailed plan of the Xiaochangliang site showing the position of the sampling site
The plan is cited from Chen *et al.* (1999) with slight modification.

Table 1 Mammals from the Xiaochangliang site recorded by the previous authors comparing with those by this study

	You <i>et al.</i> (1980)	Tang <i>et al.</i> (1995)	Chen <i>et al.</i> (1999)	This study
Small mammals	None	RODENTIA <i>Mimomys chinensis</i> * <i>Allophaiomys</i> cf. <i>pliocenicus</i> **	None	SORICOMORPHA <i>Sorex</i> sp.
				LAGOMORPHA <i>Ochotona youngi</i> <i>Ochotona</i> or <i>Ochotonoides</i> sp.
Large mammals	CARNIVORA <i>Hyaena</i> sp. PROBOSCIDEA <i>Palaeoloxodon</i> sp. *** PERISSODACTYLA <i>Hipparion</i> sp. <i>Equus sanmeniensis</i> <i>Coelodonta</i> sp. ARTIODACTYLA <i>Cervus</i> spp. <i>Gazella</i> sp.	CARNIVORA <i>Martes</i> sp. <i>Hyaena licenti</i> PROBOSCIDEA <i>Palaeoloxodon</i> sp. *** PERISSODACTYLA <i>Proboscideipparion sinense</i> <i>Hipparion</i> sp. <i>Equus sanmeniensis</i> <i>Coelodonta antiquitatis</i> ARTIODACTYLA <i>Cervus</i> sp. <i>Gazella</i> sp. Bovinae, gen. et sp. indet.	CARNIVORA <i>Viverra</i> sp. Felidae, gen. et sp. indet. PROBOSCIDEA <i>Palaeoloxodon</i> sp. *** PERISSODACTYLA <i>Hipparion</i> sp. <i>Coelodonta antiquitatis</i> ARTIODACTYLA <i>Bison</i> sp.	<i>Cricetulus</i> or <i>Phodopus</i> sp. <i>Yangia</i> cf. <i>tingi</i> <i>Borsodia chinensis</i> <i>Mimomys</i> sp. <i>Allophaiomys deucalion</i> <i>Micromys minutus</i> <i>Chardinomys nihowanicus</i>
				None

* probably the same as *Borsodia chinensis* in this study.
** probably the same as *Allophaiomys deucalion* in this study.
*** Wei *et al.* (2006) referred *Palaeoloxodon* sp. by Tang *et al.* (1995) to *Mammuthus trogontheii*. Moreover, *Palaeoloxodon* sp. by You *et al.* (1980) and Chen *et al.* (1999) are possibly referable to *Mammuthus*.

Table 2 Number of the identifiable specimens collected by this study

Small mammal form	Element	
	Mandible	Isolated teeth
SORICOMORPHA		
Soricidae		
<i>Sorex</i> sp.	—	8
LAGOMORPHA		
Ochotonidae		
<i>Ochotona youngi</i>	1	35 (+15)
<i>Ochotona</i> or <i>Ochotonoides</i> sp.	—	2
RODENTIA		
Cricetidae		
<i>Cricetulus</i> or <i>Phodopus</i> sp.	—	13
Siphneidae		
<i>Yangia</i> cf. <i>tingi</i>	—	1
Arvicolidae		
<i>Borsodia chinensis</i>	—	73
<i>Mimomys</i> sp.	—	2
<i>Allophaiomys deucalion</i>		61
Muridae		
* <i>Micromys minutus</i>	—	12
<i>Chardinomys nihowanicus</i>	—	25

The number in parenthesis indicates the number of tooth fragments possibly assigned to *Ochotona youngi*. Most of them are fragments of lower cheek teeth which are easy to break.

* extant species

In specimen number, rodents show a high percentage (80.3%) in the fauna, while lagomorphs are subordinate (16.3%), and soricomorphs are much fewer than them (3.4%). The rodents are composed of such four families as Cricetidae, Siphneidae, Arvicolidae and Muridae, but lack Sciuridae, Castoridae, Rhizomyidae, Dipodidae and Hystricidae which are sometimes found in the Pliocene and Pleistocene of China. Among the four families, Arvicolidae is very abundant, and attains to 72.7% of all the rodent specimens (58.4% of all the small mammal specimens). Almost all the arvicolid specimens are allocated to the extinct vole with rooted molars, *Borsodia chinensis*, and to the other extinct vole with rootless molars, *Allophaiomys deucalion*. The remainders are only two specimens, which are assigned to the extinct vole genus *Mimomys*. Arvicolidae is followed by Muridae in specimen number, which occupies 19.8% of the rodent specimens (15.9% of the total). About two thirds of the murid specimens are allocated to the extinct mouse with characteristic molars, *Chardinomys niho-*

wanicus, while the remainders are referred to the extant harvest mouse, *Micromys minutus*. The specimens of Cricetidae are much fewer (7.0% of the rodent specimens), and belong to the extant hamster genus *Cricetulus* or *Phodopus*. Only one specimen of Siphneidae is recognized in the rodent specimens, and is referred to the extinct mole-rat, *Yangia* cf. *tingi*.

All the lagomorph specimens are assigned to Ochotonidae, while Leporidae is absent in the specimens. They are classified into a smaller form referable to the extinct pika, *Ochotona youngi*, and a larger form, *Ochotona* or *Ochotonoides* sp. The former is a relatively abundant element in the small mammal fauna, and occupies 15.5% of all the small mammal specimens. If the fragments possibly assigned to *O. youngi* are added, its percentage becomes higher (see Table 2).

All the soricomorph specimens are referred to the extant shrew genus *Sorex*.

VI. Comparison with other faunas

The small mammal fauna of the Xiaochangliang site is compared with those of paleomagnetically and/or radiometrically dated sediments in the Nihewan Basin and its adjacent area, which are the faunas of the three layers of Qianjiashawa–Donggou, the new cultural layer of Majuangou, Layers 4 to 11 of Locality 1 of the Zhoukoudian site in Beijing, and Upper Cave of the same site (Fig. 5).

The small mammal faunas of Qianjiashawa–Donggou were reported by Zheng *et al.* (2006). They referred to the locality situated 500 m northeast of the village of Qianjiashawa as Donggou, although Zhu *et al.* (2001) already used the same place-name “Donggou” as mentioned in the previous chapter. Donggou by the former authors is obviously different from “Donggou” by the latter authors in geographic position, and both of them are probably 1.5 km apart from each other. Furthermore, they are also different in elevation. The section shown in Zheng *et al.* (2006) is considered to be placed lower than the “Donggou” section of Zhu *et al.* (2001). To avoid confusion, we here use Qianjiashawa–Donggou for Donggou of Zheng *et al.* (2006) which means Donggou near Qianjiashawa, and “Donggou” for the same place-name by Zhu *et al.* (2001).

Fig. 5 Chrono-stratigraphic positions of the small mammals from the Xiaochangliang site, and related forms from Qianjiaashawa-Donggou, the new cultural layer (NCL) of Majuangou, and Locality 1 and Upper Cave of Zhoukoudian

cf.: confer determination, J: Jaramillo, O: Olduvai. * extant species.

In the Qianjiashawa–Donggou section, seven layers yield small mammal remains. The faunas of the upper three (Layers 11, 16 and 19) of the seven are compared with the fauna of the Xiaochangliang site. These layers were dated from the late Gauss Chron to early Matuyama Chron by paleomagnetic measurements (Yang *et al.*, 1996, Fig. 5), although Zheng *et al.* (2006) considered the Gauss/Matuyama boundary placed at Layer 11 on the basis of small mammal faunas. The faunas of these layers comprise only extinct species, when small mammal forms classified at the specific level are concerned. Among the extinct species, *Ochotona youngi*, *Yangia tingi*, *Borsodia chinensis* and *Allophaiomys deucalion* are common to the fauna of the Xiaochangliang site. These species occur from two layers or more in Qianjiashawa–Donggou, and are possibly major elements. Furthermore, they are dominant and/or characteristic elements in the fauna of the Xiaochangliang site. Thus the overall characters of both the faunas are similar to each other. But a few minor differences are also observed between them. The faunas of Qianjiashawa–Donggou contain such extinct species as *Ochotona magna*, *O. aff. intermedia*, *Ochotonoides complicidens*, *Sericolagus cf. brachypus*, *Yangia trassaerti*, *Cromeromys gansunicus* and *Allophaiomys pliocaenicus*, which are absent from the fauna of the Xiaochangliang site. Most of them occur from only one layer in Qianjiashawa–Donggou, and are possibly minor elements. Additionally, the fauna of the Xiaochangliang site contains one extant species.

The small mammal fauna of the new cultural layer of Majuangou was described by Cai and Li (2003). This layer is equivalent to MJG–III of Zhu *et al.* (2004) and the artifact horizon of the Goudi site by Gao *et al.* (2005). Zhu *et al.* (2004) determined the age of the layer as 1.66 Ma by paleomagnetic measurements. Cai and Li (2003) also reported the specimen numbers of the mammal remains obtained, and thus it is possible to compare the abundance of each small mammal form between the new cultural layer and the Xiaochangliang site.

All the small mammal forms classified at the specific level are extinct in the new cultural layer, while the small mammals of the Xiao-

changliang site contain extant species in a low percentage (less than 20%), as mentioned before.

In the new cultural layer, arvicolid rodents are highly predominant as in the Xiaochangliang site. They comprise four forms, among which two are common to the fauna of the Xiaochangliang site (*B. chinensis* and *A. deucalion*). One of the remaining two, *Prolagurus praepannonicus* is an extinct vole with rootless molars, and is abundant in the fauna of the new cultural layer. The identification with this species is problematic, because it does not occur from all the other faunas compared (Fig. 5). Murid rodents are abundant in the fauna of the new cultural layer as in that of the Xiaochangliang site. Moreover the components of the murids (*Micromys* sp. and *Chardinomys nihowanicus*) and their relative abundance are similar to those in the Xiaochangliang site. In siphneid rodents, *Y. tingi* is common to both of the faunas, and is rare in both of them. Ochotonid lagomorphs are also composed of a smaller and larger forms, as in the fauna of the Xiaochangliang site. The smaller form is allocated to *O. minor* by Cai and Li (2003), but is probably identical with *O. youngi*, judging from the description of Erbajeva and Zheng (2005). Leporid lagomorphs are absent, as in the fauna of the Xiaochangliang site. It can be concluded that the fauna of the new cultural layer generally resembles that of the Xiaochangliang site.

The small mammal remains from Locality 1 and Upper Cave of the Zhoukoudian (Choukoutien) site were described in the monographs of Young (1934) and Pei (1940). The classification of some small mammal forms was later emended by Zheng (1984, 1991) and Zhang *et al.* (1993). Kahlke and Chow (1961) showed the stratigraphic distributions of mammals in the thick sediments of Locality 1, which are shown in Figure 5 with the later emendation. On the other hand, the sediments of the two localities were dated by paleomagnetic, radiometric and other non-faunal methods, and the results were summarily given in Li *et al.* (1985) and Zhao *et al.* (1985). On the basis of them, the chronological positions of the two localities are shown in Figure 5.

The small mammal faunas of Locality 1 and

Upper Cave are considerably different from that of the Xiaochangliang site. All the extinct species occurred from the site are absent in the faunas of Locality 1 and Upper Cave, which are dominated by extant species (Fig. 5). They also differ in having more diversified faunas, which include sciurid, castorid, rhizomyid and hystricid rodents as well as leporid lagomorphs, although the difference in diversity partly depends on that in their sedimentary conditions (cave versus fluvio-lacustrine, as shown in Fig. 5).

VII. Biostratigraphy

On the basis of the data given in Figure 5, we discuss the biostratigraphy of small mammals herein. The faunas of Qianjiashawa-Donggou (Layers 11, 16 and 19) are similar to that of the new cultural layer of Majuangou (NCL in Fig. 5). Both of them include no extant species, and are characterized by the occurrences of such extinct species as *Ochotona youngi*, *Ochotonoides complicidens*, *Yangia tingi*, *Borsodia chinensis*, *Cromeromys gansunicus* and *Allophaiomys deucalion*. Thus they constitute a single zone (biozone 1 in Fig. 5). The fauna of the Xiaochangliang site (SH in Fig. 5) is generally similar to those of the underlying sediments (Layers 11, 16 and 19, and NCL), and differs only in having the extant species, *Micromys minutus*. On the basis of the overall similarity, it can be regarded that the biozone 1 includes the fauna of the Xiaochangliang site which represents its uppermost stage (Fig. 5). The fauna of Locality 1 is considerably different from that of the Xiaochangliang site in much higher percentage of extant species and higher diversity of small mammals. The clear difference leads to recognize a different zone (biozone 2 in Fig. 5). The boundary between the biozones 1 and 2 is obscure, because well-dated information on small mammals is lacking in the time interval between the age of the Xiaochangliang site and Locality 1. The biozone 3 represented by the fauna of Upper Cave is distinguished from the biozone 2 by its more modernized nature of the fauna (for example, very low percentage of extinct species).

VIII. Faunal turnover

The fauna of the biozone 1 is composed mostly

of the extinct species characterizing the Late Pliocene and Early Pleistocene of northern China (for example, *Ochotona youngi*, *Borsodia chinensis*, *Allophaiomys deucalion* and *Chardonomys nihowanicus*). This fauna was somewhat changed between 1.66 Ma and 1.36 Ma by the appearance of the extant species, *Micromys minutus*, in the uppermost stage of the biozone 1. Much greater change occurred between 1.36 Ma and 0.6 Ma, namely between the biozones 1 and 2. The extinct species disappeared completely, and were replaced by many extant species characteristic to the fauna of the biozone 2 (for example, extant species of *Ochotona*, *Microtus*, *Apodemus*, *Niviventer* and *Mus*). This change is important for considering the origin of the present-day fauna of northern China. The timing, process and environmental backgrounds of the change are expected to be clarified by future studies on small mammal faunas dated between 1.36 and 0.6 Ma.

IX. Paleoenvironment

The small mammal specimens obtained by the present study are relatively well-preserved, and show no trace of water abrasion by transportation. Thus it is inferred that carcasses of small mammals inhabiting near an ancient lake were transported for short distance into the lake or an flood plain along it by running water, and their bones and teeth were buried by rapid sedimentation. This inference is roughly consistent with the taphonomic process of artifacts and larger mammal remains from the Xiaochangliang site stated by Chen *et al.* (1999).

The small mammal fauna of the site consists mainly of temperate grassland elements. Extant species of *Ochotona* live mostly in open plains and steppes, often associated with rocky outcrops. The abundant occurrence of *Ochotona* in the fauna suggests a similar vegetation. Extant species of *Cricetulus* and *Phodopus* prefer arid areas (steppe to semi-desert), and thus the occurrence of *Cricetulus* or *Phodopus* sp. in the fauna also indicates arid environment. The arvicolid species highly predominant in the fauna (*Borsodia chinensis* and *Allophaiomys deucalion*) have high-crowned prismatic molars adaptive to grass-eating. This suggests that they are grassland dwellers. The extant species,

Micromys minutus, mainly inhabits areas with tall grasses and bushes along rivers, ponds and lakes. This also suggests grasslands with shrubs near a lake.

Apart from the small mammals, grassland vegetation is also suggested by such larger mammals as horses (*Proboscideipparion sinense*, *Hipparion* sp. and *Equus sanmeniensis*) reported from the site by the previous authors (Table 1). *Palaeoloxodon* sp. also reported by them were recently emended as the steppe mammoth, *Mammuthus trogontherii*, by Wei *et al.* (2006), which is considered to have lived mainly in grasslands.

The paleoenvironment around the site is inferred to have been grasslands with sparse shrubs near a lake under temperate climate. It is almost identical with the paleoenvironment reconstructed for the new cultural layer of Majuangou by Cai and Li (2003). Thus the environment had not changed from 1.66 Ma to 1.36 Ma.

X. Conclusion

The knowledge on the small mammal fauna of the Xiaochangliang site with the age of 1.36 Ma has greatly expanded by the present study. The fauna comprises 10 forms identifiable at the generic or specific level, among which five are extinct species, and one is extant species (Tables 1 and 2). In species number, therefore, more than 80% are extinct. In specimen number, 80.3% of the identifiable specimens are rodents. Among the rodents, the arvicolids are highly predominant (72.7% of the rodent specimens), the murids are subordinate (19.8%), the cricetids are much fewer (7.0%), and the siphneids are rare (0.4%). Almost all the arvicolid specimens are allocated to such extinct species as *Borsodia chinensis* and *Allophaiomys deucalion*. The lagomorphs are much fewer than the rodents (16.3% of the identifiable specimens). Most of the lagomorphs are assigned to the extinct species, *Ochotona youngi*.

The small mammal fauna of the Xiaochangliang site is compared with the four faunas from the well-dated sediments in the Nihewan Basin and the adjacent area (Qianjiashawadonggou, the new cultural layer of Majuangou, and Locality 1 and Upper Cave of the Zhou-

koudian site, Fig. 5). The faunal comparison results in recognizing the three small mammal biozones, among which the uppermost stage of the lowest biozone is represented by the fauna of the Xiaochangliang site. The faunal turnover is also considered. The fauna dominated by the extinct species characterizing the Late Pliocene and Early Pleistocene of northern China was somewhat changed between 1.66 Ma and 1.36 Ma by the appearance of the extant species (*Micromys minutus*). Much greater change occurred between 1.36 Ma and 0.6 Ma. During this period, the above-mentioned extinct species disappeared, while many extant species newly appeared. This change resulted in the modernization of the fauna. As regards the paleoenvironment, the fauna of the Xiaochangliang site indicates grasslands with sparse shrubs near a lake under temperate climate.

Acknowledgments

We are grateful for the helpful discussion with Professor Shaohua Zheng from Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences. We also acknowledge the great convenience provided for the present study by Professor Shusaku Yoshikawa and the graduate students of Natural History of Anthropogene Laboratory, Graduate School of Science, Osaka City University. The present study was supported by the National Science Foundation of China (Grant No. 40472012).

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(C) in Chinese, (C+E) in Chinese with English abstract or summary.

中国河北省泥河湾盆地小長梁遺跡の前期更新世 小型哺乳動物群

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〔要 旨〕

小長梁遺跡は前期更新世の人工遺物を出土する遺跡として重要であるが、その遺物包含層と同一層準から採取した大量の堆積物を細かい目の篩で水洗して、多くの小型哺乳類化石を得た。遺物包含層の年代は古地磁気測定により 1.36 Ma とされている。小型哺乳類は生層序の研究や古環境復元に重要であるが、この遺跡ではこれまで小型哺乳類化石はほとんど採集されてこなかった。今回は得られた化石をもとに、この遺跡の小型哺乳類の動物群の特徴を明らかにし、それを近隣の地域にあって古地磁気層序や放射年代が明確な 4 つの化石産地の動物群と比較した。それらにもとづいて、後期鮮新世とそれ以降

の時期の地層における小型哺乳類の生層序と、それらの時期の小型哺乳類の動物相の変遷について論議した。変遷については、絶滅種が卓越する後期鮮新世から前期更新世にかけての中国北部の動物相が 1.66 Ma と 1.36 Ma の間に現生種（カヤネズミ）の出現により若干変化したあと、1.36 Ma と 0.6 Ma の間には多くの絶滅種が見られなくなる一方で、現生種が数多く出現するという大きな変化があったと考えられる。さらに、この遺跡周辺の前期更新世の古環境については、温帯の気候で、湖の近くにまばらに灌木の生えた草原という環境が推定された。

キーワード：小型哺乳動物群，生層序，前期更新世，小長梁遺跡，泥河湾盆地，中国

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