

# A preliminary report on the newly found Tianyuan Cave, a Late Pleistocene human fossil site near Zhoukoudian

TONG Haowen, SHANG Hong, ZHANG Shuangquan & CHEN Fuyou

Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing 100044, China

Correspondence should be addressed to Tong Haowen (e-mail: tonghw@mx.cei.gov.cn)

**Abstract** The Tianyuan Cave is the only human fossil-bearing site containing rich mammalian fossils found in the last decades near Zhoukoudian. Up to now more than 34 specimens of the human body have been recovered, and the mammalian fossils can be put into 29 species. Cervids dominate the fauna, and carnivores are very rare. Based on the primary examination, the human fossils can be attributed to the species *Homo sapiens*. All the mammalian fossils, except one between tooth of *Crocota* belong to the species that still exist today. But some of them are the first records in fossil form north of the Yellow River, such as *Arctonyx* and *Capri-cornis*. Based on the mammalian fauna study, it seems that the Tianyuan Cave can be correlated with the Upper Cave. Sixty-three percent of the species of the mammalian fauna from the Tianyuan Cave are also present in the Upper Cave. The characters of the deposits also share some similarities between the Tianyuan Cave and the Upper Cave; both of them are mainly composed of breccia without cement. The dating using the U-series method on deer tooth samples indicates that the geological age of the new site is around 25 thousand years B.P. This is the first discovery of human sites outside the core area of the Peking Man Site at Zhoukoudian, which throws new light onto this world famous site complex.

**Keywords:** human fossil, mammalian fauna, late Late Pleistocene, Tianyuan Cave, Zhoukoudian.

DOI: 10.1360/03wd0561

In June 2001, some workers of the Tianyuan Tree Farm found a cave while searching for water on their farm. The cave contains Quaternary deposits with very well preserved mammalian fossils. The newly found site is 6 kilometers southwest of the Peking Man Site at Zhoukoudian. The results of the excavation of 2003 tell us that the Tianyuan Cave should be among the most important late Late Pleistocene caves in the Zhoukoudian area and even in north China. The new cave not only contains a fairly well preserved profile of deposits, but also bears human fossils and rich mammalian fossils, most of which are very important in the study of faunal turnover and paleoenvironments. In the following context, a brief introduction to the site and the excavation work of 2003 will be

given.

## 1 Geographic position and geology

The Tianyuan Cave is located at the Tianyuan Tree Farm, Zhoukoudian Town, Fangshan County. The geographical coordinates are 39° 39'28" north latitude and 115° 52'17" east longitude (Fig. 1). It is 174.5 m a.s.l. The entrance of the cave looks to the northwest.

The Tianyuan Cave developed in the Precambrian limestone. Stalactites and stalagmites inside the cave are still growing in the rainy season. The deposits consist of four layers recognized as, from top to bottom, the interbeds of soil with cemented breccia, the layer of fragmental deposits without selection, the layer of breccia without cement and the basal gravel bed. The general appearance of the deposits is as follows: poorly sorted and less rounded (except the basal gravel). Most of the fossils are from the interbeds of soil and cemented breccia as well as the breccia, but few fossils were found within the other two layers.

## 2 The 2003 excavation

The excavation lasted two months (from 16 June to 17 August, 2003). At the end of the field season, 23 units were exposed and the bottom was reached. The units are numbered as follows: G8, H8, F9, G9, E10, F10, G10, I10, J10, E11, F11, G11, H11, I11, J11, E12, F12, G12, H12, E13, F13 and G13 (Fig. 2). The digging area is divided into a square grid system and each unit is one square meter. The north-south side of the squares is numbered with Arabian numbers, and the east-west side is marked with English letters. Each unit is represented by a combination of a letter and a number. For each unit, the north-south side is designated as the *Y* axis, and the east-west side is designated as the *X* axis.

The units are dug in arbitrary levels. At the beginning, the profile was divided into arbitrary levels of 20 cm, but in the digging, they were subdivided into sub-levels of 5 cm in thickness. Just because the upper parts had been removed during the search for water source, the digging of the 2003 field season began from the 10th arbitrary level downward.

The units went down to different depths. In unit I10, the floor had been exposed very quickly after the removal of the first arbitrary level. No more than 2 arbitrary levels existed before meeting the floor in units J10 and J11. The level of the floor is not uniform, which becomes lower from the inside to the entrance. In unit G8, which is closer to the entrance, the floor had been reached after the removal of 5 arbitrary levels.

Human fossils were found in the following units: H11, I10, I11, J10 and J11. The units with abundant animal fossils are G10, H11, G12 and H12.

In stratigraphy, the parts dug in the 2003 field season correspond to the breccia layer and the basal gravel.

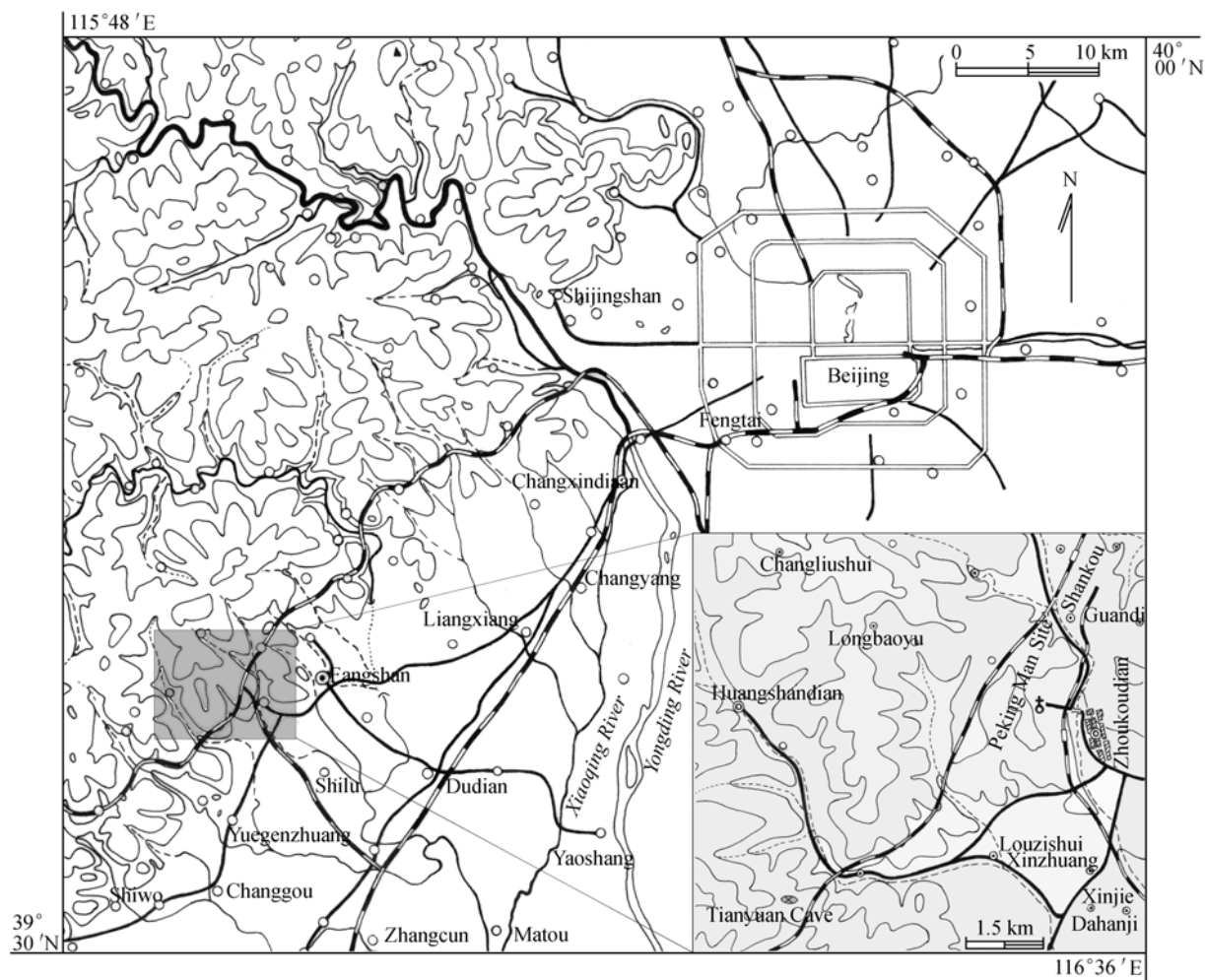


Fig. 1. Sketch map showing the location of the new site.

### 3 Introduction to the important finds

The materials obtained include: (1) those encountered by the local people during the search for water source; (2) those found in the sieving of the dirt dug up previously by the local people; (3) those encountered in the stratigraphical work; and (4) those found from the systematic excavation in 2003. Most of the finds are originated from the excavation.

The finds during the 2003 field season are mainly bone flakes and teeth, totally 628 pieces of bone flakes (all are larger than 2 cm), 326 pieces of tooth and tooth bones and 360 pieces of determinable elements. Among the determinable mammalian fossils, the phalanges of cervids are in the majority.

The fossils encountered previously by the farmers are mainly large mammals except *Hystrix*, which included most of the elements of the Tianyuan Cave fauna.

Up to now there are no stone artifacts and other cultural remains among the finds. Below is a list of the important finds.

(i) Human fossils. The human fossils include the following elements: a major part of a mandible with right  $I_2$ ,  $I/C$ ,  $P_3$ - $M_2$  (PA1281); right upper molar (PA1282); left lower molar (PA1283); axis (PA1284); lower part of sternum (PA1285); manubrium (PA1286); upper part of left scapula (PA1287); upper part of right scapula (PA1288); left humerus (PA1289); proximal part of right humerus (PA1290); right ulna without ends preserved (PA1291); almost complete left radius (PA1292); left hamate bone (PA1293); right lunate (PA1294); right magnum (PA1295); left proximal phalange of 5th digit (PA1296); right middle phalange of 4th digit (PA1297); proximal phalange (PA1298); proximal phalange (PA1299); distal phalange (PA1300); shaft of left femur (PA1301); right femur (PA1302); left tibia (PA1303); left tibia (PA1304); right tibia (PA1305); distal part of right fibula (PA1306); right calcaneum (PA1307); left astragalus (PA1308); left Mt I (PA1309); left Mt V (PA1310); right Mt II (PA1311); right Mt IV (PA1312); right 1st phalange (PA1313); right 1st phalange (PA1314).



Fig. 2. Plan of the Tianyuan Cave. The squares represent the parts excavated in the 2003 field season, all the bones larger than 2 cm are plotted. The vertical depth dug down is between 40 (at squares J10 and J11) and 100 cm (at square G8).

In geological age, the human fossils from the Tianyuan Cave can be correlated with the Upper Cave Man<sup>[1]</sup>; their anatomical and evolutionary significances are still under study.

(ii) Mammalian fossils. The mammalian fossils found up to now can be categorized as 7 orders, 18 families, 27 genera and 29 species as follows:

*Macaca* sp.

*Scaptochirus* sp.

*Erinaceus europaeus* Linnaeus, 1758

*Rhinolophus ferrumequinum* Schreber, 1774

*Eptesicus serotinus* Schreber, 1774

*Lepus europaeus* Pallas, 1778

*Petaurista sulcatus* Howell, 1927

*Cricetulus triton* De Winton, 1899

*Cricetulus barabensis* Pallas, 1773

*Myospalax* sp.

*Microtus* sp.

*Hystrix* sp.

*Canis lupus* Linnaeus, 1758

*Vulpes vulpes* Linnaeus, 1758

*Nyctereutes procyonoides* (Gray, 1834)

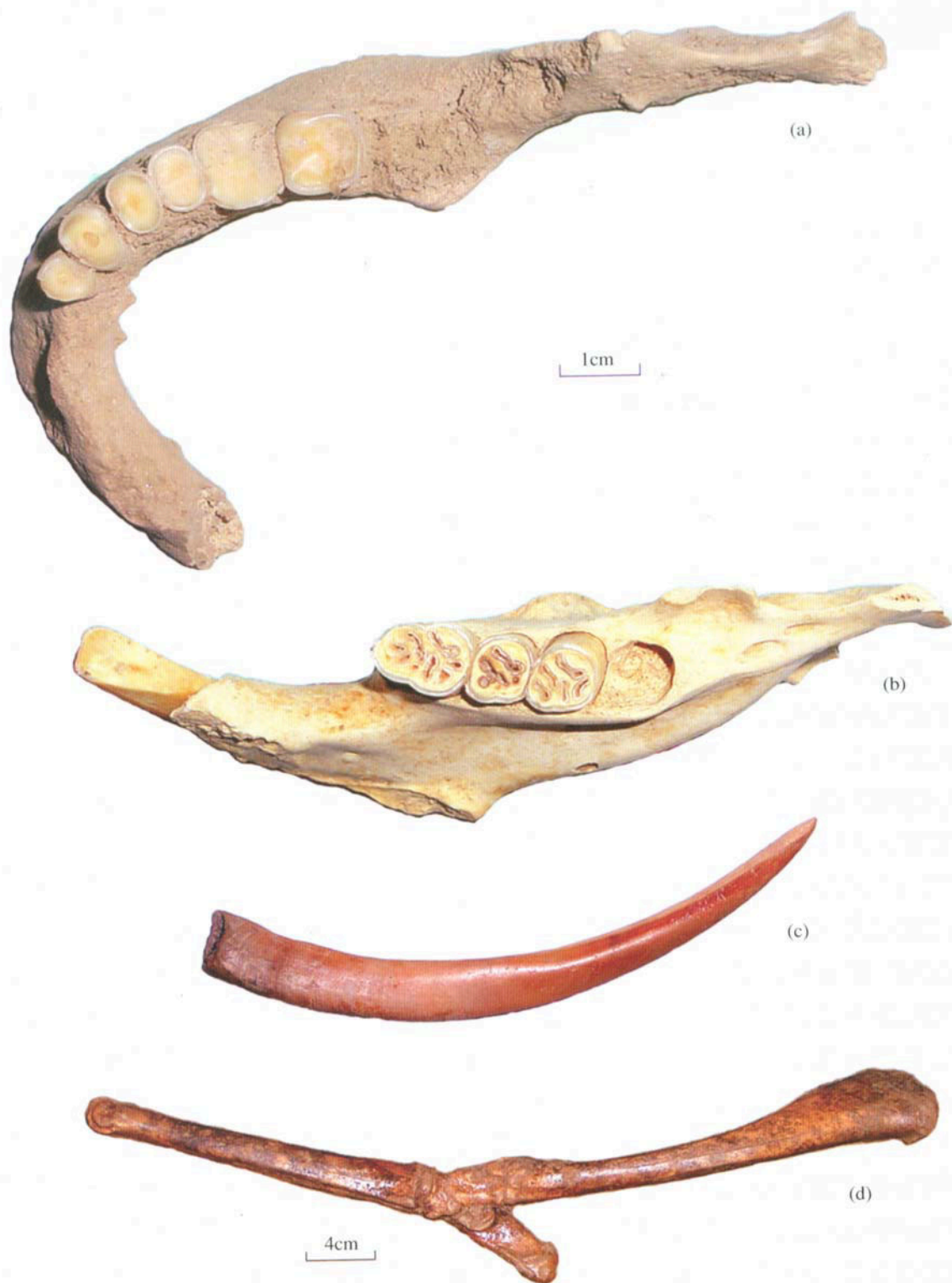


Fig. 3. (a) *Homo sapiens*, mandible (PA1281). (b) *Hystrix* sp. Right mandible (V 13948.6). (c) *Moschus moschiferus* (V 13728.2). (d) *Cervus nippon*, right hind-limb bone (V 13729.8).

*Ursus thibetanus* Cuvier, 1823  
*Arctonyx collaris* Cuvier, 1825  
*Martes* sp.  
*Paguma larvata* Hamilton-Smith, 1827  
*Felis microtis* Milne-Edwards, 1872  
*Panthera pardus* (Linnaeus, 1758)  
 ?*Crocuta* sp.  
*Sus scrofa* Linnaeus, 1758  
*Moschus moschiferus* Linnaeus, 1758  
*Cervus nippon* Temminck, 1838  
*Cervus elaphus* Linnaeus, 1758  
*Ovis* sp.  
 ?*Capricornis* sp.  
 ?*Bos* sp.

#### 4 States of preservation and the fauna features

The fossils from the Tianyuan Cave are characterized by such features as follows. (1) The degree of fossilization is low, but some fossils are seriously weathered. Near the east boundary of the cave, breccia is well cemented and the fossils are moderately fossilized. (2) Fossils are seriously fragmented, except for two broken skulls of *Hystrix*. No other skull was found. The limb bones are also highly fragmented. Bone fragments and isolated teeth are the majority of the fossils. (3) The bones from the upper part of the profile were destroyed frequently by porcupines, but there are no gnawing marks on the bones from the breccia layer, though they are highly fragmented. The causation of the breakage of the bones is still an open question.

The diversity at specific level is not high for the mammalian fauna, especially in the breccia layer. Cervids are the only group dominating the fauna; carnivores are very limited. In the upper part, there are more *Hystrix* and other rodents. *Macaca* and *Paguma* only appear in the upper layer.

#### 5 Correlation with other localities

In the composition of fossils, the Tianyuan Cave fauna can be correlated with the Upper Cave fauna<sup>[2]</sup>. Among the Tianyuan Cave fauna, 63% species also occurred in the Upper Cave fauna. But the Tianyuan Cave fauna lacks such extinct species as *Crocuta ultima* and *Ursus spelaeus* except one doubtful broken tooth of *Crocuta*. In the characters of deposits, the Tianyuan Cave is also very similar to the Upper Cave; both of them mainly consist of breccia without cement<sup>[3]</sup>. The dating using U-series method on cervid teeth shows that the major part of the cave deposits formed about 25000 years ago, which is almost the same age as that of the Upper Cave<sup>[4,5]</sup>. Some other samples are now being processed for <sup>14</sup>C dating using the AMS method.

#### 6 Conclusions

At the end of the 2003 field season, 23 units had been excavated and reached the bottom. A total of 34 pieces of human bones have been found, and all of them have been identified as *Homo sapiens*.

Quite a lot of bone fragments have been found, and it is probable that their breakage has some relationship with human activities. But whether they can be treated as tools or not is still open to question. Up to now no cultural relics have been found.

All the mammalian species in the Tianyuan Cave fauna are still living here and elsewhere in China. In composition of species, the Tianyuan Cave fauna stays between the Upper Cave fauna and the living fauna, but much closer to the Upper Cave fauna.

Only 29 species have been identified in the Tianyuan Cave fauna, with cervids outnumbering all other groups. Quite a number of *Hystrix* fossils have been found. There are few carnivores.

The dating using U-series method on cervid teeth shows that the major part of the cave deposits formed around 25000 years ago. In geological age, the Tianyuan Cave is close to the terminal part of Late Pleistocene.

**Acknowledgements** The authors thank Tian Xiumei, Tian Xiucheng and Dong Tongyuan for providing locality information; Dr. Van der Made, Profs Qiu Zhanxiang and Liu Wu, Drs. Dong Wei, Liu Jinyi and Liu Liping for providing fruitful discussions; Prof. Wu Xinzhi for constructive suggestions and for improving the manuscript; Prof. Gao Xing for supports in many aspects; Prof. Zhou Zhonghe for stylizing the English text; the officials from the Bureaus of Cultural and Relics in the Beijing Municipal Government and Fangshan District Government for their supports in administration; the Site Museum at Zhoukoudian for providing convenience in all aspects; Xu Yong for preparing the sketch map; the anonymous reviewer of CSB for improving the English text. This work was supported by Project from the Ministry of Science and Technology (2001 DIA 20025); the National Natural Science Foundation of China (Grant No. 40372015); the funds from the Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences (KJ120202).

#### References

1. Wu, X. Z., Study on the Upper Cave Man of Choukoutien, *Vertebrata Palasiatica*, 1961(3): 181—203.
2. Pei, W. C., The Upper Cave fauna of Choukoutien, *Palaeontologia Sinica*, New Ser. C, 1940(10): 1—84.
3. Pei, W. C., A preliminary report on the Late-Palaeolithic cave of Choukoutien, *Bulletin of the Geological Society of China*, 1934, 13(3): 327—358.
4. Chen, T. M., Yuan, S. X., Gao, S. J., The study on the Uranium-series dating of fossil bones and an absolute age sequence for the main Paleolithic sites of North China, *Acta Anthropologica Sinica*, 1984, 3(3): 259—269.
5. Chen, T. M., Hedges, R. E. M., Yuan, Z. X., The second batch of accelerator radiocarbon dates for Upper Cave Site of Zhoukoudian, *Acta Anthropologica Sinica*, 1992, 11(2): 112—116.

(Received November 3, 2003; accepted February 27, 2004)