

Early Pleistocene hominid teeth recovered in Mohui cave in Bubing Basin, Guangxi, South China

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Abstract Two hominid teeth recovered in Mohui cave are morphologically distinguished from *Australopithecus* in Africa, but close to *Homo erectus* in China. These teeth are therefore provisionally assigned to *Homo erectus*. The associated mammalian fauna include *Gigantopithecus blacki*, *Nesotritium sp.*, *Sus xiaozhu*, *Sus peii* and *Ailuropoda micrata*, which are typical early Pleistocene taxa in South China. The general characteristics of the Mohui faunal assemblage are similar to the Longgupo site, which is dated to 2 Ma, implying a contemporaneity for the two sites. To date, compared with the discoveries in Africa, far fewer early Pleistocene hominid fossils have been recovered in Asia, and there are intensive controversies concerning their stratigraphic provenience and typological and temporal positions. The hominid fossils from Mohui cave, with their reliable biostratigraphic positions and distinct typological features, provide important evidence regarding the issue of early human origins and evolution.

Keywords: Mohui cave, hominid teeth, stone artifact, mammalian fauna, early Pleistocene.

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Since the 1950s, researchers who examine the issue of human beginnings often turn to Africa where there is a picture of human origins and evolution based on African hominid fossils with ages that are constantly revised to be older and older. However, there are many other unsolved problems about early human origins and evolution that may be solved by looking outside Africa. Over seventy years ago, Asia was described as a dispersal center of the earliest human industry, and a key arena for human evolution. It was deemed nearly unimaginable to unravel the complex issue of human origins without Asia^[1]. Fortu-

nately, Asia has been the focus of renewed interest after having been largely ignored as an area for human origins research for many years. Further more, in opposition to the hypothesis of an Africa center, the multiregional hypothesis advocated by Franz Weidenreich who had made great contributions to the research on *Homo erectus* in Zhoukoudian has been revived^[2]. Recently, some finds from Asia have been dated to ages nearly equivalent to early sites in Africa. Here we report the newest discovery of early Pleistocene hominid fossils from Mohui cave in the Bubing Basin, Guangxi Zhuang Autonomous Region, South China.

1 Geological and archaeological background

The Bubing Basin is a small basin associated with the larger Bose Basin and lies 12 km to the west of Tiandong County. The basin is formed on limestone of Devonian to Tertiary age, with a length of 16 km by 2 km wide. There is a long and narrow horst that divides the two basins from north-west to south-east. Two small rivers flow out of the mountains to the south, crossing the Bubing Basin and downcutting the horst, to finally join the Youjiang River (Fig. 1).

Bottom of The Bubing Basin is relatively flat, with an average elevation of 130 m above sea level (ASL), which is a little higher than the Bose Basin. Karst mountains develop in the south-west margin of the basin, where there are also some isolated limestone hills within the boundaries. At least seven layers of level caves develop in these mountains and hills. The lowest layer of caves is just developing at the elevation of 120 m ASL; the highest layer of caves is about 250 m ASL (130 m above the level of the local river). Mohui cave, at the sixth layer, is situated in a limestone half-mountainside in the south-east margin of the basin (107°00.13'E, 23°34.891'N). The chamber is 50 m in length, 2–6 m in breadth and 5–6 m in height (Fig. 2). Large wavy pits on the cave walls indicate an ancient underground river that flowed from west to east. Stalactites are scattered inside. The eastward facing cave entrance is 215 m ASL and 65 m above the nearby 1st terrace of the basin (Fig. 3).

In March 2001, some mammalian fossils were first recovered in the deposits and one piece of a large hominid tooth was collected from original sediments in Mohui cave when a research project in the Bubing Basin was carried out by the Natural History Museum of Guangxi. Although local villagers had dug the cave for fertilizer in the mid 20th century, partial deposits remain, that retain the complete geological profile. From October to December, 2002 and November, 2003, two seasons of excavation took place. As a result, abundant mammalian fossils and a few stone artifacts were recovered, including another hominid tooth reported in the present paper.

From east to west inside the cave, three areas were designed as A, B and C based on the composition of the de-

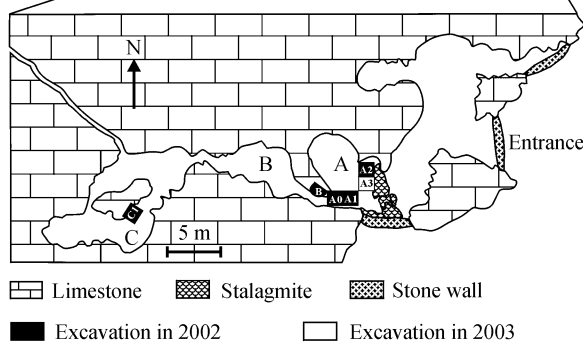
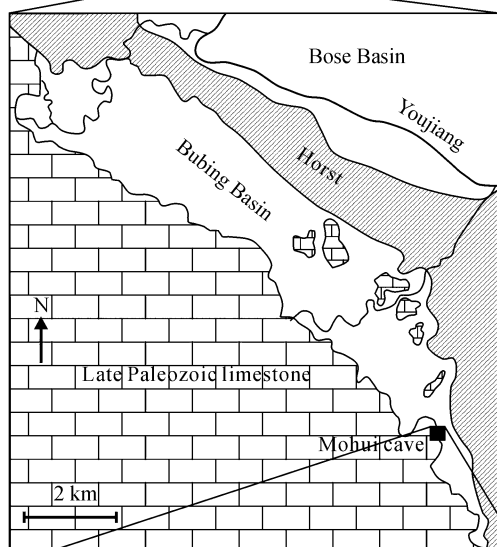


Fig. 1. Map showing the location and plan of Mohui cave.

posits. A square of 1.4 m×1 m was selected in Area B, and excavated in 5 cm levels; four squares of 2 m×2 m were chosen in Area A (A0–A3), and excavated in 10 cm levels; and one square of 2 m×2 m was investigated in Area C (C1) and excavated in 20 cm levels. In Areas A and B, all of the sediments were then water-screened for micro-mammal collection using 35 mesh sieves. Considering fossils were relatively rare in C1, we took 50 kg of

sediment per layer to sieve only.

The stratigraphic sequence can be divided from upper to lower as follows (Fig. 2):

- (5) Grey-white flow-stone covered with stalagmites yielding stone artifacts below 5–35 cm
- (4) Brown sandy clay with breccia, containing no fossils 60 cm
- (3) Brown sandy clay with rare breccia, yielding abundant mammalian fossils and some human teeth 210 cm
- (2) Light brown silt clay and sandy clay, bearing micro-mammalian fossils 400 cm
- (1) Dark brown fluvial sands with oblique bedding 20–40 cm

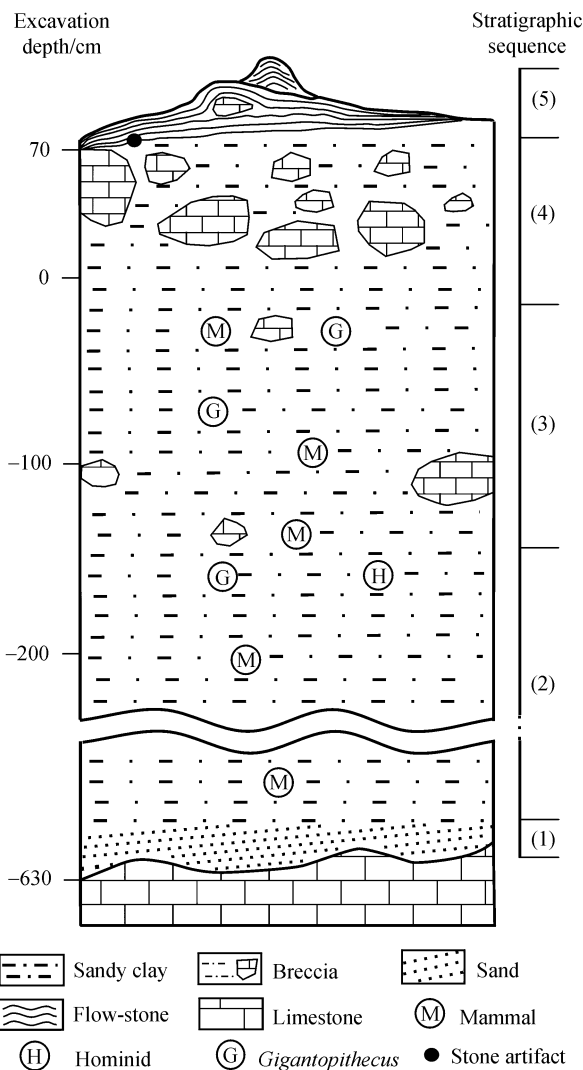


Fig. 2. Map showing stratigraphic sequence of Mohui cave.

2 Hominid and *Gigantopithecus* teeth

A complete lower right second molar (M₂)(No.

MH0001 in Fig. 4(a)–(e)) was collected from the lower part in square B (elevation -1.6 m). The second specimen is a broken upper left molar (M^1/M^2) (No. MH0018 in Fig. 4(f)) collected from disturbed deposits.

MH0001 is milky white, with a large crown and very strong roots. It is well preserved except for the tips of the roots that are absent due to porcupine gnawing. The five cusps have only been slightly worn, so their relationship is relatively clear. There is a larger oval interproximal facet at the middle of the mesial surface, while on the distal surface there is a smaller oval interproximal facet near the lingual side, adjacent to another, much smaller oval facet. According to these features, the shapes of the interproximal facets and their relationships, MH0001 is probably a lower second molar.

The crown is nearly rectangular, and its width is longer than length. It measures 15.3 mm in mesial-distal length and 16.1 mm in the buccal-lingual width, yielding a length-breadth index ($[(MD/BL) \times 100]$) of 95. The crown is broader mesially than distally. The protoconid is convex and the metaconid is the highest cusp. The mesial surface is flat while the distal, lingual and buccal surfaces are relatively convex. The five cusps on the occlusal surface, ordered from larger to smaller sequentially, are the protoconid, metaconid, hypoconid, entoconid and mesoconid. These are separated by a “Y” pattern of fissures, indicating the “*Dryopithecus* pattern”. All of the furrows are shallow and simple with no wrinkles. The mesial and dis-

tal roots of the tooth are very strong, and exhibit slightly distal curvature. The mesial or anterior surface of the mesial root has a broad, shallow fossa which divides the root into two tapered tips. The buccal-lingual breadth of the mesial root is 14.5 mm and the distal root is 10.8 mm.

MH0018 is brown and large in size, with only the buccal half preserved. The lingual half is broken, and most of the roots are absent except for a small portion on the buccal side. Based upon what is preserved, the crown has a rhomboid shape with a mesial-distal length of 14.3 mm. The paracone and metacone are integrated and are similar in height. The buccal surface is relatively convex, while the distal and mesial surfaces are flat. The mesial interproximal facet is near the buccal side and large; the distal facet is smaller and far from the buccal side. The metacone is larger than the paracone, which is separated from the hypocone but connected with the protocone. The buccal furrow is shallow and straight, extending down 1/3 of the crown. The two cusps appear simple; the occlusal surfaces are flat and relatively smooth with no wrinkles,

As MH0001 is relatively intact and can be compared with known taxa, although the size of the tooth is within the range of variation for *Pongo*, the morphology is different. MH0001 has simple furrows on the buccal surface and lacks the abundant enamel wrinkles that are characteristic of *Pongo*. MH0001 is square in overall shape, yet almost all of the second lower molars of *Pongo* are rectangular, so their breadth/length indices are distinctly



Fig. 3. Geomorphological landscape of Buling Basin in Guangxi.

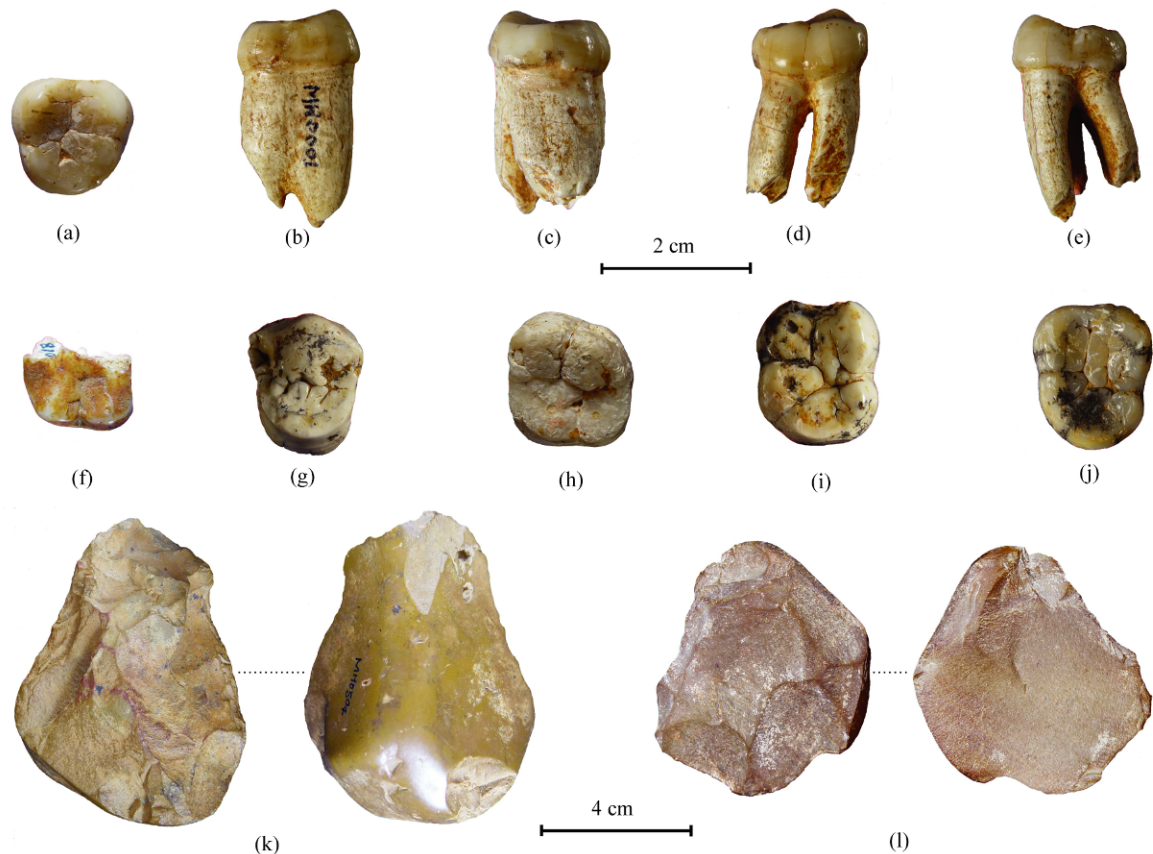


Fig. 4. Hominid, *Gigantopithecus* teeth and stone artifacts recovered from Mohui cave. (a)–(f) Hominid teeth, MH0001, right M_2 . (a) occlusal view; (b) mesial view; (c) distal view; (d) buccal view; (e) lingual view, (f) MH0018, left M^1/M^2 , occlusal view. (g)–(j) *Gigantopithecus blacki*. (g) left P^3 ; (h) left M^1/M^2 ; (i) left M_1/M_2 ; (j) left M_3 ; (k), (l) stone artifacts.

different. Thus, MH0001 cannot be assigned to *Pongo*.

The mesial-distal and buccal-lingual dimensions of MH0001 are within the range of variation of *Australopithecus africanus* (MD = 14.3–17.8 mm, BL = 12.7–16.2 mm), *A. robustus* (MD = 14.8–18.2 mm, BL = 12.8–16.2 mm) and *A. boisei* (MD = 16.4–20.0 mm, BL = 15.8–18.6 mm)^[3]. However, its breadth/length index is outside the known variation of these three species (103–118, 102–117 and 104–118 respectively)^[3]. Furthermore, although the index of MH0001 is within the *A. afarensis* range of variation (93–118), its dimensions are larger (MD = 12.1–15.4 mm, BL = 12.1–15.2 mm)^[3]. Moreover, there is no evidence supporting the existence of *Australopithecus* outside Africa to date, it is difficult to attribute MH0001 to this genus.

In comparison with *Homo erectus* in China, MH0001 is larger than the teeth from Zhoukoudian (MD = 11.3–13.2 mm, BL = 11.1–13.0 mm)^[4], Hexian (MD = 12.6 mm, BL = 13.0 mm)^[5] and Lantian (MD = 13.3 mm, BL = 13.3 mm)^[6], though the breadth/length index is very similar (99–115 for ZKD, 97 for Hexian and 100 for Lantian). Morphologically, as noted above, the cusp arrangement of

MH0001 presents the “*Dryopithecus* pattern”, the grooves between the cusps are very simple, and the lingual and distal surfaces are convex. These detailed characteristics are commonly seen in *H. erectus* from ZKD^[4]; the only difference is that the protoconid of MH0001 is large and strongly buccally projecting. The reason why the size of the Mohui hominid tooth is markedly larger than Chinese *H. erectus* may be that it represents a much earlier representative of the taxon.

Compared with hominid teeth recovered recently in Jianshi, Hubei Province, MH0001 is larger with a relatively low crown, and it has a different crown shape as illustrated by the difference in the breadth/length index (the first right lower molar, PA1277: MD = 14.6 mm, BL = 13.6 mm)^[7]. Thus, the teeth from Jianshi and Mohui are different, yet their sizes are all larger than those of teeth from ZKD, and they therefore might be earlier than the ZKD site.

As a result, MH0001 is viewed as most similar to *H. erectus* in China.

Gigantopithecus teeth (Fig. 3(g)–(j)): Thirteen in total, including one right lower canine, three left upper premolars, one right first or second upper molar, one left third

upper molar, three left first or second lower molars, one right first or second lower molar and two left third lower molars. These teeth have similar morphological features to other *Gigantopithecus* from sites in China, thus they were assigned to *G. blacki*. The dimensions of the teeth sizes are similar to those from early Pleistocene sites in Liucheng^[8], Guangxi and Longgupo, Chongqing^[9], but smaller than those from middle Pleistocene sites in China.

3 Stone artifacts

Eight stone artifacts have been recovered in Mohui cave. Two of them were separately collected from a cemented breccia bed at the cave entrance and excavated from the cover flowstone in square A2, while the other six were collected from disturbed deposits in Area C. The raw materials are quartz in two cases; the other six are made on sandstone.

Three cleavers were made from flakes, and two picks were made from a cobble and a flake. These five tools are retouched by hard-hammer technique with alternate percussion. One of the cleavers is retouched from the dorsal surface of the flake toward the right and distal edges of the ventral surface. The other three artifacts are flakes (Fig. 4). The stone artifacts recovered in Mohui cave indicate the existence of early human activities in the cave, but it is impossible that humans came into the cave when it was underground. Therefore, early humans could only have used the cave after it had been uplifted above the ground level. So, the age of human activities in Mohui cave should be later than the deposition of the sediments with the hominid and *Gigantopithecus* teeth. There is a similar technology of tool manufacturing between Mohui cave and the Bose Basin Paleolithic sites, which implies a possibility of affinity among the sites. Thus, the Mohui cave site provides a clue for solving the scientific issues surrounding the Bose Paleolithic, which is dated to 0.803 Ma^[10].

4 Mammalian fauna

Mammalian fossils recovered in Mohui cave include: *Macaca* sp., *Leopoldamys* sp., *Niviventer* sp., *Hapalomys* sp., *Typhlomys* sp., *Hystrix subcristata*, *Hystrix magna*, *Cuon (Cyon)* sp., *Nestoritherium* sp., *Ailuropoda microta*, *Ursus thibetanus*, Mustelidae, *Felis teilhardi*, *Stegodon* sp., *Sus xiaozhu*, *Sus peii*, Cervidae, and Bovidae. In addition, sixteen primate teeth are identified as hominoid according to their morphological characteristics.

Among the fauna, *Ailuropoda microta*, *Nestoritherium* sp., and *Sus peii* are typical members of the early Pleistocene Liucheng fauna^[11]. These taxa are also found in the Longgupo faunal assemblage^[9]. The size of the *Ailuropoda microta* in Mohui cave is relatively smaller, which should represent an early form of the species in the Pleis-

tocene. Based on these characters, the age of the Mohui fauna should be close to the above two sites.

5 Preliminary conclusions

In Mohui cave, a mammalian fauna with typical early Pleistocene features of the *Gigantopithecus* fauna of South China provides a strong biostratigraphic foundation for interpreting the age of the deposits as early Pleistocene. Considering that the general aspect of the fauna is similar to the aspects of Liucheng and the Longgupo sites, which has been dated to about 2 M by paleomagnetism and ESR analyses^[9], Mohui cave may represent one of the earliest hominid sites in Asia. However, this preliminary conclusion should be substantiated with further chronological studies.

Presently, considering there is no evidence of *Australopithecus* found outside Africa, and the hominid teeth in Mohui cave have many features of Chinese *H. erectus*, we temporarily assign these teeth to *Homo erectus*. Up to now, Modjokerto^[12] in Java, Yuanmou^[13], Longgupo^[9], and Jianshi^[7] in China are the rare early Pleistocene sites yielding hominid fossils in East and Southeast Asia. Moreover, there are intensive controversies concerning their stratigraphic proveniences and temporal positions. The hominid fossils from Mohui cave, with their reliable biostratigraphic position and distinct typological features, provide important evidence for addressing the role of Asia in early hominid evolution.

Recently, in the Renzidong site located at the lower Yangzi River, artifacts were recovered which might date to the beginning of the early Pleistocene based on the faunal assemblage^[14]; and in the Nihewan Basin the evidence of early human activities dates prior to 1.66 Ma^[15]. So the developing picture of early hominid evolution is presently undergoing major revisions as we learn more about the contributions of China, and Asia, in general, to paleoanthropological research.

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