# Huanglong Cave: A Newly Found Late Pleistocene Human Fossil Site in Hubei Province, China

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## Debates on modern human origins

For 20 years the debate on modern human origins has received a significant amount of attention. Primarily supported by earlier dates of anatomically modern human fossils and genetic studies, the "Out of Africa" hypothesis holds the well-known belief that the ancestor of all modern humans, including modern Chinese, came from Africa. The opposite hypothesis, "Mutiregional evolution" theory proposes that continuous evolution occurred on a regional scale, for which human paleontology offers strong support. In this debate, the discovery of human fossils, artifacts, and related materials in the same context dated around 100 ka is important. Anatomically modern human fossils dated 100 ka or earlier found in Africa have been used as the key evidence to support the "Out of Africa" hypothesis. So far, human fossils from East Asia that dated around 100 ka are very sparse. The majority of the late Pleistocene human fossils found in China are younger than 50 ka. Even though some fossils are claimed to be older than this age, either because of stratigraphic uncertainties or lack of reliable dating, all the evidence supporting such claims is weak.

The newly found human fossils, artifacts and remains of fire use from Huanglong Cave in Hubei Province, China might shed some new light on this big puzzle. Dated as 44 to 100 ka in age, the new materials offer fresh clues about behavior of this population and more importantly, the origin of modern Chinese.

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## Huanglong Cave and fossil dating

Huanglong Cave (Huanglongdong) is located in Yunxi County, Hubei Province, China (Fig. 1). The huge cave extends more than 400 meters deep and 100 meters wide. In May 2004 during a survey conducted as part of a highway construction, some mammal fossils were discovered in this cave. Subsequent excavations were conducted from 2004 to 2009 (Wu *et al*, 2006, 2007a, 2007b). These excavations resulted in the discovery of seven human teeth, some stone and bone artifacts, and evidence of fire use and other human activities. Correspondingly a series of related studies have been carried out (Liu *et al*, 2010b).

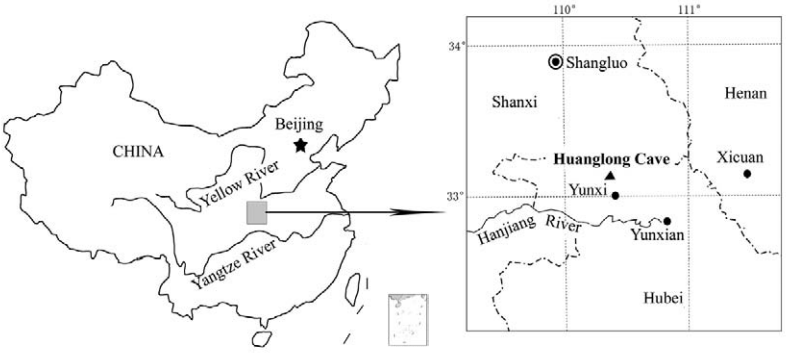
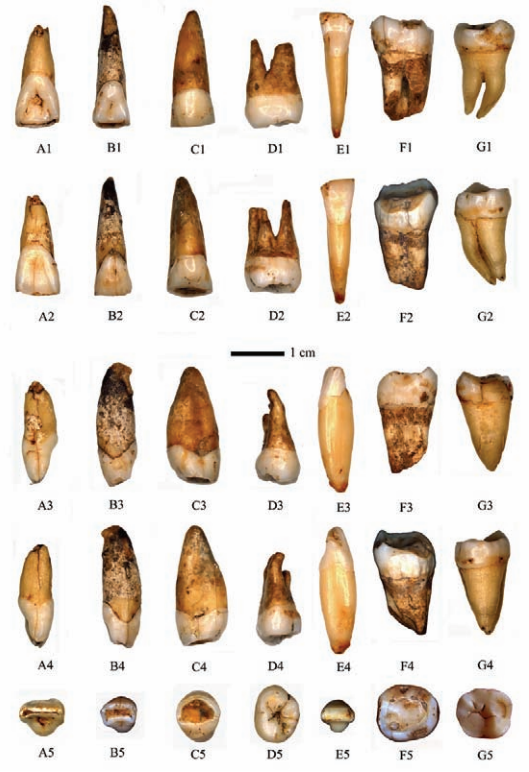



Fig.1 The location of Huanglong Cave and its horizontal profile.

More than 3,000 mammal fossils were found in Huanglong Cave. Among the 91 identified animal taxa found here, 20% are extinct species. The faunal composition indicates both tropical and sub-tropical forest environments. Based on the presence of 20% extinct faunas, the deposits were dated to the Late Pleistocene. Dating analysis for the layer yielding the human teeth was carried out in three different laboratories and an age range of 44 to 103 ka BP was derived. With all these evidence, we believe that the age of the Huanglong Cave human teeth can be conservatively bracketed between 100 ka and 44 ka.

## Morphology of the Huanglong Cave human teeth




The seven human teeth found in Huanglong Cave were identified as upper central and lateral incisors, upper canine, upper third molar, lower lateral incisor, lower second and third molars, respectively (Fig. 2). According to the occlusal wear and root formation, the ages of the individuals were estimated. Six teeth were estimated to be from adults 20 to 45 years old, and only one tooth may represent a sub-adult less than 20 years old. From the occlusal views of these teeth, very different wear patterns can be observed. Thus we believe that the seven teeth came from multiple individuals.

Most morphological and metric features of the seven human teeth found in Huanglong Cave resemble those of modern humans, and a few features that might characterize the late Pleistocene humans were also identified in these teeth. The occurrence of shoveling and double shoveling on upper incisors and the enamel extension on the upper molar suggest that the humans living in Huanglong Cave already had dental morphological features typical for East Asian populations. The present study also found that greater size and more pronounced robustness occurred on Huanglong Cave anterior teeth

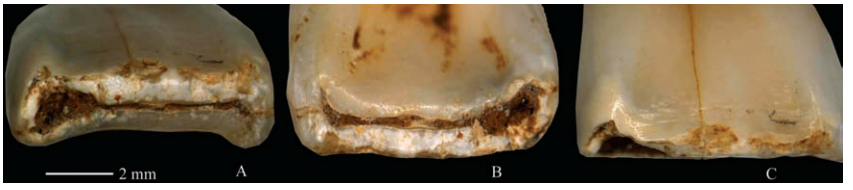
Fig. 2. The human teeth found in Huanglong Cave.
(A: right $I^1$; B: left $I^2$; C: left UC; D: left $M^3$; E: right $I_2$; F: right $M_2$; G: left $M_3$. Lingual, buccal, mesial, distal sides, and occusal surface are represented from 1 to 5 respectively)

than on those of modern humans. Our morphological and metric observation and comparisons show that Huanglong Cave human teeth most closely align with those of modern humans. On the other hand, our analysis indicates that these teeth also retain a few features characterizing Late Pleistocene humans (Liu *et al*, 2009b).

## Tooth use and living adaptations of Huanglong Cave humans

Our study also reveals that the Huanglong Cave anterior teeth display some activity-induced patterns of dental abrasion including obvious enamel chipping along the incisal region (Fig. 3), interproximal grooves, and damage on the labial surface of the lateral upper incisor. These unusual patterns of tooth use-marks suggest that the Huanglong Cave humans frequently used their anterior teeth for non-masticatory utilization. For example, the interproximal grooves on the upper anterior teeth suggest that the Huanglong Cave humans often practiced tooth-pickings. Based on these observations, we believe that the Huanglong Cave humans used their teeth to perform a series of work-related activities (*e.g.*, holding skin with their teeth during skin preparation), similar to what Neandertals may have been doing. Thus tooth morphology may be related to the functional adaptation of the anterior tooth use (Liu *et al*, 2008, 2010a).

Fig.3 The tooth wear and chippings on the upper incisor from Huanglong Cave humans.




## Fire use by Huanglong Cave humans

During the Huanglong Cave excavation, in the same layer as the human teeth, a few patches of black materials were identified embedded in the deposits. To explore whether the materials were the remains from fire use, we conducted comparative laboratory analyses of these black patches, along with samples taken from several other places in the cave. Three methods, micromorphology, element content determination and deposit temperature analysis were used. The results indicate that carbon content in the black deposit ranges between 64.59–73.29%, which is much greater than the proportion derived from the comparative samples, 5.82–9.49%. Micromorphology analysis on the black deposit samples reveals some plant structures, like *axial parenchyma*, fibrocytes, uniseriate rays and vessels (Fig. 4).

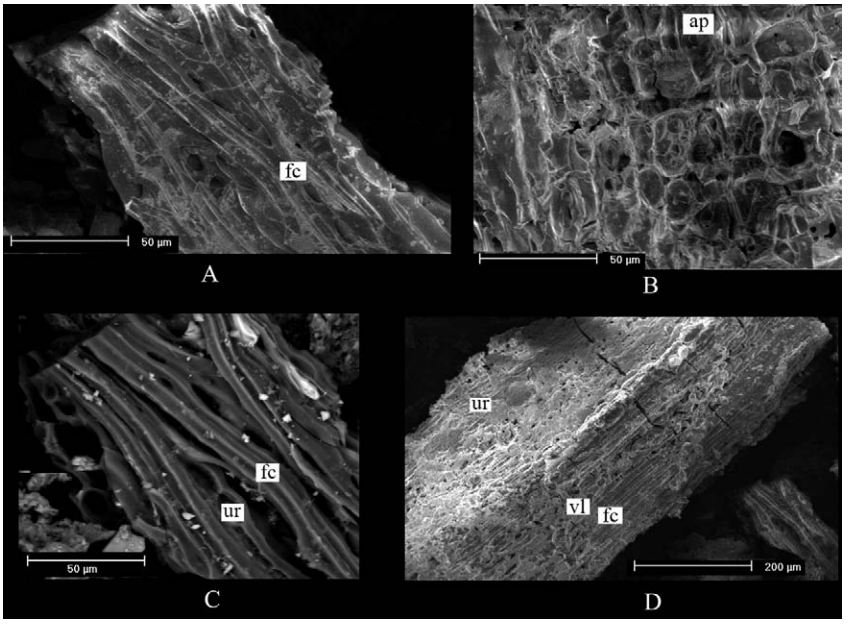



Fig. 4 Plant structures are seen in the SMC pictures of charcoal from the black layer of the Huanglong Cave Site.
(ap: axial parenchyma; fc: fibrocyte; ur: uniseriate ray; vl: vessel)

Deposit temperature analysis confirms that the blackened materials are the result from a high temperature event. Based on the above results, we conclude that the black patches are remains of fire (Liu *et al*, 2009a).

## Artifact assemblage and other human activities

The artifact assemblage found from the Huanglong Cave comprises of lithic and bone implements. The lithic assemblage includes stone hammers, core, flakes, retouched artifacts, block fragments and bipolar cores. The humans probably knapped inside the cave, as deduced from the different lithic types identified. Knapping strategies were simple, flakes show plan rather than cortical butts, and dorsal scars are parallel to the flake extraction axis, which indicates unidirectional knapping (Pei *et al*, 2008).

Evidence of butchering was found on some Huanglong Cave animal bones. Cut marks, percussion marks, and scraping marks were identified, primarily on the long bones (Fig. 5). Cut marks and scraping marks are usually considered to be evidence of defleshing activities. Percussion marks on long bone midshafts are the result of marrow processing. Based on the current evidence, we can conclude that butchered bones are present in the cave, a case not unlike what was found at Zhoukoudian Upper Cave. Huanglong Cave differs from Zhoukoudian Upper Cave however, because roughly 50% of the former faunal assemblage displays evidence of rodent gnawing (Wang *et al*, 2008).

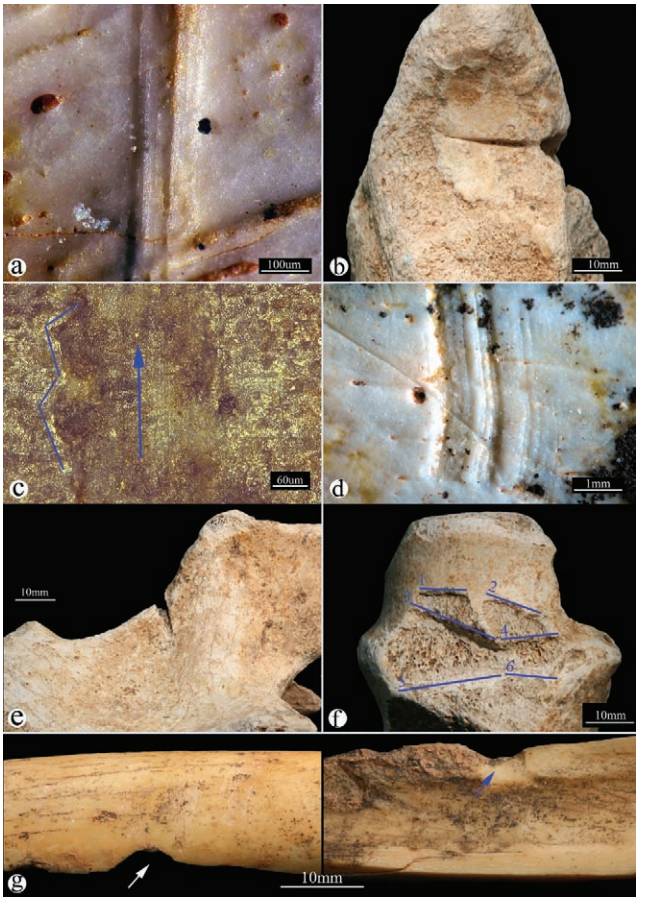



Fig. 5 Different marks on the Huanglong Cave animal bones by human activities.
(a–d: cut marks and scrape marks; e–h: chopping marks and percussion marks.)

## Implications on the origin of modern Chinese

The Huanglong Cave human fossils provide new information for addressing issues related to the emergence and dispersal of early modern humans in East Asia, which had remained hard nuts due to the paucity of reported early modern human fossils in this area.

Most morphologic and metric features of the teeth from Huanglong Cave humans resemble those of modern *Homo sapiens*. Besides, these teeth possess some dental features of modern East Asian populations. Our lab analysis confirmed that fire did occur in Huanglong Cave. Natural fire usually does not occur at a location deeply hidden in a cave; while the fire remains in the Huanglong Cave were found at about 100 meters deep from the entrance. Besides, a good deal of evidence supports human existence and activities inside the cave, including human teeth, artifacts and bone butchering. With all this evidence, it can be sure that humans who used to live here intentionally used fire.

In West Hubei and the Three Gorge Region, where Huanglong Cave is located, several human fossil sites ranging from Early to Late Pleistocene have been discovered (Liu *et al*, 2006). The human teeth from Huanglong Cave contribute to the growing list of Pleistocene human fossils from this region. Ongoing and future multi-disciplinary research at Huanglong Cave will serve to determine what kind a role this site and the materials may play in any reconstruction of human evolution from this time period and geographic region.

## References


Liu Wu, Gao Xing and Pei Shuwen *et al*., 2006. Research progress of paleoanthropology in West Hubei and the Three Gorges region. *Quaternary Sciences*, 26:514–521.

Liu Wu, Wu Xianzhu and Wu Xiujie *et al*., 2008. Living adaptation and behaviors of late Pleistocene humans from Huanglong Cave in Yunxi of Hubei Province. *Quaternary Sciences*, 28:1014–1022.

Liu Wu, Wu Xianzhu and Li Yiyin *et al*., 2009a. Evidence of fire use of late Pleistocene humans from Huanglong Cave, Hubei Province, China. *Chinese Science Bulletin*, 54, 256–264.

Liu Wu, Wu Xianzhu and Wu Xiujie, 2009b. The late Pleistocene human teeth found in Huanglong Cave, Yunxi of Hubei Province. *Acta Anthropologica Sinica*, 28:113–129.

Liu Wu, Wu Xianzhu, Wu Xiujie and Zhou Mi., 2010a. Tooth wear and tooth use of Late Pleistocene humans from Huanglong Cave in Yunxi of Hubei Province. *Acta Anthropologica Sinica*, 29: 1–14.

Liu Wu, Wu Xianzhu, Pei Shuwen and Wu Xiujie., 2010b. A preliminary report on Huanglong Cave: A Late Pleistocene human fossil site in Hubei Province, China. *Quaternary International*, 211:29–41.

Pei Shuwen, Wu Xianzhu and Wu Xiujie., 2008. Preliminary study on lithic technique and adaptive behavior of hominid at Huanglong Cave, Yunxi, Hubei Province. *Quaternary Sciences*, 28: 1007–1013.

Wang Yunfu, Wu Xianzhu and Pei Shuwen *et al*., 2008. Research on bone surface modifications from Huanglong Cave site, in Hubei Province. *Quaternary Sciences*, 28: 1035–1041.

Wu Xianzhu, Liu Wu and Gao Xing *et al*., 2006. Huanglong Cave, a new late Pleistocene hominid site in Yunxi of Hubei Province, China. *Chinese Science Bulletin*, 51:2493–2499.

Wu Xianzhu, Pei Shuwen and Wu Xiujie *et al*., 2007a. Preliminary study of cave development and burial environment at the Yunxi Man site. *Quaternary Sciences*, 27:444–452.

Wu Xianzhu, Wu Xiujie and Chen Minghui *et al*., 2007b. The excavation of Yunxi Man site in Huanglong Cave, Hubei Province in 2006. *Acta Anthropologica Sinica*, 26:193–205.