Chinese Science Bulletin 2004 Vol. 49 No. 2 175—180

120—150 ka human tooth and ivory engravings from Xinglongdong Cave, Three Gorges Region, South China

GAO Xing[1], HUANG Wanbo[1,2], XU Ziqiang[2], MA Zhibang[3] & J. W. Olsen[4]

1. Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing 100044, China;
2. Longgupo Institute of Paleoanthropology, Beijing 100044, China;
3. Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China;
4. Department of Anthropology, University of Arizona, Tucson, AZ 85721-0030, USA

Correspondence should be addressed to Gao Xing (e-mail: gaoxing @ivpp.ac.cn)

Abstract **Rich paleoanthropological materials were unearthed in primary context from the Xinglongdong Cave in Fengjie County, Chongqing, South China, including a human tooth, numerous mammalian fossils, some stone artifacts and a *Stegodon* tusk exhibiting intentional engravings. Based on biostratigraphic data and uranium series dating, the cave was utilized as a human shelter about 120000—150000 years ago. It is the first time that an archaic *Homo sapiens* fossil has been unearthed from the Three Gorges Region. Engravings on the *Stegodon* tusk appear in groups, making up simple and abstract images. It is the earliest known engravings created by human beings; it exhibits great potential for the study of the origin of art and the development of ancient cultures in south China and bears important implications for the origin of modern humans in East Asia.**

Keywords: ***Homo sapiens*, ivory engraving, primeval art, Xinglongdong Cave, Late Middle Pleistocene.**

DOI: 10.1360/03wd0214

It has been commonly accepted that artistic creativity, including engraving, carving, sculpturing, painting, and drawing, is an unique human behavior and is closely associated with modern human's physical evolution and cognitional development[1,2]. The discovery of red ochre pieces with geometric engravings in 1999 and 2000 from the Blombos Cave in South Africa, dated at 77 ka, has been taken as archaeological evidence of the oldest human artistic activity and the earliest record of modern human behavior[3]. The issue of modern human origins, especially in East Asia, is currently a hot research topic in academic world, upon which the debate between two opposite hypotheses, namely "Outside gene replacement" and "Regional continuity", has been locked in a stalemate[4,5]. Anthropologists and archaeologists are eagerly searching for new material and evidence to solve this research question. In September 2001, a field team from the Institute of Vertebrate Paleontology and Paleoanthropology, the Chinese Academy of Sciences, led by the second author, discovered a limestone cave called Xinglongdong, near the so-called Tiankeng-Difeng, a deep and long karst funnel-valley area in Fengjie County in the Sanxia (Three Gorges) Region of south China (Fig. 1). A test excavation, exposing an area of 28 m^2 inside the cave and lasting for one month, was conducted immediately upon the discovery, resulted in the recovery of one human molar, numerous faunal remains, and some stone artifacts. Among the unearthed mammalian fossils, a broken elephant tusk was found to yield great archaeological significance: human intentional engravings were identified on it, which might provide valuable clues for the study of the origin of human art and the emergence of modern human behavior in the region.

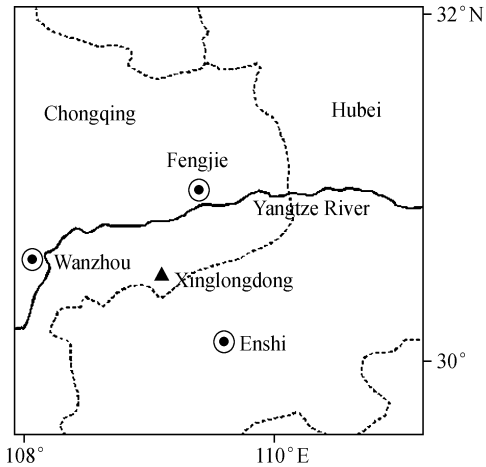

Fig. 1. A map showing the location of Xinglongdong Cave.

1 Geology and stratigraphy

The Xinglongdong, a limestone cave, is situated 1100 m above mean sea level and developed in an area of karst landform, surrounded by karstic basins and cliffs. The cave entrance, opened to the southwest and filled with deposits at the bottom, is currently measured less than 1.5 m high but is estimated to be around 3 m high based on test excavations. Inside the cave, a long and narrow chamber remains exposed, measured more than 50 m in length and high enough for people to move freely. The western side of the cave is currently blockaded by collapsed rocks, preventing us from knowing the complete original morphology of the cave at the moment. The most recent deposits in the cave have been partially removed by local residents as fertilizer. Seven 2 m × 2 m test pits, numbered A, B, C, D, E, F, G (Fig. 2), were` opened by the archaeological team in an area with rich animal fossils exposed, about 50 m away from the entrance.

The stratigraphic sequence of Xinglongdong Cave may be described from top to bottom as comprising the following 6 units (Fig. 3):

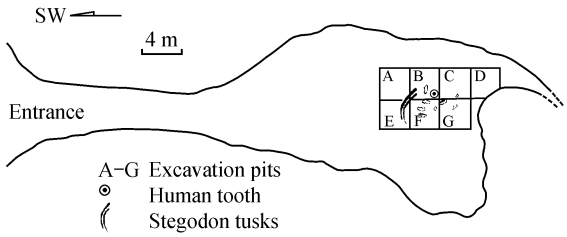

Fig. 2. Plan view of the excavation area inside the Xinglongdong Cave.

6. Sandy clay and limestone breccias, mixed with historical human remains, disturbed;

5. The upper level travertine, brownish yellow, 5—10 cm in thickness;

4. Clay, with calcareous belts and limestone blocks, brown and yellow, cemented, containing few mammalian teeth, about 140 cm thick;

3. The middle level travertine, brownish yellow, 10—15 cm in thickness;

2. Sandy clay, with limestone breccias, brown, 60—80 cm thick. Human tooth, stone artifacts, engraved elephant tusk and most mammalian fossils were unearthed from this layer;

1. The lower level travertine, 15—35 cm in thickness.

Layer 6 is partially removed and disturbed; other layers remain intact. Layer 2 is the only level yielding evidence of human occupation in the cave. Fossils and artifacts were encountered in clear primary context sandwiched between two travertine layers.

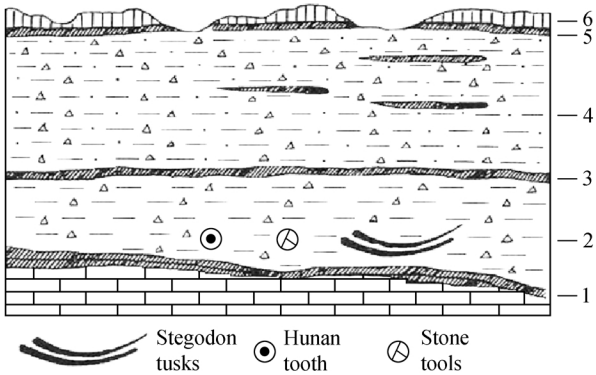

Fig. 3. Stratigraphy of Xinglongdong Cave: 6, Sandy clay and limestone breccias; disturbed; 5, the upper level travertine; 4, clay, containing few mammalian teeth; 3, the middle level travertine; 2, sandy clay, human tooth, stone artifacts, engraved elephant tusk and most mammalian fossils were unearthed from this layer; 1, the lower level travertine.

2 Human fossil

One human permanent tooth, a lower third molar was recovered in 2001. The dimensions of the crown are 9.78 mm length (mesio-distal diameter) and 9.68 mm breadth (buccal-lingual diameter). The crown is heavily worn, indicating that the tooth belongs to an old-aged individual. The lower part of the roots are broken off, only the basal parts of two roots are left. The size of this tooth is smaller than *Sinanthropus pekinesis* and in the range of *Homo sapiens*.

3 Stone artifacts

A total of 20 lithic artifacts were unearthed from the site, associated with the engraved *Stegodon* tusk. The stone artifacts include 1 core, 1 flake, 1 point, 4 scrapers, and 13 chopper-chopping tools (Fig. 4). These artifacts were made of limestone pebbles; a few flint chunks and debris were also encountered. The core and flake can be refitted and hard hammer percussion appears to be the method of core reduction. Most of the tools possess blunt cutting edges and were fabricated simply and casually by hard hammer percussion, mostly modified unifacially, exhibiting characteristic features of the Paleolithic pebble industry typical of south China[6]. Obviously, such simple and poorly manufactured stone tools could not satisfy daily subsistence activities and requirements. Therefore, tools made of other materials (e.g. wood and bamboo) might have existed or stone tools with better quality and workmanship might be unearthed from the cave in the future.

Fig. 4. A stone chopper unearthed from Xinglongdong Cave in association with the engraved elephant tusk.

4 Ivory engravings

Two elephant (*Stegodon orientalis*) tusks, belonging to 2 individuals, were unearthed from the bottom of the second layer inside the cave. These two tusks were apparently intentionally placed parallel to one another (Fig. 5), which initially drew the attention of the second author. After cleaning, engraved lines became apparent on the surface of one tusk.

The tusk is measured 184 cm long with the tip partially broken. Engravings appear on the tip of the tusk, concentrated in an area of 50 cm². These engravings in-

Fig. 5. Chinese scientists are conducting excavations at Xinglongdong Cave. Two elephant (*Stegodon orientalis*) tusks *in situ*, including the one with intentional engravings, begin to emerge.

clude straight (vertical and oblique) and curved lines, and are simple but deep and bold, appearing in groups. Here we describe two such groups of incisions:

Group 1 consists of six engraved lines and can be further divided into three parts, arranged vertically. The distal sector includes three fine, short, oblique lines (12 mm, 26 mm, and 16 mm long, respectively). These lines stretch toward the tip of the tusk, with two engravings initiating from the groove of the third. The middle part consists of a short, shallow, horizontal line (7 mm long and 1.4 mm wide) and a long, deep, vertical line (37 mm long and 1.5 mm wide). These two lines intersect forming a roughly cross-shaped figure. The proximal segment includes only one oblique line (41.5 mm in length), starting near the tail of its vertical counterpart. Under a microscope, these engraved lines exhibit "V" shape in cross section. Compositionally, this group somewhat resembles a leafless branch (Fig. 6(a)).

Group 2 consists of four lines. The first one is straight and relatively long (110 mm long and 1.2—1.5 mm wide), running parallel to the long axis of the tusk. The other three lines are curved and relatively short (20—30 mm) and wide, clearly stretching from the mid-section of the first, yielding a crest-shaped composition (Fig. 6(b)).

The tasks and engravings have been examined from many aspects, taphonomically, morphologically, mechanically, and artistically. The two tusks of different individuals appear parallel to each other in the deep end of the cave, about 50 m away from the entrance; no remains of other body parts were found in close association with them, which indicate that the tusks were neither the remain of *in situ* natural death of the elephants nor the result of other elephants' movement of the dead companion, an elephant behavior that has been observed occasionally. The possibility of other animal drawing these huge and meat-less teeth to the deep side of the cave can also be eliminated. The nature of the deposit indicates that flowing water was not a factor in the formation of the archaeological record. Therefore, it is reasonable to believe that the presence of the tusks was the result of human transportation and arrangement.

The lines on the tusk described above are distinct from marks or traces found on animal bones and teeth produced by natural agents such as weathering, root etch-

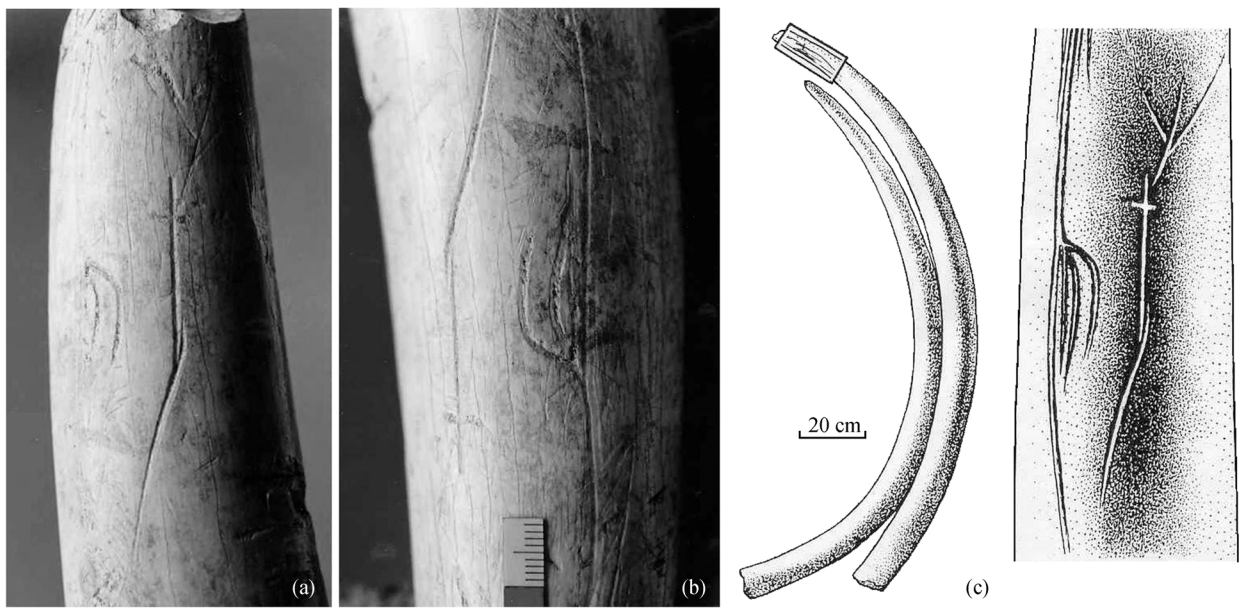

Fig. 6. Ivory engravings from Xinglongdong Cave. (a) Group 1 of the ivory engravings; (b) Group 2 of the ivory engravings; (c) Line drawings of the elephant tusks (left) and the composition of ivory engravings (right).

ing, abrasion, trampling, animal gnawing, and scratching[7], and they can be easily differentiated from rubbing traces created when the animal was alive, which normally appear in groups of oblique, short, thin, shallow and parallel lines (Fig. 7). The fact that such engravings appear on elephant tusk eliminates the possibility that they are tool marks resulting from butchering or skinning of game. The means by which the lines were created and the way they were composed indicate that they are not the careless or accidental products of human beings either.

Fig. 7. Elephant tusk with rubbing traces unearthed from Renzidong Cave in Anhui Province of central Eastern China, dated at 2 million years ago.

The above observations and analyses assure us that the lines on the tusk are human intentional creations. They exhibit some unique characters: (1) They are deep and bold and exhibit clear starting points, unlike natural rubbing traces or damage marks; (2) they vary in length, depth, starting points, and stretching directions; (3) they are generally V-shaped in cross-section, typical of sharp stone tool marks, different from animal tooth marks that are normally U-shaped in cross-section; (4) the curvilinear lines with different curvatures cannot be explained by any natural formation; (5) correlations and connections can be found among these lines; and (6) they are arranged in groups and form regular patterns (Fig. 6(c)). Therefore, these images were apparently intentionally engraved to imitate natural phenomena or attempt to express some abstract thought, the significance of which we cannot yet fully comprehend.

Questions might arise on the workability of the elephant tusk by ancient hominids using stone tools. Actually *Stegodon* tusks are not very hard materials. Unlike young *Stegodon* individuals whose tusks were covered by a thin layer of enamel, adult *Stegodon*'s tasks remained only dentine, enamel was usually wore off. Simple experimentations were carried out by the team using limestone tools similar to those found in the Xinglongdong cave to engrave on a piece of modern elephant tusk, and similar lines were created. The presence of some flint chunks and debris from the cave can be taken as a clue that more suitable engraving tools might exist at the site.

5 Mammalian fossils

Rich mammalian bones and teeth were collected from layer 2 in the cave during the excavation. Here we present a list of the fauna:

Insectivora Bowdich, 1821

Hylomys sinensis, *Uropsilus soricipes*, *Talpa* sp., *Crocidura* sp., *Anourosorex kui*, *Anourosorex squamipes*, *Sorex cylindricauda*, *Sorex araneus*, *Blarinella quadraticauda*, *Soriculus* cf. *leucops*, *Soriculus hypsibius*

Chiroptera Blumenbach, 1779

Hipposideros sp., *Murina* sp.

Rodentia Bowdich, 1821

Tamiops swinhoei, *Dremomys* sp., *Pteromys volans*, *Belomys* sp., *Petaurista* sp., *Eothenomys* cf. *miletus*, *Typhlomys cinereus*, *Micromys minutus*, *Vernaya fulva*, *Apodemus chevrieri*, *Apodemus latronum*, *Niviventer fulvescens*, *Niviventer confucianus*, *Rattus* sp., *Rhizomys* sp., *Hystrix kiangsanensis*

Primates Linnaeus, 1758

Hylobates cf. *sericus*, *Rhinopithecus roxellanae tingianus*

Carnivora Bowdich, 1821

Nyctereutes sp., *Ailuropoda melanoleuca baconi*, *Ursus thibetanus kokeni*, *Arctonyx collaris*, *Paguma* sp., *Homotherium* sp., *Panthera* sp.

Proboscidea Illiger, 1811

Stegodon cf. *orientalis*

Perissodactyla Owen, 1848

Megatapirus augustus, *Dicerorhinus hexianensis*

Artiodactyla Owen, 1848

Sus scrofa, *Muntiacus crinifrons*, *Elaphodus cephalophus*, *Cervus* cf. *unicolor*, *Megalovis* cf. *guangxiensis*, *Capricornis sumatraensis kanjereus*, *Bibos gaurus grangeri*

Among these mammalian species, *Hylobates* cf. *sericus*, *Rhinopithecus roxellanae tingianus*, *Ailuropoda melanoleuca baconi*, *Ursus thibetanus kokeni*, *Stegodon orientalis*, *Megatapirus augustus*, *Dicerorhinus hexianensis*, *Cervus* cf. *unicolor*, *Muntiacus crinifrons* and *Bibos gaurus grangeri* are also members of the Yanjinggou fauna, found from Yanjinggou site in the neighboring Wanxian County[8]. South China's local species dominate these two faunas, and North China species are largely absent, indicating that during the Middle and Upper Pleistocene, the Yangtze River functioned as a natural barricade preventing northern mammalian species from migrating into the south. In general, the Xinglongdong fauna represents warm, humid forestry and meadow ecological environments.

6 Chronology

Accurate chronometric determination for the engravings and associated artifactual and faunal remains is essential for assessing the full significance of this discovery. Both biostratigraphic methods and chronometric

analyses have been applied.

Among the mammalian species unearthed from the cave, *Homotherium* sp., *Stegodon orientalis*, *Dicerorhinus hexianensis*, *Megalovis* cf. *guangxiensis* and *Hystrix kiangsanensis* are extinct forms. The composition of the faunal assemblage and its similarity with the Yanjinggou Fauna, a typical late Middle Pleistocene fauna in south China, indicate that the cultural level in the Xinglongdong Cave was formed during the late Middle Pleistocene.

Theoretically, the two travertine layers (units 1 and 3) above and below unit 2 provide good opportunities for uranium series dating to obtain reliable maximum and minimum ages for these unearthed archaeological materials. However, such attempts have resulted in failure because the analyzed samples do not yield sufficient calcite crystals. Alternatively, U-series analyses have been carried out on a *Stegodon* molar uncovered form the same level with the engraved tusk. These analyses were performed by the Institute of Geology and Geophysics (IGG) of the Chinese Academy of Sciences and Nanjing Normal University (NNU) (Table 1). The IGG dates establish a consistent age-range of 110—130 ka. The NNU lab produced only one date, circa 154 ka. Here we use 120—150 ka as the age for the cultural horizon at the site, which is in accordance with its biostratigraphic position. Recent chronometric studies have led to a conclusion that U-series dating on ancient animal bones and teeth tends to result in ages younger than their reality[9]. Therefore, 120—150 ka should be a conservative age estimate for the Xinglongdong site.

Table 1 U-series analyses on *Stegodon* tooth from Xinglongdong Cave

Sample	Lab	U/g • g^{-1} (×10)	$^{234}U/^{238}U$	$^{230}Th/^{234}U$	Age/ka
WS-1a	IGG	1.154 ± 0.036	1.475 ± 0.052	0.711 ± 0.023	123 ± 8
WS-1b	IGG	1.187 ± 0.026	1.493 ± 0.034	0.691 ± 0.023	116 ± 7
Average	IGG	1.171 ± 0.017	1.484 ± 0.009	0.701 ± 0.010	119.5 ± 3.5
WS-2a	IGG	42.7 ± 1.7	1.410 ± 0.051	0.686 ± 0.023	118 ± 7
WS-2b	IGG	44.7 ± 1.2	1.396 ± 0.033	0.706 ± 0.017	122 ± 5
WS-2c	IGG	41.2 ± 1.1	1.443 ± 0.032	0.717 ± 0.028	124 ± 8
Average	IGG	42.9 ± 1.4	1.416 ± 0.020	0.703 ± 0.013	121.3 ± 2.5
0238	NNU	36.3	1.622 ± 0.025	0.812 ± 0.022	154 ± 9

For IGG samples, –1 represents enamel and –2 represents dentine, while a, b, and c denote replicate analyses on different samples from the same specimen. The NNU sample is dentine. All dates are presented with 1σ uncertainties in the last digits.

7 Discussions and conclusions

Archaeological materials described in this paper were unearthed from the late Middle Pleistocene deposits in the Xinglongdong Cave. The uppermost part of the cave deposits has been removed and disturbed, the rest maintains intact. The "cultural horizon", i.e. Layer 2, was sealed by a layer of travertine, and the reported materials were found from the level in clear primary context and yield *in situ* evidence of human occupation, signifying that the cave is a valuable paleoanthropological and archaeological site with great scientific significance. Through biostratigraphic analysis and uranium series dating, the absolute age of the site has been determined to be 120—150 ka.

Materials unearthed during the first excavation include an adult human tooth, 20 pieces of lithic artifacts, and numerous animal fossils. The stone artifacts were largely chopper/chopping tools, made of limestone pebbles, exhibiting simple and casual fabrication. The characteristics of the stone tools could be closely related to the poor quality of raw materials utilized at the site. However, it might also indicate that these tools were not the most important implements frequently used by the occupants of the cave in their daily lives, and tools made of better-quality lithic materials or non-stone materials (e.g. wood and bamboo) might have existed, some of which might be encountered during future investigations. Mammalian remains associated with human fossil and stone tools are mostly herbivores; only a few carnivorous species, e.g. *Ursus thibetanus kokeni* and *Homotherium* sp., are identified from the fauna. Most of the animal fossils are fragmentary, and some of them might be the food remains of ancient hominids.

The elephant tusk with human engravings unearthed from the cave is a significant discovery. A series of analysis conducted on this finding, including the taphonomic context and the appearance, directions, curvatures, morphology and composition of the lines, convincingly points to the fact that these lines on the tusk are distinct from marks or traces found on animal bones and teeth produced by various natural agents; they are the result of human engravings, and they were apparently intentionally engraved to imitate natural phenomena or attempt to express some abstract thought. Therefore, the tusk yields the earliest archaeological evidence that could be related to primeval artistic creativity by human beings ever found so far.

Human artistic expression is undoubtedly rooted in

the Paleolithic. The fragmentary data collected so far prevent us from reconstructing a precise history of its development in that remote period. However, newly unveiled archaeological evidence enables us to make a rough sketch of how such a process might have played out. Human and other animal figures and cave paintings discovered in Africa and Europe, some of which can be dated to 30—40 ka, have been generally accepted as unquestionable early human art works[10]. The discovery of red ochre pieces with geometric engravings from the Blombos Cave in South Africa might have traced the history of human artistic activity back to 77 ka. Ivory engravings of 120000—150000 years old reported in this paper provide new clues on the origin of human artistic creations. Based on archaeological evidences, we believe that even though the general tendency of pictorial art during the past 30000 years is from realism to abstract, it might have experienced an opposite developmental trend in the embryonic stage: the earliest work might have initiated from single, simple and rough engraved lines, poorly controlled, highly abstract in character and difficult for us to interpret. Ivory engravings reported in this article are such examples. A further advance may have involved multiple, finer, more complex and better-controlled lines, possibly yielding geometric or other recognizable compositions, which are still subject to varying interpretations. Ochre engravings from the Blombos cave may be taken as a representative of this stage. As artistic expression matured carved, sculpted, or painted figures or representations of anthropomorphic, zoomorphic or other subjects, with clearly interpretable morphologies and sometimes meanings, were developed. Engraved animal figures and female anthropomorphs discovered at Mal'ta and other Upper Paleolithic sites in south-central Siberia and the parietal art associated with Magdalenian horizons from Spain and southern France [11] are prime examples of this stage.

Artistic creativity is one of the unique attributes of modern human cognition and behavior. Therefore, one research topic closely related to the origin of art is the origin of modern humans. For years, two hypotheses in this regard, namely "Out of Africa" vs. Multi-regional continuity", stand in sharp opposition to each other; both are seeking archaeological backing. Ochre engravings from the Blombos cave were quickly assigned as the supporting evidence for the former theory upon their discovery. Are the materials described in this paper supportive of the latter? We can at least conclude that the human ancestors who occupied Xinglongdong Cave on the eastern periphery of the Qinghai-Tibet Plateau some 120-150 ka already possessed consciousness and behavior patterns that might be described as "modern". They not only made and used stone tools, but also attempted to use engravings and possibly other means to express complex ideas that are as yet incomprehensible to modern-day humans. Therefore, this discovery not only provides invaluable information for the study of the origin of art and the development of ancient cultures in the Three Gorges Region of south China, but also bears important implications for the origin of modern humans in East Asia.

Acknowledgements This work was supported by the Ministry of Science & Technology of China's Fund for Major Basic Research Projects (Grant No. 2001CCA01700) and China's Fengjie County government.

References

1. Mellars, P. A., Gilson, K., Modeling the Early Human Mind, McDonald Institute Monographs, Cambridge, 1996.
2. Clark, G. A., Willermet, C M., Conceptual Issues in Modern Human Origins Research, New York: de Gruyter, 1997.
3. Henshilwood, C. S. et al., Emergence of modern human behavior: Middle Stone Age engravings from South Africa, Science, 2002, 295: 1278—1280.
4. Wu, X. Z., Origin of modern humans of China viewed from cranio-dental characteristics of late *Homo Sapiens* in China, Acta Anthropologica Sinica (in Chinese), 1998, 17(4): 276—282.
5. Ke, Y.H, Su, B. & Li, H.Y., Genetic evidence of Y-Chromosome supports Africa origin of modern Chinese, Chinese Science Bulletin (in Chinese), 2001, 46(5): 411—414.
6. Wang, Y. P., Pleistocene Environment and Paleolithic Industries in South China (in Chinese), Beijing: Peking University Press, 1997.
7. Lyman, R. L., Vertebrate Taphonomy, Cambridge: Cambridge University Press, 1994.
8. Colbert, E. H., Hooijer, D. A., Pleistocene mammals from the limestone fissures of Szechuan, China, Bull. Am. Mus, Nat. Hist., 1953, 102: 41—71.
9. Shen, G. J., Wang, J. Q., Chronological studies on Chinese Middle-Late Pleistocene hominid sites, actualities and prospects, Acta Anthropologica Sinica, 2000, 19(Supp.): 279—284.
10. Breuil, H., Four hundred centuries of cave art, Centre des Études et de Documentation Préhistorique, Montignac, 1952.
11. Klein, R. G., The Human career: Human biological and cultural origins, Chicago: University of Chicago Press, 1989.

(Received June 10, 2003; accepted October 27, 2003)