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Lithic assemblage from the Jingshuiwan Paleolithic site of the early Late Pleistocene in the Three Gorges, China

Shuwen Pei[a,b,*], Xing Gao[a,b], Xingwu Feng[a,b], Fuyou Chen[a,b], Robin Dennell[c]

[a] Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing 100044, China
[b] Laboratory of Human Evolution and Scientific Archaeology, Chinese Academy of Sciences, Beijing 100044, China
[c] Department of Archaeology, University of Sheffield, Sheffield S1 4ET, UK

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ABSTRACT

The Jingshuiwan Paleolithic site lies in the second terrace of the Changjiang (Yangtze) River and has a complete geomorphological section. Archaeological materials from early Late Pleistocene fluvial deposits of silt and sand are dated by optically stimulated luminescence (OSL) to ca. 70 ka. The stone assemblage from layer 7 includes retouched tools (118), cores (304), flakes (281), flake fragments (101), stone hammers (four) and chunks (102). Artifacts were made from lithic sources locally available from the former riverbed. The main type used was silicarenite; quartzite, hypabyssal intrusive rock, extrusive rock and volcanic breccia were also used. The principal flaking technique was direct hammer percussion without prepared striking platforms. Major blanks for tool fabrication were complete flakes (67.0%), followed by cores and incomplete flakes. Most tools were large. Chopper-chopping tools and scrapers were the dominant tool types, followed by points and notches. Modified tools were mostly retouched unifacially on the surface of blanks by direct hammer percussion. Jingshuiwan provides evidence that South China was occupied during MIS 4. Because of the similarity of the stone tool assemblage with earlier ones associated with *Homo erectus*, it may also provide indirect evidence that *H. erectus* persisted into the early Late Pleistocene.

1. Introduction

The Three Gorges region is located in the transitional zone between the upper and middle reaches of the Changjiang (Yangtze) River. In the past two decades, more than 70 Paleolithic sites with human fossils, including Longgupo (Huang et al., 1995), Migong cave (Huang et al., 2000), Leiping cave (Liu et al., 2006), Xinglong cave (Gao et al., 2004) and Caotang (Cao, 2007) and artifacts as well as animal fossils have been discovered in the fluvial terraces and caves along the Changjiang River (Wei, 2004; Liu et al., 2006; Pei et al., 2006a). Since 1995, more than 20 sites have been excavated by a joint team consisting of archaeologists from the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Beijing, the Chinese Academy of Sciences, and the Chongqing Museum of Natural History. A wealth of archaeological remains and animal fossils were unearthed, making the Three Gorges region a rich and important area in Paleolithic archaeological research in China and East Asia. These sites provide valuable data on ancient human technology, adaptation and environmental changes in the region during the Pleistocene. Among these, the Jingshuiwan site is one of the most important Paleolithic sites, characterized by the largest excavated area, the longest excavation seasons, and the most abundant cultural remains recovered in the region.

2. Background

The Jingshuiwan site is located near Xinwan Village, Sanhe Town, Fengdu County of Chongqing on the right bank of the Changjiang River (29°52′38″N; 107°43′05″E) (Fig. 1). The site was discovered on March 19, 1994, and was excavated from 1998 to 2002 for five successive seasons, exposing an area of about 2132 m^2. Large numbers of stone artifacts and fossil fragments were excavated from the site.

2.1. Geology and stratigraphy

Up to seven alluvial terraces were well developed and widely distributed in the Three Gorges region, closely related to the uplift of the Qinghai–Tibet Plateau and the development of the Changjiang River (Shen, 1965; Li et al., 2001; Pei, 2004). Four terraces (T4–T1) were identified, situated 90–110 m, 60–70 m, 35–45 m,

* Corresponding author. 142 Xizhimenwai Street, PO Box 643, Beijing 100044, China. Tel.: +86 10 88369260; fax: +86 10 68337001.
E-mail address: peishuwen@ivpp.ac.cn (S. Pei).

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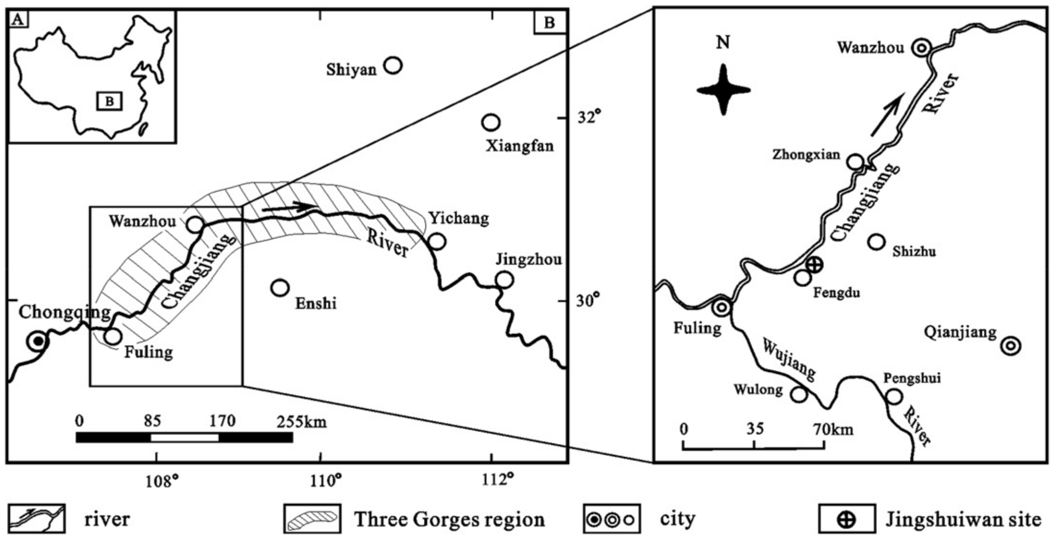

Fig. 1. Location of the Jingshuiwan Paleolithic site.

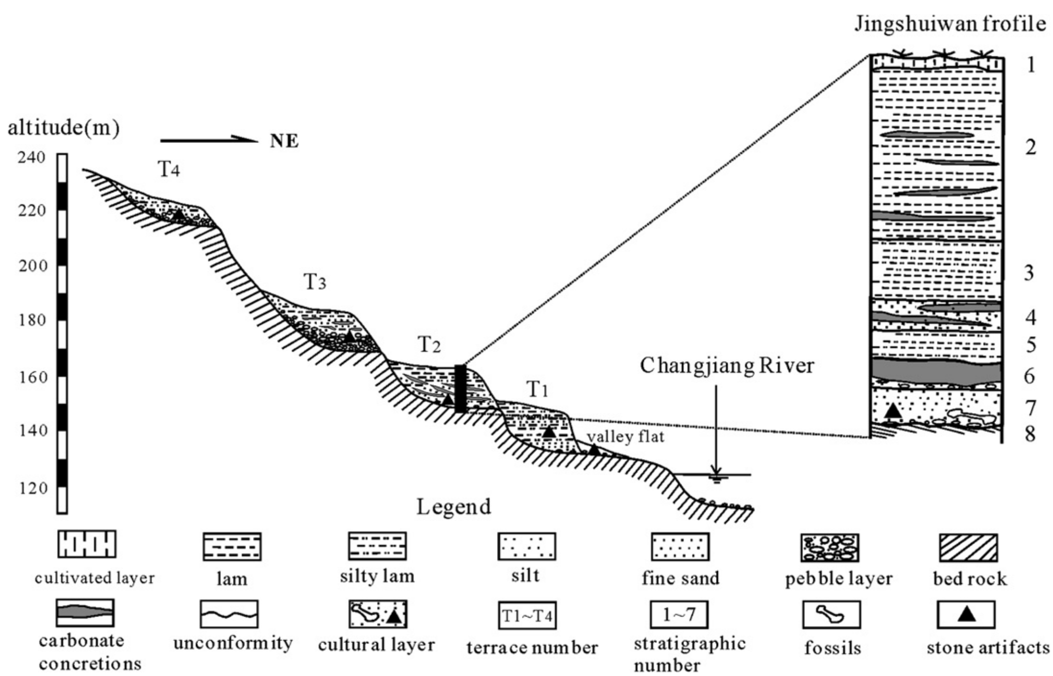

Fig. 2. Stratigraphic sequence and terrace profiles at the Jingshuiwan Paleolithic site.

Table 1
OSL dating on fluvial sediments from Jingshuiwan.

Sample	Layer	Lab code	Sediment	Depth (m)	Grains (μm)	Age (ka)
J0-2-1	2	PKU-L056	Clayey silt	6.7	90–112	69.8 ± 5.3
J0-4-1	4	PKU-L057	Silty sand	9.8	112–160	64.5 ± 4.1
J0-7-1	7	PKU-L058	Silty sand	12.1	112–160	67.8 ± 3.9
J01-7-1	7	PKU-L060	Clay silt, fine sand	7.2	112–160	71.1 ± 5.2
J01-7-2	7	PKU-L061	Clay silt, fine sand	7.2	112–160	75.9 ± 3.7

For J0-7-1, J01-7-1 and J01-7-2 samples were collected from the cultural layer.

Table 2
Lithic artifacts and mammalian fossils from Jingshuiwan.

Excavation season	Test excavation (1994)	1998	1999	2000	2001	2002	Total
	N (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)
Excavation area (m^2)	10 (0.5)	257 (12.1)	255 (11.9)	310 (14.5)	800 (37.5)	500 (23.5)	2132 (100)
Lithic artifacts	50 (5.5)	256 (28.1)	106 (11.6)	179 (19.7)	169 (18.6)	150 (16.5)	910 (100)
Fossils		12 (20.7)	8 (13.8)	17 (29.3)	11 (19.0)	10 (17.2)	58 (100)

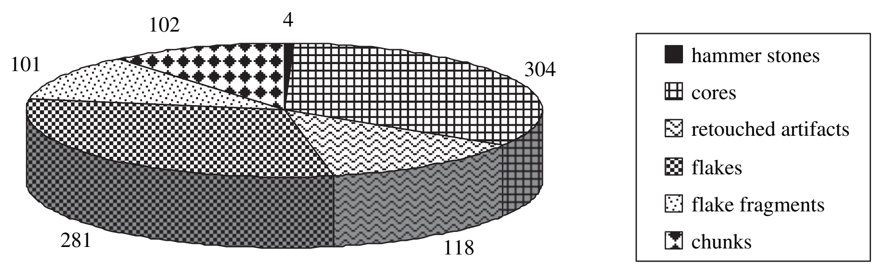

Fig. 3. Frequency distribution of lithic artifacts by class from Jingshuiwan.

and 20–30 m from top to bottom respectively above the old river level around the Jingshuiwan site, which is buried in the second terrace of the Changjiang River. The base of the terrace consists of Jurassic feldspathic sandstone, siltstone and shale. There is almost a total absence of lag gravel, with only a few pebbles scattered in depressions. The upper section is composed of fluvial deposits 16 m thick of sand and silt laminae. The altitude of the anterior margin of the terrace is 168 m a.s.l., 42 m above the water level. The stratigraphic sequence of the site may be described from top to bottom as follows (Fig. 2):

(1) a gray cultivated layer, 0.5 m in thickness;
(2) yellow silt laminae interbedded with maroon laminae, with numerous carbonate concretions, 5–8 m thick;
(3) yellow silt laminae in the upper and maroon laminae in the lower part, 2.5 m in thickness;
(4) carbonate concretions interbedded with yellow silver sand, 1.2 m thick;
(5) yellow silt laminae, with horizontal bedding, 2.0 m in thickness;
(6) weak carbonate concretions, with grayish yellow gravel interbedded with silty sand in the lower part, 1.5–2.0 m thick;
(7) yellow–gray sandy silt and silty sand, interbedded in the bottom part, with a few pebbles in depressions in the bedrock, 0.5–2.0 m in thickness. Most lithic artifacts and mammalian fossils were unearthed from this layer;
(8) Jurassic feldspar sandstone, siltstone, argillaceous siltstone and shale.

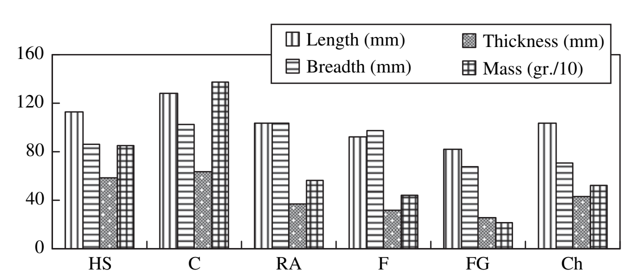

Fig. 4. Bar graph shows the mean size of the artifacts from Jingshuiwan. HS, hammer stones; C, cores; RA, retouched artifacts; F, flakes; FG, flake fragments; Ch, chunks.

2.2. Chronology

The Three Gorges region links its upper rocky valley (Sichuan Basin) to its downstream alluvial sections (Jianghan Basin) (Shen, 1965). About seven terraces were well developed along the region which date from the Early to Late Pleistocene (Li et al., 2001). The first and second terraces are the most widely distributed, and formed from the end of the Late Pleistocene to the Early Holocene, and the early Late Pleistocene or the last interglacial stage respectively. The third to fifth grade terraces were formed during the Middle Pleistocene, while the sixth to seventh grade terraces date from the Early Pleistocene respectively (Pei, 2004).

Although the archaeological team were unable to find suitable dating materials such as organics and well-crystallized carbonate concretions for radiocarbon and U-series analyses, quartz grains from the fluvial sediments of layer 7 (which contained the artifacts) were dated using the optically stimulated luminescence/single-aliquot regenerative-dose technique (Pei et al., 2006b). Five samples were taken from the cultural and overlying layers in the 2000 and 2001 excavation seasons. The optical ages of samples J07-7-1, J01-7-1 and J01-7-2 from the cultural layers indicate a depositional age of about 70 ka. The consistency of the ages of samples J0-2-1 and J0-4-1 from the fluvial sediments overlying the cultural layer, and the ages of the cultural layer suggested a rapid rate of deposition for these sediments (Table 1).

2.3. Cultural remains and mammalian fossils

A total of 968 remains, comprising 910 lithic artifacts and 58 mammalian fossils, were excavated during test excavation and five excavation seasons (Table 2). Because of the acidic soil commonly encountered in South China, mammalian fossils from the site are mostly fragmented. Identified species include *Stegodon orientalis*, Cervidae and Bovidae, characteristic of the *Ailuropoda–Stegodon* fauna typically found in South China during the Middle and Late Pleistocene (Han and Xu, 1989).

3. Jingshuiwan lithic assemblage

3.1. Classification of the artifacts

The frequencies of each tool type from Jingshuiwan are summarized in Fig. 3. As indicated, cores (33.4%) and flakes (30.9%)

Table 3
Raw material frequencies for artifacts by class.

Class	IR						MR		SR		Others	
	Hypabyssal intrusive rocks		Extrusive rock		Volcanic breccia		Quartzite		Silicarenite			
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Hammer stones									4	0.5		
Cores	35	3.9	41	4.5	42	4.6	6	0.7	175	19.2	5	0.6
Retouched artifacts	8	0.9	16	1.8	31	3.4	4	0.4	58	6.4	1	0.1
Flakes	43	0.7	32	3.5	62	6.8	3	0.3	129	14.2	12	1.3
Flake fragments	13	1.4	23	2.5	16	1.8	1	0.1	45	4.9	3	0.3
Chunks	9	1.0	14	1.6	13	1.4	6	0.7	55	6.0	5	0.5
Total	108	11.9	126	13.9	164	18.0	20	2.2	466	51.2	26	2.8

IR, igneous rock; MR, metamorphic rock; SR, sedimentary rock.

are dominant, followed by retouched artifacts (13.0%), chunks (11.2%) and flake fragments (11.1%). Hammer stones (0.4%) were scarce.

A variety of metric measurements were used to record the lithic artifacts, including length, breadth, thickness, and mass. The stone assemblage is dominated by large pieces, and the average measurements of the lithic artifacts are shown in Fig. 4. The length of most artifacts (59.3%) was between 100 and 200 mm, and about 36% were 50–100 mm long. A total of 2.7% and 2.0% of the artifacts were >200 mm and <50 mm long respectively. Regarding their size class, 76.4% of the cores, 45.8% of flakes and flake fragments, 66.1% of the retouched artifacts and 49.0% of the chunks were between 100 and 200 mm long. In contrast, 19.4% of the cores, 48.2% of flakes and flake fragments, 33.1% of the retouched artifacts and 45.1% of the chunks were between 50 and 100 mm long. The four stone hammers were 100–200 mm long.

3.2. Raw materials

In the surroundings of the Jingshuiwan site, feldspar, siltstone and shale with vein quartz are present as bedrock. These could not be exploited as raw materials for stone tools because of their hardness, isotropism and brittleness. The Changjiang originated from the Qinghai–Tibet Plateau, and different types of rocks were transported along the river. Large water-rounded pebbles could be obtained from the riverbed and used as raw materials for manufacturing artifacts. Nearly 97.2% of the lithic artifacts were made of large pebbles, which indicates that the stone raw materials exploited at the site were locally available from ancient riverbeds. The majority of raw materials examined in this analysis are igneous rock, quartzite, and silicarenite (including siliceous siltstone). Igneous rock was further subdivided into hypabyssal intrusive rock, extrusive rock and volcanic breccia. Table 3 summarizes the raw materials used at Jingshuiwan. Most of the artifacts (51.2%) were made from silicarenite. Among the other raw materials, igneous rock was the most abundant (hypabyssal intrusive rocks 11.9%, extrusive rock 13.9% and volcanic breccia 18.0%, which add up to 43.8%). Only 20 (2.2%) were from quartzite, and 26 from other materials such as vein quartz, rock crystal and mineral fragments.

An examination of the raw materials used for making various types of artifact (Fig. 5) shows that sedimentary rock (silicarenite) was the dominant rock type for making retouched artifacts, cores and chunks. The four stone hammers were all made from silicarenite. Igneous rock was dominant for flakes and flake fragments. Quartz and other raw materials were rarely used for making stone tools.

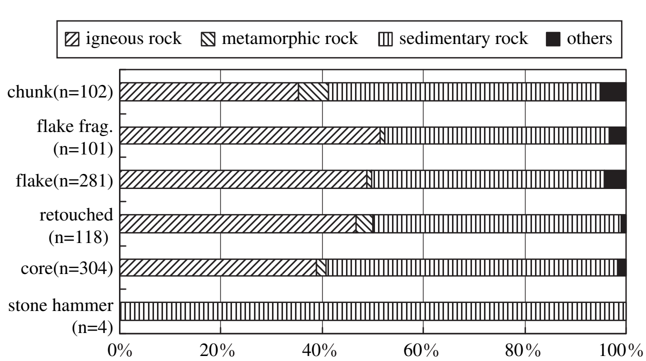

Fig. 5. Distribution of raw material types according to artifact category.

3.3. Products of the flaking process

These included cores, flakes, flake fragments, some of which were retouched.

3.3.1. Cores

Only cores made by direct hammer percussion are present at the Jingshuiwan site. A total of 304 such cores are identified. Two types are recognized: unidirectional and multidirectional. The difference between the two types is the number of directions in which flakes have been removed (Toth, 1985; Andrefsky, 1998). Unidirectional cores can be classified as having one, two and three or more flake scars, and multidirectional ones as showing evidence of flaking in two directions or more. Table 4 shows the core classes and the length measurements.

A total of 190 (62.5% of all cores) cores were identified as unidirectional (Fig. 6). Cores with three or more flake scars were the dominant subclass, followed by two flake scars (42 pieces) and a single scar (30 pieces). One-hundred and fourteen or 37.5% of the cores can be classified as multidirectional (Fig. 5). Of these, 90 were flaked in two directions, and 24 in three or more directions.

The size of the cores varies greatly, with a maximum length of 270 mm and a minimum one of 57 mm. Most cores are relatively large, with a mean length of 128 mm, a mean breadth of 103 mm, a mean thickness of 64 mm and a mean mass of 1377 g. The largest core (FJ2389) measured 261 × 176 × 118 mm and 7240 g, while the smallest (FJ0192) measured 57 × 44 × 24 mm and 100 g. In addition, the cortex coverage of the cores is high, with a maximum coverage of 95% and a mean coverage of ca. 70%. The mean platform angle was 73°.

3.3.2. Flakes

A total of 281 flakes produced by direct hammer percussion were excavated from the site. The flake type is defined by the combination of platform presence and the dorsal cortical coverage of flakes. Flakes are classified into six categories (Toth, 1985; Villa, 1983), defined by their place within a reduction sequence.

Table 4
Core classes and length measurements.

	Unidirectional core			Multidirectional core	
	One flake scar (30)	Two flake scars (42)	Three or more flake scars (118)	Two directions (90)	Three or more directions (24)
Percentage (%)	9.9	13.8	38.8	29.6	7.9
Minimum (mm)	67	60	72	57	73
Maximum (mm)	236	221	270	205	261
Mean (mm)	133	119	129	121	142
SD (mm)	41	32	33	36	47

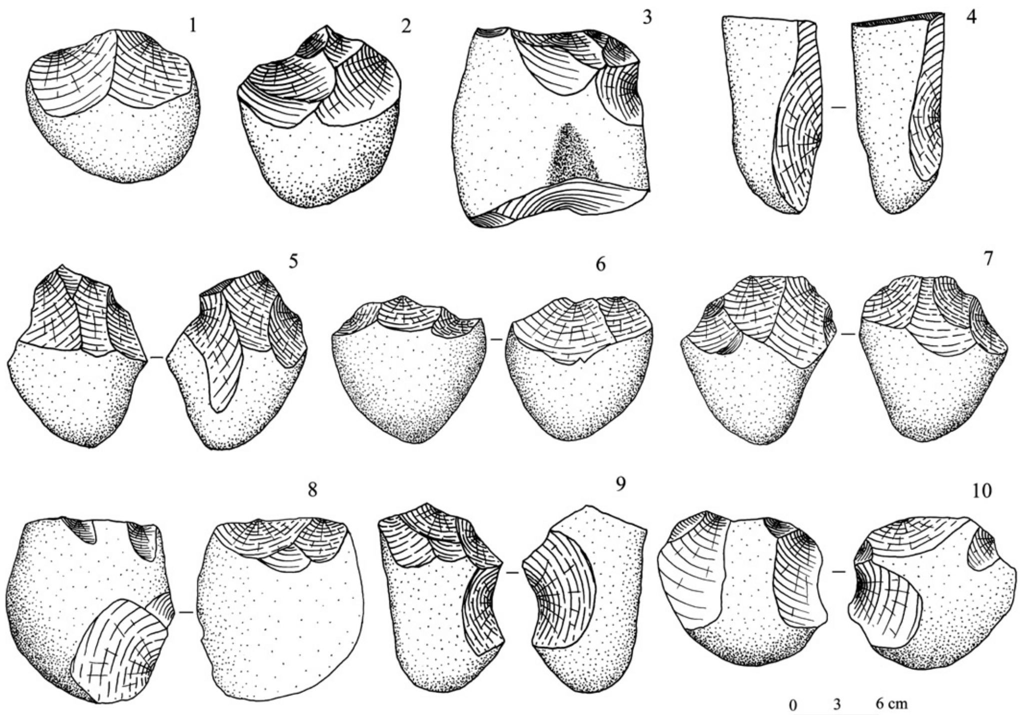

Fig. 6. Cores excavated from Jingshuiwan. 1–3, Unidirectional cores; 4–10, multidirectional core.

Type I, a primary flake with cortex on one side, would be produced in the earliest stage of the reduction sequence, whereas the frequency of occurrence of type IV, a non-cortical flake, is expected to increase as reduction progresses. Types I and IV are sometimes referred to as first generation flakes, types II and V as second generation, and types III and VI as the third generation. Flakes of the same generation can be considered as the products of roughly the same reduction stage (Villa, 1983). Fig. 7 shows the distribution of different flake types at the site.

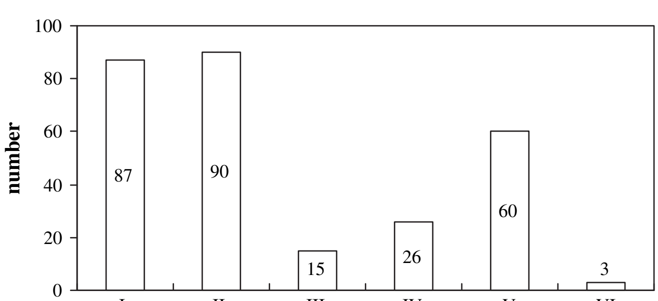

Fig. 7. Representation of the different flake types from Jingshuiwan.

A total of 192 (68.3%) flakes had a cortical platform (Fig. 7). Type I (87 pieces) and type II (90 pieces) are the dominant flake classes, followed by type III (15 pieces). In all, 89 or 31.7% of the flakes can be classified as non-cortical platform flakes (Fig. 8). Type V (60 pieces) is the dominant class, followed by type IV (26 pieces) and type VI (three pieces). According to classification used by Villa (1983), 40.2% of the flakes belonged to first generation stage, 53.4% of the flakes belonged to second generation stage, and just 6.4% of the flakes are third generation stage.

The size of the flakes varies greatly. The largest flake (FJ1712) measured 2190 × 117 × 77 mm and 2270 g, while the smallest flake (FJ1648) measured 23 × 46 × 5 mm and 5 g. Most were between 80 and 110 mm long and wide, with a thicknesses of 30–40 mm; mean length was 92 mm, mean breadth 98 mm, mean thickness 32 mm, and mean mass was 439 g (Table 5).

According to the classification of the flake platform by Andrefsky (1998), only three types were identified at Jingshuiwan: cortical, flat, and complex. No abraded platforms were identified. Most flake platforms (73.2%) were cortical, 25.3% were flat, and only 1.5% were complex. Platform angles were measured when possible. Most flakes have relatively small platform angles, with a mean of 112° for all flakes. Fig. 9 illustrates the distribution of the platform angles at the site.

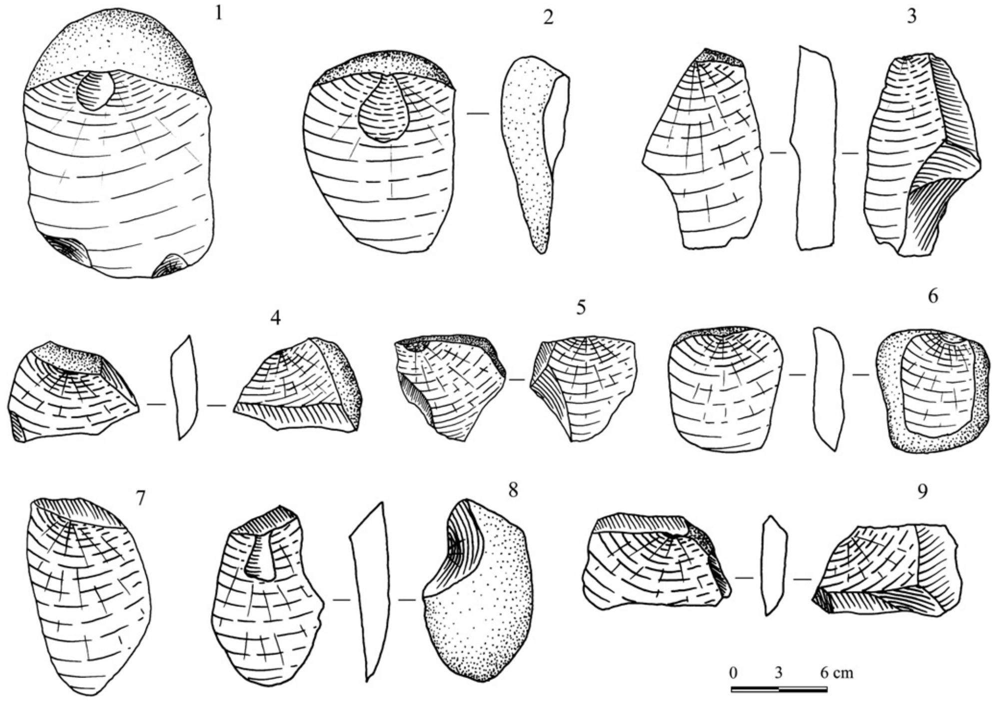

Fig. 8. Flakes excavated from the Jingshuiwan site. 1,2 – type I; 4,6 – type II; 3,5 – type III; 7 – type IV; 8 – type V; 9 – type VI.

Table 5
Size and mass for flakes ($n = 281$).

	Length (mm)	Breadth (mm)	Thickness (mm)	Mass (g)
Minimum	23	31	5	5
Maximum	190	220	95	2920
Mean	92	98	32	439
SD	32	36	14	520

Points of percussion or bulbs on flakes are well preserved. More than 90% exhibit an obvious point of percussion. More than 62% of the flakes show no bulb of percussion. Only 6% exhibit clear bulbs of percussion.

Analysis of the dorsal surfaces of the flakes helps us to reconstruct the technological strategies used by hominids. More than 40% of the flakes are totally cortical. Sixty percent of the flakes have flake scars on their dorsal surfaces, 76.6% have 1–2 negative scars from previous flaking, 13.9% of the flakes have three negative scars on their dorsal surfaces, and 9.5% of the flakes have more than four negative scars. Among the negative scars on the dorsal face of flakes, more than 80% were in the same direction as flaking.

Flake termination is the condition or character of the distal end of the detached pieces (Andrefsky, 1998). Among the flakes from Jingshuiwan, 81.7% of the flakes have indeterminate termination features, but 8.6% show stepped termination, 7.8% exhibit plunging or overshot termination, and only 1.9% possessed a hinge termination.

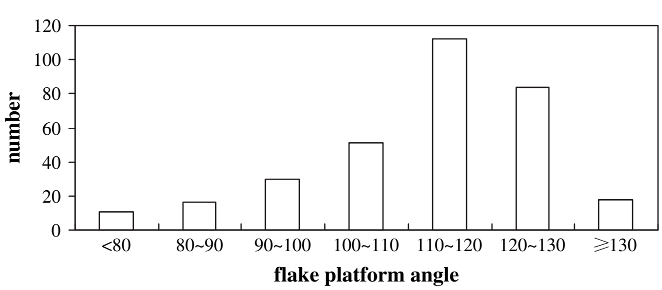

Fig. 9. Distribution of flake platform angles.

3.3.3. Flake fragments

A total of 101 flake fragments produced by direct hammer percussion were collected from the site, making up 11% of the total artifacts. According to the orientation of flakes (Toth, 1985), 18 pieces preserved the left part, 31 pieces preserved the right part, nine pieces were proximal fragments, 20 pieces were distal fragments, and only one piece was a medial fragment. Twenty pieces were debris.

3.3.4. Hammerstones

Only four hammerstones were collected at the site. They were all silicarenite cobbles and exhibited impact scars at one end. The existence of hammerstones, cores, flakes, and flake fragments, and chunks is clear evidence that stone tool making activities occurred at the Jingshuiwan site.

3.3.5. Retouched artifacts

A total of 118 retouched artifacts were collected at the site. The classes and frequencies of those implements are presented in Table 6.

Table 6
Retouched artifacts class and frequencies.

Class	Frequency	Percentage
Chopper-chopping tools	70	59.3
Single-edged	65	
Double-edged	5	
Flake scrapers	43	36.4
Single-side scrapers	27	
Double-sided scrapers	15	
Multi-sided scrapers	1	
Points	2	1.7
Notches	3	2.6
Total	118	100

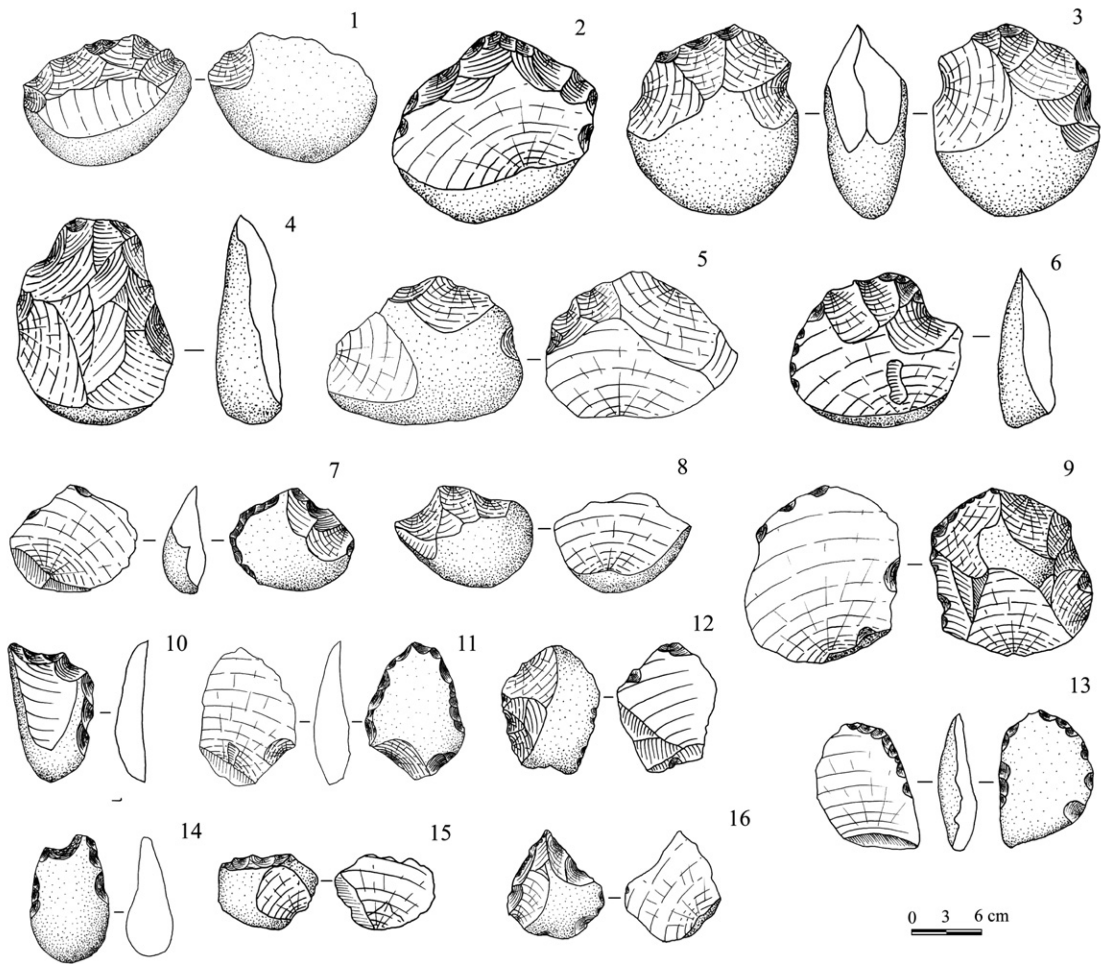

Fig. 10. Retouched artifacts excavated from Jingshuiwan. 1–9, chopper-chopping tools; 10–13, flake scrapers; 14, notch; 15, flake scraper; 16, point.

A total of 70 chopper-chopping tools were identified, making up 7.7% of the whole assemblage or 59.3% of the retouched tools (Fig. 10). Single-edged tools (65) (Fig. 10) are the dominant type, with only five examples of double-edged tools. About 43 flake scrapers were identified (Fig. 10), making up 4.7% of the whole assemblage or 36.4% of the retouched artifacts. Single-sided scrapers are the dominant type, with a total of 27 or 62.8% of the scraper classes, 15 pieces were double-sided scrapers, and only one piece was a multi-sided scraper. Other tools, including points (two) and notches (three) (Fig. 10), make up 4.2% of the retouched tools.

The size of the retouched tools varied from 106 to 178 mm, with a mean length of 108 mm, a mean breadth of 103 mm, a mean thickness of 38 mm, and a mean mass of 604 g. The largest chopper-chopping tool (FJ2078) measured $169 \times 134 \times 80$ mm and 2725 g, while the smallest chopper-chopping tool (FJ2178) measured $59 \times 57 \times 47$ mm and 180 g. The largest flake scraper (FJ2126) measured $127 \times 87 \times 14$ mm (200 g), and the smallest flake scraper (FJ2128) measured $46 \times 57 \times 17$ mm (45 g). Table 7 shows that the chopper-chopping tools were larger than the other retouched tool categories.

Most of the modified tools appeared to have been retouched by direct hard hammer percussion. Table 8 shows that the majority of the tools (67%) were retouched on flakes, 14.4% of the tools were retouched on cores, 9.3 and 7.6% of the tools were retouched on flake fragments and cobbles, and only two pieces were retouched on chunks. Among the 70 chopper-chopping tools, 36 pieces were retouched on flakes, followed by cores (17), cobbles (nine), flake fragments (six) and chunks (two). Therefore, flake blanks are the dominant types for flake scraper retouching, with 38 or 88% of the whole scrapers, and only five were retouched on flake fragments. Three notches and two points were all retouched on flakes.

Retouched directions for modified pieces were assigned to two categories: unifacial and bifacial. In total, 75 pieces or 63.6% of the retouched artifacts were modified unifacially, and the remaining 36.4% of the modified tools were retouched bifacially.

Table 7
Length (mm) and mass (g) for retouched artifacts by class.

	N	Minimum		Maximum		Mean		SD	
		Length	Mass	Length	Mass	Length	Mass	Length	Mass
Chopper-chopping tool	70	59	180	178	2725	124	838	27	530
Flake scraper	43	46	20	127	360	79	180	22	103
Point	2	92	150	106	315	99	233	10	117
Notch	3	81	155	108	320	95	237	19	116

Table 8
Blank frequencies for tools by class.

	Cobble	Core	Flake	Flake fragment	Chunk	Total
Chopper-chopping tools	9	17	36	6	2	70
Flake scraper			38	5		43
Point			2			2
Notch			3			3
Total	9	17	79	11	2	118
Percentage (%)	7.6	14.4	67.0	9.3	1.7	100

The edge length and retouched invasiveness of the retouched tools shows that chopper-chopping tools exhibit maximum retouch length and invasiveness with the mean length of 149.2 mm and invasiveness of 32.1 mm. The mean length and invasiveness of points are 142.5 and 21.5 mm, but flake scrapers show a shorter retouched length and slightly less invasiveness, with a retouch length mean of 120.4 mm and retouch invasiveness mean of 12.4 mm. The mean retouch length and invasiveness of notches are 174.5 and 10.5 mm respectively.

4. Discussion and conclusions

In Chinese Paleolithic research, Gao and Norton (2002: pp. 397–412) considered that "after a long and conservative development, Early Paleolithic in China evolved into a new stage – the Late Paleolithic on the appearance of blade and micro-blade technology and many tool types similar to those of Late Stone Age or Upper Paleolithic in Africa, Europe and western Asia". This assertion was based mainly on analysis of small lithic assemblages from North China. However, in South China, there was no comparable development, and the Pebble Tool Tradition continued even into the Early Holocene. The Jingshuiwan stone tool assemblage shows close ties with this Pebble Tool Tradition (Wang, 1998; Zhang, 2002) of South China. The discovery of the Jingshuiwan assemblage contributes greatly to the establishment of a more complete Paleolithic cultural sequence in the Three Gorges region and in South China. For a long time, Early Pleistocene sites (Huang et al., 1995), Middle Pleistocene sites (Feng et al., 2003; Chen et al., 2004; Gao et al., 2004) and late Late Pleistocene to Early Holocene sites (Wei et al., 1997) were known to exist in the Three Gorges region, but early to middle Late Pleistocene sites could not be confirmed because no reliable dates had been obtained for this period. The Jingshuiwan assemblage is the first evidence of human occupation in South China during the early to middle Late Pleistocene, and therefore, helps to restore the "missing link" of an Early → Middle → Late Pleistocene archaeological sequence in the region. It also shows a distinct and transitional feature in this sequence: large pebble tools are present, but the medium- (50–100 mm long) to small-sized (20–50 mm long) flake tools are the majority. The percentage of middle-sized artifacts is 36% while the percentage of flakes and flake fragments is 73.6%; small scrapers and points, almost absent in the Early to Middle Pleistocene assemblages, become major tool types in this collection. Such features are commonly identifiable in late Late Pleistocene industries in South China (Wang, 1998; Zhang, 2002). The Jingshuiwan industry is thus part of the developmental series of the regional Paleolithic cultures in the Three Gorges region.

The lithic assemblage from Jingshuiwan, dated at ca. 70 ka, forms part of a small but growing body of new evidence from sites such as Zhangkou Cave, Yunnan Province (Shen et al., 2005), dated to 55–110 ka , and the lower levels at Ma'anshan, Guizhou Province, dated to ca. 53 ka (Zhang et al., 2008) that China was inhabited in the early Late Pleistocene before modern humans are unambiguously documented in this region ca. 40 ka. It thus provides additional grounds for arguing that there was no temporal gap in China, as argued by Stringer (1988), between the latest specimens of *H. erectus*, dated to the late Middle Pleistocene, and the earliest modern humans at ca. 40 ka. As suggested by Shen et al. (2007), this temporal gap is most likely an artifact of systematic errors of dating, as well as insufficient fieldwork.

Because no hominin skeletal remains were found at Jingshuiwan, this site does not directly address the much-debated issue of when and how modern humans appeared in China. From current evidence, this occurred in East Asia ca. 40 ka (cal.) BP: the earliest directly dated, unambiguous example of modern *H. sapiens* in China is a femur from layer III, Tianyuan Cave, near Zhoukoudian, that was dated by AMS to $34{,}430 \pm 510$ BP (calibrated age, cal. $40{,}328 \pm 816$ BP) (Shang et al., 2007). Other human remains were found in the same layer, as were several non-human bones, some of which were directly dated to the same age range of $30{,}500 \pm 370$ to $39{,}430 \pm 680$ ^{14}C BP (calibrated range, $35{,}730 \pm 370$ to $43{,}561 \pm 620$ cal. BP). The three dental and cranial specimens of *H. sapiens* from Gaitou Cave, Laibin County in South China, are bracketed between 39 and 44 ka by ^{230}Th/^{234}U (Shen et al., 2007). The well-known cranial specimen from Niah Cave, Borneo, dated to between 39 and 45 cal. ka BP (Barker et al., 2007), is also within the same age range as the Tianyuan human remains. The few other examples of early *H. sapiens* from South and East Asia (for example, from Sri Lanka and Okinawa) are slightly younger (see Shang et al., 2007). Collectively, this evidence may imply that modern humans first arrived in East Asia ca. 40–45 ka cal. BP.

Because the artifacts from Jingshuiwan are similar in technology and typology to earlier lithic assemblages from China that are associated with *H. erectus*, the most parsimonious explanation is that they were also made by *H. erectus*. If so, the Late Pleistocene archaeological record from China may be similar to that from western Europe in that indigenous lithic traditions were maintained by hominins that were not *H. sapiens* (*H. neanderthalensis* in the case of Europe, and *H. erectus* in China) until at least 40 ka BP. However, the situation may not be so clear-cut: in Israel, for example, the earliest populations of *H. sapiens* used the same Middle Palaeolithic technology as the indigenous Neanderthals (see e.g. Shea, 2003). Additionally, there may have been several dispersals across Asia of modern humans before 40 ka, and there is no unambiguous correspondence in MIS 3 (or indeed, earlier) between lithic assemblage and hominin type. At this stage, even the possibility that Neanderthals penetrated as far east as China during the Late Pleistocene cannot be excluded. Additionally, claims of "modern" *H. sapiens* in China that pre-date 45 ka need to be clarified. A prime example is the partial hominin skeleton from Liujiang (Tongtianyan) Cave. This evidence was found by farmers digging for fertilizer (see Wu and Poirier, 1995: p. 186), and as Shen et al. (2002) note, this was an "amateur discovery … and its exact stratigraphic provenance can hardly be unequivocally fixed" without direct dating of the specimen. The uranium-series dates of $67 + 6/-5$ ka for a stalagmitic crust in layer II, and 101–227 ka for five non-human teeth below it do not therefore have any demonstrable relationship to the human remains. At Ganjian Cave, Tubo District, Guangxi Province, five human teeth are bracketed in age between 94 and 220 ka, but additional cranial–dental evidence is required to demonstrate unequivocally that these belong to *H. sapiens* and not a late population of *H. erectus*. The same consideration applies to the two human teeth under a flowstone dated at a minimum age of 160 ka (Shen et al., 2007: p. 2113) at Bailiangdong, Guangxi Province. Until issues such as these are clarified, a definitive account of how and when modern humans first appeared in East Asia remains elusive.

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