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First discovery of a bone handaxe in China

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ABSTRACT

Handaxes, the characteristic tool of the Acheulean industrial complex, are predominantly made of stone. Handaxes made of bone are much less common. Only a few have been reported, from sites in Africa, Europe and western Asia. In this study we report a bone handaxe from Chongqing, southwest China, which represents the first bone handaxe ever discovered in China or any other part of East Asia. Typologically, it is somewhat inconsistent with the classic Acheulean handaxe morphology and is therefore classified as a proto-handaxe in this study. The bone from which the handaxe was made, which is now fossilized, has been dated to ~170 ka based on a U-series technique. The handaxe was manufactured from the mandible of an individual of the stegodontid *Stegodon orientalis*, a typical member of the Middle Pleistocene *Ailuropoda-Stegodon* fauna (*sensu stricto*) of southern China. This artifact represents the earliest evidence for a tradition of bone handaxe manufacture in East Asia, and provides important evidence regarding the lifestyle, technology, and environmental surroundings of the humans that occupied the upstream region of the Yangtze River during the Middle Pleistocene.

1. Introduction

1.1. Pleistocene Paleolithic industries and raw material constraints in South China

Two main Paleolithic industries existed in China, one in the north and one in the south, alongside several local industries (Zhang, 1999). The line formed by the Qinling Mountain Range and the Huai River in central China marked the division between the main Northern and Southern industries in the Pleistocene, and still constitutes a natural geographical dividing line between North and South China (Gao and Pei, 2006). The general characteristics of the main industry of South China (which occurs in the relatively small region (23°39′– 33°22′ N; 104°38′–118°53′ E) are as follows (Zhang, 1999): most stone artifacts are large, heavy duty tools; the tools mainly consist of chopper-chopping tools, picks, handaxes, cleavers and stone bolas, with chopper-chopping tools especially abundant; a few scrapers and pointed tools are also present; and all the tools have been crudely retouched by hard hammer percussion. The main industry in South China has often been referred to as a chopper-chopping tools tradition, because most of the stone artifacts were manufactured directly from large pieces of gravel, usually pebbles (Gao and Pei, 2006). In southern China, the chopper-chopping tools industry lasted from the early Early Paleolithic until the early Neolithic, when proto-handaxes disappeared (An, 1990). Functionally, most of these Southern Chinese tools were large digging tools (LDT) used by Pleistocene human groups that inhabited tropical and subtropical environments and exploited plant food resources (Gao, 2012).

In East Asia, Paleolithic hominids faced a shortage of high quality stone material. The raw material and resource exploitation suggests that the major lithic materials utilized by Paleolithic hominids in China were quartz, quartzite, sandstone and igneous rocks; chert and obsidian were seldom procured (Gao and Pei, 2006). Most often, the Paleolithic hominids that produced the main South Chinese industry, including in Chongqing Municipality, procured only local materials to manufacture tools. The predominant raw materials used to make stone artifacts comprise two main

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types: pebbles from terraces on river banks, and limestone from karst regions. In general, the low quality of most of the available raw material that could be used to produce stone tools in China restricted the development of lithic technology in the Pleistocene. For this reason, Pope (1989) argued that bamboo was probably often used as a substitute in East Asia, including South China. Other easily available organic materials, such as bone, antler, horn, and wood, may also have been important substitutes for stone in South China. Due to the lack of the high quality lithic raw materials for tool-production, every new report of a bone artifact from the Paleolithic of South China is of great interest to archaeologists.

1.2. Temporal context of modified bone implements within the Chinese Paleolithic

Bone has played the role of a raw material for various uses since the very early in human history (Rosell et al., in press). The oldest bone tools were discovered at Bouri, Ethiopia, and have been dated to ~2.5 Ma (Semaw, 2000). Some of the most significant examples of large tools made from bone material are from the Middle Pleistocene, and were recovered at Castel di Guido, Fontana Ranuccio and Polledrara in Italy, Bilzingsleben in Germany, Vértesszölös in Hungary, and Revadim Quarry in Israel (Rosell et al., in press). At Boxgrove, a site in the Acheulean of England dated to 500 ka (Roberts and Parfitt, 1999), some animal bones were evidently made into tools (bone handaxes), while others such as deer antlers were used for shaping tools made of stone (Rosell et al., in press). In addition to these African, European, and western Asian examples, the use of animal bone for making tools has a long history in China.

Research on Paleolithic bone and antler artifacts in China dates back more than 80 years. Henri Breuil, a French Paleolithic archaeologist, carried out the first study of the controversial Paleolithic bone artifacts from the Peking Man site in 1931. An (2001) systematically reviewed the bone, antler, and horn tools from central North China. A total of 17 tool types including points, scrapers, burins, projectile points, drills, needles and harpoons, collected from 22 Paleolithic sites, have been found to range from Early to Late Pleistocene. More than 10 of these artifacts, from the Early Pleistocene Xihoudu site (ca.1.27 Ma; Zhu et al., 2003) in Shanxi and the Donggutuo site (ca.1.1 Ma; Zhu et al., 2003) in the Nihewan Basin of Hebei, represent the earliest known flaked bone and antler tools. The Xihoudu and Donggutou artifacts have been modified in a relatively sophisticated way, which suggests earlier technological stages must have existed in China.

In the 1990s, several controversial bone artifacts were unearthed from the Renzidong Cave site, Fanchang (Fig. 1; Zhang et al., 2000), Anhui. The locality lies in the downstream region of the Yangtze River, and has an Early Pleistocene age of ca. 2.14–2.15 Ma (Wang et al., 2012). Among these bone artifacts, two had undoubtedly been modified to shape them into tools (Fig. 2; Zhang et al., 2000). One had been made from a piece of long bone, and showed regular modification scars at both ends. The other, a bone pick that had been retouched in a simple manner, had been made by chipping the lingual margin of a fragment from the mandibular symphysis of an individual of *Rhinoceros* (Zhang et al., 2000). Subsequently, another 65 bone artifacts were collected from the Longgudong Cave site, Jianshi, Hubei (Li, 2004), and were estimated to be 1.8–2.4 Ma based on paleomagnetic dating (Gao and Cheng, 2004). The Longgudong bone artifacts include bone flakes, points, and shovels. On some bone specimens, marks produced by cutting and chopping can be observed (Hou and Zhao, 2010). The early Early Pleistocene bone artifacts from Renzidong and Longgudong sites are considered to be the oldest known bone tools from China, and indeed from East Asia.

Feng (2004) summarized the technological characteristics of Chinese bone artifacts. Early Paleolithic bone tools are relatively simple and crude, representing flakes of bone that have been modified in a simple way and only at the tip. Bone artifact technology had progressed by the Middle Paleolithic, mainly in that Middle Paleolithic bone tools have working edges that have been modified carefully and repeatedly. Multiple generations of continuous, overlapping scars are usually evident on bone artifacts from the Late Paleolithic, and polishing of bone artifacts began to occur at this stage. The manufacture of bone and horn artifacts was well developed in the Late Paleolithic, a change clearly reflected in the appearance of new techniques such as sawing, scraping, grinding, and drilling.

2. Discovery of a new Paleolithic bone artifact

Chongqing, the largest municipality in China, is a key region for paleoanthropology and Paleolithic studies. In 2002, some mammalian fossils were discovered in a cave, now destroyed, which was located in a limestone quarry on Gele Mountain, Huangma Village, Baishiyi Town, Jiulongpo District, Chongqing, southwest China, at an altitude of 534 m (29°28 ′31″ N, 106°23 ′35″E; Fig. 1). Most of the stratigraphic horizons within this cave, which formed in Triassic limestone, have disappeared due to mining. Many thousands of cubic meters of limestone have been removed by machinery used in the quarry. The damage sustained by the cave, following a detailed geological survey and the commencement of mining operations in the same year, is illustrated in Fig. 3. Only a small amount of deposited sediment remains in this cave, and comprises mainly calcite-cemented brown clay. The mammalian fossils collected from the cave were rather poor, the sample comprising broken teeth, mandibles, and post-cranial skeletons of *Rhinoceros sinensis*, *Tapirus sinensis* and *Stegodon orientalis*. Among this material was the artifact made from the stegodontid bone reported in this paper (Fig. 4). Unfortunately, no other artifacts, human fossils, or other evidence of the presence of humans was recovered in the limited collection from the cave. It is possible that deposits preserving other traces of ancient humans were destroyed long ago as a result of mining activities.

3. Geological age

R. sinensis, *T. sinensis* and *S. orientalis*, species found in association with the bone artifact, were typical members of the Middle Pleistocene *Ailuropoda-Stegodon* fauna (*sensu stricto*) of southern China (Colbert and Hooijer, 1953; hereafter MP*A-SF*). In spite of the poor preservation and low abundance of these fossils, they provide a sufficient basis for dating the site to the Middle Pleistocene. U-series dating of the bone artifact was carried out at the Radiogenic Isotope Laboratory, University of Queensland in 2010, and yielded a U-series age range of 167.55–171.54 ka, belonging to the late Middle Pleistocene. The U-series dating results are highly consistent with the faunal evidence regarding the age of the site (Table 1).

Material: Two bone samples (WGB-2010a and WGB-2010b) were obtained from the proximal end of the bone artifact with an electric drill.

Specimen No.: JLP001.

Dating results: 167.55–171.54 Ka B P.

Sample selection and analytical methods:

We used the TIMS (thermal ionization mass spectrometry) U-series technique to date the bone samples. We first manually cleaned the bone artifact, then got about 0.06 g of fresh bone material for each sample. The samples were each ultrasonically cleaned in Milli-Q water, dried, spiked with 0.03–0.05 g ^{229}Th-^{233}U–^{236}U mixed tracer (0.03–0.05 g), and totally dissolved