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Paleolithic Archaeology in China

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Abstract

Despite almost a century of research, the Chinese Paleolithic chronocultural sequence still remains incomplete, although the number of well-dated sites is rapidly increasing. The Chinese Paleolithic is marked by the long persistence of core-and-flake and cobble–tool industries, so interpretation of cultural and social behavior of humans in East Asia based solely on comparison with the African and western Eurasian prehistoric sequences becomes problematic, such as in assessing cognitive evolutionary stages. For the Chinese Paleolithic, wood and bamboo likely served as raw materials for the production of daily objects since the arrival of the earliest migrants from western Asia, although poor preservation is a problem. Contrary to the notion of a "Movius Line" with handaxes not present on the China side, China does have a limited distribution of Acheulian bifaces and unifaces. Similarly, Middle Paleolithic assemblages are present in the Chinese sequence. Although the available raw materials have been assumed to have limited applicable knapping techniques in China, this notion is challenged by the appearance of microblade industries in the north in the Upper Paleolithic. In the south, early pottery making by foragers emerged 20,000 years ago, thus preceding the emergence of farming but heralding the long tradition of cooking in China.

INTRODUCTION

Paleolithic archaeology in China has been making major strides in recent years, and so a new review of the recent data is now appropriate. New discoveries of human fossil remains coupled with results from a growing number of genetic studies concerning the peopling of eastern Asia and dispersals of modern populations are raising important issues in regard to cultural evolution as seen in the Chinese archaeological record, including regional trends and variability in the Paleolithic cultural sequence. Thus, the aim of this article is to provide a brief updated review of Paleolithic archaeology in China. Our attention here is on the material culture record and not on the rich paleoanthropological record of human fossil remains, which is discussed here only in passing.

LAYING THE FOUNDATIONS: A BRIEF HISTORY OF PALEOLITHIC ARCHAEOLOGY IN CHINA

As seen in the history of Paleolithic research in Africa and western Eurasia, since the early twentieth century, prehistoric stone tools were recognized in geological contexts in China in geological studies of river terraces or ancient lake beds. Pioneering work was completed by European and American scholars familiar with the schematic subdivision of the European Paleolithic sequence and the classification of Lower, Middle, and Upper Paleolithic, Mesolithic, and Neolithic based on morphological differences in stone tools. In addition, they introduced the concept of stages of climatic change that was originally based in the four glaciations recognized geomorphologically in the Alpine moraines and the terraces of the Seine, Somme, Rhine, and Danube rivers in western Europe.

The first stone tools in China were recognized by E. Licent (1876–1952), a French missionary who found seven stone tools in the loess deposits of Qingyang city (Gansu Province) in June 1920. In 1923, he was joined by P. Teilhard de Chardin (1881–1955), and together they discovered the sites of Salawasu (Inner Mongolia) and Shuidonggou (Ningxia). J.G. Andersson (1874–1960), the Swedish geologist who was the first to identify the Neolithic in China at Yangshao village (Henan), discovered the Zhoukoudian site (Hebei) (at the locality known as Dragon Bone Hill) while working at another site nearby. He informed O. Zdansky (1894–1988), who started digging this locality in 1921 and 1923, recovering two human teeth. Consultation with Davidson Black (1884–1934), a Canadian anatomist who was teaching at Peking Union Medical College since 1919, resulted in a joint excavation (Chen 2003, Cormack 2003). Black, recognizing the importance of these hominid finds, initiated a major international multidisciplinary project at the site in 1927, sponsored by the Rockefeller Foundation, under the directorship of Li Jie (1894–1977). From 1930 through 1936, five skulls, defined as S*inanthropus pekinensis*, were uncovered. Another skull, found in the latest layer, was defined as being close to *Homo sapiens*. By that time, the excavation team incorporated European scholars such as A.B. Bohlin (1898–1990), Abbé H. Breuil (1877–1961), and F. Weidenreich (1873–1948), as well as Chinese scholars Young Chung Chien (1897–1979), Pei Wenzhong (1902–1982), and Jia Lanpo (1908–2001). In addition, during this time, Black established the Cenozoic Research Laboratory of the Geological Survey of China at Peking Union Medical School, which became the forerunner of the present-day Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), the leading institution for Paleolithic research in China. Through the years since, Paleolithic research in China has also been carried out by scholars from Peking University as well as from provincial institutes of archaeology (Chen 2003, Y.P. Wang 2005).

The excavations at Zhoukoudian were the most influential in laying the foundation for succeeding Paleolithic research in China, training the first generation of Chinese Paleolithic archaeologists such as Pei Wenzhong, who also studied in France from 1935 to 1937. The discovery of the Zhoukoudian

Homo erectus crania made China a focal point in understanding the sequence of hominin evolution in the Old World. The loss of the original Zhoukoudian fossils in 1937, which were to have been sent to the United States to avoid the dangers of the Japanese invasion, remains a mystery. Fortunately, F. Weidenreich, the paleoanthropologist whose task at Zhoukoudian was to record and publish a detailed study of the fossils, prepared plaster casts of the skulls, which continue to serve modern research (e.g., Weidenreich 1939).

After World War II and the establishment of the People's Republic of China, the Zhoukoudian excavations were renewed in 1949 with Zhang Shensui (1931–2007), who was to become a prominent Paleolithic specialist, joining the team. In 1966, two additional fragments of a human skull were uncovered. A major volume reporting in detail the Zhoukoudian lithic assemblages, as first studied by Pei in 1931, was not published until almost four decades later (Pei & Zhang 1985). Following a series of specialized studies (Wu 1985) and efforts at producing radiometric dates, it was established that the bone- and artifact-bearing layers are of a Middle Pleistocene date. Field work was recently (2009–2011) renewed by archaeologists from the IVPP.

Apart from work at Zhoukoudian, numerous excavations during the 1950s were carried out in response to planned construction activities. These include the surveys and excavations of 14 localities at Dingcun (Shanxi) dating to the late Middle Pleistocene (Pei et al. 1958, Chen et al. 1984). During the 1950s, human fossils were discovered, mostly by farmers, at Ziyang, Liujiang, and Maba (Y.P. Wang 2005). Additional fossils (Lantian, Xujiayao, and Dali) were found in the 1960s, and many more Paleolithic sites were reported, first in northern and northwestern China and later also in the southern provinces. Among these, Xiaonanhai, Shiyu, Xiachuan, and Hutouliang, together with findings from other sites, facilitated the identification of the variability among stone tool assemblages dated to the Late Pleistocene. However, it still took several decades after this to realize that the Paleolithic cultural terminology commonly used in most of Eurasia and Africa, such as the term Mesolithic, was not adequate for labeling the entities of the Chinese sequence. A large number of so called "cultural markers" recognized elsewhere in the Old World were absent in China because they were not yet discovered, because they had been classified differently, or because they were not well dated: These include the Acheulian bifaces, the Levallois technique, and the early blade industries of the Upper Paleolithic. Because of this lack of information, it is now apparent that a more cautious approach would warrant attributing sites and assemblages to the Early (or Lower), Middle, and Late (or Upper) Pleistocene rather than to two stages in the Paleolithic sequences from elsewhere (e.g., Gao & Norton 2002, Y.P. Wang 2005).

Another outcome of the work at Zhoukoudian was the establishment, through its rich lithic and Pleistocene faunal assemblages, of relative chronological sequences over a lengthy period of time based in changes in either mammalian species or lithic industries—a traditional approach originally established in western Eurasia. Although it originally served as a standard in China, with advancements in radiometric dating and the excavation of many other sites, the general chronostratigraphy of Paleolithic lithic industries and fauna in China is becoming clearer, and scholars are less dependent on the Zhoukoudian sequence (e.g., Zhu et al. 2004, Shen et al. 2009).

Determination of relative chronology of open-air Paleolithic sites in China is also commonly performed on the basis of a geological sequence of river valleys having four terraces. This notion was apparently borrowed from the four Alpine glacial cycles, established in the early twentieth century in western Europe, and was adopted in the 1930s by Pei Wenzhong and Chinese Quaternary geologists. Chinese researchers do not incorporate sites within a glacial chronology: Instead, Stone Age sites are relatively dated geomorphologically on the basis of the relative height of the terraces on which the sites appear above river channels.

However, the advancement of geochronological techniques, including the paleomagnetic timescale of the loess plateau of northern China and radiometric dating (e.g., U-series dating methods), has enabled better chronological control of many prehistoric localities. Although chronology is now better understood, what is still missing in Chinese Paleolithic studies is an anthropological orientation—a behavioral orientation in the analysis of open-air and cave deposits.

EARLY PLEISTOCENE HOMININ OCCUPATIONS IN CHINA

As in other regions of Eurasia and Africa, Paleolithic research in China strives to find evidence related to the earliest presence of hominins, including fossil evidence, material culture, and faunal remains, to reconstruct lifeways of these early foragers (e.g., Y.P. Wang 2005, Dennell 2009). The current candidates for the oldest Paleolithic localities in North China are located in the Nihewan Basin and are considered to date generally to the interval between the Olduvai and the Jaramillo paleomagnetic chrons (Kukla & An 1989). There are also a few localities in the south assigned to the same time span.

The earliest site in the Nihewan Basin, considered to represent China's earliest hominin occupation, is Majuangou III (Hebei Province). Several layers have yielded artifacts and animal bones dating on the basis of the rate of sedimentation to 1.55, 1.64, and 1.66 Ma in succession. Other localities in close proximity, include Xiaochangliang (with several hundred artifacts), Donggutou (the richest in artifacts, amounting to more than 10,000 pieces), Banshan, and Xiantai. Most of these produced only a small assemblage of several artifacts per locality, and along with some additional localities, all cluster in date to ~1.36 Ma (Xie et al. 2006). Stone tools are shaped mostly from a variety of raw materials available in the area, such as volcanic rocks, chert, flint, limestone, and quartz, and they are classified as products of a basic core-and-flake industry. This general term refers to flakes detached by recursive direct percussion from a nodule as well as by the bipolar technique. The latter starts by setting a nodule on another rock that serves as an anvil and then knocking on its top. Flakes of different sizes are detached from both ends during percussion. Several cores have been classified as choppers, and among the retouched flakes, a few are classified as scrapers and denticulates. We should note that a core-and-flake industry also characterizes the first out-of-Africa assemblages, such as that dated to ~1.85–1.77 Ma in Dmanisi (Georgia), in the Caucasus area (de Lumley et al. 2005, Ferring et al. 2011). Recognizing that the first Asian populations were bearers of these simple tool kits discounts earlier notions that the earliest migrants into Eurasia were makers of Acheulian hand axes.

The faunal assemblages at the Nihewan sites, grouped here as a cluster, consist of typical Lower Pleistocene species, including *Viverra* sp. (civet), *Felis* sp. (wild cat), *Martes* sp. (marten), *Pachycrocuta licenti* (hyena), *Paleoloxodon* sp. (elephant), *Stegodon* sp. (elephant), *Hipparion sinense* (three-toed horse), *Equus samenniensis* (horse), *Coelodonta antiquitatis* (rhinoceros), and *Bison palaeosinensis* (bison), and *Leptobos crassus* (large ox), *Camelus* sp. (wild camel), *Cervus* sp. (deer), *Gazella* sp. (gazelle), and *Struthio* sp. (ostrich). In well-preserved deposits such as at Xiaochangliang, a suite of microvertebrates has also been collected (Dennell 2009).

Further south, but not crossing the Qinling mountain range, which is considered the geographic boundary between North and South China, are the sites of Xihoudu and Lantian (Shaanxi Province). The Xihoudu lithic assemblage is rather small (32 pieces) and mostly abraded by flowing water (Wei 2000). Its faunal assemblage is similar to that of the Nihewan basin sites. It is tentatively dated to 1.27 Ma (Zhu et al. 2003).

Lantian (also called Gongwangling) is known for its *Homo erectus* cranium apparently associated with ~20 quarzite objects, mostly cores and a few flakes. Here, again, it was dated by comparison with the Zhoukoudian fauna. It seems that the assemblage of Lantian is older, with Pliocene survivors [such as the tapir,

odd-toed ungulate, and the northern-most appearance of the panda (*Ailuropoda melanoleuca*)]. Paleomagnetic investigations demonstrate that the site is slightly earlier than the Jaramillo paleomagnetic chron, calculated as 1.15 Ma (Huang & Zhang 2007).

Several localities in South China have attracted attention in recent years. The first is Longgupo, a large karstic cave and fissure in the Chongqing region. This deeply stratified locality was first excavated by Huang Wanpo (1999) and later by a Sino-French joint team (Boëda & Hou 2011a,b). The revised stratigraphy (Rasse et al. 2011) incorporates a series of archaeological horizons that produce an industry similar in its morphological attributes to other core-and-flake industries in China (Boëda & Hou 2011b). According to the excavators, the lithic assemblage, made on Triassic limestone, suggests that there was clear intentionality in raw material choice and that the formation of cutting edges was achieved through either uni- or bidirectional knapping. Estimated age of 2.3 Ma was not confirmed, and a recent study indicated an age between 1.7 to 1.3 Ma by Electron Spin Resonance (Han 2011).

Renzidong (Anhui Province) is a large fissure that is rich in animal bones, many of which are articulated and thus are likely the remains of individuals who fell to their deaths (Jin et al. 2000, Jin & Liu 2009). Investigators found several dozens of artifacts and, although previously doubted (Hou & Zhao 2010), their anthropogenic origins have recently been confirmed (Boëda & Hou 2011a,b); however, the processes of their deposition within the clayey sediments, which are also rich in complete animal skeletons, are unknown. A previously suggested age for these deposits of ~2.2–2.4 Ma was not supported by direct dating. Hou & Zhao (2010) estimated an age younger than 2.6 Ma, considered today as the Plio-Pleistocene boundary.

Yuanmou (Yunnan Province) is a major faunal deposit that seems to be of Early Pleistocene age, where two incisors attributed to *Homo erectus* as well as a few artifacts were found (Zhou 2009). Given the number of Pliocene species among the animal remains, it seems reasonable to attribute the site to the Olduvai chron or somewhat later. This site as well as others in South China raise the issue of the possible late survival of older species in this region because it was favored by subtropical conditions during most of the Early Pleistocene. It is only with the advancement of the glacial cycles that environmental conditions in South China were severely affected, as can be seen in marine cores from the South China Sea (Li et al. 2006).

In summary, according to current consensus early Paleolithic hominins in China were *Homo erectus* migrants from Africa. Their first entry to western Asia is evidenced at Dmanisi at ~1.85 Ma by several skulls, postcranial elements, and a core-and-flake industry (e.g., Ferring et al. 2011). Once in China, these groups of early foragers are found across many ecozones. They were likely camping temporarily near water sources (springs and creeks) and surviving by hunting, scavenging, and feeding on edible plants. There is a paucity of archaeozoological-oriented studies and a very small amount of analyses and recording of butchery, gnawing, and trampling marks on bones. These hominins used hard rocks available in their immediate environments to make simple stone artifacts. Quartz, quartzite, flint, and different metamorphic rocks were exploited as nodules to detach flakes, some of which were retouched intentionally or bear signs of utilization. The southern sites demonstrate a more frequent exploitation of river cobbles that served as cores for obtaining sharp flakes or as choppers with which tools from bamboo could be made, as has been suggested in the literature and supported by experimental studies (Pope 1988; Schick & Dong 1993; Y.P. Wang 2005; Boëda & Yamei 2011a,b; Bar-Yosef et al. 2012). There is no need to assume that strict morphotypes were already embedded in their mental templates.

MIDDLE PLEISTOCENE ASSEMBLAGES AND THE CHINESE ACHEULIAN

The Middle Pleistocene period in China, featuring sites dating between 0.78 and 0.13 Ma, is

composed in North China of many sites bearing mostly core-and-flake industries, usually with small flakes, but on rare instances large flakes (longer than 10 cm) have been found as well. In South China, there is the Chinese Acheulian and rich cobble-dominated assemblages. The most prominent site from this time period is Zhoukoudian Locality 1 (e.g., Pei & Zhang 1985, Wu 1985 and papers therein, Goldberg et al. 2001, Shen et al. 2009) located in the Beijing municipality. The complex stratigraphy exposed at Locality 1 is subdivided according to the different nature of the deposits into layers 1 through 17. These deposits accumulated within a major intersection of two geological fissures. The main cultural deposits are interspersed between layers 2, 3, and 4 (three horizons), in layer 7, at the top of 8, and in 10, but a few artifacts were also found in every other layer. Geochronologically the entire sequence is subdivided paleomagnetically into layers 17 through 12, which accumulated prior to 0.78 Ma, and layers 11 through 1, which were deposited during the early part of the Middle Pleistocene. The various radiometric dates for the archaeological contexts at Zhoukoudian, summarized by Dennell (2009, table 10.2), along with the recent dates provided by Shen et al. (2009), support the contention of a hominin presence from ~0.78 Ma through ~0.4 Ma. The depositional and erosional history of the site features several cycles (Goldberg et al. 2001 and references therein). During the earlier period, water removed the lower fill of the fissure and the site was a cave. Successive dissolution, erosion, and the loss of stability of the fissures' fill caused many blocks, small and large, to fall down, forming layers 6 through 9. This process ended with a major formation of a speleothem (layer 5), which made Zhoukoudian an open-air site. Thus, layer 4 accumulated as a sequence of redeposited loess, which created favorable living conditions for humans, and this layer was topped by a few fallen blocks. The uppermost layers (1–3) are a mixture of further collapse of the natural fractured rock, slope wash, colluviation, and some karstic activities with a limited spread of speleothems.

The intensity of human occupations at Zhoukoudian is clearly expressed in the relative densities of artifacts reported in detail (Pei & Zhang 1985). Lithics are mostly made on vein quartz, often by bipolar percussion, which results in numerous flakes. Some flakes are retouched, and there are a few core choppers. Other stone tools were made from cobbles and nodules collected from the river or within a few kilometers. The rich faunal remains are mainly those of *Equus* sp., *Bubalus*, *Pseudaxis*, *Megaloceros*, and *Spirocerus* (equids, bovids, and three deer species). Their bones bear gnawing and butchery marks (Binford & Ho 1985, Binford & Stone 1986). Direct, unambiguous evidence for the use of fire was not disclosed during a detailed study of the western section (Weiner et al. 1998), although burned bones were found, and older excavation records indicate that some hearths were possibly found within layer 4. However, the habitual use of fire since ~0.5 Ma would not be surprising because it is well known from other Eurasian sites (Karkanas et al. 2007, Roebroeks & Villa 2011). Earlier evidence for the use of fire is now recorded in Gesher Benot Yaacov in Israel and Woderwerk Cave in South Africa (Goren-Inbar et al. 2004, Berna et al. 2012). Apparently the site was often occupied by hyenas who sometimes fed on human remains. None of the many issues pertaining to site formation processes is fully resolved, and research at Zhoukoudian continues today by IVPP investigators.

There are several additional archaeological localities at Zhoukoudian. Among these are Zhoukoudian localities 15 and 4, assigned on the basis of various dating techniques to the later part of the Middle Pleistocene, ~0.25 to 0.13 Ma. The lithic industry of Locality 15 marks a departure from the bipolar technique common in the earlier contexts. Locality 15 lithics feature direct percussion by hard hammers to produce flakes from discoidal cores and, alternately, multidirectional knapped nodules. Retouched flakes can be classified as side scrapers, making this assemblage representative of the local Middle Paleolithic (Gao 2000, Gao et al. 2005).

Locality 4 (the New Cave) produced a human tooth considered to be from *Homo sapiens* and a small collection of artifacts similar to those of Locality 15. Two other important cave sites are located on the same hill: Upper Cave and Tianyuan Cave (Shang et al. 2007, Shang & Trinkaus 2010). These date to the Late Pleistocene and are discussed below.

A major debate concerning the presence of bifaces (hand axes) in China illustrates the increasing variability among the lithic assemblages of this period. It was a seminal paper published in 1948 by H. Movius, a Harvard University Paleolithic archaeologist, that caused in the ensuing decades many debates among local and foreign prehistorians. Studying in his early career the Paleolithic of Southeast Asia, Movius (1948) concluded that the Acheulian complex, known for its variability of biface morphotypes (or hand axes) in Africa and western Eurasia, was not present in East Asia. Thus, this geographic-cum-cultural demarcation became known as the "Movius Line." Although the "Movius Line" implied a distribution of Lower and Middle Pleistocene Acheulian across Eurasia, today this tool kit is absent from most of Eastern Europe, the Iranian plateau, and the Baluchistan hilly region. Unfortunately, within the relative chronological schemes of the Quaternary established during the nineteenth and early twentieth century, the Acheulian complex was considered an important stage in human cultural evolution, and later it was used for recognizing technological evolution (Stout 2011). In previous decades, an apparent absence of bifaces from China (now known to be inaccurate) was taken as indicative of cultural inferiority. This assumption triggered an intensive search for bifaces in China and continuous debate concerning the attribution of these finds to the Acheulian (Schick 1994, Norton & Bae 2008, Petraglia & Shipton 2008). However, beside scattered finds of bifaces often collected on the fourth terrace in the geochronological scheme still in use in China, the first clues toward a greater presence of handaxes were found in two regions: the Luonan Basin in Shaanxi Province and the Baise area in Guangxi Province (Huang 2003, Xie et al. 2011). Today, through additional surface finds, we can see that the distribution of bifaces is found running approximately between these two subregions as well (**Figure 1**)

Luonan is an intermountain basin in the eastern Qingling Mountains (the geographic boundary between northern and southern China). Numerous crude hand axes were found scattered over different terraces of the Luohe River, but recently two of the loess exposures produced a few in situ items (e.g., S.J. Wang 2005, Lu et al. 2011). Magnetostratigraphy of the loess sequence and calculations of the rate of sedimentation in this area indicate an age of ~0.8–0.7 Ma for the first occupations in the area, but most of the bifaces date to ~0.4–03 Ma, although the possibility that bifaces continued to be present during the Late Pleistocene needs to be examined as well. The Longyandong cave in the same basin produced thousands of objects of the common core-and-flake industry, including retouched flakes, and dates from ~0.35 Ma to the Late Pleistocene (Wang & Huang 2001).

A larger distribution of bifaces, unifaces, and picks is known from several exposures along the Youjiang River in Guangxi, where artifacts were found with tektites dating to ~0.8 Ma. In the uppermost layer, a core-and-flake industry has been found (Hou et al. 2000; Huang & Yuan 2002; Xie et al. 2003, 2011; Xie & Bodin 2007). Many of the bifaces were shaped from large cobbles with rounded tips. Although certain scholars suggest not to refer to these assemblages as Acheulian, by the basic definition of this industry, even a minute percentage of bifaces, and even if rough in form, would still require the term Acheulian to be used. Acheulian hand axes can be found in various shapes, and when we look across all other regions in the world, in more than one case we can find hand axes that are the same as some of the Chinese finds. If the knowledge of making these tools was held by certain groups of people, then in noting that the Acheulian territory expanded into the Indian subcontinent, including the foothills of Nepal, the Baise and Luonan groups could thus represent migrants from this area.

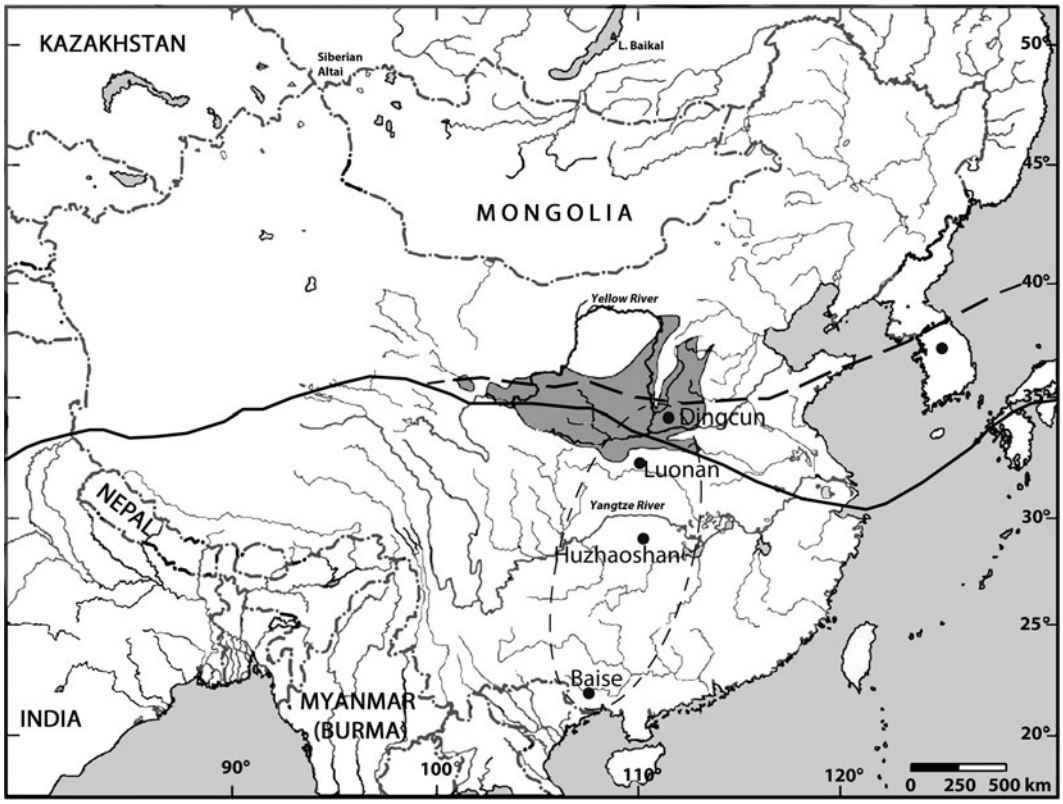

Figure 1

Map of China. The lines across mark the northern distribution of bamboo today and the dashed line indicates the Pleistocene situation. The gray area in the north is the loess plateau. Four major concentrations of bifaces are named; the oval dashed line marks the approximate surface distribution of bifaces.

The lithic industries of the late Middle Pleistocene (~0.35–0.13 Ma), the time of MIS 8–6, continue to exhibit the production of cores, choppers, and flakes (Y.P. Wang 2005). Among the best examples are Panxian Dadong, a major cave in Guizhou Province in South China (Schepartz et al. 2000, Karkanas et al. 2008), and Jinniushan cave in Liaoning Province in the north, where one of the best preserved burials of an archaic *Homo sapiens* was uncovered (Lu 2003). Dadong cave, in addition to being a large faunal assemblage, produced a reasonably rich lithic assemblage. The artifacts were made of limestone, chert, and basalt. Their frequencies change from the lower layer (dated to 0.262–0.214 Ma) to the upper layer (0.156–0.137 Ma), demonstrating the increased use of basalt and chert as well as a rise in the percentage of retouched flakes (Miller-Antonio & Schepartz 2004). Jinniushan, on the other hand, contained a small assemblage of a couple hundred flakes and some cores and is dated to 0.31–0.24 Ma by U-series and ESR (Lu 2003).

During the late Middle Pleistocene of western Eurasia, industries labeled as "Mousterian" are well-known. Mousterian stone tools are produced by several techniques, the best known of which is the Levallois. Evidence for the use of Levallois technique is limited to western China (Ningxia) (Gao & Norton 2002) and the northern area of Jilin Province (Wang et al. 2010). However, across central China there are Middle Paleolithic industries (Keates 2001). Although these lack the use of Levallois methods, their

predominance of cores and flakes, of which a certain percentage is shaped into side scrapers, is similar to that of the non-Levallois industry known as Quina Mousterian in France, where it lasted through the early Late Pleistocene, until the arrival of modern humans (Bourguignon 1996). We also note that the practice of Levallois is not related to the availability of raw material because flint is present in many provinces of China. Moreover, small nodule size is not necessarily a factor either because the so-called Levallois-based "Pontinian" Mousterian industry in Italy was made on small nodules, often no more than 3–5 cm in size (e.g., Kuhn 1995). On the other hand, several cobbles randomly collected along the Wushui River, which flows from the Guizhou plateau into Hunan, were perfectly adequate for the production of Levallois artifacts (Bar-Yosef et al. 2012, figure 6). Hence, the presence of a particular knapping technique is a matter of having a cultural template, which is created by systematic teaching, is transmitted rigidly within the mating system of a social entity, and is generally not influenced by the available raw material.

EARLY LATE PLEISTOCENE

During the first part of the Upper Pleistocene, all hunter-gatherers across China produced their stone artifacts through the traditional core-and-flake (also called flake-and-shatter; Barton et al. 2007) technique in the north and by knapping river cobbles, often flat ones, or various nodules, in the south, shaping cores, choppers, and flakes. In both regions, lithic assemblages demonstrate a rise in retouched flakes.

Traditional Levallois technique, mentioned above, occurs in western China, as in Shuidonggou near the Yellow River (e.g., Brantingham et al. 2001, Ningxia 2003), and in the northeast in Jinsitai cave in Jilin Province (Wang et al. 2010), where it appears that people with knowledge of this technique were foraging. The presence of Neanderthals, the bearers of Mousterian assemblages across most of western Eurasia during this period, is known from a few fossils as well as from ancient DNA (aDNA) studies from Altai cave sites. It is conceivable that on their dispersal route eastward they reached northern China (Bar-Yosef & Belfer-Cohen 2012). However, during this same time, the Denisovans, a previously unknown population, were also present in East Asia (Reich et al. 2011). Thus it is premature to identify the makers of the late Middle to early Late Pleistocene stone tools in China. Genetic evidence suggests that ~50–35 Kya modern humans, who carried a small percentage of Neanderthal genes (Green et al. 2010), were already living or arriving in East Asia. Thus, as in western Asia, where Middle Paleolithic assemblages were made by different morphotypes of humans (archaic modern humans and local Neanderthals), the human biological variability in East Asia could be even more complex.

THE UPPER PALEOLITHIC AND THE MICROBLADE INDUSTRIES

The Upper Paleolithic of western Eurasia is characterized by the systematic transition to blade production; changes in the frequencies of tool types such as burins; consistency in the appearance of end scrapers; the use of shells, beads, and pendants for body decorations; and the presence of bone and antler tools as well as the exploitation of ivory. Current research in Africa and western Eurasia demonstrates that the full Upper Paleolithic package is not present in every region. Raw materials such as deer antlers were used only by certain populations in temperate Europe but not by others. Similarly, while studies of Pleistocene Chinese faunal collections demonstrate the availability of several species of deer, the still-infrequent use of antlers began sometime after 20 Ka cal BP (calendar years before present) (e.g., MacNeish et al. 1998).

One of the Upper Paleolithic markers—systematic blade production—is known from western China in Shuidonggou (Ningxia) next to the Yellow River (e.g., Ningxia 2003) and joins similar phenomena in Mongolia and eastern Siberia (Derevianko 2011). In the north-

eastern subregion of Jilin Province, a blade industry shaped of obsidian and rich in burins and end scrapers is recorded in open-air sites close to the Yalu River (e.g., Chen et al. 2006). However, similar assemblages that could be attributed to the time range of 35–30/27 Ka cal BP are as yet unknown further south in northern and central China. Instead, we note the continuity of core-and flake-assemblages there during this period. One of the best examples is Upper Cave Zhoukoudian, where, in addition to the quartz core-and-flake industry, bone tools and body decorations as well as human fossils are found (e.g., Pei 1939, Harvati 2009). An additional example is the Wangfujing site (in Beijing) dated to ∼24 Ka cal BP (Y.P. Wang 2005; Qu et al. 2012, tables 1 and 2).

Around 28/27 Ka cal BP, a new technique appeared in the archaeological record of northern China. This is the well-known microblade industry found in sites where the rest of the tool kit consists of many crude artifacts produced by the core-and-flake reduction technique (**Figure 2**). The production of small bladelets was achieved in several ways, which can be recognized according to the dominant core types.

1. Wedge-shaped cores, known in Japan as the Yubetsu method, were prepared as relatively thin bifaces. An elongated platform was formed by the removal of a crested blade along one of the edges of the biface, and another detachment of one of the edges prepared it for the systematic removal of bladelets. Renewal of the platforms was done either by producing a core tablet or by carefully retouching and reshaping the platform (e.g., Morlan 1970, Flenniken 1987, Chen 2007). On the basis of the Dyuktai cave collections in Siberia, Flenniken (1987) experimented with pressure flaking to replicate the operational sequence of wedge-shaped cores. Once the bifacial object was shaped from a fine-grained siliceous nodule, it was heat treated, a process known to improve the flakeability of the raw material. This technique was practiced mainly in the northern part of North China from ∼16/15 Ka cal BP.
2. The boat-shaped core differs from the wedge-shaped core in its initial preparation because it is modified on a chunk of tabular flint, sometimes with cortex preserved on both faces. First, a striking platform is formed, then the two faces are shaped with a crest in the lower part, after which time one of the edges becomes the front from which bladelets are detached. Both the boat-shaped as well as the various conical cores described below characterize the southern part of North China from ∼28/27 cal BP onward (e.g., Zhang et al. 2011). These cores, when viewed with the crested edge up and the striking platform down, would be called carinated cores in western Eurasia (e.g., Belfer-Cohen & Grosman 2007).
3. The conical, semiconical, and funnel-shaped cores as defined by Chinese archaeologists are morphologically similar to each other and are shaped by the same reduction sequence. They are directly related to the common prismatic core except that they were either hand-held for direct percussion or enclosed between the arches of the knapper's feet. The detachment in this position was made by a punch. The cores for producing the microblades were enclosed within two wooden braces, and this signifies a change in the skill level required.
4. The pressure-flaked cores known as pencil shaped have parallel edges almost up to the distal tip. As shown experimentally, the bladelets are obtained by pressure flaking with the flaking device pushed by the chest (e.g., Inizan et al. 1999, Inizan & Pelegrin 2002). Raw materials could have been obsidian or flint that was heat-treated. This core type dates mostly to the Terminal Pleistocene and Neolithic periods.

Microblades, either with plain or retouched edges, were hafted in wooden, bone, or antler handles and shafts. There are at least three

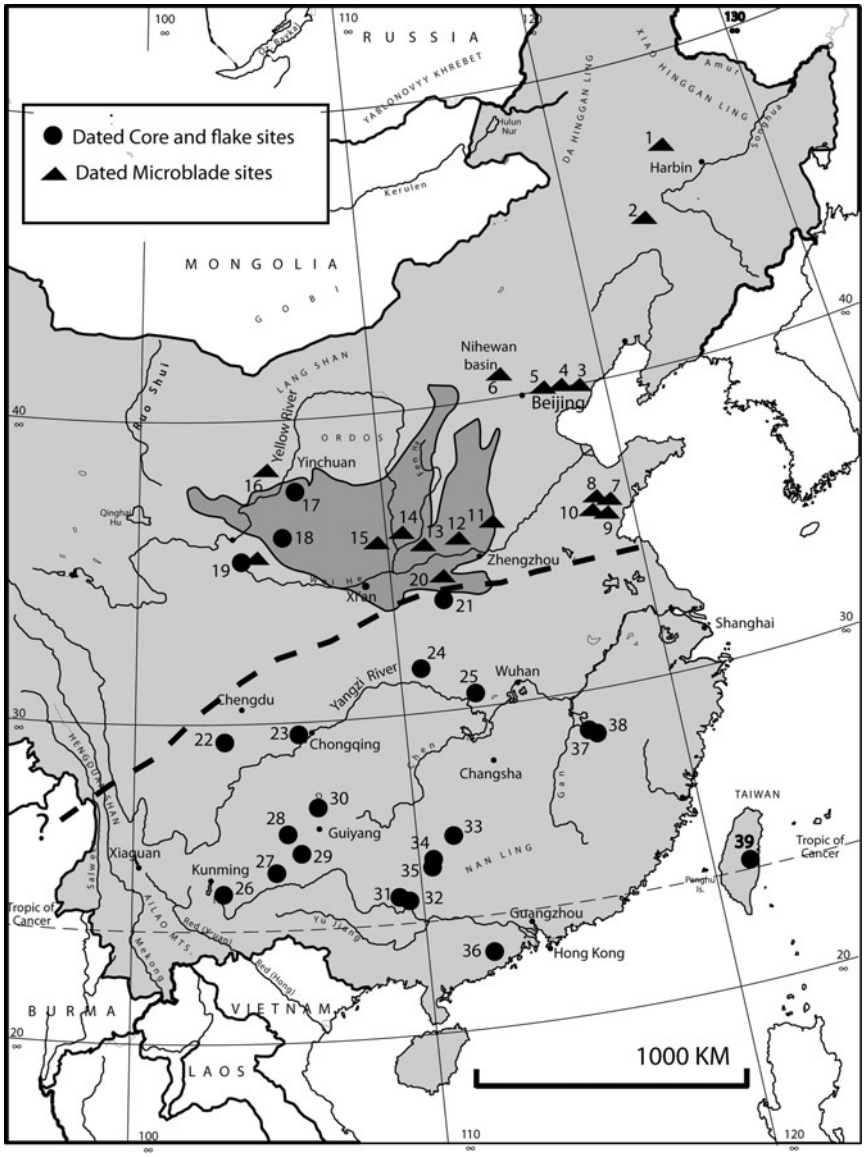

Figure 2

Distribution of dated microblade sites and contemporary core-and-flake sites (modified from Qu et al. 2012). The sites are 1. Daxingtun; 2. Dabusu; 3. Tingsijian; 4. Donghuishan; 5. Mengjiaquan; 6. Nihewan site cluster; 7. Qingfengling; 8. Fenghuangling; 9. Wanghailou; 10. Heilongtan; 11. Xiaonanhai; 12. Xiachuan (upper layer); 13. Xueguan; 14. Shizitan; 15. Longwangchan; 16. Pigeon Mountain; 17. Shuidonggou; 18. ZL05; 19. Dadiwan (stratified core and flake and microblades); 20. Dagang; 21. Xiaokongshan; 22. Fulin; 23. Tongliang; 24. Zhangnaodong; 25. Jigongshan (upper layer); 26. Longtanshan; 27. Maomaodong; 28. Chuandong; 29. Baiyanjiaodong; 30. Ma'anshan; 31. Bailiandong (middle and upper layer); 32. Liyuzui; 33. Yuchanyan; 34. Zengpiyan; 35. Miaoyan; 36. Dushizai; 37. Xianrendong; 38. Diaotonghuan; 39. Baxiandong.

archaeological examples of hafted bladelets, one uncovered in Donghulin (Archaeol. Dep. PU 2006), an early Holocene site, the other in Xinglongwa, a Neolithic site (Inner Mongolia, ~8.0 Ka cal BP), and additional example in Yuanyangchi, a later archaeological context (~4.0 Ka cal BP). In both examples, bladelets were inserted in one or two sides of a bone haft apparently to serve as knives (Lu 1998) or as antler armatures (Elston et al. 2011).

The speed with which microblades expanded across northeast Asia, the Japanese archipelago, North China, and later, during the Holocene, further south beyond the Yellow River (Kuzmin et al. 2007 and papers therein), reaching the mid-altitudes of Tibet (Madsen et al. 2006), is an amazing phenomenon. Archaeologists still wonder whether the distribution of the microblade industries resulted from dispersal of the technique through cultural transmission or by the rapid migration of foragers during several different times, as is indicated by their presence in Alaska and the southward movement along the ranges of the American northwest coast. This later dispersal is suggested to correlate with the pre-Athapaskan and Athapaskan speakers (Magne & Fedje 2007).

We also note that for a long time (~12 Ka years) the core-and-flake makers were contemporary with the producers of the microblades (Y.P. Wang 2005, Shen 2007). A similar phenomenon is recorded in some areas of Korea, where hand axes and core-and-flake assemblages persisted cheek by jowl with microblade users (Bae 2010). The continuous contemporaneity between the two or three knapping techniques, each requiring a prolonged period of teaching and learning within a concrete social group (a clan or tribe?), is intriguing. The expertise of making microblades was not adopted immediately by other groups, as demonstrated by the example from Shandong (e.g., Shen 2007). Perhaps limits on technological transmission were in operation, such as taboos on distributing knowledge or adherence to cultural traditions in making stone tools.

In addition, the use of flat grinding stones was common in many of the microblade sites. Evidence already highlights several examples of grinding stones from Holocene localities, from which starches were obtained and reported (Liu et al. 2010, 2011). These indicate the use of plant foods such as acorns, beans, and some millet. In various sites, hunting of wild pigs, cattle, three species of deer, and some equids is recorded.

THE EARLIEST POTTERY

One of the major inventions during the Chinese Upper Paleolithic is the making of pottery. In the cave sites of South China, in addition to the traditional cobble industry and the making of bone, antler, and shell tools, foragers began making pots, dated in the Xianrendong and Diaotonghuan caves (Jiangxi Province) (MacNeish et al. 1998) to 20–19 Ka cal BP and in the Yuchanyan cave (Hunan Province) to ~18–17 Ka cal BP (Boaretto et al. 2009). These manifestations precede the early Jomon in Japan that are dated to ~16 Ka cal BP and slightly later in Siberia (Kuzmin 2006, Jordan & Zveilbel 2010). Yet it is premature to suggest that pottery making began in a core area and dispersed elsewhere from there. Although the function of the pots is not known, we assume, based on superficial examination, that they were used for cooking during the relatively harsh conditions of the Late Glacial Maximum. This method was a critical improvement over the old technique of cooking in hides over fire. The making of pots since ~20–16 Ka cal BP precedes by several millennia the transition to cultivation and farming. Indeed, the definition of the Upper Paleolithic should also include the use of ceramics, as seen with figurines in Dolni Vestonice (Vandiver et al. 1989) and in the pottery making in South China and other regions of East Asia.

CONCLUSIONS

The description of the various prehistoric phases, stages, or lithic industries in China

hardly follows the traditional definitions of Lower, Middle, and Upper Paleolithic commonly employed in western Eurasia or of Early, Middle, and Late Stone Age in Africa. The unique approach in assigning finds to the local relative Pleistocene chronological scheme is due to the nature of the typical artifact types in China. Apparently the long-term continuity of artifacts known as core choppers, core and flakes, flake and shatters, and cobble tools do not fit within the Eurocentric subdivision of the prehistoric periods mentioned above. Even worse, the uncritical use of the terms Mode 1, 2, 3, etc., as proposed by Clark (1970), which were originally intended to be based on the main tool-making techniques, unfortunately sees them employed as synonyms for terms such as Oldowan, Acheulian, or the Mousterian cultures (also known as the Middle Paleolithic period). With current advancements in our understanding of issues such as the role of language, learning within the group, and the transmission of information, it is time for prehistorians of the Old World to adopt the use of terminology such as social entities or prehistoric cultures. Referring to these entities identified in space and radiometric chronological framework, recording changes along technological (core-reduction sequences) and typological (morphotypes of retouched blanks) attributes within their geographic distributions, as is done for example for European entities younger than 40 Ka cal BP, will allow us to recognize in China several cultural entities and their entanglements across the Eurasian continent. This practice would certainly demonstrate that the Paleolithic cultural variability across China is larger than the impression currently given in the available literature.

Two important subjects were not addressed in this review. The first is the paleoclimatic sequence of the Chinese Quaternary, currently recorded in terrestrial deposits and in speleothems, as well as in marine cores from both the South and East China Seas. The second issue is the paucity of anthropologically oriented zoological studies of animal bone collections from prehistoric sites. We also avoided the discussion of the hominin fossils, some of which are poorly dated, but which themselves require reassessment and in-depth discussion in light of new genetic studies.

The examination of the Paleolithic entities in China also raises doubts concerning several notions deeply embedded in archaeological research, such as the role of raw-material availability in determining the techniques of tool making and tool types. One example mentioned above relates to deer antlers, which are well preserved in Pleistocene cave deposits but are first shaped into tools only after 20 Ka cal BP.

Similar examples are available when we examine the practice of using hard rocks. Recent studies indicate that stone-knapping techniques, being learned behaviors, could have been, but are not necessarily, related to the kinds of available raw materials. The assumption derived from forager studies that foragers are fully knowledgeable of the availability in their environment of hard rock raw materials for making stone tools seems to be wrong when considering certain areas in prehistoric China. Flint, chalcedony, and chert were available in many parts of China but were simply not used either for reducing by a Levallois method or for making blades. The best example is the geographic dispersal of microblade makers who knew how to find and exploit the good-quality raw material when others did not. Finally, the making of pottery is undoubtedly an important prehistoric marker first appearing within the material culture of late Paleolithic foragers, thus heralding the long pottery-making tradition that develops in China during the Holocene (Zhang & Hung 2008, 2010).

DISCLOSURE STATEMENT

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