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What is currently (un)known about the Chinese Acheulean, with implications for hypotheses on the earlier dispersal of hominids

Ce qui est (mé)connu de l'Acheuléen chinois, avec implications sur les hypothèses de la dispersion précoce des homininés

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ABSTRACT

Progress in research on the different handaxe-bearing regions of China is making study of the Acheulean a dynamic field in the Chinese Palaeolithic. Given the separate history of these developments, in this paper we integrate the latest achievements in the four key Acheulean regions in China (namely, Dingcun, Bose, Luonan and Danjiangkou Reservoir Region). Based on this, and combined with our own observations of materials from these four regions, we summarize what is currently known about the Chinese Acheulean and propose those questions that are still awaiting resolution. Finally, we consider five arguments that are highly relevant to the origins of the Acheulean techno-complex in China. From this synthesis, we suggest that the technological transmission hypothesis might be a suitable explanation for the emergence of Chinese handaxe technology, and we provide supporting data for the migration of Acheulean hominids from west to east in the Early Palaeolithic period.

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RÉSUMÉ

Le progrès des découvertes effectuées dans les régions livrant des bifaces en Chine fait de l'étude de l'Acheuléen un champ de recherche dynamique au sein du Paléolithique chinois. En donnant le détail de ces développements dans cet article, nous intégrons les dernières réalisations provenant des quatre régions clé pour l'Acheuléen en Chine (à savoir Dingcun, Bose, Luonan et région du Danjiangkou Reservoir). Sur cette base et celle de nos propres observations effectuées sur le matériel de ces quatre régions, nous synthétisons les connaissances de l'Acheuléen chinois et nous soulevons les questions irrésolues jusqu'à

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présent. Finalement, nous considérons cinq arguments, nous semblant particulièrement pertinents, concernant les origines du techno-complexe acheuléen en Chine. À partir de cet état de la question, nous suggérons que l'hypothèse de la transmission technologique est une explication valable pour l'émergence de la technologie bifaciale chinoise et nous apportons des données qui soutiennent l'idée d'une migration des homininés acheuléens depuis l'ouest vers l'est au début du Paléolithique.

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1. Introduction

Research on the Acheulean or Acheulean-like techno-complex in China has been a significant but also controversial issue since the first discovery of such tools in the Dingcun localities during the 1950s (Jia, 1955, 1956; Pei et al., 1958). Before then, an apparent absence of handaxe technology in China was the observed wisdom, indicative of isolation, stagnation and cultural inferiority (Movius, 1944, 1948). Through sustained efforts in recent decades, a number of handaxe-bearing regions have now been documented, in addition to the earlier finds in Dingcun. Among them, Bose in the south and Luonan in central China are most well-known to western researchers. In addition, the Danjiangkou Reservoir Region (DRR) in central China has recently been studied in detail, and the findings published by the authors of this paper. All these studies have contributed to a better understanding of the Acheulean techno-complex in China.

In this paper, we first present a comprehensive review and summary of the four major Chinese Acheulean regions (namely, Dingcun, Bose, Luonan and DRR; see Fig. 1), with particular emphasis on recent achievements in each region. Based on this, and combined with our own observations of materials from these four regions, we summarise what is currently known about the Chinese Acheulean and propose those questions that need to be further resolved. Finally, we discuss the potential significance of the Chinese Acheulean materials for understanding the dispersal of, and communication between, early hominids from a global perspective.

2. The key Acheulean regions in China

2.1. Dingcun

The Dingcun localities are situated in Shanxi province, northern China (Fig. 1). This region is ~11 km long from north to south and ~2 km wide from west to east. Currently, more than 30 Palaeolithic localities have been found since the earliest discovery in 1953. These sites are distributed in the sand and gravel layers of three different terraces (terrace four, terrace three and terrace two) of the Fen River, a tributary of the Yellow River. The various chronological studies show that the age of the Dingcun localities extends from Middle Pleistocene times (terraces four and three) to a late stage of the Late Pleistocene (terrace two) (Chen et al., 1984; Li, 2001; Wang, 2014; Wang et al., 1994; Wu and Liu, 2002; Yang et al., 2014; Zheng, 1989; Zhou, 1989).

It is around the findings in Dingcun that scholars developed the first round of arguments for Acheulean technology in China. Even today, the debate about the significance of Dingcun is ongoing. Here, we provide examples mainly from two recent studies to show the progress of this discussion. One study was conducted by Yang et al. (2014). They restudied 1177 artifacts that were both excavated and surface-collected in the field season of 1953 and 1954. The techno-typological analysis of these artifacts shows that the typical Acheulean tool types, i.e. handaxes, cleavers and picks, occur in the assemblage, and moreover, an incipient Middle Palaeolithic technology can be argued on the basis of the various light-duty tools and the prepared cores in the assemblage. Overall, Yang et al. (2014) conclude that the Dingcun industry belongs to the Late Acheulean techno-complex, as previously suggested by Breuil and Freeman (Henri Breuil's opinion is in Freeman, 1977; Pei, 1965). We agree with Yang et al.'s opinion that the Dingcun assemblage can be ascribed to the Acheulean. However, detailed study of the *in situ* assemblages is needed to examine if a transitional technology is present at Dingcun.

Another study was conducted by Y.R. Wang (2014). He systematically analysed the artifacts retrieved from 1976 to 1980, the second period of large-scale surveys and excavations conducted at Dingcun after the 1950s. The artifacts were both surface collected and excavated from three different terraces of the Fen River, including six localities on terrace four, six localities on terrace three and one locality on terrace two. Based on the large number of lithics, Wang's (2014) study further confirms some conclusions reached by Yang et al. (2014) and also provides new insights into the Dingcun industry.

First, the study expands the chronological and spatial range of the Dingcun culture. The original discoveries of the 13 Palaeolithic localities in the 1950s are all situated on the third terrace (older than 128 ka and younger than 336 ka; see Yang et al., 2014). The new findings show that a consistent lithic industry is also present in the older fourth terrace (> 336 ka, as suggested by Yang et al., 2014), with continuity in the younger second terrace (late Late Pleistocene; Wang, 2014). Secondly, the Kombewa method is used; this is considered a skilful technique, which uses large flakes as core to produce flakes with bi-convex profiles and sharp edges. Some Kombewa flakes were further shaped into cleavers, which is also suggested by Yang et al. (2014). Thirdly, from a typological perspective, knives were identified as a new tool type in the Dingcun assemblage (Wang, 2014). The knife is regarded as a representative type in the Large Cutting Tools of the African Acheulean (Clark, 1974, 2001; Isaac, 1977; Kleindienst, 1962). In China, it has only been previously reported in the Luonan Basin (Wang, 2007). Another point of consensus between Yang et al. (2014) and Wang (2014) is that the Dingcun industry is

Fig. 1. Distribution of all currently known handaxe-bearing regions in China (plus IHRB in South Korea) and possible dispersal routes for spread of the Acheulean techno-complex. Black circles show the four major handaxe-bearing regions discussed in this paper.
Fig. 1. Répartition des régions connues comme livrant des bifaces en Chine (plus IHRB en Corée du Sud) et les routes de diffusion possibles pour le techno-complexe acheuléen. Les cercles pleins noirs indiquent les quatre régions majeures livrant des bifaces en Chine.

not dominated by chopper-chopping tools; on the contrary, chopper-chopping tools were not actually an important type in the Dingcun industry.

Thus far, all observations by Wang (2014), in our opinion, are appropriate and pertinent. However, regarding the use of terminology to define the most representative tools in the Dingcun assemblage, Wang (2014) suggests using two types – trihedral points and big points. As a consequence, Wang argues that the similarity of trihedral points and big points to the typical western Acheulean types of pick and handaxes (respectively) can be regarded as technological convergence. We have discussed the misuse of the term point in the Chinese Palaeolithic elsewhere (Kuman et al., 2014). Based on our observation of a large sample of so-called trihedral points and big points stored in the Shanxi Provincial Institute of Archaeology and the Dingcun Culture Museum, we suggest that these tools are clear examples of handaxes and picks in the western sense, and there is no necessity to deny their technological attributes as Acheulean.

2.2. Bose

Twenty years after the first discovery of Dingcun in 1953, archaeologists launched a field survey in a river basin in the western Guangxi Zhuang Autonomous Region, southern China (Li and You, 1975; see Fig. 1). It is this area, the Bose Basin, that scholars soon identified as another important handaxe-bearing region (Huang, 1987; Zeng, 1983). Currently, more than 110 Palaeolithic sites have been found in an area of ~800 km^2, and all of the Large Cutting Tools (LCTs, i.e. handaxes, picks, cleavers) have been collected from the fourth terrace of Youjiang River (Hou et al., 2000; Huang, 2003; Huang et al., 2012; Wang and Bae, 2015). In addition, several sites on terrace four have been systematically excavated in recent years and LCTs have been unearthed *in situ* (Gao et al., 2014; Hou et al., 2011; Lin, 2002; Pei et al., 2007; Wang et al., 2008, 2014b; Xie and Lin, 2008). The age of these sites has been dated to ~0.83 Ma using the $^{40}Ar/^{39}Ar$ dating method on tektites discovered together with the artifacts (Hou et al., 2000; Koeberl et al., 2000; Wang and Bae, 2015; Wang et al., 2008, 2014b). We accept that their earliest appearance in Bose can be traced back to ~0.8 Ma, as several excavations have confirmed the coexistence of handaxes and tektites in the same stratigraphic layer, and importantly, these tektites have not been re-worked (Wang and Bae, 2015; Wang et al., 2008, 2014b; and personal communication with G.M. Xie).

The Bose LCTs became widely known by western researchers after the publication of the Hou et al. (2000) paper, which also immediately aroused a new round of

discussion about the Acheulean phenomenon in China. Some scholars argue that the findings in Bose Basin demonstrate that people ~0.8 Ma years ago in China were flaking tools that are as sophisticated as anything made in Africa (Bar-Yosef and Wang, 2012; Hou et al., 2000; Huang et al., 2005, 2009; Shen, 2008; Zhang et al., 2010). On the other hand, other scholars think that it is unwise to press too close a cultural connection of the Bose LCTs with western Acheulean examples. Their reasons include: the Bose LCTs are dominated by unifacial flaking (65% of LCTs) and only a quarter of the bifacially flaked tools are made on large flakes; there is no evidence of true cleavers (contra Huang, 2003); the morphological attributes (especially the thickness) of the Bose handaxes are different from handaxes in the western Acheulean; and the sample from the various sites taken together is too small (Corvinus, 2004; Dennell, 2009; Gao, 2012; Lycett and Bae, 2010; Lycett and Norton, 2010; Norton and Bae, 2008; Norton et al., 2006; Schick, 1994; Wang et al., 2012, 2014b). In addition to the intensive arguments on lithic technology and morphology, the age of the Bose LCTs has also been highly debated (see Langbroek, 2015 and Wang and Bae, 2015 for the latest discussion).

Based on our observation of the Bose materials stored in Y.M. Hou's office in IVPP (Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences) and our related comparative studies (Kuman et al., 2014; Li et al., 2014a, 2014b), we would argue that the Bose LCTs possess technological characteristics comparable with typical Acheulean. The materials stored in IVPP are mainly the surface-collected LCTs published by Hou et al. in 2000 in *Science*. Although the morphology of Bose handaxes, mainly the thickness, is out of the range of variability for typical Acheulean handaxes, we suggest this is the result of regional adaptation. The context of the Bose location should be carefully considered, e.g., the type and quality of the raw materials and the specifics of subsistence ecology. The thick body of the Bose handaxes is likely related to the use of large and/or poor quality river cobbles as raw material, and to the emphasis on heavy-duty woodworking activities that took place in the local subtropical environment (Kuman et al., 2014; Li et al., 2014a; Yuan et al., 2008).

2.3. Luonan

Luonan Basin is situated in Shannxi province, central China (Fig. 1). It covers an area of ~70 km long from west to east, and 20–30 km wide from north to south. More than 300 open-air Palaeolithic sites have been found since the first field survey in 1995. These sites are distributed along the different terraces (from terrace six to terrace two) of the South Luo River, a tributary of the Yellow River. Hundreds of LCTs, including handaxes, picks, cleavers and knives, have been collected from the terraces (Shaanxi Provincial Institute of Archaeology et al., 2007; Wang, 2005, 2006, 2007; Wang et al., 1997, 2005). Recent excavations on terrace two have unearthed LCTs *in situ*, which confirm the primary stratigraphy of the abundant LCTs that were surface-collected from the second terrace of the Luonan Basin (Wang et al., 2011, 2013; Xing, 2014). Multiple analyses of the chronology indicate that the first occupation of the Luonan Basin was from ca. 0.8 Ma ago, but most of the LCTs are associated with the younger terrace two ca. 0.25 Ma, and they continue to be present during the early part of the Late Pleistocene (Lu et al., 2007, 2011, 2012; Sun et al., 2014; Wang, 2005; Wang and Huang, 2001; Xing, 2014; and personal communication with S.J. Wang).

LCTs found in the Luonan Basin have been regarded as exhibiting a technology most similar to the typical Acheulean in Africa and western Europe. One main reason is because this is currently the only area in China with numerous typical cleavers (Gao, 2012; Petraglia and Shipton, 2008; Wang, 2006), in addition to the findings in Dingcun. Moreover, the extensive use of large flake blanks and bifacial shaping in making LCTs are evidence of a true Acheulean techno-complex in Luonan (Gao, 2012; Wang, 2005; Wang et al., 2005). Despite these similarities to Acheulean technology, different opinions still exist. Some scholars believe that both the technology and morphology of the Luonan LCTs fit comfortably within the Acheulean range of variation, and this may mean that hominids with knowledge of Acheulean tool making strategies dispersed into East Asia from a western source (Bar-Yosef and Wang, 2012; Gao, 2012; Petraglia and Shipton, 2008; Shipton and Petraglia, 2010; Wang, 2005; Xing, 2014). In contrast, other scholars point to the fact that handaxes in Luonan Basin are generally thicker than classic western Acheulean forms, and the bifacial components of the lithic collections are proportionally very small (Norton and Bae, 2008). They therefore argue that the material should not be used to support scenarios involving the intrusion of western Acheulean traditions into this region during the Middle-Late Pleistocene (Lycett and Bae, 2010).

Our inter-regional comparative study of the thickness variability of handaxes has shown that the Luonan handaxes overlap with examples from some typical Acheulean sites, e.g., Doornlaagte in South Africa and Mudnur VIII in India (Kuman et al., 2014; Li et al., 2014a, 2014b). We have also proposed that the number of handaxes in a site is not a good criterion by which to judge the attributes of an industry; rather this should be seen as a by-product of behavioural (or social) processes (Li et al., 2014b, 2014c). Therefore, overall, we agree with S.J. Wang's opinion that LCTs found in the Luonan Basin do demonstrate the existence of the real Acheulean techno-complex in this area (Wang, 2005).

2.4. DRR

The Danjiangkou Reservoir Region (DRR) is located at the southeastern edge of the Qinling Mountains and is fed by the Han River, the longest tributary of the Yangtze River (Fig. 1). The archaeological work in this region actually started as early as the 1970s with the discovery of human fossils and stone artifacts in some cave sites (Qiu et al., 1982; Wu and Dong, 1980; Wu and Wu, 1982). The most important findings in this area are two human crania discovered in the open-air Xuetangliangzi site (or Yunxian Man site), Yunxian county in 1989 and 1990 respectively (Li and Etler, 1992; Li and Feng, 2001; Li et al., 1991). The site is located on the fourth terrace of the Han River and has been dated by palaeomagnetism and fauna to an approximate

age of 0.936/0.8 Ma (Chen et al., 1996, 1997; de Lumley and Li, 2008; Huang and Li, 1995; Li and Feng, 2001; Yan, 1993). In addition to the two crania, abundant animal fossils and stone artifacts were unearthed from this site, with one handaxe found *in situ* and 13 LCTs collected from the surface near to the site (de Lumley and Li, 2008; Feng, 2008).

The most intensive discovery of LCTs in DRR occurred in 1994. In cooperation with the construction of the national South-to-North Water Transfer Project, the field team of IVPP (Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences) conducted a systematic survey around the margin of the Danjiangkou Reservoir. Fifty-six open-air Palaeolithic sites (from terrace four to terrace two) were discovered associated with LCTs such as handaxes, picks and cleavers (Huang et al., 1996; Li, 1998; Li et al., 2009). In addition, local museums also carried out investigations and collected numerous stone artifacts (including LCTs) from this region (Shiyan Museum, 2011; Shiyan Museum and Danjiangkou Museum, 1999; Zhu, 1999, 2001). In 2004, the field team from IVPP conducted a second large-scale Palaeolithic survey in DRR. Through this investigation, the number of the Palaeolithic sites in DRR increased to more than 110, and many more LCTs were surface-collected (Li et al., 2012). The number of LCTs used in our study is approximately 200 (Kuman et al., 2014; Li et al., 2014c). From 2006, systematic excavations in this region began, and currently more than 30 Palaeolithic sites have been excavated, such as Pengjiahe (Pei et al., 2008a), Beitaishanmiao (Zhou et al., 2009), Songwan (Niu et al., 2012), Beitaishanmiao II (Fang et al., 2012), Guochachang II (Li et al., 2013), Shuiniuwa (Chen et al., 2014), and Maling 2A (Pei et al., 2015). Comprehensive chronological analyses indicate that LCT sites in this region have persisted for a long period, from the late Early Pleistocene to the early part of the Late Pleistocene (Chen et al., 1996; de Lumley and Li, 2008; Huang and Li, 1995; Huang et al., 1996; Liu and Feng, 2014; Li et al., 2014b; Pei et al., 2015; Shen, 1956; Yan, 1993; Zhu, 1955).

Because of these intensive surveys and excavations, the DRR has now become one of the most important areas in Chinese Palaeolithic research. Through a detailed study from typological, technological and morphological perspectives, we have now achieved some significant understanding of the Acheulean techno-complex in DRR, especially its regional variability and adaptation compared with other Acheulean regions in China (Kuman et al., 2014; Li et al., 2014a, 2014b, 2014c, 2014d; Li et al., 2015). The major results of our DRR research are discussed in the section below.

3. What is currently known about the Acheulean in China

Our updated understanding of the Chinese Acheulean through research in the four key regions – Dingcun, Bose, Luonan and DRR – can be summarised as follows.

First, although raw material can be the cause of the technological and morphological variability of LCTs found in different regions, it is not an impediment to the production of LCTs. The types of raw material in the Chinese sites are varied: quartzite is the most commonly used raw material in Bose and Luonan, while in Dingcun, hornfels dominates, and in DRR, quartz phyllite and trachyte dominate. All these raw materials are locally available. The quality of the raw materials also varies. Generally speaking, raw materials in Luonan and Dingcun are of good quality, whereas the Bose and DRR raw materials are of poor quality, with coarse grain sizes for quartzite in Bose and platy structure and internal joints for the materials in DRR. In addition, the original size of raw materials varies in the different regions. In those areas where giant-sized raw materials can be easily found, namely Luonan and Dingcun, most of the LCTs are made on large flakes. In contrast, in regions where large flakes could not easily be produced from the raw materials, namely Bose and DRR, large proportions of LCTs were made directly on river cobbles, and in the case of these two sites, the number of cleavers is also small. A similar paucity of cleavers has also been observed in many sites in the western Acheulean where suitable raw materials are absent (Santonja and Villa, 2006; Villa, 1983). This inter-regional variability of raw materials in China, on the other hand, demonstrates the stability of an Acheulean technological tradition in the East, and it also shows great flexibility in raw material exploitation.

Second, the ability to detach large flakes and make LCTs (i.e. handaxes, picks, cleavers, knives) in the four regions is comparable to that found in the typical Acheulean techno-complex in the western part of the Old World. This is the main reason that we suggest using the term Acheulean for the LCT-bearing sites in China. However, the question of Acheulean technology in China originating from a western source is still only a hypothesis, and the exact origins of the Chinese Acheulean still need to be further explored.

Third, we argue that although the concept of Acheulean tool-kits existed in the maker's mind, there was no standardized morphological concept for the end products. The same situation also applies to Acheulean in the western part of the Old World (McNabb et al., 2004). Variability in the final morphology of the LCTs can be caused by multiple factors, e.g., the quality of raw materials, degree of reduction intensity, individual skill and interest, etc.

Fourth, the quantitative inter-continental comparison of handaxe morphologies, especially with regard to thickness, shows that the handaxes from DRR fall very close to the range of typical western Acheulean handaxes, while those from Luonan show only a small overlap with some Acheulean assemblages but are less thick than the rest from East Asia (Kuman et al., 2014; Li et al., 2014a, 2014b). Therefore, we suggest that morphological difference is not a very reliable variable for demonstrating handaxe differences between the East and the West.

Fifth, the low proportion of LCTs in all complete tool assemblages is a consistent observation for in Bose, DRR and Luonan. In Bose and DRR, the total number of stone artifacts is also small for the size of the excavation area, good examples being the sites of Fengshudao and Nanbanshan (Wang et al., 2008, 2014b) in Bose, and Shuangshu and Guochachang (Li et al., 2013, 2014b) in DRR. However, for the sites located at higher latitude, the situation seems to be different. In the Luonan Basin, although the number of LCTs per site is generally low, the total number

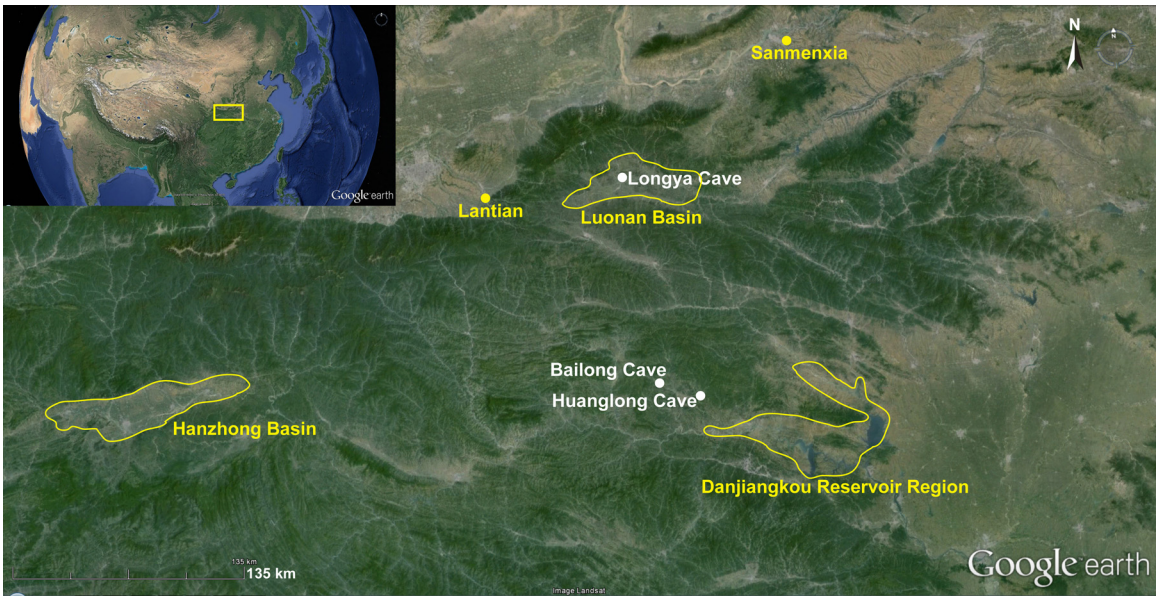

Fig. 2. The co-existence of core and flake technology cave sites (shown in white) and handaxe-bearing open-air sites (shown in yellow) around the Qinling Mountains, central China.
Fig. 2. Coexistence des sites à technologie à débitage d'éclats (en blanc) et de ceux livrant des bifaces (en jaune) autour des monts Qinling, en Chine centrale.

of artifacts is much higher than at the sites in Bose and DRR. The Zhanghuokou site located on the second terrace of the South Luo River in Luonan can be used as an example. More than 23,000 artifacts were unearthed from 170 m^2 area (Wang et al., 2011). To the north of Luonan, the proportion of LCTs at some of the Dingcun sites is higher than in all three other regions. For example, at the terrace three 80:01 Locality in Dingcun, a total of 403 artifacts was discovered. Among them, 118 artifacts were defined as formal tools, including five unifacially flaked heavy trihedral points (picks in our definition), three big points (handaxes in our definition, with one unifacial, one bifacial and one partly bifacial handaxe according to the illustrations in Wang, 2014), 12 cleaver-like tools (cleavers in our definition), and nine large knives. In addition, of the 14 choppers, most were bifacially flaked and were called bifaces by the author (Wang, 2014). Our observation of the illustrations in Wang (2014) indicates that some bifacial choppers can actually be classified as handaxes. In addition to the large number of LCTs in this locality, six heavy-duty scrapers and 38 spheroids were also documented (Wang, 2014). Therefore, we suggest that there is a perceptible change in the proportion of LCTs as the geography and/or chronology changes.

Sixth, in Dingcun, Luonan and DRR, the technological characteristics of the LCTs from the Middle Pleistocene to the Late Pleistocene are consistent, which shows the conservatism of the Acheulean technological tradition over a relatively long period, which is also a western Acheulean trait (e.g., see Sharon et al., 2011). But, there is one interesting phenomenon at the late Late Pleistocene site of Dingcun, namely the 77:01 Locality. At this site, microliths were unearthed together with the LCTs, which clearly shows that at the time this Late Palaeolithic technology emerged, the previous Acheulean technological tradition had not disappeared (Wang, 2014). This may imply contact between two different population groups in northern China.

Seventh, the LCT-bearing sites in these four regions were all found in open-air river terrace deposits. And so far, all scattered finds in other regions are also at open-air sites, e.g., the Middle and Late Pleistocene handaxe-bearing sites at the Lantian area (Wang et al., 2014a; Fig. 2). In contrast, all the cave sites situated in the same region as LCT sites have shown only the small-sized core and flake technology, e.g., Longyadong Cave in the Luonan Basin, and Bailongdong Cave and Huanglongdong Cave in the DRR (Pei et al., 2008b; Wang and Huang, 2001; Wu et al., 2006, 2007, 2009; see Fig. 2). This is interesting in the light of current discoveries. While it may demonstrate that the Acheulean hominids conducted different activities in different contexts (cave sites vs. open-air sites), it could equally well indicate that there were two different hominid groups living in the same region at similar times, but with different cultural or subsistence practices. A detailed comparative study between cave sites and open-air sites in the future should provide a satisfactory answer to this interesting contrast.

Eighth, because of the findings of Luonan and DRR, which are situated between the Bose sites in southern China and the Dingcun sites in northern China, the distributional range of the Acheulean techno-complex in China has now been expanded. Consequently, discussion of the migration and dispersal routes of the hominids possessing Acheulean technology is becoming possible.

4. The unresolved questions

As a result of the current studies, some significant but still unanswered questions about the Chinese Acheulean are being taken on board.

First, when did LCTs first appear in China? This is an important question for understanding the earliest origins of the Chinese Acheulean. Currently, the earliest LCTs have been reported from the fourth terrace sites of Bose (~0.803 Ma) and in the late Early Pleistocene Yunxian Man site in DRR (ca 0.936/0.8 Ma) (de Lumley and Li, 2008; Hou et al., 2000; Li and Feng, 2001; Wang and Bae, 2015; Wang et al., 2014b). Although we agree with the age of the LCT sites in Bose, further dating work, in our opinion, is still very necessary to settle all controversy. For the Yunxian Man site, the original report states that all bifacially shaped tools were actually collected from the nearby surface (Li et al., 1998). Therefore, further excavation work on terrace four is needed to reveal the earliest origin of the Acheulean technology in DRR. In addition, at the Lantian Man site (1.15 Ma according to An and Ho, 1989; and ca. 1.62 Ma in Zhu et al., 2015), the report of a single handaxe that may be associated with the Lantian cranium also needs to be further examined because of the different proveniences of this handaxe with the Lantian cranium (~2 km east of the Lantian Man site; see Dai, 1966).

Second, as we have already mentioned, how do we interpret the co-existence of open-air LCT sites and the cave sites with core and flake technology. In addition to the abundant open-air sites found along the river terraces, the cave sites are also important findings in both DRR and Luonan, e.g., the Middle Pleistocene Bailongdong cave and the Late Pleistocene Huanglongdong cave at DRR, and the Middle Pleistocene Longyadong cave at Luonan (see Fig. 2). Preliminary studies of the lithic artifacts from these cave sites show that unlike the LCT technology displayed in the open-air sites, only simple core and flake technology was used in these cave sites (Pei et al., 2008b; Shaanxi Provincial Institute of Archaeology and Museum of Luonan County, 2008; Wang, 2005). A detailed comparative study of the two different types of sites in the future should provide answers for this co-existence phenomenon, particularly if the non-LCT technologies are contrasted.

Third, why was the Acheulean techno-complex in DRR, Luonan and/or Dingcun not replaced by Levallois technology or other forms of advanced technology during the Late Pleistocene? What does this tell us about the origins of modern humans in China? For example, current dating evidence shows that the LCT sites in DRR persisted until the early stage of the Late Pleistocene (Liu and Feng, 2014). Nevertheless, in the western part of the Old World, this is a time period characterised by the use of innovative Levallois technology. We are not expecting to answer these questions in the short term, but it is now the time to carefully consider them and intentionally collect the data to address such questions.

Fourth, what is the real distribution pattern of the Acheulean sites in China? Currently, only four major Acheulean regions are discussed. But from the scattered findings at other places reported in Chinese journals (Figs. 1 and 3), we are confident that there are more regions of the Acheulean techno-complex awaiting discovery. For instance, a small number of LCTs is reported in the Lishui valley, Hunan Province (Chu, 1998; Yuan, 1996; see Figs. 1 and 3). This region is situated between the DRR in central China and Bose in southern China and may play an important role in linking the two regions. Another good example is the new finding of LCTs from the Nanjiang valley, Guangdong Province (Li, 2014; see Fig. 1), which is located in the same river system as the Bose Basin, about 500 km east of it. This new finding clearly indicates a wider distribution of the Acheulean techno-complex in southern China. Therefore, we suggest that it is necessary to pay more attention to these promising areas to better understand the distribution pattern of LCT-bearing sites in China.

5. Implications of the Chinese Acheulean for the early dispersal of hominids in Eurasia

From the review of current progress in each region, we can see that the most debatable question about the Chinese Acheulean is probably: how did this new techno-complex originate? Did it evolve indigenously, or it was brought into China from the West? If the latter hypothesis is correct, it would indicate that hominids possessing Acheulean technology migrated from the west to the east. Either way, study of the Chinese Acheulean can benefit our understanding of early hominids' migration history in Pleistocene Eurasia. Here, from an integrated perspective, we are inclined to favor the migration hypothesis for the Acheulean technology in China. But, we recognize that further study in the future may confirm or reject this hypothesis.

Five aspects should be incorporated into our analysis: lithic technology, palaeoanthropology, palaeoenvironment, chronological relationships and distribution patterns of the Acheulean sites in China. The first has been sufficiently described, and it has been shown that LCT technology in China is comparable with the western Acheulean, especially when compared with the complete sequence of Acheulean in Africa. For the second aspect, the earliest finding of human fossils associated with Acheulean technology is currently reported from the Yunxian Man site in DRR (de Lumley and Li, 2008; Feng, 2008). Study of the two late Early Pleistocene Yunxian crania indicates that they possess some sapiens-like features and are more advanced than the classic *Homo erectus* crania from the Middle Pleistocene cave site of Zhoukoudian Locality 1 in Beijing (see Fig. 1), where only small-sized core and flake technology is present (Etler and Li, 1994; Li and Etler, 1992; Vialet et al., 2005, 2010; and personal communication with A. Vialet). Taking this evidence together, we think that it is much more likely that the Yunxian hominids represent either a new human group that migrated from the West, or admixture of such a people with local populations.

From the palaeoenvironmental perspective, the Ailuropoda-Stegodon fauna persisted in southern China during most of the Pleistocene (Li and Feng, 2001; Qiu et al., 1982; Wu et al., 2008, 2009). In addition, the influence of the East Asian winter monsoon on southern China was generally more limited than it was on northern China, although climate fluctuations did take place in South China (Ji, 1982; Xie et al., 2003; Zhao and Yang, 1995). Therefore, we argue that there was no environmental pressure leading to the origin of Acheulean technology at Bose, which is located in the more stable subtropics of southern China. Fourth, from the perspective of chronology, the

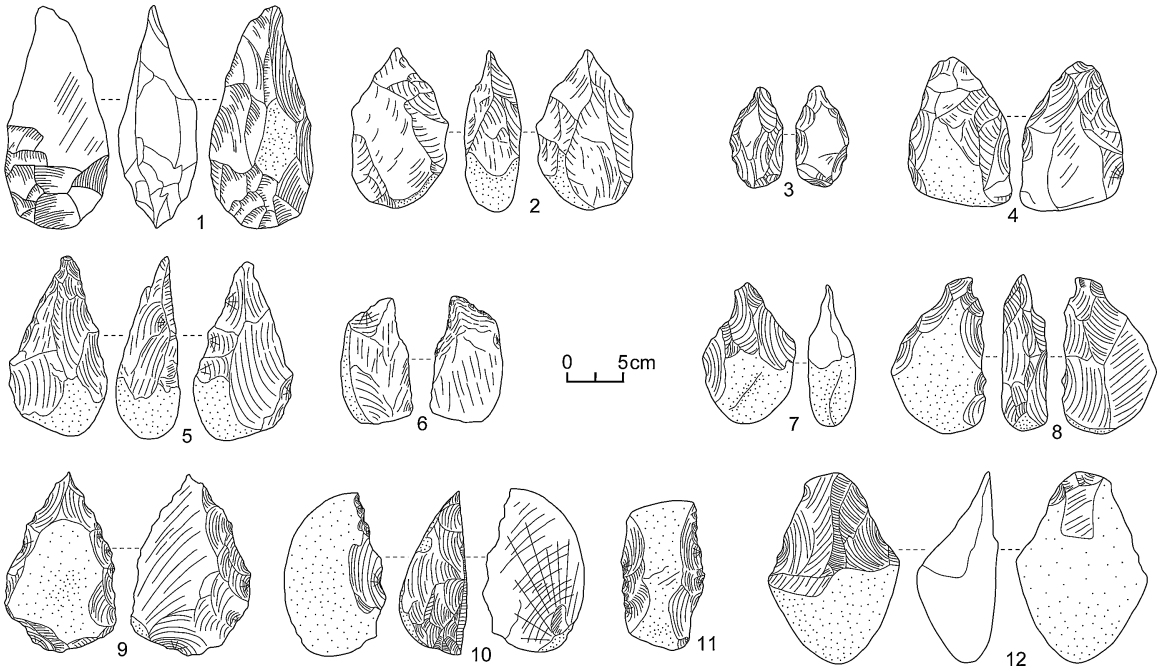

Fig. 3. Large cutting tools retrieved from the less-well studied regions of China: 1–2, from Lishui River valley, adapted from Chu (1998); 3–4, from Liaohe River valley, adapted from Li and Xu (1991); 5–6, from Xiangyang, adapted from Li (1983); 7–8, from Hanzhong, adapted from Huang and Qi (1987) and Huang (1987); 9–11, from Sanmenxia, adapted from Huang (1964); 12, from Shuiyangjiang River valley, adapted from Chu (1998).
Fig. 3. Assemblages à grands éléments bifaciaux (*large cutting tools* [LCTs]) provenant des régions moins étudiées de Chine : 1–2, Lishui River valley, adapté de Chu (1998) ; 3–4, Liaohe River valley, adapté de Li et Xu (1991) ; 5–6, Xiangyang, adapté de Li (1983) ; 7–8, Hanzhong, adapté de Huang et Qi (1987) et Huang (1987) ; 9–11, Sanmenxia, adapté de Huang (1964) ; 12, Shuiyangjiang River valley, adapté de Chu (1998).

earliest Acheulean technology appeared in China at around 0.8 Ma (e.g. Bose and DRR; de Lumley and Li, 2008; Hou et al., 2000; Koeberl et al., 2000; Li and Feng, 2001; Wang and Bae, 2015; Wang et al., 2008, 2014b). In Southeast Asia, the earliest LCT-bearing site is currently Ngebung in Indonesia, which has also been dated back to about 0.8 Ma ago (Simanjuntak et al., 2010). And in India, numerous Early and Middle Pleistocene Acheulean sites have been found (Gaillard et al., 2010; Paddayya et al., 2002; Pappu et al., 2011; Petraglia, 2006). So, it seems that Acheulean hominids dispersed into Southeast and East Asia at about 0.8 Ma, possibly with a dispersal route from the south. However, a northern route that crossed through central Asia also has the potential to be examined in greater detail. Currently all that is known is that after 0.35 Ma, Late Acheulean sites (along with typical Levallois technology) are found in the southern Caucasus and central Asia (Doronichev, 2008; Derevianko and Shunkov, 2014).

Lastly, considering the current distribution pattern of handaxe-bearing sites within China itself, it seems that there were two migratory routes for the transmission of Acheulean technology. One is a south-north route along the transitional zones between the mountains and the plains; the other is a west-east route along the Yangtze River and its tributaries (Fig. 3). Regardless of which hypothesis is adopted for the initial origins of Chinese Acheulean technology (indigenous vs. intrusive), we suggest that the transmission of this technology from a regional source (in or outside of China) is the most likely explanation, rather than the repeated invention of Acheulean technology in different regions. Future investigation and excavation work in the regions along these two routes will further test this inference.

6. Conclusions

The progress achieved on research at the different handaxe-bearing regions of China is making study of the Acheulean an exciting and important field in the Chinese Palaeolithic. In this paper, we have integrated the latest achievements in four key Acheulean regions in China and, importantly, we have summarized what is currently known about the Chinese Acheulean. On the other hand, the questions that are still awaiting resolution were also discussed. Finally, through the synthesized consideration of five aspects that are highly pertinent to the origins of the Acheulean techno-complex in China, we suggest that the case for a technological transmission hypothesis might be stronger, which would indicate the migration of Acheulean hominids from the West to the East.

The Acheulean techno-complex found in China explicitly demonstrates the technological diversity and variability in the East Asian Early Palaeolithic (EAEP), and furthermore it shows that with deeper research on the EAEP, our relevant understanding will be deeper as well. In addition, the migration of early hominids in the Pleistocene time period should not be restricted today by too close a national focus; only by considering the EAEP from a global perspective can we correctly understand the migration history of our ancestors. We therefore hope that the

advances in the study of Chinese Acheulean described in this paper will come to be known by more English readers, which will further promote academic communication between us.

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