Chapter 4
Africa and Asia: Comparisons of the Earliest Archaeological Evidence

David R. Braun, Christopher J. Norton, and John W.K. Harris

Abstract The earliest archaeological sites in East Asia suggest that making and using stone artifacts was a consistent part of the subsistence strategy of these earliest immigrants to East Asia. Although there are many differences between the earliest archaeological record in Africa and Asia, a few aspects of these industries allow formal comparisons. Here we review aspects of the African Oldowan archaeological record and compare it to the large and well-studied archaeological record from the Nihewan Basin. We suggest that the technological strategies shown in these East Asian Early Paleolithic assemblages are consistent with a subsistence pattern where stone tool mediated resources played a very different role than that found in East Africa. We suggest that the poor quality of available materials were not conducive to the maintenance of complex toolkits. Early Pleistocene hominins in East Asia may have exploited a series of diverse resources that had distinct technological requirements. In this sense the ecology of these hominins may have been very different from their African counterparts.

Keywords Early Stone Age • Lower Paleolithic • Oldowan • Koobi Fora • Olduvai • Nihewan • Kanjera

Introduction

The appearance of stone tool assemblages in Asia has important implications for the place of technology in human evolution. As new research uncovers older archaeological sites outside of Africa (Zhu et al. 2004) the role of stone tools in the dispersals of hominins from Africa needs to be addressed. Although the archaeological record outside of East Africa is unfortunately relatively meager, the overwhelming evidence is that the earliest stone tool use evolved in Africa (Semaw et al. 1997). However, in order to address the role of stone tool technology in the dispersal of hominins into Asia it is vital to understand the similarities and differences between hominin toolkits between these two regions. Here we review what is currently known about the use and manufacture of stone tools in East Africa. We then develop hypotheses about what the earliest assemblages outside of East Africa may look like based on a brief review of the ecology of latitudinal changes, as well as the local contextual information known from the earliest sites outside of Africa. Some assemblages from Asia are particularly well-studied, and therefore provide the information necessary for comparisons with the African record. Finally, we formulate some hypotheses that may explain some of the patterning seen in the artifact assemblages of East Asia.

The Oldowan of Africa

There is an emerging view about the complexity of the earliest Oldowan stone tool assemblages (Roche 2000; Semaw 2000; de la Torre 2004; Delagnes and Roche 2005). Although initial discussion suggested that hominins before 2 Ma lacked the full capacity to produce long reduction sequences (Kibunjia et al. 1992; Kibunjia 1994), it is now clear that there is great variability in the ability of hominin toolmakers (Roche 2000). There is a growing body of evidence from the sites in the Kada Gona region that early hominins were able to select stones based on the flaking quality (Stout et al. 2005) and that these hominins were adept toolmakers (Semaw 2000). Further evidence from the Nachukui Formation suggests that at least some hominins followed a specific set of rules that governed tool production (Delagnes and Roche 2005). These rules allowed hominins to extend the sequence of removals in particular core forms. Although there were apparently some technological obstacles that these hominins could not overcome, many Pliocene industries show a remarkable degree of technological flexibility (de la Torre 2004; Delagnes and Roche 2005).

The Oldowan is often characterized as merely simple core and flake tools (Foley and Lahr 2003); however the techniques and systems employed in these earliest assemblages
appear to be more complex than the simplest solution to producing a sharp edge (Isaac and Harris 1997). Indeed, many studies now suggest that stone tool use in the Oldowan represented a complex system of resource acquisition (Braun and Harris 2003; Goldman et al. 2006; Harmand 2006). Although there is still some debate as to whether or not Pliocene stone tool industries represent an advanced technological system, major changes in the Early Pleistocene suggest a dramatic increase in the dependence of hominins on stone tool technology. Various Developed Oldowan industries show increases in the complexity of tool reduction (de la Torre et al. 2003), landscape use (Rogers et al. 1994), and tool transport (Kimura 2002), as well as the intensity of stone tool resource utilization (Braun and Harris 2003). This is probably most dramatically displayed in simple comparisons of mean maximum flake size and mean maximum core size in 20 Pliocene and Pleistocene archaeological assemblages from East Africa. These sites show that before 1.7 Ma hominins were not emphasizing the size of flakes being produced from cores. When hominins had access to larger cores they appear to have made similarly sized flakes irrespective of initial cobble size. After 1.7 Ma this pattern changes and the size of flakes tracks the size of cores. It is possible this trend is the result of increasing need by hominins in the Pleistocene to increase the distance between raw material procurement and activity loci on the ancient landscape by producing the largest flake possible from a given core (Braun and Harris 2001). This change that represents a shift to Developed Oldowan Industries represents a shift to standardized reduction systems like the single platform core (Ludwig and Harris 1998) and the centripetal hierarchical bifacial core structure (de la Torre et al. 2003).

These technological developments through the course of the Oldowan are likely associated with an increase in the utilization of stone artifact mediated resources: as seen in the increase in the utilization of carcasses on the landscape at sites at Olduvai (Monahan 1996) and Koobi Fora (Harris et al. 2002). In other words, the need for stone artifacts increased extensively and as a consequence of natural selection favoring technological systems that increased the efficiency (higher yield per unit of cost: (Christenson 1982) of stone artifact manufacture and use (Jeske 1989; Torrence 1989b). At many East African localities, the appearance of a more organized and standardized technological system, is often associated with the habituation of more arid and grassland environments. Certainly for sites like Gadeb (Williams et al. 1979) and Melka Kontoure (Isaac 1971) which are situated at extreme elevations, these xeric conditions would have imparted new constraints on hominin behavior/ecology – some of which may have necessitated shifts in lithic technologies. At Koobi Fora, the Karari Industry is associated with a shift to more xeric environments as documented by a recent analysis of paleosols (Wynn 2004). Developed Oldowan Industries at Olduvai may also be associated with a shift to more xeric conditions (Leakey 1971; Monahan 1996).

An Asian Perspective on the Oldowan

Previous efforts to characterize stone tool use outside of Africa have been hindered by small collections excavated from contexts that are not fully understood. This was largely the result of reduced infrastructure for prehistoric studies relative to the long history of research in Africa (Dennell 1998, 2001). Although there is clearly more research to be done on Early Stone Age archaeology outside of Africa, a clearer picture of the earliest Asian industries is beginning to appear (Keates 2004). Yet it is clear that, at least superficially, there are major differences between the African and Asian Early Stone Age records (Norton et al. 2006; Lycett and Norton 2010). As yet there are no sites in Asia that possess similar densities of lithic materials found in localities such as Koobi Fora, Hadar, Gona and Olduvai. While assemblage size is likely the result of a number of factors, including but not limited to: raw material availability, raw material quality, excavation strategy, and/or ancient hominin group size (Ammerman and Feldman 1974; Potts 1991; McHenry and Coffing 2000). Unfortunately, many of these factors cannot be controlled for or easily modeled. Yet a few certainties can be deduced in the comparisons of Asian and Oldowan industries. First, hominins in East Asia used stone tools to procure resources, some of which appear to be animal resources as seen by the percussion notched bone at Majuangou (Shen and Chen 2000; Zhu et al. 2004). Second, hominins that produced stone tools in East Asia had an understanding of fracture mechanics that was similar, at a minimum, to that expressed in the earliest Oldowan industries (Schick et al. 1991). Any further comparison between Asian and African lithic industries requires a more detailed discussion of the context of the Asian localities.

The Context of the Asian Early Paleolithic

Recent reviews of the dispersals of hominins out of Africa have remarked on the apparent lack of technological development associated with this range expansion (Anton and Swisher 2004). However, there may be some reason to believe that stone artifacts performed a different role in the adaptation of hominins in Asia than Africa. The work of Robin Dennell (1998, 2003) is particularly relevant to this explanation. Dennell (2003) has reviewed the environmental context of many of the earliest sites in Asia and his models of
Dispersal and colonization provide a framework that can be used to investigate the nature of the earliest tool-use outside of Africa. Dennell’s (2003) assertion that early hominin occupation of Eurasia probably represents several failed colonization attempts following the expansion of grasslands into western Eurasia seems very plausible.

Many of the changes associated with the expansion into Asian habitats can be associated with variability in latitude. If hominins continued to gain some portion of their diet from large mammal remains, they would need to expand their annual ranges as opportunities for carcass acquisition would likely have been more widely dispersed. Increased distances from the equator are correlated with decreases in lower net production as well as total above ground productivity (Rosenzweig 1968; Binford 2001). Species diversity has an inverse relationship with latitude and therefore the availability of alternative resources decreases (Torrence 2001). The result is that the risk of hunter-gatherers failing to meet dietary requirements becomes more intense with movement toward the poles. These ecological differences, combined with a more diverse carnivore paleoguild in Asia in the Early Pleistocene and the increase in carnivore size with latitude (Klein 1986), would have meant that carcass acquisition would have been far more difficult in East Asia than in parts of East Africa (Turner 1992). High frequencies of carnivore modification on several East Asian Paleolithic localities attests to the high competition for large mammal resources in Asian contexts (Bakken 1997), though by the latter part of the Early Paleolithic hominins appear to have become dominant members of the carnivore guild (Norton and Gao 2008). Other differences associated with increases in latitude would relate to the slower rates of putrification of carcasses in higher latitudes associated with the interplay of temperature, humidity, and exposure to sunlight (Haynes 1982, 1988). Therefore, the reduced availability of flesh on carcasses may have been countered by an increased time frame for accessing marrow in carcasses. The implications for stone tool assemblages would be an increased reliance in pounding technologies associated with marrow processing, as opposed to cutting technologies. Another major change would have been the habitation of environments that have not been previously recorded in African archaeological sites. These habitats such as tropical rainforests (Pope 1995) or steppe and woodland environments (Aigner 1981; Belmaker 2006; Teague and Potts 2007) would have had a different resource structure than African savannas. These environments have lower percentages of their biomass in leafy material available for grazing and browsing animals to eat (Binford 2001). As a consequence these ecosystems would have had much lower frequencies of secondary biomass (large ungulates).

The broad reconstruction of Pliocene habitats by Dennell (2003) and Holmes (2007) using data from the PRISM project (Dowsett et al. 1994) shows the expansion of grasslands into much of the Asian continent but also the persistence of many forested habitats in much of Asia. In many of these habitats the majority of resources available to Pleistocene hunter-gatherers would have had low activity failure rates (i.e. plant tissues) (Jeske 1989). Thus, we can expect that Early Pleistocene toolmakers in East Asia would have invested less energy into the procurement, and maintenance of their toolkits (Jeske 1989; Torrence 1989a; Bamforth and Bleed 1997). The toolkits of East Africa are associated with the energy costs of transport and selection of high quality raw materials (Stout et al. 2005; Braun al. 2008a), as well as the time costs associated with the consistent production of numerous sharp edges (Delagnes and Roche 2005). These costs are offset by the high activity failure rates of large mammal butchery that was clearly a part of the East African Oldowan subsistence pattern (de Heinzelin et al. 1999; Harris et al. 2002; Dominguez-Rodrigo et al. 2005). However, if the East Asian Pleistocene toolmakers were focused on plant tissues as a higher percentage of their tool-assisted resource base, then we may expect a limited investment of energy into the production of large cutting tools. Subsequently, we may expect shorter tool use-lives and higher discard rates associated with these East Asian toolkits (Jeske 1989; Bousman 1993). We would predict that toolkits from East Asian contexts would not have required the long systematic reduction sequences found in East Africa, because the large mammal carcasses that require numerous small sharp edges may not have been a regular aspect of the resource base of East Asian hominins. If Early Pleistocene hominins in East Asia did shift their resource base away from large mammal tissue it may have been associated with a major shift in diet. Current understanding of Homo erectus sensu lato physiology suggests that this species required access to high quality diets (Wood and Collard 1999; McHenry and Coffing 2000). However, in some instances, these dietary requirements were met with the assistance of technologies that did not focus exclusively on the sharp edges required for acquisition of large mammal tissues (e.g. Goren-Inbar et al. 2002; Mora and De la Torre 2005). A focus on percussion technology or expedient flake and core technology to access high quality, predictable resources such as nuts, fruits or underground storage organs may have become a major focus of East Asian hominin behavior.

The Asian Early Paleolithic: Predictions and Current Data

The Early Paleolithic artifacts from East Asia differ from some the African Oldowan industries. Four main factors distinguish Asian and African Early Pleistocene assemblages.
First, in many Asian sites, it appears that there is a low density of lithic materials (Clark and Schick 1988; Shen and Qi 2004). Second, cores at Asian localities appear to have relatively short reduction sequences (Gao et al. 2005). Third, there is a high incidence of pounded pieces in some Asian assemblages (Pope 1988). Some assemblages show consistent evidence of core tools that also have evidence of pitting or bruising (Pope and Keates 1994). Fourth, the artifacts from East Asian assemblages appear to be demonstratively smaller than African Oldowan assemblages (Clark 1998). This is by no means an exhaustive review of East Asian Early Pleistocene localities. These observations are overgeneralizations of a diverse group of assemblages and there are particular instances that will refute each one of these observations. However, these generalizations allow a framework that facilitates comparisons with East African artifacts. Unfortunately, very few of the East Asian localities in this time frame have enough artifacts to investigate patterns of tool manufacture and use (e.g., Xihoudu: 30 artifacts). Subsequently, we restrict our discussion to the best known Early Pleistocene sites, those located in the Nihewan Basin, northern China.

**Nihewan Basin**

In contrast to other regions in Asia, the large size and extensive exposures make assemblages from the Nihewan basin more comparable to Oldowan localities in Africa. Further, paleoenvironmental reconstruction of the sites in the Nihewan Basin suggests that these sites were found in habitats that are more similar to East African sites relative to other East Asian sites (Zhu et al. 2004). The tremendous preservation of vast deposits of the Nihewan formation makes it possible to examine hominin artifact transport and selection of stone raw materials. It is likely the Nihewan hominins were collecting raw materials from local deposits (Schick et al. 1991). Schick and colleagues (1991) suggest that the high frequency of localities on the eastern side of the Cenjiawan Platform is because of the proximity to these exposed Precambrian quartzites and cherts. Keates’ (2000) analysis of the Xiaochangliang and a subset of the Donggutou collections indicate that this chert is the material most often selected. Interestingly, basalt represents a small portion of the Xiaochangliang assemblage (Keates 2000). Although there are exposed volcanic materials near Xiaochangliang the only real exposures of basalts are some 100 km to the east (Schick and Dong 1993). These raw materials may have been collected from secondary deposits much closer to the site. Extensive sampling of conglomeratic deposits would be necessary to fully understand these behaviors in detail.

Like many Early Pleistocene sites in Africa, the Nihewan sites display a pattern where hominins appear to have collected and used artifacts near to where they were eventually deposited. Local sources are a defining feature of many Oldowan assemblages (Stout et al. 2005; Goldman et al. 2006; Harmand 2006). Although chert was locally abundant, it was not a high quality material for artifact production. Schick and colleagues (1991) note that, within one chert nodule, one half may be completely homogenous while the other half may be riddled with impurities that cause the piece to fracture in unpredictable ways. This likely explains why Schick and colleagues’ (1991) analysis of the Donggutou material show an extremely high incidence of angular fragments and very few cores. Similar patterns are found in a recent analysis of the Xiaochangliang materials (Shen and Chen 2003). Schick and colleagues analysis of the core forms from Donggutou note that none of the cores could be described as formal core forms in Leakey’s (1971) typology. This pattern may be an adaptation to the particular constraints of the available raw materials. In the absence of raw material that fractures in predictable ways, the development of standardized flake removal system offers few advantages (Brantingham et al. 2000). On a similarly intractable raw material at the Oldowan site of Kanjera South in western Kenya, hominins employed a haphazard reduction strategy (Braun 2006). This highlights some basic parallels between African and Asian industries. We predict that the lack of high quality material in the Nihewan Basin and the potentially decreased reliance on high activity failure rate resources (Jeske 1989) mediated by sharp edged stone tools in these high latitude ecosystems (Binford 2001; Torrence 2001), resulted in a technology that does not involve the utilization of high quality raw materials intensively.

When compared to the patterns that characterize the Developed Oldowan, the Nihewan assemblages do not show similar patterns of flake production (Fig. 4.1). Artifacts from the Nihewan Basin seem to fall within the pattern of flake production similar to that expressed in Pliocene African assemblages, despite the fact that the Nihewan sites are in fact younger than the Developed Oldowan sites of East Africa (Zhu et al. 2004). We believe these patterns are to be expected. The available raw materials in the Nihewan Basin did not allow the systematic continuous production of large flakes that is seen in the Developed Oldowan (Ludwig and Harris 1998; Braun and Harris 2001; de la Torre et al. 2003). The parallels between the Nihewan and Pliocene Oldowan assemblages we have outlined here does not suggest some type of cultural stagnation on the part of East Asian Pleistocene toolmakers. Non-standardized core and flake industries are very well adapted to a number of different ecological scenarios. Modern humans have employed a simple core and flake technology with great success (Hayden 1979, 1989; Gould 1980; Shott and Sillitoe
It is possible that the resources that were being acquired with the stone tools in the Pleistocene of the Nihewan Basin did not require the consistent production of large sharp edged flakes. It is interesting to note that very few modified bones have been recorded from the Nihewan assemblages despite excellent fossilization of bones (>75% in Behrensmeyer’s (Behrensmeyer 1978) weathering stage 1 or 2 at Xiaochangliang) found in association with artifacts (Peterson et al. 2003). Interestingly, several examples of percussion fractured bones have been recovered (Peterson et al. 2003; Zhu et al. 2004). It is possible that the incidence of percussion-fractured bones in the absence of cut-marks reflects the slower rate of carcass decay found in higher latitude ecosystems. If hominins in the Nihewan were not dependent on a sharp edged stone tool technology and instead practiced a more diverse foraging strategy that included a heavier reliance on plant foods relative to their African counterparts this may be reflected in these Asian industries. Unfortunately, pounding tools are not well known from the archaeological record of the Nihewan Basin (Shen and Chen 2003). However, other East Asian localities do show some evidence of a percussive technology. The site of Chenjiawo in the Lantian region displays examples of very large (>16 cm) cobbles with pitting and bruising (Keates 2000). Anvils and hammerstones have also been identified at the Middle Pleistocene Zhoukoudian Locality 1 site (Chiu et al. 1973; Zhang 1985).

Another possible scenario that has been forwarded to explain the differences between East African Oldowan assemblages and the Early Pleistocene assemblages of East Asia is that the stone tool technology found in East Asian localities represents the basis of a more extensive but archaeologically invisible technology. Actualistic experiments show that the technology found in the Nihewan Basin could be used to manufacture a broad suite of bamboo implements (Clark 1998). Comparisons between African and Asian assemblages show much promise for teasing apart the impetus behind the differences and similarities in these assemblages.

Discussion

It might be tempting to use the superficially rudimentary aspects of the earliest evidence of stone tools in Asia to suggest a series of cultural waves out of Africa associated with different technological systems. It is possible to then associate these different movements with different cognitive capacities (e.g. Pre-Oldowan, Oldowan, Developed Oldowan) (Rolland 1998; Carbonell et al. 1999). This may be an oversimplification of the Early Paleolithic archaeological record. In relation to the African Oldowan record, the East Asian record represents a similar behavioral system applied to a unique context. Although it appears that many Asian sites were found in grasslands (Teague and Potts 2007) that may have been similar to East African grasslands, the differences in latitude associated with changes in secondary biomass (Binford 2001; Torrence 2001) and the persistence of diverse carnivore forms throughout the Pleistocene (Turner 1992) would have made for vastly different ecologies in these two areas. One aspect of the Chinese Early Paleolithic that seems to contrast the African record is the long periods of what appears to be static technological change (Gao and Norton 2002). This may be because many of the environments in Asia are best exploited using a simple core and flake technology.

There is good reason to believe that the African archaeological record represents a consistent increase in technological efficiency (Christenson 1982) associated with adaptations to increasingly variable habitats in Africa (Potts 1994, 1996; Rogers et al. 1994; Braun and Harris 2001; Braun et al. 2008b). It is possible that the habitats seen in some Asian localities represented unique circumstances that did not always require the flaked stone toolkit that environments in East Africa necessitated. Subsequently, the archaeological record of Asia may represent the application of a similar technological system to a new context. The hypotheses we have developed here show some promise for understanding the similarities and differences between the East African Oldowan and the East Asian Early Paleolithic; however, two attributes of the East Asian record do not support this hypothesis. The first is the general lack of pounding tools currently described at East Asian Early Paleolithic industries. Current reviews of the Early and Middle Pleistocene archaeological record of East Asia (Keates 2000) describe small quantities of lightly flaked diminutive quartz pebbles at many of these localities. The second piece of data that contradicts the hypothesis forwarded here derives from microwear evidence from the Nihewan Basin (Shen and Chen 2003). This analysis suggests that at least some of the tools from Xiaochangliang were used in the processing of animal material (Shen and Chen 2003).
Conclusion

The differences between the African record and the Early Paleolithic record in the Nihewan Basin represent the variability of a generalized Oldowan behavioral system. The variability seen in the core and flake industries of East Asia need not imply the presence of a relict population of Mode I toolmakers in the Early Pleistocene (Rolland 1998; Carbonell et al. 1999). It is possible that the hominins that first dispersed into East Asia arrived with a simple toolkit that was well adapted to the environments these hominins encountered. The presence of Mode I industries in central and south Asia and Europe well into the Middle Pleistocene attest to the success of these industries (Dennell 1998, 2003; Rolland 1998; Lycett 2007). We caution the attribution of different archaeological assemblages to specific waves of hominins moving out of Africa with specific toolkits. Regardless of cognitive or technical associations with Mode I technologies (Inizan et al. 1992; Stout and Chaminade 2007), the presence of simple core and flake toolkits over wide temporal and geographic ranges suggests they were extremely adaptive for particular ecological contexts.

Acknowledgements  The authors would like to thank Professors Gao Xing, Wei Qi, Jin Changzhu, and other members of the Institute of Vertebrate Paleontology and Paleoanthropology staff that provided us with an enlightening tour of the archaeological sites in China in the summer of 2006. We thank Alison Brooks for imparting some of her expansive understanding of the East Asian archaeological record. We also thank the helpful suggestions of three anonymous reviewers. David R. Braun would like to thank the support of the University of Cape Town Emerging Researchers Program and constant careful assistance of Kathryn Underwood.

References


