Quaternary International 211 (2010) 55–65

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

A demographic model for Palaeolithic technological evolution: The case of East Asia and the Movius Line

Stephen J. Lycett [a,*], Christopher J. Norton [b]

[a] Department of Anthropology, University of Kent, Marlowe Building, Canterbury, Kent CT2 7NR, UK
[b] Department of Anthropology, University of Hawai'i, 2424 Maile Way, Saunders Hall 346, Honolulu, HI 96822, USA

ARTICLE INFO

Article history:
Available online 25 December 2008

ABSTRACT

The Pleistocene record of East Asia continues to pose controversial questions for palaeoanthropology, especially with regard to Palaeolithic technological patterns. In recent years, an increased understanding of the effect of demography on cultural transmission has improved our understanding of the incidence, proliferation, and elaboration of technological traditions. Here, we present a generalised null model of Lower–Middle Palaeolithic technological evolution, which expressly links cultural transmission theory and demographic factors (i.e. population size, density, and social interconnectedness). Consistent with our model, Africa exhibits evidence of major technological innovations during the Early to Middle Pleistocene, due to a constant source of population and growth due to accumulation through time. In comparison, Pleistocene East Asian assemblages are dominated by Mode 1-type technologies, and only a few localized occurrences of bifacial technology are currently known. We detail evidence suggesting that during much of the Pleistocene a combination of biogeographical, topographical, and dispersal factors are likely to have resulted in relatively lower effective population sizes in East Asian hominins compared with western portions of the Old World, particularly Africa. Thus, the Movius Line – as is the case with its namesake 'Wallace's line' – must be examined in terms of its biogeographical context, if the divergent evolutionary trajectories of entities either side of it are to be understood. Most parsimoniously, the Movius Line *sensu lato* is thus a 'line' which represents the crossing of a demographic threshold. Under the parameters of our (testable) null model, geographically and temporally sporadic occurrences of bifacial technology in East Asia are the product of short-lived instances of technological convergence. As a consequence, the *in situ* evolution of Levallois (Mode 3) was inhibited in East Asia due to the constraints of relatively smaller effective population sizes.

1. Introduction

Palaeoanthropological research in East Asia plays a key role in understanding the dispersal of Pleistocene hominins and global patterns of biological and technological evolution. It is increasingly understood that human evolution during the Pleistocene (both biological and cultural) can only be understood within a comparative framework, whereby the evidence from one region is contrasted with that of others in order to understand both their similarities and differences. However, over the last century, comparisons of East Asia with other regions of the Old World have posed controversial questions. In particular, it has been suggested that a marked division of technological industries may exist between East Asia and large portions of the western Old World (Movius, 1948, 1969). Most notably, a lack of Acheulean (or 'Mode 2') handaxe technologies in East Asia was proposed by some (e.g., Movius, 1948), and this geographic line of technological demarcation subsequently became known as the 'Movius Line' (Swartz, 1980). Movius (1969) also proposed that a lack of Middle Palaeolithic prepared core (i.e. 'Levallois' or 'Mode 3') industries may be evinced in East Asia, and tentatively proposed a techno-cultural connectivity between Acheulean handaxe and Levallois core traditions of stone tool manufacture as a possible means of explaining the absence of both technologies within East Asia (see also Schick, 1998; Lycett, 2007). Somewhat in parallel, it has been suggested that specific species of the genus *Homo* may have evolved within East Asia, supporting the notion that the biological, as well as cultural, evolutionary trajectory of East Asia may have displayed marked, and potentially unique, differences from patterns seen in western regions (Wood, 1991).

Since the original comments of Movius (1948), 'handaxes' within East Asian contexts have been discovered (Pei et al., 1958; Yi

* Corresponding author. Tel.: +44 (0)1227 82 7739.
E-mail addresses: s.j.lycett@kent.ac.uk (S.J. Lycett), cnorton@hawaii.edu (C.J. Norton).

1040-6182/$ – see front matter © 2008 Elsevier Ltd and INQUA. All rights reserved.
doi:10.1016/j.quaint.2008.12.001

and Clark, 1983; Huang, 1989; Hou et al., 2000; Bae, 2002; Wang, 2005, 2007; Norton et al., 2006; Xie and Bodin, 2007). These discoveries have led others to suggest that a strong technological division between eastern and western portions of the Old World did not exist during the Pleistocene, thus rendering the so-called 'Movius Line' obsolete (e.g., Yi and Clark, 1983; Gamble and Marshall, 2001). Other workers, however, while recognising the importance of discoveries of handaxes and handaxe-like technologies in East Asia have suggested that important patterns of technological differentiation may still be noted between the east and the west (Clark, 1994; Pope and Keates, 1994; Schick, 1994; Keates, 2002; Corvinus, 2004; Norton et al., 2006; Lycett, 2007; Lycett and Gowlett, 2008; Norton and Bae, 2008). In particular, the true morphological and technological comparability of 'handaxe' artefacts from regions east and west of the Movius Line has been drawn into question, with several workers suggesting that East Asian specimens tend to be thicker, less refined, and exhibit less bifacial and invasive flaking routines (Schick and Dong, 1993; Pope and Keates, 1994; Keates, 2002; Corvinus, 2004). Indeed, several morphometric analyses have identified statistically significant differences between the attributes of specific biface assemblages from east and west of the Movius Line (Norton et al., 2006; Lycett and Gowlett, 2008; Norton and Bae, 2008). It has also been noted that the number of sites from which handaxes have been recovered in East Asia tend to be geographically sparse compared with many regions west of the Movius Line (Chauhan, 2004; Norton et al., 2006; Petraglia, 2006). Norton et al. (2006) also noted that when discovered, 'handaxe' specimens tend only to comprise a small percentage of the total number of artefacts recovered, a situation that contrasts with many classic Acheulean sites in western portions of the Old World, where bifacial handaxes may dominate assemblages in large numbers.

It is upon consideration of these multiple factors that Norton et al. (2006) proposed the concept of a 'Movius Line *sensu lato*' (see also Norton and Bae, 2008). This concept proposes that due to the discovery of handaxes in East Asian contexts, the original concept of a 'Movius Line *sensu stricto*' predicated upon the presumed *total* absence of handaxes in East Asia can no longer be upheld. However, in light of the continued presence of technological, compositional, and distributional differences between handaxe assemblages east and west of the Movius Line, the concept of a 'Movius Line *sensu lato*' should still be retained. The motivation for such a concept hinges on the basic premise that a fundamental component of Palaeolithic research should be to identify potentially important patterns that may exist in the available data, and then – crucially – to identify potential causes of such patterning.

Here, drawing on cultural transmission theory and demographic considerations, we propose a generalised model for Palaeolithic technological evolution during the Pleistocene. We then examine the evidence from East Asia in light of this model. We propose that the model is able to accommodate the presence of low frequencies of handaxes in East Asia with the concept of a Movius Line *sensu lato*. Thus, the model reconciles precisely those elements of the currently available evidence that previously have led to controversial and sometimes acrimonious debate.

2. Cultural transmission, demography and Pleistocene technological evolution: a model

2.1. Cultural transmission underlies technological traditions

A tradition may be defined as a particular behaviour (e.g., tool manufacture and use) that is repeated over generations, and is learned and passed on between individuals via a process of social interaction (Fragaszy, 2003). Hence, by definition, social transmission is the basis on which all traditions are built. It has long been recognised that the manufacture of stone tools conforms to a tradition of behaviour under these criteria (e.g., Oakley, 1958). Indeed, there is a growing mass of evidence to demonstrate that many behavioural patterns in extant primates may be considered traditions of behaviour that are socially learned, transmitted and inherited between individuals and groups over generations of time (Whiten et al., 1999, 2005, 2007; McGrew, 2004, 2007; Biro et al., 2006; Horner et al., 2006; Perry, 2006; Bonnie et al., 2007; Hopper et al., 2007; Lycett et al., 2007). Such work indicates that socially learned patterns of behaviour (i.e. cultural traditions) were practiced by early hominins even prior to any detectable archaeological evidence in the form of deliberately flaked stone tools (Panger et al., 2002).

In recent decades, it has also increasingly been recognised that social learning can be modelled as a form of information transmission and inheritance broadly analogous to that of genetic (information) transmission (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985; Durham, 1992; Neiman, 1995; Shennan, 2000; Eerkens and Lipo, 2005, 2007). This, of course, does not imply that cultural inheritance and genetic inheritance are identical in every respect. One of the most obvious differences is that, in contrast to genetic information, cultural information is not necessarily inherited solely from biological parents; there is also the opportunity to copy and learn behaviours from more distantly related kin and unrelated individuals. Nevertheless, many workers in the fields of psychology, primatology, archaeology, and anthropology are recognising the analytical potential of modelling cultural transmission as a process with broad resemblances to genetic transmission and inheritance (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985; Eerkens and Lipo, 2005, 2007; Mesoudi et al., 2006; O'Brien et al., 2008). Indeed, some workers argue for a model of 'dual inheritance' in the evolutionary analysis of human behaviour, whereby humans are seen as the inheritors of both genetic information and cultural information (Boyd and Richerson, 1985; Durham, 1992). Given the evidence that our closest living primate relatives also inherit behavioural traditions (Whiten, 2005), there is no operational reason why such an approach cannot be extended to extinct hominin populations under a unified analytical framework. A further corollary of the recognition of broad similarities between cultural transmission and genetic transmission is that many of the factors known to structure patterns of genetic variation and transmission (e.g., drift, selection, dispersal and demography) must also be taken into account when examining patterns of cultural variation across space and time (Lipo and Madsen, 2001; Mellars, 2006; Shennan, 2000, 2006). In turn, this has led to the use of formal analytical models drawn from the field of population genetics being applied to cultural data (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985; Neiman, 1995; Shennan, 2001, 2006; Bentley et al., 2004, 2007; Richerson and Boyd, 2005; Lycett and von Cramon-Taubadel, 2008; Lycett, 2008; Shennan and Bentley, 2008; Mesoudi and Lycett, 2009).

2.2. Demography and its effects on cultural transmission processes and technological evolution

An increased awareness of the broad similarities between the genetic transmission of information and processes of cultural transmission has highlighted that – as in the field of population genetics – demographic parameters must be considered if patterns of cultural variation and change through time (i.e. between generations) are to be fully understood (Neiman, 1995; Shennan, 2006). As Neiman (1995) and Shennan (2000) have outlined, when populations are relatively small, chance (i.e. stochastic) factors play a greater role in determining which cultural elements will be transmitted to subsequent generations. In other words, 'drift' will tend to have a greater effect upon outcomes of cultural transmission processes in small populations. In the field of population genetics, sharp decreases in population size are termed 'founder effects', due to the loss of (genetic) diversity that tends to occur as a result of drift. It is important to note that 'population size' here refers not to the total number of individuals within a population (i.e. 'group size'), but to the number of individuals actively involved in the reproductive process (i.e. only those individuals actually responsible for passing on genetic information to subsequent generations). Population geneticists refer to this subset of the total population as the 'effective population size' (N_e). Similarly, we can think of the number of skilled practitioners of a given craft tradition involved in passing on those skills to subsequent generations via social transmission, as the 'effective population size' for that skill (see e.g., Shennan, 2001).

Sustained population growth and larger social transmission networks will result in more effective instances of cultural transmission and mitigate the loss of useful cultural traits via cultural drift (Shennan, 2000; Henrich, 2004). For instance, Shennan (2001) has illustrated the effects that change in effective population size (N_e) can have upon the successful spread of innovations and particular cultural variants through a series of simulation analyses. The results of these analyses demonstrated that when population sizes are relatively large, useful innovations are more likely to spread within subsequent generations. This is due to the fact that in larger populations useful innovations are less likely to be swamped by cultural drift (i.e. stochastic sampling effects). This effect was shown by Shennan (2001) in larger simulated populations in situations of both parent-to-offspring (i.e. vertical) cultural transmission and peer-to-peer (i.e. horizontal) forms of transmission. It is interesting to note that van Schaik et al. (2003) have shown that in the case of wild orangutan cultural behaviours, increased opportunity for social associations beyond those of close kin (within a group), correlates directly with the size of cultural repertoire exhibited by different groups. Such observations suggest that Shennan's (2001) observations have general applicability in primates, including extinct hominins.

Hosfield (2005) drew directly on Shennan's (2001) simulations in a discussion of Palaeolithic assemblages from the Solent River system (United Kingdom). Using studies of artefact densities as a proxy for population sizes, Hosfield (2005, pp. 228–231) argued that a substantial increase in population size occurred during Marine Isotope Stage 9, which also coincides with the first appearance of Levallois technologies in the region. Following Shennan (2001), Hosfield (2005) contends that this represents an incidence of successful technological innovation and transmission (i.e. adoption) facilitated by increased population levels.

Congruent with Shennan's (2001) observations, Henrich (2004) has shown via mathematical modelling that a *decrease* in effective population size (N_e) may lead to a loss of pre-existing socially transmitted cultural elements. This effect is due to the fact that in each instance of cultural transmission, the copying of a given craft skill will be imperfect to a lesser or greater degree. In turn, this leads to variation around the mean in terms of the expressed skill level of any craft technique within a given population. The greater the number of models, the more choice is available for selecting the best (i.e. most skilled) models from which to copy. That is, in larger populations, cumulative cultural learning is possible because the effect of having a larger number of models from which to pick the most skilled, exceeds the losses resulting from imperfect copying of that skill. Hence, the chance of copying the most skilled elements of a given practice correlates directly with the number of models from which to copy. Henrich (2004) suggests these effects will be especially profound in instances where the skill levels required to replicate a given task effectively are relatively more complex. Henrich (2004) further notes that under such circumstances demography is a reflection of three inter-related factors: population size, density and interconnectedness (Fig. 1). Social interconnectedness reflects the likelihood of encountering a given craft skill and the regularity of such encounters. Social interconnectedness is thus somewhat proportional to the parameters of effective population size (i.e. number of skilled craft practitioners) and population density (i.e. probability of encounter due to degree of aggregation) (Fig. 1).

Henrich (2004) illustrated the effects of a sharp reduction in effective population size on cultural transmission processes with reference to the loss of skills in the Tasmanian Islanders. He describes how when Tasmania became cut off from mainland Australia around 10–12 kyrs ago due to rising sea levels, a sharp founder effect occurred. In contrast to their contemporaries on the mainland, however, Tasmanians appear to have lost and/or never developed the ability to manufacture bone tools, cold-weather clothing, fishhooks, hafted tools, fishing spears, barbed spears, fish and eel traps, nets, spear throwers, and boomerangs. Indeed, the apparent loss of technological skills in island populations due to what we might today term 'cultural founder effects' has long been noted (Rivers, 1926), as have similar processes resulting from sharp drops in effective population size due to environmental catastrophes (Riede, 2008). As Shennan (2000) has discussed at length, these factors ensure that greater emphasis must be placed on the role of population increases, crashes, fluctuations and localized extinctions, when considering observable geographic and diachronic patterns in cultural data.

2.3. A parsimonious null model for the evolution of Pleistocene technologies based on demographic factors

Drawing on the considerations outlined above concerning the links between demographic parameters and (in)effective cultural transmission, we propose a generalised null model of technological evolution during the Old World Lower to Middle Palaeolithic. This model is illustrated in Fig. 2. The model deliberately takes as its foci the three main Palaeolithic technological variants that are recognised (under various guises of terminology) as having occurred at different times in different places. Using Clark's (1969) terminology,

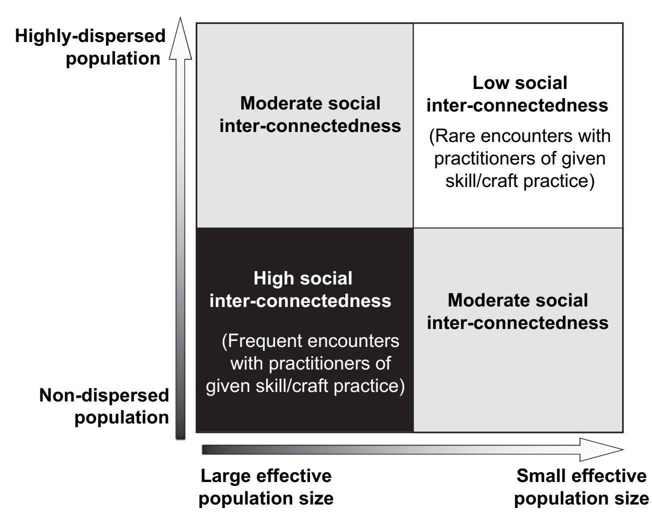

Fig. 1. Inter-relationships between the demographic parameters of effective population size, density, and degree of social interconnectedness (*sensu* Henrich, 2004). Different conditions of density and effective population size will have profound consequences for the degree of social interconnectedness, the latter of which will essentially equate to the number of skilled practitioners of a given craft skill per km^2.

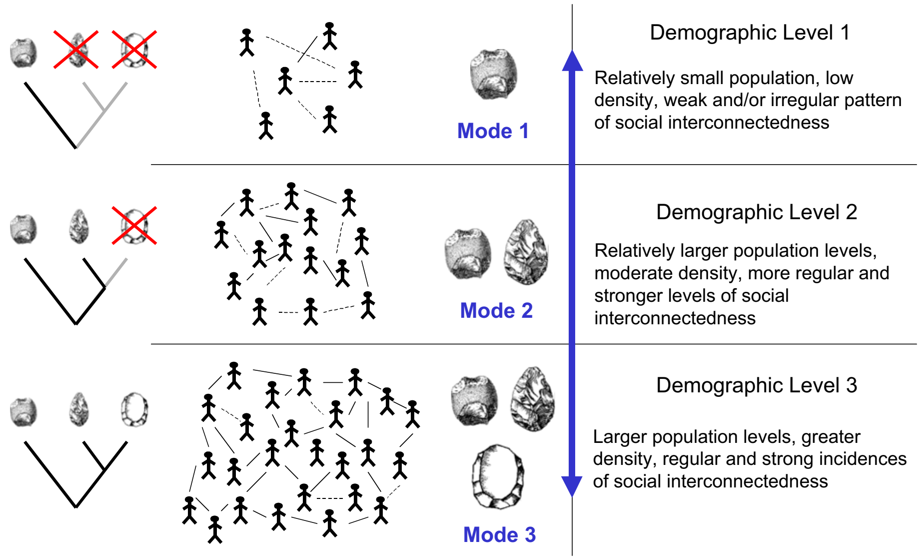

Fig. 2. Model of demographic levels and lithic technological phylogeny. The model highlights and takes account of evidence that prevailing demographic conditions will have an effect on the effective transmission of technological skills and practices. It is important to note that different demographic levels refer to relative differences in the effective population size (N_e); that is, the number of individuals passing on cultural information. Also note that demographic levels may decrease and lead to a loss of lithic elements. Dotted lines indicate instances of weak social transmission, while solid lines indicate a relatively stronger incidence of social contact and transmission (see text for further discussion).

these three main technological variants may be termed Mode 1 (i.e. core, core tool, flake and flake tool comprised assemblages), Mode 2 (i.e. assemblages that contain bifacial 'handaxes' frequently alongside Mode 1 technological elements), and assemblages containing examples of the Mode 3 prepared core (i.e. Levallois) technique. We use this terminology of 'Modes' not because it is the most precise, but because it is the coarsest level of taxonomic technological description (Lycett, 2007), taking no account of chronological or regional 'variants' that may emerge *within* these broadly defined technological distinctions. However, in many places, the appearance of prepared core Levallois technologies is taken to be a diagnostic component of Middle Palaeolithic (Eurasian contexts) or Middle Stone Age (African contexts) industries (Schick and Toth, 1993; Mellars, 1996; Gao and Norton, 2002; Porat et al., 2002).

It should be noted that the model (Fig. 2) explicitly incorporates (*sensu* Henrich, 2004) the three inter-related demographic factors of effective population size (N_e), density, and social interconnectedness with the appearance and disappearance of the three major technological variants, under the framework of social transmission outlined above. The model may be considered as a null or generalised model to the extent that while differences in demographic factors (i.e. effective population size, density and interconnectedness) will be axiomatic for hominins distributed widely through time and space, cognitive and/or biomechanical evolution that might otherwise effect the appearance and disappearance of technological patterns need not. Thus, the model is parsimonious in regard to these latter factors.

It is important to note that under the parameters of the model, demographic and technological levels can both increase and decrease (arrows in Fig. 2). This ensures that the model takes account of the evidence discussed above, which has highlighted that demographic parameters will have an effect on both the occurrence and spread of technological innovations, as well as potentially impeding their effective replication and eventual loss from the cultural repertoire of a given population (i.e. technological 'reversals'). This also highlights that the three demographic/technological levels are not tightly bounded entities that will necessarily shift sharply from one level to another. Rather, the model predicts that as the demographic parameters of size, density, and interconnectedness increase *within* a given level, then elements of the next level may begin to appear at rather low and somewhat ephemeral levels. That is, technological innovations and variants will appear sporadically in time and space. This is somewhat equivalent to what Isaac (1972, pp. 185–186) referred to as the "random walk" in assemblage composition due to stochastic factors. However, what will determine whether those innovations spread and become elaborated through time under the parameters of this specific model are the prevailing demographic conditions.

Mithen (1994) has previously considered the role that factors relating to social transmission might have on Mode 1 versus Mode 2 traditions of manufacture in regard to the stone tool industries of southern England. However, there are some marked differences between the scenario posited by Mithen and the model outlined here. In particular, Mithen's scenario for southern England was predicated on putative links between specific environmental parameters (woodlands versus grasslands) and particular stone tool traditions, the basic premises of which have since been questioned (Roe, 1994; McNabb and Ashton, 1995; Wenban-Smith, 1996, 1998; White, 2000, pp. 48–49). Moreover, Mithen's (1994) discussion did not incorporate consideration of Middle Palaeolithic industries (Levallois/Mode 3). In addition, 'group size' was the key variable in Mithen's model, rather than effective population size. Likewise, the inter-relationships between effective population size, density and interconnectedness (*sensu* Henrich, 2004) were not fully articulated, nor – most importantly – was the model presented as a null hypothesis of technological change for the Lower to Middle Palaeolithic. Hence, key differences between Mithen's hypothesis and our model should be noted.

2.4. *"Ex Africa semper aliquid novi" (There is always something new out of Africa), Pliny the Elder (AD 23–79), Natural History VIII, 17*[1]

In an instance of characteristic foresight, Darwin (1871, p. 155) predicted that evidence of the "early progenitors" of the human lineage would probably be found in Africa because our closest living primate relatives can still be found there. Since then, Africa has

[1] With apologies to Aldhouse-Green (2001).

produced fossil representatives of more hominin palaeospecies than any other continent (Wood and Richmond, 2000). In contrast with other continents (Dennell, 2003), there is no evidence that Africa was ever totally deserted by hominins during the Plio-Pleistocene. Indeed (sub-Saharan) Africa may have been the only continent continuously inhabited by hominins until the Middle Pleistocene (Dennell, 2003). It is perhaps unsurprising that Africa is, therefore, generally considered the founding source of all major hominin dispersals during the Plio-Pleistocene (Gamble, 1993; Larick and Ciochon, 1996; Tattersall, 1997; Carbonell et al., 1999; Goren-Inbar et al., 2000; Bar-Yosef and Belfer-Cohen, 2001; Antón and Swisher, 2004; Klein, 2005; Lycett and von Cramon-Taubadel, 2008; although see Dennell and Roebroeks (2005) for a somewhat dissenting view). Hence, although estimating the demographic parameters of Plio-Pleistocene hominin populations is a notoriously difficult task, it can be stated with some confidence that, on a relative basis, demographic levels will have been higher within Africa than over most of Eurasia during the Early to Middle Pleistocene.

The probability of relatively sustained demographic conditions and more extensive periods of population growth within Africa during the Pleistocene is a particularly salient factor when archaeological evidence for technological evolution is considered in combination with our model. It is particularly interesting to observe that Africa provides the earliest First Appearance Dates (FADs) for Mode 1 technologies (Semaw et al., 1997, 2003; Roche et al., 1999; Semaw, 2000; Delagnes and Roche, 2005), Acheulean handaxe (Mode 2) production (Asfaw et al., 1992), and the earliest evidence of the Levallois (Mode 3) technique (Tryon and McBrearty, 2002; Tryon et al., 2006). Thus, at least in Africa, the model we present is consistent with evidence for a connection between sustained population growth and the appearance and spread of major technological innovations (Table 1). It is also interesting to note, as others have done previously, the disjunction between the FAD of African *H. erectus* and the FAD of the Acheulean in Africa (the species with which the early Acheulean is most frequently aligned [e.g., Corvinus, 2004]) some 200,000 years later. Such a time lag again evinces a potential dislocation between major biological events and major technological innovations, suggestive of a demographic, rather than strictly genetic, proximate mechanism underpinning the effective transmission and proliferation of Mode 2 technological knapping skills. It is also notable that the first appearance of Levallois in Africa overlaps with the Late Acheulean (e.g., Leakey et al., 1969; Tryon et al., 2006). This again is consistent with the model in that as demographic levels rise through time, elements of technological innovations and elaboration will begin to appear alongside existing technological traditions.

Table 1
The first appearance dates and localities of major technological innovations in Africa.

Technological mode	First appearance datum (FAD)	Localities	References
Mode 1 (Oldowan)	~2.6–2.3 MYA	Gona (Ethiopia); Hadar (Ethiopia); Omo, Shungura Formation (Ethiopia); Lokalalei, Nachukui Formation (Kenya)	Kibunjia, 1994; Kimbel et al., 1996; Semaw et al., 1997, 2003; Roche et al., 1999; Semaw, 2000; Delagnes and Roche, 2005
Mode 2 (Acheulean)	~1.7–1.4 MYA	Konso-Gardula (Ethiopia); Sterkfontein, Member 5 (South Africa)	Asfaw et al., 1992; Kuman and Clarke, 2000
Mode 3 (Levallois)	≤ ~0.25 MYA	Koimilot, Kapthurin Formation (Kenya)	Tryon, 2006; Tryon and McBrearty, 2002; Tryon et al., 2006

3. The case of East Asia

Although continued hominin population growth and sustained population densities in Africa may have led to the development of different lithic technologies (e.g., Oldowan – Acheulean – Levallois), in East Asia the hominin technological trajectory appears to have differed. For the most part, the East Asian lithic toolkits differ markedly from comparably aged assemblages from the western Old World (Clark, 1994; Pope and Keates, 1994; Schick, 1994, 1998; Norton et al., 2006; Lycett, 2007). In general, East Asian lithic assemblages are dominated by Mode 1 core and flake technologies (Bae, 1994), with few or little evidence of technologically more advanced Acheulean and Levallois technologies (Norton et al., 2006).

One of the most debated topics in East Asian Paleolithic research is the nature of the Early Paleolithic stone toolkits (Ikawa-Smith, 1978). In particular, since the identification of Acheulean-like bifacial implements in Korea in 1978, the debate has focused on the nature of the Movius Line (Yi and Clark, 1983; Yi, 1986, 1989; Huang, 1987, 1989, 1993; Bae, 1988, 2002; Clark, 1994; Pope and Keates, 1994; Schick, 1994, 1998; Petraglia, 1998; Leng and Shannon, 2000; Norton, 2000; Keates, 2001, 2002; Corvinus, 2004; Wang, 2005, 2007; Norton et al., 2006; Lycett, 2007; Yoo, 2007; Lycett and Gowlett, 2008; Lycett and von Cramon-Taubadel, 2008; Norton and Bae, 2008; Petraglia and Shipton, 2008).

Occurrences of heavy duty tools (handaxes, cleavers, picks) have been reported sporadically in China since the excavations of the Zhoukoudian localities in the 1920s and 1930s. For instance, an Acheulean-like handaxe was excavated from Zhoukoudian Locality 1 and the Dingcun site is perhaps best known for the presence of thick trihedral picks (Movius, 1956). However, it was not until 1978 with the discovery of Acheulean-like bifacially worked handaxes and cleavers at Chongokni in Korea (Kim and Bae, 1983) that some archaeologists (e.g., Yi and Clark, 1983; Yi, 1986, 1989) began to question the validity of the Movius Line. In the 1980s and 1990s Palaeolithic archaeologists from UC Berkeley and other places in North America and Europe began conducting fieldwork in East Asia and often noted the similarities between the East Asian bifaces and the African Sangoan (Clark, 1982, 1994; Schick and Dong, 1993; Schick, 1994, 1998).

Norton et al. (2006) observed that the number of handaxe-bearing sites and handaxes at each of these sites in East Asia (comprising only China, Korea, and Japan) is lower than comparable regions of Africa and South Asia. Despite covering an area of about 12,000,000 km^2, bifaces have been recovered from only four primary (localized) areas in East Asia: Dingcun, Baise Basin, Luonan Basin (all in China), and the Imjin/Hantan River Basin (IHRB) (Korea) (Fig. 3). Acheulean or Acheulean-like heavy duty tools have yet to be reported from Southeast Asia (Pope and Keates, 1994). This is in contrast to many regions of East Africa and India where it is often noted that hundreds of sites that have bifaces exist (Leng and Shannon, 2000; Noll and Petraglia, 2003; Petraglia, 2006). East Asia, despite being of comparable or larger area than Africa or India, has markedly fewer bifaces-bearing sites (Norton et al., 2006; Norton and Bae, 2008).

In all of the lithic assemblages from the East Asian biface sites, or localities within these basins, the artefact composition is dominated by simple core and flake tools. The bifaces are only a small component of the entire lithic assemblage (Bae, 1994; Norton and Bae, 2008). For instance, in the Luonan Basin sites, usually only a few bifaces are present in each lithic scatter (Wang, 2005, 2007). As of 2007, a total of 238 handaxes were surface collected in the

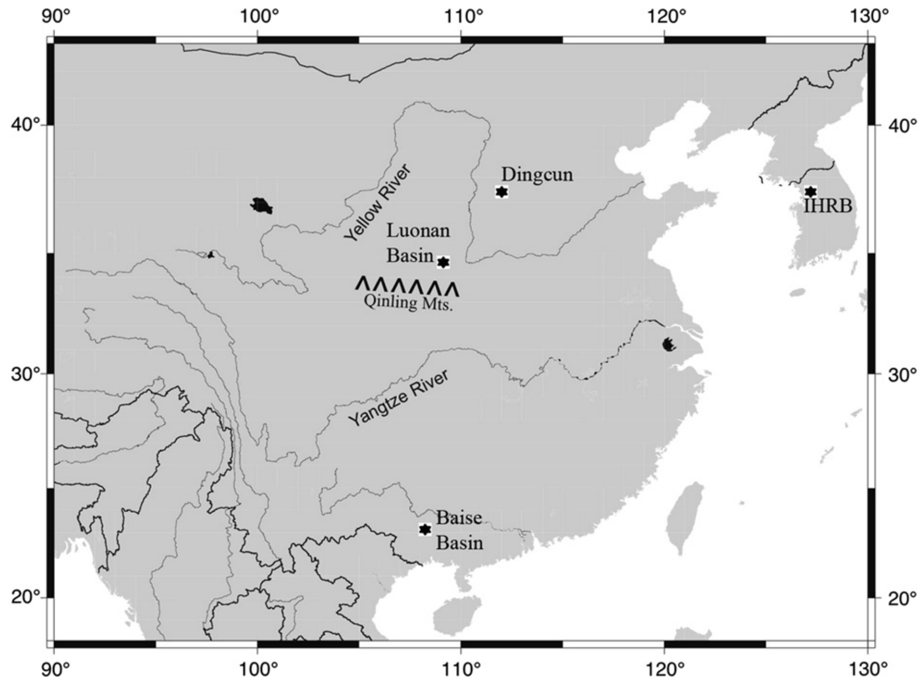

Fig. 3. Despite covering an area of about 12,000,000 km^2, bifaces have been recovered from only four primary (localized) areas in East Asia: Dingcun, Baise Basin, Luonan Basin (all in China), and the Imjin/Hantan River Basin (IHRB) (Korea).

Luonan Basin from 268 sites (Wang, 2005, 2007). This means that on average less than one handaxe per site was found. Even in the IHRB in Korea where bifaces have been reported in higher densities, these implements still represent less than 5% of the artefacts collected and excavated (Norton et al., 2006; Norton and Bae, 2008). Bae (1994) has proposed the term 'Chongoknian' to refer to East Asian lithic assemblages dominated by cores and flakes, but have a small component of bifacial heavy duty tools (<5%). Although future fieldwork may prove otherwise, currently the only possible exception to this pattern is the Fengshudao site in the Baise Basin, where six handaxes were excavated *in situ* from a 40-m^2 area, as were another ~100 bifacial implements surface collected from the surrounding area (Xie and Bodin, 2007; W. Wang, personal communication, 2008). Hence, there is much evidence to support the view of Corvinus (2004, p. 147) who stated "[t]he handaxe-like tools which occasionally occur at [East Asian] sites like Lantian, Dingcun, Bose [Baise], and Chongokni (Korea) are few and widely dispersed from each other, *and do not form a distinct handaxe tradition*" (our emphasis).

One further observation that is not often noted is that the artefact density of most of the Early Palaeolithic sites in East Asia is also usually very low. For instance, in Fangniushan and Chenshan, two Middle Pleistocene open-air sites in central-east China, the artefact densities are less than one per m^3 (Norton et al., in press-b). This suggests that occupations were likely sporadic short-term visits. Chongokni, in Korea, is actually comprised of a series of localities, with only one area having an artefact density comparable to Olorgesailie and the sites from the Narmada Basin (Bae et al., 1995). It is also worth emphasising that all sites in East Asia that have produced collections of bifaces date to the Middle and Late Pleistocene. No large accumulations of bifaces have been reported from any of the Early Pleistocene sites in East Asia.

One point of debate that has been receiving more attention over the past few decades is the presence/absence of certain lithic types that may be related to a true Acheulean tradition. For instance, it has been argued that if a true Acheulean tradition is present, then in addition to handaxes, cleavers should also be present (Petraglia and Shipton, 2008). Nevertheless, in only a few reported cases (e.g., Luonan Basin, IHRB) are cleavers found in association with handaxes in East Asia (Norton, 2000; Wang, 2005, 2006, 2007; Norton et al., 2006). For example, 119 cleavers have been reported from sites in the Luonan Basin (Wang, 2005, 2006, 2007). However, the same problem exists with any interpretation of these cleavers as that mentioned above in regard to the handaxes from the Luonan Basin (see also Norton and Bae, 2008). That is, the cleavers were surface collected and/or derive from questionable contexts. In addition, due to the overall number of sites identified in the Luonan Basin, on average less than one cleaver per site is present (Wang, 2005, 2006, 2007).

It has also been reasoned that because the Levallois technique developed from Acheulean technologies, if a true Acheulean is present, then examples of Levallois should be present in younger deposits overlying strata containing bifacial implements (Schick, 1994, 1998). However, Gao and Norton (2002; see also Gao, 1999, 2000; Norton et al., in press-a) confirmed earlier suggestions (e.g., Movius, 1948, Schick, 1994, 1998) that there is a virtual absence of Levallois technology in East Asia. No conventional Levallois flakes or cores have been identified from anywhere in East Asia before ~30 kya. Levallois technology only appears in certain parts of northern China after 30 kya. For instance, traditional Levallois cores and flakes are present in combination with standard blade technologies at the Shuidonggou site in Ningxia Autonomous Region, northern China (Brantingham et al., 2001; Madsen et al., 2001). However, the earliest Shuidonggou materials date to 26–25 kya (Madsen et al., 2001), thus falling within the Gao and Norton (2002) defined Late Palaeolithic. Shuidonggou is the only site currently identified in China or Korea that has Levallois flakes and cores, though field reconnaissance in the Ningxia region indicates more sites like Shuidonggou are present (Gao et al., 2004). But even in the Shuidonggou case, there is no evidence at the site that an Acheulean or Acheulean-like bifacial technology was present that either co-occurred or preceded the introduction of the Levallois technology there. In fact, it was suggested by Brantingham et al. (2001) that Shuidonggou may have been occupied by foraging groups that dispersed southward from Mongolia and Siberia, with occupations and dispersals in the latter regions beginning ~45–40 kya, finally reaching northern China by ~26 kya. No evidence of the Levallois technology has been identified in Korea (Norton, 2000).

4. Discussion: toward an understanding of the historical contingencies of technological evolution in East Asia during the Pleistocene

The question that arises from the variation in the lithic toolkits east and west of the Movius Line is can we identify the causal factors that underlie the development of the hominin behavioural trajectory in East Asia during the Pleistocene that appears to differ from the western Old World? A number of ideas have been put forth to best explain the absence or near absence of bifacial implements east of the Movius Line. Explanations for the paucity of bifaces in East Asia have ranged from raw material constraints to the widespread use of other types of raw materials (e.g., bamboo), to different environments equals different toolkits (Boriskovskii, 1968; Hutterer, 1977; Watanabe, 1985; Pope, 1989; as reviewed by Schick, 1994). Most of these explanations have been shown to be possibilities, but not widely accepted or shown to be universally applicable to all of East Asia (Schick and Toth, 1993; Schick, 1994, 1998). In fact, perhaps the greatest weakness with these models is that many of them are largely untestable due to their reliance on biodegradable materials that do not routinely survive in the archaeological record.

East Asia has long been considered to be a periphery for hominin dispersals out of Africa (e.g., Movius, 1948; Wolpoff et al., 1984; Schick, 1994). However, within recent years several observations have further indicated that demographic levels in East Asia may have been substantially lower than seen in other parts of the Old World (especially Africa) during the Early and Middle Pleistocene. For instance, Dennell (2003) notes that during the Early Pleistocene, the FADs of hominin occupation outside of East Africa imply spatially and temporally discontinuous incursions, rather than evidence of continuous occupation. During the Early and Middle Pleistocene the Himalaya–Karakorum mountain range, the Tibetan Plateau, the deserts of central Asia, and the Zagros mountains are all likely to have been barriers to hominin dispersal, especially into East Asia (Schick and Toth, 1993; Dennell, 2004). Environmental variables associated with latitude (both climate and factors such as number of day-light hours) are also likely to have been pertinent to hominin dispersal patterns and population densities (Dennell, 2003). Such considerations make the use of higher latitudes as dispersal routes for large numbers of hominins into East Asia, thus theoretically avoiding some of the geographic barriers already mentioned, less probable. Moreover, as Dennell (2004, pp. 218–219) has noted, the Acheulean of southern and southwest Asia is confined largely to areas south of 35°N (i.e. only areas that already evince hominin occupation in the Early Pleistocene), with all evidence archaeological of hominin expansion into latitudes of 35–45°N during the Early Pleistocene restricted solely to Mode 1 style technologies.

China, Korea, and Southeast Asia are the most geographically distant regions from East Africa colonised by hominins during the Early–Middle Pleistocene. Studies of modern human dispersals from Africa have shown that when hominin taxa dispersed over large geographic distances, there is likely to be a reduction in their effective population size that correlates directly with increased distance from the original 'source' region. This phenomenon has been termed the 'iterative founder effect': quite literally, serial bottlenecking due to the sequential reduction of within-group genetic diversity as effective population sizes become progressively smaller with each dispersal event. In the case of modern human dispersals from Africa, such serial bottlenecking is evinced in both global patterns of genetic diversity and phenotypic diversity in contemporary or near-contemporary populations (Prugnolle et al., 2005; Ramachandran et al., 2005; Manica et al., 2007; von Cramon-Taubadel and Lycett, 2008). Serial bottlenecking has also been demonstrated in the case of human stomach bacteria (*Helicobacter pylori*), suggesting that the demographic consequences of human global dispersal also had an effect on the population genetics of these 'hitchhiking' bacterial populations, as humans carried them out of Africa in their stomachs (Linz et al., 2007).

As noted earlier, a broad analogy between genetic transmission and cultural transmission may reasonably be drawn, which in turn allows analytical models drawn from population genetics to be usefully applied to cultural data (see above). Hence, Lycett and von Cramon-Taubadel (2008) predicted that if the widely held assumption that Acheulean populations dispersed from Africa into parts of western and northern Eurasia is correct, then similar serial bottlenecking effects might be evinced in samples of Acheulean handaxes from various regions of the Palaeolithic Old World. The iterative founder effect model predicts the sequential reduction of within-group (or in this case, within-assemblage) variance as geographic distance from origin increases along a hypothesised dispersal route. Lycett and von Cramon-Taubadel (2008) tested this prediction using samples of Acheulean handaxes from sub-Saharan Africa, north Africa, the Near East, the Indian subcontinent, and Europe. They found statistically significant support for the serial founder effect model with ~45–50% of within-assemblage handaxe plan-form shape variance explained by geographic distance from East Africa. Using a contrasting series of non-African start points, they found that no residual variation could be explained by a significant fit to the iterative founder effect model. This suggests that due to geographic distance factors alone, effective population sizes in Acheulean hominins became progressively smaller as they moved into regions increasingly distant from Africa and, in turn, stretched networks of social transmission involved in the learning of effective handaxe manufacturing skills. Under such parameters, the geographically distant location of East Asia may have been beyond the threshold of hominin effective population sizes required to maintain handaxe manufacturing skills.

The stretching of lines of social transmission due to dispersal events, as outlined by Lycett and von Cramon-Taubadel (2008) may have been exacerbated by the presence of geographic barriers to dispersal from the Indian subcontinent (i.e. the region most proximate to East Asia with clear signal of Acheulean traditions). Schick and Toth (1993, pp. 277–278) have previously considered the role that geographic barriers might have in terms of the dispersal of Acheulean lithic traditions into East Asia, thus leading to 'cultural bottlenecks'. Aside from the Himalayas, the Ganges–Brahmaputra river system in particular may have been a formidable barrier (Field and Lahr, 2006). It is interesting to note that large rivers consistently appear to inhibit the dispersal of primates, including great apes, as evinced by genetic studies (Ayres and Clutton-Brock, 1992; Gonder et al., 2006; Anthony et al., 2007). As Chauhan (in press) has recently noted, the north east of India has proved to be something of a genetic bottleneck even amongst modern human populations (Cordaux et al., 2004), potentially hinting at a similar role for patterns of both genetic and cultural transmission during the Early and Middle Pleistocene. Paucity of lithic raw materials in such regions (Dennell, 2007) is further likely to have inhibited hominin dispersal across the large river systems of northeastern India into East Asia during the Pleistocene.

All of the foregoing suggests that biogeographic factors unique to East Asia – both in terms of distant location from Africa, and the potential of topographical and ecological barriers to hominin dispersals into the region – resulted in the hominin demographic levels of East Asia being substantially lower than in other parts of the Old World during the Early and Middle Pleistocene. The paucity of bifacial assemblages, lack of Levallois technologies, the low density of artefacts and site densities during this period, are all consistent with the null demographic model of technological evolution proposed here. Henrich's (2004) assertions that the loss of certain craft skills under lower demographic conditions will be exacerbated in cases where the skills associated with a given task are relatively more complex, may have all the more pertinence in regard to handaxe technologies, since the production of such artefacts is widely recognised as being relatively more complex than Mode 1-type artefacts (Schick, 1994). Under the parameters of this model, the low incidences of bifacial technology in East Asia can most parsimoniously be seen as sporadic instances of convergence with Acheulean handaxes west of the Movius Line *sensu lato*, as defined by Norton et al. (2006).

The lack of Levallois technologies in East Asia can also be seen as a consequence of the constraints that these demographic conditions placed upon the technological evolution of this region, under the parameters of our null model. Some time ago, Movius (1948) observed a frequent geographic overlap in the distribution of Lower Palaeolithic handaxes and Middle Palaeolithic Levallois assemblages. Subsequently, Schick (1994, p. 592) has proposed that that the absence of an Acheulean tradition and Levallois technologies in East Asia "may serve as a corroboration of important technological differentiation between east and west and also as a possible key to potential reasons behind these differences". Elsewhere, Schick (1998, p. 456) has elaborated further on this, noting that since the knapping procedures of Levallois reduction are frequently thought to be an extension of Acheulean reduction schemas (e.g., Leroi-Gourhan, 1966; Copeland, 1995; Rolland, 1995; Tuffreau, 1995; Tuffreau and Antoine, 1995; deBono and Goren-Inbar, 2001; Tryon et al., 2006), the lack of Levallois technologies east of the Movius Line may ultimately be due to the absence of a strong precursorial bifacial tradition in East Asia. Subsequently, cladistic analyses of Palaeolithic Old World assemblages have confirmed the phylogenetic propinquity of Acheulean and Levallois technologies (Lycett, 2007), thus supporting the case that where there is an absence of a strong bifacial tradition within a given region, Levallois techniques are unlikely to develop *in situ*.

5. Conclusions

Norton et al. (2006) proposed that the concept of a "Movius Line *sensu lato*" should replace that of a "Movius Line *sensu stricto*" in order to take account of three key factors evident in the lithic record of Early and Middle Pleistocene East Asia: (1) a lower frequency of handaxe sites in East Asia; (2) a lower percentage of bifaces compared with coeval Acheulean sites in India and East Africa; and (3) frequent morphological differences between East Asian handaxes and classic Acheulean examples, especially Middle Pleistocene specimens. Currently available evidence still supports all three aspects of Norton et al.'s (2006) Movius Line *sensu lato* (Norton and Bae, 2008). The absence of Levallois technologies in East Asia (Gao and Norton, 2002) might also be seen as a fourth component, at least in terms of continuity with the original observations of Movius (1969), and in regard to geographic contrasts with Africa and western Eurasia going into the Mid–Late Pleistocene.

Here, drawing on cultural transmission theory, we have proposed a generalised null model of Early–Middle Pleistocene technological evolution, which is underpinned by demographic considerations. We have detailed evidence suggesting that during much of the Pleistocene, biogeographical, topographical, and dispersal factors are likely to have resulted in relatively lower effective population sizes in East Asian hominins compared with those in western portions of the Old World, particularly Africa. Thus, the Movius Line – as is the case with its namesake 'Wallace's line' – must be examined in terms of its biogeographical context, if the divergent evolutionary trajectories of entities either side of it are to be understood. Hence, we propose that the evidence from East Asia in terms of technological patterning may be seen as the result of relatively lower effective population sizes compared with regions west of the Movius Line *sensu lato*. Most parsimoniously, the Movius Line *sensu lato* is thus a 'line' which represents the crossing of a demographic threshold and, ultimately, a technological point of demarcation as per our null model of Pleistocene technological evolution. Under the parameters of this model, geographically and temporally sporadic occurrences of bifacial technology in East Asia are the product of short-lived instances of convergence with conventional Acheulean examples from western Eurasia and Africa, which ultimately do not flourish due to the constraints of relatively smaller effective population sizes. As a consequence, the *in situ* evolution of Levallois (Mode 3) is prohibited in East Asia.

The demographic model presented here decouples any automatic link between cognitive/genetic evolution and technological evolution. Of course, this does not necessarily deny a role for biological factors in the observable features of change in Palaeolithic technologies. Given the substantial evolutionary changes that took place in the hominin lineage during the course of the Plio-Pleistocene, it is probable that such factors will manifest themselves in behavioural changes that are visible archaeologically (cf. Foley and Lahr, 1997). However, it appears frequently to be taken as given that if a line is drawn between eastern and western portions of the Old World, that this automatically implies distinct biological and cognitive differences either side of it. We believe that this is why vociferous and sometimes vehement opposition has been raised to the suggestion of a 'Movius Line' and why to this day some wish to eradicate it, even in the face of evidential differences in archaeological patterning. What the model proposed here highlights, is that recognition of a 'Movius Line *sensu lato*' does not *automatically* require the need to invoke hardwired (i.e. genetic) cognitive and biological differences in order to explain the appearance and maintenance of such a phenomenon when demographic factors and context are taken into account.

It should also be noted that the model does not necessarily preclude the diversification of Mode 1-type entities within East Asia, perhaps along what will eventually be recognised as distinctive lines. Indeed, there is already some evidence available in the frequent emphasis on smaller flake tools in East Asia (Schick et al., 1991; Schick and Dong, 1993; Schick, 1994; Keates, 2000), and in terms of the overall diversity and geographic variability in East Asian assemblages (Yi and Clark, 1983; Pope and Keates, 1994), to suggest that the evolution of distinct technological patterns occurred in East Asia, albeit within the broad confines of a 'Mode 1' technological category. Thus, the hypothesis we present is not automatically synonymous with notions of 'stagnation'; rather, with a divergent (cultural) evolutionary trajectory mediated by demographic factors that place some constraints on the specifics of that trajectory.

Like all null models, the demographic model we propose is testable; it predicts that evidence for demographic levels in East Asia will be found to be significantly different from those in many parts of western Eurasia and Africa during the Early and Middle Pleistocene. Here, we have hinted at some of the currently available evidence that suggests this may have been the case. What is now urgently needed are more sophisticated means than we have provided here of assessing Pleistocene demographic parameters in the key regions east and west of the Movius Line *s.l.* Considerations of site densities provide one possible means of testing this (e.g., Hosfield, 2005), while detailed analysis of the chronological distribution of dated sites (e.g., Buchanan et al., 2008) provides another potential means of formally testing the applicability of our model. Of course, none of these methods are entirely without potential problems when considering Pleistocene East Asia. Artefact density, for instance, may be influenced by a variety of factors such as raw material availability and artefact use life (see e.g., Ammerman and Feldman, 1974; Blumenschine et al., 2008; Braun et al., 2008) and raw materials sourcing studies are sparse in East Asia, except for maybe Japan (Norton and Jin, n.d.). Moreover, the extent of low energy sedimentary sequences associated with the necessary volcanism that provides the chronostratigraphic control seen in East Africa, differs in the case of East Asia, where relatively little volcanic activity occurred during the Quaternary.

Nevertheless, the further development of such research avenues in East Asia potentially points to future positive lines of enquiry, especially at the inter-continental level of analysis proposed here. In that regard, there may currently be a more immediate problem that needs addressing: the fact that the comparability of systematic fieldwork differs in intensity between East Asia and other regions (Braun et al., in press; Norton et al., in press-b). However, we predict that as alternative explanations such as raw material differences or sharp cognitive differences between East Asia and the west are found to be increasingly problematic as proximate causes for the Movius Line *sensu lato*, site densities and the chronological distribution of sites in East Asia will continue to differ from those in the west. If such a prediction is borne out, the demographic model we propose here provides the most parsimonious proximate mechanism for the archaeological patterns observed.

Acknowledgements

We appreciate the constructive comments on an earlier draft of this manuscript from the anonymous reviewers. We take full responsibility for any errors that may be present here.

References

Aldhouse-Green, S., 2001. Ex Africa aliquid semper novi: the view from Pontnewydd. In: Milliken, S., Cook, J. (Eds.), A Very Remote Period Indeed: Papers on the Palaeolithic Presented to Derek Roe. Oxbow Books, Oxford, pp. 114–119.
Ammerman, A.J., Feldman, M.W., 1974. On the "making" of an assemblage of stone tools. American Antiquity 39, 610–616.
Anthony, N.M., Johnson-Bawe, M., Jeffery, K., Clifford, S.L., Abernethy, K.A., Tutin, C.E., Lahm, S.A., White, L.J.T., Utley, J.F., Wickings, E.J., Bruford, M.W., 2007. The role of Pleistocene refugia and rivers in shaping gorilla genetic diversity in central Africa. Proceedings of the National Academy of Sciences USA 104 (51), 20432–20436.
Antón, S.C., Swisher, C.C., 2004. Early dispersals of *Homo* from Africa. Annual Review of Anthropology 33, 271–296.
Asfaw, B., Beyene, Y., Suwa, G., Walter, R.C., White, T.D., WoldeGabriel, G., Yemane, T., 1992. The earliest Acheulean from Konso-Gardula. Nature 360, 732–735.
Ayres, J.M., Clutton-Brock, T.H., 1992. River boundaries and species range size in Amazonian primates. American Naturalist 140 (3), 531–537.
Bae, K.D., 1988. The significance of the Chongokni stone industry in the tradition of Paleolithic culture in East Asia. Ph.D. Dissertation, University of California, Berkeley.
Bae, K.D., 1994. Paleolithic tradition of East Asia: Chongoknian, presence of few bifaces in Paleolithic stone industries. In: Bae, K.D. (Ed.), Paleolithic Culture of East Asia. National Research Institute of Cultural Properties, Seoul pp. 193–211.
Bae, K.D., 2002. Chongokni Paleolithic site: current understandings. In: Bae, K.D., Lee, J.C. (Eds.), Paleolithic Archaeology in Northeast Asia. Yeoncheon County and The Institute of Cultural Properties, Seoul & Yeoncheon County pp. 55–75.
Bae, K.D., Lee, H.Y., Shin, Y.H., Hwang, S.H., Oh, Y.S., 1995. Report of Excavation of the Chongokni Paleolithic Site 1994–95. In: Hanyang Anthropological Series, vol. 6. Hanyang University, Seoul (in Korean).
Bar-Yosef, O., Belfer-Cohen, A., 2001. From Africa to Eurasia – early dispersals. Quaternary International 75, 19–28.
Bentley, R.A., Hahn, M.W., Shennan, S., 2004. Random drift and culture change. Proceedings of the Royal Society of London B 271, 1443–1450.
Bentley, R.A., Lipo, C.P., Herzog, H.A., Hahn, M.W., 2007. Regular rates of popular culture change reflect random copying. Evolution and Human Behavior 28, 151–158.
Biro, D., Sousa, C., Matsuzawa, T., 2006. Ontogeny and cultural propagation of tool use by wild chimpanzees at Bossou, Guinea: case studies in nut cracking and leaf folding. In: Matsuzawa, T., Tomonaga, M., Tanaka, M. (Eds.), Cognitive Development in Chimpanzees. Springer, New York, pp. 476–508.
Blumenschine, R.J., Masao, F.T., Tactikos, J.C., James, I., Ebert, J.I., 2008. Effects of distance from stone source on landscape-scale variation in Oldowan artifact assemblages in the Paleo-Olduvai Basin, Tanzania. Journal of Archaeological Science 35, 76–86.
deBono, H., Goren-Inbar, N., 2001. Note of a link between Acheulian handaxes and the Levallois method. Journal of the Israel Prehistoric Society 31, 9–23.
Bonnie, K.E., Horner, V., Whiten, A., de Waal, F.B.M., 2007. Spread of arbitrary conventions among chimpanzees: a controlled experiment. Proceedings of the Royal Society of London B 274, 367–372.
Boriskovskii, P.I., 1968. Vietnam in primeval times. Soviet Anthropology and Archaeology 7, 14–32.
Boyd, R., Richerson, P., 1985. Culture and the Evolutionary Process. University of Chicago Press, Chicago.
Brantingham, P.J., Krivoshapkin, A.I., Li, J.Z., Ya, T., 2001. The Initial Upper Paleolithic in Northeast Asia. Current Anthropology 42, 735–747.
Braun, D.R., Rogers, M.J., Harris, J.W.K., Walker, S.J., 2008. Landscape-scale variation in hominin tool use: evidence from the developed Oldowan. Journal of Human Evolution 55, 1053–1063.
Braun, D.R., Norton, C.J., Harris, J.W.K., in press. Africa and Asia: comparisons of the earliest archaeological evidence. In: Norton, C.J., Braun, D. (Eds.), Asian Paleoanthropology: From Africa to China and Beyond. Vertebrate Paleobiology and Paleoanthropology Series, Springer Press, Dordrecht, The Netherlands.
Buchanan, B., Collard, M., Edinborough, K., 2008. Paleoindian demography and the extraterrrestrial impact hypothesis. Proceedings of the National Academy of Sciences USA 105 (33), 11651–11654.
Carbonell, E., Mosquera, M., Xose, P.R., Sala, R., 1999. Out of Africa: the dispersal of the earliest technical systems reconsidered. Journal of Anthropological Archaeology 18, 119–136.
Cavalli-Sforza, L.L., Feldman, M.W., 1981. Cultural Transmission and Evolution: A Quantitative Approach. Princeton University Press, Princeton, NJ.
Chauhan, P.R., 2004. A review of the early Acheulian evidence from south Asia. Assemblage 8. Available from: http://www.shef.ac.uk/assem/issue8/chauhan.html.
Chauhan, P.R., in press. The Indian subcontinent and 'Out of Africa I'. In: Fleagle, J., Shea, J., Leakey, R. (Eds.), Proceedings of the Life Matters – Stony Brook Human Evolution Workshop, Paleobiology and Paleoanthropology Series, Kluwer-Academic Press.
Clark, G., 1969. World Prehistory: A New Outline. Cambridge University Press, Cambridge.
Clark, J.D., 1982. Report on the visit to Palaeolithic sites in Korea. Munhwajae 15, 134–140.
Clark, J.D., 1994. The Acheulean industrial complex in Africa and elsewhere. In: Corruccini, R.S., Ciochon, R.L. (Eds.), Integrative Paths to the Past: Paleoanthropological Advances in Honor of F. Clark Howell. Prentice-Hall, Englewood Cliffs, NJ, pp. 451–469.
Copeland, L., 1995. Are Levallois flakes in the Levantine Acheulian the result of biface preparation? In: Dibble, H.L., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, Wisconsin, pp. 171–183.
Cordaux, R., Weiss, G., Saha, N., Stoneking, M., 2004. The northeast Indian passageway: a barrier or corridor for human migrations? Molecular Biology and Evolution 21 (8), 1525–1533.
Corvinus, G., 2004. *Homo erectus* in East and Southeast Asia, and the questions of the age of the species and its association with stone artifacts, with special reference to handaxe-like tools. Quaternary International 117, 141–151.
Darwin, C., 1871. The Descent of Man and Selection in Relation to Sex. John Murray, London.
Delagnes, A., Roche, H., 2005. Late Pliocene hominid knapping skills: the case of Lokalalei 2C, West Turkana, Kenya. Journal of Human Evolution 48, 435–472.
Dennell, R.W., 2003. Dispersal and colonisation, long and short chronologies: how continuous is the Early Pleistocene record for hominids outside East Africa? Journal of Human Evolution 45, 421–440.
Dennell, R.W., 2004. Hominid dispersal and Asian biogeography during the Lower and early Middle Pleistocene. Asian Perspectives 43 (2), 205–226.
Dennell, R.W., 2007. "Resource-rich, stone-poor": early hominin land use in large river systems of northern India and Pakistan. In: Petraglia, M.D., Allchin, B. (Eds.), The Evolution and History of Human Populations in South Asia. Springer, New York, pp. 41–68.
Dennell, R.W., Roebroeks, W., 2005. An Asian perspective on early human dispersal from Africa. Nature 438, 1099–1104.
Durham, W.H., 1992. Applications of evolutionary culture theory. Annual Review of Anthropology 21, 331–355.
Eerkens, J.W., Lipo, C.P., 2005. Cultural transmission, copying errors, and the generation of variation in material culture and the archaeological record. Journal of Anthropological Archaeology 24, 316–334.
Eerkens, J.W., Lipo, C.P., 2007. Cultural transmission theory and the archaeological record: context to understanding variation and temporal changes in material culture. Journal of Archaeological Research 15, 239–274.
Field, J.S., Lahr, M.M., 2006. Assessment of the southern dispersal: GIS-based analyses of potential routes at Oxygen Isotopic Stage 4. Journal of World Prehistory 19, 1–45.

Foley, R.A., Lahr, M.M., 1997. Mode 3 technologies and the evolution of modern humans. Cambridge Archaeological Journal 7, 3–36.

Fragaszy, D., 2003. Making space for traditions. Evolutionary Anthropology 12, 61–70.

Gamble, C., 1993. Timewalkers: The Prehistory of Global Colonization. Penguin, London.

Gamble, C., Marshall, G., 2001. The shape of handaxes, the structure of the Acheulian world. In: Milliken, S., Cook, J. (Eds.), A Very Remote Period Indeed: Papers on the Palaeolithic Presented to Derek Roe. Oxbow Books, Oxford, pp. 19–27.

Gao, X., 1999. A discussion of the 'Chinese Middle Paleolithic'. Acta Anthropologica Sinica 18, 1–16 (in Chinese).

Gao, X., 2000. Interpretations of Typological Variability within Paleolithic Remains from Zhoukoudian Locality 15, China. Ph.D. dissertation, University of Arizona.

Gao, X., Norton, C.J., 2002. A critique of the Chinese 'Middle Palaeolithic'. Antiquity 76, 397–412.

Gao, X., Pei, S., Wang, H., Zhong, K., 2004. A report on Paleolithic reconnaissance in Ningxia, north China. Acta Anthropologica Sinica 23, 307–325.

Gonder, M.K., Disotell, T.R., Oates, J.F., 2006. New genetic evidence on the evolution of chimpanzee populations and implications for taxonomy International. Journal of Primatology 27 (4), 1103–1127.

Goren-Inbar, N., Feibel, C.S., Verosub, K.L., Melamed, Y., Kislev, M.E., Tchernov, E., Saragusti, I., 2000. Pleistocene Milestones on the Out-of-Africa Corridor at Gesher Benot Ya'aqov, Israel. Science 289, 944–947.

Henrich, J., 2004. Demography and cultural evolution: how adaptive cultural processes can produce maladaptive losses: the Tasmanian case. American Antiquity 69, 197–214.

Hopper, L.M., Spiteri, A., Lambeth, S.P., Schapiro, S.J., Horner, V., Whiten, A., 2007. Experimental studies of tradition and underlying transmission processes in chimpanzees. Animal Behaviour 73 (6), 1021–1032.

Horner, V., Whiten, A., Flynn, E., de Waal, F.B.M., 2006. Faithful replication of foraging techniques along cultural transmission chains by chimpanzees and children. Proceedings of the National Academy of Sciences USA 103 (37), 13878–13883.

Hosfield, R., 2005. Individuals among palimpsest data: fluvial landscapes in southern England. In: Gamble, C., Porr, M. (Eds.), The Hominid Individual in Context: Archaeological Investigations of Lower and Middle Palaeolithic Landscapes, Locales and Artefacts. Routledge, London, pp. 220–243.

Hou, Y., Potts, R., Baoyin, Y., Zhengtang, G., Deino, A., Wei, W., Clark, J., Guangmao, X., Weiwen, H., 2000. Mid-Pleistocene Acheulean-like stone technology of the Bose Basin, South China. Science 287, 1622–1626.

Huang, W.W., 1987. Bifaces in China. Acta Anthropol. Sinica 6, 61–68 (in Chinese).

Huang, W.W., 1989. Bifaces in China. Human Evolution 4, 87–92.

Huang, W.W., 1993. Typology of the heavy-duty implements in the East and Southeast Asian Lower Paleolithic and a comment on the Movius typological system. Acta Anthropol. Sinica 12, 297–304 (in Chinese).

Hutterer, K.L., 1977. Reinterpreting the Southeast Asian Paleolithic. In: Allen, J., Golson, J., Jones, R. (Eds.), Sunda and Sahul. Academic Press, Orlando, pp. 31–72.

Ikawa-Smith, F., 1978. Introduction: The Early Paleolithic Tradition of East Asia. In: Ikawa-Smith, F. (Ed.), Early Palaeolithic in South and East Asia. Mouton, The Hague, pp. 1–10.

Isaac, G.L., 1972. Early phases of human behaviour: models in lower Palaeolithic archaeology. In: Clarke, D.L. (Ed.), Models in Archaeology. Methuen, London, pp. 167–199.

Keates, S.G., 2000. Early and Middle Pleistocene Hominid Behavior in Northern China. British Archaeological Reports. Archaeopress, Oxford.

Keates, S.G., 2001. Perspectives on 'Middle Palaeolithic' settlement patterns in China. In: Conard, N.J. (Ed.), Settlement Dynamics of the Middle Paleolithic and Middle Stone Age. Kerns Verlag, Tubingen, pp. 153–175.

Keates, S.G., 2002. The Movius Line: fact or fiction? Bulletin of the Indo-Pacific Prehistory Association 22, 17–24.

Kibunjia, M., 1994. Pliocene archaeological occurrences in the Lake Turkana Basin. Journal of Human Evolution 27, 159–171.

Kim, W.Y., Bae, K.D., 1983. Report of excavation, 1979–1983, Chongokni. Bureau of Cultural Properties, Korea.

Kimbel, W.H., Walter, R.C., Johanson, D.C., Reed, K.E., Aronson, J.L., Assefa, Z., Marean, C.W., Eck, G.G., Bobe, R., Hovers, E., Rak, Y., Vondra, C., Yemane, T., York, D., Chen, Y., Evensen, N.M., Smith, P.E., 1996. Late Pliocene *Homo* and Oldowan tools from the Hadar Formation (Kada Hadar Member), Ethiopia. Journal of Human Evolution 31, 549–561.

Kuman, K., Clarke, R.J., 2000. Stratigraphy, artefact industries and hominid associations for Sterkfontein, Member 5. Journal of Human Evolution 38, 827–847.

Klein, R., 2005. Hominin dispersal in the Old World. In: Scarre, C. (Ed.), The Human Past: World Prehistory and the Development of Human Societies. Thames & Hudson, London, pp. 84–123.

Larick, R., Ciochon, R.L., 1996. The African emergence and early Asia dispersal of the genus *Homo*. American Scientist 84, 538–551.

Leakey, M., Tobias, P.V., Martyn, J.E., Leakey, R.E.F., 1969. An Acheulean industry with prepared core technique and the discovery of a contemporary hominid mandible at Lake Baringo, Kenya. Proceedings of the Prehistoric Society 35 (3), 48–76.

Leng, J., Shannon, C.L., 2000. Rethinking Early Paleolithic typologies in China and India. Journal of East Asian Archaeology 2, 9–35.

Leroi-Gourhan, A., 1966. La Préhistoire. Universitaires de France, Paris.

Linz, B., Balloux, F., Moodley, Y., Manica, A., Liu, H., Roumagnac, P., Falush, D., Stamer, C., Prugnolle, F., van der Merwe, S.W., Yamaoka, Y., Graham, D.Y., Perez-Trallero, E., Wadstrom, T., Suerbaum, S., Achtman, M., 2007. An African origin for the intimate association between humans and *Helicobacter pylori*. Nature 445, 915–918.

Lipo, C.P., Madsen, M.E., 2001. Neutrality, "style", and drift: building methods for studying cultural transmission in the archaeological record. In: Hurt, T.D., Rakita, G.F.M. (Eds.), Style and Function: Conceptual Issues in Evolutionary Archaeology. Bergin & Garvey, Westport, Connecticut, pp. 91–118.

Lycett, S.J., 2007. Why is there a lack of Mode 3 Levallois technologies in East Asia? A phylogenetic test of the Movius-Schick hypothesis. Journal of Anthropological Archaeology 26 (4), 541–575.

Lycett, S.J., 2008. Acheulean variation and selection: does handaxe symmetry fit neutral expectations? Journal of Archaeological Science 35 (9), 2640–2648.

Lycett, S.J., Gowlett, J.A.J., 2008. On questions surrounding the Acheulean 'tradition'. World Archaeology 40 (3), 295–315.

Lycett, S.J., von Cramon-Taubadel, N., 2008. Acheulean variability and hominin dispersals: a model-bound approach. Journal of Archaeological Science 35 (3), 553–562.

Lycett, S.J., Collard, M., McGrew, W.C., 2007. Phylogenetic analyses of behavior support existence of culture among wild chimpanzees. Proceedings of the National Academy of Sciences USA 104, 17588–17592.

Madsen, D.B., Li, J.Z., Brantingham, P.J., Gao, X., Elston, R.G., Bettinger, R.L., 2001. Dating Shuidonggou and the Upper Palaeolithic blade industry in North China. Antiquity 75, 706–716.

Manica, A., Amos, W., Balloux, F., Hanihara, T., 2007. The effect of ancient population bottlenecks on human phenotypic variation. Nature 448, 346–349.

McGrew, W.C., 2004. The Cultured Chimpanzee: Reflections on Cultural Primatology. Cambridge University Press, Cambridge.

McGrew, W.C., 2007. New wine in new bottles: prospects and pitfalls of cultural primatology. Journal of Anthropological Research 63 (2), 167–183.

McNabb, J., Ashton, N., 1995. Thoughtful flakers. Cambridge Archaeological Journal 5, 289–301.

Mellars, P., 1996. The Neanderthal Legacy: An Archaeological Perspective from Western Europe. Princeton University Press, Princeton, NJ.

Mellars, P., 2006. Going east: new genetic and archaeological perspectives on the modern human colonization of Eurasia. Science 313, 796–800.

Mesoudi, A., Lycett, S.J., 2007. Random copying, frequency-dependent copying and culture change. Evolution and Human Behavior 30 (1), 41–48.

Mesoudi, A., Whiten, A., Laland, K.N., 2006. Towards a unified science of cultural evolution. Behavioral and Brain Sciences 29, 329–383.

Mithen, S., 1994. Technology and society during the Middle Pleistocene: hominid group size, social learning and industrial variability. Cambridge Archaeological Journal 4 (1), 3–32.

Movius, H.L., 1948. The Lower Palaeolithic Cultures of Southern and Eastern Asia. Transactions of the American Philosophical Society 38, 329–426.

Movius, H.L., 1956. New Palaeolithic sites, near Ting-Ts'un in the Fen river, Shansi province, North China. Quarteraria 3, 13–26.

Movius, H., 1969. Lower Paleolithic archaeology in southern Asia and the Far East. In: Howells, W.W. (Ed.), Early Man in the Far East, Studies in Physical Anthropology No.1. Humanities Press, New York, pp. 17–82.

Neiman, F.D., 1995. Stylistic variation in evolutionary perspective: inferences from decorative diversity and interassemblage distance in Illinois Woodland ceramic assemblages. American Antiquity 60 (1), 7–36.

Noll, M., Petraglia, M.D., 2003. Acheulean bifaces and early human behavioural patterns in East Africa and South India. In: Soressi, M., Dibble, H.L. (Eds.), Multiple Approaches to the Study of Bifacial Technologies. University of Pennsylvania Press, Philadelphia, pp. 31–53.

Norton, C.J., 2000. The current state of Korean paleoanthropology. Journal of Human Evolution 38, 803–825.

Norton, C.J., Bae, K., 2008. The Movius Line sensu lato (Norton et al. 2006) further assessed and defined. Journal of Human Evolution 55, 1148–1150.

Norton, C.J., Bae, K., Harris, J.W.K., Lee, H., 2006. Middle Pleistocene handaxes from the Korean Peninsula. Journal of Human Evolution 51, 527–536.

Norton, C.J., Gao, X., Feng, X.W., in press-a. The criteria defining the East Asian Middle Paleolithic reexamined. In: Camps, M., Chauhan, P.R. (Eds.), Sourcebook of Paleolithic Transitions: Methods, Theories, and Interpretations. Springer Press, Dordrecht, The Netherlands.

Norton, C.J., Gao, X., Liu, W., Braun, D., Wu, X.J., in press-b. Central-East China – a Plio-Pleistocene migration corridor: the current state of evidence for hominin occupations. In: Norton, C.J., Braun, D. (Eds.), Asian Paleoanthropology: From Africa to China and Beyond. Vertebrate Paleobiology and Paleoanthropology Series, Springer Press, Dordrecht, The Netherlands.

Oakley, K.P., 1958. Man the Tool-Maker, fourth ed. Trustees of the British Museum, London.

O'Brien, M.J., Lyman, R.L., Collard, M., Holden, C.J., Gray, R.D., Shennan, S., 2008. Transmission, phylogenetics, and the evolution of cultural diversity. In: O'Brien, M.J. (Ed.), Cultural Transmission and Archaeology: Issues and Case Studies. Society for American Archaeology Press, Washington, D.C., pp. 39–58.

Panger, M.A., Brooks, A.S., Richmond, B.G., Wood, B., 2002. Older than the Oldowan? Rethinking the emergence of hominin tool use. Evolutionary Anthropology 11, 235–245.

Pei, W.C., Woo, J.K., Chia, L.P., Chow, M.C., Liu, H.T., Wang, C.Y., 1958. Report on the Excavation of Palaeolithic Sites at Tingtsun, Hsiangfenhsien, Shansi Province, China. Science Press, Beijing.

Perry, S.E., 2006. What cultural primatology can tell anthropologists about the evolution of culture. Annual Review of Anthropology 35, 171–190.

Petraglia, M.D., 1998. The Lower Palaeolithic of India and its bearing on the Asian record. In: Petraglia, M.D., Korisettar (Eds.), Early Human Behaviour in Global Context: The Rise and Diversity of the Lower Palaeolithic Record. Routledge, London, pp. 343–390.

Petraglia, M.D., 2006. The Indian Acheulian in global perspective. In: Goren-Inbar, N., Sharon, G. (Eds.), Axe Age: Acheulian Tool-making from Quarry to Discard. Equinox, London, pp. 389–414.

Petraglia, M.D., Shipton, C., 2008. Large cutting tool variation west and east of the Movius Line. Journal of Human Evolution 55, 962–966.

Pope, G.G., 1989. Bamboo and Human Evolution. Natural History, 49–57.

Pope, G.G., Keates, S.G., 1994. The evolution of human cognition and cultural capacity: a view from the Far East. In: Corruccini, R.S., Ciochon, R.L. (Eds.), Integrative Paths to the Past. Prentice Hall, Englewood Cliffs, NJ, pp. 531–567.

Porat, N., Chazan, M., Schwarcz, H., Horwitz, L.K., 2002. Timing of the Lower to Middle Paleolithic boundary: new dates from the Levant. Journal of Human Evolution 43, 107–122.

Prugnolle, F., Mancia, A., Balloux, F., 2005. Geography predicts neutral genetic diversity of human populations. Current Biology 15, 159–160.

Ramachandran, S., Deshpande, O., Roseman, C.C., Rosenberg, N.A., Feldman, M.W., Cavalli-Sforza, L.L., 2005. Support from the relationship of genetic and geographic distance in human populations for serial founder effect originating in Africa. Proceedings of the National Academy of Sciences USA 102 (44), 15942–15947.

Richerson, P.J., Boyd, R., 2005. Not by Genes Alone: How Culture Transformed Human Evolution. University of Chicago Press, Chicago.

Riede, F., 2008. The Laacher See-eruption (12,920 BP) and material culture change at the end of the Allerød in Northern Europe. Journal of Archaeological Science 35 (3), 591–599.

Rivers, W.H.R., 1926. The disappearance of useful arts. In: Rivers, W.H.R. (Ed.), Psychology and Ethnology. Kegan Paul, Trench, Trubner & Co. Ltd., London, pp. 190–210.

Roche, H., Delagnes, A., Brugal, J.-P., Feibel, C., Kibunjia, M., Mourre, V., Texier, P.-J., 1999. Early hominid stone tool production and technical skill 2.34 Myr ago in West Turkana, Kenya. Nature 399, 57–60.

Roe, D., 1994. Comment on Mithen 1994. Cambridge Archaeological Journal 4 (1), 18–19.

Rolland, N., 1995. Levallois technique emergence: single or multiple? A review of the Euro-African record. In: Dibble, H.L., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, Wisconsin, pp. 333–359.

van Schaik, C.P., Ancrenaz, M., Borgen, G., Galdikas, B., Knott, C.D., Singleton, I., Suzuki, A., Utami, S.S., Merrill, M., 2003. Orangutan cultures and the evolution of material culture. Science 299, 102–105.

Schick, K.D., 1994. The Movius line reconsidered. In: Corruccini, R.S., Ciochon, R.L. (Eds.), Integrative Paths to the Past. Prentice Hall, Englewood Cliffs, NJ, pp. 569–596.

Schick, K.D., 1998. A comparative perspective on Paleolithic cultural patterns. In: Akazawa, T., Aoki, K., Bar-Yosef, O. (Eds.), Neandertals and Modern Humans in Western Asia. Plenum Press, New York, pp. 449–460.

Schick, K.D., Toth, N., 1993. Making Silent Stones Speak: Human Evolution and the Dawn of Human Technology. Weidenfeld and Nicolson, London.

Schick, K.D., Dong, Z., 1993. Early Paleolithic of China and Eastern Asia. Evolutionary Anthropology 2, 22–35.

Schick, K.D., Wei, Q., Clark, J.D., Etler, D., Toth, N., 1991. Archaeological perspectives in the Nihewan Basin, China. Journal of Human Evolution 21, 13–26.

Semaw, S., 2000. The world's oldest stone artefacts from Gona Ethiopia: their implications for understanding stone technology and patterns of human evolution between 2.6-1.5 million years ago. Journal of Archaeological Science 27, 1197–1214.

Semaw, S., Renne, P., Harris, J.W.K., Feibel, C.S., Bernor, R.L., Fesseha, N., Mowbray, K., 1997. 2.5 million-year-old stone tools from Gona, Ethiopia. Nature 385, 333–336.

Semaw, S., Rogers, M.J., Quade, J., Renne, P.R., Butler, R.F., Dominguez-Rodrigo, M., Stout, D., Hart, W.S., Pickering, T., Simpson, S.W., 2003. 2.6-Million-year-old stone tools and associated bones from OGS-6 and OGS-7, Gona, Afar, Ethiopia. Journal of Human Evolution 45, 169–177.

Shennan, S., 2000. Population, culture history, and the dynamics of culture change. Current Anthropology 41, 811–835.

Shennan, S., 2001. Demography and cultural innovation: a model and its implications for the emergence of modern human culture. Cambridge Archaeological Journal 11, 5–16.

Shennan, S., 2006. From cultural history to cultural evolution: an archaeological perspective on social information transmission. In: Wells, J.C.K., Strickland, S., Laland, K. (Eds.), Social Information Transmission and Human Biology. Taylor & Francis, New York, pp. 173–189.

Shennan, S.J., Bentley, R.A., 2008. Style, interaction, and demography among the earliest farmers of central Europe. In: O'Brien, M.J. (Ed.), Cultural Transmission and Archaeology: Issues and Case Studies. Society for American Archaeology Press, Washinton, D.C., pp. 164–177.

Swartz, B.K., 1980. Continental line-making: a reexamination of basic Palaeolithic classification. In: Leakey, R.E.F., Ogot, B.A. (Eds.), Proceedings of the Eighth Congress of Prehistory and Quaternary Studies, Nairobi, 5–10th September 1977. The International Louis Leakey Memorial Institute for African Prehistory, Nairobi, pp. 33–35.

Tattersall, I., 1997. Out of Africa again and again? Scientific American 276, 46–53.

Tryon, C.A., 2006. 'Early' Middle Stone Age lithic technology of the Kapthurin Formation (Kenya). Current Anthropology 47, 367–375.

Tryon, C.A., McBrearty, S., 2002. Tephrostratigraphy and the Acheulian to Middle Stone Age transition in the Kapthurin formation, Kenya. Journal of Human Evolution 42, 211–235.

Tryon, C.A., McBrearty, S., Texier, J.-P., 2006. Levallois lithic technology from the Kapthurin Formation, Kenya: Acheulian origin and Middle Stone Age diversity. African Archaeological Review 22 (4), 199–229.

Tuffreau, A., 1995. The variability of Levallois technology in northern France and neighboring areas. In: Dibble, H.L., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, Wisconsin, pp. 413–427.

Tuffreau, A., Antoine, P., 1995. The earliest occupation of Europe: continental northwestern Europe. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occuptation of Europe. University of Leiden and European Science Foundation, Leiden, pp. 147–163.

von Cramon-Taubadel, N., Lycett, S.J., 2008. Human cranial variation fits iterative founder effect model with African origin. American Journal of Physical Anthropology 136 (1), 108–113.

Wang, S.J., 2005. Perspectives on Hominid Behaviour and Settlement Patterns: A Study of the Lower Palaeolithic Sites in the Luonan Basin, China. Archaeopress, Oxford.

Wang, S., 2006. Cleavers collected from the open-air sites in Luonan Basin, China. Acta Anthropol Sinica 25, 332–342 (in Chinese).

Wang, S.J., 2007. The Paleolithic Open-air Sites in the Luonan Basin, China. Science Press, Beijing. Shaanxi Provincial Institute of Archaeology, Cultural Relics Administrative Committee of Shangluo District, Museum of Luonan County(in Chinese).

Watanabe, H., 1985. The Chopper-Chopping Tool Complex of Eastern Asia: an ethnoarchaeological–ecological reexamination. Journal of Anthropological Archaeology 4, 1–18.

Wenban-Smith, F.F., 1996. Another one bites the dust. Lithics 16, 99–107.

Wenban-Smith, F.F., 1998. Clactonian and Acheulian industries in Britain: their chronology and significance reconsidered. In: Ashton, N., Healy, F., Pettitt, P. (Eds.), Stone Age Archaeology: Essays in Honour of John Wymer. Oxbow Books, Oxford, pp. 90–97.

White, M.J., 2000. The Clactonian question: on the interpretation of core-and-flake assemblages in the British Lower Palaeolithic. Journal of World Prehistory 14 (1), 1–63.

Whiten, A., 2005. The second inheritance system of chimpanzees and humans. Nature 437, 52–55.

Whiten, A., Goodall, J., McGrew, W.C., Nishida, T., Reynolds, V., Sugiyama, Y., Tutin, C.E.G., Wrangham, R.W., Boesch, C., 1999. Cultures in chimpanzees. Nature 399, 682–685.

Whiten, A., Horner, V., de Waal, F.B.M., 2005. Conformity to cultural norms of tool use in chimpanzees. Nature 437, 737–740.

Whiten, A., Spiteri, A., Horner, V., Bonnie, K.E., Lambeth, S.P., Schapiro, S.J., de Waal, F.B.M., 2007. Transmission of multiple traditions within and between chimpanzee groups. Current Biology 17, 1038–1043.

Wolpoff, M.H., Wu, X.Z., Thorne, A.G., 1984. Modern Homo sapiens origins: a general theory of hominid evolution involving the fossil evidence from East Asia. In: Smith, F.H., Spencer, F. (Eds.), The Origins of Modern Humans. Liss, New York, pp. 411–484.

Wood, B., 1991. Koobi Fora Research Project: Hominid Cranial Remains. Clarendon Press, Oxford.

Wood, B., Richmond, B.C., 2000. Human evolution: taxonomy and paleobiology. Journal of Anatomy 196, 19–60.

Xie, G., Bodin, E., 2007. Les industries paléolithiques du bassin de Bose (Chine du Sud) (Paleolithic industries of the Bose Basin (South China)). L'Anthopologie 111, 182–206.

Yi, S.B., 1986. Lower and Middle Paleolithic of Northeast Asia: a geoarchaeological review. Ph.D. Dissertation, Arizona State University.

Yi, S.B., 1989. Northeast Asian Paleolithic Research. Seoul National University Press, Seoul (in Korean).

Yi, S., Clark, G.A., 1983. Observations on the Lower Palaeolithic of Northeast Asia. Current Anthropology 24, 181–202.

Yoo, Y., 2007. Long term changes in the organization of lithic technology: a case study from the Imjin-Hantan River Area, Korea. Ph.D. Dissertation, McGill University, Montreal.