From Africa to Eurasia — early dispersals

Ofer Bar-Yosef[a],*, A. Belfer-Cohen[b]

[a]*Department of Anthropology, Peabody Museum, Harvard University, Cambridge, MA 02138, USA*
[b]*Institute of Archaeology, Hebrew University, Jerusalem 91905, Israel*

Abstract

The dispersals of early hominins in the late Pliocene or early Pleistocene into Eurasia were essentially sporadic. Little geographic and temporal continuity is observed between the various dated archaeological contexts, and the lithic assemblages do not demonstrate a techno-morphological continuity. The archaeological evidence from 1.8 to 0.7 Ma indicates at least three waves of early migrations. The earliest sortie involved bearers of core-chopper industries sometime around 1.7–1.6 Ma. Early Acheulean producers followed possibly around 1.4 Ma. The third wave occurred sometime around 0.8 Ma, and is represented by Acheulean groups who manufactured numerous flake cleavers. The geographic scope of each of these waves is not yet well known.The reasons for 'why' early humans dispersed from Africa into Eurasia include the 'push' of environmental change and relative 'demographic pressure', as well as the opening of new niches. Humans may have gained their meat supplies either from carcasses or through active predation. The archaeological and fossil records demonstrate that *Homo erectus* was a successful species, and like other successful species it enlarged its geographic distribution at all costs. Even if the trigger for the initial dispersal of *Homo erectus* remains unknown or controversial, the success of the hominid occupation of the Eurasian habitats was not primarily facilitated by the availability of food, or the human flexibility in food procuring techniques, but by the absence of the zoonotic diseases that plagued and constrained hominins in their African 'cradle of evolution'. Once humans succeeded in crossing the disease-plagued belts of Africa the chances for survival of many more members of their groups rose steeply. It was only thereafter that humans could exploit their latent capacities and came to enjoy their global colonization. © 2001 Elsevier Science Ltd and INQUA. All rights reserved.

1. Introductory remarks

The goal of this paper is to discuss certain aspects of the dispersal phenomena of hominins migrating out of Africa into Eurasia. The dispersal most probably occurred as episodic, rather sporadic events, which took place after a long stable evolution in humanity's primordial homeland (e.g. Klein, 1999). Currently, there is a general consensus that the first 'sorties' from Africa occurred immediately after the Olduvai chron, around 1.7–1.5 Ma (e.g. Klein, 1989, 1999; Bar-Yosef, 1994, 1998; Swisher et al., 1994; Gabunia and Vekua, 1995; Potts, 1998a, b; Tchernov, 1998, 1999; Arribas and Palmqvist, 1999; Bar-Yosef and Belfer-Cohen, 2000). The dates derive from Lower Paleolithic sites, with the artifacts and rare human fossils uncovered in various parts of Eurasia providing evidence for the incipient hominin migrations. Apparently, not all of these migrations culminated in successful colonization, since there are well documented chronological gaps in Lower and Middle Pleistocene regional sequences. This gives credence to the interpretation that several of the early migratory lineages became extinct (Bar-Yosef, 1994, 1998). Thus, despite the overall success of early hominin populations in establishing themselves in the lower latitudes within the Eurasian continent, it seems that the 'out of Africa' events were mainly episodic and not incremental.

It seems quite obvious that particular bio-behavioral characteristics of the hominins involved in these dispersal events during the 1.8–0.8 Ma time span enabled them, in several cases at least, to carry out successful colonization. One should also bear in mind that there were apparent advantages for those groups who managed to survive their departure from the African homeland. It seems to us that certain human capacities, and in particular, the uniquely African environmental hazards have not been sufficiently emphasized in previous publications.

2. Hominid propensities and capacities

The behavioral repertoire of early *Homo* populations, while in Africa, was paramount in their ability to adjust

---

* Corresponding author.

to various environmental circumstances, facilitating the succeeding occupation of Eurasia. Among the bio-behavioral features identified and discussed by various scholars (see Klein, 1999 and references therein), the following are, in our view, the most crucial in accounting for the success of Eurasian hominid adaptations:

(a) Steady and prolonged walking capacity at normal pace (Steudel, 1994, 1996).

(b) Adaptation to heat exposure, as reflected in their particular post-cranial morphology (elongated body) and the pattern of cranial vascular blood vessels (Falk, 1992; Walker and Leakey, 1993; Wheeler, 1993).

(c) A greater brain capacity than that of the contemporaneous Australopithecinae — justifying their being called 'human' — whether in terms of heat resistance adaptation, social complexity and learning (Humphrey, 1978; Dunbar, 1996; O'Connell et al., 1999), predation (Walker and Shipman, 1996), sharing prey (Stanford, 1998), high-quality diet (Aiello and Dunbar, 1993; Aiello and Wheeler, 1995) or combinations of the above.

(d) A social structure different from that of recent apes, more human-like, as inferred from the archaeological data: site patterning (e.g. Kroll, 1994); stone artifacts and manuports; exploitation of large animal tissues (e.g. Rose and Marshall, 1996 and references therein); and flexibility in subsistence strategies (Cachel and Harris, 1998). Biological studies provide additional features pertaining to the social behavior of those hominins: reduced sexual dimorphism (McHenry, 1994; McHenry and Berger, 1998); and caring for sick group members (Walker and Shipman, 1996 as regards KNM-ER 1808 who suffered from vitaminosis A; and see also Walker et al., 1982).

3. Stone tools and human populations

Every discussion of Lower Paleolithic archaeological sites and human fossils touches upon the aspect of particular human adaptations to variable environments in low and middle latitudes. Often, in the absence of other sources of information, investigators employ a sociobiological approach (O'Connell et al., 1999) including comparative studies of the great apes (Stanford, 1998), and a discussion of the role of stone artifacts within those early communities.

Simply linking a particular 'archaeological culture' or 'Industrial Complex' with a particular hominid species is an archaeological practice that has not survived the rigors of modern research (e.g. Mellars and Stringer, 1989 and references therein; Bar-Yosef and Kuhn, 1999). Although recently Wood (1997) suggested that the Oldowan Industrial Complex was manufactured by

Paranthropus rather than by a *Homo* sp., his argument is based on the assumption that the supposed technological stasis of the 'Oldowan Industrial Complex' can best be ascribed to the evolutionary stasis observed in the lineage of *Paranthropus aethiopicus/boisei* during the same time span (2.5–1.5 Ma). Accordingly, Wood rejects the idea of a *Homo* sp. being the manufacturer of the Oldowan artifacts, since morphological breaks in the *Homo* fossil record occur more than once during that time.

An equation of cultural traits to biological characteristics was common in the pioneering days of archaeological investigations. There was a tendency to link particular archaeological cultures with certain human groups; thus the terms 'Mousterian cultures' and 'Neanderthal humans' became interchangeable. This attitude reflected a Eurocentric approach, when it was assumed that European prehistory reflected precisely the course, means, and tempo of cultural evolution in human history. From the 1930s onwards, following the excavations of the Mt. Carmel caves (Garrod and Bate, 1937; McCown and Keith, 1939), it became apparent that a particular 'culture' and a particular hominid could not be regarded as synonymous. Mousterian assemblages were manufactured by both European Neanderthals and Levantine anatomically modern humans. With our current knowledge of prehistoric cultural phenomena, it would be most inappropriate to relate or explain 'culture' using criteria originating in the biological domain.

Since stone artifacts are the most common archaeological finds, while human fossils are rare, the mere presence of the former is taken to indicate the spread of humanity across the Old World. Based on the ways and means by which the stone tools were made, their shapes and sizes, archaeologists cluster them into 'prehistoric cultures'. Therefore, in order to trace human movements across the continents, we must begin with the definition of the early lithic industries in sub-Saharan Africa.

Prehistoric research in Africa demonstrated that the earliest mode of stone tool production was based on knapping cobbles and obtaining flakes with sharp edges. Originally, such lithic assemblages were named by Leakey (1971) as Oldowan, following the convention of that time for defining lithic traditions. Later, considering the frequencies of particular tool types, she defined the Developed Oldowan A and B entities, each containing a quantity of bifaces (handaxes). However, the divergence of concepts concerning the interpretations of these early stone industries led scholars to adapt new classifications. A five-partite system was suggested by Clark (1971), in which Mode 1 represented the Oldowan, Mode 2 the Acheulean, Mode 3 the Mousterian, and so on. Unfortunately, this scheme was based implicitly on a linear evolutionary scenario, assuming the advance of stone making technologies through time. The inadequacy of this terminology is demonstrated by the contemporaneity of Modes 1 and 2 industries in the Lower Paleolithic of

Africa and by the prevalence of Mode 1 techniques in the Middle and part of the Upper Pleistocene of East Asia. In addition, using the term 'Mode 1' industries and 'Movius core-chopper' industries (Schick, 1994) is confusing, as these are alternate terms designating the same lithic assemblages.

In order to avoid the thorny issue of differentiating 'tool' from 'waste product', Isaac (1986) suggested that the products of early stone industries be classified as 'detached pieces' (blanks such as flakes), 'flaked pieces' (core-choppers), and 'pounded and battered pieces' (hammerstones, anvils, etc.).

Though Isaac's classification is most appropriate for studying lithic assemblages, it does not resolve the issue of how to name all the assemblages which are similar to each other and need, for a descriptive narration, to be clustered under one term. Therefore, in the present paper we use the traditional cultural terminology, as it facilitates comparisons between African and early Eurasian assemblages, which is rather relevant to the issue of early colonizations.

Whether the adaptive flexibility of *Homo erectus* and its immediate predecessors (*Homo habilis* and *Homo rudolfensis*) is reflected in their material culture is indeed a debatable issue. Neither the Early Acheulean nor the Developed Oldowan, as defined by Leakey (1971) and see Leakey and Roe (1994), demonstrate the presence of a complex *chaîne opératoire* (operational sequence), when compared to the later stages of the Acheulean (e.g. Gowlett, 1990; Belfer-Cohen and Goren-Inbar, 1994; Roche and Texier, 1995) or to the complexity of the Levallois methods (e.g. Boëda, 1995; Meignen, 1995). Certain hominid groups continued to produce Oldowan or core-chopper (also labeled core and flake) industries, while contemporaneous groups began to shape the Acheulean bifaces along with various retouched flakes. A variety of bifaces is present in developed Oldowan assemblages (Bar-Yosef and Goren-Inbar, 1993; Leakey and Roe, 1994), often considered as a 'facies' within the Acheulean complex. Thus, *Homo erectus* groups were the bearers of both Acheulean and core-chopper (or Oldowan-type) industries. Identifying *Homo erectus* solely with the Acheulean is completely erroneous. The evidence from beyond the 'Movius line' in Asia, as well as from Eastern and Central Europe, indicates that several *Homo erectus* populations, and later *archaic Homo sapiens*, utilized distinct operational sequences producing core-choppers, while never manufacturing bifaces. Studies of Paleolithic operational sequences (*chaînes opératoires*) demonstrate that the dominant artifact forms resulted from different learned behavioral traditions. This is not surprising, as an operational sequence is basically a system of technical skills that is learned, the teaching being done through instructional sessions and/or by demonstrative examples, ensuring the passage of knowledge from one generation to the next. In many

instances, the knappers practiced their own *chaîne opératoire* ignoring the constraints of the locally available raw materials (e.g. Bordes, 1977; Schick and Zhuan, 1993; Boëda, 1995; Roche and Texier, 1995). In every region, the chronometric information from site sequences indicates how long a certain *chaîne opératoire* was employed or, phrased differently, how long a lithic tradition lasted.

4. The constraints of African environments and the advantages of dispersal into Eurasia

The geographic distribution of archaeological sites in Africa dated to 1.8–1.0 Ma is rather limited, if one takes into account the overall surface size of the continent and the climatic changes that caused certain areas to open up or become closed to human exploitation. We can assume that hominid population growth in the African homeland was constrained not necessarily by predation or intra- and inter-group violence, but by disease, as is the case for the living pongids [for example, 55% of chimpanzees die of disease (Teleki, 1973; Goodall, 1986)]. It should be remembered that Africa is the home of most zoonotic diseases (caused by organisms that rely for transmission primarily on other plants or animals rather than people, for example, the 'sleeping sickness'). These have a severe impact on the living human body. Since the disease-causing organism is not usually dependent on human transmission, there has been no selection for a strain of the parasite that is less virulent or more compatible with human life. Moreover, many zoonotic diseases attack adults more than they attack children. Indeed, these diseases differ from the more recent common infectious diseases, which are density dependent, such as 'measles', 'mumps', 'rubella', 'influenza' and the 'common cold' (Cohen, 1989; Karlen, 1995). The latter are self-limiting in isolated populations below a certain threshold size (see below). The worst post-Second World War new diseases appeared in Africa, as "a growing population exploited the environment and invited zoonoses ..." (Karlen, 1995, p. 163). In this sense, Africa might be considered as the garden of germs.

Africa's ecology included (and continues to include, see Linthicum et al., 1999) a dense array of microparasites that evolved along with humanity itself. They are so well adjusted to the human presence that any notable increase in human numbers promptly provokes a sharp intensification of infection and infestation. Together with limitations on the availability of food, tropical microparasites sufficed to keep our remote ancestors relatively scarce in the balance of nature (McNeill, 1980, p. 11).

Apes suffer from a variety of worms and other intestinal parasites that also afflict humans, but although they inhabit moister habitats — and therefore more parasite-tolerant soil regimes — apes generally move less rapidly and less widely, keeping away from the African

disease-belt (DeSalle, 1999). Once humans expanded their ranging territories and moved out of the disease-infected zones, they were left with fewer parasites altogether (especially if they moved to colder environments).

The triggers for the movement of humans out of Africa are not well explored. Among the reasons considered are population increase (as every successful species expands beyond its original homeland), or climatic changes that severely reduced and modified the size of the exploitable territories (Larick and Ciochon, 1996). A major climatic change affecting the African environment is currently recognized in the Olduvai subchron, which was accompanied by the desertification of numerous wet and lush environments (Potts, 1998a).

Another current explanation for early humans' (i.e. *Homo erectus*) urge to expand their exploitation grounds lies in the notion that this was the hominid species that evolved into an efficient predator (Walker and Shipman, 1996). Walker and Shipman present evidence for humans becoming a social predator thus needing to lower its population density. The options are either to eliminate most of its total population or to spread that population over a much larger geographic range. As Walker and Shipman give a very detailed account of their hypothesis, suffice it here to say that they believe humans increased their home range size and thus decreased population densities, the mechanism being migrations out of the *Homo erectus* homeland into the great beyond.

The spread into new habitats in Eurasia, where hominins were previously unknown, meant that they escaped their many biological foes, the insect transmitted diseases such as 'sleeping sickness', 'malaria', 'elephantiasis', 'encephalitis', etc., which decimate primate populations as well as those of other mammals (McNeill, 1976).

Moving into new environments, especially away from the tropics to cooler, drier environments, reduces the danger of being exposed to zoonotic diseases. That humans were exposed to them for a long duration of time is indicated by the phenomena of genetic mutations. While in a homozygotic condition, these mutations induce illness — 'sickle-cell' anemia is an example — in heterozygotic conditions they provide a certain immunity to a particular zoonotic disease — in this case 'malaria'. It is of interest to note that to date no mutations have been reported that help humans to overcome non-zoonotic infections.

In considering the role of diseases in the past, it is important to emphasize that the current world distribution of diseases and plagues cannot be used as an analogy for the situation during the Lower Pleistocene. In a world without today's rapid transportation, most zoonotic diseases would have had their distribution dramatically limited by the dispersal rates of the wild host and vector species.

In addition, the viral infections — 'smallpox', 'measles', 'whooping cough', and the like — can exist only within large human populations, allowing the chain of virus generations to continue uninterrupted. In recent times, for example, 'measles' required a community of between 40,000 and 300,000 persons in order to survive (McNeill, 1976, p. 63). Clearly, such a disease could exist on a permanent basis only among 'civilized' societies, where human populations are comparatively dense and communication nets far-flung.

5. Eurasian evidence for early dispersals

The archaeological evidence from the Lower and early Middle Pleistocene in this vast continent is still rather scarce, and secure dates for the rare human fossils, isolated artifacts, or even rich, well-excavated lithic assemblages are few. The following overview will include mainly the sites attributed to this period in an east–west transect, which indicates how far geographically humans had dispersed (Fig. 1).

The earliest Chinese sites, tentatively dated to 3.0–1.0 Ma with animal fossils and artifacts although for the most part they seem to be just geofacts (Wei, 1999), include the Longgupo cave in Chongqing province (Wanpo et al., 1995), and the Renzindong site in Anhui province. The age of the Dongyaozitou site (Hebei province), with one reported stone artifact, suggested as 2.48–3.01 Ma, is not well dated (Wei, 1999). In his brief communication, Wei (1999) considers the other, aforementioned occurrences, as of mainly a Lower Pleistocene age (ca. 1.78–0.9 Ma). A somewhat similar conclusion was reached earlier by Schick and Zhuan (1993). The main problem with the Chinese early sites is the paucity of radiometric dates and/or paleomagnetic sequences, which would provide a general chronological framework.

There is today sufficient evidence for the presence of the Acheulean Industrial Complex in China (Huang et al., 1995; Huang and Wang, 1995). However, the number of the lithic assemblages is as yet very small, and they may indicate only cursory incursions of the 'Acheuleans' beyond the 'Movius line'.

The Javanese *Homo erectus* is currently believed to have arrived in Southeast Asia some 1.8–1.6 Ma ago (Swisher et al., 1994). This is still debated in the literature by Southeast Asia archaeologists (e.g. Keates, 1998). The meager information available does not allow a meaningful discussion of the archaeological evidence. However, the few recovered stone artifacts seem to indicate a core-chopper industry.

An intriguing find is the stone tool from Riwat in Pakistan. There is no doubt that this is a human-made core-chopper, however, the date of 2.4 Ma attributed to the gravel in which it was embedded is subject to criticism.

There are no other securely dated Early Paleolithic sites in the Indian sub-continent (Korisettar and
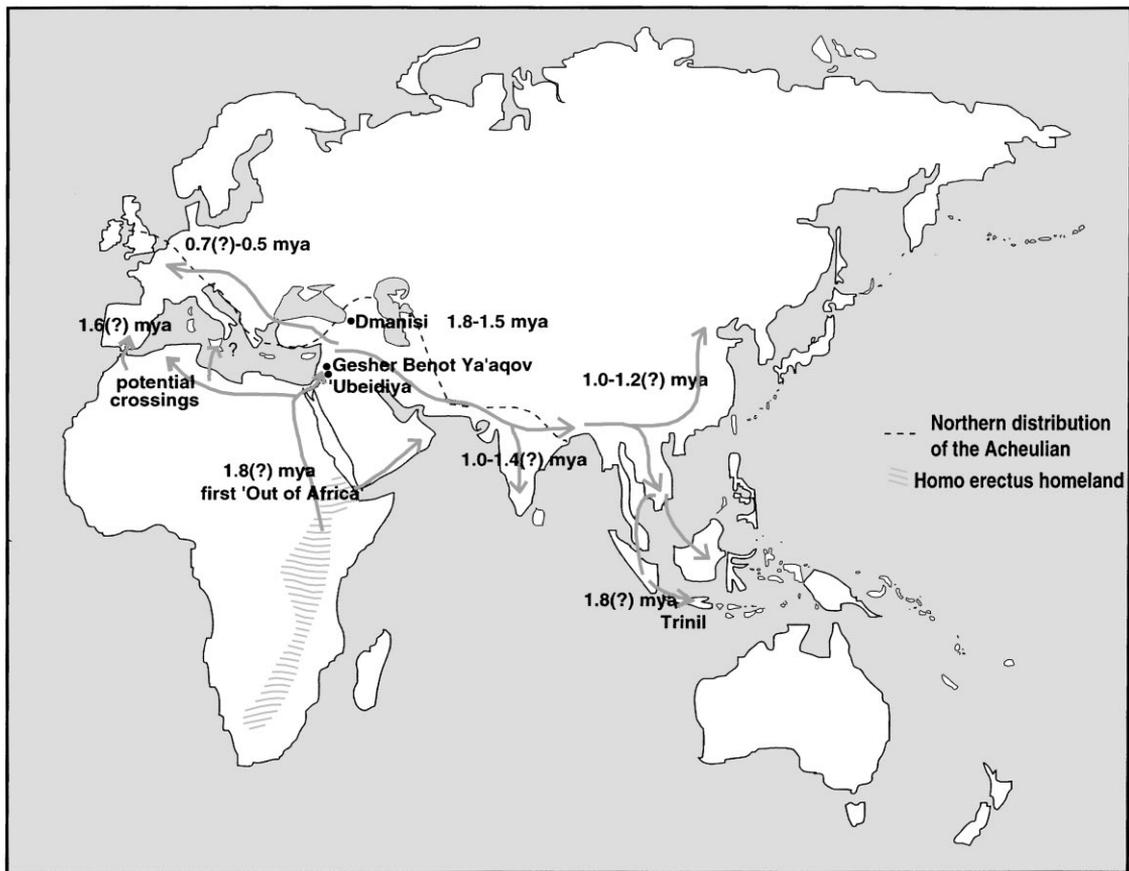
Fig. 1. Suggested routes for early colonizations from Africa.

Rajaguru, 1998; Petraglia, 1998; Petraglia et al., 1999). However, this vast region has produced numerous later, Acheulean sites (e.g. Paddayya and Petraglia, 1993; Corvinus, 1998). When compared to the area beyond the 'Movius line', without a doubt there are more Acheulean occurrences in south Asia than in China (Fig. 1).

Further west, in the southern part of the Caucasus, there is the site of Dmanisi, Georgia (Dzaparidze et al., 1989), where a *Homo erectus* jaw was found (Gabunia and Vekua, 1995). The deposit seems to have been a large burrow, perhaps a hyena den, rich in animal bones but rare in artifacts. This burrow produced a reversed magnetic signal but the layers below have normal polarity and were probably accumulated immediately after the deposition of a lava flow dated to 1.8 Ma K/Ar (Dzaparidze et al., 1989; Ferring and Swisher, pers. comm.). A cautious estimate for the earliest occupation of Dmanisi would therefore be around 1.7–1.6 Ma.

The presence of a core-chopper industry at Dmanisi, described only briefly (Dzaparidze et al., 1989; Liubin and Bosinski, 1995), cannot be explained by a scarcity of appropriate raw material for making bifaces. We may therefore conclude that the earliest settlers produced only cores and flakes, which do not differ essentially from the basic forms of the Oldowan industry.

The site of 'Ubeidiya in the Jordan Valley (Israel) has so far produced the best data sets for the Levant, although it is not impossible that earlier sites are present in the region. Despite the lack of supporting radiometric dates for all of the Lower Paleolithic occurrences in the Levant, the proliferation of find spots and occasional implements in gravel deposits dated by means of relative chronology to earlier than 1.0 Ma, dramatically increases the amount of information from the Levant. These early Paleolithic occurrences are often small assemblages of core-choppers (or core and flake industry), located in the Israeli coastal plain, Lebanese shorelines, and within Syrian fluvial formations (e.g. Hours, 1975, 1981; Horowitz, 1979; Sanlaville et al., 1993).

'Ubeidiya, the best-known site, is a sequence of both lacustrine and fluvial deposits within which a large number of archaeological horizons have been identified and excavated (Bar-Yosef and Goren-Inbar, 1993). Long-distance faunal correlations between 'Ubeidiya, Dmanisi, and localities in Western Europe indicate an age for this site of 1.0–1.5 Ma (Tchernov, 1986, 1987, 1992, 1999; Aziz et al., 1999; De Vos et al., 1999; Sondaar et al., 1999; Van Den Bergh et al., 1999). Based on typological criteria, the rich lithic assemblages can be defined as either 'Developed Oldowan B' following the definitions

proposed by Leakey (1971) or as Early Acheulean (Bar-Yosef and Goren-Inbar, 1993). The results of recent seasons of excavations indicate that a previous observation claiming the exclusive presence of core and flake industry in the lowermost archaeological horizon (Bar-Yosef, 1994) could not be validated, as a trihedral pick was found in one of the earliest horizons.

Acheulean assemblages are spread geographically across the Levant into Anatolia, although no bifaces have been documented in its western part (Yalçinkaya, 1981; Taskiran, 1998). This distribution continues into the Caucasus (Liubin and Bosinski, 1995). One may therefore speculate that the bearers of the Early Acheulean also came out of Africa. The date of the Early Acheulean in East Africa is now considered as 1.7–1.6 Ma. However, shifts in both the basic knapping method and the final morphology of bifaces may indicate a later sortie by bearers of yet another tradition of hand-axe production.

In the African Acheulean sequence, the appearance of cleavers made on large flakes is dated to ca. 1.0 Ma in sites such as Olorgesailie (Potts, 1989). It is perhaps not surprising that a similar industry is present in Western Asia at Gesher Benot Ya'aqov, Israel (Stekelis, 1960; Goren-Inbar and Saragusti, 1996), recently paleomagnetically dated to ca. 0.78 Ma (Verosub et al., 1998). It is suggested that the assemblages of this site should be interpreted as the product of a newly arrived group, the main reason being that, despite the fact that large portions of Western Asia are covered with lava flows, no similar industry has yet been reported. For example, on the lava plateau of the Golan, Upper Acheulean assemblages are made of flint (e.g. Goren-Inbar, 1985). It was therefore concluded that the assemblages of Gesher Benot Ya'aqov represent the migration of an African group of foragers who continued to exploit raw material similar to that available in their original homeland (Bar-Yosef, 1987; Goren-Inbar and Saragusti, 1996).

While attempting to trace the route of these foragers from Africa into the Levant, we should mention an Acheulean assemblage with cleavers and other tool types made of andesite, uncovered in Saffaqah near the Red Sea (Whalen et al., 1984). Unfortunately, it lacks radiometric dates.

The information from North Africa is derived from excavations and surveys, mainly in Egypt, Algeria, and Morocco. Early makers of core-choppers may have been the first to colonize this region, as evidenced from the stratigraphy observed at Abassieh (today a suburb of Cairo) (Bovier-Lapierre, 1925, 1926). An Early Acheulean industry was reported to overlie a core-chopper one. However, no dates are given and the site is not available for further research. Acheulean assemblages were also recorded in various parts of eastern Sahara, including Kharga oasis (Caton-Thompson, 1952), Dakhla oasis, and Refuf Pass (Wendorf and Schild, 1980). It seems that most of these occurrences are Upper/Late Acheulean and therefore outside the time period discussed in this paper.

In the Maghreb, the sequence established by Biberson (1961) is not yet fully validated by the fieldwork and radiometric dates carried out since (Raynal et al., 1995). The site of Ain Hanech, which attracted attention a few decades ago, was the target of new excavations (Sahnouni and de Heinzelin, 1998). According to the current report, two stratified industries, previously considered as the same assemblage, were exposed: an Oldowan and an Early Acheulean one. The former is attributed to the Olduvai subchron on the basis of paleomagnetic readings of 1.95–1.78 Ma (Sahnouni and de Heinzelin, 1998), although it could also belong to an early phase of the Brunhes chron. The Acheulean finds were surface collected during the new project and are therefore not yet dated. Of interest is the close similarity between the large mammalian species at Ain Hanech and those of the 'Ubeidiya complex (Arambourg, 1970, 1979; Tchernov, 1986; Sahnouni and de Heinzelin, 1998), which may support the earlier date.

Moving across the Mediterranean Sea into Europe, one can subdivide the archaeological and geo-chronological data concerning early colonizations into two generalized ecological belts, namely, of the Mediterranean and temperate Europe. Earlier, a critical appraisal of the evidence for claims of artifacts in datable contexts raised many doubts of whether Europe was colonized before the Middle Pleistocene (e.g. Roebroeks, 1994; Roebroeks and van Kolfschoten, 1994). However, following additional dating of the Atapuerca complex and the discoveries at Orce in Spain, attention was drawn to the Iberian sequence (Freeman, 1975; Gibert, 1992; Raposo and Santonja, 1995; Roe, 1995; Dennell and Roebroeks, 1996; Turq et al., 1996; Gibert et al., 1998; Arribas and Palmqvist, 1999). A cautious age estimate for the early sites in Spain would be around 1.4–1.3 Ma. This could indicate early crossings from Africa to Mediterranean Europe, perhaps through the Gibraltar Straits (Arribas and Palmqvist, 1999; Martinez-Navarro, 1999, pers. comm.). Another potential pathway across the Mediterranean Sea could have been by way of Sicily (Alimen, 1979), as suggested by the spread of the Acheulean in Italy and the presence of core-chopper assemblages in localities such as Monte Poggiolo and Isernia (e.g. Peretto, 1991, 1994; Mussi, 1995). However, there is as yet no positive archaeological evidence to support this route (Fig. 2).

6. Discussion

From all of the above it becomes clear that the dispersals of early hominins in the late Pliocene or early Pleistocene into Eurasia were essentially sporadic. Little geographic and temporal continuity is observed between the various dated archaeological contexts, and the lithic
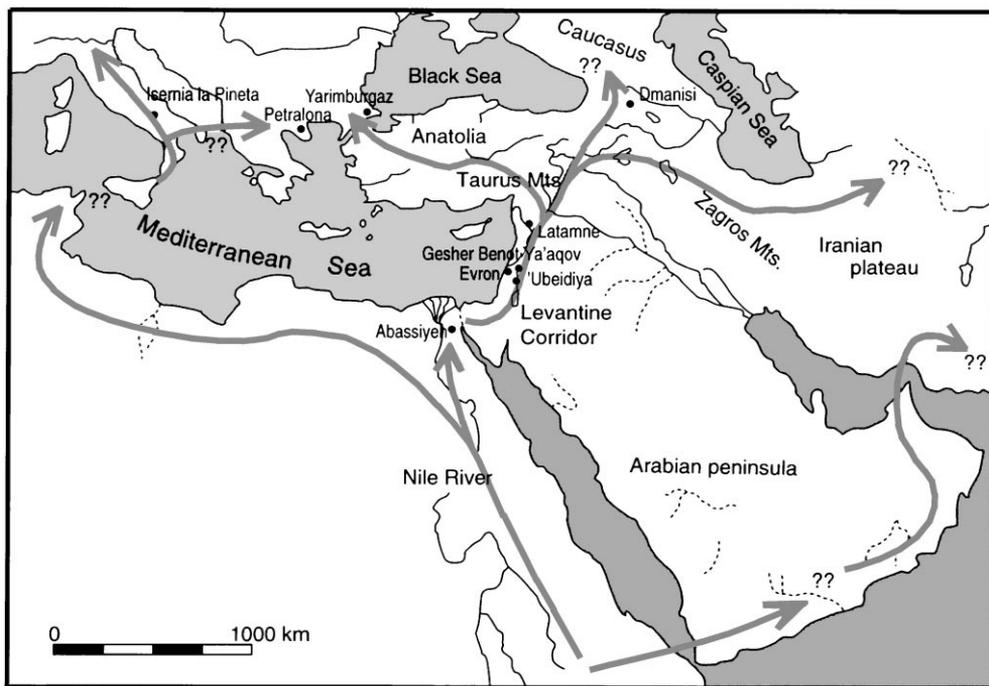
Fig. 2. Suggested routes for a late Lower Pleistocene/early Middle Pleistocene 'wave' out of Africa.

assemblages do not demonstrate a techno-morphological continuity, as was already observed by Movius (1944). The presence of a boundary between the Acheulean and the core-chopper assemblages has been noted by various scholars (e.g. Rolland, 1998 and references therein). The archaeological evidence from 1.8 to 0.7 Ma indicates at least three waves of early migrations (Figs. 1 and 2) but there were probably more.

The earliest sortie was of bearers of core-chopper industries (or the Oldowan Complex) sometime around 1.7–1.6 Ma. They were followed by producers of the Early Acheulean possibly around 1.4 Ma. The third wave is represented by Acheulean groups who manufactured numerous flake cleavers, sometime around 0.8 Ma. The geographic scope of each of these waves is not yet well known. It seems that the Oldowan industry reached East Asia, and slightly later, Western Europe. The Acheulean bearers were confined to Western Europe, and western and southern Asia. The latest wave could have been of limited scope, although it probably reached the Caucasus through the Levant (Bar-Yosef, 1998).

During the late Lower Pleistocene, regional continuities in the production of artifacts are discernible. Within the Acheulean territories the general production of bifaces continued, while beyond the 'Movius line', core-chopper assemblages (or core and flake industries) were dominant.

While dietary constraints are of great importance in human evolution, most of the vegetal food consumed by early hominins such as the Habilines, was probably similar to that of the Australopithecines, namely, sedges and grasses (e.g. Sponheimer and Lee-Thorpe, 1999). Underground resources such as tubers (known also as USOs) were presumably discovered by *Homo erectus*. However, even if cooking or parching of these tubers is considered as triggering a major breakthrough from the old, primate-like social structure (Wrangham et al., 1999, but see Leopold and Ardrey, 1972), the scarcity of tubers in the Mediterranean basin or Western Asia means that they were not an essential element in the course of the successful colonization of these regions. Perhaps, it is only when hominins reached Southeast Asia that they could replicate their African diet and include underground vegetal resources in their daily menu.

The reasons for 'why' early humans dispersed from Africa into Eurasia include the 'push' of environmental change and relative 'demographic pressure', as well as the opening of new niches. Whether humans gained their meat supplies from carcasses following carnivores or themselves became active predators (e.g. Turner, 1992; Bar-Yosef, 1994; Rolland, 1998; Arribas and Palmqvist, 1999) is yet unresolved. Lately, Turner (1999) has suggested that his model of humans following the big carnivores coming out of Africa would fit perhaps the colonization of temperate Europe but not of the Mediterranean basin. Undoubtedly, as the archaeological and fossil record demonstrate, *Homo erectus* was a successful species and like other successful species, enlarged its geographic distribution at all costs.

Even if the trigger for the initial dispersal of *Homo erectus* remains unknown or controversial, the success of the hominid occupation of the Eurasian habitats was not

primarily facilitated by the availability of food, or the human flexibility in food procuring techniques, but by the absence of the zoonotic diseases that plagued and constrained hominins in their African 'cradle of evolution'. Once humans succeeded in crossing the disease-plagued belts of Africa the chances for survival of many more members of their groups rose steeply. It was only thereafter that humans could exploit their latent capacities and came to enjoy their global colonization.

References

Aiello, L.C., Dunbar, R.I.M., 1993. Neocortex size, group size, and the evolution of language. Current Anthropology 34, 184–193.

Aiello, L.C., Wheeler, P., 1995. Expensive-tissue hypothesis: the brain and digestive system in human and primate evolution. Current Anthropology 36, 199–221.

Alimen, M.H., 1979. Les 'isthmes' hispano-marocain et siculo-tunisien aux temps acheuléens. L'Anthropologie 79, 399–436.

Arambourg, C., 1970. Les vertébrés du Pleistocène de l'Afrique du Nord. Archives du Museum National d'Histoire Naturelle 7ème série 1, 1–127.

Arambourg, C., 1979. Les Vertébrés Villafranchiens d'Afrique du Nord. Singer-Polignac, Paris.

Arribas, A., Palmqvist, P., 1999. On the ecological connection between sabre-tooths and hominids: faunal dispersal events in the Lower Pleistocene and a review of the evidence for the first human arrival in Europe. Journal of Archaeological Science 26, 571–585.

Aziz, F., Sondaar, P.Y., Van Den Bergh, G.D., De Vos, J., 1999. Homo erectus in S.E. Asia: time, space and migration routes: a global model II. The Java case. In: Gibert, J., Sánchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Environment during the Lower and Middle Pleistocene of Eurasia: Proceedings of the International Conference of Human Palaeontology, Orce, Museo de Prehistoria y Paleontología, pp. 363–368.

Bar-Yosef, O., 1994. The Lower Paleolithic of the Near East. Journal of World Prehistory 8, 211–265.

Bar-Yosef, O., 1998. Early colonizations and cultural continuities in the Lower Palaeolithic of Western Asia. In: Petraglia, M.D., Korisettar, R. (Eds.), Early Human Behaviour in Global Context: The Rise and Diversity of the Lower Palaeolithic Record. London, Routledge, pp. 221–279.

Bar-Yosef, O., Belfer-Cohen, A., 2000. Early human dispersals: the unexplored constraint of African diseases. In: Otte, M. (Ed.), Dmanisi, Etudes et Recherches Archéologiques de l'Université de Liège, Liège.

Bar-Yosef, O., Goren-Inbar, N., 1993. The Lithic Assemblages of 'Ubeidiya: A Lower Palaeolithic Site in the Jordan Valley, Vol. 34, Qedem — Monographs of the Institute of Archaeology. The Hebrew University of Jerusalem, Jerusalem.

Bar-Yosef, O., Kuhn, S., 1999. The big deal about blades: laminar technologies and human evolution. American Anthropology 101, 1–17.

Belfer-Cohen, A., Goren-Inbar, N., 1994. Cognition and communication in the Levantine Lower Paleolithic. World Archaeology 26, 144–157.

Biberson, P., 1961. Le Paléolithique Inférieur du Maroc Atlantique. Service des Antiquités du Maroc, Rabat.

Boëda, E., 1995. Levallois: A volumetric construction, methods, a technique. In: Dibble, H.L., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, pp. 41–68.

Bordes, F., 1977. Que sont le Pré-Aurignacien et le Yabroudien? In: Arensburg, B., Bar-Yosef, O. (Eds.), Eretz Israel, Vol. 13, Moshé Stekelis Memorial Volume. Israel Exploration Society, Jerusalem, pp. 49–55.

Bovier-Lapierre, R.P., 1925. Le paléolithique stratifié des environs du Caire. L'Anthropologie 35, 37–46.

Bovier-Lapierre, R.P., 1926. Les gisements paléolithiques de la plaine de l'Abbassieh. Bulletin de l'Institut d'Égypte series 6 & 8, pp. 257–275.

Cachel, S., Harris, J.W.K., 1998. The lifeways of Homo erectus inferred from archaeology and evolutionary ecology: a perspective from East Africa. In: Petraglia, M.D., Korisettar, R. (Eds.), Early Human Behaviour in Global Context. Routledge, London, pp. 108–132.

Caton-Thompson, G., 1952. Kharga Oasis in Prehistory. Athlone Press, London.

Clark, J.D., 1971. A re-examination of the evidence for agricultural origins in the Nile Valley. Proceedings of the Prehistoric Society for 1971 37, 34–79.

Cohen, M.N., 1989. Health and the Rise of Civilization. Yale University Press, New Haven.

Corvinus, G., 1998. Lower Palaeolithic occupations in Nepal in relation to South Asia. In: Petraglia, M.D., Korisettar, R. (Eds.), Early Human Behaviour in Global Context: the Rise and Diversity of the Lower Palaeolithic Record. Routledge, London, pp. 391–417.

De Vos, J., Aziz, F., Sondaar, P.Y., Van Den Bergh, G.D., 1999. Homo erectus in S.E. Asia: time, space and migration routes: a global model III. Migration Routes and Evolution. In: Gibert, J., Sánchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Environment during the Lower and Middle Pleistocene of Eurasia: Proceedings of the International Conference of Human Palaeontology. Museo de Prehistoria y Paleontología, Orce, pp. 369–381.

Dennell, R., Roebroeks, W., 1996. The earliest colonization of Europe: the short chronology revisited. Antiquity 70, 535–542.

DeSalle, R. (Ed.), 1999. Epidemic!: The World of Infectious Diseases. The New Press, New York.

Dunbar, R.I.M., 1996. Grooming, Gossip, and the Evolution of Language. Harvard University Press, Cambridge, MA.

Dzaparidze, V., Bosinski, G., Bugianisvili, T., Gabunia, L., Justus, A., Klopotovskaja, N., Kvavadze, E., Lordkipanidze, D., Majsuradze, G., Mgeladze, N., Nioradze, M., Pavlenisvili, E., Schmincke, H.-U., Sologasvili, D., Tusabramisvili, D., Tvalcrelidze, M., Vekua, A., 1989. Der altpaläolithische Fundplatz Dmanisi in Georgian (Kaukasus). Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz 36, 67–116.

Falk, D., 1992. Braindance, 1st Edition. H. Holt, New York.

Freeman, L.G., 1975. Acheulian sites and stratigraphy in Iberia and the Maghreb. In: Butzer, K.W., Isaac, G.L. (Eds.), After the Australopithecines. Mouton, The Hague, pp. 661–744.

Gabunia, L., Vekua, A., 1995. A Plio-Pleistocene Hominid from Dmanisi, East Georgia, Caucasus. Nature 373, 509–512.

Garrod, D.A.E., Bate, D.M., 1937. The Stone Age of Mount Carmel, Vol. 1. Clarendon Press, Oxford.

Gibert, J. (Ed.), 1992. Presencia humana en el Pleistoceno inferior de Granada y Murcia, Ayuntamiento de Orce (Granada). Proyecto Orce-Cueva Victoria (1988–1992), Museo de Prehistoria, Orce.

Gibert, J., Gibert, L., Iglesias, A., Maestro, E., 1998. Two 'Oldowan' assemblages in the Plio-Pleistocene deposits of the Orce region, southeast Spain. Antiquity 72, 17–25.

Goodall, J., 1986. The Chimpanzees of Gombe: Patterns of Behavior. Belknap Press of Harvard University Press, Cambridge, MA.

Goren-Inbar, N., 1985. The lithic assemblage of the Berekhat Ram Acheulian Site, Golan Heights. Paléorient 11, 7–28.

Goren-Inbar, N., Saragusti, I., 1996. An Acheulian biface assemblage from Gesher Benot Ya'aqov, Israel: indications of African affinities. Journal of Field Archaeology 23, 15–30.

Gowlett, J.A.J., 1990. Technology, skill and the psychosocial sector in the long term of human evolution. Cambridge Archaeological Review 9, 82–103.

Horowitz, A., 1979. The Quaternary of Israel. Academic Press, New York.

Hours, F., 1975. The Lower Paleolithic of Lebanon and Syria. In: Wendorf, E., Marks, A.E. (Eds.), Problems in Prehistory: North Africa and the Levant. Southern Methodist University Press, Dallas, pp. 249–271.

Hours, F., 1981. Le Paléolithique inférieur de la Syrie et du Liban. Le point de la question en 1980. In: Sanlaville, P., Cauvin, J. (Eds.), Préhistoire du Levant. Maison de l'Orient, Lyon, pp. 165–184.

Huang, W., Si, X., Hou, Y., Miller-Antonio, S., Schepartz, L.A., 1995. Excavations at Panxian Dadong, Guizhou Province, southern China. Current Anthropology 36, 844–846.

Huang, W., Wang, D., 1995. La Recherche récente sur le Paléolithique ancien en Chine. L'Anthropologie 99, 637–651.

Humphrey, N.K., 1978. The origins of human intelligence. Human Nature 1, 42–47.

Isaac, G., 1986. Foundation stones: early artefacts as indicators of activities and abilities. In: Bailey, G.N., Callow, P. (Eds.), Stone Age Prehistory: Studies in Memory of Charles McBurney. Cambridge University Press, Cambridge, pp. 221–241.

Karlen, A., 1995. Man and Microbes: Disease and Plagues in History and Modern Times. Putnam, New York.

Keates, S.G., 1998. A discussion of the evidence for early hominids on Java and Flores. In: Bartstra, G.-J. (Ed.), Bird's Head Approaches: Irian Jaya Studies — A Programme for Interdisciplinary Research, Modern Quaternary Research in Southeast Asia, Vol. 15. A.A. Balkema, Rotterdam, pp. 179–191.

Klein, R.G., 1989. Biological and behavioural perspectives on modern human origins in Southern Africa. In: Mellars, P., Stringer, C. (Eds.), The Human Revolution: Behavioural and Biological Perspectives in the Origins of Modern Humans. Edinburgh University Press, Edinburgh, pp. 529–546.

Klein, R.G., 1999. The Human Career: Human Biological and Cultural Origins, 2nd Edition. University of Chicago Press, Chicago.

Korisettar, R., Rajaguru, S.N., 1998. Quaternary Stratigraphy, Palaeoclimate, and the Lower Palaeolithic of India. In: Petraglia, M.D., Korisettar, R. (Eds.), Early Human Behaviour in Global Context: The Rise and Diversity of the Lower Paleolithic Record. Routledge, London, pp. 304–342.

Kroll, E.M., 1994. Behavioral implications of Plio-Pleistocene archaeological site structure. Journal of Human Evolution 27, 1–3.

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

Leakey, M.D., 1971. Olduvai Gorge, Excavations in Beds I and III, 1960–1963, Vol. 3. Cambridge University Press, Cambridge.

Leakey, M., Roe, D., 1994. Olduvai Gorge, Vol. 5. Cambridge University Press, Cambridge.

Leopold, A.C., Ardrey, R., 1972. Toxic substances in plants and the food habits of early man. Science 176, 512–513.

Linthicum, K.J., Anyamba, A., Tucker, C.J., Kettey, P.W., Myers, M.F., Peters, C.J., 1999. Climate and satellite indicators to forecast rift valley fever epidemics in Kenya. Science 285, 397–400.

Liubin, V., Bosinski, G., 1995. The earliest occupation of the Caucasus region. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 207–253.

McCown, T.D., Keith, A., 1939. The Stone Age of Mount Carmel II: The Fossil Human Remains from the Levalloiso-Mousterian. Clarendon Press, Oxford.

McHenry, H.M., 1994. Behavioral ecological implications of early hominid body size. Journal of Human Evolution 27, 1–3.

McHenry, H.M., Berger, L.R., 1998. Body proportions in Australopithecus afarensis and A. africanus and the origin of the genus Homo. Journal of Human Evolution 35, 1–22.

McNeill, W.H., 1976. Plagues and Peoples, 1st Edition. Anchor Press, Garden City, NY.

McNeill, W.H., 1980. The Human Condition: An Ecological and Historical View. Princeton University Press, Princeton, NJ.

Meignen, L., 1995. Levallois lithic production systems in the Middle Paleolithic of the Near East: The case of the unidirectional method. In: Dibble, H., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, pp. 361–380.

Mellars, P., Stringer, C. (Eds.), 1989. The Human Revolution: Behavioral and Biological Perspectives on the Origins of Modern Humans. Edinburgh University Press, Edinburgh.

Movius, H.L., 1944. Early man and Pleistocene Stratigraphy in Southern and Eastern Asia, Vol. 19. Papers of the Peabody Museum of American Archaeology and Ethnology. Harvard University, Cambridge.

Mussi, M., 1995. The earliest occupation of Europe: Italy. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 27–49.

O'Connell, J.F., Hawkes, K., Blurton Jones, N.G., 1999. Grandmothering and the evolution of Homo erectus. Journal of Human Evolution 36, 461–486.

Paddayya, K., Petraglia, M., 1993. Formation processes of Acheulian localities in the Hunsgi and Baichbal Valleys, peninsular India. In: Goldberg, P., Nash, D.T., Petraglia, M.D. (Eds.), Formation Processes in Archaeological Context, Monographs in World Archaeology, Vol. 17. Prehistory Press, Madison, pp. 61–82.

Peretto, C. (Ed.), 1991. Isernia La Pineta. Nuovi Contributi Scientifici. Instituto Studi Storici del Molise, Isernia.

Peretto, C. (Ed.), 1994. The First Italians. Le industrie litiche des giacimento paleolitico di Isernia La Pineta. Cosmo Iannone, Castello.

Petraglia, M., LaPorta, P., Paddayya, K., 1999. The first Acheulian quarry in India: stone tool manufacture, biface morphology, and behaviors. Journal of Anthropological Research 55, 39–70.

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

Potts, R., 1989. Olorgesailie: new excavations and findings in Early and Middle Pleistocene contexts, southern Kenya Rift Valley. Journal of Human Evolution 18, 477–484.

Potts, R., 1998a. Environmental hypotheses of hominin evolution. Yearbook of Physical Anthropology 41, 93–136.

Potts, R., 1998b. Variability selection in hominid evolution. Evolutionary Anthropology 7, 81–96.

Raposo, L., Santonja, M., 1995. The earliest occupation of Europe: The Iberian peninsula. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 7–25.

Raynal, J.-P., Magoga, L., Sbihi-Alaoui, F., Geraads, D., 1995. The earliest occupation of Atlantic Morocco: The Casablanca evidence. In: Roebroeks, W., van Kolfschoten, T. (Eds.), The Earliest Occupation of Europe. University of Leiden, Leiden, pp. 255–262.

Roche, H., Texier, P.-J., 1995. Evaluation of technical competence of Homo Erectus in East Africa during the Middle Pleistocene. In: Bower, J.R.F., Sartono, S. (Eds.), Evolution and Ecology of Homo Erectus, Vol. 1, Palaeo-Anthropology, Hominid Evolution in its Ecological Context. Pithecanthropus Centennial Foundation, Leiden, pp. 153–167.

Roe, D., 1995. The Orce Basin (Andalucía, Spain) and the initial Palaeolithic of Europe. Oxford Journal of Archaeology 14, 1–12.

Roebroeks, W., 1994. Updating the earliest occupation of Europe. Current Anthropology 35, 301–305.

Roebroeks, W., van Kolfschoten, T., 1994. The earliest occupation of Europe: a short chronology. Antiquity 68, 489–503.

Rolland, N., 1998. The Lower Palaeolithic settlement of Eurasia, with special reference to Europe. In: Petraglia, M.D., Korisettar, R.

(Eds.), Early Human Behaviour in Global Context. Routledge, London, pp. 187–220.

Rose, L., Marshall, F., 1996. Meat eating, hominid sociality, and home bases revisited. Current Anthropology 37, 307–338.

Sahnouni, M., de Heinzelin, J., 1998. The site of Ain Hanech Revisited: new investigations at this Lower Pleistocene Site in Northern Algeria. Journal of Archaeological Science 25, 1083–1101.

Sanlaville, P., Besançon, J., Copeland, L., Muhesen, S. (Eds.), 1993. Le Paléolithique de la vallée moyenne de l'Oronte (Syrie), BAR International Series, Vol. 587. British Archaeological Reports, Oxford.

Schick, K., 1994. The Movius Line reconsidered: perspectives on the earlier Paleolithic of eastern Asia. 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. 569–596.

Schick, K.D., Zhuan, D., 1993. Early Paleolithic of China and eastern Asia. Evolutionary Anthropology 2, 22–35.

Sondaar, P.Y., Van Den Bergh, G.D., De Vos, J., Aziz, F., 1999. Homo erectus in S.E. Asia: time, space and migration routes IV. Overseas traveling of homo erectus and faunal turnovers. In: Gibert, J., Sánchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Environment during the Lower and Middle Pleistocene of Eurasia: Proceedings of the International Conference of Human Palaeontology, Museo de Prehistoria y Paleontología, Orce, pp. 383–388.

Sponheimer, M., Lee-Thorpe, J.A., 1999. Isotopic evidence for the diet of an early hominid, Australopithecus Africanus. Science 283, 368–370.

Stanford, C.B., 1998. The social behavior of chimpanzees and Bonobos: empirical evidence and shifting assumptions. Current Anthropology 39, 399–420.

Stekelis, M., 1960. The Palaeolithic deposits of Jisr Banat Yaqub. The Bulletin of the Research Council of Israel 9G, 61–90.

Steudel, K.L., 1994. Locomotor energetics and hominid evolution. Evolutionary Anthropology 3, 42–48.

Steudel, K.L., 1996. Limb morphology, bipedal gait, and the energetics of hominid locomotion. American Journal of Physical Anthropology 99, 345–355.

Swisher, C.C., Curtis, G.H., Jacob, T., Getty, A.G., Suprijo, A., Widiasmoro, 1994. Age of the earliest known hominids in Java, Indonesia. Science 263, 1118–1121.

Taskiran, H., 1998. The distribution of bifaces in Anatolia. In: Otte, M. (Ed.), Préhistoire d'Anatolie: Genèse de deux mondes, Vol. 2, Etudes et Recherches Archéologiques de l'Université de Liège 85. Service de Préhistoire, Liège, pp. 569–578.

Tchernov, E. (Ed.), 1986. The Lower Pleistocene Mammals of 'Ubeidiya (Jordan Valley). Mémoires et Travaux du Centre de Recherche Français de Jérusalem 5. Association Paléorient, Paris.

Tchernov, E., 1987. The age of the 'Ubeidiya formation, an early Pleistocene hominid site in the Jordan Valley, Israel. Israel Journal of Earth Sciences 36, 3–30.

Tchernov, E., 1992. Biochronology, paleoecology, and dispersal events of hominids in the Southern Levant. In: Akazawa, T., Aoki, K., Kimura, T. (Eds.), The Evolution and Dispersal of Modern Humans in Asia. Hokusen-sha, Tokyo, pp. 149–188.

Tchernov, E., 1998. The faunal sequence of the Southwest Asian Middle Paleolithic in relation to hominid dispersal events. In: Akazawa, T.,

Aoki, K., Bar-Yosef, O. (Eds.), Neandertals and Modern Humans in Western Asia. Plenum Press, New York, pp. 77–90.

Tchernov, E., 1999. The earliest hominids in the Southern Levant. In: Gibert, J., Sánchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Environment during the Lower and Middle Pleistocene of Eurasia: Proceedings of the International Conference of Human Palaeontology. Museo de Prehistoria y Paleontología, Orce, pp. 389–406.

Teleki, G.P., 1973. The omnivorous chimpanzee. Scientific American 228, 32–42.

Turner, A., 1992. Large carnivores and earliest European hominids: changing determinants of resource availability during the Lower and Middle Pleistocene. Journal of Human Evolution 22, 109–126.

Turner, A., 1999. Assessing earliest human settlement of Eurasia: Late Pliocene dispersals from Africa. Antiquity 73, 563–569.

Turq, A., Deroux, J., Diot, M.-F., 1996. Formations alluviales du Pleistocene moyen entre Sainte-Livrade et le Temple-sur-Lot (Lot-et-Garonne): donnees stratigraphiques, paleobotaniques et archeologiques. Bulletin, Société préhistorique française 93, 463–469.

Van Den Bergh, G.D., De Vos, J., Aziz, F., Sondaar, P.Y., 1999. Homo erectus in S. E. Asia: time, space and migration routes I. The Flores case. In: Gibert, J., Sánchez, F., Gibert, L., Ribot, F. (Eds.), The Hominids and their Eenvironment during the Lower and Middle Pleistocene of Eurasia: Proceedings of the International Conference of Human Palaeontology. Museo de Prehistoria y Paleontología, Orce, pp. 353–362.

Verosub, K.L., Goren-Inbar, N., Feibel, C., Saragusti, I., 1998. Location of the Matuyama/Brunhes boundary in the Gesher Benot Ya'aqov archaeological site, Israel. Journal of Human Evolution 34, A22.

Walker, A., Leakey, R.E., 1993. The Nariokotome Homo Erectus Skeleton. Harvard University Press, Cambridge, MA.

Walker, A., Shipman, P., 1996. The Wisdom of the Bones: In Search of Human Origins, 1st Edition. Knopf, New York.

Walker, A., Zimmerman, M.R., Leakey, R.E.F., 1982. A possible case of hypervitaminosis in Homo erectus. Nature 296, 248–250.

Wanpo, H., Ciochon, R., Yumin, G., Larick, R., Qiren, F., Schwarcz, H., Yonge, C., De Vos, J., Rink, W., 1995. Early Homo and associated artefacts from Asia. Nature 378, 275–278.

Wei, Qi., 1999. Paleolithic archaeological sites from the Lower Pleistocene in China. In: Serizawa, C. (Ed.), From Sozudai to Kamitakamori: World Views on the Early and Middle Palaeolithic in Japan. Tohoku Fukushi University, Tokyo, pp. 123–124.

Wendorf, F., Schild, R., 1980. Prehistory of the Eastern Sahara. Academic Press, New York.

Whalen, N., Siraj-Ali, J.S., Davis, W., 1984. Excavations of Acheulean sites near Saffaqah, Saudi Arabia, 1403 AH 1983. Atlal 8, 9–24.

Wheeler, P.E., 1993. Influence of stature and body form on hominid energy and water budgets; a comparison of Australopithecus and early Homo physiques. Journal of Human Evolution 24, 13–28.

Wood, B., 1997. The oldest whodunnit in the world. Nature 385, 292–293.

Wrangham, R.W., Jones, J.H., Laden, G., Pilbeam, D., Conklin-Brittain, N.L., 1999. The raw and the stolen: cooking and the ecology of human origins. Current Anthropology 40(4).

Yalçinkaya, I., 1981. Le Paléolithique Inférieur de Turquie. In: Cauvin, J., Sanlaville, P. (Eds.), Préhistoire du Levant, Vol. 598. CNRS, Paris, pp. 207–218.