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The revolution that wasn't: a new interpretation of the origin of modern human behavior

Proponents of the model known as the "human revolution" claim that modern human behaviors arose suddenly, and nearly simultaneously, throughout the Old World ca. 40–50 ka. This fundamental behavioral shift is purported to signal a cognitive advance, a possible reorganization of the brain, and the origin of language. Because the earliest modern human fossils, *Homo sapiens sensu stricto*, are found in Africa and the adjacent region of the Levant at >100 ka, the "human revolution" model creates a time lag between the appearance of anatomical modernity and perceived behavioral modernity, and creates the impression that the earliest modern Africans were behaviorally primitive. This view of events stems from a profound Eurocentric bias and a failure to appreciate the depth and breadth of the African archaeological record. In fact, many of the components of the "human revolution" claimed to appear at 40–50 ka are found in the African Middle Stone Age tens of thousands of years earlier. These features include blade and microlithic technology, bone tools, increased geographic range, specialized hunting, the use of aquatic resources, long distance trade, systematic processing and use of pigment, and art and decoration. These items do not occur suddenly together as predicted by the "human revolution" model, but at sites that are widely separated in space and time. This suggests a gradual assembling of the package of modern human behaviors in Africa, and its later export to other regions of the Old World. The African Middle and early Late Pleistocene hominid fossil record is fairly continuous and in it can be recognized a number of probably distinct species that provide plausible ancestors for *H. sapiens*. The appearance of Middle Stone Age technology and the first signs of modern behavior coincide with the appearance of fossils that have been attributed to *H. helmei*, suggesting the behavior of *H. helmei* is distinct from that of earlier hominid species and quite similar to that of modern people. If on anatomical and behavioral grounds *H. helmei* is sunk into *H. sapiens*, the origin of our species is linked with the appearance of Middle Stone Age technology at 250–300 ka.

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Introduction and background

The human revolution in Europe

For at least the past 15 years, most reconstructions of later human evolutionary history have featured a relatively brief and dramatic shift known as the "human revolution" (Binford, 1985, 1989; Mellars & Stringer, 1989; Klein, 1989a, 1994, 1995,

2000; Diamond, 1992; Mellars, 1995, 1996; Nobel & Davidson, 1991; Tattersall, 1995; Bar-Yosef, 1998). The "human revolution" model proposes a dramatic alteration in human behavior at the Middle Paleolithic to Upper Paleolithic transition at about 40 ka. This behavioral breakthrough is thought by some to correspond to increased cognitive sophistication, the

manipulation of symbols, and the origin of language (e.g., White, 1982; Mellars & Stringer, 1989; Diamond, 1992; Byers, 1994; Mithen, 1994, 1996; Klein, 1995; but see Kay *et al.*, 1998). We believe that the model of the “human revolution” is fatally flawed. Modern humans and modern human behaviors arose first in Africa, and we examine the African record to reveal a different picture of the nature of events.

The concept of a “human revolution” and the periodization of Stone Age prehistory have their roots in the nineteenth-century probings of the Western European archaeological record. The first paleolithic classificatory schemes were based on the Western European large mammal succession (Lartet & Christy, 1865–1875; Lyell, 1868), and these authors emphasized the wide technological gulf separating the *l'age du renne* (Upper Paleolithic) from the earlier phases (Lartet & Christy, 1865–1875:25). By the 1920s the concept of an Upper Paleolithic distinguished by the appearance of engraving, sculpture, painting, beads, and worked bone tools had become current. A tripartite division into Lower, Middle and Upper Paleolithic based upon stone tool technology (De Mortillet, 1900; Obermeier, 1924; Burkitt, 1921, 1928, 1933; Kendrick, 1925; Menghin, 1931) echoed the three-age systems of Thomsen (1837) and Worsaae (1849) that partitioned the total prehistoric record into ages of Stone, Bronze, and Iron.

The Lower, Middle and Upper Paleolithic divisions of the western European record have continued to dominate discourse in the field, despite problems in the application of these divisions to sequences in Eastern and Southern Europe (Morselli, 1926:292). None of these temporal divisions was intended as an evolutionary scheme, but rather they were thought to reflect repeated invasions by outsiders with new ideas. Perhaps not surprisingly, a picture of Europe conquered by invaders with superior technology had little appeal in the light of

two great European wars, and the trend in archaeology in the second half of the twentieth century has been the study of local sequences and the application of models of cultural evolution (Otte & Keeley, 1990).

In terms of developments in world prehistory, however, Western Europe is a remote *cul de sac* with a somewhat anomalous prehistoric record. We argue here that models derived from the unique record of European prehistory do not explain events in Africa where the origin of modern people actually occurred. In the Holocene, western Europe experienced a series of incursions from the less peripheral portions of the Old World. Each arrival of a wave of invaders and alien technology induced a fairly sudden, rapid cultural turnover. These disruptive episodes are reflected in the European archaeological record as discontinuities that punctuate industrial periods of relatively long duration. They have been sometimes described as “revolutions,” such as the “neolithic revolution” of Childe (1936, 1942).

Recent paleoclimatic data and refined chronologies have supported the early suggestion of Howell (1951) that regions of Pleistocene Europe were repeatedly isolated by ice and mountain barriers, so that its hominid populations were periodically reduced or even eliminated (Howell, 1952; Gamble, 1986, 1994; Jochim, 1987; Hublin, 1998a). Moreover, it has become increasingly clear that the Neanderthals were replaced by modern humans in Europe within too short a period for the former to have evolved into the latter (Mellars, 1998a,b, 1999, Bocquet-Appel & Demars, 2000). Thus, the “revolutionary” nature of the European Upper Paleolithic is most probably due to discontinuity in the archaeological record rather than to the sort of rapid cultural, cognitive, and/or biological transformation that has been argued by proponents of the “human revolution.”

The earliest modern Europeans were Africans

Who were the earliest modern Europeans? It is becoming increasingly difficult to deny that they were Africans. Although the “mitochondrial Eve” hypothesis, first articulated by Cann *et al.* (1987), has been revised in light of criticism (Templeton, 1992; Hedges *et al.*, 1992; Ayala, 1995), and population size and structure have effects on the distribution of genetic characters that were not taken into account in early reconstructions (Harpending *et al.*, 1993, 1998; Sherry *et al.*, 1994; Relethford, 1995; Relethford & Harpending, 1995), genetic data either directly support or are consistent with an African origin for modern humans (Wainscoat *et al.*, 1986; Cann, 1988; Stringer & Andrews, 1988; Vigilant *et al.*, 1991; Stoneking, 1993; Stoneking *et al.*, 1993; Relethford & Harpending, 1994; Ayala, 1995; Nei, 1995; Goldstein, 1995; Tishkoff *et al.*, 1996; Ruvolo, 1996, 1997; Irish, 1998; Pfeiffer, 1998; Zietkiweicz *et al.*, 1997; Pritchard *et al.*, 1999; Quintana-Murci, 1999; Relethford & Jorde, 1999; Tishkoff *et al.*, 2000; see Relethford, 1998 and Jorde *et al.*, 1998 for recent reviews). As Howell (1994:306) observes, “The phylogenetic roots of modern humans are demonstrably in the Middle Pleistocene. The distribution of those antecedent populations appear to lie outside of western and eastern Eurasia, and more probably centered broadly on Africa.”¹

1. The Middle to Late Pleistocene boundary is the beginning of the last interglacial, at approximately 130 ka; the base of the Middle Pleistocene is the shift from reversed to normal magnetic polarity at the Matuyama–Brunhes boundary, dated to about 780 ka (Butzer & Isaac, 1975; Imbrie & Imbrie, 1980; Berger *et al.*, 1984; Martinson *et al.*, 1987; Shackleton *et al.*, 1990; Deino & Potts, 1990; Cande & Kent, 1992; Baksi *et al.*, 1992; Tauxe *et al.*, 1992). Further evidence may confirm recent suggestions (Schneider *et al.*, 1992; Singer & Pringle, 1996; Hou *et al.*, 2000) that the age of this geomagnetic polarity reversal be revised to ca. 790 ka.

The fossil evidence for an African origin for modern humans is robust. It is clear that modern humans (*H. sapiens sensu stricto*) were certainly present in Africa by 130 ka (Day & Stringer, 1982; Deacon, 1989), and perhaps as early as 190 ka if specimens such as Singa are considered modern (McDermott *et al.*, 1996; Stringer, 1996). Modern humans do not appear in Europe or Central Asia before ca. 40 ka; earliest dates for the Levant range between ca. 80 ka and 120 ka (Day, 1969, 1972; Day & Stringer, 1982, 1991; Stringer, 1989, 1992; McBrearty, 1990b; Stringer *et al.*, 1989; Bräuer, 1984a,b, 1989; Stringer & Andrews, 1988; Valladas *et al.*, 1988; Grün & Stringer, 1991; Miller *et al.*, 1991; Foley & Lahr, 1992; Mercier *et al.*, 1993; Deacon, 1993b; Brooks *et al.*, 1993a,b; Stringer, 1993a; Schwarcz, 1994; Straus, 1994; Bar-Yosef, 1994, 1995a, 1998; but see Howells, 1989). Recent evidence suggests that modern humans were present in Australia as early as 62 ka (Stringer, 1999; Thorne *et al.*, 1999).

Although some, notably Bräuer (1984a,b, 1989), favor a scenario involving some interbreeding among Neanderthal and modern human populations, the successful extraction and analysis of fragmentary mitochondrial DNA (mtDNA) from both the Neanderthal type fossil (Krings *et al.*, 1997, 1999) and additional material from the northern Caucasus (Ovchinnikov *et al.*, 2000) appears to remove the Neanderthals from modern human ancestry. Body proportions of early European *H. sapiens* fossils suggest a tropical adaptation and support an African origin (Holliday & Trinkaus, 1991; Ruff, 1994; Pearson, 1997, 2000; Holliday, 1997, 1998, 2000). A single migration or population bottleneck was originally envisaged in the “African Eve hypothesis” (Cann *et al.*, 1987), but a succession of population dispersals, subsequent isolation induced by climatic events and local adaptation may better account for the complexity of the

fossil record and the genetic composition of present human populations (Howells, 1976, 1989, 1993; Boaz *et al.*, 1982; Foley & Lahr, 1992; Lahr & Foley, 1994, 1998; Ambrose, 1998b).

It can be deduced from the archaeological evidence that on a continent-wide scale the African record differs markedly from that of Europe in its degree of population continuity. While parts of Africa, such as the Sahara or the interior of the Cape Province of South Africa, do appear to have experienced interruptions in human settlement during glacial maxima (Deacon & Thackeray, 1984; Williams, 1984; Butzer, 1988b; Brooks & Robertshaw, 1990; Mitchell, 1990), climatic reconstructions suggest that the contiguous expanse of steppe, savanna and woodland biomes available for human occupation, especially in the tropical regions of the continent, was always substantially larger than the comparable regions in Europe. Perhaps as a result, hominid populations in Africa, while probably widely dispersed, appear to have been consistently larger (Relethford & Harpending, 1995; Jorde *et al.*, 1998; Relethford & Jorde, 1999; Tishkoff *et al.*, 2000).

Revolution or evolution? The African data

How might the archaeological signature of continuous evolutionary change be expected to differ from that of abrupt replacement? If the entire human species experienced a simultaneous, punctuated, genetically encoded event, such as the development of modern capacities for language (Klein, 1995; Diamond, 1992), one would expect the transition to modern human behavior to be abrupt, in Africa as well as in Europe and Asia. On the other hand, if aspects of modern human culture in Africa were developed by hominids using existing cognitive capabilities and transmitted by cultural

rather than by genetic processes, the most likely scenario would be an accretionary process, a gradual accumulation of modern behaviors in the African archaeological record (cf. Allsworth-Jones, 1993). This change need not be unidirectional or confined to a single location. Rather, we might expect innovative behaviors to appear at different times and in different regions, and due to low population densities we might expect the transmission of new ideas to be sporadic.

As early as the 1920s it was clear that the African archaeological record could not be accommodated within the European Paleolithic model. A separate scheme of Earlier, Middle and Later Stone Ages (ESA, MSA, and LSA) was devised for Stone Age Africa (Goodwin & van Riet Lowe, 1929) to emphasize its distinctiveness from the Lower, Middle, and Upper Paleolithic of Europe. The ESA, MSA and LSA were first defined on technological grounds on the basis of material from South Africa (Goodwin, 1928; Goodwin & van Riet Lowe, 1929). The terms were formally endorsed by the Panafrican Congress of 1955 (Clark, 1957a: xxxiii). The ESA as it is now understood includes both the Oldowan and the Acheulian; the MSA encompasses flake and blade tool industries which often include prepared cores and points; and the LSA is characterized by microlithic technology. The MSA was distinguished by the presence of prepared core technology and, at most sites, unifacial and/or bifacial projectile points, and by the absence of handaxes and microliths, hallmarks of the Acheulian and LSA respectively.

Before 1972, in the absence of accurate chronometric dates, a radiocarbon date of 60 ka from Acheulian levels at Kalambo Falls, Zambia (Clark, 1969) was not recognized as infinite. This frequently cited date was particularly influential in establishing the impression of a short chronology for Africa. The MSA, at <60 ka, was

considered the temporal equivalent of the Upper Paleolithic of Europe. Therefore the discovery of anatomically modern human remains associated with MSA artefacts at the South African sites of Border Cave and Klasies River occasioned no surprise.² The degree of regional differentiation, the ubiquitous presence of blades and blade cores, and the sophistication of projectile point technology in the African MSA were considered comparable to the European Upper Paleolithic. However, bone tools, art objects and beads were sparse when compared to the European Upper Paleolithic, particularly the late Upper Paleolithic.

The rarity of elements regarded as critical to modern human culture in the MSA served as grounds for regarding Africa as a “cultural backwater,” the place that initially gave rise to humanity, but failed to nurture its later development (e.g., Butzer, 1971; cf. Clark, 1975). In the later 1970s, new dating techniques and more accurate climatic correlations pushed back the age of the MSA well beyond 100 ka. The MSA was recognized as the temporal equivalent of the European Middle Paleolithic, not the Upper Paleolithic. Attention focused on the human fossils associated with the MSA, which were now thought to be anomalously modern in appearance. The fact that many MSA artefacts recalled the Upper Paleolithic of Europe in both form and technology was forgotten.

The use of a classificatory scheme designed for Africa did not entirely remove ambiguity, as many industries displayed characteristics of two different stages and could not be assigned to one of the three divisions. Long transitional periods or “Intermediates” were added to the tripartite ESA–MSA–LSA scheme at the 1955 Panafrikan Congress (Clark, 1957a: xxxiii), but the “Intermediate” concept was subse-

quently retired (Bishop & Clark, 1967: 987), when a mixture of different occupation levels was found to have occurred during excavation at the “Second Intermediate” type site of Magosi (Wayland & Burkitt, 1932; Clark, 1957b; Hole, 1959; Cole, 1967). Yet anachronisms, as well as long periods of transition between stages, remain as problems (Vishnyatsky, 1994).

A fairly abrupt MSA–LSA transition is apparent in the Mediterranean zones at the northern and southern margins of Africa. This seems consistent with the significant documented gaps in the settlement history of both regions (Close *et al.*, 1990; Wendorf *et al.*, 1990, 1993a; Mitchell, 1990; Deacon & Thackeray, 1984; Klein, 1989b: 307). However, at rock shelter sites in tropical Africa with relatively continuous occupational records, such as Mumba, Tanzania (Mehlman, 1979, 1989), Matupi, D. R. Congo (van Noten, 1977) and White Paintings, Botswana (Robbins & Murphy, 1998; Robbins *et al.*, under review) there is a gradual transition from MSA to LSA technology over as much as 30 ka. Mehlman (1991) has urged the development of new paradigms to accommodate the lack of a punctuated event.

Because of the late, sudden, and nearly simultaneous appearance in Europe of modern humans and complex behavior, archaeologists working in Africa have sought a similar “human revolution” there. The fully developed signature of modern human behavior, including planning, sophisticated technology and resource use, and symbolic behavior in the form of decorative art is clearly present in the African LSA. As a result, the MSA–LSA transition has been conflated with the Middle to Upper Paleolithic and the emergence of modern human behavior. Consequently the earliest anatomically modern humans, which occur in MSA contexts, are not accepted as fully “human”.

We suggest that the expectation of a “human revolution” in Africa is ultimately

2. The name Klasies River rather than Klasies River Mouth or KRM is adopted here to conform with the recent usage of Hilary Deacon and his team.

a misapplication of a European model. Further, we reject the idea of a time lag between anatomical and behavioral change in Africa, such as that proposed by Klein (1992, 1994, 1995, 1998). There was no “human revolution” in Africa. Rather, in this paper we present data from the human fossil and archaeological records to show that novel features accrued stepwise. Distinct elements of the social, economic, and subsistence bases changed at different rates and appeared at different times and places. We describe evidence from the African MSA to support the contention that both human anatomy and human behavior were intermittently transformed from an archaic to a more modern pattern over a period of more than 200,000 years.

The hominid fossil record

Until recently, most reconstructions of later human phylogeny recognized only one species after *H. erectus*. Grade-based schemes commonly divided *H. sapiens* into two variants, “archaic” *H. sapiens* and “anatomically modern” *H. sapiens* (*H. sapiens sensu stricto*). The Neanderthals were then sometimes distinguished from other “archaic” *H. sapiens* at the subspecific level as *H. sapiens neanderthalensis* (e.g., Campbell, 1964). We concur with such authors as Tattersall (1986, 1992), Kimbel (1991), Harrison (1993), Rak (1993) and Stringer (1994, 1996) that there are grounds for distinguishing “archaic” from “modern” *H. sapiens* at the species level, and thus we regard the appearance of “modern” *H. sapiens* as a speciation event. Here, we treat the Neanderthals as the distinct species *H. neanderthalensis* King, 1864, and use the name *H. sapiens* to refer only to *H. sapiens sensu stricto*. The use of the “anatomically modern” label for *H. sapiens sensu stricto* is not only unnecessary but also misleading, as many of the cranial features used to distinguish *H. sapiens* are in fact primitive for

the genus *Homo* when compared to the more derived state in the Neanderthals (Rak, 1993).

Specimens formerly attributed to “archaic” *H. sapiens* exhibit a number of plesiomorphic traits, including long low crania, large brow ridges, large, prognathic faces with large teeth, and the lack of a chin. The chief justification for the inclusion of these fossils in our species has been their large brain sizes, though brain size is in part a function of body mass, known to be quite large among these hominids (Grine *et al.*, 1995; Ruff *et al.*, 1997; Kappelman, 1997). Recent discussions of later hominid phylogeny (e.g., Stringer, 1993b, 1994, 1995, 1996; Lahr & Foley, 1994; Foley & Lahr, 1997; Rightmire, 1998) have recognized the distinctiveness of non-Neanderthal Middle Pleistocene hominids and have resurrected the taxon *H. heidelbergensis* Schoetensack, 1908 for them, but we question the attribution of the African material to this taxon.

Paradoxically, *H. sapiens* Linnaeus, 1758 lacks a satisfactory definition. Howell (1978: 201) observed over 20 years ago,

“The extensive relevant literature reveals an unexpected lack of concern with the biological distinctiveness of a now-dominant mammalian species”,

and the situation is virtually unchanged today. The anatomy of *H. sapiens* is characterized by a high round cranium, a chin, a small orthognathic face, as well as reduced masticatory apparatus and brow ridges. It has been argued that most of these features can be explained by greater flexion in the basicranium of *H. sapiens* (Lieberman, 1998b; Spoor *et al.*, 1999).

Because early fossils of *H. sapiens* dating to 130 ka, and perhaps as early as 190 ka, are found in Africa (Grün *et al.*, 1990; Deacon, 1989, 1993b; Day & Stringer, 1982; McDermott *et al.*, 1996), it is reasonable to seek evidence for the processes leading to the origin of *H. sapiens* in the African

record of the Middle Pleistocene (Howell, 1994). Although often described as “scrappy” or insubstantial, the African hominid fossil sample from this time period numbers several dozen individuals (Table 1, Figure 1). While the circumstances of recovery for some of the specimens are far from ideal, this is unfortunately true for many fossil discoveries, and in fact a fair number of the African specimens were recovered by controlled excavation (e.g., Ndotu, Cave of Hearths, Haua Fteah, Mumba, Ngoloba, Klasies, Kapthurin post-cranials). For others, stratigraphic context can be reasonably inferred, despite the fact that they are surface finds (e.g., Kapthurin mandibles, Eyasi, Buia).

Howell (1994: 305f) has deemed the solution of the evolutionary relationships among later Middle Pleistocene hominid populations one of the central problems in the study of human evolution, and the taxonomic status of the African fossils is much debated (e.g., Tattersall, 1986; Clarke, 1990; Foley, 1991a; Kimbel, 1991; Stringer, 1992, 1993a, 1994, 1996; Aiello, 1993; Foley & Lahr, 1997; Lahr & Foley, 1998; Rightmire, 1998). Revision of fossils ascribed to *Homo* (Wood, 1991, 1992; Wood & Collard, 1999) has resulted in a more “bushy” or speciose taxonomic picture for our genus in the Pliocene and Early Pleistocene, but for the African Middle and Late Pleistocene a unilineal model is often invoked. It is our belief that the number of African Middle and Late Pleistocene hominid species has been underestimated, because behavioral and reproductive isolation may precede changes in the bony skeleton (Tattersall, 1986, 1992, 1993; Rak, 1993).

Over 25 years ago, Day (1973) suggested separating African Middle and Late Pleistocene hominids into “early,” “intermediate,” and “modern” groups, and this grade-based practice has been followed, explicitly and implicitly, in many subsequent

works (Bräuer, 1984a,b, 1989; Smith, 1985, 1993; Clark, 1988; Klein, 1989b, 1994; Stringer, 1993a). Data in Table 1 roughly follow Day’s tripartite construct, though this should not be construed as an endorsement for anagenesis or a grade-based taxonomy. Both the ascription of fossils to group and the attachment of taxonomic labels are problematic, and Group 1 specimens probably belong to several different species (e.g., *H. louisleakeyi*, *H. rhodesiensis*).

The principal unresolved issue in the clarification of the evolutionary relationships of the hominids in Group 1 is the enigmatic status of *H. erectus*. This species is believed by many to have been confined to Asia (Andrews, 1984; Tattersall, 1986; Groves, 1989; Clarke, 1990; Kimbel, 1991; Larick & Ciochon, 1996). Following Wood (1991, 1992), some now ascribe to *H. ergaster* African fossils in the 1.5–2 Ma age range formerly attributed to *H. erectus*. Other authors (e.g., Rightmire, 1990, 1994, 1995, 1998; Bräuer & Mbua, 1992; Harrison, 1993; Walker, 1993; Bräuer, 1994) regard *H. erectus* as a single polytypic species distributed throughout most of the Old World, and African specimens in our Group 1, spanning a broad range of time, continue to be ascribed to this taxon (e.g., OH9, Kapthurin, in Wood, 1992). Attribution of the African and Asian Middle Pleistocene material to a single species assumes an adequate degree of gene flow to prevent speciation, but the archaeological differences between the regions suggest long term isolation (Schick, 1994; but see Hou *et al.*, 2000).

Group 1 in our scheme includes the Kabwe (Broken Hill) cranium, type specimen of *H. rhodesiensis* Woodward, 1921, as well as OH9. The latter specimen is usually referred in the literature to *H. erectus*, but Louis Leakey (1961, 1963) emphatically rejected this position. He saw the origin of *H. sapiens* as a strictly African phenomenon, and regarded OH9 as morphologically

Table 1 Later African Hominidae, their archaeological associations and dates

Site	Specimen	Archaeology	Date	Method	Selected references
Group 1 (<i>H. erectus</i>, <i>H. ergaster</i>, <i>H. louisleakeyi</i>, <i>H. rhodesiensis</i>)					
Ain Maarouf (El Hajeb), Morocco	Left femoral shaft	Acheulian	Early Middle Pleistocene	Associated fauna	Hublin, 1992; Geraads <i>et al.</i> , 1992
Berg Aukas , Namibia	Femoral fragment	None	Undated		Grine <i>et al.</i> , 1995
Bodo , Ethiopia	Adult cranium, parietal, distal humerus	Acheulian	Mid to later Middle Pleistocene, 350 ka	Associated fauna	Conroy <i>et al.</i> , 1978; Kalb <i>et al.</i> , 1980, 1982 <i>a,b</i> ; Asfaw, 1983; Clark <i>et al.</i> , 1984; Rightmire, 1996
		cf. Oldowan	640 ka–550 ka	⁴⁰ Ar/ ³⁹ Ar, associated fauna	Clark <i>et al.</i> , 1994
Buia , Danakil (Afar) Depression, Eritrea	Adult cranium, 2 incisors, pelvic fragments	None reported	1.0 Ma	Paleomagnetism, associated fauna	Abbate <i>et al.</i> , 1998
Cave of Hearths , South Africa	Mandible, radius	Acheulian	Early Late Pleistocene	Associated fauna	Cooke, 1962; Mason, 1962; Mason <i>et al.</i> , 1988; Tobias, 1971; Partridge, 1982; Pearson & Grine, 1997
			End Middle Pleistocene	Associated fauna	Howell, 1978
Eyasi , Tanzania	Cranial fragments representing 3–4 individuals	Sangoan	>130 ka	Extrapolation from overlying ¹⁴ C dates, underlying ²³⁰ Th/ ²³⁴ U dates, faunal correlation	Cooke, 1963; Mehlman, 1984, 1987

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Kabwe (Broken Hill), Zambia (holotype of <i>H. rhodesiensis</i>)	Adult cranium (E686), cranial, maxillary dental and postcranial (humeral, pelvic, femoral, tibial) remains of ≥ 3 individuals	?Sangoan or MSA?	125 ka	Associated fauna	Woodward, 1921; Pycraft <i>et al.</i> , 1928; Oakley, 1957; Clark, 1959; Clark <i>et al.</i> , 1950, 1968; Klein, 1973, 1994; Santa Luca, 1978; Partridge, 1982; Vrba, 1982; Stringer, 1986
			110 ka	Aspartic acid racemization on hominid femoral fragment EM 793	Bada <i>et al.</i> , 1974
			700–400 ka	Associated fauna (cf. Olduvai Beds III–IV)	Klein, 1994; Rightmire, 1998
			780 ka–1.33 Ma	Associated fauna (cf. Olduvai Beds III–IV). Correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Klein, 1973, 1994; Partridge, 1982; Hay, 1976; Walter <i>et al.</i> , 1991, 1992; Tamrat <i>et al.</i> , 1995; Kimbel, 1995; Delson & van Couvering, 2000
			1.07–1.33 Ma	Associated fauna (cf. Olduvai Beds III–IV). Correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	This paper, based upon Klein, 1973, 1994; Partridge, 1982; Hay, 1976; Walter <i>et al.</i> , 1991, 1992; Tamrat <i>et al.</i> , 1995; Kimbel, 1995; Delson & van Couvering, 2000

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Kapthurin (Baringo) Kenya	Two adult mandibles, (KNM-BK 67, 8518) postcranials (ulna, talus, manus phalanges, KNM-BK 63-66)	Undiagnostic	230-780 ka	K/Ar, associated fauna, paleomagnetism	Leakey <i>et al.</i> , 1969; van Noten, 1982; Howell, 1982; van Noten & Wood, 1985; Wood & van Noten, 1986; Tallon, 1978; Dagley <i>et al.</i> , 1978; Rightmire, 1980; Solan & Day, 1992; Wood, 1992; Groves, 1998
			500-550 ka		Deino & McBrearty, under review
Kébibat (Rabat), Morocco	Subadult calvaria, maxillary fragment, mandible	None	>200 ka	$^{230}\text{Th}/^{234}\text{U}$	Stearns & Thurber, 1965
			300 ka-1.0 Ma	Associated fauna	Saban, 1975, 1977; Howell, 1978; Sausse, 1975 <i>b</i>
Lainyamok , Kenya	Femoral shaft, isolated teeth	Undiagnostic	390-330 ka	$^{40}\text{Ar}/^{39}\text{Ar}$	Shipman <i>et al.</i> , 1983; Potts <i>et al.</i> , 1988; Potts & Deino, 1995
Loyangalani	Maxillary and mandibular dentition	None	Late Middle/Early Late Pleistocene	Associated fauna	Twisselmann, 1991
Melka Konturé , Ethiopia	Cranial fragments	Acheulian	Middle Pleistocene	Associated fauna	Chavaillon <i>et al.</i> , 1974; Howell, 1978; Chavaillon, 1982
Ndutu , Tanzania	Adult cranium	cf. Acheulian	500-600 ka	AAR on associated mammalian bone	Mhuri, 1976; Rightmire, 1980, 1983; Clarke, 1976, 1990

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Ndutu , Tanzania <i>continued</i>			490–780 ka	Upper limit: correlation of reversed polarity excursion in underlying Norkilili Member of Masek Beds with Emperor subchron. Lower limit: correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Tamrat <i>et al.</i> , 1995
			370–990 ka	Upper limit: $^{40}\text{Ar}/^{39}\text{Ar}$ on Kerimasi caldera, probable source of Norkilili Member of Masek Beds. Lower limit: correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	This paper, based upon Hay, 1976, 1990; Leakey <i>et al.</i> , 1972; Leakey & Hay, 1982; Clarke, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995
OH 9 , LLK, Olduvai Gorge, Tanzania (type of H. louisleakeyi)	Adult partial cranium	Developed Oldowan or Acheulian	1·15 Ma (surface, top of Bed II)	K/Ar, paleomagnetism	Hay, 1963, 1973, 1976, 1990; Leakey, 1961, 1963; Leakey, 1971 <i>a,b</i> ; Leakey & Hay, 1982; Rightmire, 1979 <i>a</i> , 1980, 1990, 1994; Wood, 1994
			0·7–1·0 Ma	K/Ar, paleomagnetism	Hay, 1971
			1·33–1·48 Ma	$^{40}\text{Ar}/^{39}\text{Ar}$, paleomagnetism	Hay, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
OH 11 , DK, Olduvai Gorge, Tanzania	Palate, maxilla	None; both Acheulian & MSA elsewhere in Ndutu Beds	ca. 400 ka (surface, probably lower Ndutu Beds)	K/Ar, paleomagnetism inferred sedimentation rates	Rightmire, 1979 <i>a</i> ; Leakey & Hay, 1982; Hay, 1994
			ca. 490 ka	Paleomagnetism; correlation of reversed polarity excursion in underlying Norkilili Member of Masek Beds with Emperor subchron.	This paper, based upon Tamrat <i>et al.</i> , 1995
			ca. 370 ka	⁴⁰ Ar/ ³⁹ Ar on Kerimasi caldera, probable source of Norkilili Member of Masek Beds.	Hay, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000; Delson & van Couvering, 2000
OH 12 , VEK, Olduvai Gorge, Tanzania	Palate, maxilla, cranial fragments	None; Acheulian elsewhere in Bed IV	780–620 ka (upper Bed IV)	K/Ar, paleomagnetism, inferred sedimentation rates	Rightmire, 1979 <i>a</i> ; Leakey & Hay, 1982; Hay, 1994; Leakey & Roe, 1994
			780 ka–1.2 Ma	Paleomagnetism; correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Tamrat <i>et al.</i> , 1995
			1.07–1.2 Ma	⁴⁰ Ar/ ³⁹ Ar paleomagnetism; correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	Hay, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000; Delson & van Couvering, 2000

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
OH 22, VEK/MNK, Olduvai Gorge, Tanzania	Partial mandible	None; Acheulian elsewhere in Bed IV and overlying Ndutu Beds	800–600 ka (surface, Bed IV)	K/Ar, paleomagnetism, inferred sedimentation rates	Day, 1986; Leakey & Hay, 1982; Leakey & Roc, 1994; Rightmire, 1979 <i>a</i> , 1990; Hay, 1994
			780 ka–1.2 Ma	Paleomagnetism; correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Tamrat <i>et al.</i> , 1995
			1.07–1.2 Ma	⁴⁰ Ar/ ³⁹ Ar, paleomagnetism; correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	Hay, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000; Delson & van Couvering, 2000
OH 23, FLK, Olduvai Gorge, Tanzania	Mandibular fragment	Acheulian	400–600 ka (<i>In situ</i> , Masek Beds)	K/Ar, paleomagnetism, inferred sedimentation rates	Day, 1986; Rightmire, 1990; Leakey & Roc, 1994; Hay, 1994
			490–780 ka	Paleomagnetism. Upper limit: correlation of reversed polarity excursion in underlying Norkilili Member of Masek Beds with Emperor subchron. Lower limit: correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Tamrat <i>et al.</i> , 1995

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
OH 23 , <i>continued</i>			990–370 ka	Upper limit: $^{40}\text{Ar}/^{39}\text{Ar}$ on Kerimasi caldera, probable source of Norfolk Member of Masek Beds. Lower limit: correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	Hay, 1976, 1990; Manega 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000; Delson & van Couvering, 2000
OH 28 , WK, Olduvai Gorge, Tanzania	Left innominate, femur	Acheulian	780–620 ka (upper Bed IV)	K/Ar, paleomagnetism, inferred sedimentation rates	Day, 1971, 1986; Leakey, 1971 <i>a</i> ; Rightmire, 1979 <i>a</i> ; Leakey & Hay, 1982; Hay, 1994
			780 ka–1.2 Ma	Paleomagnetism; correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Tamrat <i>et al.</i> , 1995
			1.2–1.07 Ma	$^{40}\text{Ar}/^{39}\text{Ar}$, paleomagnetism; correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	Hay, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000; Delson & van Couvering, 2000
OH 34 , JK, Olduvai Gorge, Tanzania	Femur and partial tibia	Acheulian	0.8–1.1 Ma (Bed III)	K/Ar, paleomagnetism	Day, 1971; Leakey & Roe, 1994; Hay, 1990, 1994
			1.2–1.33 Ma	$^{40}\text{Ar}/^{39}\text{Ar}$, paleomagnetism	This paper, based upon Hay, 1976, 1990; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
OH 51 , GTC, Olduvai Gorge, Tanzania	Mandibular fragment	None; Acheulian elsewhere in Bed III	0.8–1.1 Ma (Bed III)	K/Ar, paleomagnetism	Leakey & Roe, 1994; Rightmire, 1990; Hay, 1990, 1994
			1.2–1.33 Ma	⁴⁰ Ar/ ³⁹ Ar, paleomagnetism	This paper, based upon Hay, 1976, 1990; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; White, 2000
Saldanha (Hopefield Elandsfontein), South Africa	Adult calvaria, mandibular fragment	Acheulian	ca. 130–780 ka (Middle Pleistocene)	Associated fauna	Drennan, 1953; Singer, 1954; Cooke, 1963; Partridge, 1982; Deacon, 1988
			600–800 ka	Associated fauna, cf Bed IV Olduvai Gorge	Klein, 1973; Singer & Wymer, 1968; Leakey & Hay, 1982; Hay, 1994; Leakey & Roe, 1994
			500–200 ka	Associated fauna	Klein, 1988
			700–400 ka	Associated fauna	Klein & Cruz-Urbe, 1991; Klein, 1994; Rightmire, 1998
			780 ka–1.2 Ma	Associated fauna (cf Olduvai Bed IV). Correlation of top of Bed IV with Matuyama Brunhes boundary	This paper, based upon Gentry, 1978; Klein & Cruz Urbe, 1991; White, 2000; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Saldanha , <i>continued</i>			1·07–1·33	Associated fauna (cf Olduvai Bed IV). Correlation of normal polarity paleomagnetic zone at base of Masek Beds with Jaramillo subchron	This paper, based upon Gentry, 1978; Klein & Cruz Uribe, 1991; White, 1999; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995
Salé , Morocco	Adult calvaria, cranial fragments, endocast	None	300 ka–1·0 Ma	Associated fauna	Jaeger, 1973, 1975; Howell, 1978; Hublin, 1985, 1991, 1994; Dean <i>et al.</i> , 1993
			389–455 ka	LU ESR on associated bovid tooth enamel	Hublin, 1991
Sidi Abderrahman (Casablanca) Morocco	Partial mandible	Acheulian	Middle Pleistocene ("Tensiftian" = "Riss")	Geomorphology, associated fauna	Arambourg & Biberson, 1956; Biberson, 1963; Howell, 1960, 1978
Tighénif (formerly Ternifine), Oran, Algeria	Three mandibles, parietal fragment	Acheulian	Middle Pleistocene	Associated fauna	Arambourg, 1955; Arambourg & Hoffsteter, 1963; Howell, 1960, 1978; Balout <i>et al.</i> , 1967; Tobias, 1968; Schwartz & Tattersall, 2000
			0·6–1·0 Ma	Associated fauna	Geraads, 1981; Jaeger, 1981
			700 ka	Associated fauna, paleomagnetism	Geraads <i>et al.</i> , 1986
Thomas 1 Quarry , Morocco	Subadult partial mandible, cranial and maxillary fragments	None	Middle Pleistocene ("Amirian")	Associated fauna, geomorphology	Ennouchi, 1969 <i>a</i> , 1970; Sausse, 1975 <i>b</i> ; Oakley <i>et al.</i> , 1977; Howell, 1960, 1978; Brauer, 1984 <i>a,b</i> ; Dean <i>et al.</i> , 1993

Table 1, Group 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Wadi Dagadlé, Djibouti	Maxilla, partial dentition	None	<250 ka	TL on basalt, associated fauna	de Bonis <i>et al.</i> , 1984, 1988
Group 2 (<i>H. hehmei</i> or <i>H. sapiens</i>) Eliye Springs, West Turkana, Kenya	Adult cranium ES11693	None	None	Surface find	Bräuer & Leakey, 1986
Florisbad, South Africa	Adult cranium	?MSA?	Infinite	AAR, ¹⁴ C	Vogel & Beaumont, 1972; Bada <i>et al.</i> , 1973
			> 100 ka	²³⁰ Th/ ²³⁴ U, peat I, associated fauna	Dreyer, 1935, 1936; Rightmire, 1978 <i>a</i> ; Clarke, 1985; Kuman & Clarke, 1986; Brink, 1988; Burzer, 1988 <i>a</i> ; Kuman <i>et al.</i> , 2000
			260 ka	ESR, direct assay on hominid tooth	Grün <i>et al.</i> , 1996
Guomde, Chari Fm, Ileret, Kenya	Adult cranium (KNM-ER 3884), femur (KNM-ER 999)	None	270–300 ka	U-series, direct assays on hominid cranium & femur	Bräuer <i>et al.</i> , 1992, 1997; Feibel <i>et al.</i> , 1989
Haua Fteah, Libya	Two young adult mandibular fragments	MSA (“Levalloiso- Mousterian”)	Infinite	¹⁴ C on burnt bone	McBurney, 1961, 1967; Tobias, 1967; Rak, 1998:364
			> 130	Associated artefacts (Generalized MSA is stratified under Aterian elsewhere in Sahara)	This paper, based upon Debenath, 1994; Wendorf <i>et al.</i> , 1987, 1993 <i>a</i>

Table 1, Group 2 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Haua Fteah , Libya <i>continued</i>			> 90 ka	Associated artefacts, TL & OSL reported for <i>in situ</i> Aterian material in Libya; generalized MSA is stratified under Aterian elsewhere in Sahara	This paper, based upon Martini <i>et al.</i> , 1996; Cremaschi <i>et al.</i> , 1998
			127–40 ka	Associated artefacts	Klein, 1999
Jebel Irhoud , Morocco	Adult cranium (JI1), adult calvaria (JI2), infant mandible (JI3), fragmentary postcranials (JI4)	MSA (“Levallois-Mousterian”)	Infinite	¹⁴ C	Ennouchi, 1966
			90–125 ka (EU), 105 190 ka (LU)	Extrapolation from ESR dates on mammalian teeth overlying <i>in situ</i> hominid specimen JI4	Ennouchi, 1962, 1963, 1968, 1969 <i>a,b</i> ; Howell, 1978; Hublin, 1985, 1991, 1993; Hublin <i>et al.</i> , 1987; Grün & Stringer, 1991
Mugharet el Aiya , Morocco	Juvenile maxillary fragment with partial dentition, adult tooth	MSA, presumed Aterian (not <i>in situ</i>)	Late Middle/Early Late Pleistocene (“Ouljian-Soltanian”)	Associated fauna	Biberson, 1961, 1963; Debénath, 1980; Debénath <i>et al.</i> , 1982, 1986; Amani & Geraads, 1993; Hublin, 1993
			60–90 ka	Associated Aterian artefacts; TL & OSL reported for <i>in situ</i> Aterian material in Libya	This paper, based upon Debénath, 1994; Martini <i>et al.</i> , 1996; Cremaschi <i>et al.</i> , 1998

Table 1, Group 2 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Ngaloba (Laetoli Hominid 18) Tanzania	Adult cranium	MSA	> 120 ka	Correlation with marker tuff in Lower Nduvu Beds at Olduvai Gorge bracketed by ^{14}C & K/Ar dates	Hay, 1976; Leakey & Hay, 1982; Magori & Day, 1983; Day <i>et al.</i> , 1980
			130–108 ka	$^{230}\text{Th}/^{234}\text{U}$ on associated mammalian bone	Hay, 1987
			100–200 ka	Isoleucine epimerization of associated mammalian bone	Bada, 1987
			200 ka	AAR on ostrich eggshell, correlation with units dated by $^{40}\text{Ar}/^{39}\text{Ar}$	Manega, 1995
			200–370 ka	$^{40}\text{Ar}/^{39}\text{Ar}$, on Kerimasi caldera, probable source of Norkilili Member of Masek Beds.	This paper, based on Hay, 1976, 1990; Manega, 1993; Tamra <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995
		200–490 ka	$^{40}\text{Ar}/^{39}\text{Ar}$, paleomagnetism; correlation of reversed polarity excursion in underlying Norkilili Member of Masek Beds with Emperor subchron.	This paper, based on Hay, 1976, 1990; Manega, 1993; Tamrat <i>et al.</i> , 1995; Walter <i>et al.</i> , 1991, 1992; Kimbel, 1995; Delson & van Couvering, 2000	

Table 1, Group 2 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Omo II , Site PHS, Kibish Formation, Ethiopia	Adult calvaria	?MSA?	> 39 ka	^{14}C on <i>Ethiopia</i> shell in overlying unit	Day, 1969, 1972; Butzer, 1969; Butzer <i>et al.</i> , 1969; Merrick <i>et al.</i> , 1973; Day & Stringer, 1982
			> 130 ka	$^{230}\text{Th}/^{234}\text{U}$ on <i>Ethiopia</i> shell in overlying unit	Day, 1969, 1972; Butzer, 1969; Butzer <i>et al.</i> , 1969; Merrick <i>et al.</i> , 1973; Day & Stringer, 1982, 1991
Porc Épic (Dire Dawa), Ethiopia	Mandibular fragment	MSA	Late Pleistocene	Associated fauna	Breuil <i>et al.</i> , 1951; Vallois, 1951; Clark, 1954, 1982; Bräuer, 1984a; Howell, 1978
			> 60–77 ka	Obsidian hydration	Clark <i>et al.</i> , 1984; Clark, 1988
Singa , Sudan	Calvaria	?MSA?	Early Late Pleistocene	Associated fauna	Bate, 1951; Stringer, 1979; Bräuer, 1984a,b; Stringer <i>et al.</i> , 1985; Clark, 1988
			82–112 (EU), 133–187 (LU)	ESR on associated mammalian teeth	Grün & Stringer, 1991
			190–130 ka	U-series on calcrete enclosing skull and associated mammalian teeth	McDermot <i>et al.</i> , 1996

Table 1 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Group 3 (<i>H. sapiens</i>) Border Cave, South Africa	Adult calvaria (BC1), 2 adult mandibles (BC 2 & 5), infant partial skeleton (BC3), adult postcranial fragments	MSA	90–115 ka	Geomorphology, associated fauna, extrapolation from overlying ¹⁴ C dates, amino acid racimization	Cooke <i>et al.</i> , 1945; Wells, 1950, 1959; de Villiers, 1973, 1978; Protsch, 1975; Beaumont <i>et al.</i> , 1978; Butzer <i>et al.</i> , 1978; Rightmire, 1979 <i>b</i> ; Beaumont, 1980; Grün <i>et al.</i> , 1990; Grün & Stringer, 1991; Morris, 1992 <i>b</i> ; Miller <i>et al.</i> , 1993, 1999; Pfeiffer & Zehr, 1996; Pearson & Grine, 1996 (but see Sillen & Morris, 1996)
Dar-es-Soltan, Morocco	Cranial, maxillary & mandibular fragments of >2 individuals, adult & subadult	MSA (Aterian)	Infinite	AAR, associated fauna, geomorphology, extrapolation from overlying ¹⁴ C dates	Klein, 1999
				¹⁴ C	McBurney, 1961; Fereimbach, 1976 <i>b</i> ; Howell, 1978; Bräuer & Rimbach, 1990; Wendorf <i>et al.</i> , 1990; Bräuer, 1992; Debénath, 1980, 1994; Debénath <i>et al.</i> , 1982, 1986; Hublin, 1993
			60–90 ka	Associated Aterian artifacts; TL & OSL for <i>in situ</i> Aterian material in Libya	This paper, based upon Debénath, 1994; Marrini <i>et al.</i> , 1996; Cremaschi <i>et al.</i> , 1998

Table 1, Group 3 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Die Kelders , South Africa	24 teeth, mandibular fragment, 2 manual phalanges	MSA	>40 ka, >60 ka (EU), >80 ka (LU)	ESR	Grine & Klein, 1985; Grine <i>et al.</i> , 1991; Avery <i>et al.</i> , 1997
			71–45 ka	ESR, associated fauna, geologic context	Klein, 1999
			60–80 ka	ESR, TL, OSL, IRSL	Grine, 2000; Schwarcz & Rink, 2000; Feathers & Bush, 2000
Equus Cave , South Africa (hyena layer)	Mandibular left corpus fragment with 2 molars; additional isolated adult teeth	MSA	93–44 ka	U-series on tufa, ¹⁴ C on Mn patina	Grine & Klein, 1985; Klein <i>et al.</i> , 1991
			71–>27 ka	¹⁴ C, associated fauna, geologic context	Klein, 1999
Hoedjies Punt , South Africa	Cranial and postcranial fragments, isolated teeth	MSA	>70 ka	U-series	Volman, 1978; Berger & Parkington, 1995
			300–71 ka	U-series, associated fauna, geologic context	Klein, 1999
Kabua , Kenya	Cranial & mandibular fragments of 2 individuals	Uncertain	?Late Pleistocene	Geologic context	Whinworth, 1966; Rightmire, 1975

Table 1, Group 3 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Klasies River , South Africa	Five partial adult mandibles, 2 partial adult maxillae, cranial fragments, ulna, radius, other fragmentary postcrania, isolated teeth	MSA	LBS member: 118 ka (oxygen isotope stage 5e); SAS member: 94–105 ka	$^{16}\text{O}/^{18}\text{O}$ on marine molluscs, aspartic acid racemization of mammalian bone, ESR on mammalian teeth, $^{230}\text{Th}/^{234}\text{U}$ on speleothem, geomorphology, associated fauna	Bada & Deems, 1975; Rightmire, 1978b; Butzer, 1982; Singer & Wymer, 1982; Shackleton, 1982; Bräuer <i>et al.</i> , 1982; Hندی & Volman, 1986; Deacon, 1988, 1989, 1993b, 1995; Deacon & Geeljnse, 1988; Deacon & Shurman, 1992; Brooks <i>et al.</i> , 1993b; Bräuer & Singer, 1996; Churchill <i>et al.</i> , 1996; Lam <i>et al.</i> , 1996; Pearson & Grine, 1997; Grooves, 1998; Grine <i>et al.</i> , 1998; Pearson <i>et al.</i> , 1998; Pfeiffer, 1998
Mumba Rock Shelter , Tanzania	Three unerupted molars	MSA	110–130 ka	$^{230}\text{Th}/^{234}\text{U}$ on associated mammalian bone	Klein, 1999 Mehlman, 1987; Bräuer & Mehlman, 1988
Mumbwa , Zambia	Radial fragments	?MSA?	Undated		Dart & Del Grande, 1931; Jones, 1940; Clark, 1989; Barham, 1995, 1996
Omo I , Site KHS, Kibish Formation, Ethiopia	Adult partial skeleton	?MSA?	> 39 ka	^{14}C on <i>Eiheria</i> shell in overlying unit	Day, 1969, 1972; Butzer, 1969; Butzer <i>et al.</i> , 1969; Merrick <i>et al.</i> , 1973; Day & Stringer, 1982

Table 1, Group 3 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Omo I <i>continued</i>			> 130 ka	$^{230}\text{Th}/^{234}\text{U}$ on <i>Ethiopia</i> shell in overlying unit	Day, 1969, 1972; Butzer, 1969; Butzer <i>et al.</i> , 1969; Merrick <i>et al.</i> , 1973; Day & Stringer, 1982, 1991; Bräuer & Rimbach, 1990; Bräuer, 1992
Sea Harvest , Saldanha Bay, South Africa (hyena layer)	Tooth, phalanx	MSA	> 40 ka	^{14}C on ostrich egg shell	Volman, 1978; Grine & Klein, 1993; Klein, 1994
Soleb , Sudan	Cranial & mandibular fragments of 3 individuals	MSA ("Late Levalloisian")	?Late Pleistocene	Associated fauna	Klein, 1999 Giorgini, 1971; Sausse, 1975a
Témara (Grotte de Contrabandiers, El Mnasra 2, Rabat) Morocco	Adult mandible with dentition, maxillary teeth, occipital, frontal and parietal fragments	MSA (Aterian)	> 90 ka, > 160	Associated artefacts. Generalized MSA precedes Aterian dated by U-series at sites in Egyptian Sahara	This paper, based upon Kleindienst, 2000b; Kleindienst & Wiseman, 1996; Kleindienst <i>et al.</i> , 1996; Wendorf <i>et al.</i> , 1987, 1993a
			Late Middle Pleistocene ("Epi-Ouljian")	Associated fauna	Vallois, 1960; Biberson, 1961; Tobias, 1968; Saban, 1972; Roche & Texier, 1976; Ferembach, 1976a; Howell, 1978; Debénath, 1980; Debénath <i>et al.</i> , 1982, 1986; Hublin, 1993
			> 40 ka	Associated artefacts (infinite ^{14}C for Aterian elsewhere in Sahara)	Close, 1984; Wendorf <i>et al.</i> , 1993a; Cremaschi <i>et al.</i> , 1998

Table 1, Group 3 *Continued*

Site	Specimen	Archaeology	Date	Method	Selected references
Témara , <i>continued</i>			130–40 ka	Associated artefacts	This paper, based upon Debénath, 1994
			60–90 ka	Associated artefacts; TL & OSL reported for <i>in situ</i> Aterian material in Libya	This paper, based upon Martini <i>et al.</i> , 1996; Cremaschi <i>et al.</i> , 1998
Taramsa , Egypt	Partial juvenile skeleton	MSA	50–80 ka	OSL on sand	Vermeersch <i>et al.</i> , 1998
Zouhrah (El Harhoura, Morocco)	Mandible, isolated tooth	MSA (Aterian)	> 40 ka	Associated artefacts (infinite ¹⁴ C for Aterian elsewhere in Sahara)	Close, 1984; Wendorf <i>et al.</i> , 1993 <i>a</i> ; Cremaschi <i>et al.</i> , 1998
			130–40 ka	Associated artefacts	This paper, based upon Debénath, 1994
			60–90 ka	Associated artefacts, TL & OSL reported for <i>in situ</i> Aterian material in Libya	This paper, based upon Martini <i>et al.</i> , 1996; Cremaschi <i>et al.</i> , 1998

Age estimates considered to be most accurate are in boldface. When multiple age estimates are equally well supported, all are in boldface (e.g., estimates based on recalibrated Olduvai sequence). AAR analyses on bone performed before 1980 should be regarded with caution. Question marks in the archaeology column indicate that either industrial attributions or associations are problematic. Recent re-examination of Kibish Formation geology indicates that the Omo Kibish finds may be substantially older than the date given here (Flagle, personal communication). General references: Oakley *et al.*, 1977; Howell, 1978, 1982; Bräuer, 1984*a,b*; Rightmire, 1984; Day, 1986; Stringer & Andrews, 1988; Morris 1992*a*; Klein, 1999; Delson *et al.*, 2000.

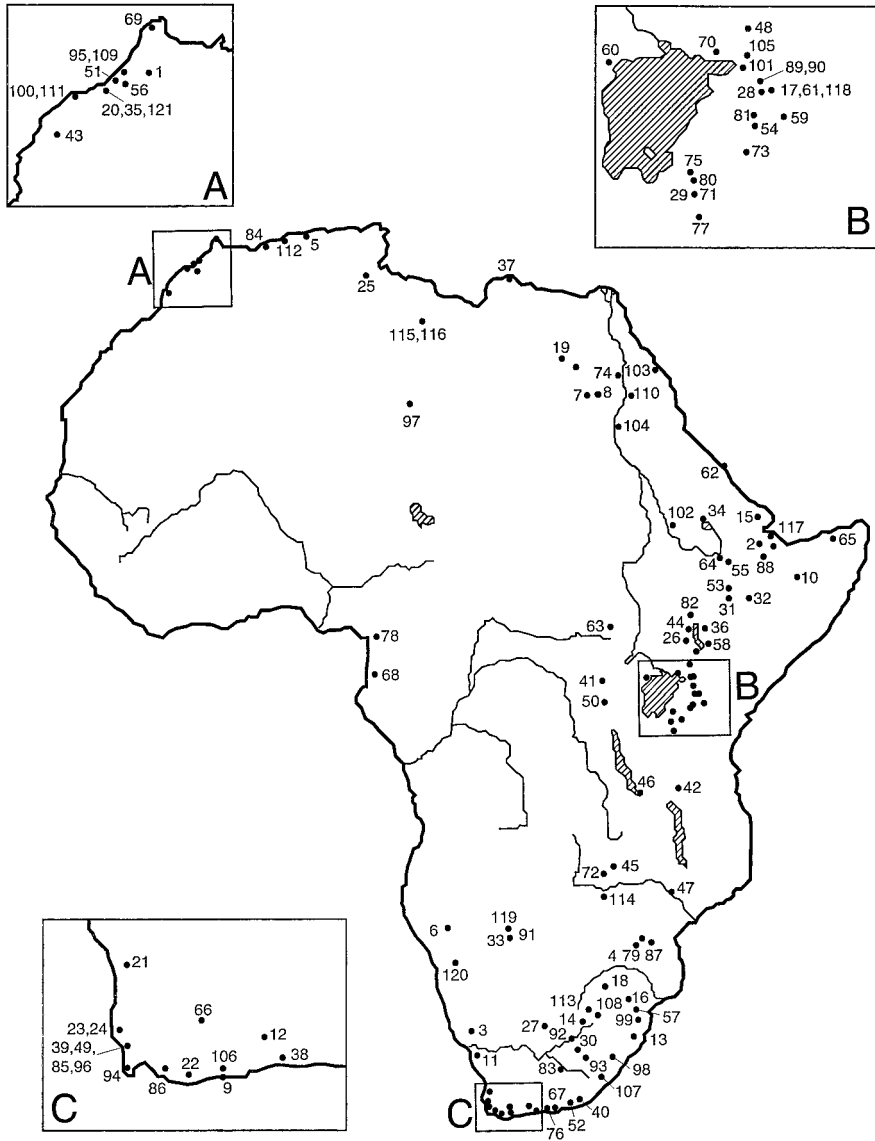


Figure 1. Map of archaeological and hominid fossil sites mentioned in the text. © Sally McBrearty and Alison S. Brooks.

Figure 1. Key to sites.

Ain Maarouf (MOR)	1	Massawa (ERI)	62
Aduma (ETH)	2	Matupi Cave (DRC)	63
Apollo 11 Rock Shelter (NAM)	3	Melka Konturé (ETH)	64
Bambata (ZIM)	4	Midhishi (SOM)	65
Bérard (ALG)	5	Montagu Cave (SA)	66
Berg Aukas (NAM)	6	Mossel Bay (SA)	67
Bir Sahara East (EGY)	7	Mosumu (EQG)	68
Bir Tarfawi (EGY)	8	Mugharet el-Aliya (MOR)	69
Blombos Cave (SA)	9	Muguruk (KEN)	70
Bodo (ETH)	10	Mumba Shelter (TAN)	71
Boegoeberg (SA)	11	Mumbwa (ZAM)	72
Boomplaas (SA)	12	Nasera Rock Shelter (TAN)	73
Border Cave (SA)	13	Nazlet Safaha (EGY)	74
Boskop (SA)	14	Ndutu (TAN)	75
Buias (ERT)	15	Nelson Bay Cave (SA)	76
Bushman Rock Shelter (SA)	16	Ngaloba (TAN)	77
Cartwright's Site (KEN)	17	Njuinye (CAM)	78
Cave of Hearths (SA)	18	Nswatugi (ZIM)	79
Dakleh Oasis (EGY)	19	Olduvai Gorge (TAN)	80
Dar-es-Soltan (MOR)	20	Ologesailie (KEN)	81
Diepkloof (SA)	21	Omo (ETH)	82
Die Kelders (SA)	22	Orangia (SA)	83
Dunefield Midden (SA)	23	Oued Djebanna (ALG)	84
Elands Bay Cave (SA)	24	Paternoster (SA)	85
El-Guettar (TUN)	25	Peer's Cave (SA)	86
Eliye Springs (KEN)	26	Pomongwe (ZIM)	87
Equus Cave (SA)	27	Porc Épic (Dire Dawa) (ETH)	88
Enkapune ya Muto (KEN)	28	Prolonged Drift (KEN)	89
Eyasi (TAN)	29	Prospect Farm (KEN)	90
Florisbad (SA)	30	Rhino Cave (BOT)	91
Gademotta (ETH)	31	Rooidam (SA)	92
Gadeb (ETH)	32	Rose Cottage Cave (SA)	93
≠ Gi (BOT)	33	Saldanha (Elandsfontein, Hopefield) (SA)	94
Gorgora (ETH)	34	Salé (MOR)	95
Grotte d'el Mnasra (MOR)	35	Sea Harvest (SA)	96
Guomde (KEN)	36	Seggédim (NGR)	97
Haua Fteah (LIB)	37	Sehonghong (LES)	98
Herolds Bay (SA)	38	Sibebe Rock Shelter (SA)	99
Hoedjies Punt (SA)	39	Sidi Abderrahman (MOR)	100
Howiesons Poort (SA)	40	Simbi (KEN)	101
Ishango (DRC)	41	Singa (SUD)	102
Isimila (TAN)	42	Sodmein Cave (EGY)	103
Jebel Irhoud (MOR)	43	Soleb (EGY)	104
Kabua (KEN)	44	Songhor (KEN)	105
Kabwe (Broken Hill) (ZAM)	45	Still Bay (SA)	106
Kalambo Falls (ZAM)	46	Strathalan (SA)	107
Kalemba (ZAM)	47	Swartkrans (SA)	108
Kapthurin (KEN)	48	Témara (MOR)	109
Kasteelberg (SA)	49	Taramsa (EGY)	110
Katanda (DRC)	50	Thomas I Quarry (MOR)	111
Kébitat (Rabat) (MOR)	51	Tighénif (Ternifine) (ALG)	112
Klasies River (SA)	52	Tuinplaas (SA)	113
Kukuleti (ETH)	53	Twin Rivers (ZAM)	114
Lainymok (KEN)	54	Uan Afuda (LIB)	115
Lake Ziway (ETH)	55	Uan Tabu (LIB)	116
Le Chaperon Rouge (MOR)	56	Wadi Dagladlé (DJB)	117
Lion Cavern (SWA)	57	Wetherall's Site (KEN)	118
Loyangalani (KEN)	58	White Paintings Shelter (BOT)	119
Lukenya Hill (KEN)	59	Windhoek (NAM)	120
Magosi (UGA)	60	Zourah (MOR)	121
Malewa Gorge (KEN)	61		

intermediate between *H. habilis* and *H. sapiens*. Clarke (1990), after detailed study of the Ndutu cranium and Swartkrans cranium SK847, also usually attributed to *H. erectus*, concurred with Leakey. He considered the verticality of the parietal walls and the upper scale of the occipital as particularly compelling features distinguishing the African fossils from *H. erectus*. Its correct designation is *H. louisleakeyi*, Kretzoy, 1984.³ If *H. louisleakeyi* is a distinct species, questions remain as to which specimens, currently loosely housed within *H. erectus*, might reasonably be included within it, and how they might be distinguished from contemporaneous hominid species.

We would favor retaining the designation *H. rhodesiensis* Woodward, 1921 for Kabwe and related African specimens, although it has been argued that there is no significant anatomical difference between African *H. rhodesiensis* and European specimens attributed to *H. heidelbergensis* (Stringer, 1974; Bräuer, 1984a; Van Vark, 1995; Rightmire, 1998). If the latter position is valid, the name *H. heidelbergensis* Schoetensack, 1908 clearly has priority for some of the Group 1 fossils. However, the Mauer mandible, type specimen of *H. heidelbergensis*, has a retromolar space, suggesting affinities with *H. neanderthalensis* (cf. Rak, 1998). Stringer (1993b, 1996) has also called the status of *H. heidelbergensis* into question and suggests it may be necessary for it to be sunk into *H. neanderthalensis*, because the highly variable Sima de los Huesos sample from Atapuerca, dating to about 300 ka and presumed to represent a

3. Clarke (1990) resurrected the taxon *H. leakeyi* Heberer, 1963, whose holotype is OH9, for this and other African specimens formerly attributed to *H. erectus*. However, Groves (1999) has pointed out that because Heberer (1963) awarded the name *leakeyi* conditionally, it is not available according to the *International Code of Zoological Nomenclature*. Kretzoi's (1984) proposal of *H. (Proanthropus) louisleakeyi* for OH9 is thus the valid designation for it and related fossils.

single population (Arsuaga *et al.*, 1993, 1997a,b; Bischoff *et al.*, 1997), includes specimens that would formerly have been attributed to both *H. neanderthalensis* and *H. heidelbergensis*.

In light of the complexity presented by the European Middle Pleistocene record (Hublin, 1998a; Stringer & Hublin, 1999), there are grounds for retaining *H. rhodesiensis* for Middle Pleistocene hominids not on the Neanderthal lineage.⁴

In Group 2 specimens frontal curvature is greater than in Group 1 fossils. Brow ridge development and angulation of the occiput, among other traits, are less pronounced than in fossils of Group 1, but still fall outside the range of modern human variation. Group 2 includes the Florisbad cranium, type specimen of *H. helmei*, and thus if these fossils represent a species distinct from *H. sapiens* and *H. rhodesiensis*, the name *H. helmei* is the appropriate designation for them. *H. helmei* is a somewhat problematic taxon, as there is as yet no formal diagnosis for the species and its unique autapomorphies are not defined. Like all species (Hennig, 1965; Harrison, 1993), *H. helmei* may be expected to exhibit a mix of primitive and derived features, and the specimens attributed here to *Homo helmei* share characteristics with both *H. sapiens* and Group 1 hominids.

In a curious departure from normal taxonomic practice, Lahr & Foley (1998:

4. A potential complication for Middle Pleistocene nomenclature is presented by the hominid fossils from Gran Dolina, Atapuerca, dating to >780 ka (Pares & Pares-Gonzalez, 1995; Bermúdez de Castro *et al.*, 1997), for whom the investigators have erected the taxon *H. antecessor*. They claim that derived features in the fossils make it likely that they represent a population ancestral to both *H. neanderthalensis* and *H. sapiens*. If the Gran Dolina fossils, like later Sima de los Huesos material, dating to about 300 ka (Arsuaga *et al.*, 1993, 1997a,b; Bischoff *et al.*, 1997), fall on the Neanderthal lineage, they are excluded from modern human ancestry (Rightmire, 1998). If the taxon *H. antecessor* has validity, it is critical clearly to distinguish it from *H. heidelbergensis*, if it is proposed to extend the latter taxon to non-European material. Resolution of these issues requires further detailed study of the fossils themselves and the application of cladistic methods.

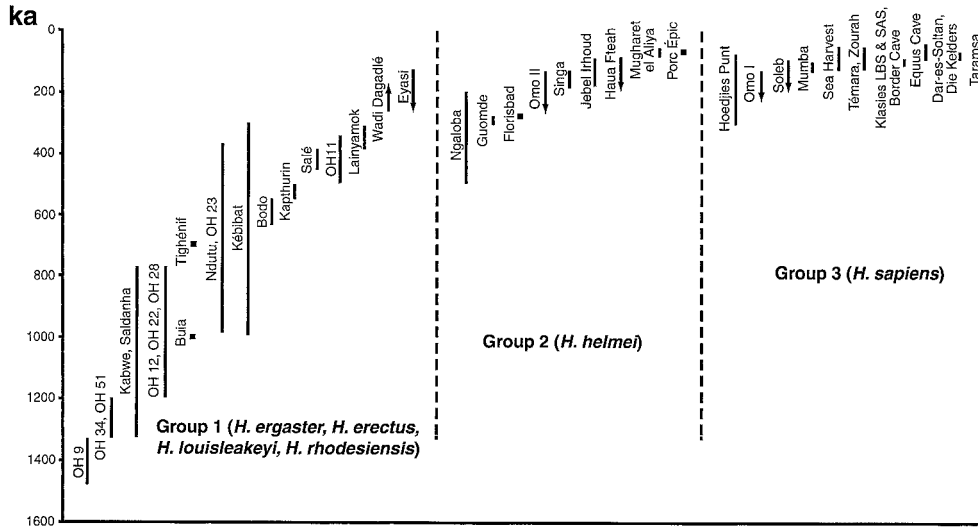


Figure 2. Time ranges of African hominid taxa mentioned in the text. © Sally McBrearty.

157) have included certain European fossils in *H. helmei* on the basis of their ages (isotopic stages 6, 7, and 8) and presumed associated technology (“mode 3”). [Stringer \(1996\)](#), in a consideration of cranial characters, places Asian specimens such as Dali, Maba, Narmada, and Zuttiyeh in this group. These practices are not followed here. Rather, the species is taken to encompass those African fossils described by previous authors (e.g., [Day, 1973](#); [Bräuer, 1984a,b, 1989](#); [Smith, 1985, 1993](#); [Clark, 1988](#); [Klein, 1989b](#); [Stringer, 1993a, 1995, 1996](#)) as “intermediate” in morphology between those of Group 1 and *H. sapiens sensu stricto*. These include Ngaloba (LH 18), Dar-es-Soltan, Guomde, Eliye Springs, and Omo Kibish II, though the latter specimen is currently undergoing reconstruction by [Lahr & Foley](#) (personal communication) and its taxonomic evaluation may change as a result. The Singa specimen is included because, although it shows clear pathology in the cranial vault ([Stringer, 1979](#); [Stringer et al., 1985](#); [Spoor & Stringer, 1998](#)), [Stringer](#) (personal communication) believes that it shows primitive features that exclude it from *H. sapiens sensu stricto*.

Fossils in Group 3 are those of *H. sapiens sensu stricto*, sometimes distinguished by others as the subspecies, *H. sapiens sapiens*. Early African fossils of *H. sapiens* include Klasies River, Border Cave (but see [Sillen & Morris, 1996](#)) and Omo Kibish I. While in some cases retaining a degree of skeletal robusticity, these fossils are essentially like modern people in their morphology (e.g., [Grine & Klein, 1985, 1993](#); [Habgood, 1989](#); [Rightmire & Deacon, 1991](#); [Stringer, 1995, 1996, 1998](#); but see [Schwartz & Tattersall, 2000](#)). Klasies frontal fragment 16425, for example, is modern in the conformation of its supraorbital region, and mandibles 21776 and 41815 have well developed chins and no retromolar spaces ([Klein, 1994](#); [Grine et al., 1998](#); [Rightmire, 1998](#)). The Klasies hominids show a high degree of variation that may represent sexual dimorphism. Some of the smaller Klasies fossils, such as the temporal fragment SAM-AP 6269, fall within or even below the range of modern female San ([Grine et al., 1998](#)).

Current best estimates of age ranges for relevant Pleistocene hominid taxa are presented in [Figure 2](#). It is unlikely that the

known fossils represent the true first and last appearances of these hominid species. Statistical principles suggest that the known age range for any taxon is in part a function of sample size, and it has been empirically demonstrated that expanded sample sizes can affect first and last appearance data for fossil taxa, including hominoids (Hill, 1987; Strauss & Sadler, 1989; Marshall, 1990; Springer, 1990; Flynn *et al.*, 1995). In short, larger samples tend to lengthen fossil taxa's lifespans, and we may expect discoveries of fossils both older and younger than those represented here.

Early dating attempts by ^{14}C and AAR produced results that often were not recognized as infinite. Prior to recent redating efforts, age estimates for many of these specimens were derived from faunal comparisons. Unlike the Pliocene or earlier Pleistocene, there are few good faunal temporal indicators for the Middle Pleistocene, and there was a tendency in previous studies to refer fragmentary specimens to modern species, and thus systematically to inflate the numbers of modern taxa in Middle Pleistocene faunal assemblages. Consequently age estimates for many hominid specimens converged upon 130 ka, the Middle to Late Pleistocene boundary. With the application of refined techniques, the trend in nearly all cases has been for age estimates to be revised downward. It is unclear whether faunal assemblages from this time range contain a higher proportion of undetected archaic taxa, or whether the modern African fauna has a greater antiquity than previously recognized.

The age of the recently discovered Buia cranium is estimated at ca. 1.0 Ma (Abbate *et al.*, 1998). Recent recalibration of the Olduvai Gorge sequence (Kimbel, 1995; Tamrat *et al.*, 1995; Walter *et al.*, 1991; 1992; White, 2000; Delson & Van Couvering, 2000; for other references see Table 1) directly affects the ages of OH9 (formerly ca. 1.2 Ma, now ca. 1.4 Ma)

OH12, OH22, and OH28 (formerly 600–800 ka, now 0.78–1.2 Ma), and OH23 and the Ndutu cranium (now ca. 370–990 ka). Many of the age estimates for other hominids in Group 1 are derived from faunal correlation with Olduvai Beds III and IV. For example, the age of the Saldanha cranium, once thought to perhaps be as young as 130 ka, was revised to ca. 400–700 ka on the basis of comparison of its associated fauna to that in Olduvai Bed IV. The same faunal evidence now may bring Saldanha into the 1.07–1.3 Ma time range (see Table 1 for references). Parallel reasoning can be applied to the Kabwe cranium, the type of *H. rhodesiensis*, as well as other hominids in Group 1. Though these ideas require testing with independent methods, it is interesting to note that humans may be part of an essentially modern fauna that has deeper roots in Africa than has been thus far appreciated.

H. sapiens is present in South Africa at 110–120 ka at Klasies River and before 130 ka in East Africa in the Kibish Formation and at Mumba, Tanzania (for references see Table 1). These are only slightly earlier than early *H. sapiens* in Israel, which date to ca. 80–120 ka at Skhul (Stringer *et al.*, 1989; Mercier *et al.*, 1993; Bar-Yosef, 1998) and to 92–115 ka at Qafzeh (Valladas *et al.*, 1988; Schwarcz *et al.*, 1988; Bar-Yosef, 1998). Dates for *H. helmei* fall between ca. 300 ka for Guomde (Feibel *et al.*, 1989; Bräuer *et al.*, 1997) and ca. 130 ka. The antiquity of this species is supported by the ESR age determination of 260 ka made by direct assay on a hominid tooth associated with the holotype at Florisbad (Grün *et al.*, 1996; Brink & Grün, 1998).

A number of inferences can be drawn from these data. In contrast to the pattern seen in western Europe, eastern Asia, and the Near East, there is a series of closely related taxa that provide plausible ancestors for *H. sapiens*, and the record shows no

abrupt discontinuities. This pattern in itself is suggestive of *in situ* evolution of *H. sapiens* in Africa. The data may represent one of two evolutionary modes: (1) a series of arbitrarily defined chronospecies, or (2) a Middle Pleistocene adaptive radiation within genus *Homo* in Africa. The latter scenario has appeal because, although it would greatly complicate archaeological interpretations, it parallels more closely what is known of earlier evolutionary events within the Hominidae. However, greater chronologic control is needed to evaluate its merits.

Behavior from fossils

The origin of *H. sapiens* cannot be understood without reference to behavior. Behavior can sometimes be established from examination of the fossils themselves. For example, cutmarks on the Bodo skull and the Klasies River sample may indicate cannibalism or ritual behavior (White, 1986, 1987; Deacon & Deacon, 1999). Postcrania are a possible source of information regarding postural and locomotor habits and activity levels, though postcranial remains from African Middle Pleistocene and early later Pleistocene contexts are few in number (see Table 1) and, in most cases, problems of association render taxonomic attribution difficult. Fossil postcrania exhibit both primitive and derived traits (Stringer, 1986; Solan & Day, 1992; Churchill *et al.*, 1996; Pearson & Grine, 1997; Groves, 1998; McBrearty *et al.*, 1999). Features of the proximal ulnae from Klasies River and the Kapthurin Formation led Churchill *et al.* (1996) to suggest a different pattern of forearm loading during flexion than is found in most living representatives of *H. sapiens*.

The gracilization of the upper limb which marks the advent of anatomical modernity (Churchill *et al.*, 1996; Pearson *et al.*, 1998; Pfeiffer, 1998) is a reversal of a previous trend towards robusticity and may suggest a

relaxation of selection for constant mobility and close encounters with prey (Trinkaus, 1983, 1984, 1986, 1987). Fewer serious traumatic injuries are observed on skeletons of early *H. sapiens* than on Neanderthals, indicating either fewer or more successful violent encounters with animals or other humans (Berger & Trinkaus, 1995). The tropical limb proportions of early *H. sapiens* in late glacial Europe suggest not only an extension of the human geographic range out of the tropics, but also the use of cultural rather than physical solutions to the problems of cold temperatures and scarce resources (Trinkaus, 1981; Torrence, 1983; Foley, 1987; Ruff, 1994; Holliday, 1997, 1998, 2000; Pearson, 1997). That these solutions resulted in less nutritional stress among juveniles in early modern human populations is reflected in the lower incidence of Harris' lines and enamel hypoplasias among these populations relative to the Neanderthals (Bermúdez de Castro, 1988; Ogilvie *et al.*, 1989; Brennan, 1991; Trinkaus, 1995), although sample sizes in these studies are small.

Cultural solutions to the challenges imposed by dangerous predators and intermittent food scarcity are implicit in the archaeological record of the MSA in Africa. Projectile technology lessens the inherent risk of hunting dangerous game animals by inflicting "death at a distance" (Berger & Trinkaus, 1995; Cattelain, 1997; but see Bartram, 1997; Hitchcock & Bleed, 1997), and it is quite likely that some MSA points were used as projectiles. Modern foragers combat seasonal scarcity through economic adaptations such as food storage, scheduled resource use, and the intensification of habitat exploitation, either through the use of small scale resources or through modification of the environment. Social adaptations to scarcity may involve the maintenance of long-distance reciprocal exchange relationships, or the long-term retention of individual and group memories

of distant resources or survival strategies, often aided by the use of symbol and ritual (de Garine & Harrison, 1988). We argue that most, if not all, of these behaviors were practised in the MSA.

Three African Middle Pleistocene hominid fossil crania show signs of pathology that are relevant to behavioral reconstruction. The Kabwe skull displays extensive dental caries as well as lesions to both the squamous and petrous portions of the left temporal bone and to the left mastoid process. Although Yearsley (1928) had proposed acute mastoiditis as the cause of the lesions to the mastoid and the petrous temporal, examination by Montgomery *et al.* (1994) shows these to be the result of post-mortem trauma. However, the same study describes the everted edges of the squamous temporal lesion, indicating that it is a partially healed pre-mortem or perimortem injury. While these authors attribute the lesion to a cyst or benign tumor, the suggestion of Wells (1964) that it represents an abscess resulting from the dental caries cannot be ruled out.

The Singa calvaria exhibits a pronounced thickening of the diploic layer of the temporals (Stringer *et al.*, 1985), as well as complete ossification of the bony labyrinth of the petrous portion of the right temporal (Sporer & Stringer, 1998). These features are consistent with either infection or anemia. Total ossification requires at least one year to complete, and would have resulted in complete deafness in the right ear. The initial bout of disease, lasting from a few days to a few months, would have been accompanied by vertigo, postural imbalance, and possible paralysis (Sporer & Stringer, 1998). The Salé calvaria shows deformation to the nuchal area that resulted from weakened and asymmetrically developed nuchal musculature. The condition suggests *in utero* deformity or perinatal trauma and probably resulted in reduced mobility of the head and marked asym-

metries of the face and mandible, which are not preserved in this specimen (Hublin, 1994). It is feasible that the survival of these three individuals required intervention by other members of the group, particularly in the case of Salé, which demonstrates the survival of a handicapped infant into adulthood.

Archaeology, behavior and hominid taxonomy

How do the hominids of Groups 1, 2, and 3 differ in their adaptations and other aspects of their behavior, and are these differences adequate to distinguish them at the species level? In both neotology and paleontology, behavior is considered part of what separates a species from closely related forms (Dobzhansky, 1937; Mayr, 1963). It is a significant component in determining a species' adaptation, geographic range, and mate recognition system, all of which contribute to the maintenance of species boundaries (Wiens, 1977; Paterson, 1985; Tattersall, 1986; Foley & Lee, 1989; Foley, 1991a, 1994). Darwin (1859: 76) and his successors (e.g., Dobzhansky, 1937; Mayr, 1963) have generally argued that closely related species experience the greatest competition for resources, and can only coexist if they use the environment differently. In the study of human evolution, species definitions have often been underlain, overtly or covertly, by supposed behavioral distinctions, as in the case of *H. habilis* (Leakey *et al.*, 1964; Tobias, 1991).

Archaeological remains are a good source of evidence for past behavior, and may help to clarify the nature of later Middle Pleistocene speciation events themselves. The most conspicuous behavioral event in the late Middle Pleistocene archaeological record of Africa is the disappearance of the Acheulian industry before 200 ka, and its replacement by diverse MSA traditions. Thus, it is to the late Acheulian and early

Table 2 Summary of hominids and their archaeological associations

GROUP 1=ESA (<i>H. louisleakeyi</i> , <i>H. rhodesiensis</i>)	GROUP 2=MSA (<i>H. helmei</i> or <i>H. sapiens</i>)	GROUP 3=MSA (<i>H. sapiens</i>)
Ain Maarouf (Ach)	Florisbad (?)	Border Cave
Bodo (Ach/Old)	Haua Fteah	Dar-es-Soltan
Cave of Hearths (Ach)	Jebel Irhoud	Die Kelders
Eyasi (Sang)	Mugharet el Aliya (?)	Equus Cave
Kabwe (?Sang/MSA?)	Ngaloba	Hoedjies Punt
Melka Konturé (Ach)	Omo II (?)	Klasies River
Ndutu (Ach)	Porc Epic (?)	Mumba
OH 9 (Ach/Old)	Singa (?)	Mumbwa (?)
OH 23 (Ach)		Omo 1 (?)
OH 28 (Ach)		Sea Harvest
OH 34 (Ach)		Soleb
Saldanha (Ach)		Témara
Sidi Abderrahman (Ach)		Taramsa
Tighénif (Ach)		Zouhrah

Question marks indicate that associations are problematic.

MSA that we should look to understand the circumstances surrounding the origin of *H. sapiens*. This obvious fact is consistently overlooked because Europe's earliest modern human inhabitants, about 150,000 years later, were makers of Upper Paleolithic technology. Thus the origin of *H. sapiens* has been conflated with the origin of the Upper Paleolithic. The Acheulian contains large bifaces, while most MSA industries are characterized by smaller flake tools, sometimes made on flakes struck from prepared cores, a technology often referred to as Mode 3 (Clark, 1977).⁵ The abandonment of handaxes and cleavers for smaller flake tools represents the replacement of hand-held by hafted implements and signals a profound technological reorganization.

To what extent can behavioral data help to resolve the issue of whether these species

5. Mode 3 technology alone, however, cannot be equated with the MSA (contra Foley & Lahr, 1997; Lahr & Foley, 1998) for a number of reasons: (1) Prepared core technology first makes its appearance in the Acheulian (ESA); (2) many MSA assemblages lack prepared cores; (3) in South, East, and Northeast Africa, many MSA industries are blade-based (Mode 4 technology); and (4) several MSA industries are now known to contain backed geometrics (Mode 5 technology).

are sound taxonomic categories? How consistent are the archaeological associations of each group and how great are the behavioral or ecological differences among them? The correlations between archaeological industries and hominid taxa in Middle Pleistocene and early Late Pleistocene Africa are summarized in Table 2.

While hominids cannot necessarily be assumed to be the makers of the artefacts with which they are found, the associations are striking in their consistency. Fossils of Group 1 in all cases are associated with Oldowan, Acheulian or Sangoan artefacts (here considered ESA technology), while both *H. helmei* and early members of *H. sapiens* are associated with MSA technology. Thus, it appears that the major adaptive shift represented by the Acheulian-MSA boundary ca. 250–300 ka corresponds with a speciation event. In contrast, there is no evidence for hominid morphological change during the MSA–LSA transition, which is the product of culture change. Overlying the Acheulian and underlying the MSA at some sites is a heavy-duty industrial variant called the Sangoan (McBrearty, 1987, 1988, 1991; Cornelissen, 1995). The

associations of the Sangoan artefacts suggest that this industry may best be regarded as part of the behavioral repertoire of the hominids in Group 1.

The coincidence of a major archaeological change with the origin of *H. helmei* suggests that this species possessed enhanced cognitive abilities when compared with the hominids in Group 1. *H. helmei* may be indistinguishable behaviorally from *H. sapiens*, suggesting a close phylogenetic relationship. Lahr (1996) and Stringer (1996, 1998) have suggested including some or all of the fossils in Group 2 in *H. sapiens*. We would argue that taxonomy should be done on the basis of fossil, not archaeological evidence. Nonetheless, the archaeological data do lend plausibility to this suggestion. Should further study of the fossils ultimately support inclusion of specimens here ascribed to *H. helmei* in *H. sapiens*, there may be grounds for sinking the taxon *H. helmei*. *H. sapiens* and MSA technology would then be seen to appear simultaneously in the record between 250 ka and 300 ka.

It is clear that the features diagnostic of physical modernity emerge in conjunction with MSA technologies. In this paper we present evidence to support the presence of modern human behaviors in subsaharan Africa at remote times far predating any such traces outside Africa. We contend that the appearance of modern behaviors accompanied or even preceded the appearance of *H. sapiens* during the African MSA, suggesting that the behaviors may perhaps have driven the anatomical changes seen in the fossils. We also suggest that these behaviors developed gradually over a substantial period of time and sporadically in different parts of the continent.

The origin of language?

In much of the recent literature, the "human revolution" is synonymous with the origin of

"fully syntactical" language (e.g., Mellars, 1991; Noble & Davidson, 1991, 1996; Klein, 1992, 1995; Mithen, 1994, 1996). Abstract and symbolic behaviors imply language, but it is doubtful that the point at which they can first be detected coincides with the birth of language. Attempts to identify the earliest signs of language, whether from study of the brain (e.g., Falk, 1980, 1990; Holloway, 1983, 1985; Deacon, 1997), the speech apparatus (e.g., Falk, 1975; Lieberman, 1975, 1984; Arensburg *et al.*, 1990; Lieberman *et al.*, 1992; Kay *et al.*, 1998), stone tools (e.g., Wynn, 1979; Dibble, 1989; Toth & Schick, 1993), or primate communication (e.g., Cheney & Seyfarth, 1990; Savage-Rumbaugh & Rumbaugh, 1993), contribute to a sense of continuity, rather than discontinuity, between human and nonhuman primate cognitive and communicative abilities (e.g., Parker & Gibson, 1979; papers in Parker & Gibson, 1990; Gibson, 1993; Gibson & Ingold, 1993; Mellars & Gibson, 1996). Language does not fossilize, and technology provides insight only into the minimum cognitive abilities of its makers and users (Wobst, 1983; Wynn, 1985; Goren-Inbar, 1988). We infer that some form of language originated early in human evolution, and that language existed in a variety of forms throughout its long evolution, but we concur with those who have pointed out the inherent untestability of many propositions regarding the origin of language, and the profound silence of the archaeological record on this issue (Dibble, 1989; Foley, 1991*b*; Graves-Brown, 1994).

Geographic limits

In this paper, discussion is limited to the archaeological record of Africa, in order to provide the clearest contrast between Africa and Europe. We do not attempt systematically to integrate the evidence from the Levant, which is increasingly seen as a

contact zone between the Eurasian fauna, including *H. neanderthalensis*, and the African fauna, including *H. sapiens* (Jacobs, 1985; Bar-Yosef, 1987, 1995b, 1998; Valladas *et al.*, 1988; Tchernov, 1988, 1998; Grün *et al.*, 1991; Holliday & Trinkaus, 1991; Ruff, 1994; Bar-Yosef *et al.*, 1996; Mellars, 1996, 1998a,c; Stringer, 1998; Howell, 1998; Hublin, 1998b). The presence of both Neanderthals and *H. sapiens* in the Levant presents a challenge for behavioral interpretation, though some interesting reconstructions have been proposed (Lieberman, 1993, 1998a; Lieberman & Shea, 1994). In fact, we hope that the systematic contrast between the European and African records that we provide here may ultimately help to clarify the picture in the southwest Asian contact zone.

The number of well-documented late African Middle Pleistocene or early Late Pleistocene sites is not large (Figure 1). Africa is vast, researchers are few, and research history is short. Mehlman (1989) points out the contrast between East Africa, with an area of 1.6 million km² and fewer than ten excavated sites, and southwestern France, with an area of only 21,000 km² and more than 100 such sites. West Africa is particularly poorly represented in the record. A further factor in our skewed perception is the reliance in the literature upon a small number of excavated caves on the coasts of North and especially South Africa (McBurney, 1967; Singer & Wymer, 1982; Volman, 1984; Deacon & Geleijnse, 1988; Klein, 1989a, 1994, 1998; Thackeray, 1992). While caves may provide the best conditions for preservation, the vast majority of African occupation sites are in open air contexts. We privilege here the less well known but critically important excavated archaeological samples from the African tropical and subtropical regions at the heart of the continent, rather than those from its northernmost and southernmost fringes. The tropics encompass a larger area, were more

continuously occupied, and have climatic regimes more typical of Africa as a whole. Further, the use of terminology derived from Europe in much of the literature treating the Sahara and the Mediterranean littoral obscures the uniqueness of the MSA in these regions (Kleindienst, 2000b).

Middle Paleolithic or Middle Stone Age?

Some authors (e.g., Klein, 1989b, 1995, 1998) have argued that the Middle Stone Age of Africa is just like the Middle Paleolithic of Eurasia, a long and monotonous period of flake tools and stagnation, followed by a rapid revolutionary change to technological sophistication and economic and social complexity. Klein (1989b: 292, 1994: 496) argues that the use of a separate terminology for Africa is a result of historic precedent, is unfounded in the light of current research, and should be dropped. This view ignores descriptions of the African MSA published just 30 years ago that stressed its similarities to the European Upper Paleolithic when the two were considered contemporary (e.g., Clark, 1970). We argue that a separate terminology is required for Africa, and that the distinction between “Middle Paleolithic” and “Middle Stone Age” is more than semantic. As we will show here, this is due in part to the presence in Africa at an early date of elements traditionally associated with *H. sapiens* in the European Upper Paleolithic.

Chronology

The most serious impediment to interpretation of the Middle Pleistocene record has been the lack of a sound chronological framework. Despite improvements in sample preparation techniques and increased selectivity about the material dated, ¹⁴C dates, even using accelerator

mass spectrometry (AMS) become unreliable between six to seven half-lives (by ca. 40 ka at best), due to instrumental limitations or to the inevitable contamination by modern carbon (Gowlett & Hedges, 1986; Wintle, 1996; Ambrose, 1997; Chappell *et al.*, 1998). Further, fluctuations in the earth's geomagnetic field during the most recent glacial period and resulting variations in cosmic nuclide production may render ^{14}C dates in the 40 ka range several thousand years too young (Mazaud *et al.*, 1991; Taylor, 1996; Jöris & Weninger, 1998; Schlüchter, 1998; see Ambrose, 1998a for a useful review).

The conventional K/Ar technique cannot reliably be employed for material younger than about 500 ka or perhaps 250 ka (Curtis, 1966). The Argon/Argon ($^{40}\text{Ar}/^{39}\text{Ar}$) technique is both accurate and precise when applied to younger volcanics (McDougall, 1981; Deino & Potts, 1990; Hu *et al.*, 1994; Renne *et al.*, 1997), though suitable volcanic deposits associated with MSA assemblages are uncommon, even in the Rift Valley. With rare exceptions (e.g., Wilson & Hey, 1981; Champion *et al.*, 1988; Tamrat *et al.*, 1995), paleomagnetism is not useful for the long period of normal polarity since 780 ka. Some of the methods employed for this time period, such as electron spin resonance (ESR), thermoluminescence (TL), optically stimulated luminescence (OSL), infrared stimulated luminescence (IRSL), U-series enhanced by thermal ionization mass spectrometry (TIMS), and amino acid racemization (AAR) are prone to error under the varying conditions encountered in archaeological contexts. Successful application requires accurate reconstruction of sedimentary and diagenetic processes, ground water action, and temperature history (Hare, 1980; Grün & Stringer, 1991; Schwarcz, 1992; Miller *et al.*, 1993, 1997; Schwarcz & Grün, 1993a; Feathers, 1996; Wintle, 1996; Schwarcz, 1998; Schwarcz & Rink, 1998). Concordant

results from multiple techniques based upon independent theoretical assumptions increase confidence. In nearly all cases, new age determinations have increased rather than reduced previous age estimates.

Earliest MSA

On purely stratigraphic grounds, the MSA has long been known to postdate the Acheulian and predate the LSA, although temporal overlap among industries at both ends of the MSA timespan is likely. The high degree of variability in Middle Pleistocene industries makes it difficult to identify the earliest MSA, and perhaps lends support to the idea of multiple contemporary hominid lineages (McBrearty *et al.*, 1996; McBrearty, 2000).

Late Acheulian and early MSA dates cluster between 200 ka and 300 ka, and the Acheulian seems to have disappeared in most of Africa by about 200 ka. The Acheulian at Isimila, Tanzania has been dated by U-series to ca. 260 ka (Howell *et al.*, 1972). Acheulian occurrences in the Kapthurin Formation, Kenya, underlie volcanics dated by K/Ar to ca. 240 ka (Leakey *et al.*, 1969; Tallon, 1976, 1978; McBrearty *et al.*, 1996), but now estimated by $^{40}\text{Ar}/^{39}\text{Ar}$ at ca. 280 ka (Deino & McBrearty, under review). The Acheulian in the western desert of Egypt is also thought to end at either about 200 ka (McHugh *et al.*, 1988) or perhaps as much as 350 ka (Wendorf & Schild, 1992). A U-series date of ca. 174 ka on a late Acheulian occurrence at Rooildam, South Africa (Szabo & Butzer, 1979) seems somewhat anomalous in this context.

Dates for the earliest MSA in East Africa converge on the interval 240–280 ka. Very early K/Ar dates were reported by Evernden & Curtis (1965) for East African MSA sites when the method was still in its infancy. Dates of >440 ka and <557 ka for “pseudo-Still Bay” occurrences at Cartwright's and

Wetherill's sites on the Kinangop Plateau, Kenya, may be accurate, but the stratigraphic relationship of the dated tuffs to the occupation horizons is less secure (Curtis, personal communication; personal observation). A date of 240 ka was reported in the same paper for a crystal rich pumiceous lapilli tuff overlying "Kenya Still Bay" artefacts at Malewa Gorge in the central Kenya Rift Valley. A K/Ar date of 180 ka for the Ethiopian site of Gademotta, cited for many years as the earliest for the MSA (Wendorf *et al.*, 1975), has been revised to 235 ± 5 ka (Wendorf *et al.*, 1994). The earliest MSA in the Kapthurin Formation, Kenya, appears to predate volcanics dated by $^{40}\text{Ar}/^{39}\text{Ar}$ to ~ 280 ka (McBrearty, 1999; Deino & McBrearty, under review). U-series dates on speleothem support an antiquity for the early MSA at Twin Rivers, Zambia, of 230 ka or older (Barham & Smart, 1996). U-series and AAR dates from Mumba Rock Shelter, Tanzania (Mehlman, 1987, 1989) indicate an age for the base of the MSA sequence there of ca. 130 ka, and obsidian hydration indicates an age of ca. 120–50 ka for the MSA at Prospect Farm, Kenya (Michels *et al.*, 1983).

In North Africa, a series of 160 dates using a variety of methods (OSL, AAR, ESR, TL, U-series) indicates that the MSA at the sites of Bir Tarfawi and Bir Sahara East in southwestern Egypt begins ca. 230 ka (Miller *et al.*, 1991; Wendorf & Schild, 1992; Bluszcz, 1993; Miller, 1993; Schwarcz & Grün, 1993b). U-series dates indicate that the Aterian at Dakleh oasis in the western desert of Egypt predates 90 ka, and may be as old as 160 ka (Kleindienst & Wiseman, 1996; Kleindienst *et al.*, 1996; Kleindienst, 2000b). The Aterian of the Mediterranean littoral and the Maghreb may be a bit younger; TL and OSL dates on sands containing *in situ* Aterian artefacts at the sites of Uan Afuda and Uan Tabu, Libya, indicate an age for the industry there of 90 ka to 60 ka (Martini *et al.*, 1996;

Cremaschi *et al.*, 1998), but, as in Egypt, the Aterian is preceded in the Maghreb by an unspecialized MSA industry of far greater antiquity (Hublin, 1993; Debénath, 1994; Kleindienst, 2000b). Some investigators place the end of the Aterian at 20 ka, on the basis of ^{14}C on lacustrine carbonate (Wengler & Vernet, 1992; Wengler, 1997; Kleindienst, 2000b), but this method has proved unreliable in other contexts, and these dates should probably be treated as infinite. The main body of Aterian sites thus predates the aridification of the Sahara during the last glacial maximum that begins at ca. 40 ka (Wendorf & Schild, 1993; Wendorf *et al.*, 1993a; Close, 1984; Cremaschi *et al.*, 1998).

In the interior of South Africa, sites where MSA assemblages overlie Acheulian remains, such as Cave of Hearths (Mason, 1962), are undated. The oldest dates for the MSA in South Africa are ESR determinations from the sequence at Florisbad (Grün *et al.*, 1996). An undiagnostic MSA assemblage from the basal deposits at Florisbad (Units N, O, and P), is estimated at ca. 280 ka. Units higher in the section containing *in situ* MSA artefacts date to ca. 160 (Units M–G) and 120 ka (Unit F) (Kuman & Clarke, 1986; Kuman *et al.*, 2000). At Border Cave TL and AAR dates for strata 4WA and 5BS are at least 100 ka (Grün *et al.*, 1990; Miller *et al.*, 1993). The underlying strata 5WA and 6BS may be considerably older (Grün *et al.*, 1990), perhaps as much as 195 ka (Butzer *et al.*, 1978).

At coastal South African sites evidence for MSA habitation prior to the last interglacial is lacking. Middle Pleistocene deposits may have been scoured out of coastal caves during marine high stands preceding stage 5, and countless early sites may lie on the now inundated offshore coastal platform. At Klasies River features of the geomorphology and microfauna, the oxygen isotope content of marine shell, ESR dates on fossil mammalian teeth, and U-series dates on

speleothem indicate an age for the earliest MSA levels (MSA I) of >110 ka, perhaps 130 ka (Deacon, 1988, 1989, 1993b; Deacon & Geleijnse, 1988; Deacon & Shurman, 1992; Schwarcz & Grün, 1993a; Thackeray, 1992), although South African MSA technology no doubt has its beginnings substantially earlier (Volman, 1984). Probably the most convincing evidence for the antiquity of the MSA at Klasies is provided by Shackleton (1982) who notes that the last time the ocean was isotopically as light as the shells from the MSA I levels was during the last interglacial (stage 5e) dating to 118 ka. Further support is provided by sands in the lowermost sedimentary unit that were derived from a nearby beach, and sea levels have not been high enough to provide the source material since that time (Hendey & Volman, 1986; Deacon & Geleijnse, 1988; Deacon & Shurman, 1992).

Earliest LSA

Dating the end of the MSA and the beginning of the LSA is also somewhat problematic. First, in much of tropical Africa the MSA–LSA transition lies at or beyond the limits of the radiocarbon method, and ^{14}C dates reported in the 1970s for the earliest LSA (e.g., Beaumont & Vogel, 1972a,b) should be regarded as infinite (Ambrose, 1997, 1998a). In East and Central Africa the record for the LSA begins well before 40 ka at sites such as Enkapune ya Muto, Kenya (Ambrose, 1998a) and at Mumba Rock Shelter and in the Naisusu Beds, Tanzania, (Kokis, 1988; Mehlman, 1989; Manega, 1993). Second, there is considerable disagreement over which criteria define the earliest LSA. The presence of microliths, bladelets, microblade cores, and backed geometric forms, or the absence of points or other typical MSA elements are variously used as criteria in assigning assemblages to the LSA. This leads to inevitable

problems. For example, van Noten (1977) has referred the industry from Matupi Cave, D.R. Congo, to the LSA, based on the presence of microlithic debitage. He gives an age estimate of ca. 50 ka for this assemblage, based on extrapolation from ^{14}C dates higher in the sequence. But because classic microblade cores and backed elements are lacking, the attribution of the industry to the LSA has been questioned. On the other hand, at sites such as Rose Cottage Cave (Kohary, 1989), Sehonghong, and Strathalan, South Africa, the earliest bladelet levels, dated by ^{14}C to ca. 26 ka, are referred to a final or “microlithic” MSA by Wadley (1991, 1993, 1995, 1997; cf. Mitchell, 1994), due to the presence of foliate points, typical of the MSA, that are found in association with the bladelets and microblade cores, though circumstances of recovery at Sehonghong may make questions of association problematic.

The Howiesons Poort is no longer seen as a transitional industry between the MSA and the LSA, and the concept of a “Second Intermediate” was abandoned along with the Magosian industry. Yet controlled excavation at stratified sites with fairly continuous sequences has documented industries containing both LSA and MSA elements that overlie industries which are unquestionably MSA and underlie those which fall clearly in the LSA. The undated MSA 1 level at Sodmein Cave, on the Red Sea coast of Egypt, as described by van Peer *et al.* (1996) contains blades and other elements indicating that it may be a transitional industry. The Mumba Industry, a late MSA entity containing backed geometrics, typical of the LSA, has been described from Bed V at Mumba Rock Shelter, Tanzania, by Mehlman (1979, 1987, 1989). At Mumba, backed elements increase in frequency through the section, as mean artefact size declines. U-series dates on bone

from middle Bed V indicate an antiquity of ca. 65 ka, and this age is confirmed by AAR dates on ostrich eggshell ranging from 45–65 ka from the upper part of the same unit (Kokis, 1988; Brooks *et al.*, 1993b). Similar “transitional” industries are known from Botswana, Zimbabwe, and South Africa, and their presence confirms the lack of abrupt discontinuities in the African prehistoric record.

At White Paintings Shelter, Botswana, an MSA–LSA transitional unit with a bone point, bladelets, and a large backed crescent, but without the MSA points found in the underlying units, is dated by several techniques to 50–38 ka (Robbins *et al.*, 1994, under review; Kokis *et al.*, 1998). A similar industry is known from ≠Gi, Botswana (Brooks & Yellen, 1987; Brooks *et al.*, 1990). In Zimbabwe, the MSA–LSA transition appears to be particularly long and complex, with some sites containing MSA points as late as 13 ka (Walker, 1990, 1991, 1995; Larsson, 1996). At Nswatugi, Zimbabwe, large backed crescents in the uppermost MSA with an infinite radiocarbon date (>42 ka) may represent the earliest phase of the post-MSA or late MSA Tshangula industry (Cooke, 1966, 1969) or perhaps an MSA industry related either to the Howiesons Poort (Walker, 1995) or to the Mumba industry (Mehlman, 1979, 1989).

In South Africa, with one of the best-documented records of Late Pleistocene human occupation on the continent, three different scenarios have been described. One is a major hiatus at many sites between the final MSA, predating 60 ka, and the earliest LSA, at or after 20 ka (Brooks & Robertshaw, 1990; Mitchell, 1990; Parkington, 1990; Walker, 1990). A second, as at Border Cave, is the appearance of an early LSA (ELSA) by 38 ka, based on ¹⁴C and AAR dates on ostrich eggshell (e.g., Beaumont, 1973b; Beaumont *et al.*, 1978; Miller *et al.*, 1993), with no apparent occupational hiatus.⁶ A third is a

late appearance of the LSA at about 20 ka at sites such as Rose Cottage Cave, Sehonghong and Strathalan (Wadley & Harper, 1989; Opperman & Heydenrych, 1990; Wadley & Vogel, 1991; Wadley, 1993, 1997). It is unclear whether this discrepancy is due to problems with the radiocarbon dating or with the definition of the LSA, or whether it reflects a real persistence of the MSA until very late at the southern tip of the continent.

Archaeological signals for Modern Behavior

The European Upper Paleolithic, because it is known to be the product of *H. sapiens*, is often used as a standard for modern human behavior, which is contrasted with the European Middle Paleolithic produced by the Neanderthals (e.g., White, 1982; Clark & Lindly, 1989, 1991; Hayden, 1993; Klein, 1995; Mellars, 1995). The literature converges upon a number of common ingredients thought to characterize modern human behavior:

- Increasing artefact diversity.
- Standardization of artefact types.
- Blade technology.
- Worked bone and other organic materials.
- Personal ornaments and “art” or images.
- Structured living spaces.
- Ritual.
- Economic intensification, reflected in the exploitation of aquatic or other resources that require specialized technology.
- Enlarged geographic range.
- Expanded exchange networks.

6. Problematic ESR dates of ca. 28–31 ka for this industry at Border Cave (Grün *et al.*, 1990; Schwarcz & Grün, 1993a) are 30% younger than ¹⁴C ages for the same units and may reflect systematic error in estimating the annual dose rate (Miller *et al.*, 1993). A similar problem may exist for the uppermost MSA levels at Klasies River, dated by ESR to 40 ka (Grün *et al.*, 1990), but by ¹⁴C to >50 ka (Deacon, 1993b) and by AAR to 60 ka (Brooks *et al.*, 1993b).

Table 3 Archaeological signatures of modern human behavior**Ecology**

Range extension to previously unoccupied regions
(tropical lowland forest, islands, the far north in Europe and Asia)
Increased diet breadth

Technology

New lithic technologies: blades, microblades, backing
Standardization within formal tool categories
Hafting and composite tools
Tools in novel materials, e.g., bone, antler
Special purpose tools, e.g., projectiles, geometrics
Increased numbers of tool categories
Geographic variation in formal categories
Temporal variation in formal categories
Greater control of fire

Economy and social organization

Long-distance procurement and exchange of raw materials
Curation of exotic raw materials
Specialized hunting of large, dangerous animals
Scheduling and seasonality in resource exploitation
Site reoccupation
Intensification of resource extraction, especially aquatic and vegetable resources
Long-distance exchange networks
Group and individual self-identification through artefact style
Structured use of domestic space

Symbolic behavior

Regional artefact styles
Self adornment, e.g., beads and ornaments
Use of pigment
Notched and incised objects (bone, egg shell, ocher, stone)
Image and representation
Burials with grave goods, ocher, ritual objects

At first glance, this inventory is reminiscent of the sort of trait list that [Childe \(1928, 1950\)](#) and others once used to define civilization. However, they reveal assumptions about underlying hominid capabilities. We would argue that modern human behavior is characterized by:

- Abstract thinking, the ability to act with reference to abstract concepts not limited in time or space.
- Planning depth, the ability to formulate strategies based on past experience and to act upon them in a group context.
- Behavioral, economic and technological innovativeness.
- Symbolic behavior, the ability to represent objects, people, and abstract con-

cepts with arbitrary symbols, vocal or visual, and to reify such symbols in cultural practice.

Tangible traces of these early behavioral shifts toward modernity can be seen in the African archaeological record, and can be tied explicitly to hominid cognitive and cultural capabilities. These are set out in [Table 3](#).

- **Ecological** aspects of the record reflect human abilities to colonize new environments, which require both innovation and planning depth.
- **Technological** features reveal human inventiveness and capacity for logical thinking.

- **Economic & Social** features show human abilities to draw models from individual and group experience, to develop and apply systematic plans, to conceptualize and predict the future, and to construct formalized relationships among individuals and groups.
- **Symbolic** features demonstrate a capacity to imbue aspects of experience with meaning, to communicate abstract concepts, and to manipulate symbols as a part of everyday life.

Ecology

Increased geographic range

Expansion of human populations into challenging habitats by means of improved technology is seen as a sign of cognitive sophistication and social complexity (Torrence, 1983; Klein, 1989*b*; Davidson & Noble, 1992; Jones, 1992; Soffer, 1994; O'Connell & Allen, 1998). This trend is seen in the African MSA. MSA sites in Africa are more numerous than those of the Acheulian (Figure 1), which may simply reflect preservational bias and an increase in population size. However, the fact that they are found in virtually every corner of the continent argues against population expansion as the single explanatory factor. This extension into previously uninhabited zones is thought by Clark (1964, 1965, 1970, 1972, 1981, 1982, 1988, 1993) to illustrate the improved adaptive abilities of MSA hominids over those of their Acheulian predecessors. The geographic distribution of MSA sites does indicate human adaptations to a wide range of challenging habitats. Two of these, desert and forest, merit special consideration.

Sparse Acheulian sites indicate sporadic occupation of what is now the Sahara, Namib, Karoo, and Kalahari deserts, but our understanding of the significance of most of these is tempered by three factors: (1) good data for the interior of the Sahara is

lacking; (2) the ready visibility of Acheulian bifaces tends to inflate the numbers of Acheulian sites relative to those of other periods; and (3) the environmental conditions in these regions at the time of occupation are unknown. The few known dates suggest that these occupations date to the late Middle Pleistocene (Miller *et al.*, 1991; Miller, 1993). Associated lake and spring deposits indicate a much wetter habitat than at present (Wendorf *et al.*, 1993*a,b*; Churcher *et al.*, 1999; Nicoll *et al.*, 1999). Sites of the MSA Aterian industry do indicate widespread habitation of the Sahara between ca. 90 ka and ca. 40 ka. Aterian sites are found in habitats varying from marine to mountain to semiarid desert, and occupation was not confined to humid periods (Marks, 1975; Williams, 1976; Clark, 1980; Debénath, 1994; Kleindienst, 2000*b*). For South Africa, Deacon (1989) observes that MSA occupations, in contrast to those of the Acheulian, are not restricted to sites near water sources. He suggests the use of water containers in the MSA and a perception of the environment indistinguishable from that of people of later periods.

Human life in a tropical rainforest environment, with its dispersed fauna, and fruit and root resources that are often inaccessible and toxic, requires complex technology. No modern human groups are known to subsist in the forest solely by foraging without a source of domesticated carbohydrates, and this adaptation has been held to have been impossible for prehistoric groups (Bailey *et al.*, 1989). Others, however, argue that it is feasible, particularly if fish are incorporated into the diet (Gragson, 1992). Evidence for early occupation of tropical forest environments is equivocal. Acheulian sites are very rare for the Congo Basin. Clark (1964, 1965, 1970, 1975, 1981) has suggested that the technology of the Sangoan industry provided the equipment necessary for a forest adaptation.

However, Sangoan artefacts are found in regions far outside the Congo Basin, such as at Isimila, Tanzania (Howell *et al.*, 1962, 1972), and perhaps in the Kapthurin Formation, Kenya (McBrearty *et al.*, 1996; Cornelissen, 1995), where they are clearly not elements of forest extractive technology. Other sites occur in regions of tropical Africa that are now forested, but where evidence indicates arid or semiarid conditions at the time of occupation, probably during cold isotope stage 6 (195 ka–130 ka) (McBrearty, 1987, 1993a,b; Clark, 1988).

The MSA is represented in the greater Congo Basin by the Lupemban industry, characterized by beautifully made lanceolate points. However, there are few excavated Lupemban sites (Cahen, 1978; McBrearty, 1986, 1988), and virtually no dates or paleoenvironmental data for this industry. Many Lupemban sites formerly regarded as in good context have been found to be profoundly bioturbated (Cahen, 1976). LSA sites in the Congo Basin are reported by Fiedler & Preuss (1985). Mercader *et al.* (2000c) document a sequence of LSA occupations in the Ituri forest in association with paleobotanical indicators of forest conditions dating back to the last glacial maximum, showing that use of the forest by hunter gatherer groups has great antiquity. Mercader & Marti (1999a,b, 2000; Mercader *et al.*, 2000a,b) document two probable MSA sites in West Africa that suggest occupation of the tropical forest. Njuinye, Cameroon, and Mosumu, Equatorial Guinea are dated by AMS ¹⁴C radiocarbon to >30 ka and >34 ka, respectively (Mercader & Marti, 2000; Mercader, personal communication). Direct paleoenvironmental evidence is lacking at the sites themselves, but pollen records and plant macrofossils are preserved at nearby paleobotanical sampling localities with a comparable time depth. These show that while temperatures were no doubt cooler in this region of West Africa during the last glacial maximum,

rainfall remained adequate to support tropical forest species, even in areas now occupied by savanna vegetation (Mercader & Marti, 2000).

Technology

Blades

The earliest true Upper Paleolithic industry, the Aurignacian, appears in Europe at approximately the same time as the first traces of *H. sapiens* ca. 40–45 ka (White, 1982, 1989a, 1992; Bischoff *et al.*, 1989; Cabrera Valdes & Bischoff, 1989; Klein, 1989a; Mellars, 1989a, 1993, 1996, 1998b,c; Otte, 1990; Bischoff *et al.*, 1994; Straus, 1994; Bar-Yosef, 1998). Though some would argue for continuity in lithic industries across the European Middle to Upper Paleolithic boundary (e.g., Otte, 1990; Clark & Lindly, 1989; Straus, 1983, 1994, 1995; d'Errico *et al.*, 1998), it seems increasingly likely that Upper Paleolithic technology was introduced into Europe by *H. sapiens* migrants (Mellars, 1999). In some cases, aspects of Upper Paleolithic technology were adopted by the Neanderthal residents (Demars & Hublin, 1989; Mellars, 1989b, 1998a,b; Farizy, 1990; Ruiz & Hublin, 1994).

European Upper Paleolithic technology is dominated by blades, and thus blade production has been considered a key ingredient of the “human revolution” (e.g., Mellars & Stringer, 1989). At the simplest level, blades are simply flakes with a breadth:length ratio ≤ 0.5 . Although some (e.g., Wurz, 1999) distinguish between blades and flake-blades, this practice is not followed here. Long narrow flakes will be produced fortuitously in the course of almost any kind of flake production, but the repeated, consistent production of blades requires a deliberate series of technological steps. Elongated Levallois cores struck repeatedly from either end can yield blades which are indistinguishable from those

produced on the cylindrical or pyramidal cores more typical of the European Upper Paleolithic. Blades are a more efficient use of lithic raw material than either core or flake tools, as they represent a greater length of cutting edge per unit volume of stone. Blades also functioned as blanks with standardized proportions that were used as the basis of composite tools in many late prehistoric industries. Blade production, whether by direct or indirect percussion, requires the cognitive skills to perceive artefact forms not preordained by the raw material and to visualize the manufacturing process in three dimensions, in addition to the dexterity to carry out a complex series of operations and corrections as the process advances. However, convincing cases can be made for the cognitive sophistication and manual dexterity required to produce earlier artefact forms, such a handaxe (Roche & Texier, 1991, 1995; Texier & Roche, 1993) or a Levallois flake (Roebrooks *et al.*, 1988; van Peer, 1992).

Blade production is often treated in the literature as a uniquely modern human invention with a recent genesis, but in fact, the origins of blade production are more complex. While most European Middle Paleolithic industries are flake-based, it is now realized that assemblages from several Middle Paleolithic sites in France, Belgium, England, and Germany have a blade component. Some of these sites may date to only ca. 60 ka, while others, including Coquelles (France), Crayford (England), and Le Rissori (Belgium), may be as old as 250 ka if paleoclimatic interpretations are correct (Conard, 1990; Révillion & Tuffreau, 1994; Révillion, 1995). In the Levant, if the TL dates are accurate, the Acheuleo-Yabrudian (Mugharan) industry, which contains blades, may predate 350 ka, though the ESR chronology at the key site of Tabun indicates an age for this industry of <250 ka. The lack of concordance may perhaps be due to unequal external U dose in different

parts of the cave as a result of the stratigraphic heterogeneity of the cave fill (Jelinek, 1982, 1990; Grün *et al.*, 1991; Grün & Stringer, 1991; Schwarcz & Grün, 1993a; Bar-Yosef, 1994, 1995a, 1998; Schwarcz, 1994; Mercier *et al.*, 1995; Mellars *et al.*, 1997).

In Africa, blade production has great antiquity. Blades are found in the pre-Aurignacian industry at the Haua Fteah, Libya (McBurney, 1967; Chazan, 1994), which has been correlated with isotopic stage 5 on faunal grounds and therefore estimated by Klein & Scott (1986) to date to ca. 127–75 ka. Blades produced by Levallois technology also figure prominently in the MSA of the Nile Valley beginning before 200 ka (van Peer, 1992, 1998; Kleindienst, 2000a). In South Africa, the makers of MSA industries routinely manufactured blades from a variety of core types (Sampson, 1972, 1974; Volman, 1984; Kuman & Clarke, 1986; Kuman, 1989). This technology was clearly in place by 120 ka, but its beginnings are poorly constrained temporally.

In East Africa, the presence of volcanics makes possible a chronology based on K/Ar and, more recently, $^{40}\text{Ar}/^{39}\text{Ar}$. In much of Kenya, Tanzania, and eastern D. R. Congo, MSA lithic industries are based not upon blades, but upon flakes produced from radial, Levallois, and other less formalized core types. However, MSA sites in northern Kenya and the Horn of Africa also contain quantities of early blades. At MSA sites at Gademotta, Ethiopia, blade index values (reflecting the numbers of blades and blade cores relative to other kinds of artefacts in the assemblages) range from 13.6% in levels dated to ≥ 235 ka to 37.7% at younger sites (Wendorf & Schild, 1974). Blades also constitute a significant proportion of the debitage at the MSA sites at Aduma in the Middle Awash Valley of Ethiopia (Brooks, 1996, 1999).

The Kapthurin Formation, Kenya, provides unequivocal evidence for early African

blades in a late Acheulian industry. Trachyte blades were recovered from both surface and excavated contexts at the site of GnJh-03 (Leakey *et al.*, 1969). The material occurs *in situ* at a depth of ca. 3 m below the base of K4, a volcanic unit. Conventional K/Ar dates for K4 indicated an age on the order of 240–250 ka (Tallon, 1978); a current program of redating by $^{40}\text{Ar}/^{39}\text{Ar}$ (Deino & McBrearty, under review) indicates that the true age lies closer to 280 ka.

Between 20% and 30% of the cores from site GnJh-03 can be classified as blade cores, while about one-quarter of the excavated flakes can be classified as blades (Leakey *et al.*, 1969; Cornelissen, 1992). The remainder of the flakes were produced by radial and Levallois core reduction. Experimental knapping in local trachyte and comparison with the archaeological sample reveals that the technique used in blade production was direct percussion, most likely with a hammerstone, though soft hammer percussion cannot be ruled out (Texier, 1996; McBrearty & Texier, n.d.). Approximately 13% of the assemblage from GnJh-03 can be conjoined (Cornelissen, 1992), and examination of refitting sets permits detailed reconstruction of blade production techniques, including both Levallois and semi-cylindrical blade removals (Figure 3) (McBrearty & Texier, n.d.). Both unidirectional and bidirectional blade removals are represented; blades show both plain and faceted platforms. Distinct levels of skill are reflected in the different refitted sets, and the most skilled knapper was able to proceed through a long series of blade removals to core exhaustion. The resulting blades are remarkable in their length, thinness and flatness (Figure 4). The Kapthurin Formation blades demonstrate the presence of a fully conceptualized, well-executed method of blade production, and high level of technical competence in East Africa before 280 ka.

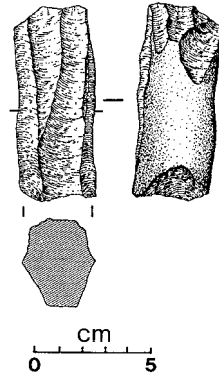


Figure 3. Semi-cylindrical core from site GnJh-03 in the Kapthurin Formation, Kenya. © Sally McBrearty.

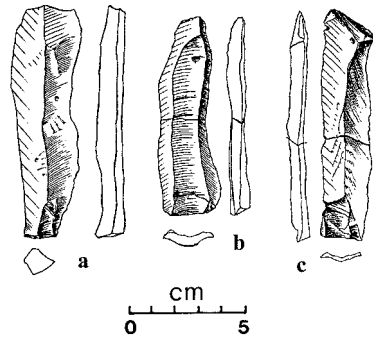


Figure 4. Blades from site GnJh-03 in the Kapthurin Formation, Kenya. Figure courtesy of Pierre-Jean Texier. C.N.R.S. Sophia Antipolis, France.

MSA points

The presence of stone points has been considered a defining characteristic of the MSA since the inception of the term (Goodwin & van Riet Lowe, 1929). Pointed flakes and flake-blades seem to have been deliberate target forms for many MSA toolmakers, and retouched points are among some of the earliest MSA artefacts at 235 ka (Wendorf *et al.*, 1994). The large numbers and careful design of points in the retouched component of many MSA assemblages, and the relative lack of emphasis on scrapers, are major differences between the African MSA and the classic Mousterian of southwestern France. For this reason, the Lower and

Middle Paleolithic typologies of Bordes (1961) and Debénath & Dibble (1994) are not useful in describing most African MSA industries, particularly those from south of the Sahara. It is now clear that bone points also are characteristic of some African MSA industries. This difference between the African and European records renders it important to understand the manner of use and the stylistic implications of MSA points.

Hafting was probably routine in most MSA contexts. MSA points are often deliberately modified to facilitate hafting either by thinning at the butt, or, in the case of Aterian points, by the fabrication of a tang. While seldom preserved in the archaeological record, vegetable gums are frequent in the African ethnographic record as a hafting medium, and traces of mastic have been found on a blade in MSA level E at Apollo 11 (Wendt, 1976; Vogelsang, 1998).

Many MSA points were most likely used to dispatch game. Milo (1998) has reported a point tip embedded in a cervical vertebra of the large bovid, *Pelorovis* [see Figure 8(a)] as well as a similar puncture wound in an eland thoracic vertebra from MSA deposits at Klasies River, South Africa. Impact scars have been observed on MSA points from a number of African sites, including ≠Gi, Botswana, and Blombos, South Africa (Kuman, 1989; Henshilwood & Sealy, n.d.). Wendorf & Schild (1993) have argued that the points from the Lake Ziway region of Ethiopia show signs of use as cutting and scraping tools. Kuman (1989), however, has demonstrated that points from ≠Gi were highly curated tools that performed many functions, including cutting, over their long life spans. The importation of finished Nubian points to Sodmein Cave, Egypt (van Peer *et al.*, 1996; van Peer, 1998) would seem to indicate use of the site as a special purpose hunting station, and the large numbers of finished pressure flaked foliate

Still Bay points at Blombos, South Africa seems likewise to indicate a hunting station or a specialized production encampment (Henshilwood & Sealy, n.d.).

Retouched points from sites throughout Africa are the appropriate size for projectiles; they are carefully made, thin, and symmetrical. Further, points made on end and corner struck flakes from Botswana and Zimbabwe show deliberate shaping to create equal distribution of mass around the midline, suggesting aerodynamic design (Yellen, personal communication). While these may have been used to arm the business end of stabbing or throwing spears, they could also have been delivered by bow and arrow. The small size of some late MSA points (e.g., Gresham & Brandt, 1996) in particular suggest their use with bow and arrow. Western European points frequently lack basal thinning to facilitate hafting, or the impact scars indicating use as spears described by Shea (1988) for the Levantine Mousterian. In the late Mousterian of eastern Europe (e.g., Marks & Chabai, 1996) and Portugal (Marks & Brugal, 2000) there are pointed forms which may indeed have served as hafted projectiles, but these appear to postdate 60 ka. It is tempting to surmise that this late flowering of point technology in eastern Europe reflects a bow wave effect, the result of contact with hominids to the east and south, who had possessed this technology for many tens of thousands of years.

Social organization

Regional variety in MSA points

The diversification of MSA toolkits and the varying proportions of different artefact classes at different sites no doubt reflect regional traditions as well as different extractive activities. Points comprise the single functionally equivalent class of artefacts that best reflects regional differences, and signals

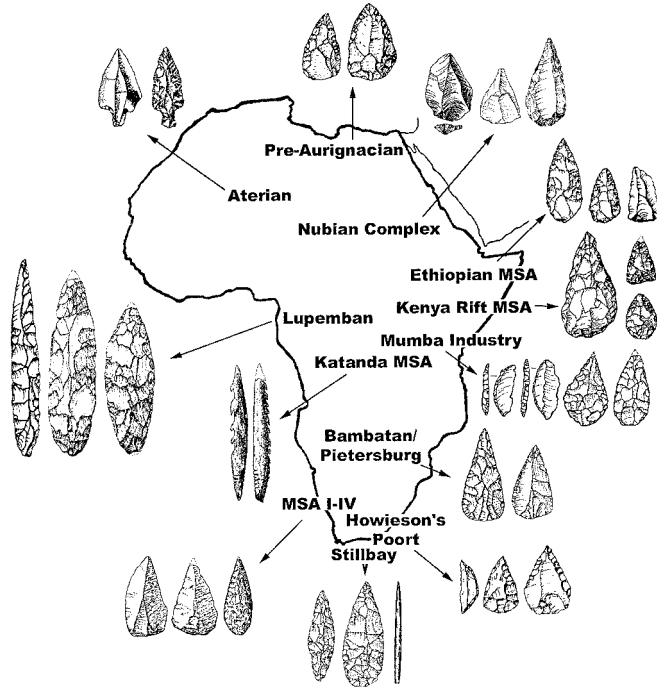


Figure 5. Map of distribution of point styles in the African MSA (after Clark, 1993, Figure 1). © Sally McBrearty & Alison S. Brooks.

the presence of regional styles (Figure 5). Projectile points have traditionally been used by archaeologists to define later prehistoric industries worldwide. They are thought to encode stylistic information for their makers for two reasons: (1) point design is tightly constrained by aerodynamic and hafting requirements, and therefore successful designs tend to be closely replicated (Wilmsen, 1974; Knecht, 1993); (2) within groups, sharing or exchange of projectile points imposes design limits. Ethnographically, individuals have been observed to continue to manufacture projectiles long after their declining eyesight, reflexes, and endurance have diminished their own success as hunters. Among the !Kung and other people, projectiles are provided to successful hunters in exchange for a claim on the meat (Yellen, 1977; Lee, 1979). Thus, the maker must conform to a familiar template so that the hunter will be able to perform with

tools produced by a variety of craftsmen (Wiessner, 1982, 1983). This contributes to abrupt discontinuities in projectile point style that coincide with the boundaries of the ethnic groups within which projectiles are exchanged. Such geographic patterning of form in functionally equivalent artefacts has been seen as the archaeological signature of style, however it is construed (Sackett, 1977, 1982, 1990; Wobst, 1977; Hodder, 1985; Conkey, 1990). On the whole, there is not a high degree of variability in the Middle Paleolithic of western Europe, where pointed forms are rare (Chase & Dibble, 1987).

What is the patterning of point styles in the African MSA? For most of Africa, we do not have data that are sufficiently fine-grained to construct detailed local maps that reveal the kind of stylistic boundaries known from the ethnographic record. On a continent-wide scale, however, regional

styles can be recognized (Figure 5). The Aterian is characterized by projectile points and other artefacts with a carefully crafted tang for hafting. It occurs in North Africa at about 20°–15°N, from Morocco in the west to the western desert of Egypt in the east (Debénath, 1994; Kleindienst, 2000b). The Nubian complex, containing truncated and faceted Nazlet Khater points, occurs in the Nile Valley (van Peer, 1991, 1998). The Lupemban industry is found in the greater Congo basin as far south as Namibia (MacCalman & Viereck, 1967) and as far east as the Lake Victoria region. It is characterized by lanceolate points, some of which are thin, skillfully made, and may exceed 30 cm in length (McBrearty, 1988). Foliates, narrow foliates, and triangular points, both unifacial and bifacial, are found at East African Rift Valley sites.

In the absence of a firm chronology, it is impossible to distinguish chronological from geographical effects, but the impression is of pronounced stylistic variation *within* the MSA of East Africa. Clark (1988: 297) notes that to the extent that stylistic differences can be recognized in the MSA of the Horn,

“these might be the preferential forms represented by the markedly subtriangular points at Gorgora, the pointed leaf-shaped forms at Proc Épïc and Gademotta, [and] the Levallois points at Midhishi”.

Late MSA points of the Horn are very distinctive and can be distinguished from those of Kenya and Tanzania by their increasing elongation and small size (Clark, 1954; Gresham, 1984; Brandt, 1986; Gresham & Brandt, 1996). In East and Central Africa, MSA points have a great antiquity. At Mumba Rock Shelter, Tanzania, they date to as early as 130 ka (Mehlman, 1989, 1991) and to about 230 ka at Twin Rivers, Zambia (Barham & Smart, 1996), and Gademotta and Kukuleti, Ethiopia (Wendorf *et al.*, 1994).

Within South Africa a number of MSA variants were defined by early workers.

Of these, the Still Bay (Goodwin, 1928), Howiesons Poort (Stapleton & Hewitt, 1927, 1928), and perhaps the Bambata (Armstrong, 1931) and Pietersburg industries (Mason, 1962, 1993) seem to have clear regional and chronological specificity. Although the term Still Bay was subsequently appropriated for use as far afield as Kenya and Zambia (Leakey, 1931; Cooke & Paterson, 1960), the Still Bay as originally defined by Goodwin & van Riet Lowe (1929) is confined to the southern Cape coast of South Africa. It contains a variety of pointed forms, but the elongated “willow leaf” Still Bay points are highly distinctive and limited to the Cape region. They are characterized by shallow invasive retouch, and are usually executed on good quality raw materials including chert, quartzite and silcrete. While the industry is known from a number of surface occurrences and early excavations, the only excavated sample from secure context is that reported by Henshilwood & Sealy (1997) from the site of Blombos, where 52% of the retouched tools are bifacial points.

The Howiesons Poort industry, containing small, well-retouched unifacial and bifacial foliate points, as well as backed geometrics, may extend over a wider region of southern Africa than the Still Bay. While it is concentrated at sites on the Cape, such as Klasies River (Singer & Wymer, 1982; Deacon, 1989; Deacon & Wurz, 1996; Wurz, 1997, 1999) or Montagu Cave (Keller, 1973), materials from Apollo 11 rock shelter on the Namibia–South Africa border (Wendt, 1972, 1976; Vogelsang, 1996, 1998), Cave of Hearths in the Transvaal, and Border Cave on the Zululand–Swaziland border (Mason, 1962, 1993; Beaumont *et al.*, 1978; Beaumont, 1980) have also been attributed to the Howiesons Poort. As yet, no Howiesons Poort occurrences are known from Namibia north of Apollo 11, or from Botswana. Early industries with backed segments and MSA

points are known from Zimbabwe (Cooke, 1971) and from Tanzania (Mehlman, 1989), but these appear to be somewhat later in time and do not contain the full array of features described for the South African Cape Province Howiesons Poort sites.

The Pietersburg industry is centered in Gauteng, but it is not well dated (but see Miller *et al.*, 1991). It is characterized by elongated points on blades, more often unifacial than bifacial, and with trimming confined to the periphery (Mason, 1962).⁷ A common form is a long foliate unifacial point with ventral bulbar reduction. The Bambata industry of Zambia, Zimbabwe, Namibia, and Botswana is distinguished by short, broad foliate and triangular points, both unifacial and bifacial, with retouch ranging from marginal to invasive (Kuman, 1989). It is dated at \neq Gi by TL and AAR on ostrich eggshell to 70–80 ka (Brooks *et al.*, 1990; Franklin & Hornyak, n.d.). In brief, the African MSA is characterized by well-differentiated regional point styles, and points in tropical Africa predate any known from Europe by tens of thousands of years.

Technology

Geometric macroliths and microliths

Backing or blunting of the edges of artefacts is a form of retouch characteristic of Upper Paleolithic and Mesolithic industries of Late Pleistocene and Holocene Europe. It is usually performed on blades and is considered a feature of mode 4 technology. In the European Mesolithic and Neolithic, small tools were produced by backing blades or blade segments to create standardized geometric shapes, including triangles, trapezes, and crescents (mode 5 technology). Backed segments <20 mm (e.g., Andrefsky, 1998) or <30 mm (Clark & Kleindienst,

7. The Later Pietersburg industry (e.g. Cave of Hearths Bed 9) contains backed crescents, and may be attributed to the LSA or the Howiesons Poort.

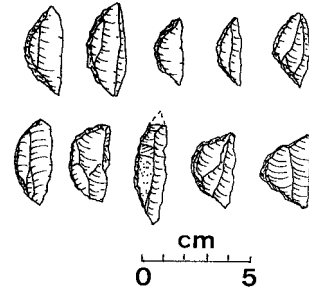


Figure 6. MSA geometric microliths; top row, Klasies River Howiesonspoort, after Wurz (1997); bottom row, Mumba Industry, Mumba Rock Shelter, level V, after Mehlman (1989). © Sally McBrearty.

1974) in length are termed microliths. The resulting small tools are usually mounted in multiples as components of complex composite implements, such as arrows or cutting tools. They are an advance over simple flakes and blades in terms of raw material economy, and they clearly signal a modern approach to technology. They facilitate retooling, as damaged segments can be replaced without overhauling the entire implement. They are unknown in Europe prior to the Uluzzian industry of peninsular Italy, dated to ca. 35 ka, and do not become common or widespread in Europe until after 20 ka (Palma di Cesnola, 1993; d'Errico *et al.*, 1998).

In Africa, geometric microliths are the hallmark of the LSA. The sequence at Mumba Rock Shelter, Tanzania, documents the first appearance of this technology in East Africa. In the Mumba industry in lower Bed V (Figure 6, bottom row), the earliest geometrics are rare, macrolithic, and made on flakes from Levallois or radial cores. Later in Bed V, the geometrics increase in number, decrease to microlithic size, and are made on blades (Mehlman, 1989). Both U-series and AAR dates indicate an age of 65 ka from Middle to Upper Bed V for the appearance of geometric microliths at Mumba (Mehlman, 1989; Brooks *et al.*, 1993b).

In South Africa, geometrics appear somewhat earlier, in the Howiesons Poort industry (Figure 6, top row). Goodwin & Van Riet Lowe (1929) first described the Howiesons Poort on the basis of material reported by Stapleton & Hewitt (1927, 1928) from the type site near the Cape coast of South Africa. Like the Mumba industry, the Howiesons Poort contains items characteristic of both the MSA and the LSA. MSA elements include unifacial or bifacial foliate or lanceolate points, sometimes with faceted butts that are ventrally trimmed, as well as scrapers and burins made on flakes or blades produced from single platform, double platform, radial, and irregular cores. Features more common to LSA industries are the small size of the artefacts overall (often <30 mm), a greater reliance on exotic fine grained raw materials, and the presence of geometrics. Singer & Wymer (1982) and Wurz (1997) declare that the Klasies River Howiesons Poort blades are punch-struck, a feature characteristic of European Upper Paleolithic blades, but they report no experimental basis for this observation, and as Ambrose & Lorenz (1990) remark, distinguishing blades struck with a punch from those produced by soft hammer presents a difficult challenge (cf. Bordes & Crabtree, 1969).

The Howiesons Poort was considered a possible “transitional” industry between the MSA and LSA, but subsequent excavations have shown that the Howiesons Poort is interstratified within the MSA at a number of sites in South Africa, including Klasies River (layers 10–21 in shelter 1A and in layers 1–5 in cave 2) (Singer & Wymer, 1982; Deacon *et al.*, 1984; Deacon, 1989), Boomplaas, (member OCH) (Deacon, 1979, 1989), Montagu Cave (layer 2) (Keller, 1973), and Border Cave (layer III) (Beaumont, 1973*b*; Butzer, 1978; Beaumont *et al.*, 1978). While the excavators of Klasies River considered the interstratified MSA and Howiesons Poort

assemblages to have been made by populations with different technological traditions (Singer & Wymer, 1982), later investigators have seen them as the product of shifting territorial organization, raw material acquisition, and symbolic signaling (Ambrose & Lorenz, 1990; Wurz, 1997, 1999; Deacon & Deacon, 1999).

Radiocarbon dates available in the 1960s seemed to indicate that the Howiesons Poort should be incorporated within the LSA (Klein, 1971). A late date was considered reasonable when modern human remains were recovered in possible association with Howiesons Poort artefacts at Border Cave (Cooke *et al.*, 1945; Malan, 1955; Mason, 1962; Sampson, 1974) and at Peers (Skildergat) Cave (Keith, 1931; Jolly, 1948; Anthony, 1967), though elemental analysis now indicates that the Peers Cave material represents an intrusive burial (Sillen, personal communication). New age estimates for Howiesons Poort occurrences have generated debate because they involve experimental dating methods and rely upon the correctness of detailed depositional, postdepositional, and climatic reconstructions, and inferred correlations with the global marine isotopic record. However, out of recent dating efforts has emerged a consensus that the age of the industry is 60–70 ka.

At Boomplaas, a series of 22 radiocarbon dates established that the Howiesons Poort is >49 ka (Deacon, 1989). AAR dates on ostrich eggshell from the Howiesons Poort at Klasies River range in age from 80 ka at the bottom of the sequence to 65 ka at the top; application of the same method at Boomplaas yielded an age estimate for the Howiesons Poort there of 72–80 ka (Brooks *et al.*, 1991, 1993*a*; Miller *et al.*, 1993, 1999). Judging from the dates, together with faunal and geomorphological evidence, Deacon (1989: 554) places the Howiesons Poort levels at both sites at ca. 70 ka, near the end of the last Interglacial (oxygen

isotope stage 5a-4). ESR dates for the Howiesons Poort at Border Cave range from 45 ± 5 to 75 ± 5 ka, with a mean of 62 ka (Schwarcz & Grün, 1993a; Grün *et al.*, 1990), but initial analyses of protein diagenesis in ostrich eggshell from Howiesons Poort levels at the same site indicated an age of >70 ka (Miller *et al.*, 1993, 1999), and analysis of the micromammals suggested a timespan similar to that at Klasies River (Thackeray & Avery, 1990). Miller *et al.* (1999) report a new series of isoleucine epimerization dates on ostrich eggshell for Howiesons Poort occurrences at Border Cave, Klasies River, Boomplaas, and Apollo 11, ranging between 56 and 80 ka. They conclude that a reasonable age estimate for the industry is 66 ± 5 ka.

Parkington (1990) is in the minority in arguing for a shorter chronology and seems to be in error in favoring an age for the Howiesons Poort of between 50 ka and 35 ka. Interestingly, however, he stresses the differences between pre-Howiesons Poort ("MSA 1 and 2" or "Pietersburg") and post-Howiesons Poort ("MSA 3 and 4" or "Bambatan") assemblages, and questions the MSA affiliation of the post-Howiesons Poort material. As Thackeray (1992) points out, if Parkington is correct, and industries overlying the Howiesons Poort are identified as LSA, then the Howiesons Poort may indeed play a role in the "transition" to the LSA. Further, if current age estimates for the Howiesons Poort are accurate, then the time range of the LSA is considerably lengthened, and the "time lag" that Klein (1992) imputes between the appearance of *H. sapiens* and the LSA is much reduced.

Wurz (1997, 1999; Deacon & Wurz, 1996) has conducted a detailed analysis of Howiesons Poort material from Cave 2 at Klasies River. She finds that the geometrics are generally manufactured on whole blades, though others (e.g., Thackeray, 1989) have suggested that the blades were snapped

into segments before backing. Singer & Wymer (1982, cited by Wurz, 1999) point out 18 examples of the microburin technique, in which a notch is made to facilitate snapping the blade. Notches on the unbacked edge are found on 19.4% of the backed artefacts in Wurz's (1999) sample, and she interprets this as evidence for hafting and binding.

Volman (1984) considers Howiesons Poort geometrics to be projectile armatures, while Deacon (1989) believes that in view of their relatively large size in comparison to LSA examples, they may have functioned as barbs for spears. For nearly all ESA and MSA artefacts, function is a matter of conjecture, usually unsupported by usewear or other direct evidence. But because geometric microliths remained in use until recent times, there is good archaeological and ethnographic evidence that they were used as arrow armatures, both for hunting and in warfare. Arrow shafts with the microlithic armatures still in place have been recovered in Europe from Mesolithic, Epipaleolithic, and Neolithic contexts (Rust, 1943; Clark, 1951, 1952; Rozoy, 1985; Fischer, 1985) and in Egypt from dynastic tombs (Clark *et al.*, 1974). Nineteenth-century southern African ethnographic examples are described by Clark *et al.* (1976). Clark *et al.* (1974) remark upon the striking similarity between the South African and Egyptian arrow designs; in both, microliths were generally mounted with mastic, often in pairs, and in some cases treated with poison. As shown by Rozoy (1985) and Fischer (1985), a set of paired armatures mounted behind the point enlarges its cutting edge, thereby increasing the size of the laceration. Wurz (1997) cites experimental work (Friss-Hansen, 1990; Nuzhnyi, 1990) which demonstrates the effectiveness of this technique in wounding animals and in preventing damage to the armature. Furthermore, microwear on replicated geometrics hafted in this way is

consistent with observed microwear on Howiesons Poort segments (Harper, 1994; Wurz, 1997).

Coefficients of variation for microlith dimensions reported by Wurz (1997) show that the Howiesons Poort geometrics are as standardized as their LSA counterparts and therefore appear to have been manufactured to specific design parameters. With mean lengths of about 30–45 mm, the backed geometrics of the Mumba and Howiesons Poort industries (Keller, 1973; Volman, 1984; Wurz, 1997) are larger than those of typical LSA microliths, usually ≤ 25 mm (Deacon, 1984), but their size is comparable to that of northern European Epipaleolithic armatures (Rust, 1943; Rozoy, 1985). As Rozoy (1985) points out, however, the critical size property for an armature is not its linear dimensions, but its weight, usually < 10 g for European examples. Published weights are not available for African geometrics, and it is not known how many, mounted together, would comprise a single armature. The heavier Howiesons Poort or Mumba industry geometrics may have been used in cutting implements or in stabbing or throwing weapons, but they would also have been suitable for arming an arrow that would perhaps have traveled less than the 20–50 m usual for arrows propelled by the bow (Rozoy, 1985). Such arrows may have been unfletched; Clark *et al.* (1974) observe that among their Egyptian dynastic sample, lighter arrows are fletched, while heavier ones are without fletching. Whatever the details of their design, the Mumba and Howiesons Poort microliths support the presence of composite projectiles in Africa by 65 ka, about 30,000 years earlier than they are found in Europe.

Bone tools

The shaping of bone and other organic materials into points, awls, and other tools has been a hallmark of the Upper Paleolithic

since the days of [Lartet & Christy \(1869–1875\)](#). Large bones were sometimes flaked in the same way as stone by Oldowan tool makers ([Leakey, 1971b](#)), and [Blackwell & d'Errico \(2000\)](#) claim that Pliocene hominids at Sterkfontein and Swartkrans were using bone shaft fragments to raid termite mounds. Formal techniques of bone-working, however, are generally agreed to have been significant to late human evolution, though it is not clear why carving and polishing a bone point should be beyond the capabilities of the maker of a Levallois flake. Even within the European Upper Paleolithic, however, bone tools are not common compared to retouched stone tools. At Abri Pataud, France, for example, in all four of the early and basal Aurignacian levels combined, there are only three fragmentary possible split-base bone points, whereas there are 900 retouched stone tools and thousands of bones and bone fragments ([Brooks, 1995](#)). A few sites with hundreds of worked bone objects like Castanet, France, seem to have served as “factory sites,” but many Aurignacian sites have no bone artefacts at all ([White, 1992](#)).

Perhaps bone working is intimately tied to the development of projectile technology, which would explain why it is present in the African MSA. Until recently, only a few bone artefacts were known from MSA contexts, and these were widely discounted as late aberrations or the result of stratigraphic admixture. In North Africa, polished bone tools have been reported from Aterian context from the site of Grotte d'el Mnasra, Morocco ([Hajraoui, 1994](#)). The relatively informal assemblage of pointed bone objects associated with the Khormusan was formerly thought to date to ca. 18–23 ka ([Wendorf *et al.*, 1965](#)), but it has now been redated to > 40 ka, and possibly to 60 ka, bringing the Khormusan firmly into the time range of similar MSA industries ([Marks, 1968](#); [Wendorf & Schild, 1992](#); Marks, personal communication).

In southern Africa, a bone point was among the artefacts recovered from the site of Kabwe, Zambia (Clark, 1959), though the question of its association with the hominid, faunal remains and stone artefacts is unresolved. The age of Kabwe was formerly estimated at 125 ka on the basis of an early AAR date of 110 ka (Bada *et al.*, 1974) and faunal comparison with Olduvai Bed IV (Klein, 1973), but recent recalibration of the Olduvai sequence (Hay, 1990; Manega, 1993; Tamrat *et al.*, 1995; Walter *et al.*, 1991, 1992; Kimbel, 1995; White, 2000) suggests an age >780 ka for the material (see Table 1). Possible “daggers” of wart hog tusk probably dating to ca. 80 ka have been reported from the Howiesons Poort levels at Border Cave (Beaumont, 1978, Volman, 1984), though their artefactual nature is open to question.

Singer & Wymer (1982) describe a thin cylindrical bone point from Howiesons Poort layer 19 in Shelter 1A at Klasies River, dated by several techniques to 65–80 ka (Bada & Deems, 1975; Deacon *et al.*, 1986; Deacon & Geleijnse, 1988; Deacon, 1989; Grün *et al.*, 1990). The excavators themselves expressed skepticism at this unique find (Singer & Wymer, 1982: 115), and it has been dismissed as intrusive (e.g., Volman, 1984). The point, however, was excavated from “compressed, laminated levels that showed not the slightest sign of disturbance”, and the color and condition of the point are described as similar to other bones in the Howiesons Poort levels, and quite unlike those from the LSA middens (Singer & Wymer, 1982:115).

Evidence from three MSA sites at Katanda, D. R. Congo, indicates that the Klasies bone artefact is not an isolated phenomenon. At Katanda, a series of barbed and unbarbed bone points has been recovered from secure stratigraphic context [Brooks *et al.*, 1995; Yellen *et al.*, 1995; Yellen, 1998; see Figure 7(a), (b)]. The three occurrences, Kt-2, Kt-9, and Kt-16,

are all associated with a distinctive paleosol that crops out along a 1 km long exposure in the cliffs above the Semliki River. At each site, the MSA horizon containing the bone points is overlain by 3–5 m of fluvial and colluvial deposits, up to three distinct paleosols, a massive capping ash, and a Holocene soil. The Katanda sites are dated to ca. 90 ka by a variety of techniques, including TL and OSL on sands above the MSA occurrences, ESR and U-Series on tooth enamel recovered from the MSA horizon at Kt-9, and AAR on mollusc shells and ostrich eggshells from horizons both above and below the MSA levels at a number of sampling localities. Dates for the MSA occupations containing the bone points range from 82+8 ka (T/L) to 174+1 ka (U-series); all suggest a minimum age in excess of 75 ka. A recent redating effort by OSL on multiple aliquots from seven additional samples of the sands overlying the MSA layer confirms the original age estimate (Feathers & Migliorini, 2000).

Initially, objections were raised to the MSA associations of the Katanda points because bone points are known from the nearby late Pleistocene site of Ishango (de Heinzelein, 1957, 1962; Brooks & Smith, 1987). The stratigraphic conditions and consistent associations described here clearly rule out the possibility of Holocene intrusion. The Katanda bone points are associated with MSA artefacts at three different sites. At no locality is the MSA material overlain by LSA assemblages from which the points could have been derived. Indeed LSA sites of younger (Ishangian) age are located on a terrace ca. 20 m lower in the modern landscape. There are no anomalous elements in the MSA assemblages, such as microliths, that would indicate LSA admixture. The degree of mineralization of the Katanda points resembles that of non-artefactual bone from the MSA occupation, which represents several locally extinct

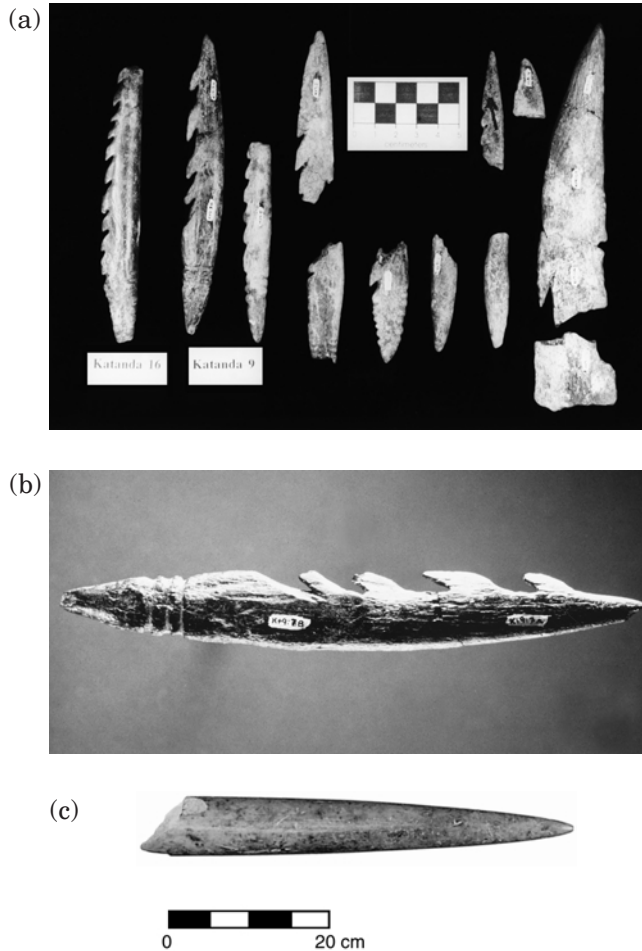


Figure 7. Bone points of the African MSA. (a) Katanda 16 and Katanda 9 (after Yellen *et al.*, 1995), © Alison S. Brooks; (b) detail of point from Katanda 9. © Chip Clark, Smithsonian Institution; (c) Blombos Stillbay level, after Henshilwood & Sealey, 1997, figure 7, photo courtesy of Chris Henshilwood.

species. Even if the Katanda faunas represent secondary accumulations of considerable duration, as suggested by Klein (1999: 439, 2000; but see Yellen, 1996), their minimum age is none the less limited by the age of the capping sands. There are also stylistic differences between the Ishango late Pleistocene and the Katanda MSA bone points, particularly in the manner in which they were hafted. The Ishango points are smaller, and have a backward facing notch at the base to secure the line from slipping,

whereas the Katanda points have a series of basal grooves [Figure 7(b)]. Experimental work (Krupsha, 1993) shows that while a backward facing notch will retain the line when such a point is used as a harpoon, grooves are insufficient for the purpose. Thus, while the late Pleistocene Ishango bone points were probably designed for use as harpoons, those from the Katanda MSA sites may have functioned as spear points.

The unique character of the Katanda bone points may not be surprising, given the

absence in Central Africa of comparable excavated sites of this age with associated fauna in similar riparian settings. Yellen (1998) has suggested, however, that this phenomenon may be due to an MSA social landscape of small, relatively isolated populations that is without parallel in historic times. The idea of bone armatures is not unique to the MSA inhabitants of the Congo Basin. Recent discoveries elsewhere on the continent confirm the presence of bone points and other bone tools in the MSA.

At Blombos cave in the southern Cape Province of South Africa, retouched stone projectile points and other MSA artefacts have been recovered in sealed context in association with well preserved fauna and a series of 21 worked bone objects. These include two cylindrical bone points [Figure 7(c)] that are clearly intentionally shaped by symmetrical grinding and polishing. The other bone objects include two "awls," a possible peg, and a flat piece with parallel incisions made by a stone tool that may represent either a decorative image or a utilitarian object [see Figure 10(a)]. Analysis of carbon to nitrogen (C:N) ratios shows that the points and other bone tools are unequivocally derived from the same horizon as the MSA fauna. Initial age estimates derived from multiple techniques indicated a minimum age of 72 ka (Henshilwood & Sealy, 1997, n.d.). The Holocene and MSA levels at Blombos are separated by a layer of sterile sand 10–20 cm thick, for which recent OSL analyses indicate an age of ca. 73 ka (Henshilwood, personal communication).

Another set of data supporting early bone working in Africa is a series of barbed points from White Paintings Shelter in the Tsodilo Hills of northern Botswana. Here the MSA occurrence at the base of the sequence, at depths exceeding 4 m, is overlain by a "transitional MSA/LSA" horizon, at a depth of 3.5 m, containing large blades, faunal remains including fish and mammals, and a

single unbarbed bone point. A series of bone harpoons and other bone tools lie in LSA deposits at about 3 m below the surface. A large sample of ostrich eggshell fragments from deposits higher in the sequence, from depths ranging between 3 m and 1.5 m, have been dated by AMS ¹⁴C and AAR to between ca. 33 and 37 ka. The transitional level itself is dated to 38–50 ka by a variety of techniques (Robbins *et al.*, 1994; Robbins & Murphy, 1998; Kokis *et al.*, 1998; Robbins, 1999; Robbins *et al.*, under review). It is regrettable that faunal preservation is poor in the lower levels at White Paintings Shelter, and that bone artefacts have not been found here in MSA context. However, it is significant that a bone point, dating to >30 ka, has been recovered from the "transitional MSA/LSA" occurrence.

The bone artefacts from Blombos and Katanda together firmly document bone working in the Middle Stone Age, and support the MSA associations of previously reported finds, such as those from Klasies river and Border Cave. Dates from White Paintings Shelter confirm an antiquity for bone points in the LSA that considerably closes the gap between the Katanda and Blombos points on the one hand, and the widespread African bone working industries known from after 25 ka on the other (de Heinzelein, 1957; 1962; Sutton, 1974, 1977; Barthelme, 1985; Brooks & Smith, 1987; Yellen, 1998). This evidence suggests continuous development of a bone working tradition with origins well back in the Pleistocene.

Economy

Hunting

Increased intensification in resource use, greater planning depth, and seasonal scheduling of hunting and fishing are frequently cited elements of the "human revolution" (e.g., Mellars & Stringer, 1989; Nitecki & Nitecki, 1989). In contrast, MSA

people have been portrayed as scavengers (Binford, 1981, 1984), or as less effective hunters than their LSA successors (Klein, 1976, 1978, 1989a; 1992, 1994, 1995, 1998, 1999, 2000).

Much of the debate revolves around the species composition, body part representation, age profiles, and position of cutmarks in the MSA faunal collection from Klasies River, compared to LSA remains from nearby Nelson Bay Cave. Marean & Assefa (1999), noting that a significant portion of the Klasies River fauna was discarded by the original excavators as unidentifiable (Singer & Wymer, 1982), have suggested setting the material aside and concentrating on studies of unbiased collections. Nevertheless, Klasies River continues to dominate the debate, despite the fact that its location on the Cape coast of South Africa, the continent's most southern extremity, is not representative of Africa as a whole, and that open air sites present a different picture from that seen for caves. Nor does the Klasies sequence record the early MSA or the MSA-LSA transition. Rather, at many sites in the southern Cape there appears to be an occupational hiatus of 40 ka to 20 ka duration between the MSA and the LSA, which creates an impression of dramatic behavioral changes when earlier and later sites are compared.

Here we refute three assertions about hunting behavior in the MSA: (1) that hunting was not practiced at all; (2) that dangerous species were not hunted on a regular basis; (3) that hunters did not focus upon prime age adults. We will also describe instances of specialization on a single prey species in the MSA.

The arguments against the practice of hunting in the MSA commonly rely upon relative element abundance and the position of cutmarks. The underrepresentation of meaty limb elements in MSA faunal assemblages has been taken to imply late access to carcasses, that is, scavenging kills

from which the most valued elements have already been consumed by primary carnivores. Decisions by human hunters about which carcass parts to transport to camp and which to abandon at the kill site reflect carcass part utility, as well as daily contingencies not visible in the archaeological record (Perkins & Daly, 1968; Klein *et al.*, 1999). Further, limb bones are known to have been processed for marrow extraction from the earliest times (Bunn *et al.*, 1980; Bunn, 1981, 1989; Blumenschine, 1987; Blumenschine & Selvaggio, 1991), resulting in fragmentation of the shafts. These elements may be further damaged by subsequent taphonomic processes that typically destroy limb bone ends with greater severity than shafts. Unfortunately, early excavators often regarded shafts as non-identifiable and discarded them, as they did at Klasies River. In an elegant recent study, Marean has convincingly shown by painstaking refitting of the MSA bone assemblage from Layer 10 in Cave 1 at Die Kelders, South Africa, that high utility limb bones are not absent, just better represented by the shafts as opposed to the ends. When minimum numbers of elements are based on the shafts, the skeletal element representation is consistent with early access to carcasses, and thus with a hunting, not a scavenging, adaptation (Marean, 1998; Marean & Kim, 1998; Bartram & Marean, 1999; Marean & Assefa, 1999; Marean *et al.*, 2000).

Cutmark evidence also supports MSA hunting. Despite the assertions of Binford (1984), there is evidence for neither carnivore damage prior to hominid acquisition nor for the accumulation of carcasses by carnivores at Klasies River (Klein, 1999; Klein *et al.*, 1999). A detailed analysis of assemblage composition, breakage and traces of butchery and carnivore ravaging on the fauna from Cave 1 at Klasies River performed by Milo (1998) leads him to conclude,

“In the KRM faunal assemblage . . . abundant butchering marks on upper hindquarters and forequarters indicate that the hominids enjoyed early access to carcasses in all size classes”

(Milo, 1998: 124). In East Africa, at MSA sites at Lukenya Hill, Kenya, Marean (1997) has observed low frequencies of carnivore involvement and an abundance of cutmarks and percussion marks indicating “that people were the primary accumulators of these assemblages” (Marean, 1997: 210).

Conscious selection of a single prey species is seen as a sign of modern human behavior (Mellars, 1989a,b; but see Chase, 1989; Stiner, 1994; and Mellars, 1996 for prey selectivity among Neanderthals). Lieberman & Shea (1994) have argued that seasonal patterning in faunal use is one of the few characteristics that distinguish the occupation sites attributed to *H. sapiens* from those attributed to Neanderthals in the Levant. There are several examples of hunting selectivity in the MSA. In South Africa, Klein (1989a, 1994) has suggested that the catastrophic age profile for eland at Klasies River and other MSA sites indicates tactical or intercept hunting of entire herds. In East Africa, at the MSA site of GvJm-46 at Lukenya Hill, Kenya (Miller, 1979; Marean, 1992), the focus on a single prey species (a small extinct alcelaphine bovid) the catastrophic mortality profile, the palimpsest nature of the accumulation, implying repeated kill events, and “the open location in a natural topographic trap” (Marean, 1997: 217) combine to suggest repeated use as a tactical mass kill site. There is some indication that this may have taken place during the annual game migration.

The opinion voiced most frequently is that MSA people were ineffective hunters when compared to their LSA successors. The taking of large prey species and prime age adults are regarded as signs of fully competent hunting ability (Stiner, 1990,

1994). Klein (1976, 1978, 1989a, 1992, 1994, 1995, 1998, 1999) argues, primarily from comparisons of species composition and age profiles in MSA (Klasies River, Die Kelders, Border Cave) vs LSA (Nelson Bay Cave) assemblages, that MSA hunters did not often hunt dangerous animals and rarely brought down prime age adults. However, there is good evidence that MSA hunters did not confine themselves to docile prey species or to juvenile targets. It seems likely that the artefact fragment embedded in a cervical vertebra from MSA levels at Klasies River [Figure 8(a); Milo, 1998] represents the weapon used to dispatch the animal, although Marean & Assefa (1999) question whether it might have become lodged there during butchery. The vertebra is that of an adult *Pelorovis* (size class 5) (Milo, 1998), an animal for which Klein (1976) estimates body weight at >900 kg. *Pelorovis*' modern descendant, *Syncerus caffer*, though significantly smaller, is regarded as one of the most dangerous game animals in Africa. Among the modern Jun/wasi, an individual who takes two large animals (size class 3 or greater) per year is considered a successful hunter (Lee, 1979).

Evidence at the MSA site of ≠Gi, in the Kalahari desert of Botswana, dated to 77 ka, also appears to represent deliberate hunting of dangerous game. Historically, the seasonal pan adjacent to the sites has been the locus of ambush hunting practices. Ethnographically, hunting from blinds was restricted to a few days per year, during the full moon at the end of the rainy season, when the pan was the only local source of water. More than 600 points were found in the MSA levels at ≠Gi, making up 41% of the retouched tools ($n=1497$). The fauna, represented mainly by isolated teeth, is dominated by zebra (*Equus burchelli* and *E. capensis*), cape warthog (*Phacochoerus aethiopicus*), and large bovids including at least one individual *Pelorovis* (Helgren & Brooks, 1983; Brooks & Yellen, 1987; Kuman,

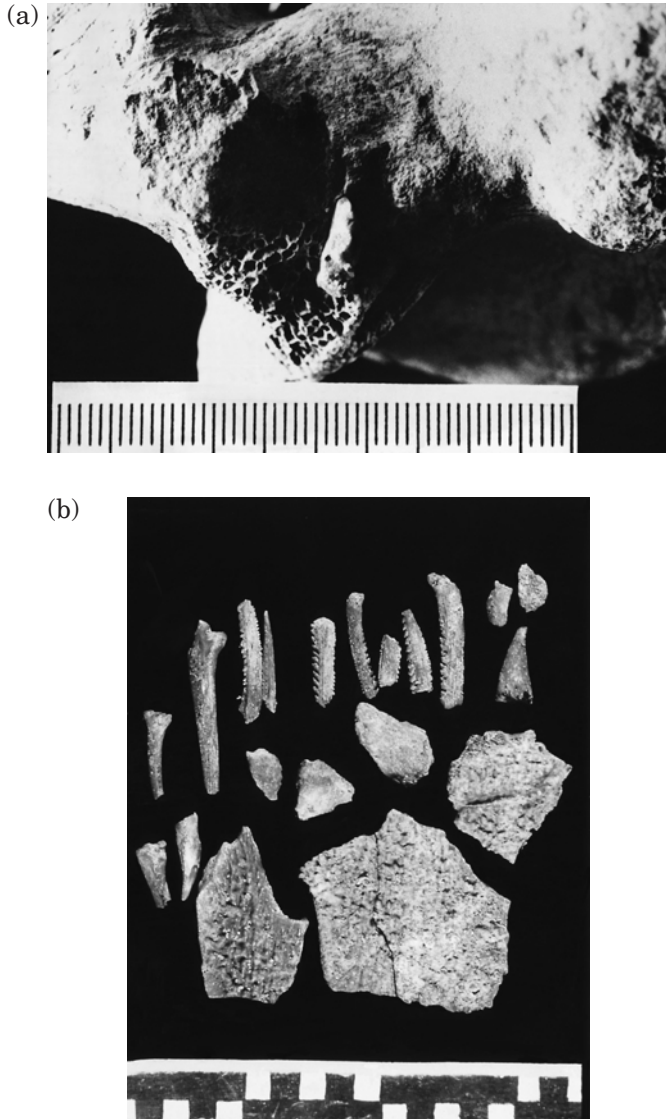


Figure 8. Faunal evidence for hunting and fishing in the African MSA. (a) Stone point tip embedded in bovid (*Pelorovis*) cervical vertebra, Klasies River (scale in mm) after Milo, 1998, Fig. 17; photo courtesy of Richard Milo; (b) fish bones (*Clarias*) from Katanda 9 (scale in cm). © Alison S. Brooks.

1989; Klein, personal communication). The number of projectile points in the MSA assemblage at \neq Gi indicates deliberate hunting, and the presence of species known to be large and aggressive shows competent hunting. Warthogs are particularly dangerous to human hunters, and the herd strate-

gies of zebra render them notoriously difficult to pursue. The location of the site and the presence of game species that are water dependent supports an interpretation of tactical hunting. This practice was probably even more effective in the past, when water availability was more restricted than

at present (Crowell & Hitchcock, 1978; Brooks *et al.*, 1980; Brooks & Yellen, 1987).

Klein, however, argues not on the basis of presence or absence, but from relative numbers. Warthog and buffalo, while not absent at MSA sites, are outnumbered by eland, and buffalo in some assemblages are represented only by juveniles (but see Milo, 1998, cited above). The age structures and species compositions of the LSA assemblages more closely approximates the living communities thought to be present at the time of occupation. Klein infers that MSA hunters were unable to take the more dangerous animals regularly and were forced to concentrate upon the more tractable eland. He concludes that MSA hunters were deficient not only technologically, but also cognitively and socially. These arguments can be questioned on both empirical and theoretical grounds. Gifford-Gonzalez (1991) has questioned Klein's method for estimating ruminant ages, and Marean & Assefa (1999) point out the confounding effects of time averaging on the MSA assemblages, which accumulated over substantially greater spans of time than the LSA assemblages. Minichillo & Marean (2000) argue that the greater species richness of the LSA when compared to the MSA may be explained by the larger sample sizes for LSA fauna. More fundamentally, one might wonder why one would query the intelligence of a hunter who chooses to pursue the eland rather than the ornery buffalo! Marean & Assefa (1999), Deacon (1984), and Bar-Yosef (1998) reject Klein's contrast between LSA and MSA hunting behavior as a sign of cognitive differences. A more satisfactory explanation is provided by Deacon (1989) and Marean (Marean & Assefa, 1999; Minichillo & Marean, 2000), who suggest that the faunal differences seen between MSA and LSA represents a progressive expansion of diet breadth. Less preferred items were included in the diet as a response to increased competition brought

about by population increase. In essence, the situation faced by LSA peoples was brought about by the success of preceding MSA hunters and fishers.

Ecology, economy and social organization

Aquatic and small-scale resource use

Whether deliberate fishing was habitually practised in the MSA has long been debated. In the absence of clear fishing paraphernalia, it is difficult to distinguish the signature of human acquisition from those of other piscivores in nonanthropogenic deposits. Deliberate procurement may sometimes be inferred on the basis of stratigraphic context or species' known habitat preferences. Thus, the remains of cichlid fish from White Paintings Shelter, Botswana, are interpreted as the products of fishing because they are found in eolian sediments. OSL determinations indicate that these date to 50–75 ka (Robbins *et al.*, 1994; Robbins & Murphy, 1998; Robbins *et al.* under review). Fish bones in the upper horizon at Site 440 in the northern Sudan are explained as the product of deliberate fishing because they are dominated by large deep-water species inconsistent with a riparian location. Likewise, at Bir Tarfawi, in the western desert of Egypt, several faunal assemblages associated with Grey Lake Phases 1 and 2 include Nile perch, a deep, permanent water species (Wendorf & Schild, 1992). In MSA levels at Blombos Cave, in the southern Cape province, South Africa, faunal remains include not only marine molluscs and small fish but also large deep water fish including *Cymatoceps nasutus* and *Aries feliceps* (Henshilwood & Sealy, 1997). Poeggenpoel (1999) argues that the taphonomy of the Blombos fish bones, especially the apparently deliberate damage to the spines, is consistent with human capture of live fish, and not with scavenging or nonhuman predation. These

finds establish the competence of MSA people at marine coastal fishing, if not the presence of watercraft.

Stewart (1989), from an analysis of East African LSA sites, provides a method for distinguishing human from nonhuman fish exploitation patterns, based on body size, species ecology, and skeletal element representation. Application of this method to open-air river margin MSA sites at Katanda, D. R. Congo, where bone points are found in association with the fish, suggests that, by at least 75 ka, African hominids exploited large catfish (*Clarias*) weighing more than 35 kg [Figure 8(b)]. All remains represent adult fish. The absence of other age classes indicates that fishing was carried out exclusively at the beginning of the rainy season when *Clarias* is known to spawn nearshore. This suggests that exploitation took place as part of a specialized seasonal strategy, rather than on an *ad hoc* basis. Furthermore, the relative paucity of fish vertebrae implies that edible portions were separated from heads at the site and removed to be consumed elsewhere (Brooks *et al.*, 1995; Yellen *et al.*, 1995). Clearly MSA people were competent hunters and fishers who planned their settlement choices around the seasonal availability of game and fish.

Studies by Crawford and others (e.g., Crawford, 1992; Chamberlain, 1996; Broadhurst *et al.*, 1998; Crawford *et al.*, 1999) have shown that Omega-3 (or n-3) polyunsaturated fatty acids (long-chain lipids with a first double bond at the carbon-3 position, counting from the methyl end) are essential to the developing brain of young mammals. They suggest (e.g., Crawford, 1992) that it is the limited availability of such lipids in terrestrial foods which is primarily responsible for limiting the growth of the brain in terrestrial megafauna. These lipids, primarily docosahexaenoic and arachidonic acids, are absent in plants and minimally present in terrestrial animals except for brain tissue,

which contains up to 600 g of lipids per kg (Broadhurst *et al.*, 1998). Since marine foods are particularly rich in such lipids, marine mammals face no such limitation and can grow relatively larger and more complex brains. Crawford *et al.* (1999) argue that access to marine foods was essential to the development of the modern human brain, and that the evolution of *H. sapiens* took place at the land-water interface. Use of rift valley fish, such as *Clarias*, which are especially rich in Omega-3 fatty acids, by MSA peoples suggests that this adaptation, with its potential for improved infant nutrition, survivorship and consequent population increase was already in place by at least 80 ka.

Deacon has held that subsistence behavior in the MSA is indistinguishable from that in the LSA, in part on the basis of the shellfish debris and plant remains. He maintains, for example, that the charred lenses of vegetal material in the Howiesons Poort levels at Klasies River represent burnt geophyte residues. Ethnographically, geophyte patches were sustained by controlled burning, which stimulates corm production. The Klasies traces may therefore indicate environmental management and a reliance on carbohydrate-rich plant foods that parallel Holocene practices (Deacon, 1985, 1989, 1993a,b; Deacon & Geleijnse, 1988; Deacon & Deacon, 1999). Intensive processing of plant foods is revealed by the general presence of grindstones at many MSA sites, including Bir Tarfawi, Egypt; Katanda, D. R. Congo; ≠Gi, Botswana; and Mumbwa, Zambia (Wendorf *et al.*, 1993b; Brooks *et al.*, 1995; Yellen *et al.*, 1995; Brooks & Yellen, 1987; Barham, 1998). This activity seems to have commenced in late Acheulian contexts at Kalambo Falls, Zambia (Clark, 1988) and in the Kapthurin Formation, Kenya.

The use of small scale resources, either aquatic or terrestrial, is usually viewed as a sign of economic intensification. MSA

people were certainly capable of harvesting small-scale resources and showed a taste for these food items. In North Africa, molluscs are present in the MSA levels at Haua Fteah, Libya (McBurney, 1967; Klein & Scott, 1986), at Bérard, Algeria (Roubet, 1966), and at Témara (Roche & Texier, 1976), Mugharet el-Aliya (Howe, 1967), and Zouhra (Debénath & Sbihi-Alaoui, 1979) in Morocco. Walter *et al.* (2000) report stone artefacts and marine bivalves, gastropods, and other invertebrate fossils from a reef platform near Massawa on the Red Sea coast of Eritrea, dated by U-series on fossil coral to ca. 125 ka (see also Stringer, 2000). Despite the presence of handaxes, the artefacts are described as MSA. Although the behavior represented by the finds is difficult to evaluate without details of the artefacts or their archaeological context, the authors have interpreted the material to represent the harvesting of marine resources in a shallow subtidal environment. In South Africa, shellfish remains are found at Klasies River (Singer & Wymer, 1982; Deacon & Geleijnse, 1988; Thackeray, 1988; Deacon, 1989, 1995), Die Kelders (Avery *et al.*, 1997; Grine *et al.*, 1998; Goldberg, 2000; Klein & Cruz-Uribe, 2000), and Herolds Bay (Brink & Deacon, 1982), as well as at Hoedjies Punt, Sea Harvest, and Boegoeberg 2 (Volman, 1978; Klein, 1989a, 1999). MSA populations apparently were also sometimes subject to conditions leading to the intensive exploitation of these resources, as shown by the unusually large quantities of giant land snail (*Burtoa nilotica*) shell in the later MSA deposits in Bed V at Mumba Rock Shelter, Tanzania (Mehlman, 1989), and the large numbers of angulate tortoises (*Chersina angulata*) at Die Kelders (Klein, 1994; Klein & Cruz-Uribe, 2000). Evidence from coastal Italy (Stiner, 1993, 1994; Stiner *et al.*, 1999, 2000) and Gibraltar (Barton *et al.*, 1999) shows that Neanderthals did sometimes eat marine shellfish, but the impressive

escargotière at Mumba and the numbers of coastal African sites containing quantities of shellfish seem to indicate a more regular intensive use of small scale resources in the MSA.

Klein (1989a, 1995, 1999) has contrasted the MSA levels at Klasies River and other southern Cape sites in which marine resources are relatively scarce, to the subsequent LSA occupations in which they are relatively abundant. The MSA inhabitants at Klasies River, Die Kelders, Sea Harvest, Hoedjies Punt, Mossel Bay, and Herolds Bay Cave did utilize shellfish (limpets), and, at Klasies, marine mammals (seals), and birds (penguins) (Volman, 1978; Brink & Deacon, 1982; Thackeray, 1988; Klein, 1994; Avery *et al.*, 1997). The MSA levels yielded smaller quantities of shells than LSA levels at some sites. It may be that the use of marine resources was not as frequent or as regular in the MSA as in the LSA, but the smaller volume of shell in the MSA levels at Klasies River and Die Kelders is in part the result of decalcification of the older cave deposits. At both sites the lower strata are clearly compressed, the bulk of bone and shell having been leached away (Goldberg, 2000; Deacon, personal communication; Avery, personal communication; personal observation).

Comparison of shell diameters from the MSA deposits at Hoedjies Punt, Sea Harvest, and Boegoeberg 2 with LSA middens at Paternoster and Elands Bay Cave, South Africa, shows a decline in the mean size of the limpet *Patella granatina* from MSA to LSA times (Klein, 1989a, 1999). This trend reflects the harvesting of less mature individuals, one of the clear signs for economic intensification in the LSA. The mean size of mammalian prey species also decreased. Comparison of seal mortality profiles from MSA (Klasies River and Die Kelders) and LSA (Dunefield, Die Kelders, Kasteelberg, Elands Bay Cave, Nelson Bay Cave) reveals that seals in the

LSA of the South African Cape coast were harvested during their breeding season, while in the MSA, seals were apparently taken throughout the year (Klein, 1994, 1995; Klein & Cruz-Urbe, 1996). Klein has argued that this pattern indicates a more selective, seasonally focused strategy for the LSA hunters. Marean & Assefa (1999) have pointed out that LSA assemblages represent shorter time intervals than most of those from the MSA. They may thus be less subject to the problems of time averaging and thereby show clearer patterns of seasonality. Furthermore, it is not clear why taking seal when natural mortality is high should indicate greater intelligence or technical competence.

Klein (1989a, 1994, 1995, 1998, 1999, 2000) has repeatedly asserted that the greater intellectual abilities and technological sophistication of LSA people allowed for intensification and resulted in an increase in the human population. LSA sites greatly outnumber MSA sites on the African landscape, and while LSA sites have been presented with fewer opportunities for obliteration, the greater number of sites no doubt reflects a real increase in human numbers. We would argue that there is no intellectual difference in the abilities of MSA and LSA hominids. Rather, a long-term trend in population growth led to residual crowding and a diminished resource base, rendering further intensification necessary in the LSA (cf. Voigt, 1982; Deacon, 1989; Milo, 1998; Marean & Assefa, 1999). In addition, crowding probably led to greater residential stability in the LSA, which in turn may contribute to higher archaeological visibility for small food items. Yellen (1991) has shown that at Jun/wasi sites, longer residential times result in higher representation of small species in faunal assemblages. Small faunal elements are at risk of destruction by carnivore gnawing, but lose their attractiveness to scavengers after a period of three days, whereas larger bones may retain

grease or marrow for several weeks or even months. The presence of people discourages scavenging by nondomestic carnivores, and after the departure of the human group, many of the smaller faunal remains are no longer of interest to scavengers. Residential stability thus "protects" the small-mammal component from the attentions of scavengers and leads to better small element survival. The decreased mobility of larger, more dense human populations may thus exaggerate our perception of increased use of small scale resources in the LSA.

Economy and social organization

Lithic resource procurement

The exchange of goods and the development of trade networks are important components of contemporary society and have been considered key ingredients in modern human behavior (White, 1982; Mellars, 1996; Klein, 1989b, 1995). In Upper Paleolithic Europe, raw materials such as elk teeth, mammoth ivory, amber, marine shells, and fossils were obtained from distant sources and transformed into decorative objects (White, 1982, 1989b, 1993; Taborin, 1993).

Studies of the sources of lithic materials can provide information on ranging patterns and resource networks for stone tool-using populations. Two general principles apply in nearly all prehistoric contexts. First, local raw materials almost invariably outnumber those obtained from distant sources. Second, in most cases, exotic stone, being of higher quality, was more intensively utilized and presumably more highly prized (Geneste, 1989a,b; Turq, 1989; Kuhn, 1991; 1992; Mellars, 1996; Blades, 1999).

In the Middle Paleolithic of western Europe, according to Féblot-Augustins (1997), most raw material is locally derived, but 13–17% of sites ($n=116$) contain small quantities of stone from as far away as 80–120 km (cf. Conard & Adler, 1997). In the late Middle Paleolithic of central and

eastern Europe, 71% of sites ($n=24$) yield materials from sources lying at distances >80 km, in one case as much as 300 km. Mellars (1996: 164) points out that sources of flint are far more widely dispersed in central and eastern Europe than in southwestern France, but both Féblot-Augustins (1997: 162–163) and Steele & Gamble (1998; Gamble, 1986) explain the differences between eastern and western Europe raw material procurement on ecological grounds. Their view is that colder, more continental climates in the east would have necessitated greater seasonal displacement and larger home ranges for hominids, as it does for other mammals, and these would be reflected in raw material acquisition patterns.

Local raw materials continue to dominate Upper Paleolithic assemblages. For example, at nearly all the German Gravettian sites studied by Scheer (1993), more than 95% of the lithic artefacts were made from raw material obtained from within a radius of 25 km. At some French Upper Paleolithic sites the proportion of exotic flint makes up 25% of the assemblage, but the distance the material is transported remains much the same as in the Middle Paleolithic (Mellars, 1996; Geneste, 1989b; Féblot-Augustins, 1997; Blades, 1999). Only five (1.9%) of 263 western European sites, all in Belgium and Germany, studied by Féblot-Augustins (1997) have raw materials from distances exceeding 100 km, and no transport distance from any Châtelperronian site in his study exceeds 100 km ($n=26$). Exotic stone from sources more distant than 100 km does occur in the Perigordian/Gravettian and the Magdalenian, although in only one case in the Magdalenian does the transport distance exceed 200 km (Féblot-Augustins, 1997: Table 38). In central Europe, transport distances and proportions of exotic materials in the early Upper Paleolithic are greater than in western Europe, with 27.6% of his

Szeletian sites ($n=76$) and 42% of his Aurignacian sites ($n=150$) having distances exceeding 100 km. Maximum transport distances in the eastern European early Upper Paleolithic are as great as 300–420 km (Féblot-Augustins, 1997: Tables 38 and inventories 57–62).

If the greater transport distances in the eastern European Paleolithic can be explained on ecological grounds, as suggested by Gamble (1986; Steele & Gamble, 1998), it would seem that the African MSA should be characterized by smaller territories and transport distances, especially in the tropics (Deshmukh, 1986; Foley, 1987), but the reverse is true. At African Acheulian sites, exotic raw materials are rare (Merrick & Brown, 1984; Merrick *et al.*, 1994; Féblot-Augustins, 1997: inventories 8–13). Fewer than 1% of the items in the artefact inventories have been transported for distances greater than 40 km, and the maximum transport distance is 100 km for the Ethiopian site of Gadeb. In the East African MSA, while the proportion of exotic raw materials remains under 1%, known transport distances for materials at some sites are much greater. Through analysis of their elemental and chemical compositions by electron microprobe (EMP), and in some cases x-ray fluorescence (XRF), about a dozen distinct petrological groups can be distinguished among the obsidian flows in the central Kenyan Rift Valley (Merrick & Brown, 1984; Merrick *et al.*, 1994). Artefacts manufactured in obsidian from these sources have now been identified from a number of MSA sites in Kenya and Tanzania. A specimen from the MSA site at Songhor, western Kenya (McBrearty, 1981), has been shown to be from a source at Njorowa Gorge, 145 km to the east. Two specimens from the MSA Pundo Makwar industry from member 6 at the site of Muguruk, western Kenya (McBrearty, 1986, 1988) are derived from sources at Eburru and Sonanchi, 185 km and 190 km

from the site. Between Muguruk and Songhor and their obsidian sources lies the western shoulder of the Gregory Rift, and to transverse this impressive physiographic obstacle involves a climb of at least 1000 m.

Obsidian at two MSA sites in northern Tanzania are derived from some of the same central Kenya Rift sources as the Muguruk and Songhor artefacts, and was transported over even greater distances. A sample of four pieces of obsidian from the MSA Kisele industry in levels 14–22 at Nasera Rock Shelter, near Lake Eyasi in northern Tanzania, are from sources at Sonanchi, Eburru, and Masai Gorge, near Lake Naivasha, 240 km north-northeast of Nasera (Merrick & Brown, 1984; Mehlman, 1989). A sample of seven pieces of obsidian from the MSA Sanzako and Kisele industries in Bed VI at the Mumba Rock Shelter in the same region of northern Tanzania (Mehlman, 1977, 1979, 1989, 1991) are derived from an outcrop that lies 320 km from the shelter (Merrick & Brown, 1984; Mehlman, 1989). The Sanzako industry is dated by U-series to 100–130 ka (Mehlman, 1987).

Nor are these isolated examples. At Porc Épic, Ethiopia, obsidian makes up 5.5% of the MSA assemblage. Though geochemical analyses have not been carried out, the obsidian is believed to have come from sources 90 km or 140 km to the west (Clark *et al.*, 1984). Merrick *et al.* (1994) believe that although movement of ~100 km might fall within the range of mobile foraging groups, it is unlikely that transport of obsidian for distances >300 km represents deliberate collecting forays. They suggest instead that increased interaction and exchange among human groups can explain the distribution of obsidian over the MSA landscape.

At some East African MSA sites where obsidian is plentiful, raw material procurement and use patterns are different. At the GvJm-16 rockshelter on Lukenya Hill,

Kenya, obsidian comprises 5–8% of the artefacts. In the earlier MSA levels here, the majority of the obsidian (53%), is derived from sources <65 km distant. The remaining 31% of the obsidian, or 2% of the total assemblage, comes from sources between 105 and 135 km away. In the later MSA levels, 62% of the obsidian comes from these exotic sources. There appears to be no difference in the manner in which local and exotic materials are treated at Lukenya Hill for artefact production, and there is no evidence for the importation of finished tools. At the open air MSA site of Prospect Farm, excavated by Anthony (1978) and dated by obsidian hydration to >120 ka (Michels *et al.*, 1983), as many as 99.5% of the artefacts in any given level are obsidian. The site is located on Mount Eburru itself, in extremely close proximity to obsidian outcrops, but even here, low frequencies of exotic obsidian from a source at Kisanana, 75 km away, are found throughout the sequence (Merrick *et al.*, 1994). The MSA inhabitants of the nearby site of Prolonged Drift (GrJi-11), Kenya, seem to show a definite preference for exotic obsidians. Here nearly 90% of the obsidian is imported from sources at Sonanchi and Njorowa Gorge, 45–55 km from the site, and only a few specimens have been found to represent the much nearer Masai Gorge outcrops near Mount Eburru (Merrick *et al.*, 1994). There is no evidence to suggest that approach to any of these obsidian outcrops was prevented by physiological factors in the past. While the suggestion is speculative, it is possible that some human groups controlled access to valuable obsidian sources and prevented collection by others. The presence of stylistic provinces in the African MSA strengthens the impression of distinct ethnic groups, and seems to support trade rather than transport as the obsidian distribution mechanism.

On the Cape coast of South Africa, the use of fine grained raw materials is a

feature of the Howiesons Poort industry that distinguishes it from other MSA industries, and these raw materials are selectively used for the manufacture of microliths (Singer & Wymer, 1982; Volman, 1984; Thackeray, 1992; Deacon & Wurz, 1996; Wurz, 1997, 1999). While 96.0–99.8% of the artefacts in the other MSA levels at Klasies River main site are local quartzite, this raw material comprises only 73.0% of the Howiesons Poort assemblage. The remaining 27.0% is made up of silcrete, quartz, and hornfels (Wurz, 1997). Although determining the precise source areas for the silcretes is problematic, outcrops exist in the inland Cape Folded Mountains at distances ≥ 15 km (Singer & Wymer, 1982; Wurz, 1997). In a recent sample of Howiesons Poort artefacts from Klasies River cave 2, only 4% of the total sample is nonquartzite, but 39% of the retouched artefacts are made in nonquartzitic raw materials (Wurz, 1997).

Ambrose & Lorenz (1990), Deacon (1989), and others portray the Howiesons Poort as an adaptation to cool, moist conditions and a closed vegetation community. This interpretation is supported by the presence of *éboullis sec* (angular rock fragments with little chemical weathering) in Howiesons Poort deposits at Border Cave, Boomplaas, Montagu Cave, and Nelson Bay Cave (Ambrose & Lorenz, 1990), by ^{18}O values on marine molluscs from Klasies River indicating cool sea water temperatures (Shackleton, 1982), by the absence of beach sand in the same levels indicating low sea level (Butzer, 1982), and by the preponderance among the Howiesons Poort ungulate faunas at Klasies River, Boomplaas, and Border Cave of small, closed habitat forms (Klein, 1976, 1978; Deacon, 1979; Ambrose & Lorenz, 1990). Ambrose & Lorenz (1990; Ambrose, 1998c) view raw material procurement as embedded within the resource acquisition round and see technological change in part as a response to

changing lithic resource availability. Thus higher frequencies of exotic lithics in the Howiesons Poort relative to the preceding MSA I and II and the succeeding MSA III and IV signal the larger territories required due to resource patchiness or unpredictability. While most authors (e.g. Deacon, 1989; Ambrose & Lorenz, 1990; Deacon & Wurz, 1996; Deacon & Deacon, 1999; Wurz, 1999) imply that the Howiesons Poort and the MSA I–IV are the varied responses of a single population seen through time, it seems at least equally likely that these distinct interstratified technologies were produced by different hominid groups.

High-quality raw materials were used preferentially to manufacture the Howiesons Poort geometrics (Singer & Wymer, 1982; Wurz, 1997), which may have played a major role in the maintenance of social networks. Ethnographically, subsistence under adverse conditions such as those documented for the Howiesons Poort requires territories too big for even a large group to defend. It encourages information sharing among groups and the maintenance of a network of sometimes elaborate and ritualized obligations with distant allies as insurance against times of resource scarcity (Gould, 1978; Wiessner, 1982, 1983, 1986, 1998). Deacon (1989; Deacon & Wurz, 1996) considers the standardized geometrics of the Howiesons Poort expensive and notes that they are precisely the kind of objects used in the ritual *hxaro* exchange system of modern San people, as described by Wiessner (1982, 1983, 1986), even though geometrics may only require 10–20 seconds each to produce, once the raw material has been obtained (Rozoy, 1985). Both Deacon (1989) and Wurz (1999; Deacon & Wurz, 1996) stress the symbolic content of Howiesons Poort backed geometrics. Deacon sees the specialized Howiesons Poort artefacts as a means of maintaining populations and their social structures

during times of resource stress, rather than simply as a coping mechanism to deal with colder and drier conditions. Because quartzite geometrics do not differ significantly in their measurable attributes from silcrete examples, Wurz (1999) concludes that selection of silcrete was not made for utilitarian reasons. Rather she argues that the use of a more costly raw material rendered the finished object, presumably arrow or spear armatures, more valuable as an item in an exchange network. While future experimental replication may well show that the flaking properties of silcrete are superior to those of quartzite for the manufacture of geometrics, this would not diminish the value of the objects as items of exchange.

Economy and social organization

Site structure and modification

The designation of different areas of a habitation site for different activities reveals a formalized conceptualization of the living space that is considered by many to indicate sophisticated cognitive functions (e.g., Binford, 1989; Hodder, 1987). The deliberate modification of the occupation area is thought to be unique to *H. sapiens*, and is a feature that consistently distinguishes European Upper Paleolithic from Middle Paleolithic sites (Farizy, 1990; Mellars, 1996). Potential bias in our perception of patterning in residential sites has several sources. Ephemeral sites may have little formal structure imposed by their inhabitants, but sites occupied for long periods may have any existing patterns "smeared" by later inhabitants. Caves may preserve occupation features better than open sites, but they also circumscribe the occupation area and impose space limits. The result may be overprinting of different activities or a higher degree of activity segregation, depending upon the inhabitants' response.

Many examples of MSA site modification remain ambiguous due to our inability to

eliminate natural agents in their formation. Thus the store pavement from Katanda, D. R. Congo, reported by Yellen (1996) and dating to 70–90 ka (Brooks *et al.*, 1995), may represent a deliberately constructed habitation substrate or may be a lag concentrated by fluvial processes or termites (cf. McBrearty, 1990a). Its sharp boundaries resemble those from the Acheulian artefact concentrations at the Olorgesailie Main Site, interpreted by Isaac (1977) as fluvial cut and fill features, but by Potts *et al.* (1999a,b) as the result of human activities. Similarly, the concentration of bipolar flaking debris at Simbi, Kenya, reported by McBrearty (1993b) and dating to between 200 and 60 ka, may be an undisturbed activity area or deliberately dumped refuse (cf. Wilson, 1994), but the possibility that it was concentrated by gently flowing water cannot be ruled out. An often cited example of semi-circular MSA windbreaks at Orangia, South Africa (Sampson, 1968, 1974) is now thought to date to the LSA (Klein, 1989b).

However, there are a number of unambiguous examples of deliberate site modification from MSA contexts. Debénath (1994; Debénath *et al.*, 1986) reports the remains of structures from a number of Aterian sites both on the Mediterranean littoral and in the Sahara. Traces of post-holes have been found at le Chaperon-Rouge, Morocco, and at Seggédim, Niger. At the latter site, the sharp edges of the flint scatter adjacent to the post holes suggests the location of an ephemeral wall or palisade. At the Grotte Zouhra (El Harhoura), Morocco, arrangements of stone wedges are believed to have served as supports for poles. At the sites of Nazlet Safaha in the Nile Valley of Egypt, extensive MSA quarrying for flint has created a series of ditches up to 2 m wide and 1.7 m deep covering an area of 600 m² (Vermeersch *et al.*, 1990). A similar practice is reported for the nearby extensive Taramsa site complex (Vermeersch *et al.*, 1990; van Peer, 1998).

Deliberate arrangement of large piles of stones, whose purposes are as yet unknown, are also known from the MSA. From Aterian context at Dar-es-Soltane 2, Debénath (1994) describes an enigmatic heap of sandstone slabs about 1 m in diameter and 30 cm high. A larger pile of approximately 60 limestone balls was recovered from a fossil spring at the site of El-Guettar, Tunisia, together with broken bone, flaking waste, and a collection of retouched tools that includes a tanged Aterian point (Gruet, 1954, 1955; Clark, 1982). Some of the El-Guettar stone balls are deliberately shaped spheroids, others are naturally round; they have diameters ranging between 4.5 and 18.0 cm. The base of the pile may have been surrounded by a ring of larger stones. A similar mass of stone balls 1.3 m in diameter and 75 cm high has been recovered from an ancient spring near Windhoek, Namibia (Fock, 1954; Clark, 1982). It is made up of 36 spheroids, each weighing between 600 and 1200 g. The unique association of these piles of stone balls with springs has been emphasized by Clark (1982: 265), who suggests that they may have been cairns, implying a symbolic function, or more prosaically, that they may have provided a platform from which to collect water, though why spheroids would be needed for this purpose is unclear. The possibility that the spheroids may have tumbled by chance into the eyes of the springs cannot be ruled out, but their large numbers suggest that these are not chance associations, and deliberate placement by the site occupants seems most likely.

A striking example of MSA structures from subsaharan African is reported by Barham (1996) at Mumbwa Cave, Zambia. Here three superimposed arc-shaped features of stone blocks, ash, baked sediment and lithic and bone debris are associated with a number of hearths and post holes. Barham (1996) interprets these as the remains of three circular windbreaks

that would have had diameters of about 3 m. His interpretation is supported by the distribution of lithic debitage and bone debris, which dip toward the center of the arcs, suggesting that they were banked up against the perimeter, possibly by deliberate sweeping. Barham notes that these windbreaks would have served to deflect the prevailing easterly winds and to create a trap for heat generated by the afternoon sun against the cave wall.

Also in the MSA levels at Mumbwa is clear evidence for deliberately constructed stone-lined hearths. Six of these, built of large limestone blocks as well as transported stone, contain quantities of indurated ash, burned bone, and burned limestone and sediment. One partially eroded example would have had a diameter of >70 cm when complete, was 25 cm deep, was filled with 10 cm of ash and surrounded by a zone of baked sediment. Barham suggests it may have been used as a roasting pit. Another example measures 90 cm × 70 cm, with a depth of ash of 5 cm. Five others are superimposed, and apparently stones from earlier hearths were reused in the construction of the later features. This indicates a clear conception of space and its deliberate, repeated use for the same function. The many superimposed hearths in the Howiesons Poort levels at the main site at Klasies River (Henderson, 1992; Deacon, 1995, 1998) suggest similar reuse and a formal conception of domestic space.

Symbolic behavior

Special treatment of the dead

Burial and other special treatments of the dead are a consistent feature of the symbolic life of modern human societies, and the belief that the Neanderthals deliberately buried their dead has been a major factor contributing to an impression of their humanity and, for some, their inclusion in

our species. Despite the ambiguities introduced by taphonomic processes and nineteenth-century recovery techniques (Gargett, 1989, 1999), there is general agreement that most if not all relatively complete Neanderthal skeletons were deliberately interred (comments to Gargett, 1989; Defleur, 1993; Mellars, 1996, and references therein). For modern human groups, burial connotes respect for the dead as well as symbolic and ritual ideas. If Neanderthals did deliberately bury their dead, there can be no certainty that the practice was ritual and not merely hygienic in nature. These issues have often been discussed (e.g., Mellars, 1996) and are cogently reviewed by Chase & Dibble (1987) and Hayden (1993). Particularly significant is the lack of grave goods in Neanderthal burials, apart from materials normally encountered in the archaeological sediments that composed the grave fill.

While skeletal completeness and articulation of elements have been regarded as evidence for Neanderthal burial (Belfer-Cohen & Hovers, 1992), Gargett (1989, 1999) emphasizes the importance of natural disarticulation (e.g., Hill, 1979), rockfall (Farrand, 1985), and postmortem tissue dehydration at low temperatures as factors to be considered in Pleistocene cave environments. If his interpretation were correct, we would owe the richness of the Neanderthal fossil record to the hazards of living in caves, rather than to Neanderthal corpse disposal habits. However, there is good evidence for earlier occupation of caves at numerous sites with good faunal preservation in Middle Pleistocene Europe (e.g., Arago, Lazaret, Peche de l'Azé, Vértesszöllös), in the Near East (e.g., Yabrud, Tabun, Zuttiyeh) and in Africa (e.g., Cave of Hearths, Haula Fteah), and it is difficult to explain why articulated skeletons are completely lacking from this time range. The hominids from the Sima de los Huesos, Atapuerca, Spain, numbering at

least 32 individuals, dated by ESR and U-series to 320–200 ka (Bischoff *et al.*, 1997) may have been accumulated by deliberate disposal down a 13 m shaft in the interior of the cave. Alternatively, carnivores or natural sedimentary processes may have introduced the hominid material into the site, or the *sima* may have acted as a death trap for hominids, as well as for bears and other carnivores (Arsuaga *et al.*, 1997b; Andrews & Fernandez-Jalvo, 1997).

The earliest evidence for burial among *H. sapiens* is found in the Levant at the site of Qafzeh, where at least four out of as many as 15 individuals represented in the cave are interpreted as deliberate interments (Vandermeersch, 1981; Bar-Yosef *et al.*, 1986). These are dated by TL, ESR, and AAR to ca. 90–120 ka (Schwarcz *et al.*, 1988; Valladas *et al.*, 1988; Brooks *et al.*, 1993b; Bar-Yosef, 1998). At least one of these, Qafzeh 11, may be associated with grave goods (Vandermeersch, 1981; Bar-Yosef & Vandermeersch, 1993).

Population movements among both Neanderthals and *H. sapiens* as a response to climatic change may have been frequent in the Pleistocene. Mammalian fauna associated with early *H. sapiens* in the Levant suggests an extension of the Ethiopian fauna, including *H. sapiens*, to the region during or prior to oxygen isotope stage 5 (Tchernov, 1988, 1998), and a later expansion of the Neanderthals as part of a European fauna, into the same territory (Hublin, 1990, 1998b; Klein, 1995–1996; Bar-Yosef, 1998). Neanderthals and *H. sapiens* coexisted in Europe for a period of about 10,000 years (Mellars, 1998b,c), and aspects of modern behavior represented in European archaeological industries of the period between 40 ka and 30 ka, such as the Châtelperronian, Uluzzian, and Szeletian, appear to be the result of Neanderthal acculturation (e.g., Allsworth-Jones, 1986, 1990; Demars & Hublin, 1989; Farizy, 1990; Ruiz & Hublin, 1994; Mellars, 1998a; but see

d'Errico *et al.*, 1998; Zilhão & d'Errico, 1998). Neanderthal burials in Europe date to after 75 ka (Mellars, 1986, 1996), and it is quite plausible that the practice of burial of the dead was also learned by the Neanderthals from their modern neighbors in the Near East, among whom the practice predates 90 ka.

In Africa, deliberate burials of Middle Pleistocene hominids are absent. The cutmarks on the temporal bone of the Bodo cranium, however, indicate defleshing with a stone tool (White, 1986), and suggest either cannibalism or a postmortem ritualized treatment of the skull. Evidence for cannibalism is also present in the modern human sample from Klasies River (White, 1987; Deacon & Deacon, 1999), where the state of the human remains in terms of fragmentation, cutmarks and burning is indistinguishable from that of the nonhuman bones, which are presumably food remains. It is interesting to speculate upon whether the fragmented modern human fossils represent a prey population, while the stone tools were made by their predators, whose remains have not become incorporated into the cave fill.

There is evidence that deliberate interment was practiced by early *H. sapiens* in Africa, but it is not uncontroversial. Modern human remains have been recovered from Border Cave, South Africa. These include a partial cranium, two mandibles, some postcranial bones (BC1, BC2), and a nearly complete infant skeleton (BC3), which is interpreted as a deliberate burial (Beaumont *et al.*, 1978). Doubt has been cast on the provenience of the Border Cave hominid fossils, because the cranium and limb bones were found in the course of guano mining, and all of the human fossils, with the exception of the second mandible, were recovered in the 1940s, when recovery techniques were far from ideal. Parkington (1990) argues that the human fossils from Border Cave are intrusive from upper levels in the

cave as they are unfragmented and in an excellent state of preservation, unlike the balance of the MSA fauna. Sillen & Morris (1996) have argued that the diagenetic state of the BC3 infant skeleton is not consistent with great antiquity. This is difficult to reconcile with the report of the excavators, who noted that it was found in a shallow grave, covered with intact sediments.

If the Border Cave hominids were *in situ* in the MSA levels, their age is beyond the range of reliability for radiocarbon. Radiocarbon dates for the later MSA levels at the site are infinite (>48 ka), and Beaumont *et al.* (1978) estimate the age of the hominids at 90–100 ka on paleoclimatic grounds. Sediments overlying the grave contained ostrich eggshell fragments that are now dated to 105 ka by AAR calibrated by ¹⁴C determinations on charcoal from higher in the cave sequence (Miller *et al.*, 1993, 1999). If the associations are valid, and if the age estimate is accurate, then the Border Cave infant (BC3) may be the earliest known human burial. It is significant that the infant was associated with a single perforated *Conus* shell, which is interpreted as a pendant (Cooke *et al.*, 1945; Wells, 1950; Beaumont & Boshier, 1972).

Another deliberate human burial from MSA context is described by Vermeersch *et al.* (1998) from the site of Taramsa, a flint extraction and reduction site complex in the Nile Valley of Egypt. Here the complete skeleton of a juvenile with an estimated age at death of 8–10 years has been recovered in association with Nubian Levallois technology and foliate points. The skeleton has preliminarily been described as fully modern. The face is somewhat prognathic and the teeth are large, and there are no appreciable supraorbital tori; it is comparable in these features to Qafzeh 9. The child's skeleton was found in a seated position, with the legs flexed and the head facing upward. There appear to be no grave goods, apart from the stone artefacts. While

the grave fill consists of large cobbles and eolian sand, interpreted as quarry dump debris, the burial is overlain by intact MSA deposits. OSL dates on sand range from 80 ka to 50 ka.

An additional case of possible deliberate burial has been reported from the site of Mumbwa, Zambia, where stone beehive-shaped structures have been found to contain fragmentary human bones (Dart & Del Grande, 1931; Jones, 1940; Clark, 1989; Barham, 1996). One cairn is found at a depth consistent with a date in the MSA, but as Barham (1996) points out, the structure may be intrusive, and it closely resembles Holocene examples from higher in the sequence.

Beads and ornaments

Ornaments, as symbolic artefacts, have long been recognized as a hallmark of modern human behavior, although their distribution in the European Upper Paleolithic is uneven, and many Aurignacian sites lack pierced or decorated items altogether (e.g., White, 1989a,b, 1993). Ornaments are infrequent at European Middle Paleolithic sites. Nearly all of these rare items are in questionable stratigraphic contexts or from early uncontrolled excavations (e.g., La Quina, La Ferrassie) or are associated with final Middle Paleolithic contexts postdating the appearance of *H. sapiens* in Europe (e.g., Bacho Kiro, Cueva Morín, Arcy sur Cure) (d'Errico *et al.*, 1998; Zilhão & d'Errico, 1998). Hublin (1998b, 1999; Hublin *et al.*, 1996) has argued that though the techniques of manufacture of early Upper Paleolithic and late Middle Paleolithic pierced tooth ornaments differ, the idea of ornamentation itself was acquired by the Neanderthals from their *H. sapiens* neighbors through trade or imitation (cf. Mellars, 1998a).

Ornaments have also been thought to be lacking in the African MSA, but it is now clear that the African tradition of body

ornamentation predates that of Europe by tens of thousands of years. The perforated *Comus* shell associated with the infant burial BC3 in MSA context at Border Cave may date to before 105 ka, though the cautions of Sillen & Morris (1996) regarding the possibly intrusive context of BC3 must be borne in mind. A number of body ornaments are now known from Aterian sites dating from at least 130 ka to ca. 40 ka. These include a bone pendant from the Grotte Zouhra, Morocco (Debénath, 1994), four deliberately drilled quartzite flakes, probably designed for use as pendants, from Seggédim in eastern Niger (Tillet, 1978; Debénath, 1994), and a perforated shell of *Arcularia gibbonsula* from Oued Djebanna, Algeria (Morel, 1974). It is also of interest that the only perforated objects found in the Levant prior to the Upper Paleolithic are associated with *H. sapiens* and fauna including African taxa (Bar-Yosef & Vandermeersch, 1993).

The manufacture and use of ostrich eggshell beads is widespread in the African LSA. The earliest LSA ostrich eggshell beads in southern Africa are documented by Robbins (1999), where direct AMS ¹⁴C assays on a drilled bead preform from White Paintings Rock Shelter yielded an age of 26 ka (Kokis *et al.*, 1998; Robbins, 1999). Deeper in the section at White Paintings, an eggshell partial disc that resembles the opening of a water container has been dated to 31 ka, and indicates a greater antiquity for the practice of eggshell working (Robbins, 1999). At Enkapune ya Muto, Kenya, beads are known from an early LSA content [Figure 9(a)], where radiocarbon dates on ostrich eggshell fragments from bead manufacture indicate an antiquity of ca. 37–40 ka (Ambrose, 1998a). An early set of radiocarbon dates on charcoal indicate a similar age for ostrich eggshell beads from LSA context at Kisese II rock shelter, Tanzania (Inskip, 1962). Ambrose (1998a) makes a compelling case that dates in this age range

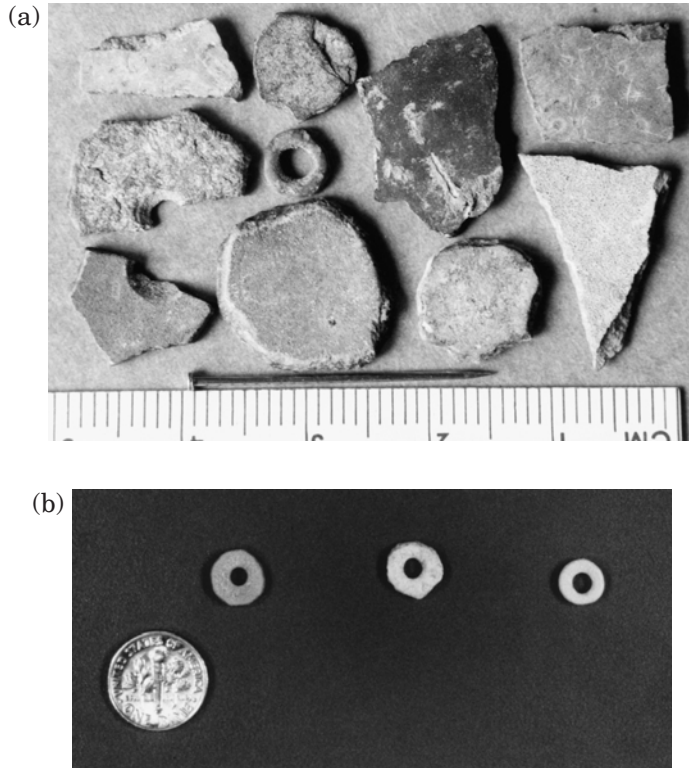


Figure 9. Early ostrich eggshell beads. (a) Enkapune ya Muto, after Appenzeller, 1998; photo courtesy of Stanley Ambrose; (b) Mumba. © Alison S. Brooks.

are particularly likely to be underestimates. The layer containing the beads at Enkapune ya Muto is underlain by units estimated by obsidian hydration to date to >46 ka (Ambrose, 1998a).

Beads have been reported from three MSA sites in South Africa, Cave of Hearths (Mason, 1962; Mason *et al.*, 1988), Boomplaas (Deacon, 1995), and Bushman Rock Shelter (Plug, 1982), from late MSA (Tshangulan) levels at Nswatugi, Zimbabwe (Cooke, 1971), and from one MSA site in East Africa, Mumba Rock Shelter, Tanzania (Mehlman, 1989). Radiocarbon dates on charcoal indicate an age of 42 ka for the beads at Boomplaas (Deacon, 1995). The Mumba beads [Figure 9(b)] were found in Layer V, associated with an industry that contains elements of both LSA and MSA

technology. They were originally thought to be intrusive from the early LSA horizon in lower Bed III, dated by ^{14}C and AAR to 30–37 ka (Mehlman, 1979, 1989, 1991; Kokis, 1988; Brooks *et al.*, 1993b; Hare *et al.*, 1993). Direct AAR assays on two of the Bed V beads show that one may indeed be intrusive from Level III, but the other dates to ca. 52 ka (Hare *et al.*, 1993). These new age determinations establish a considerable antiquity for the practice of personal ornamentation in Africa, and link it with MSA technology.

Incised and notched objects are known from a much wider range of sites in southern Africa. These include ocher plaques and two notched bones from Klasies River, South Africa (Singer & Wymer, 1982), two notched bones from Apollo 11, Namibia

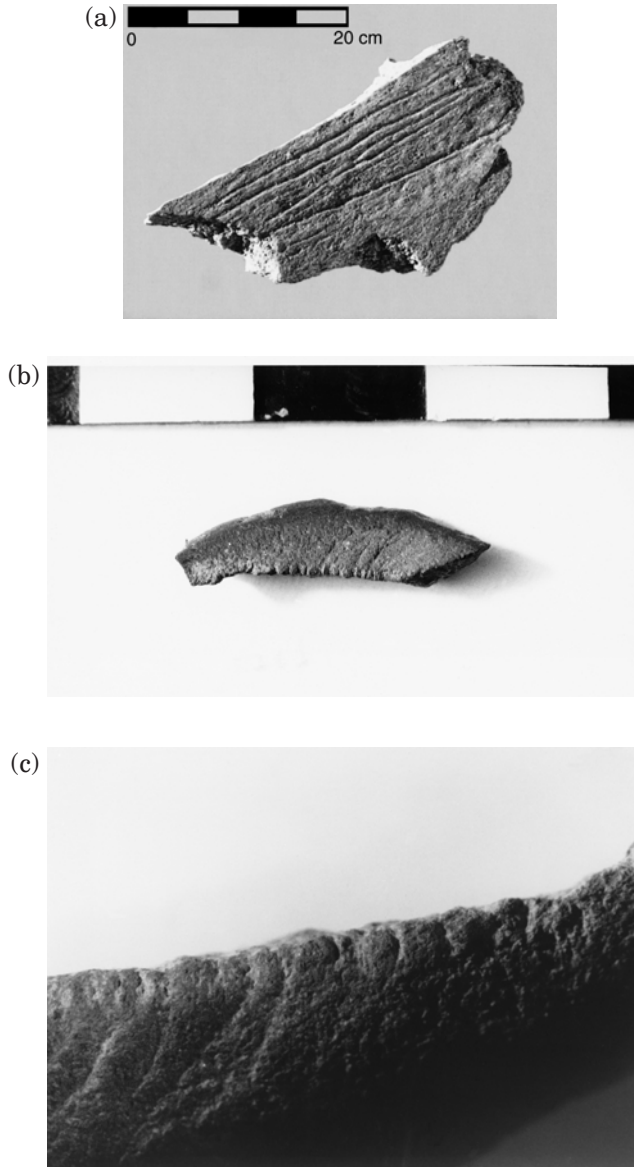


Figure 10. Notched and incised objects from MSA contexts (a) incised bone from Stillbay level at Blombos, after Henshilwood & Sealey, 1997, figure 8; photo courtesy of Chris Henshilwood; (b) incised ochre from Hollow Rock Shelter (scale in cm); (c) detail of 8(b). Photos (b) and (c) courtesy of Ian Watts.

(Wendt, 1972, 1976; Vogelsang, 1998), an incised bone, a notched piece of red ochre and a piece of ochre with multiple incised cross-hatchings from Blombos, South Africa [Henshilwood & Sealey, 1997; Figure 10(a); Gore, 2000: 100], and incised and notched

ochre from Hollow Rock Shelter, South Africa [Figures 10(b,c), 12(b,c)]. Analysis of C:N ratios shows the Blombos incised bone to have a ratio identical to that of the rest of the MSA faunal assemblage (Henshilwood & Sealey, 1997, n.d.). The

incised bone and notched and incised red ochre at Blombos all underlie sterile dune sands dated by OSL to 73 ka (Henshilwood, pers. comm.). A more elaborately modified bone, with a set of repeated incised notches has been described from transitional MSA/LSA context at Border Cave, Swaziland (Beaumont, 1978). Incised ostrich eggshell fragments, that may be pieces of water containers like those of the modern San, have been found at Diepkloof, South Africa, and Apollo 11, Namibia (Wendt, 1972; Vogelsang, 1998). At all these sites, the notched objects predate 40–50 ka. At Apollo 11, incised fragments continue to the base of the MSA, dated by AAR of ostrich eggshell to >83 ka (Kokis, 1988; Miller *et al.*, 1999).

Use of pigment

Pigment is a substance that imparts color to other materials, and the systematic use of pigment is one of the hallmarks of the European Upper Paleolithic (White, 1982). While the sophisticated cave art at some of the best known European painted caves dates to the Magdalenian period, ca. 18 ka, recent direct dating by AMS ^{14}C shows that the European cave art tradition dates back to ca. 30 ka (Clottes *et al.*, 1992, 1995; Valladas *et al.*, 1992; Chauvet *et al.*, 1996), and mobiliary art is likewise known from the Aurignacian (Hahn, 1993). Organic compounds can be used as pigment, but those detected in the archaeological record are more frequently metallic oxides. While carbon in the form of both graphite and charcoal, manganese, and kaolin were used in prehistory (Courard, 1988; Clottes *et al.*, 1990; Clottes, 1993), the pigments most commonly encountered in archaeological contexts are iron oxides. These may take the form of red hematite (Fe_2O_3) or yellow limonite [$\text{FeO}(\text{OH}) \cdot n\text{H}_2\text{O}$]. Limonite can be transformed into hematite by oxidation; the process is most efficiently achieved by burning, and requires a temperature of at least 250°C (Couraud, 1988).

Although some would identify the use of pigment in prehistory as *de facto* evidence for symbolic behavior (e.g., Marshack, 1981, 1989), others are skeptical of the symbolic content of this behavior (e.g., Chase & Dibble, 1987, 1992) and urge consideration of taphonomic factors (Bednarik, 1992). Some authors have distinguished between symbolic and domestic use, such as for hide preparation (e.g., Mellars, 1996). Others have suggested possible medical uses for ochre, as a styptic or antiseptic treatment for wounds or for eradicating internal or external parasites (Cole, 1954; Velo, 1984, 1986). If metallic oxides are recovered in association with undoubted art objects, or at sites whose inhabitants are known to have functioned within a well articulated symbolic system, the materials are usually assumed to have been used as a coloring medium. For example, characoal has been found to have been an ingredient in European Upper Paleolithic paint recipes (Clottes, 1993), but if found in archaeological deposits in the absence of other evidence it would probably be confounded with domestic refuse. Pigment must be adequately preserved to show traces of grinding, and may be expected to survive less well at open air sites than in caves. If the material was completely pulverized in prehistory, it may show up as little more than a stain. Evidence for burning has been argued to be a byproduct of natural processes for the ochre at Terra Amata (Wreschner, 1985); in other cases, burning may be interpreted as evidence for a deliberate processing strategy, as has been maintained for the Châtelperronian occurrences at Arcy-sur-Cure (Demars, 1992; Couraud, 1991).

Pigment, in the form of both iron and manganese oxides, has been encountered at about a dozen European Middle Paleolithic sites (Bordes, 1952; Marshack, 1981; Demars, 1992; Mellars, 1996), and a limestone ochre receptacle is reported from late Mousterian level at Grotte de Néron,

France (Comber, 1989; de Beaune, 1993). Fragments of pigment that show signs of scraping and wear facets, and grindstones perhaps used for ochre preparation are present in Mousterian levels at Cueva de Castillo and Cueva Morin, Spain (Kraybill, 1977). Although Mellars (1996) argues for domestic use, it can equally reasonably be inferred that the pigment was used as a coloring agent, and lends support to the idea of some form of symbolic or imaginative life among the later Neanderthals. It is significant that the pigment at Arcy-sur-Cure postdates the appearance of *H. sapiens* in Burgundian France (Mellars, 1998a,b). Because the systematic use of pigment occurs earlier in the Near East, Hublin (1990, 1998b) has suggested that, like burial, the practice may have been acquired by the Neanderthals through long-distance cultural diffusion.

The use of red ochre is widespread in modern subsaharan Africa. Either in dry powdered form or mixed with fat or water it is applied as a cosmetic to the hair and skin and as a decoration to beads, hides, and clothing. It is commonly applied as paint to house walls and pottery. It is clear that hematite and limonite were almost universally used as coloring agents in late Pleistocene and Holocene Africa. Countless fragments of pigment with unambiguous evidence of grinding, as well as grindstones with traces of ochre, have been recovered from LSA sites. Undoubted art objects, including artefacts of stone, bone, shell and other organic materials with traces of applied ochre are also often found in LSA contexts, and painted stones are frequently encountered in LSA graves (Rudner, 1971). Painted and engraved rock outcrops and caves dating to the LSA have wide distribution in subsaharan Africa, where naturalistic images depict aspects of a foraging way of life. In North Africa the tradition persists after the introduction of domestic animals; in South Africa a few post-contact paintings

depict Europeans, guns, and horses. There is good ethnographic evidence for continuity in the symbolic content of southern African rock art with modern San belief systems (Vinnicombe, 1975, 1976; Lewis-Williams, 1982, 1983). The paintings are believed to have retained their power into modern times, and some are now at risk, due to the removal of pigment from the images by non-San local healers for use in curing rituals (Hall, 1999).

Fock (1972) postulates an early date for petroglyphs in southwestern Gauteng, based on his identification of an engraving of a bovid as the extinct *Megalotragus* or *Homoioceras*. While additional supporting evidence would be welcome, Fock is correct to point out that the African rock art tradition may have an early origin. Subsaharan Africa contains few deep limestone caves which can provide the alkaline conditions conducive to preservation. Prehistorically occupied rock-shelters are often no more than overhangs with walls exposed to the elements. As Phillipson (1977: 288) points out, the earliest mural rock paintings in Africa have probably long since been lost through exfoliation and the natural collapse of shallow cave systems, and only rare discoveries of buried pieces of painted rock provide an indication of the true antiquity of the tradition (cf. Beaumont, 1992).

Granite slabs with ochre traces have been found at Nswatugi, Zimbabwe, in a late MSA (Tshangulan) horizon with an infinite radiocarbon age (Cooke, 1971; Walker, 1995; Larsson, 1996). Wendt (1975, 1976) and Vogelsang (1996, 1998) report painted slabs from the Apollo 11 cave, Namibia, in an MSA horizon stratified above a level containing artefacts with Howiesons Poort affinities (Figure 11). The painted slabs may be exfoliated from the cave ceiling, or, as argued by Wendt, may be portable art objects. Ochre crayons occur in MSA levels throughout the sequence. Radiocarbon dates ranging between 26 ka and 28 ka from

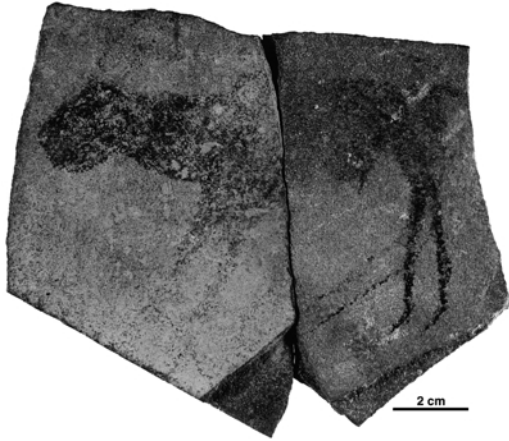


Figure 11. Painted slab from MSA levels at Apollo 11 Rock Shelter, after Vogelsang, 1998. Photo courtesy of Ralf Vogelsang and the Heinrich-Barth-Institut.

the level containing the painted slabs have been reported (Wendt, 1976; Freundlich *et al.*, 1980; Vogelsang, 1998). These young dates are anomalous for material with MSA associations, and Miller *et al.* (1999) report an age of 59 ka for the MSA overlying the Howiesons Poort at Apollo 11, based on a series of 62 isoleucine epimerization dates on ostrich eggshell from the sequence.

Economy and symbolism

Pigment acquisition and processing

Many early reports of MSA sites in both South and East Africa mention ochre and grindstones, but these were often discounted due to the uncontrolled nature of early excavations and the possibility of mixing with overlying LSA debris. Grindstones were sometimes discarded, and those that survive, if inadequately curated, cannot now be examined for traces of pigment. Many were no doubt used for plant food processing. But evidence is accumulating for the widespread, controlled and systematic acquisition, processing and use of pigment in the MSA. While there is little archaeological or biological evidence to support their idiosyncratic sociobiological interpretation,

Knight *et al.* (1995; cf. Knight, 1991; Power & Watts, 1996; Power & Aiello, 1997) are correct to highlight the importance of pigment in understanding human behavior in the African MSA.

In tropical Africa, lateritic soils provide a plentiful and accessible supply of iron oxides. In southern Africa, on the other hand, where lateritic soils are less developed, red ochre is less readily available. Deliberate mining for hematite, specularite (a micaceous form of hematite), and manganese, in both open cast and deeply excavated caverns, has been documented for the historic, Iron Age, LSA, and, in a few cases, MSA periods in southern Africa (Dart, 1967; Boshier & Beaumont, 1972; Beaumont, 1973b; Beaumont & Boshier, 1974; Robbins *et al.*, 1998). Large scale mining for hematite in the MSA is reported from Lion Cavern in the Ngwenya Range, Swaziland, where Beaumont (1973a; Boshier & Beaumont, 1972; Beaumont & Boshier, 1974) reports that at least 1200 metric tons of pigment were extracted prehistorically from a cliff-face exposure. Rubble fill had accumulated to a depth of 4 m at the base of the cliff; upon excavation, the basal 76 cm of this fill yielded tens of thousands of MSA artefacts. Radiocarbon dates on charcoal from this layer range from ca. 10 ka to ca. 43 ka. The older dates, best regarded as infinite, derive from materials at a greater distance from the more recently worked face (Beaumont, 1973a: 141), showing how the face had moved inward with the passage of time. Similar large scale mining operations for specular hematite, dating to the Holocene, is reported from a complex of cave sites in the Tsodilo Hills by Robbins *et al.* (1998). Mining at one of these caves, Rhino Cave, during the MSA is indicated by the presence of specular hematite crystals, hammerstones, and grindstones in MSA levels in the cave.

Singer & Wymer (1982) report a total of 180 pieces of red ochre from Klasies River

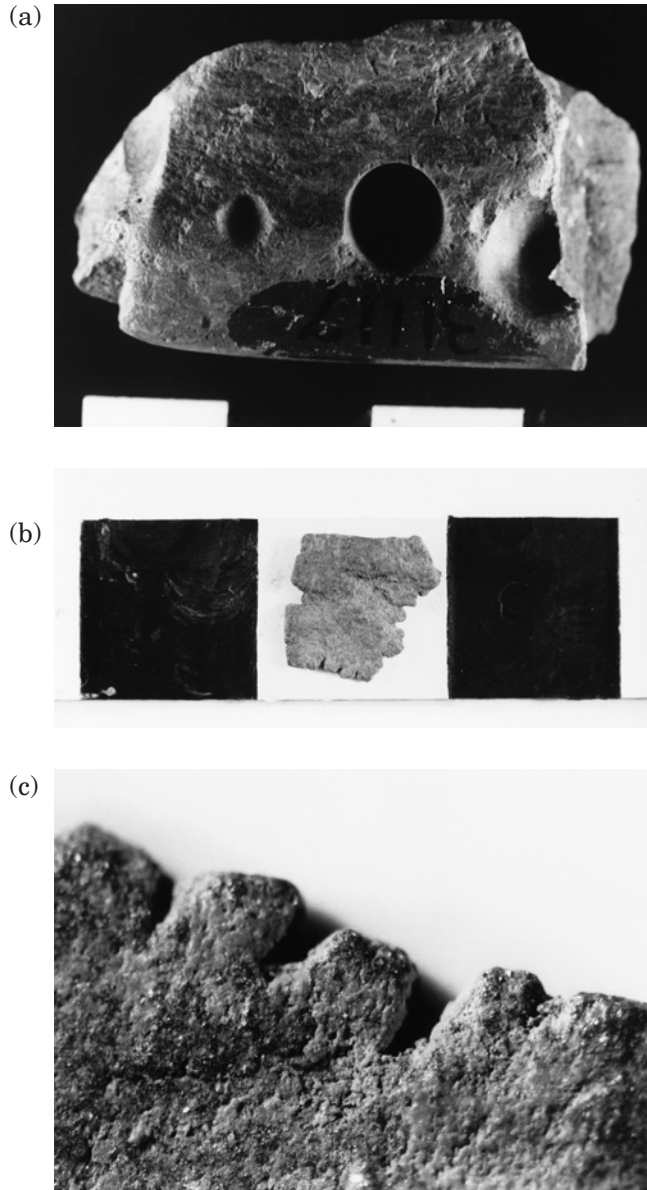


Figure 12. Red ochre from MSA contexts; (a) ground ochre, Klasies River (scale in cm), perforated by marine organism, after Knight *et al.* 1995, Figure 4; (b) notched ochre, Hollow Rock Shelter (scale in cm) after Knight *et al.*, 1997, Figure 3; (c) detail of 10(b). Photos (a) and (b) courtesy of Ian Watts.

on the Cape coast of South Africa. Many of these show wear facets, and the authors suggest that the small pieces were used as “pencils.” Some from the MSA have clear traces of incising to remove pigment powder

[Figure 12(a)]; others are merely scratched and may have functioned as “palettes” [cf. Figure 10(b,c)]. The material is distributed throughout the section; 14 specimens derive from the lowest (MSA I) levels in the

cave system, dated to >100 ka. Over 50% of the ochre found at Klasies ($n=102$) comes from the Howiesons Poort levels that are interstratified within the MSA, and dated to 65–80 ka. These levels yielded a cylindrical piece of red ochre ca. 3 cm long, with three depressions 40–70 mm deep. At Blombos, South Africa, many large pieces of hematite occur both the Still Bay and lower undifferentiated MSA. Several of these appear to have been cached in a small natural niche in the cave wall (Henshilwood, personal communication). Twenty-one pieces of ochre from Blombos have single or multiple holes up to 25 mm deep and 10 mm in diameter [Figure 10(a)] (Henshilwood & Sealy, n.d.). While these were initially thought to have been drilled with a bone or wooden drill (Henshilwood & Sealy, n.d.; Milo, personal communication), they are now believed to have been bored by a marine organism (Henshilwood, personal communication).

Hematite pencils are reported throughout the entire MSA sequence at Border Cave, South Africa; the age of the base of the sequence has been estimated at >100 ka (Beaumont *et al.*, 1978; Miller *et al.*, 1999). Fibrous material, stained with iron oxide and interpreted as bedding material, has also been recovered from an MSA context at Border Cave (Volman, 1984), and the human infant burial (BC3) from the same site is stained through the application of hematite (de Villiers, 1973). Grindstones stained with traces of ochre have been recovered from MSA levels at Pomongwe, Zimbabwe (Walker, 1987), Die Kelders, South Africa (Avery *et al.*, 1997) and at \neq Gi, Botswana. A total of 298 fragments of ochre, at least 40 of them with clear wear facets resulting from grinding, have been found in MSA levels at Porc Épic, Ethiopia, where age estimates based on obsidian hydration indicate a minimum age of 77 ka (Clark *et al.*, 1984; Clark, 1988). Large grinding slabs are also reported from

MSA layers at Florisbad, South Africa (de Beaune, 1993), dated by ESR to 121 ± 6 ka (Grün *et al.*, 1996). Ambrose (1998a: 384) reports traces of ochre and an ochre-stained grindstone from basal levels at Enkapune ya Muto, Kenya, associated with artefacts of the MSA Endingi industry.

At some East African sites, the presence of volcanics allows the use of the K/Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ dating methods. At the site of GnJh-15 in the Kapthurin Formation, Baringo, Kenya, the use of pigment in a context of great antiquity has recently come to light. Here stone artefacts, fragmentary bone, and ostrich eggshell fragments lie on a paleosol sealed by many meters of volcanic tephra. Pyroclastic material overlying the site has been dated by K/Ar to >240 ka (Tallon, 1978; McBrearty *et al.*, 1996), and a current program of $^{40}\text{Ar}/^{39}\text{Ar}$ dating indicates an age closer to 280 ka (Deino & McBrearty, under review). “Red stained earth” was observed in excavation at GnJh-15 by a team of Belgian researchers (van Noten *et al.*, 1987a,b; Cornelissen *et al.*, 1990 and references therein). New excavations and reexamination of previously excavated material reveal that while the hematite fragments are too friable to preserve traces of grinding, they are numerous and widespread at the site (McBrearty, 1999). The previously excavated samples consist of 74 items with a total weight of >5 kg; these range in size from pulverized granular material weighing <3 g to large chunks >250 g. Excavations in 1997 recovered more ochre and ochre stained grindstones likely used to process it. The Kapthurin discovery is not an isolated find. Pigment has recently been reported from an early MSA context at the cave site of Twin Rivers, Zambia. Here, three pieces of ochre, one limonite, two hematite, have been recovered from artefact and bone-bearing breccia overlain by a speleothem dated by U-series to 230 ka (Barham & Smart, 1996; Barham, 1998).

Summary and discussion

H. sapiens appears early in Africa, but it has been argued by proponents of the “human revolution” that the behavior of these early people was indistinguishable from that of more archaic hominids. In this paper we provide a new way of looking at the origin of our species that is more consistent with the evidence.

The Middle Pleistocene African hominid fossil record provides reasonable candidates for the ancestors of *H. sapiens*, and support for *in situ* evolution of *H. sapiens* in Africa long before 100 ka. Improved temporal resolution and further scrutiny of the fossils themselves are needed to determine whether the record represents a series of chronospecies or an adaptive radiation in late *Homo*. The degree of species diversity now known for our genus in the Earlier Pleistocene leads us to favor a similar adaptive radiation in the Middle Pleistocene. The presence of coeval hominid species would help to explain the degree of variability seen in the African Middle Pleistocene archaeological record. In our view, the appearance of modern human morphological features in *H. helmei* by 260 ka indicates that elements of a new adaptation are already in place.

Both *H. helmei* and early members of *H. sapiens* are associated with MSA technology, and thus it is clear that the main behavioral shift leading to modernity lies at the Acheulian–MSA boundary about 250–300 ka, not at the MSA–LSA boundary at 50–40 ka as many assume. We have shown here that many sophisticated behaviors are present in the MSA. This implies increased cognitive abilities with the appearance of *H. helmei*, and behavioral similarities and a close phylogenetic relationship between *H. helmei* and *H. sapiens*. It could be argued that the specimens referred here to *H. helmei* are more correctly attributed to *H. sapiens*, and that *H. helmei* should be sunk into

H. sapiens. If that is the case, our species has a time depth of ca. 250–300 ka, and its origin coincides with the appearance of MSA technology.

However, we are not seeking simply to move the “human revolution” back to the Acheulian–MSA boundary. Use of the term “revolution” implies not only profound, but also rapid change (cf. Greene, 1999). Popular treatments of these issues (e.g., Diamond, 1992) borrow the vocabulary of punctuated equilibria from paleobiology (Eldredge & Gould, 1972), but even in paleontology, punctuated events are notoriously difficult to document (Gingerich, 1984; Gould & Eldredge, 1996), and there is no agreement about how rapid a change must be to qualify.

There is no logical reason to expect a single sudden event to represent what we see as essentially a cultural, not a neurological process (cf. Bar-Yosef, 1998). Figure 13 summarizes the first appearances in Africa of the modern behaviors as discussed in this paper. The record shows that the new behaviors do not appear suddenly together, but rather are found at points separated by sometimes great geographical and temporal distances. It seems inappropriate to label changes accumulating over a period of 200,000 years either a revolution or a punctuated event. Early modern human populations in late Middle Pleistocene Africa were relatively small and dispersed, change was episodic, and contact among groups intermittent. This resulted in a stepwise progress, a gradual assembling of the modern human adaptation. Abrupt “leaps” are perceived at the northern and southern tips of the continent, where the record is discontinuous, and where the impression of contrast has been enhanced by the practice of comparing materials from the earliest Late Pleistocene with those from the latest Pleistocene.

From a terminological point of view, it is important not to conflate the African MSA

Behavioral Innovations of the Middle Stone Age in Africa

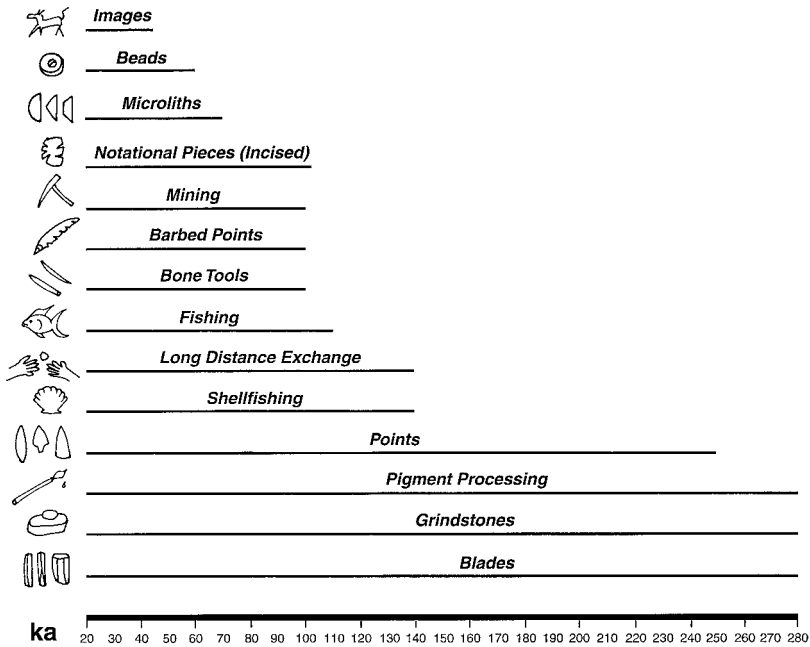


Figure 13. Modern behaviors and their time depths in Africa. © Sally McBrearty & Alison S. Brooks.

with the European Middle Paleolithic. While MSA and Middle Paleolithic technologies share common features (Thackeray & Kelley, 1988; Thackeray, 1989, 1992, 2000), the evidence reviewed in this paper serves to highlight their essential differences. It is particularly critical that the Middle to Upper Paleolithic transition in Europe not be confused with the origin of *H. sapiens*. The European Middle to Upper Paleolithic transition represents the local replacement of the Neanderthals by *H. sapiens*, while in Africa, *H. sapiens* is a product of *in situ* evolution. The African MSA–LSA transition is a cultural and technological change that occurred many tens of thousands of years later. Furthermore, the Middle to Upper Paleolithic transition in Europe is a change from mode 3 to mode 4 technology, while in Africa, modes 3, 4, and 5 are all already present in the African MSA. In fact, the diversity in stone tool industries suggests

that the terms ESA, MSA, and LSA are too vague, broad, and temporally imprecise to be particularly illuminating when attempting detailed behavioral reconstructions (Kleindienst, 1967).

The presence of stone working techniques such as backing in the African MSA at 80 ka shows a level of technical competence not achieved until tens of thousands of years later outside the continent. Microwear studies are in their infancy in Africa, but from artefact design and ethnographic evidence it seems clear that MSA artefacts were habitually hafted, and some of them were used as projectiles, perhaps in some cases propelled by the bow. From the long-term stylistic conservatism of barbed bone tools in Central Africa, and the slowness with which this particular technology (but not bone tools in general) spread beyond the great lakes region, Yellen (1998) concludes that MSA exchange networks may have

remained regionally restricted. We would suggest that future research at lacustrine sites in this time range may well fill in what now appear to be lacunae in the bone tool record. Other evidence suggests that residential territories were large in the MSA, especially in tropical Africa. Among modern foraging groups, long-distance social ties are maintained through ritualized exchange in part to reduce risk in times of famine (Wiessner, 1982; Hayden, 1992). The presence of exotic obsidians at some East African sites indicates that the distances involved in some tropical Africa MSA exchange networks exceeded 300 km. This activity may have involved both a higher degree of planning and scheduling, and more complex interactions among early human groups than has customarily been envisaged. The regional distributions of projectile point styles suggest social networks on a similar order of magnitude.

Despite suggestions to the contrary, there is good faunal evidence to show that MSA people were competent hunters who brought down a variety of dangerous game animals, some of them larger than their present day counterparts. Intensified and scheduled resource use are evident at sites such as Mumba and Katanda, and the use of both marine and freshwater fish and shellfish can also be seen at Katanda, Klasies River, Blombos, White Paintings Shelter, Bir Tarfawi, and the Haua Fteah. Sophisticated bone tools were used in specialized, seasonally scheduled fishing at Katanda. Bone points were also used at Blombos and possibly Klasies River. The general presence of grindstones in the MSA indicates that plant food processing was routine, and burned geophyte residues in the Howiesons Poort levels at Klasies River suggests continuous plant exploitation and perhaps resource management similar to that practiced by the San inhabitants of the region in the Holocene (Deacon, 1989; Deacon & Deacon, 1999).

At other sites, grindstones appear to have been used to process pigment, and red ochre dating to well before 200 ka is found both GnJh-15 in the Kaphurin Formation, and at Twin Rivers. Other sites show notching and incising not only of ochre, but also of bone and ostrich eggshell, most likely as part of a symbolic or notational system. Determining whether these objects represent elements of a fully articulated symbolic system awaits further research, but a lack of formal art objects need not preclude the presence of modern cognitive ability, as has been observed by Deacon (1989: 561). It would not be surprising if the widely dispersed human groups of the African MSA did not signal their identities as intensively as later, more crowded populations. Mellars (1996: 371ff) concludes that the rarity of purportedly "symbolic" artefacts in Mousterian contexts argues against their being part of a widespread shared Neanderthal symbolic system. Despite the relatively small number of excavated MSA sites, the quantity and quality of evidence for symbolic behavior that has been reviewed here far exceeds that known for the European Middle Paleolithic where the site sample is more than ten times greater. Pigment processing and bead production, in particular, are comparable in kind to that seen in the Africa LSA and European Upper Paleolithic, and it is not extravagant to suggest that they functioned within a shared symbolic system. MSA point styles, moreover, do show regional differences that are reasonably construed as stylistic.

As a whole the African archaeological record shows that the transition to fully modern human behavior was not the result of a biological or cultural revolution, but the fitful expansion of a shared body of knowledge, and the application of novel solutions on an "as needed" basis (cf. Ambrose & Lorenz, 1990; Vishnyatsky, 1994; Belfer-Cohen, 1998; Bar-Yosef, 1998). The complex content of human cultures has been built incrementally, with cognitive

equipment present since at least 250 ka, in a process that continues today.

The MSA–LSA transition is clearly decoupled temporally from the origin of *H. sapiens*, and the transition was incremental in the tropics, as shown from the gradual changes in artefact frequencies and a diminution in artefact size that presages microlithic technology at sites such as Enkapune ya Muto, Mumba, and Aduma. Some LSA elements appear quite early and some MSA elements persist quite late, suggesting that the transition was not only gradual but also episodic in nature. For example, at Matupi, small microlithic cores predate 40 ka, whereas at Kalemba and Rose Cottage Cave, MSA radial and disc core types persist as late as 25 ka. However, it is particularly misleading to read the late survival of MSA flake production techniques as a failure of South African *H. sapiens* populations to achieve behavioral modernity. As Wobst (1983) and others (e.g., Wynn, 1985; Goren-Inbar, 1988) have pointed out, the study of Stone Age technology reveals only the lower limits of hominid cognitive capacity. After all, disc core technology was widespread during the Neolithic in the Near East, and Australian Holocene assemblages contain few formal tools, yet there is no suggestion that either of these populations were not behaviorally modern! In fact, if the OSL, TL, and ESR dates of ca. 60 ka for the Australian Mungo 3 hominids are accurate (Thorne *et al.*, 1999; Stringer, 1999; Bowler & Magee, 2000; Gillespie & Roberts, 2000; Grün *et al.*, 2000), humans possessed the means to cross large bodies of water at least 10,000 years before the usual dates invoked for the “human revolution”.

Population growth and the MSA–LSA transition

We believe that the intensification visible at the MSA–LSA transition after about 50 ka

is in part the result of simple population growth coupled with environmental deterioration, factors that go far to explain later, more familiar archaeological phenomena such as the origin of domestication in the Near East or the elaboration of the late Upper Paleolithic in Europe. What might have accounted for dramatic population growth in Africa early in the Late Pleistocene? Throughout this paper, we have suggested factors that would have acted to increase infant survivorship and decrease overall mortality rates due to either periodic starvation or accidental injury. Two of the most important of these are new technologies and risk-management strategies involving long-distance exchange. New projectile technologies reduced the need to grapple at close range with large game animals, and would have increased hunting productivity. Fishing technology allowed humans to exploit a vast new resource. Not only would these technologies have decreased the territory required to sustain a single individual, but they apparently allowed expansion into entirely new habitats, such as the tropical forest. As Stiner *et al.* (1999, 2000) have argued, the availability of small-scale resources may improve infant survivorship, driving further population expansion and contributing to a positive feedback system. In addition, fish and shellfish may provide optimum maternal and child nutrition as a major source of omega-3 fatty acids (Broadhurst *et al.*, 1998; Crawford *et al.*, 1999).

Long-distance exchange, maintained by the use of symbolic systems, would also have acted to increase population during the Middle Stone Age. Risk-management strategies involving long-distance exchange are at the heart of historically observed hunter-gatherer adaptive systems (Gould, 1978; Wiessner, 1982, 1983, 1986, 1998). Exchanges may involve marriage partners, raw materials, red ochre, objects of

adornment and technologically important items such as projectile points, knives or axes, often in exotic and colorful materials carrying symbolic meaning. Such exchanges create far-flung reciprocity networks that can operate in times of scarcity to allow exchange partners and their families access to distant areas where resources are plentiful (Yellen, 1986), thereby optimizing the mapping of populations to resources, reducing infant mortality and contributing to overall population maintenance. As in the case of small-scale resources, positive feedback would have produced further population growth and contributed to the expansion of such systems over time.

Environmental deterioration is the third factor contributing to increased concentration of existing populations. The technology that made LSA extractive intensification possible was present in the MSA as early as 70 ka, both in South Africa in the form of the Howiesons Poort industry, and in East Africa in the Mumba industry, but the need for intensification became general in the Late Pleistocene as successful MSA populations grew and placed ever more severe demands upon local resources. Crowding, decreased mobility and declining resources necessitated hunting more dangerous game, including less preferred food items in the diet, and developing more elaborate technology for food gathering, processing and storage. Population growth, a quantitative phenomenon, has qualitative effects upon human lives, and competition over resources obviously affects the nature of relations among groups. Possible responses range from outright conflict (warfare), through claims of ownership by symbolic signals, to cooperation and trade. Perhaps more significantly, the life experiences and perceptions of a person who encounters 200 individuals in his or her lifetime are substantially different from those of someone who encounters 2000. Increased

population density, therefore, affects not only economy and technology, but also symbolic and linguistic aspects of social life and the pace of cultural change.

Conclusions: the revolution that wasn't

The search for revolutions in western thought has been in part, as Greene (1999) points out, a search for the soul, for the inventive spark that distinguishes humans from the rest of the animal kingdom. Landau (1991) makes a convincing case that many syntheses of human evolution are cast in the mold of hero myth, with the clever hero passing through trials to achieve a reward. It was the desire to believe that brain expansion preceded bipedalism that fostered the acceptance of Piltown and the rejection of *Australopithecus* for many decades. We believe that by continuing to insist upon revolutions, researchers, perhaps unwittingly, create a gulf separating humans from the rest of the biological world. By stressing human uniqueness, proponents of the "human revolution" effectively remove the origin of *H. sapiens* from the realm of normal scientific inquiry (cf. Foley, 1987). As Foley (1987) points out, all species are by definition unique, and presumably each species has its own unique form of consciousness. Humans no doubt share elements of their consciousness, as they do their behavior, with their close relatives. Chimpanzees have been shown to use and make tools and to engage in organized inter-group aggression. Our close extinct relatives, the Neanderthals, were intelligent hominids who demonstrated the skills needed to survive in a challenging periglacial environment. It will certainly not be surprising if they are shown to have possessed language or rudimentary symbolizing abilities, either inherited from a common ancestor, developed in parallel, or learned from *H. sapiens* through culture contact.

There is a profound Eurocentric bias in Old World archaeology that is partly a result of research history and partly a product of the richness of the European material itself. The privileging of the European record is so entrenched in the field of archaeology that it is not even perceived by its practitioners. Works on the “human revolution” can trace their ancestry to the urban and agricultural revolutions of V. Gordon Childe (1934), whose initial definitions were formulated as analogies with the industrial revolution of eighteenth century Europe (Greene, 1999). Childe himself owed an intellectual debt to Lewis Henry Morgan (1871), whose transition from Savagery to Barbarism was seen as an inevitable step on the road to human progress. In this paper, at the risk of being labeled as eurocentric ourselves, we have used standards for behavioral modernity derived from the European record, because these criteria are universally recognized and are frequently repeated in the literature. We see this as a necessary initial exercise in the shedding of an inappropriate paradigm, and believe that the more interesting and fruitful era of research into the questions raised here has only begun. The behaviors unique to *H. sapiens* are to be discovered, not prescribed. It is not really reasonable to expect all early populations of *H. sapiens* to have made bone tools, eaten fish, or used paint.

The “human revolution” is a semantic, as well as a romantic issue, and our conundrum stems from the use of the loaded term “modern” to describe the behavior of people prior to the sixteenth century, let alone those of the Pleistocene. Our lists of modern behaviors are derived from populations living today or those alive in the relatively recent past, who all are or were products of their evolution and history. Past human populations were products of different histories, and the qualities stressed in our lists of modern behaviors may have had little relevance for our ancestors.

If it is acknowledged that both modern human behavior and modern human

anatomy originated in Africa, the European Upper Paleolithic is freed of the encumbrance of false rhetoric about human origins and human revolutions. Archaeologists working on the later Pleistocene of Europe can seek in their data the traces of the flow of people, ideas, and technology, and the signs of interactions among groups, as has been suggested for the Châtelperronian and Szeletian records (Harrold, 1983, 1989; Allsworth-Jones, 1986, 1990; Koslowski, 1988; Mellars, 1996, 1998a; *contra* d’Errico *et al.*, 1998; Zilhão & d’Errico, 1998). We should expect the emerging picture to be complex and to generate controversy, as has been the case with the debate over the earliest peopling of the New World. Attention has already been directed at sites in the Levant for what they may reveal about these processes, but sites in other regions that are possible avenues of migration out of Africa, such as the Nile Valley, the Sinai and Arabian peninsulas, southeastern Europe, the Maghreb, and Gibraltar assume greater importance as well.

This view also challenges Africanist archaeologists to evaluate the African evidence on its own terms. Rather than applying arbitrary criteria for modernity, one could take the position that behavioral innovation drove the morphological changes that are observed in early modern human anatomy. When we realize that the modern human adaptation appeared gradually, rather than suddenly, the process can be broken into its constituent parts, each having its own origin and demanding its own explanation. It is necessary to establish the nature of the changes, the order of the changes, and the pace of change in order to discover the causes. This presents us with a fresh opportunity to expand our understanding of the range of behaviors practiced by members of our own species.

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