

The antiquity of hunter-gatherers

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Introduction

It is often said that humans have lived by hunting and gathering for more than 99% of our evolutionary history, but there is something more to being a hunter-gatherer than just eating non-domesticated plants and animals. This chapter examines resemblances and differences between modern hunter-gatherers and earlier Pleistocene humans in northern Eurasia, and explores some general explanations for observable variation.

In comparing modern and ancient foragers, it is not sufficient to use one or two modern hunter-gatherer groups as 'model foragers'. The strategy adopted here is to characterise the limits of variation in the economies, technologies, and social arrangements of recent hunter-gatherers, and to use these observations as a baseline for assessing behavioural variation in the remote past. If ancient human groups showed similar ranges of variation to modern foragers, then the basic structure of modern human hunter-gatherer adaptations was probably in place long ago. If the expected patterns of variation are not manifest archaeologically, we are dealing with a very different sort of hunting and gathering hominid.

This chapter concentrates on two fundamental dimensions of recent forager behaviour – subsistence and technology – both of which have robust archaeological consequences. It encompasses cases from the Middle and the late Upper Palaeolithic of Europe and western Asia, spanning environments from the arid subtropics to the periglacial steppes and attributable to both modern (*Homo sapiens sapiens*) and archaic humans (Neanderthals and *H. heidelberg-*

ensis). We focus on Pleistocene Eurasia in particular because of its high density of archaeological data, diverse environments, and appreciable climatic and latitudinal gradient.

Hunters of the recent and remote past

We reserve the term 'recent' hunter-gatherers for Holocene foragers that coexisted with agricultural societies, especially for groups documented over the past 150 years. 'Ancient' hunter-gatherers refers to all Pleistocene humans, regardless of taxonomic or cultural status.

Obviously, recent and ancient foragers inhabited very different worlds. The natural environments of the last 150 years of the Holocene are quite different from those of most Palaeolithic groups. Environments are variable over time and across space, however, making impossible broad generalisations about how conditions differ today from those 'back then'. Ecological factors thus are more profitably approached by considering known clines or other physical gradients. A more general difference between recent and ancient hunter-gatherers concerns demography: modern populations are several orders of magnitude larger (Groube 1996, Pennington, this volume). Moreover, the world is no longer occupied exclusively by foragers. Even at first contact with colonial societies, hunter-gatherers lived in regular and sometimes close proximity with agriculturalists, pastoralists, or merchants (Layton, this volume). Surviving hunter-gatherers have been part of 'world systems' for as long as Western scholars have known about them (e.g. Bird-David 1991, Woodburn 1991).

This has led some scholars to question the relevance of ethnographic accounts to understanding human life in the remote past (Spielfmann and Eder 1994). However, we are better served by seeking to understand the factors that moulded the diversity of recent foraging adaptations. Uncovering predictable relations among a few key variables in the modern world would provide a sound basis for recognising and ultimately accounting for unexpected patterns in ancient foragers. It is particularly important to

emphasise patterns that cross-cut groups with very different histories (see also Layton, this volume) to minimise the influences of the post-Neolithic world.

Variation in recent hunter-gatherer diet and technology

Researchers have identified a number of robust patterns of variation in subsistence, technology, land use, and social life among ethnographically documented hunter-gatherer groups. There is clear environmentally linked variation in the range and importance of food sources. Humans have exploited a vast array of wild foods. A convenient way of classifying them is to rank them in terms of their net 'cost' to foragers, and whether they are primarily sources of food energy (e.g. fats and carbohydrates) or nutrients essential to physical growth and maintenance (e.g. protein) (Speth and Spielmann 1983). A high-rank resource provides a rich nutritional return relative to the costs of locating, procuring, and processing. Lower-ranked resources provide less food value, are more costly to obtain, or both.

Experimental and ethnographic studies of wild food collection are summarised in Table 5.1. Several conclusions can be drawn despite some obvious limitations of the data. In general, efficiency follows nutritional values, with meat providing the greatest food value per unit weight, foliage the lowest. Large game animals rank highest because of their size, and tubers, seeds and nuts rank lowest because of yield per unit time or cost of procurement and processing. Small to medium-sized animals (reptiles, small mammals, birds) have intermediate rankings. Few data are available for marine foods, fruits, and insects, but some of them provide exceptional returns in some environments (Dufour 1987, Hayden 1981*a*).

The relation between gross yields (kJ/kg) and net productivity (kJ/hr) is important for small animals, and for seeds and nuts. Meat from small animals is as nourishing per kilogram as large game, yet procurement of smaller species is less efficient. This is because efficiency is measured in terms of net yields. Considerably more energy may be needed to catch a deer than a rabbit, but a large

Table 5.1. *Net (kJ/hr) and gross (kJ/kg) energy yields of various resource classes for human foragers.*

	Number of cases	kJ/hr			kJ/kg	
		Mean	Min.	Max.	Mean	SD.
Large game	4	63 398 ^a	36 000 ^a	75 115 ^a	6980 ^b	1383 ^b
Small mammals	14	16 034 ^a	1672 ^a	56 317 ^a	6980 ^b	1383 ^b
Reptiles	3	15 850 ^a	17 556 ^a	12 435 ^a	4489 ^b	715 ^b
Birds	3	4472	961 ^a	8255 ^a		(no data)
Roots and tubers	14	6120 ^a	418 ^a	26 133 ^a	2926 ^c	1680 ^c
Roots and tubers	9	10 412 ^d	3695 ^d	23 333 ^d	2926 ^c	1680 ^c
Seeds and nuts	34	3520 ^a	380 ^a	18 538 ^a	13 188 ^c	9334 ^c
Seeds and nuts	9	6508 ^d	1203 ^d	24 933 ^d	13 188 ^c	9334 ^c
Foliage	—		(no data)		1250 ^c	819 ^c
Fruits	—		(no data)		2403 ^c	1463 ^c

^a Data from Kelly 1995, Table 3.3. ^b Data from Hawkes *et al.* 1982, Hurtado and Hill 1987. ^c Data from Pennington 1989. ^d Data from Wright 1994, Table 2.

animal provides a much greater amount of food. Small animals must be obtained and processed in large numbers to equal the food provided by one modestly-sized ungulate (Gamble 1986: 113, Bailey 1978). Small prey may be attractive for other reasons, such as their more consistent availability, and certain reptiles and shellfish may be unusually desirable simply because they can be collected with little effort. Seeds and nuts are remarkably concentrated sources of nourishment, exceeding on average the caloric value of wild game. Their ranking based on net returns is relatively low because processing seeds by grinding or pounding is very labour-intensive (Hawkes and O'Connell 1985, Simms 1987, Stahl 1989, Wright 1994). The nutritional figures in Table 5.1 are for cooked grains; their yield would be far less if they were not fully processed.

The relative ranking of resource classes also seems to be inversely correlated their general abundance or absolute productivity per unit land (Winterhalder, this volume). Large game animals tend to be dispersed and mobile, while smaller game exist at higher densities. Grass seeds and nuts may be the most abundant and concentrated of all (Pianka 1978: 278–83). The link between the relative yield and spatial concentration of a resource influences the mobility of human foragers. If high-ranked resources are not aggregated, as with salmon runs or caribou migrations, it is impossible to depend on them year-round without extensive mobility (Kelly 1995: 130–31).

Theory predicts that consumers will rely on resources that provide the best return for effort in whichever currency is most limited, turning to lower-ranked resources only when the cost of searching for the higher-ranked foods becomes excessive (see Winterhalder, this volume). Addition of a new resource to the diet depends not so much on its natural abundance, but on the availability of the next highest-ranked food. These ideas inform the study of environmentally linked variation in forager diet.

Some of the clearest patterns of variation in modern hunter-gatherer diets follow latitude. The degree of dependence on vegetable foods declines away from the Equator as a simple function of primary environmental productivity. They are 'replaced' in the north by terrestrial game or aquatic resources, depending on the

proximity of coastlines, lakes, and marshes (Lee 1968, Hayden 1981a, Keeley 1995); in the far north, meat may constitute almost 100% of the diet. Closer to the equator there is greater variation in dietary composition as a consequence of higher diversity and abundance of birds, small mammals and reptiles (Pianka 1978: 291–6, Rosenzweig 1996: 25). Because the returns from small and medium-sized animals generally are higher than those for plants, we would expect foragers to exploit such animals in preference to seeds or tubers, if the former are available. None the less, many low-latitude hunter-gatherers rely extensively on vegetable foods, especially in arid regions.

Table 5.2 shows that as reliance on vegetable foods increases, seeds, the very resources that require most processing and yield the lowest returns, become more important. Thus a heavy dependence on vegetable foods in lower latitudes is not simply explained by the presence of easily obtained plant foods. Instead, it reflects situations in which access to higher-ranked foods is limited, or in which human populations have grown so far that they can no longer be sustained on the least costly resources. In some environments large animals and other high-ranked food types are highly dispersed and unreliable. Unfortunately, we have few clues as to what the natural abundance of game should have been in most places.

Of course hunter-gatherers do not collect and process food without tools. Durable elements of technology provide direct and indirect clues about economic adaptations. Projectile tips, spear points, arrow heads, harpoons, and the like are the more obvious material correlates of hunting and fishing. Grinding stones, mortars and pestles, querns, mullers, and similar objects are good indicators of a heavy reliance on wild seeds and nuts. Their relative abundance in archaeological assemblages should reflect the extent to which human groups depended on vegetable resources with high processing requirements. Simple ratios of hunting weapons to grinding tools cannot be used to reconstruct dietary emphases, however, as these artefact classes have very different use lives and discard patterns. None the less, seed-grinding implements are valuable relative indicators of diet.

Torrence (1983, 1989, this volume) and others (Shott 1986,

Table 5.2. *Relationship between dependence on plant foods and types of staples*

Percentage plants in diet	Number of plant staples	Foliage	Fruit	Fruit and roots	Roots	Fruit, roots and nuts	Nuts	Fruit, roots and nuts and seeds	Seeds
0-5	6	1	4						
6-15		2	14	2					
16-25			4	7	1				
26-35			1	2	5	4			
36-45			1	1	2	3	10	1	
46-55			2			2	4	2	2
56-65				1			3	2	3
66-75						1			1
76-85							1		

Source: After Keeley 1995, Table 9.2.

Oswalt 1976, Binford 1977, 1979, Bousman 1993) have observed that the complexity, variety, and degree of labour investment in artefact production and maintenance all are closely connected to how the food quest is organised. Most notably, the elaboration of hunter-gatherer technologies, measured in terms of the number of distinct artefact forms and the number of individual elements combined to form single artefacts, increases with latitude and with the degree of dependence on fish or game (Oswalt 1976, Torrence 1983, Bousman 1993). As technological complexity increases, the amount of time and energy expended in making and mending artefacts also increases. Torrence sees latitudinal trends in artefact complexity as by-products of hunter-gatherers' strategies for risk reduction, responses to the discontinuous availability of resources and a focus on mobile elusive prey. Narrow windows of opportunity for getting game place a premium on optimal tool performance, achieved primarily through the use of elaborate, 'overdesigned' and highly specialised equipment (Bleed 1986, Bousman 1993). Human mobility can be a complicating factor, however, as frequent residential moves tend to promote lightweight tool-kits (Kuhn 1994, Shott 1986).

No aspects of human behaviour are so consistently documented in the archaeological literature as diet and technology, although there are other interesting and potentially significant axes of variability. However, one strategy of risk reduction typical of many recent foragers has distinct archaeological consequences. Residential mobility is a common solution to local fluctuations in food availability, as it allows hunter-gatherer groups to 'map on' to fluctuating resource distributions (Binford 1980, Kelly 1983). Uninhibited residential mobility is only feasible in a relatively empty environment, however. If many foraging groups have an interest in the same set of resources, access must be co-ordinated or selectively restricted in order to avoid conflict. Virtually all documented foraging groups thus possess norms of land tenure or preferential access to resources.

Dyson-Hudson and Smith (1978) and Kelly (1995: 198) conclude that systems of social boundary defence develop where one group experiences a surplus of food while another is experiencing a shortage. In this case access to land is regulated socially rather than

through active defence: permission is required to use an area or to establish rights of access via kinship, friendships, or partnerships (Peterson 1975, Cashdan 1983). Non-kin relationships are often maintained by the exchange of goods (Wiessner 1982, Cashdan 1985, Burch 1988). Archaeologically, the movement of exotic items can be a signature of this form of territorial organisation. The value of having access to another individual's territory lies in the likelihood that it will contain desirable resources when foods are scarce in one's own home range, so relationships with far-away individuals may be more important than with close neighbours. In some environments it is even expected that hunter-gatherers will exclude adjacent groups from their lands, while using social mechanisms to promote access to more distant territories (Kelly 1995: 198). Long-distance exchange may therefore be especially significant.

To summarise, variation among recent foragers provides a number of general expectations for Pleistocene foragers. Most obviously, the degree of dependence on hunting and/or marine resources should increase to the north, and also within a given area as conditions become colder during glacial/interglacial cycles. Conversely, dependence on vegetable resources should be higher nearest to the Equator, or as conditions became warmer and drier over time. Plant remains seldom survive in Palaeolithic sites, and their role in early diets is difficult to assess. Fortunately, the ethnographic record indicates that any substantial dependence on vegetable foods normally entails a focus on seeds and nuts and requires non-perishable processing equipment. We should also expect to find a greater variety of complex technologies in northern parts of the human range, or during colder climatic intervals. Finally, evidence for the exchange of exotic goods in connection with territorial organisation and strategies for managing resource risk should be manifest widely.

The Pleistocene evidence: cultural geography in the Palaeolithic

In applying expectations derived from modern foragers to Pleistocene archaeological data, we focus only on general tendencies.

Deviations from our expectations are of greatest interest, as they signal a different set of foraging behaviours, even a fundamentally different kind of forager. We focus on the later Upper Palaeolithic and Middle Palaeolithic of Europe and southwest Asia (the Near East), where the density of data is sufficient to evaluate the trends and patterns summarised in the previous section. The Middle and Late Stone Ages of sub-Saharan Africa have also yielded abundant evidence, but the climatic gradient is not steep enough for our purposes.

The late Upper Palaeolithic and Epipalaeolithic

The late Upper Palaeolithic and Epipalaeolithic are the most recent Pleistocene cultures, and it is no surprise that they display the greatest behavioural affinity to modern hunter-gatherers. The late Upper Palaeolithic (LUP) in Europe and the Epipalaeolithic in western Asia lasted from approximately 20 000 (uncalibrated radiocarbon) years ago to the end of the Pleistocene, roughly 10 000 years ago. It is in the LUP that one first gets a strong sense that the human world was structured according to fine-grained cultural differences as much as physical geography (Gamble 1986, Byrd 1994, Goring-Morris and Belfer-Cohen 1998). In Europe, the LUP subsumes a number of technocomplexes, including late Gravettian, Solutrean, Magdalenian, Epigravettian, and Azilian (Gamble 1986). In southwestern Asia it includes Kebaran, Geometric Kebaran, Natufian, and Mushabian in the Levant, and Zarzian in the Tauros/Zagros region (Bar-Yosef 1981, Madeyska 1990, Goring-Morris 1995, Henry 1995). The LUP spans the Last Glacial Maximum and subsequent climatic amelioration, which are some of the most extreme and rapidly fluctuating environmental conditions of the Pleistocene. The LUP is characterised by a rich and well-studied archaeological record (Gamble and Soffer 1990a, Soffer and Gamble 1990) and was exclusively the product of anatomically modern humans (*Homo sapiens sapiens*).

Several technological constants typify this period. One is the tendency toward microlithisation – many tiny retouched tools occurring in lithic assemblages. Microliths are widely presumed to

have served as the edges, points, and barbs of composite tools. By and large, microlithic and larger tools are made on small elongated blanks known as blades and bladelets, although production technology varies considerably. Some LUP toolmakers also employed a variety of durable organic materials such as bone, antler, and ivory. Ornaments, exotic materials (shell, amber, rare pigments) and art are present in most regions and in some, but not all, assemblages.

Although LUP cultures shared a number of general features, they vary greatly in their details. A large component of this variation fits well with the trends described for recent hunter-gatherers by Torrence (1983, 1989 and this volume) and Oswalt (1976). Projectile weapons are a case in point. The LUP arsenal of northern Europe includes a vast range, from stone points to plain, unbarbed bone or antler saggaie, to organic armatures equipped with stone cutting edges, to barbed harpoons (Figure 5.1). These preserved parts may represent only the tip of the technological iceberg – some of the durable elements must have formed the cutting edges, tips, and barbs for an even wider variety of implement types whose organic parts are no longer preserved.

The full range of tool forms known for the LUP is never represented within a single industry or phase (e.g. Straus 1993, Knecht 1997). Some specialised forms, such as Magdalenian and Azilian barbed harpoons, are found in only a limited area (Julien 1982). The greatest diversity in LUP weaponry, including the stone, bone, and antler components, is found in northern and alpine Europe (Gamble 1986: 225–6). Sites on the Russian plain (Borziyakov 1993, Grigor'ev 1993: 55) have yielded especially large and varied assemblages of bone, antler, and ivory implements, and several Magdalenian sites in Germany have yielded collections of more than 50 osseous projectile points (Weniger 1987). In contrast, the northern Mediterranean is characterised by a narrower variety of bone and stone weapons (Gamble 1986, Bietti 1990, Mussi 1990). In the Near East bone and antler points are even more scarce compared with northern Europe (Bar-Yosef 1981, 1990, Goring-Morris 1995). The Near Eastern artefacts tend to be relatively simple sharpened bone splinters (Newcomer 1974, Campana 1989) (Figure 5.2). Only at the end of the Epipalaeolithic, during the

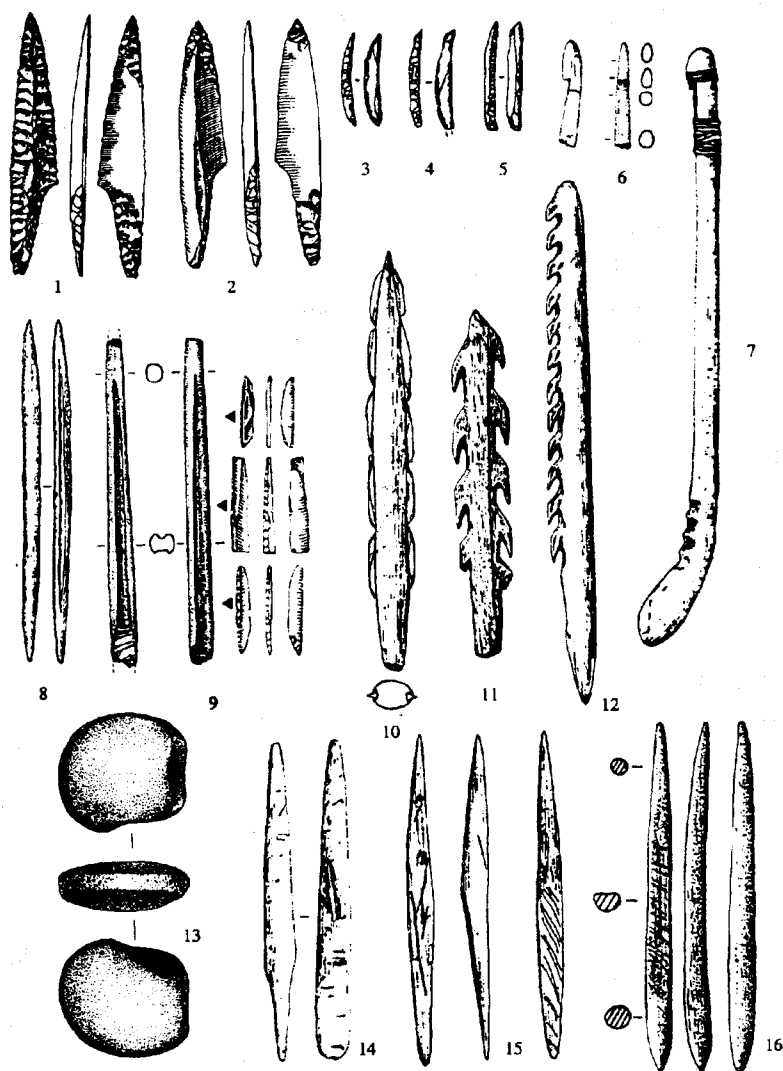
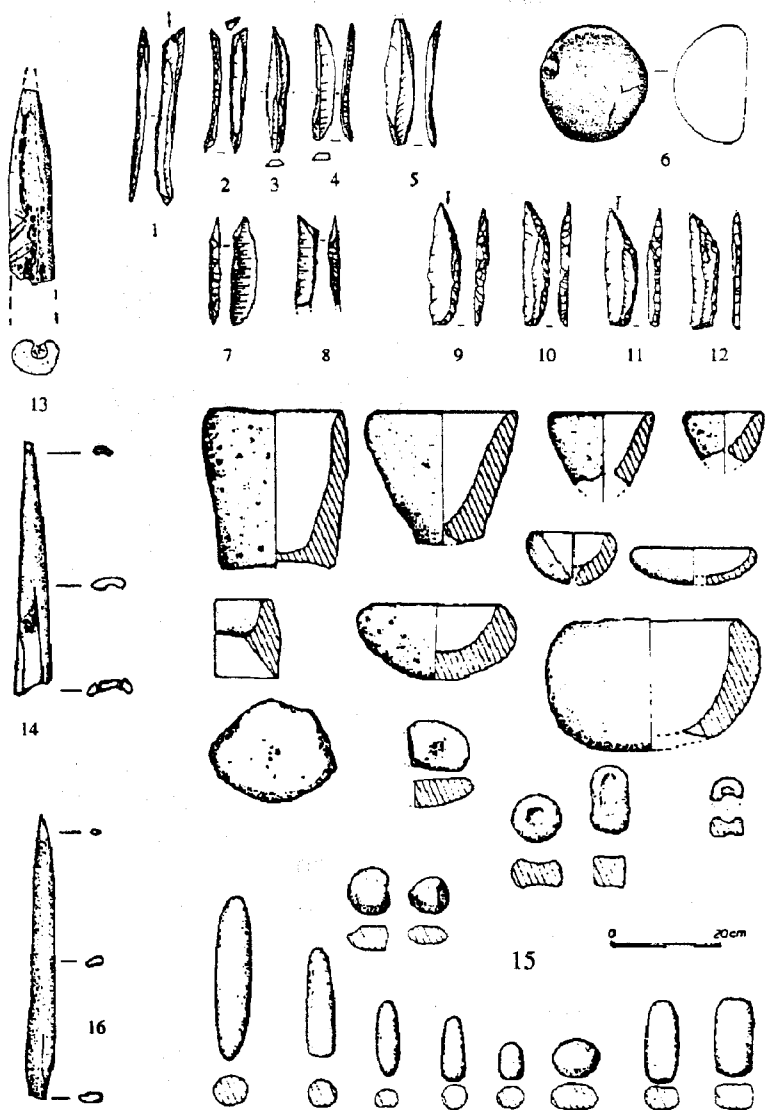


Figure 5.1. Examples of foraging technology of high-latitude European later Upper Palaeolithic hunter-gatherers. (From Laville *et al.* 1980, Strauss and Clark 1986, Geneste and Maury 1987, Borziyak 1993, Geneste and Plisson 1993, Pokines and Krupa 1997.)



Natufian period, do substantial and diverse bone artefact assemblages appear, and even then projectile components continue to be fairly scarce (Campana 1989).

Of course, foraging tool-kits of the Near Eastern Epipalaeolithic may have emphasised stone and perishable wood materials rather than bone and antler. Still, such raw materials have important implications concerning manufacturing investment. The production of bone, antler, or ivory artefacts is particularly labour- and time-intensive compared to the manufacture of stone tools (Knecht 1997: 200). Replication experiments suggest that even the simplest bone or antler points require a minimum of three production stages, involving a combination of abrasion, carving, and other labourious techniques (Newcomer 1977, Julien 1982, Campana 1989, McComb 1989). Elaborate harpoon barbs or hafting elements entail several more steps (e.g. Julien 1982: 127–35.) Thus, even if wooden armatures were common in southern Eurasia during the LUP, the use of bone and antler in high-latitude regions shows that there was both greater variety of and greater investment in the production of artefacts.

Geographic patterning in technology for plant use complements that of hunting equipment. The Epipalaeolithic of southern Eurasia is not simply an impoverished version of the northern LUP. A variety of implements for the exploitation of vegetable foods, including grinding slabs, querns, and mortars and pestles, is found in early Epipalaeolithic sites of the Near East (Bar-Yosef 1987, 1990, Byrd and Garrard 1990, Wright 1994, Goring-Morris and Belfer-Cohen 1998) and North Africa (Wendorf and Schild 1980). Their frequency increases over the final 10 000 years of the Pleistocene, but even the early specimens were relatively well made (Wright 1994) (Figure 5.2). Remarkable preservation at the waterlogged site of Ohalo II in Israel provides a rare glimpse of highly diversified plant-food diets from the Last Glacial Maximum (Kislev *et al.* 1992). Farther south, in the Nile Valley, early grindstones are found in the LUP Kubbanian culture, where they seem to have been used to process the bulbs and rhizomes of wetland plants (Hillman *et al.* 1989, Close and Wendorf 1990). The early importance of grinding equipment in southwest Asia indicates late Pleistocene foragers in

low latitude, arid regions were not only making use of concentrated but relatively low-yield foodstuffs, but also relying on these foods heavily enough to warrant elaborate processing. In northern Europe, by contrast, grinding stones are far less visible in the late Palaeolithic or even Mesolithic (Jochim 1998: 148). Grinding stones suitable for processing plants do occur sporadically in Upper Palaeolithic layers in some northern sites (de Beaune 1993, Borziyak 1993), but their functions are difficult to ascertain. Many of them may have been used to pulverise bone for grease rendering or for grinding pigments (e.g. Soffer 1985 de Beaune 1993).

Most discussions of LUP and Epipalaeolithic diet and subsistence behaviour focus on larger prey, especially ungulates. Exploitation of megafauna (mammoth, mastodon, rhinoceri) occurred only in a limited range of conditions, and it is not clear that healthy individuals were regularly hunted anywhere (Soffer 1990 1993, Abramova 1993). Ungulates were the main focus of large game hunting during the Palaeolithic everywhere except Australia. Eurasia is particularly rich in ungulate species (Diamond 1994) and nearly all of them were hunted to some degree. Monospecific or nearly monospecific ungulate faunas are reported for LUP sites in several regions of the Old World, and include assemblages dominated by barberry sheep in North Africa (Close and Wendorf 1990), gazelle in the Levant (Legge 1972, Davis 1982), reindeer, horse, bison or ibex in northerly or highland areas (Audouze 1987, Weniger 1987, Straus 1990b, Krotovna and Belan 1993). These cases have sometimes been taken as evidence for 'specialised hunting' and intentional restriction of diet breadth. For the most part, faunas dominated by a single ungulate species can be explained more simply in terms of climate- or latitude-driven shifts in mammalian communities, or hunting opportunities mediated by prey behaviour and biogeography (Garrard 1980, Bailey 1983, Davidson 1983, Simek and Snyder 1988, Stiner 1990 1994, Bar-Oz *et al.* 1998).

Human hunting of artiodactyls during the LUP and Epipalaeolithic followed the long-established theme of prime-dominated harvesting, irrespective of climate or latitude (Stiner 1990). Subtle reductions in the mean age at death in artiodactyl death assemblages indicate nearly continuous harvesting pressure in some

regions of Eurasia (Stiner 1994). The diversification of foraging technology characteristic of the LUP and Epipalaeolithic further suggests increasing specialisation in hunting techniques, and by implication, increases in harvesting efficiency. Concentrated seasonal harvesting in colder areas may also have become more common at this time (Audouze 1987, Weniger 1987). Methods for maximising the food value of carcasses, including grease rendering via boiling as done by some modern hunting peoples (Binford 1978), probably evolved in the LUP. The thick litter of fire-cracked stones in some Magdalenian sites in France and Germany (Audouze 1987, Weniger 1987), for example, could result from the extraction, concentration, and storage of bone grease.

Important shifts in the use of small game also occurred during the Upper Palaeolithic. In addition to the longer-standing reliance on slow-moving, easily collected reptiles, molluscs, and eggs in low-latitude regions during earlier periods (discussed in greater detail below), a variety of elusive prey was increasingly emphasised from the early Upper Palaeolithic onward. The first of these were birds such as fast-reproducing partridges (Stiner *et al.* 1999, 2000). Heavy use of lagomorphs, particularly hares, tends to appear somewhat later, mainly after the Last Glacial Maximum. This later shift probably was more widespread, including areas of the northern interior and arid lands to the south. Hares became an important component of the diet by LUP times in southern Europe (Davidson 1983, Clark 1987, Straus 1990b, Zilhão 1990, Stiner *et al.* 1999), western Europe (Berke 1984), Moravia (Svoboda 1990), the Central Russian Plain (Soffer 1990) and in the Dnestr region (Borziyak 1993). A surge in lagomorph exploitation occurs by roughly the same time in western Asia (Byrd and Garrard 1990, Munro 1999, Stiner *et al.* 2000), but apparently a good deal later in North Africa (Smith 1998). Environmental changes brought on by global warming may have expanded the habitats favoured by lagomorphs and thus their numbers in Eurasia. However, early wolf den faunas reveal that lagomorphs were locally abundant yet largely ignored by humans prior to the Upper Palaeolithic in some areas (Stiner 1994).

While shellfish had been a part of human subsistence since the Middle Palaeolithic (Klein and Scott 1986, Stiner 1993), they began

to suffer population declines from overexploitation during the late Upper Palaeolithic and Epipalaeolithic. Economically important taxa along the Mediterranean and Atlantic shores included mussels, limpets, and turban shells (e.g. Bailey 1978, 1983, Clark and Straus 1983), all of which could be gathered from the littoral zone. Over-harvesting by humans caused significant shell size diminution in limpet populations in Italy by 23 000 BP (Stiner *et al.* 1999), and by the late Magdalenian and Azilian (12 000–10 000 BP) at La Riera on the Atlantic coast of Spain (Clark and Straus 1983). Substantial exploitation of fish came very late to the north, however. There is evidence for limited use of salmon beginning with the Solutrean or Magdalenian at the earliest (Mellars 1985, Hayden *et al.* 1987, Zilhão 1990, Jochim 1998), but evidence for substantial dependence on fish is common only in the Mesolithic (e.g. Straus and Clark 1986, see Rowley-Conwy, this volume). Intensive fresh-water fish exploitation occurred as early as 18 000 BP in some arid southern regions, such as the Jordan and Nile Valleys (Close and Wendorf 1990, Nadel 1991, Nadel and HersHKovitz 1991). In the Maghreb of North Africa, land snails were extensively used from Last Glacial Maximum onward, their shells forming dense middens in some sites (Close and Wendorf 1990).

Small-scale exchange of goods was virtually ubiquitous in the LUP. Although the production of art is often considered a hallmark of the period, most, though not all, art objects come from northern Europe (Gamble and Soffer 1990b: 16). On the other hand, most LUP populations, whether in southern Europe (Bahn 1982, Bietti 1990, Mussi 1990, Straus 1990b: 203), northern Europe (e.g. Gamble 1986: 222, 332–8, Weniger 1987 1990), or the Near East (e.g. Bar-Yosef 1987, 1990, Goring-Morris and Belfer-Cohen 1998), found some use for unusual objects or raw materials, usually modified for suspension. A minor but significant proportion of the ornaments from LUP sites was made of raw materials that could only be obtained from distant sources. For example, Kebaran (early Epipalaeolithic) sites in the Levant contain marine shells obtained from sources up to 300 km away (Bar-Yosef 1990: 66, Byrd and Garrard 1990: 90–2). Baltic amber is found in continental sites of northeastern Europe in later phases of the LUP (Soffer 1985). Lithic

raw materials of exceptional quality were also sometimes moved considerable distances, presumably via trade and exchange. The quantities of exotic items vary from region to region (e.g. Straus 1990*b*), and the uneven reporting makes it difficult to test for geographic clines in the amount of long-distance transfer of goods. It none the less appears that exchange of raw materials was especially common in northern and central Europe (Schild 1976, Weniger 1990, Svoboda *et al.* 1996: 153, Jochim 1998: 219–20). It appears that some sort of long-distance exchange was practised by most LUP populations, and that the differences were largely a matter of degree. More research is needed on this question, but the kinds of socially-mediated options for managing resource risk associated with trading networks among recent hunter-gatherers seem to have been quite widespread during the LUP and Epipalaeolithic.

The last 10 000 years of the Pleistocene represents an exceptionally dynamic period in terms of global climate and the organisation of human lifeways. Many of the general features of the LUP and Epipalaeolithic described above became more strongly expressed with time. For example, proportions of microlithic artefacts increased throughout Eurasia. In coastal northern Europe, shellfish and fish took on ever greater dietary roles toward the end of the Palaeolithic and the Mesolithic (Gamble 1986, Clark 1987), the same may be said for lagomorph exploitation in many regions of Eurasia. In the Near East, people came to rely more and more on seeds, nuts, and other wild vegetable foods, culminating in the Natufian and other culture complexes (Henry 1989, Belfer-Cohen 1991, Byrd 1994). This apparent directionality of change suggests that people were increasingly locked into new routines, with fewer and fewer options to return to the prior conditions and ways of living.

The Middle Palaeolithic

Chronologically and environmentally, the Middle Palaeolithic covers much more than the LUP. Mousterian assemblages were first produced roughly 250 000 years ago in the Near East (Mercier *et al.*

1995), slightly later in Europe (Mellars 1996). Middle Palaeolithic technologies lasted as late as 30 000 years ago in southwestern Europe (Straus 1996, D'Errico *et al.* 1998). The Middle Palaeolithic of Eurasia spans at least two major glacial maxima and two warm intervals, and many shorter oscillations (Van Andel and Tzedakis 1996). Mousterian industries are most commonly associated with the Neanderthals (*Homo neanderthalensis* or *H. sapiens neanderthalensis*), but the remains of anatomically modern humans (*H. sapiens sapiens*) have been found in Mousterian layers at the sites of Skhul and Qafzeh in the Levant (Vandermeersch 1981, Bar-Yosef 1992).

The Middle Palaeolithic is often described as being comparatively homogeneous across vast stretches of the Old World (e.g. Foley 1991). However, calling the Mousterian monotonous disguises a great deal of diversity in certain dimensions of material culture, and thus noteworthy complexity of some aspects of human behaviour. Mousterian assemblages embody a startling array of techniques for reducing stone into flakes and blanks, including but not limited to the many varieties of Levallois technology (Boëda *et al.* 1990, Boëda 1991, Kuhn 1995, Hovers 1998). Even prismatic blades, generally associated with the Upper Palaeolithic, are common in some Middle Palaeolithic sites (Marks and Monigal 1995, Révillion 1995, Bar-Yosef and Kuhn 2000). Some of these methods of stone-working are more difficult to execute than the techniques commonly used by modern hunter-gatherers in the Americas or Australia. Researchers debate the reasons for this technological diversity, citing functional or economic variables, limitations imposed by raw materials, and socially encoded traditions of flint-working (reviewed in Hovers 1998). Regardless of its causes, the existence of such varied lithic technologies contradicts the common view of the Middle Palaeolithic as monotonous.

Other archaeological data also testify to considerable behavioural flexibility and even sophistication on the part of Mousterian hominids. These hominids flourished in a great variety of environments, ranging from desert margins to the edges of continental glaciers. What is more, artefacts were sometimes transported over distances well in excess of a single day's foraging radius (Geneste 1986, Roebroeks *et al.* 1988, Féblot-Augustins 1993, 1997), indicating that

Mousterian tool-makers sometimes thought well ahead about their needs for tools. Variable strategies of raw material consumption and artefact resharpening also indicate flexible responses to the challenges of keeping mobile groups supplied with tools and raw materials (e.g. Wengler 1990, Kuhn 1992, 1995, Féblot-Augustins 1993, 1997, Henry 1995). Subsistence data likewise suggest that Middle Palaeolithic hominids were resourceful foragers, capable and willing to take anything from clams to wild cattle and bison, and perhaps some even larger animals as well.

What seems to be missing from the Mousterian, and primarily responsible for its reputation for monotony, are the predictable geographic *trends* in material culture typical of both the ethnographic record of recent foragers and the archaeological record of LUP hunter-gatherers. In contrast to the LUP, it is difficult to find consistent links between environmental variables and the preserved elements of Mousterian technology that might be related to food procurement. Most Middle Palaeolithic assemblages contain pointed artefacts, either unretouched Levallois points or retouched Mousterian points, which some investigators believe were used as projectile tips (Shea 1989 1998) (Figure 5.3). Microwear studies suggest that these artefacts were multi-functional (Beyries 1988, Shea 1989, Anderson-Gerfaud 1990), however, so not all 'points' were specifically made to serve as projectile tips. Shea (1998) argues that the frequencies of points in assemblages from the Levant vary with local environment and reflect the relative importance of large-game hunting. However, the same basic range of forms appears throughout the vast temporal and geographic range of the Mousterian.

Globally, there is no evidence that the diversity or degree of elaboration in potential weapon tips increases as one moves from the Near East into northern Europe, a marked contrast to the LUP. Variation in the sizes and shapes of Levallois or Mousterian points generally are more closely linked to limitations imposed by raw materials or to methods of production than to functional differences. There are rare departures from the basic theme of the Levallois/Mousterian point in Eurasia, including uni- or bifacially worked 'leaf points' in Middle Palaeolithic assemblages stretching from

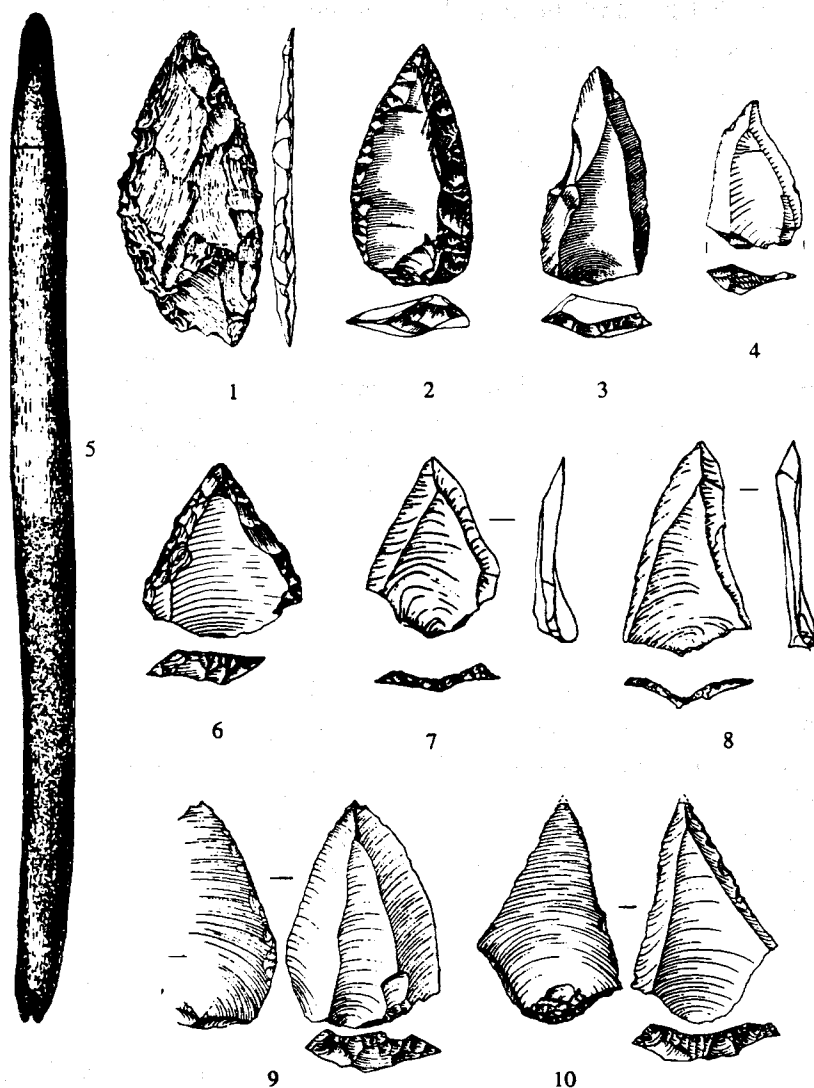


Figure 5.3. Examples of Middle Palaeolithic foraging technology. Numbers 1–5 are from Europe, numbers 6–10 are from the Near East. (From Crew 1976, Ronen 1984, Juffreau 1984, Müller-Beck 1988, Rigaud 1989, Henry 1995, Kuhn 1995, Gaudzinski 1999.)

Greece to Belgium (Mellars 1996: 130), and the so-called 'backed points' on thick blades from Tönchesberg, an early Middle Palaeolithic site in Germany (Conard 1992). Even the bifacial points are essentially the same kind of artefact as Mousterian and Levallois points – namely large, pointed stone tools, which, if hafted at all, were probably fitted to heavy thrusting weapons. Similarly, there is no evidence that the complexity and diversity of Mousterian hunting weapons waxed or waned with climate. In southwest France, for example, the Quina Mousterian variant is most consistently associated with cold conditions (Mellars 1996: 188–9), when humans' need for meat and animal fat would have been great. However, Quina-type assemblages are known for their large, heavily modified sidescrapers, and certainly not for the abundance or elaboration of potential projectile points (Bordes 1961 1972).

Overall, the Middle Palaeolithic tool-kit also shows a remarkably consistent and low level of investment per implement across Eurasia. Aside from the wooden spears or spear shafts thought to have been used, nothing in the classic Mousterian repertoire would require more than about 20 minutes' work to produce. In the LUP, and among recent foragers, high levels of technological elaboration and labour investment are manifest in certain tools as well as in the exploitation of durable but difficult-to-work organic substances such as bone and antler. Mousterian hominids sometimes used these materials, but much less frequently than their LUP counterparts; moreover, they were generally either employed 'as is' or minimally modified (Vincent 1989, Gaudzinski 1999). Of the few organic artefacts that survive, only the wooden spear from Leheringen (Adam 1951), and much older examples from Shoeningen (Thieme 1997), seem to be directly related to hunting (but see Gamble 1987). Most of the other items are of ambiguous function, or, in the case of large mammal ribs pointed at one end (e.g. Gaudzinski 1999, Vincent 1989) (Figure 5.3), could have been 'digging sticks'.

The lack of elaborate hunting technology should not be taken to imply that Mousterian foragers were ineffective predators. Hominids have been hunters of large game for a very long time with a rather limited range of technological aids. The contents of many

Middle Palaeolithic sites are dominated by hominid-generated bone debris, including abundant remains of ungulates. As early as the later Middle Pleistocene, some game selection is biased toward prime adult prey (Gaudzinski 1995, Stiner and Tchernov 1998), a feature distinguishing human habits from those of all large non-human predators (Stiner 1990 1994). In Europe and the Near East, human-caused damage to the bones (cut marks, percussion fractures, and burning), as well as relatively complete body-part representation indicate that Middle Palaeolithic humans enjoyed uninhibited access to large game (e.g. Chase 1986, David and Poulain 1990, Hoffercker *et al.* 1991, Farizy and David 1992, Stiner 1994, Rabinovitch and Tchernov 1995). The products of foraging were deliberately aggregated in some later sites, where they were processed and consumed by multiple individuals, creating thick refuse accumulations (e.g. Speth and Tchernov 1998). Other sites appear to represent individual kills (e.g. Conard 1992) or even loci of repeated kills of one or several animals (e.g. Jaubert *et al.* 1990, Debénath and Jelinek 1998). Other aspects of Middle Palaeolithic foraging behaviour are not easy to reconcile with the practices of recent hunter-gatherers. In some instances, hominids left artefacts in sites where the majority of faunal remains are attributable to large carnivores (Lindly 1988, Brugal and Jaubert 1991, Stiner 1994, Stiner *et al.* 1996). In others, occasional scavenging, primarily of ungulate head parts in spring, is associated with small-game use in some Italian sites (Stiner 1994).

Perhaps the most striking feature of Middle Palaeolithic game use is the dominance of high-ranked prey, regardless of latitude. Common prey species included large and medium-sized ungulates (Chase 1986, David and Poulain 1990, Jaubert *et al.* 1990, Stiner 1990, 1994, Hoffercker *et al.* 1991, Bar-Yosef *et al.* 1992, Gaudzinski 1995, Speth and Tchernov 1998, Stiner and Tchernov 1998). The only small animals regularly exploited had very low costs of capture (Stiner *et al.* 1999, 2000). Shellfish were collected, albeit in small quantities, throughout the Mediterranean region (Klein and Scott 1986, Stiner 1993 1994), as were tortoises in low-latitude areas (Stiner and Tchernov 1998, Stiner *et al.* 1999). Rare are the remains of agile small prey such as rabbits and birds (Stiner *et al.* 1999,

2000), species that are difficult to catch without special equipment. For assemblages whose taphonomic histories have been examined systematically – an essential qualifier to any comparison – data on Middle Palaeolithic game use fulfill the ecological expectation of declining prey species diversity with increasing latitude. Small animals were relatively more important to Middle Palaeolithic diets at lower latitudes than in the north, where preserved faunas consist almost exclusively of ungulate remains.

Direct evidence for the use of plant resources is sparse in the Middle Palaeolithic, at least partly because of preservation biases. A few unusual sites have limited evidence for plant exploitation. Kebara cave in Israel yielded burned seeds of wild legumes (Bar-Yosef *et al.* 1992: 530), presumably collected by hominids. Mousterian levels at Gorham's Cave, on Gibraltar, preserve burned remains of pine nuts and wild olives (Barton *et al.* 1999) in association with battered beach cobbles. Interestingly, the technological components necessary for intensive processing are uncommon or absent. Aside from hammerstones, which served a range of purposes, artefacts that could have been used to process vegetable foods are seldom if ever reported in Mousterian sites, whether in the southern Levant or in northern Europe. We should not be surprised to learn that Mousterian foragers consumed seeds and other vegetable foods, but it is clear that they did not go to any great lengths to process them. These high-cost, high-yield resources thus were not key dietary staples.

Finally, there is the question of how Middle Palaeolithic groups coped with resource risk via social relations. Ornaments and long-distance movement of shell and other raw materials, ubiquitous features of LUP and Epipalaeolithic cultures, are remarkably rare in the Middle Palaeolithic. Lithic raw materials were sometimes moved considerable distances (Féblot-Augustins 1997), but this may reflect no more than the normal transport of artefacts in the course of foraging and residential movement (Kuhn 1992). Unusual objects such as crystals and fossils are known for the Middle Palaeolithic, but they are very rare and seldom came from distant sources. Potential ornaments from Mousterian sites are limited to a few pierced animal teeth spread over thousands of square kilometres

(Chase and Dibble 1987, Mellars 1989*a,b*, 1996: 369–75, Davidson and Noble 1989, Hayden 1993), and all date to the late Middle Palaeolithic. The exchange of exotic items, whatever their social or symbolic value, was not a regular or frequent part of the Mousterian behavioural repertoire.

Humans with a difference

The records of the LUP and the Middle Palaeolithic both reveal considerable variability across time and space. However, neither the range of variation nor the trends across environmental gradients is the same for the two periods. The differences can highlight the question of the antiquity of the hunter-gatherer lifeways as we know them from ethnographic and historical accounts.

LUP and Epipalaeolithic peoples were distributed from the tropics to the subarctic. Variation across environmental gradients in subsistence and technology is much like that observed among ethnographically documented hunter-gatherers, with good evidence for greater dependence on hunted and/or fished foods in northern Eurasia, and earlier, intensive use of plant foods in southern areas such as the Levant. Diversity, elaboration, and relative investment in foraging technology, especially hunting gear, appear to increase with latitude. Low-volume, long-distance exchange, taken as evidence for broad networks of alliances, is ubiquitous. Of course it is impossible to find complete recent analogues for LUP groups, so Pleistocene evidence thus actually expands the range of known hunter-gatherer adaptations. None the less, the picture of broad-scale variability in the LUP is not unfamiliar to anthropologists who study modern hunter-gatherers.

In contrast, the Middle Palaeolithic world seems to have been populated by very different sorts of foragers. Human behaviour of this period certainly varied from one context to the next, but global variation in the archaeological evidence does not fit the expectations based on recent or LUP hunter-gatherers. At least three major differences can be identified. First, technological and faunal evidence for the Middle Palaeolithic suggests rather limited variation in subsistence with latitude, beyond that governed by prey distribu-

tion. Second, the labour invested in subsistence technology shows no relation to climatic variation. Wherever they lived, Mousterian foragers employed a fairly similar tool-kit, at least from stone, and seldom elaborated the production of artefacts. Interestingly, the ways in which tools were made and raw materials obtained show considerable flexibility – it is only the end-products that are so similar. Third, it appears that Mousterian groups had little need for durable symbols of group membership and individual identity, and they seldom exchanged distinctive, durable goods to maintain relationships across territorial boundaries.

These particular features of the Middle Palaeolithic record are not in themselves unexpected. Even in the recent past some foragers might have subsisted on high-ranked foods, used relatively unelaborated technologies, or practised little exchange with their neighbours. What is surprising is that such a pattern persisted for so long over such a broad area, from full glacials to prolonged interglacial periods and from the central Russian steppes to the deserts of North Africa. Clearly, one can not explain the shared characteristics of Middle Palaeolithic artefact and faunal assemblages by reference to a particular set of ecological conditions.

Since the Middle Palaeolithic archaeological evidence does not fit with expectations based on modern hunter-gatherers, what sort of adaptations does it represent? Middle Palaeolithic (and earlier) foraging groups seem to have been very 'light on the landscape'. They consistently targeted high-return, highly-ranked resources in most circumstances, expending little effort on small game and vegetable foods. Because high-ranked foods are most susceptible to over-harvesting, this would imply that human population densities remained very low. Nor did Mousterian hominids substantially affect the size/age distributions of slow-growing, slow-reproducing small animals (Stiner *et al.* 1999, 2000). We can further infer that group sizes were small or that larger aggregations were uncommon. Just how small Mousterian groups were is not clear, but even the widely cited minimum hunter-gatherer band size of 25 (see discussion in Kelly 1995: 205–13) could be an overestimate. The evidence also suggests that individuals did not participate in broader alliance networks of the types documented among recent hunter-gatherers

and perhaps that residence patterns and group affiliation were even more fluid than they were among recent foragers (Gamble 1986: 384–6).

If Middle Palaeolithic regional populations were small and subdivided into essentially autonomous foraging groups, some of the other departures from expected modern hunter-gatherer behaviours make more sense. Small, independent foraging groups naturally limit the scope of consumer and food-sharing networks. It can be argued that much of the pay-off for technological innovation among modern hunter-gatherers stems from (a) the sizes of co-operating consumer groups, and (b) the social benefits obtained by successful and generous providers (e.g. Hawkes 1991). If there were few individuals partaking in the fruits of foraging during the Middle Palaeolithic, the social and energetic benefits of increasing foraging efficiency by investing in elaborate technology would have been minimal (Kuhn and Stiner 1998a). Moreover, the pressure for dietary and technological diversification would also have been weak, because levels of intra-specific competition would have been relatively low. Higher population densities in the LUP produced the opposite effect.

The notion that Mousterian hominid populations were thinly distributed could therefore explain aspects of resource use and technological evolution. However, this begs the question of why population levels remained low for so long. Taken at face value, hominids seem to have manifest exceptionally slow population growth rates over the long term (Groube 1996: 101, Pennington, this volume). A lack of evidence for regular long-distance exchange implies that the sorts of alliance networks that allowed more recent foragers to cope with severe fluctuations in the food supply (Wiessner 1982, Cashdan 1985, Smith 1988) simply did not exist in the Middle Palaeolithic. Mousterian populations may have responded to environmental stress demographically, whereas late Upper Palaeolithic populations elaborated tools to process costly resources more efficiently and employed social mechanisms for buffering risk in addition to demographic responses.

What about the early Upper Palaeolithic?

The earlier Upper Palaeolithic (EUP) (ca. 45 000 to 20 000 BP) is central to debates about the origin and spread of anatomically modern humans. Up to this point we have explicitly distanced our discussion from the thorny topic of modern human origins, in order to separate the idea of 'modern' hunter-gatherer adaptations from considerations of the taxonomic status of Palaeolithic populations. Researching patterns of geographic variation for the EUP is complicated by ambiguities with dating, particularly as one approaches the limits of the radiocarbon method. Moreover, the demographic situation may have been unusually complex, with two human (sub)species – Neanderthals and anatomically modern *Homo sapiens* – coexisting for several thousand years. Any interactions between these populations should have had profound consequences for the formation of archaeological records. These reservations notwithstanding, it is worth briefly considering the EUP evidence for variation in light of the discussions above.

Some aspects of the EUP fit well with the tendencies described for the LUP. There is some evidence for greater elaboration of technology in northern Eurasia. The Aurignacian, the most widely-distributed EUP complex in Europe, is associated with a variety of distinctive bone and antler artefacts, especially points (e.g. Hahn 1977, Delporte 1991). Relatively 'costly' weapon types are known from EUP assemblages of the Near East but are comparatively rare; at Hayonim Cave (Israel), the Levantine Aurignacian assemblage of layer D included typical bone or antler points (Belfer and Bar-Yosef 1981). However, the more widely distributed Ahmarian complex is associated with a limited bone and antler technology (Bar-Yosef and Belfer-Cohen 1988, Gilead 1991, Schyle 1992). The Castelperroian and the Uluzzian, the former of which at least was produced by Neanderthals, also contain a few simple bone points and other bone artefacts (reviewed in D'Errico *et al.* 1998).

In Europe at least, the EUP also marks the abrupt appearance of ornaments, as well as the exchange of exotic materials over long distances (Hahn 1972, Soffer 1985, Mellars 1989*a,b*, White 1989 1993, Taborin 1993*a,b*, Fiocchi 1996–7, Kuhn and Stiner 1998*b*).

Both of these qualities suggest that the social mechanisms for maintaining relationships between distant groups or individuals were already established in Europe. Some EUP assemblages of western Asia also contain modest numbers of shell ornaments (e.g. Rust 1950, Schyle 1992), but the data are sparser, perhaps due to preservational factors. Information about long-distance transport of lithic raw materials in the EUP is ambiguous. EUP assemblages contain more exotic flints than do Mousterian assemblages in some places (Kuhn 1995, Svoboda *et al.* 1996: 120–6, Turq 1996), but in other areas Mousterian and EUP raw material exploitation patterns are similar (Geneste 1986, Roebroeks *et al.* 1988).

Subsistence data suggest that intensification in resource use, particularly the exploitation of birds, began with the EUP in Eurasia (Stiner *et al.* 1999, 2000), but that artefacts associated with the processing of vegetable foods remained quite limited (de Beaune 1993, Wright 1994). There seems to have been some pressure on EUP populations to intensify the means for hunting animals, but not enough to foster heavy reliance on seeds and nuts. However, the EUP dates to a period of relatively cold climatic conditions, while the LUP and the longer Middle Palaeolithic include both warm and cold intervals. For this reason, we cannot rule out the possibility that the scarcity of evidence for plant food exploitation is due simply to the scarcity of suitable plant foods.

In the long run we suspect that most of the trends in human variation during the EUP will prove similar to those observed in the late Upper Palaeolithic. Problems with chronology and the demographic complexities of the EUP are sufficient grounds for withholding judgement at present. We also emphasise that the question of the taxonomic status is more often a source of distraction than clarification for questions of the evolution of behaviour.

Conclusion

Modern hunter-gatherer adaptations in diet and technology were globally established by the LUP (20 000 BP), perhaps even by the EUP (ca. 45 000 BP). While the lifeways of particular Upper

Palaeolithic groups were unlike those of recent foragers, LUP hunter-gatherers responded to ecological and demographic factors in ways similar to modern foraging societies. By contrast, the archaeological record of the Middle Palaeolithic represents a different – albeit quite successful – range of behaviours. Mousterian foragers dealt with environmental variation in some unexpected ways, and their potential for population growth may have been lower as a consequence. While Middle Palaeolithic hominids hunted and gathered, they were a different kind of hunter-gatherer from any presently known.

If Mousterian hominids did not behave in quite the same ways as modern hunter-gatherers, it is likely that earlier humans probably did not either. None the less, one should not simply divide prehistory into pre-Upper Palaeolithic foraging groups and Upper Palaeolithic hunter-gatherers. So-called modern hunter-gatherer adaptations did not appear suddenly as a complete package. Many profound evolutionary changes in hominid adaptations occurred prior to the Upper Palaeolithic in Eurasia, and some of these remain essential to definitions of what it is to be human. The foragers of the Upper Palaeolithic and recent ethnographic past are distinguished by greater technological investment in response to seasonal or unpredictable food supplies. They also exhibited unique capacities to pack landscapes with people and to manipulate social ties in ways that buffered the most serious risks of a foraging lifestyle. Nevertheless, they represent just a few late chapters in a long and complicated evolutionary story that began more than 2.5 million years ago.

Important evolutionary events are not necessarily manifest where we first search for them. Paleoanthropologists have focused attention on evidence for the exploitation of large mammals, and consider the emergence of 'Man the (Big Game) Hunter' a great milestone in human evolutionary history. But hominids have hunted large game since at least the late Middle Pleistocene, well before the appearance and spread of anatomically modern humans or Upper Palaeolithic technology. Unexpectedly, the exploitation of small game and plants shows much more interesting trends.

A number of technological changes must have accompanied the trends in small-game exploitation. The early success of hominids as

large-game predators was not accompanied by major advances in hunting technology. The use of wooden spears goes back at least 500 000 years (Thieme 1997) and the only major change in hunting weapons prior to the Upper Palaeolithic would have been the lashing of a pointed stone flake to the end of a wooden shaft. There is, on the other hand, a clear association in time between increases in human diet breadth and rapid radiations in the formal elements of Upper Palaeolithic technology in the late Pleistocene. A variety of new artefact forms, ranging from harpoons to traps and nets – to use Hayden's (1981*b*) felicitous term, 'gadget technologies' – were probably necessary to make the collection of many kinds of small animals worthwhile (Hayden 1981*b*, Soffer 1985: 313, Holliday 1998). Milling equipment would have been needed to make the most of seeds and nuts. While these kinds of tools may enhance the overall efficiency or reliability of foraging, they are sometimes costly to manufacture, and their appearance and proliferation may mark fundamental changes in the allocation of time and labour among foragers. Traps, nets, and grindstones are also not items that normally attract the attention of Palaeolithic archaeologists, partly because they are difficult to identify in archaeological contexts, but they are very important from an evolutionary perspective.

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References

- Abramova, Z.A. (1993). Two examples of terminal Palaeolithic adaptations. In *From Kostenki to Clovis: Paleoindian and Upper Paleolithic Adaptations*, ed. O. Soffer and N. Praslov (eds.) 85–100. New York: Plenum Press.

- Adam, K. (1951). Der Waldelefant von Lehringen, ein jagdbeute des diluvialen menschen. *Quartär* 79–92.
- Anderson-Gerfaud, P. (1990). Aspects of behaviour in the Middle Palaeolithic: functional analysis of stone tools from southwest France. In *The Emergence of Modern Humans: An Archaeological Perspective*, ed. P. Mellars, pp. 389–418. Edinburgh: Edinburgh University Press.
- Audouze, F. (1987). The Paris Basin in Magdalenian times. In *The Pleistocene Old World: Regional Perspectives*, ed. O. Soffer, pp. 183–200. New York: Plenum Press.
- Bahn, P. (1982). Inter-site and inter-regional links during the Upper Palaeolithic: the Pyrenean evidence. *Oxford Journal of Archaeology* 1: 247–268.
- Bailey, G. (1978). Shell middens as indicators of postglacial economies: a territorial perspective. In *The Early Postglacial Settlement of Northern Europe*, ed. P. Mellars, pp. 37–64. London: Duckworth.
- Bailey, G. (1983). Economic change in late Pleistocene Cantabria. In *Hunter-Gatherer Economy in Prehistory: A European Perspective*, ed. G.N. Bailey, pp. 149–165. Cambridge: Cambridge University Press.
- Bailey, G. (ed.) (1983). *Hunter-Gatherer Economy in Prehistory: A European Perspective*. Cambridge: Cambridge University Press.
- Bar-Oz, G., Dayan, T. and Kaufman, D. (1999). The Epipalaeolithic faunal sequence of Israel: a view from Neve David. *Journal of Archaeological Science* 26: 67–82.
- Bar-Yosef, O. (1981). The Epi-Palaeolithic complexes in the southern Levant. In *Prehistoire du Levant*, ed. J. Cauvin and P. Sanlaville, pp. 389–408. Paris: Editions du CNRS.
- Bar-Yosef, O. (1987). Late Pleistocene adaptations in the Levant. In *The Pleistocene Old World: Regional Perspectives*, ed. O. Soffer, pp. 219–236. New York: Plenum Press.
- Bar-Yosef, O. (1990). The Last Glacial Maximum in the Mediterranean Levant. In *The World at 18,000 BP*, vol. 2, *Low Latitudes*, ed. C. Gamble and O. Soffer, pp. 58–77. New York: Plenum Press.
- Bar-Yosef, O. (1992). The role of western Asia in modern human origins. In *The Origin of Modern Humans and the Impact of Chronometric Dating*, ed. M. Aitken, C. Stringer and P. Mellars, pp. 193–200. London: The Royal Society.
- Bar-Yosef, O. and Belfer-Cohen, A. (1988). The early Upper Palaeolithic in Levantine caves. In *The Early Upper Palaeolithic: Evidence from Europe and the Near East*, ed. J. Hoffecker and C. Wolf, B.A.R. International Series 437, pp. 23–41. Oxford: British Archaeological Reports.
- Bar-Yosef, O. and Kuhn, S. (2000). The big deal about blades: laminar technologies and human evolution. *American Anthropologist* (in press).
- Bar-Yosef, O., Vandermeersch, B., Arensburg, B., Belfer-Cohen, A., Goldberg, P., Laville, H., Meignen, L., Rak, Y., Speth, J., Tchernov, E., Tillier,

- A.-M. and Weiner, S. (1992). The excavations in Kebara Cave. Mt. Carmel. *Current Anthropology* **33**: 497–550.
- Barton, R.N.E., Currant, A., Fernandez-Jalvo, Y., Finlayson, J.C., Goldberg, P., Macphail, R., Pettit, P. and Stringer, C. (1999). Gibraltar Neanderthals and results of recent excavations in Gorham's, Vanguard and Ibex Caves. *Antiquity* **73**: 13–24.
- de Beaune, S. (1993). Nonflint stone tools of the early Upper Palaeolithic. In *Before Lascaux: The Complex Record of the Early Upper Palaeolithic*, ed. H. Knecht, A. Pike-Tay and R. White, pp. 163–192. Boca Raton: CRC Press.
- Belfer-Cohen, A. (1991). The Natufian of the Levant. *Annual Review of Anthropology* **20**: 167–186.
- Belfer, A., and Bar-Yosef, O. (1981). Aurignacian at Hayonim Cave. *Paléorient* **7**: 19–42.
- Berke, H. (1984). The distributions of bones from large mammals at Petersfels. In *Upper Palaeolithic Settlement Patterns in Europe*, ed. H. Berke, J. Hahn, and C.-J. Kind, pp. 103–108. Tübingen: Verlag Archaeologica Venatoria, Institut für Urgeschichte der Universität Tübingen.
- Bevries, S. (1988). Functional variability in lithic sets in the Middle Palaeolithic. In *Upper Pleistocene Prehistory of Western Eurasia*, ed. H. Dibble and A. Montet-White, pp. 213–224. Philadelphia: University Museum Monograph 4.
- Bietti, A. (1990). The late Upper Palaeolithic in Italy: an overview. *Journal of World Prehistory* **4**: 95–155.
- Binford, L. (1968). Post-Pleistocene adaptations. In *New Perspectives in Archaeology*, ed. S. Binford and L. Binford, pp. 313–341. Chicago: Aldine.
- Binford, L. (1977). Forty-seven trips. In *Stone Tools as Cultural Markers*, ed. R.V.S. Wright, pp. 24–36. Canberra: Australian Institute of Aboriginal Studies.
- Binford, L. (1978). *Nunamiut Ethnoarchaeology*. New York: Academic Press.
- Binford, L. (1979). Organisation and formation processes: looking at curated technologies. *Journal of Anthropological Research* **35**: 255–273.
- Binford, L. (1980). Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* **45**: 4–20.
- Bird-David, N. (1991). Hunter-gatherers and other people: a re-examination. In *Hunter-Gatherers*, vol. 1, *History, Evolution and Social change*, ed. T. Ingold, D. Riches and J. Woodburn, pp. 17–30. New York: Berg.
- Bleed, P. (1986). The optimal design of hunting weapons. *American Antiquity* **51**: 737–747.
- Boëda, E. 1991. Approche de la variabilité des systèmes de production lithique des industries du Paléolithique inférieur et moyen: chronique d'une variabilité attendue. *Techniques et Culture* **17–18**: 37–79.
- Boëda, E., Geneste, J.-M., and Meignen, L. (1990). Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen. *Paleo* **2**: 43–80.
- Bordes, F. (1961). Mousterian cultures in France. *Science* **134**: 803–810.

- Bordes, F. (1972). *A Tale of Two Caves*. New York: Harper and Row.
- Borziyay, I.A. (1993). Subsistence practices of late Palaeolithic groups along the Dneister River and its tributaries. In *From Kostenki to Clovis: Paleoindian and Upper Paleolithic Adaptations*, ed. O. Soffer and N. Praslov, pp. 67–84. New York, Plenum Press.
- Bousman, B. (1993). Hunter–gatherer adaptations, economic risk, and tool design. *Lithic Technology* **18**: 59–86.
- Brugal, J.-P. and Jaubert, J. (1991). Les gisements paléontologiques Pleistocènes a indices de fréquentation humaine: un nouveau type de comportement de predation? *Paleo* **3**: 15–41.
- Burch, E. (1988). Modes of exchange in north-west Alaska. In *Hunters and Gatherers*, vol 2, *Property, Power and Ideology*, ed. T. Ingold, D. Riches, and J. Woodburn, pp. 95–109. New York: Berg.
- Byrd, B.F. (1994). From early humans to farmers and herders – recent progress on key transitions in southwest Asia. *Journal of Archaeological Research* **2**: 221–253.
- Byrd, B. and Garrard, A. (1990). The Last Glacial Maximum in the Jordanian desert. In *The World at 18,000 BP*, vol. 2, *Low Latitudes*, ed. C. Gamble and O. Soffer, pp. 78–96. New York: Plenum Press.
- Campana, D. (1989). *Natufian and Protoneolithic Bone Tools: The Manufacture and Use of Bone Implements in the Zagros and the Levant*. BAR International Series 494. Oxford: British Archaeological Reports.
- Cashdan, E. (1983). Territoriality among human foragers: ecological models and an application to four Bushman groups. *Current Anthropology* **24**: 47–66.
- Cashdan, E. (1985). Coping with risk: reciprocity among the Basarwa of northern Botswana. *Man* (N.S.) **20**: 454–474.
- Chase, P. (1986). *The Hunters of Combe Grenal: Approaches to Middle Palaeolithic Subsistence in Europe*, BAR International Series 286. Oxford: British Archaeological Reports.
- Chase, P. and Dibble, H. (1987). Middle Palaeolithic symbolism: a review of current evidence and interpretations. *Journal of Anthropological Archaeology* **6**: 263–296.
- Clark, G.A. (1987). From the Mousterian to the Metal Ages: longterm change in the human diet of northern Spain. In *The Pleistocene Old World: Regional Perspectives*, ed. O. Soffer, pp. 293–316. New York: Plenum Press.
- Clark, G.A. and Straus, L.G. (1983). Late Pleistocene hunter–gatherer adaptations in Cantabrian Spain. In *Hunter–Gatherer Economy in Prehistory: A European Perspective*, ed. G. Bailey, pp. 131–148. Cambridge: Cambridge University Press.
- Close, A. and Wendorf, F. (1990). North Africa at 18,000 BP. In *The World at 18,000 BP*, vol. 2, *Low Latitudes*, ed. C. Gamble and O. Soffer, pp. 41–57. New York: Plenum Press.

- Copeland, L. and Hours, F. (1977). Carved and plain bone tools from Jüta (Lebanon) and their early Kebaran Context. *Proceedings of the Prehistoric Society* **43**: 295–301.
- Conard, N. (1992). *Tönchesberg and its Position in the Palaeolithic Prehistory of Northern Europe*. Bonn: Dr Rudolf Habelt.
- Crew, H. (1976). The Mousterian site of Rosh ein Mor. In *Prehistory and Palaeoenvironments in the Central Negev, Israel*, vol. 1, *The Avdat/Aqev Area*, ed. A.E. Marks, pp. 75–112. Dallas: Southern Methodist University.
- David, F., and Poulain, T. (1990). La faune de grands mammifères des niveaux XI et XC de la Grotte du Renne à Arcy-sur-Cure (Yonne): étude préliminaire. In *Paléolithique Moyen Récent et Paléolithique Supérieur Ancien en Europe*, ed. C. Farizy, pp. 319–323. Ile de France: Mémoires du Musée de Préhistoire 3.
- Davidson, I. (1983). Site variability and prehistoric economy in Levante. In *Hunter-Gatherer Economy in Prehistory: A European Perspective*, ed. G. Bailey, pp. 79–95. Cambridge: Cambridge University Press.
- Davidson, I. and Noble, W. (1989). The archaeology of perception: traces of depiction and language. *Current Anthropology* **30**: 125–155.
- Davis, S. (1982). Climatic change and the advent of domestication: the succession of ruminant artiodactyles in the late Pleistocene/Holocene in the Israel region. *Paléorient* **8**: 5–14.
- Debénath, A., and Jelinek, A. (1998). Nouvelles fouilles à La Quina (Charente). Résultats préliminaires. *Gallia Préhistoire* **40**: 29–74.
- Delporte, H. (1991). La séquence aurignacienne et périgordienne sur la base des travaux récents réalisés en Périgord. *Bulletin de la Société Préhistorique Française* **88**: 243–256.
- D'Errico, F., Zilhão, J., Julien, M., Baffier, D. and Pelegrin, J. (1998). Neanderthal acculturation in western Europe? A critical review of the evidence and its interpretation. *Current Anthropology* **39** (Supplement): S1–S44.
- Diamond, J. (1994). Zebras and the Anna Karenina Principle. *Natural History* **103**: 4–10.
- Dufour, D. (1987). Insects as food: a case study from the northwest Amazon. *American Anthropologist* **89**: 383–397.
- Dyson-Hudson, R. and Smith, E. (1978). Human territoriality: an ecological reassessment. *American Anthropologist* **80**: 21–41.
- Farizy, C., and David, F. (1992). Subsistence and behavioural patterns of some Middle Palaeolithic local groups. In *The Middle Palaeolithic: Adaptation, Behaviour, and Variability*, ed. H. Dibble and P. Mellars, pp. 87–96. Philadelphia: University Museum Monographs 72.
- Féblot-Augustins, J. (1993). Mobility strategies in the late Middle Palaeolithic of Central Europe and Western Europe: elements of stability and variability. *Journal of Anthropological Archaeology* **12**: 211–265.

- Féblot-Augustins, J. (1997). La Circulation des Matières Premières au Paléolithique. ERAUL 75. Liège: Université de Liège.
- Fiocchi, C. (1996–7). Le conchiglie marine provenienti dalla Grotta di Fumane (Monti Lessini-Verona). *Atti dell' Istituto Veneto di Scienze, Lettere ed Arti* **155**: 1–22.
- Foley, R. (1991). Hominids, humans and hunter-gatherers: an evolutionary perspective. In *Hunters and Gatherers*, vol. 1, *History, Evolution and Social Change*, ed. T. Ingold, D. Riches and J. Woodburn, pp. 207–221. New York: Berg.
- Gamble, C. (1986). *The Palaeolithic Settlement of Europe*. Cambridge: Cambridge University Press.
- Gamble, C. (1987). Man the shoveler: alternative models for Middle Pleistocene colonisation and occupation in northern latitudes. In *The Pleistocene Old World: Regional Perspectives*, ed. O. Soffer, pp. 81–98.
- Gamble, C. and Soffer, O. (eds.) (1990a). *The World at 18,000 BP*, vol. 2, *Low Latitudes*. New York: Plenum Press.
- Gamble, C. and Soffer, O. (1990b). Pleistocene polyphony: the diversity of human adaptations at the Last Glacial Maximum. In O. Soffer and C. Gamble, pp. 1–23. New York: Plenum Press.
- Garrard, A. (1980). Man-animal-plant relationships during the Upper Pleistocene and Early Holocene of the Levant. Unpublished PhD, University of Cambridge.
- Gaudzinski, S. (1995). Wallertheim revisited: a re-analysis of the fauna from the Middle Palaeolithic site of Wallertheim (Rheinhessen/Germany). *Journal of Archaeological Science* **22**: 51–66.
- Gaudzinski, S. (1999). Middle Palaeolithic bone tools from the open-air site Salzgitter-Lebenstedt (Germany). *Journal of Archaeological Science* **26**: 125–142.
- Geneste, J.-M. (1986). Systèmes d'approvisionnement en matières premières au Paléolithique moyen et au Paléolithique supérieur en Aquitaine. In *L'Homme de Néandertal*, vol. 8, *La Technique*, ed. M. Otte, pp. 61–70. Liège: ERAUL 35.
- Geneste, J.-M. and Maury, S. (1997). Contributions of multidisciplinary experimentation to the study of Upper Palaeolithic projectile points. In *Projectile Technology*, ed. H. Knecht, pp. 165–189. New York: Plenum Press.
- Geneste, J.-M. and Plisson, H. (1993). Hunting technologies and human behaviour: lithic analysis of Solutran shouldered points. In *Before Lascaux: The complex Record of the Early Upper Paleolithic*, ed. H. Knecht, A. Pike-Tay and R. White, pp. 117–135. Boca Raton: CRC Press.
- Gilead, I. (1991). The Upper Palaeolithic period in the Levant. *Journal of World Prehistory* **5**: 105–153.
- Goring-Morris, N. (1995). Complex hunter-gatherers at the end of the Palaeolithic (20,000–10,000 BP). In *The Archaeology of Society in the Holy Land*, ed. T. Levy, pp. 141–168. London: Leicester University Press.

- Goring-Morris, N., and Belfer-Cohen, A. (1998). The articulation of cultural processes and late Quaternary environmental changes in Cisjordan. *Paléorient* **23**: 71–93.
- Grigor'ev, G.P. (1993). The Avedvo archaeological culture and the Willendorf–Pavlov–Kostenki–Avedvo cultural unity. In *From Kostenki to Clovis: Paleonindian and Upper Paleolithic Adaptations*, ed. O. Soffer and N. Praslov, pp. 51–66. New York: Plenum Press.
- Groube, L. 1996. The impact of diseases upon the emergence of agriculture. In *The Origins and Spread of Agriculture and Pastoralism in Eurasia*, ed. D. Harris, pp. 101–129. Washington, DC: Smithsonian Institution Press.
- Hahn, J. (1972). Aurignacian signs, pendants, and art objects in Central and Eastern Europe. *World Archaeology* **3**: 252–266.
- Hahn, J. (1977). *Aurignacien: das ältere Jungpaleolithikum in Mittel- und Osteuropa*. Köln: Fundamenta Reihe.
- Hawkes, K. (1991). Showing off: tests of an hypothesis about men's foraging goals. *Ethology and Sociobiology* **12**: 29–54.
- Hawkes, K. and O'Connell, J. (1985). Optimal foraging models and the case of the !Kung. *American Anthropologist* **87**: 401–405.
- Hayden, B. (1981a). Subsistence and ecological adaptations of modern hunter/gatherers. In *Omnivorous Primates: Gathering and Hunting in Human Evolution*, ed. R. Harding and G. Teleki, pp. 344–421. New York: Columbia University Press.
- Hayden, B. (1981b). Research and development in the Stone Age: technological transitions among hunter-gatherers. *Current Anthropology* **22**: 519–548.
- Hayden, B. (1993). The cultural capacity of Neandertals: a review and reevaluation. *Journal of Human Evolution* **24**: 113–146.
- Hayden, B., Chisholm, B. and Schwarcz, H.P. (1987). Fishing and foraging: marine resources in the Upper Palaeolithic of France. In *The Pleistocene Old World: Regional Perspectives*, ed. O. Soffer, pp. 279–291.
- Henry, D. (1989). *The Levant at the End of the Ice Age*. Philadelphia: University of Pennsylvania Press.
- Henry, D. (1995). *Prehistoric Cultural Ecology and Evolution*. New York: Plenum Press.
- Hillman, G., Madeyska, E. and Hather, J. (1989). Wild plant-foods and diet in late Palaeolithic Wadi Kubbaniya: the evidence from charred remains. In *The Prehistory of Wadi Kubbaniya*, vol. 2, *Paleoenvironmental and Stratigraphic Studies*, ed. F. Wendorf, R. Schild and A. Close, pp. 162–242. Dallas: Southern Methodist University Press.
- Hoffecker, J.F., Baryshnikov, G. and Potapova, O. (1991). Vertebrate remains from the Mousterian site of Il'skaya I (northern Caucasus, U.S.S.R.): new analysis and interpretation. *Journal of Archaeological Science* **18**: 113–147.
- Holliday, T. (1998). The ecological context of trapping among recent hunter-gatherers: implications for subsistence in terminal Pleistocene Europe. *Current Anthropology* **39**: 711–720.

- Hovers, E. (1998). The lithic assemblages of Amud cave: implications for understanding the end of the Mousterian in the Levant. In *Neandertals and Modern Humans in Western Asia*, ed. T. Akazawa, K. Aki and O. Bar-Yosef, pp. 143–164. New York: Plenum Press.
- Ingold, T., Riches, D. and Woodburn, J. (eds.). (1991). *Hunters and Gatherers*, vol. 1, *History, Evolution and Social Change*. New York: Berg.
- Jaubert, J., Lorblanchet, M., Laville, H., Slott-Moller, R., Turq, A. and Brugal, J.-P. (1990). *Les Chasseurs d'Aurochs de La Borde*. Paris: Editions de la Maison des Sciences de L'Homme, Documents d'Archéologique Français 27.
- Jochim, M. (1998). *A Hunter-Gatherer Landscape*. New York: Plenum Press.
- Julien, M. (1982). *Les Harpons Magdaléniens. XVII Supplément à Gallia Préhistoire*. Paris: Editions du CNRS.
- Keeley, L. (1995). Protoagricultural practices among hunter-gatherers: a cross-cultural survey. In *Last Hunters, First Farmers*, ed. T.D. Price and A.B. Gebauer, pp. 243–272. Santa Fe: School of American Research.
- Kelly, R. (1983). Hunter-gatherer mobility strategies. *Journal of Anthropological Research* **39**: 277–306.
- Kelly, R. (1995). *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways*. Washington DC: Smithsonian Institution Press.
- Kelly, R.L. and Todd, L.C. (1988). Coming into the country: early Paleoindian hunting and mobility. *American Antiquity* **53**: 231–244.
- Kislev, M.E., Nadel, D. and Carmi, I. (1992). Epi-Palaeolithic (19,000 BP) cereal and fruit diet at Ohalo II, Sea of Galilee, Israel. *Review of Palaeobotany and Palynology* **71**: 161–166.
- Klein, R.G., and Scott, K. (1986). Re-analysis of faunal assemblages from the Haua Fteah and other Late Quaternary archaeological sites in Cyrenaican Libya. *Journal of Archaeological Science* **13**: 515–542.
- Knecht, H. (1997). Projectile points of bone, antler and stone: experimental explorations of manufacture and use. In *Projectile Technology*, ed. H. Knecht, pp. 191–212. New York: Plenum Press.
- Knecht, H. (ed.) (1997). *Projectile Technology*. New York: Plenum Press.
- Knecht, H., Pike-Tay, A. and White, R. (eds.). (1993). *Before Lascaux: The Complex Record of the Early Upper Palaeolithic*. Boca Raton: CRC Press.
- Krotovna, A.A., and Belan, N.G. (1993). Amvrosievka: a unique Upper Palaeolithic site in Eastern Europe. In *From Kostenki to Clovis: Paleoindian and Upper Paleolithic Adaptations*, ed. O. Soffer and N.D. Praslov, pp. 125–142.
- Kuhn, S. (1992). On planning and curated technologies in the Middle Palaeolithic. *Journal of Anthropological Research* **48**: 185–214.
- Kuhn, S. (1994). A formal approach to the design and assembly of transported toolkits. *American Antiquity* **59**: 426–442.
- Kuhn, S. (1995). *Mousterian Lithic Technology: An Ecological Approach*. Princeton: Princeton University Press.

- Kuhn, S. and Stiner, M.C. (1998a). Middle Palaeolithic creativity: reflections on an oxymoron? In *Creativity in Human Evolution and Prehistory*, ed. S. Mithen, pp. 146–164. London: Routledge.
- Kuhn, S., and Stiner, M.C. (1998b). The earliest Aurignacian of Riparo Mochi (Liguria, Italy). *Current Anthropology* **39** (Supplement): S175–S189.
- Laville, H., Rigaud, J.-P. and Sackett, J. (1980). *Rock-Shelters of the Périgord*. New York: Academic Press.
- Lee, R. (1968). What hunters do for a living, or, how to make out on scarce resources. In *Man the Hunter*, ed. R. Lee and I. DeVore, pp. 30–48. New York: Aldine.
- Legge, A.J. (1972). Prehistoric exploitation of the gazelle in Palestine. In *Papers in Economic Prehistory*, ed. E. Higgs, pp. 119–124. Cambridge: Cambridge University Press.
- Lindly, J. (1988). Hominid and carnivore activity at Middle and Upper Palaeolithic cave sites in eastern Spain. *Munibe* **40**: 45–70.
- Madeyska, T. (1990). The distribution of human settlement in the extra-tropical Old World, 24,000–15,000 BP. In *The World at 18,000 BP*, vol. 2, *Low Latitudes*, ed. C. Gamble and O. Soffer, pp. 24–37.
- Marks, A. and Monigal, K. (1995). Modeling the production of elongated blanks from the early Levantine Mousterian at Rosh Ein Mor. In *The Definition and Interpretation of Levallois Technology*, ed. H. Dibble and O. Bar-Yosef, ed. H. Dibble and O. Bar-Yosef, pp. 267–278. Madison: Prehistory Press.
- McComb, P. (1989). *Upper Palaeolithic Osseous Artefacts from Britain and Belgium*. BAR International Series 481. Oxford: British Archaeological Reports.
- Mellars, P.A. (1985). The ecological basis of social complexity in the Upper Palaeolithic of southwestern France. In *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity*, ed. T.D. Price and J. Brown, pp. 271–297. New York: Academic Press.
- Mellars, P. (1989a). Technological changes at the Middle to Upper Palaeolithic transition: economic, social, and cognitive perspectives. In *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans*, ed. P. Mellars and C. Stringer, pp. 338–365. Princeton: Princeton University Press.
- Mellars, P. (1989b). Major issues in the emergence of modern humans. *Current Anthropology* **30**: 349–385.
- Mellars, P. (1996). *The Neanderthal Legacy*. Princeton: Princeton University Press.
- Mercier, N., Valladas, H., Valladas, G., Reyss, J.-L., Jelinek, A., Meignen, L. and Joron, J.-L. (1995). TL dates of burnt flints from Jelinek's excavations at Tabun and their implications. *Journal of Archaeological Science* **22**: 495: 509.
- Müller-Beck, H. (1988). The ecosystem of the 'Middle Palaeolithic' (Late Lower Palaeolithic) in the Danube region: a stepping-stone to the Upper Palaeolithic. In *The Upper Pleistocene Prehistory of Western Eurasia*, ed.

- H. Dibble and A. Montet-White, pp. 233–254. Philadelphia: University Museum Monograph 54.
- Munro, N.D. (1999). An investigation of occupation duration through population modeling in the Natufian period in the Levant. In *High Resolution Faunas of the Holocene Boundary*, ed. J. Driver, BAR International Series 800, pp. 37–45. Oxford: British Archaeological Reports.
- Mussi, M. (1990). Continuity and change in Italy at the Last Glacial Maximum. In *The World at 18,000 BP*, vol. 1, *High Latitudes*, ed. O. Soffer and C. Gamble, pp. 126–147. New York: Plenum Press.
- Nadel, D. (1991). Ohalo II – the third season (1991). *Journal of the Israel Prehistoric Society* **24**: 158–163.
- Nadel, D. and HersHKovitz, I. (1991). New subsistence data and human remains from the earliest Levantine Epipalaeolithic. *Current Anthropology* **32**: 631–635.
- Newcomer, M. (1974). Study and replication of bone artefacts from Ksar Akil. *World Archaeology* **6**: 138–154.
- Newcomer, M. (1977). Experiments in Upper Palaeolithic bone work. In *Méthodologie Appliquée à l'Industrie de l'Os Préhistorique*, ed. H. Camps-Febrer, pp. 293–301. Paris: Editions du CNRS.
- Oswalt, W. (1976). *An Anthropological Analysis of Food-Getting Technology*. New York: John Wiley.
- Pennington, L. (1989). *Bowes and Church's Food Values of Portions Commonly Used*. New York: Harper and Row.
- Peterson, J. (1978). Hunter–gatherer/farmer exchange. *American Anthropologist* **80**: 335–351.
- Peterson, N. (1975). Hunter–gatherer territoriality: the perspective from Australia. *American Anthropologist* **77**: 53–68.
- Pianka, E. (1978). *Evolutionary Ecology*. 2nd edn. New York: Harper and Row.
- Pokines, J. and Krupa, M. (1997). Self-barbed antler spearpoints and evidence of fishing in the late Upper Palaeolithic of Cantabrian Spain. In *Projectile Technology*, ed. H. Knecht, pp. 241–262. New York: Plenum Press.
- Rabinovich, R., and Tchernov, E. (1995). Chronological, paleoecological and taphonomical aspects of the Middle Palaeolithic site of Qafzeh, Israel. In *Archaeozoology of the Near East*, vol. 2, ed. H. Buitenhuis and H.-P. Uerpmann, pp. 5–44. Leiden: Backhuys Publishers.
- Révillion, S. (1995). Technologie du débitage laminaire au Paléolithique moyen en Europe Septentrionale: état de la question. *Bulletin de la Société Préhistorique Française* **92**: 425–441.
- Rigaud, J.-P. (ed.) (1989). *La Grotte Vaufray: Paléoenvironnement, Chronologie, Activités Humaines*, Mémoires de la Société Préhistorique Française 19. Paris: Editions due CNRS.
- Roebroeks, W., Kolen, J. and Rensink, E. (1988). Planning depth, anticipation, and the organisation of Middle Palaeolithic technology: the 'archaic natives' meet Eve's descendants. *Helinium* **28**: 17–34.

- Ronen, A. (1984). *Sefunim Prehistoric Sites, Mount Carmel, Israel*, vol. 1, BAR International Series 230i. Oxford: British Archaeological Reports.
- Rosenzweig, M. (1996). *Species Diversity in Time and Space*, 2nd imp. Cambridge: Cambridge University Press.
- Rust, A. (1950). *Die Höhlenfunde von Jabrud (Syrien)*. Neumünster: Karl Wacholtz.
- Schild, R. (1976). The Final Palaeolithic settlements of the European plain. *Scientific American* **234**: 88–99.
- Schyle, D. (1992). *Near Eastern Upper Palaeolithic Cultural Stratigraphy*, Beihefte zum Thbinger Atlas des Vorderen Orients, Reihe B (Geisteswissenschaften) 59. Wiesbaden: Dr Ludwig Reichert.
- Shea, J. (1989). A functional study of the lithic industries associated with the hominid fossils in the Kebara and Qafzeh caves, Israel. In *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans*, ed. P. Mellars and C. Stringer, pp. 598–610. Princeton: Princeton University Press.
- Shea, J. (1998). A regional-scale approach to lithic evidence for hunting in the Levantine Mousterian. *Current Anthropology* **39** (Supplement): S45–S78.
- Shott, M. (1986). Settlement mobility and technological organisation: an ethnographic examination. *Journal of Anthropological Research* **42**: 15–51.
- Simek, J.F., and Snyder, L.M. (1988). Changing assemblage diversity in Perigord archaeofaunas. In *Upper Pleistocene Prehistory of Western Eurasia*, ed. H. Dibble and A. Montet-White, pp. 321–332. Philadelphia: University Museum Monograph 54.
- Simms, S. (1987). *Behavioural Ecology and Hunter-Gatherer Foraging: An Example from the Great Basin*. BAR International Series 381. Oxford: British Archaeological Reports.
- Smith, A. (1998). Intensification and transformation processes towards food production in Africa. In *Before Food Production in North Africa*, ed. S. di Lernia and G. Manzi, pp. 19–33. UISPP, XIII World Congress. Forlì: A.B.A.C.O.
- Smith, E. (1988). Risk and uncertainty in the 'original affluent society': evolutionary ecology of resource-sharing and land tenure. In *Hunters and Gatherers*, vol. 1, *History, Evolution and Social Change*, ed. T. Ingold, D. Riches and J. Woodburn, pp. 222–251. New York: Berg.
- Soffer, O. (1985). *The Upper Palaeolithic of the Central Russian Plain*. New York: Academic Press.
- Soffer, O. (ed.) (1987). *The Pleistocene Old World: Regional Perspectives*. Plenum Press: New York.
- Soffer, O. (1990). The Central Russian Plain at the Last Glacial Maximum. In *The World at 18,000 BP*, vol. 1, *High Latitudes*, ed. O. Soffer and C. Gamble, pp. 228–252. New York: Plenum Press.
- Soffer, O. (1993). Upper Palaeolithic adaptations in Central and Eastern Europe and man-mammoth interactions. In *From Kostenki to Clovis: Paleo-*

- dian and Upper Paleolithic Adaptations, ed. O. Soffer and N.D. Praslov, pp. 31–49. New York: Plenum Press.
- Soffer, O. and Gamble, C. (eds.). (1990). *The World at 18,000 BP*, vol. 1, *High Latitudes*. New York: Plenum Press.
- Soffer, O. and Praslov, N. (eds.). (1993). *From Kostenki to Clovis: Paleoindian and Upper Palaeolithic Adaptations*. New York: Plenum Press.
- Speth, J.D., and Spielmann, K.A. (1983). Energy source, protein metabolism, and hunter-gatherer subsistence strategies. *Journal of Anthropological Archaeology* 2: 1–31.
- Speth, J.D., and Tchernov, E. (1998). The role of hunting and scavenging in Neanderthal procurement strategies: new evidence from Kebara Cave (Israel). In *Neanderthals and Modern Humans in West Asia*, ed. T. Akazawa, K. Aoki and O. Bar-Yosef, pp. 223–240. New York: Plenum Press.
- Spielmann, K. and Eder, J. (1994). Hunters and farmers: now and then. *Annual Review of Anthropology* 23: 203–223.
- Stahl, A. (1989). Plant-food processing: implications for dietary quality. In *Foraging and Farming: The Evolution of Plant Exploitation*, ed. D. Harris and G. Hillman, pp. 171–194. London: Unwin Hyman.
- Stiner, M.C. (1990). The use of mortality patterns in archaeological studies of hominid predatory adaptations. *Journal of Anthropological Archaeology* 9: 305–351.
- Stiner, M.C. (1993). Small animal exploitation and its relation to hunting, scavenging, and gathering in the Italian Mousterian. In *Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia*, ed. G.L. Peterkin, H. Bricker, and P. Mellars, pp. 101–119. Archaeological Papers of the American Anthropological Association 4.
- Stiner, M.C. (1994). *Honor Among Thieves: A Zooarchaeological Study of Neandertal Foraging Ecology*. Princeton: Princeton University Press.
- Stiner, M.C., and Tchernov, E. (1998). Pleistocene species trends at Hayonim Cave: changes in climate versus human behaviour. In *Neanderthals and Modern Humans in West Asia*, ed. T. Akazawa, K. Aoki, and O. Bar-Yosef, pp. 241–262. New York: Plenum Press.
- Stiner, M.C., Arsebuk, G. and Howell, F.C. (1996). Cave bears and Palaeolithic artefacts in Yarımburgaz Cave, Turkey: dissecting a palimpsest. *Geoarchaeology* 11: 279–327.
- Stiner, M.C., Munro, N.D., Surovell, T.A., Tchernov, E. and Bar-Yosef, O. (1999). Palaeolithic population growth pulses evidenced by small game use. *Science* 283: 190–4.
- Stiner, M.C., Munro, N.D. and Surovell, T.A. (2000). The tortoise and the hare: small game use, the Broad Spectrum Revolution and Palaeolithic demography. *Current Anthropology* (in press).
- Straus, L. (1990b). The Last Glacial Maximum in Cantabrian Spain: the Solutrean. In *The World at 18,000 BP*, vol. 1, *High Latitudes*, ed. O. Soffer and C. Gamble, pp. 89–108. New York: Plenum Press.

- Straus, L. (1993). Upper Palaeolithic hunting tactics and weapons in western Europe. In *Hunting and Animal Exploitation in the later Palaeolithic and Mesolithic of Eurasia*, ed. G.L. Peterkin, H. Bricker and P. Mellars, pp. 83–94. Archaeological Papers of the American Anthropological Association 4.
- Straus, L. (1996). Continuity or rupture; convergence or invasion; adaptation or catastrophe; mosaic or monolith: views of the Middle to Upper Palaeolithic transition in Iberia. In *The Last Neandertals, The First Anatomically Modern Humans*, ed. E. Carbonell and M. Vaquero, pp. 203–218. Tarragona: Universitat Rovira I Virgili.
- Straus, L., and Clark, G. (eds.) (1986). *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*. Anthropological Research Papers 36. Tempe: Arizona State University.
- Svoboda, J. (1990). Moravia during the Upper Pleniglacia. In *The World at 18,000 BP*, vol. 1, *High Latitudes*, ed. O. Soffer and C. Gamble, pp. 193–203. New York: Plenum Press.
- Svoboda, J., LoÖek, V. and VlÖek, E. (1996). *Hunters between East and West: The Palaeolithic of Moravia*. New York: Plenum Press.
- Taborin, Y. (1993a). *La Parure en Coquillage au Paleolithique*, Supplement à Gallia Préhistoire 29. Paris: Editions du CNRS.
- Taborin, Y. (1993b). Shells of the French Aurignacian and Périgordian. In *Before Lascaux: The Complex Record of the Early Upper Paleolithic*, ed. H. Knecht, A. Pike-Tay and R. White, pp. 211–228. Boca Raton: CRC Press.
- Thieme, H. (1997). Lower Palaeolithic hunting spears from Germany. *Nature* **385**: 807–810.
- Torrence, R. (1983). Time budgeting and hunter-gatherer technology. In *Hunter-Gatherer Economy in Prehistory: A European Perspective*, ed. G. Bailey, pp. 11–22. Cambridge: Cambridge University Press.
- Torrence, R. (1989). Re-tooling: towards a behavioural theory of stone tools. In *Time, Energy and Stone Tools*, ed. R. Torrence, pp. 57–66. Cambridge: Cambridge University Press.
- Tuffreau, A. (1984). Les Industries mousteériennes et castelperroniennes de La Ferrassie. In *Le Grand Abri de la Ferrassie*, ed. H. Delporte, Études Quaternaires Mémoire 7, pp. 111–144. Paris: Editions du Laboratoire de Paléontologie Humaine et Préhistoire, Institut de Paléontologie Humaine.
- Turq, A. (1996). L'Approvisionnement en matière première lithique au Moustérien et au début du Paléolithique supérieur dans le nord est du bassin Aquitain: continuité ou discontinuité? In *The Last Neandertals, The First Anatomically Modern Humans*, ed. E. Carbonell and M. Vaquero, pp. 355–362. Tarragona: Universitat Rovira I Virgili.
- Van Andel, T. and Tzedakis, P. (1996). Palaeolithic landscapes of Europe and Environs, 150,000–25,000 years ago: an overview. *Quaternary Science Reviews* **115**: 481–500.

- Vandermeersch, B. (1981). *Les Hommes Fossiles de Qafzeh (Israël)*. Paris: Editions du CNRS.
- Vincent, A. (1989). Remarques préliminaires concernant l'outillage osseux de la Grotte Vaufray. In *La Grotte Vaufray: Paléoenvironnement, Chronologie, Activités Humaines*, ed. J.-P. Rigaud, Mémoires de la Société Préhistorique Française 19, pp. 529–533. Paris: Editions du CNRS.
- Wendorf, F. and Schild, R. (1990). *Prehistory of the Eastern Sahara*. New York: Academic Press.
- Wengler, L. (1990). Economie des matières premières et territoires dans le Moustérien et l'Atérien maghrébiens: exemples du Maroc oriental. *l'Anthropologie* 94: 335–360.
- Weniger, G.-C. (1987). Magdalenian settlement pattern and subsistence in central Europe: the southwestern and central German cases. In *The Pleistocene Old World: Regional Perspectives*, ed. O. Soffer, pp. 201–215. New York: Plenum Press.
- Weniger, G.-C. (1990). Germany at 18,000 BP. In *The World at 18,000 BP*, vol. 1, *High Latitudes*, ed. O. Soffer and C. Gamble, pp. 171–192. New York: Plenum Press.
- White, R. (1989). Production complexity and standardisation of early Aurignacian bead and pendent manufacture: evolutionary implications. In *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans*, ed. P. Mellars and C. Stringer, pp. 366–90. Princeton: Princeton University Press.
- White, R. (1993). 'Technological and social dimensions of "Aurignacian-age" body ornaments across Europe.' In *Before Lascaux: The Complex Record of the Early Upper Paleolithic*, ed. H. Knecht, A. Pike-Tay and R. White, pp. 277–300. Boca Raton: CRC Press.
- Wiessner, P. (1982). Risk, reciprocity, and social influences on !Kung San economics. In *Politics and History in Band Societies*, ed. E. Leacock and R. Lee, pp. 61–84. Cambridge: Cambridge University Press.
- Wobst, H.M. (1978). The archaeo-ethnology of hunter-gatherers and the tyranny of the ethnographic record in archaeology. *American Antiquity* 43: 303–309.
- Woodburn, J. 1991. African hunter-gatherer social organisation: is it best understood as a product of encapsulation. In *Hunters and Gatherers*, vol. 1, *History, Evolution and Social Change*, ed. T. Ingold, D. Riches and J. Woodburn, pp. 31–64. New York: Berg.
- Wright, K. (1994). Ground-stone tools and hunter-gatherer subsistence in southwest Asia: implications for the transition to farming. *American Antiquity* 59: 238–263.
- Zilhão, J. (1990). The Portuguese Estremadura at 18000 BP: the Solutrean. In *The World at 18,000 BP*, vol. 1, *High Latitudes*, ed. O. Soffer and C. Gamble, pp. 109–125. New York: Plenum Press.