B. Demarsin & M. Otte (dir.). *Neanderthals in Europe*.
Proceedings of the International Conference held in the Gallo-Roman Museum in Tongeren (September 17-19th 2004).
Liège, ERAUL 117 - Tongeren, ATVATVCA 2, 2006, p. 91-105.

STAGE 3 CLIMATE AND THE UPPER PALAEOLITHIC REVOLUTION IN EUROPE: EVOLUTIONARY ERSPECTIVES[1]

Paul MELLARS
Department of archaeology, Cambridge University, Downing Street, CB2 3DZ Cambridge, U.K.

The nature and causes of the extraordinary "revolution" in human behavioural patterns which marked the transition from the Middle to the Upper Palaeolithic periods in Europe have generated a large and spirited literature over the past 20 years. Innovations that are customarily linked with this transition are reflected in almost all aspects of the archaeological record: major changes in the form and underlying technology of both stone and, above all, bone, antler and ivory artefacts; the emergence of more extensive distribution and exchange networks for raw materials; the earliest fully ceremonial burial practices; more highly structured living sites; and an effective "explosion" in various forms of explicitly symbolic expression, ranging from a sudden proliferation of laboriously shaped beads and other forms of personal ornaments, through symbolic notation systems, to remarkably varied and sophisticated forms of naturalistic art. There are also a number of more inferential but apparently closely related shifts in the demographic, social and subsistence patterns of the human groups (Bar-Yosef 1998, 2002; Gibson 1996; Sherratt 1997; Gamble 1999; Klein 2000; Kuhn & Stiner 2001; White 1993, 1997; Marshack 1991; Mellars 1973, 1989a & b; 1996a & b, 2001, 2004).

If the basic features of these changes in the archaeological record are now widely agreed, the precise causes and mechanisms of the changes remain much more controversial. Inevitably, current discussions of these issues are closely intertwined with debates over the nature and timing of the replacement of archaic (i.e. Neanderthal) by anatomically modern human populations (e.g. Stringer & McKie 1996; Stringer 2002; Clark & Willermet 1997; Lahr & Foley 1998; Zilhão & d'Errico 1999; Richards & Macaulay 2000; Krings *et al.* 2000; Hublin 2000; Eswaran 2002). Equally controversial is the extent of any changes in the cognition - or indeed innate cognitive *capacities* - of the populations involved (e.g. Donald 1991; Mithen 1996; Noble & Davidson 1996; Mellars & Gibson 1996; Deacon 1997; Mellars 1991, 1998, 2003; Lewis-Williams 2002). It is in this area that Colin Renfrew himself has made major contributions to the modern human origins debate (1996, 2001, 2002).

To attempt even a cursory review of all these issues in a single paper would be at best optimistic. Here I want to focus on just one specific aspect of the current debates, namely, the impact of the rapid changes in climatic and related environmental conditions which are now known to have occurred over the period of the Middle to Upper Palaeolithic transition in Europe, and the ways in which the human populations may have reacted to these changes. The critical question in the present context is how far - if at all - these adaptations may help to explain the patterns we see in the archaeological records of the conventional Middle-Upper Palaeolithic transition in Europe. As discussed further below, the main aim is to view these changes within an essentially Darwinian, evolutionary framework - that is, in terms of the effects of specific behavioural innovations or adaptations on the overall survival and reproductive capacities of the human populations involved (see Shennan 2002, with associated references). Some of the potential problems with this approach are discussed in the final section.

Environmental oscillations

The transition from the Middle to the Upper Palaeolithic falls around the middle of the last glaciation in Europe, during the period now generally referred to as Oxygen-isotope Stage 3 (OIS-3) as defined in the oxygen-isotope records from deep-sea cores, and extending from *c*. 60,000 to 25,000 BP in radiocarbon terms[2] (van Andel 1998, 2002; van Andel

[1] This paper was previously published: Mellars P. (2004) - Stage 3 climate and the Upper Palaeolithic revolution in Europe: evolutionary perspectives. In: Chris Scarre & Stephen Shennan (eds.), Explaining Social Change: Studies in Honour of Colin Renfrew. Cambridge, McDonald Institute for Archaeological Research, McDonald Institute Monographs, p. 27-43. It is reprinted here by permission of the author and the McDonald Institute for Archaeological Research.

[2] All radiocarbon dates used here are quoted in 'uncalibrated' terms. For the period of OIS-3, this is likely to underestimate the true (calendrical) age of the samples by between 2000 and 3000 years (Voelker *et al.* 1998).

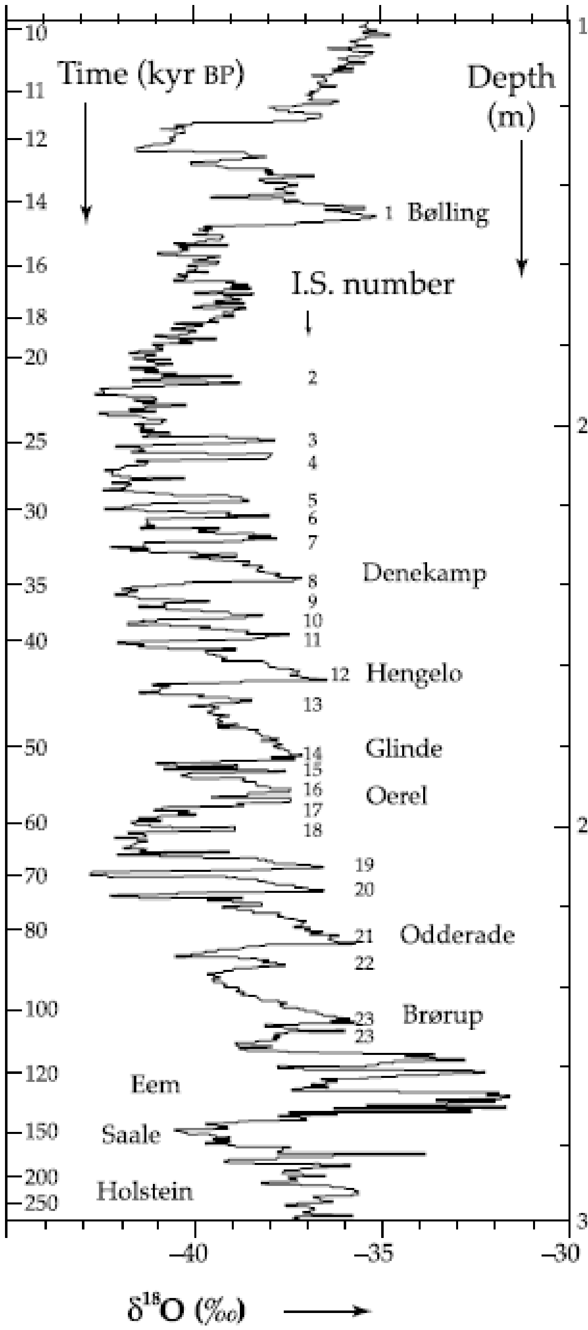

Figure 1. Climatic fluctuations during the last glaciation, as reflected in variations in oxygen-isotope ratios in the "Grip Summit" ice core from Greenland (after Dansgaard *et al*. 1993). Note that the timescale is in uncalibrated radiocarbon years, which are approximately 2000-3000 years older than uncalibrated dates for the later part of OIS-3.

& Tzedakis 1996; Shackleton *et al*. 2000). Stated briefly, this period is characterized by a rapid series of oscillations between periods of cold, essentially full-glacial climate, and much warmer interstadial episodes - the so-called "Dansgaard-Oeschger" events (fig. 1). These oscillations are best reflected at present in the fine-grained and relatively well-dated climatic sequences recorded in the Greenland ice cores (Dansgaard *et al*. 1993). There are also a number of long pollen sequences from sites such as La Grande Pile in France and Monticchio in Italy, and newly emerging sequences of combined pollen and oxygen-isotope records from cores off the Iberian coast (Woillard & Mook 1982; Huntley *et al*. 1999; Shackleton *et al*. 2000; Sanchez Goñi *et al*. 2002). Largely through the efforts of Tjeerd van Andel and his collaborators in the mutidisciplinary "Stage 3" project, we now have an increasingly clear picture of climatic and related environmental events throughout this period in Europe, although specific details of these oscillations and their reflection in different aspects of the related palaeoenvironmental records (pollen, faunal assemblages, etc.) remain problematic (van Andel & Davies 2003).

Even allowing for these uncertainties, however, we can now see that shifts from major cold peaks in the OIS-3 sequence to the intervening warm peaks are likely to have involved temperature changes of at least 5-7°C, with even greater contrasts between seasonal extremes of temperature and associated degrees of rainfall and snow cover. Vegetation records from several parts of Europe reflect changes from essentially open tundra or steppe-like vegetation in the colder periods to at least partial forest cover in the intervening warm phases, the precise patterns of vegetation varying along both north-south and east-west transects across Europe (Huntley *et al*. 1999). Overall, the boundaries between major vegetational zones (as for example between open and more wooded landscapes) could have shifted by several hundred kilometres between adjacent stadial and interstadial episodes (van Andel & Tzedakis 1996).

Similar shifts in the composition of the associated faunal communities would have been equally significant. In southwestern France, for example, we now see that faunal communities at different points during OIS-3 shifted from those heavily dominated reindeer (sometimes comprising over 90 per cent of the total faunal assemblages from contemporaneous archaeological levels) in the colder periods to those dominated by large bovids (*Bos* or *Bison*), horse, or even red deer during the major interstadial phases (Delpech 1983; Boyle 1990; Mellars 1996a:37-48).

The main point to stress here, however, is not simply the scale but the *rapidity* of many of these climatic and ecological oscillations. The earlier part of OIS-3, from *c*. 60,000 to 40,000 BP, was dominated by three major interstadials (Oerel, Glinde and Hengelo), each around 3000-5000 years in length, with shorter intervening cold peaks of around 1000-2000 years duration (fig. 1). In the later part of the period there was a complex succession of much shorter warm/cold oscillations (interstadials 5-11 of the Greenland ice-core sequence) in some cases at intervals of only 1000-2000 years. Some of the transitions from the cold stadial episodes to the following warm phases occurred within a space of only a few decades (Dansgaard *et al*. 1993; Shackleton *et al*. 2000; van Andel 2002).

Clearly, this highly abbreviated account of the complex pattern of ecological oscillations which characterized OIS-3 hardly does justice to the complexities of the relevant palaeoenvironmental records. One major question, for example, is exactly how rapidly the vegetational and faunal communities in the different areas of Europe were able to respond to the rapid changes in climate: to what extent these communities were fully in equilibrium with the associated climatic conditions (Huntley *et al*. 1999). We should also keep in mind the difficulty of dating accurately many of the changes in the environmental and archaeological records, given the current limitations of radiocarbon and other methods in this time-range. Above all, there is the problem of radiocarbon calibration and the complex fluctuations in the atmospheric radiocarbon content over the period in question (Voelker *et al*. 1998; Beck *et al*. 2001; Pettitt & Pike 2001). Nevertheless, the basic message of these recent studies of OIS-3 is clear: that the human communities throughout this period would have been forced to cope with a closely-spaced succession of climatic and related environmental changes which may have impacted, repeatedly and substantially, on many different aspects of their demographic and behavioural adaptations. What follows is an attempt to explore some of the ramifications of this conclusion for specific aspects of the archaeological records from Europe (see also Hopkinson 2004).

Demographic adjustments

Given the nature and scale of these climatic and environmental changes, certain basic demographic adjustments by the human populations could be seen as largely predictable, if not inevitable, in ecological and demographic terms. Briefly, these can be summarized as follows:

1. Arguably the most direct and predictable response would be shifts in the total geographical ranges exploited by specific local and regional populations, in response to displacements in regional ecological or vegetation zones. These would no doubt be most directly predictable at the geographical limits of human occupation - especially at the northern limits of the human ranges, but also perhaps in the exploitation of more marginal ranges at the interface between lowlands and uplands. During warmer phases, populations could be expected to have expanded their ranges towards the north, in much the same way as reflected in the late glacial and early postglacial colonization of Northern Europe (Housley *et al*. 1997). They may also have extended at least seasonally into higher altitudes (Roebroeks & Gamble 1999). In colder phases some corresponding contraction of ranges towards the south, or to lower elevations, might be anticipated.

But if we assume a fairly close correlation between the geographical ranges occupied by specific populations and the nature of local ecological or environmental conditions (and their associated resources) then one could also reasonably predict shifts in the ecological ranges exploited by particular groups in more southerly areas (Binford 2001; Kelly 1995). In other words, in most areas of Europe we might expect significant shifts in these population ranges at frequent and, in some cases, closely-spaced intervals throughout the time range of OIS-3.

2. Significant changes in local and regional population densities would seem equally predictable in ecological terms. As studies by Birdsell (1968), Binford (2001) and others have documented, hunter-gatherer population densities in general seem to be highly dependent on either the primary productivity of the ecosystem as a whole or on the frequency of some specific resources in these ecosystems that were critical to group survival. The nature of these population/ resource relationships can be visualized in different ways:

• in terms of the availability of specific food resources during annual, seasonal or longerterm episodes of resource scarcity (according to the demographic "law of the minimum");

• in terms of the effects of these resource fluctuations on the overall mobility, stress and work-load of the human groups, and especially the effects on mobility and birth-spacing in women (e.g. Lee 1979; Pennington 2001);

• or indeed the similar impact of ecologicallybased social disruptions on human productivity and mating systems in general (Read & LeBlanc 2003; Shennan 2002; Mellars 1996a:345-348).

However the relationships are visualized - whether in crude Malthusian or more complex social terms - some significant shifts in human population numbers and local population densities would again seem largely inevitable and predictable in response to the major ecological oscillations of OIS-3.

3. Similar factors could no doubt have led in certain contexts to episodes of local population extinction. Evidently, such population extinctions would have related closely to the absolute sizes of the local mating networks (and hence their vulnerability to short-term fluctuations in total population numbers) as well as to their dependence on certain specific resources which were critical to group survival, and the scale of the fluctuations in these resources during periods of climatic change (Wobst 1974; Zubrow 1989; Gamble 1999; Binford 2001). Smaller, relatively isolated populations would inevitably have been more vulnerable to ecological oscillations than larger populations with more extended mating networks. Similarly, groups dependent on highly specialized economic resources would in general have been more vulnerable to fluctuations in resource abundance than groups with a more diverse and generalized subsistence base. But overall, episodes of local population extinction would again seem largely predictable if not inevitable at particular times and locations during OIS-3 (cf. Read & LeBlanc 2003). One important corollary of this, of course, is that any such local population extinctions would have provided a further opportunity for the range-expansion of other, adjacent populations to colonize the newlyvacated ecological space.

4. Finally, one potentially critical consequence of the various demographic processes outlined above would have been repeated episodes of increased interaction, and varying degrees of social and demographic competition between the local population units, in response to any climatically induced demographic changes. As local population densities increased or decreased, or the geographical ranges exploited by particular groups shifted in response to changes in the distribution of specific resources or ecological zones, then both the pressures and the opportunities for local groups to expand into, or impinge upon, the territories and territorial resources of their neighbours would inevitably have increased (Read & LeBlanc 2003). It is this direct and recurrent demographic competition between adjacent groups which, combined with

the other adaptive and evolutionary pressures discussed below, could have imposed especially strong selective pressures on the behavioural patterns of the human groups.

Behavioural adaptations

The point of the preceding discussion is to underscore the fact that the human populations occupying the different areas of Europe during the period of OIS-3 would have had to cope with a succession of climatic and associated environmental changes which were not only substantial in scale (whether in terms of temperature, rainfall, snow-cover, vegetation and animal populations) but were above all in some cases extremely rapid and closely-spaced in time. The individual cycles from major cold peaks to intervening warm peaks were frequently spaced at intervals of only one or two millennia. In other words, the human populations had to cope with landscapes which were in an almost continuous process of change, with periods of relative climatic (if not necessarily ecological) stability lasting at most only *c*. 1000 to 3000-4000 years.

To some extent, as discussed above, the impact of these environmental changes could have been mitigated by corresponding demographic adjustments: shifts in the spatial ranges occupied by individual groups, increases or decreases in local population densities, or changes in the annual or seasonal mobility patterns of the human groups. But presumably there would have been equal pressures to change not only the demographic organization of the populations but many other features of their economic, technological and social behaviour. As noted earlier, I am assuming here that the most appropriate way to view these adaptive changes is from an explicitly Darwinian, evolutionary perspective, which places the primary emphasis on the capacity of any economic, technological or social adjustments to increase the long-term reproductive viability of the individuals or societies in question, and thereby to ensure their long-term continuity in the evolutionary record (see Shennan 2002 for an excellent recent review of these issues). The assumption, in short, is that however these behavioural adjustments or innovations originated - whether by "pure" innovation (analogous to a genetic mutation) or by increasing application of elements already present in the existing behavioural systems - the strong selective pressures imposed by the major climatic oscillations of OIS-3 would lead to an increased frequency in these patterns of behaviour in competition with less appropriate (i.e. less selectively advantageous) forms of behaviour.

Viewed in these terms it would be reasonable to anticipate significant changes in at least four separate behavioural dimensions throughout OIS-3:

Subsistence changes

Changes in subsistence strategies are perhaps the most direct and obvious behavioural response to the ecological oscillations of OIS-3. Here one might anticipate changes not only in the total range and relative importance of the different food resources exploited (largely in response to shifts in the frequencies of the resources in the local environment) but also changes in the strategies of exploitation of these resources: in specific hunting strategies, hunting technologies, food-processing or storage techniques, or in the spatial and logistical movements of the human groups to cope with variations in the annual or seasonal distribution of different resources (Binford 2001; Torrence 2001; Kelly 1995). However these changes are envisaged, shifts in the overall structure and organization of subsistence strategies are likely to have been under especially strong selective pressures throughout the rapid environmental oscillations of OIS-3.

Technological changes

Changes in the range and organization of different forms of material technology are likely to have been under similar selective pressures. Some of these would no doubt have derived from changes in subsistence patterns discussed above, such as in the form, construction or complexity of hunting missiles or plant-food processing equipment; technology related to the butchery and transportation of animal carcasses, and the subsequent processing of the carcasses and bone residues; or techniques employed in the freezing, drying or long-term storage of food supplies (Torrence 2001).

Other technological changes could have derived more directly from the nature of the climatic fluctuations themselves - and especially from the impact of extreme winter conditions. Possible adaptations here would have included changes in the design and preparation of skin clothing; similar changes in the construction of living shelters; or changes in travel or transportation technology arising, for example, from the depth and duration of snow cover, or the impact of frozen rivers on winter travel. Any major changes in the availability of different raw materials (such as the effects of heavy vegetation or prolonged snow cover in obscuring flint supplies, or changes in the availability of antler, ivory or particular plant materials) could no doubt have had a similar impact on at least some aspects of technology. Other selective pressures on the precise forms of material technology could no doubt have derived from more social and demographic factors, as discussed further below.

Social changes

The most significant social changes during the period of OIS-3 are likely to have been related to the various demographic adjustments discussed in the preceding section. Two factors may have been especially significant in this context. First, it could be argued that any major increase in local or regional population densities would almost inevitably have created an increased level of competition between adjacent groups for the use of both space and resources (Read & LeBlanc 2003). In certain contexts this might have led to an increased emphasis on group territoriality and the clearer definition of territorial boundaries - and, perhaps, corresponding pressures towards an increased emphasis on social identities and associated "ethnicity" between adjacent territorial groups (Dyson-Hudson & Smith 1978; Price & Brown 1985; Keeley 1988, 1996; Mellars 1996b:190-191; Rowley-Conwy 2001; Binford 2001).

Secondly, it can be argued that any sharp increase in local population densities would at least *facilitate* the formation of larger and perhaps longerterm residential groupings, and perhaps have encouraged the formation of such groups as a direct adaptive response to greater efficiency and group security in the use of the available resources - especially the use of large game resources (Binford 2001; Price & Brown 1985; Mellars 1996b:186-188). As many ethnographic studies have shown, formation of these larger social aggregates can also be heavily dependent on localized concentrations of food resources at particular times and places in the environment (Kelly 1995; Rowley-Conwy 2001; papers in Lee & Devore 1968). It could be argued in turn that the formation of larger or more sedentary residential units would certainly have provided the essential *pre-conditions* for any increased separation of distinct social, economic or personal roles within the groups in question, and might well have exerted significant selective pressures towards social separation and role definition, in terms of the increased efficiency or increased social integration and cohesion of the local groups (Price & Brown 1985; Keeley 1988; Mellars 1996b:188-190; Rowley-Conwy 2001). Whether or not similar factors could have favoured other kinds of role separation and identification, such as those based on age, gender or kinship relationships, is no doubt more debatable. Lastly, as Gamble (1999) and others have emphasized, certain patterns in the spatial and chronological distribution of economic resources (notably the emergence of more localized, patchy or unpredictable distributions of the resources) could well have favoured a significant increase in the spatial scale of social contact between widely-dispersed human groups, in order to provide greater longterm security against the effects of short-term and unpredictable fluctuations in local food supplies. As Féblot-Augustins (1993, 1999) has argued, similar social factors could no doubt have operated at the level of lithic and other raw material supplies - though of course these (at least in the case of lithic resources) would have been less directly under the influence of climatic change.

Symbolic changes

The ways in which the demographic and social patterns discussed above could have impinged on various forms of "symbolic" expression and interactions between local groups, or individuals within these groups, have been discussed at length in the earlier literature (Wobst 1977; Wiessner 1983, 1984; Price & Brown 1985; Keeley 1988; White 1993, 1997; Mellars 1985, 1996b; Knight *et al*. 1995; Gamble 1999; Kuhn *et al*. 2001). The usual line of argument is that the emergence of a clear symbolic component in material culture could be selectively favoured by at least two social situations:

• first, by the emergence of increased densities of local populations leading (as discussed above) to increased territoriality between adjacent groups, and arguably an increased need for certain forms of material symbolism to reflect and reinforce these emerging territorial, social and ethnic divisions (Wiessner 1983; Gamble 1999; Mellars 1996b:190-191; Read & LeBlanc 2003);

• second, by any substantial increase in the total size, permanence or sedentism of local residential groups, which would arguably favour the emergence of separate social, economic or personal roles within these larger residential units generating the associated "need" for symbolic artefacts, body ornamentation, or whatever, to clearly identify and to communicate these social identities to other members of the group (Wiessner 1984; Price & Brown 1985; Mellars 1996b:188-190; White 1993, 1997; Kuhn *et al*. 2001).

Arguably both forms of symbolism - whether at the level of group ethnicity or of individual social or personal identity - could also be reflected in other dimensions of material culture. One such may have been the degree of "stylistic" (as opposed to "functional") investment in the precise forms of stone or bone/antler tools, leading, as discussed further below, to an increased element of consciously imposed form or visual symbolism in the detailed shapes and visual appearance of the tools (Mellars 1989b, 1991). Any increase in group ceremonial or ritualistic activities (social, economic, religious) would, needless to say, provide a further powerful stimulus to an increased symbolic investment in material culture.

Late Mousterian innovations

If we turn now from theoretical speculation to archaeological reality, the central question is how far we can recognize any hard evidence for the kinds of behavioural and cultural adaptations discussed above that could potentially be attributable to the climatic and environmental instability of OIS-3. Here I want to focus initially on the earlier part of OIS-3 between *c*. 60,000 and 40,000 BP - the time-range of the later Middle Palaeolithic or Mousterian of Europe, prior to the critical cultural threshold of *c*. 40,000 BP[1]. As we shall see, the whole issue of the "Upper Palaeolithic revolution" in Europe poses a special set of questions, which will be discussed separately in the following section. The primary focus of what follows will be on the archaeological evidence from southwestern France: partly, no doubt, as a reflection of my own particular research interests, but above all as this is still the area that provides by far the richest, best-documented, best-dated and most fine-grained record of late Neanderthal behavioural patterns anywhere in Europe.

The earlier part of OIS-3 (*c*. 60,000-40,000 BP) coincides broadly with the last major episode of Middle Palaeolithic technology in southwestern France, in the form of the Mousterian of Acheulian Tradition (usually abbreviated to "MTA": see Mellars 1996a for a full review of the relevant dating and technological succession). Climatically, this period spans two major episodes of relatively warm climate (the Glinde and Oerel interstadials) together with a number of shorter oscillations that collectively comprise interstadials 13 to 17 of the Greenland ice-core sequence (fig. 1; Dansgaard *et al*. 1993). The issue at stake is how far we can identify any significant shifts or innovations in the archaeological records of this time range which could be attributed to the kind of climatically driven evolutionary mechanisms discussed in the preceding sections. The answer, I would suggest, is that while we can perhaps detect certain potentially significant innovations in the archaeological records of the MTA, the precise significance of these changes remains difficult to evaluate.

Demography

One of the most striking features of the MTA is the relatively large number of site locations which have now been documented - especially from open-air localities between the major river valleys of the region (Mellars 1996a:245-268, fig. 8.11). These certainly dwarf the numbers of sites which can be confidently attributed to the earlier stages of the Mousterian sequence (Ferrassie, Quina, Denticulate, etc.) and could no doubt be seen as a reflection of some major population expansion during the final stages of the Mousterian succession, perhaps in response to the generally milder and more ecologically-productive conditions of OIS-3 (fig. 2). The problem in this case (as in most site-based estimates of population densities) is to know how far the large total of open-air MTA sites is simply a reflection of either the high visibility of the distinctive bifacial hand-axe forms in surface collections (and no doubt their special attractions to collectors), or simply a much more mobile and dispersed pattern of use of open-air localities during the major warm phases of early OIS-3, compared with the much colder conditions of the preceding OIS 4. Since a high proportion of the recorded MTA sites seem to consist of isolated finds of just one or two bifaces, particular caution is required (Mellars 1996a:262).

Subsistence patterns

The widespread distribution of open-air MTA sites on the plateaux of southwestern France could no doubt be seen (as noted above) as a simple response to milder and more ecologically-productive environmental conditions, with a corresponding broadening of the subsistence base to include a wider range of more temperate species (red deer, horse, bison, aurochs, etc.) as opposed to specialized steppe/tundra species such as reindeer (Mellars 1996a). Potentially more significant is the occurrence in at least some late Mousterian sites of much more highly specialized faunas, focused heavily on the exploitation of large bovids - either *Bison* or *Bos primigenius*. Examples of these highly-specialized bovid faunas have now been documented from apparently late Mousterian contexts in at least two or three open-air or plateau-top locations in southwestern France (most notably Mauran and Le Roc). They may be reflected equally in the old faunal collections from the classic MTA levels in the Le Moustier rock-shelter in the Vézère valley (Mellars 1996a: 48, 231-244; Farizy *et al*. 1994; Jaubert 1999). In Germany and Italy the possibility of more specialized faunal exploitation during the later stages of the Middle Palaeolithic has been raised (Stiner 1994; Gaudzinski 1999; Kuhn & Stiner 2001). In all these cases, of course, one has the perennial problem of assessing how far the documented *quantitative* specialization in the faunal assemblages represents a deliberate element of *selection* on the part of the human groups, and how far it could simply reflect the natural composition of the local faunal communities at the specific times and locations in question (Mellars 1996a:196-201, 2004; Grayson *et al*. 2001). Nevertheless, the possibility remains of some significant shift in faunal exploitation patterns during the later stages of the Middle Palaeolithic, perhaps (though highly speculatively) reflecting more logistical organization of hunting patterns, and conceivably improved forms of hunting technology.

Social organization

In terms of social patterning we can still say very little about potential changes in the later Middle Palaeolithic with the exception perhaps of hints of a shift towards a more intensive pattern of site occupation in some of the cave and rock-shelter sites. The MTA levels at Pech de l'Azé I, for example, seem to be characterized by an unusually high density of archaeological material, associated with a succession of closely-spaced hearths (Bordes 1954-55, 1972). In the similar, later MTA levels at Le Moustier it was commented that some of the levels comprised more artefacts and faunal remains than intervening sediments (Laville *et al*. 1980:177). And the large, complex and heavily-burned hearth recently documented in the MTA levels at Grotte XVI is perhaps one of the most substantial and impressive hearths so far documented in a Middle Palaeolithic context (Rigaud *et al*. 1995). Immediately beyond southwestern France, one might note the pattern of closelyspaced occupation levels and associated hearths in the late Mousterian levels in the Abric Romaní rock shelter in Catalonia (Vaquero 1999). All of these could hint at a potentially increased intensity - and perhaps increased duration - of site-occupation patterns during the later stages of the Middle Palaeolithic. The evidence, however, remains at best tenuous. Whether any of these sites show significantly more intensive patterns of occupation than those reflected in much earlier Mousterian levels, such as the OIS-5 levels at Combe Grenal and elsewhere (Bordes 1972; Turq 1999), remains to be documented. Whether or not the MTA sites could be taken to reflect the formation of residential groups any larger than those of the earlier Mousterian is equally unclear.

Technology

Potentially the most interesting feature of the French MTA lies in one or two novel features in lithic technology. Unlike most of the earlier phases of the French Mousterian, the MTA is characterized by two well characterized and visually distinctive type fossils - bifacial cordiform or triangular hand-axes, and steeply blunted-back knives. The former could certainly be argued to exhibit a clear element of deliberately "imposed form" (though perhaps no more strikingly than in some much earlier Acheulian bifaces) while a small proportion of the backed knives show an invasiveness of blank reduction which at least hints at some attempt at intentional shaping (Mellars 1996a:120-132). Similar visually distinctive "type-fossil" forms are of course equally conspicuous in the later Mousterian leaf-point industries of Central Europe, and perhaps in the idiosyncratic flake cleavers from the later Mousterian levels in northwest Spain and the Pyrenees (Mellars 1996a:130-132).

The point has already been argued by Hopkinson (2004) and others that the appearance of these visually distinctive bifacial forms in the later Mousterian of western and central Europe could well reflect the emergence of a new (or at least increased) element of social or ethnic patterning in the forms of stone tools, possibly as a direct response to the demographic pressures and associated social competition of OIS-3. The point clearly remains hypothetical, but it is at

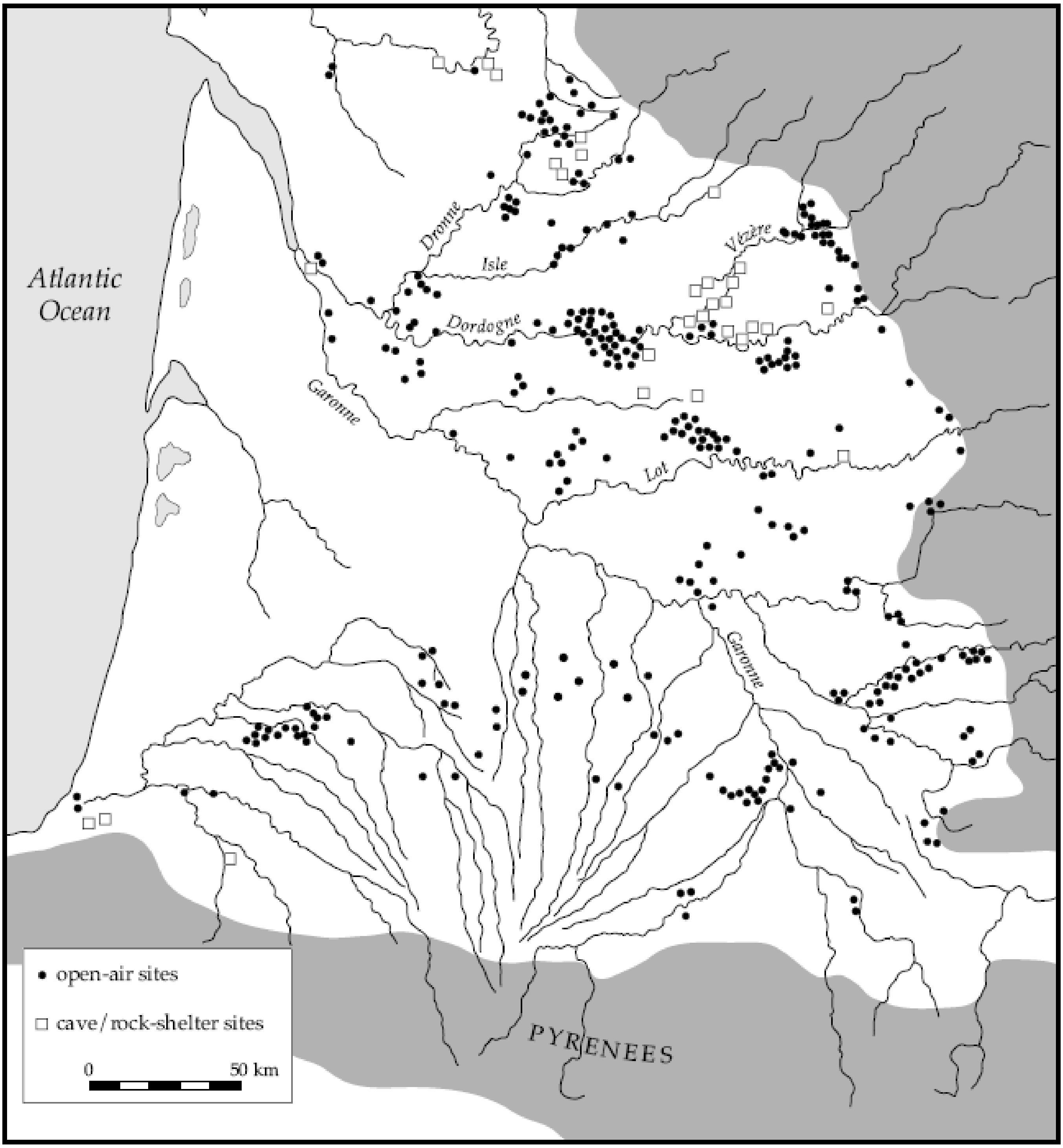

Figure 2. Distribution of Mousterian of Acheulian Tradition (MTA) sites in southwestern France as reflected by finds of cordiform hand-axes (after Mellars 1996a).

least interesting that these new, distinctive type-fossil forms seem to emerge more conspicuously during the later stages of the Middle Palaeolithic than during its earlier stages. Perhaps we do have a significantly new element in material culture patterning here.

How far significant innovations can be recognized in other aspects of technology remains more debatable. MTA industries certainly include some element of deliberate blade technology (Pelegrin 1990) but equally if not more impressive blade techniques have been documented in much earlier Mousterian contexts probably extending back to the time of OIS-7, between *c*. 200,000 and 250,000 BP (Mellars 1996a:77-87; Bar-Yosef & Kuhn 1999). As regards the emergence of distinctively Upper Palaeolithic tool forms, both Rigaud (1993:118) and Anderson-Gerfaud (1990:406) have claimed that both end-scrapers and burins are not only extremely rare in Mousterian contexts in France, but almost invariably "atypical" in form. Most conspicuous of all is the lack of any clear element of systematic bone, antler or ivory technology in the French MTA, or indeed in earlier Mousterian industries, as d'Errico (2003) has recently stressed.

Symbolic expression

How far one can detect evidence for increased "symbolism" in the MTA depends largely on how one interprets the evidence for the two new type-fossil forms discussed above, and the potentially symbolic significance of the use of colouring pigments. Bordes, for example, noted the occurrence of large numbers of fragments of black manganese dioxide in the MTA levels at Pech de l'Azé I, and several fragments of red ochre, some of them with clear evidence for scraping of the surfaces (presumably to produce powder) or deliberate facets or rounding suggesting application to either a hard or soft surface (Bordes 1954-55, 1972). Colouring pigments have also been recorded from several other MTA sites, such as Les Merveilles, Combe-Capelle Haute and Abri Brouillaud.

There are, however, two main problems with the interpretation of this evidence. First, it is an open question how far we can reliably interpret the simple use of colouring pigments as an unequivocally 'symbolic' activity, in the absence of any clear evidence as to exactly how and in what contexts they were employed (Mellars 1996a:369-371; see also Keeley 1980; Knight *et al*. 1995). Secondly it is now clear that the use of these pigments extends well back before the time-range of the MTA industries and OIS-3, as for example in the long succession of earlier Mousterian industries at Combe Grenal (Demars 1992), and apparently in much earlier Acheulian levels at Terra Amata and elsewhere (Barham 2002). Even if we accept some symbolic significance for the use of colouring materials, this can hardly be seen as a specifically late Neanderthal innovation.

Aside from these features, other evidence for unequivocally symbolic artefacts in the MTA is conspicuous mainly by its absence. There are at present no claims for perforated animal teeth, imported marine shells, regular notching or other "notational" marking, or clearly intentional "design" motifs on either bone or stone artefacts. Clear features of this kind (as discussed below) appear only during the Aurignacian and later Châtelperronian episodes in France from (at most) 36,000-38,000 BP onwards, and almost certainly contemporaneously with the presence of anatomically modern populations in adjacent areas of Europe (White 2001; Conard & Bolus 2003). While we could no doubt argue for some potentially 'incipient' patterns of symbolic expression in the later Mousterian of western Europe, the evidence remains at best sparse and distinctly ambiguous in its interpretation. The same, of course, could be said for the emergence of deliberate burial practices (Defleur 1993) which, in the absence of unambiguous grave offerings, remain once again controversial in terms of their symbolic significance.

Discussion

Following the lines of reasoning outlined above one could no doubt formulate an argument that at least some of the cultural and behavioural features which characterize the Middle to Upper Palaeolithic transition in Europe could have originated by a purely internal process of evolutionary change, largely if not directly in response to the climatic oscillations and associated human demographic adjustments of OIS-3. One could go on to argue that an increased tempo of climatic and associated ecological changes during the later stages of OIS-3 - between, say, 45,000 and 25,000 BP (fig. 1) - would have put further selective and adaptive pressures on the local European populations. These could have intensified all of the selective pressures towards more "complex" patterns of subsistence, technology, social organization and associated symbolic expression, and could have led directly, and perhaps inexorably, into a characteristically Upper Palaeolithic pattern of culture. In an earlier paper I have in fact explored a broadly similar scenario, founded essentially on the notion of sharply increasing population densities, and associated demographic and social competition, during the initial stages of the Upper Palaeolithic sequence (Mellars 1996b; see also Gilman 1984, Gibson 1996). This scenario remains an intriguing theoretical perspective which will no doubt continue to attract close scrutiny in future research (e.g. Clark 1997; Zilhão & d'Errico 1999).

Making the most generous possible allowance for these arguments, however, I continue to see a range of major obstacles to viewing this kind of local, indigenous evolution as more than, at best, a very partial and incomplete explanation for the broad sweep of behavioural and cultural innovations which define the Middle-Upper Palaeolithic transition in Europe. The problems as I see them are essentially as follows:

1. First, any attempt to explain the Upper Palaeolithic revolution entirely in terms of local evolutionary processes would effectively ignore the totality of the available biological evidence for a major episode of population dispersal and relacement in Europe, coinciding closely if not precisely with the initial stages of the Upper Palaeolithic (Stringer & McKie 1996; Stringer 2002; Lahr & Foley 1998; Krings *et al*. 2000; Richards & Macaulay 2000; Churchill & Smith 2000; Trinkaus *et al.* 2003). Here we have to account not only for the rapid changes in skeletal morphology (from typically Neanderthal to typically anatomically modern form), but also for the massively accumulating DNA evidence - derived from both mitochondrial and Y-chromosome studies - for the effective elimination of Neanderthal genetic patterns in Europe and their replacement by new, essentially African patterns of DNA (Richards & Macaulay 2000; Krings *et al*. 2000; Underhill *et al.* 2001; Caramelli *et al.* 2003). Unless all of this evidence is wildly misleading, it would seem impossible to deny some major injection of new human populations into Europe at a point coinciding closely with the Middle-Upper Palaeolithic behavioural transition.
2. A closely related problem stems from both the scale and the evident rapidity of the cultural and behavioural changes which characterize the initial stages of the Upper Palaeolithic in the different areas of Europe. This is hardly the place to repeat all the widely-rehearsed arguments for the dramatic character of the Upper Palaeolithic revolution, but it should be recalled that these embrace not only radical changes in stone and (above all) bone, antler and ivory technology, but

also the sudden explosion of explicitly symbolic artefacts in an extraordinary diversity of forms:

• perforated animal teeth and marine shells, together with laboriously manufactured ivory, bone and stone bead forms - now recorded in thousands from early Upper Palaeolithic levels (White 1993, 1997);

• various forms of symbolic "notation" on bone and antler artefacts (Marshack 1991); and

• the sudden appearance of highly varied and complex art forms, ranging from outlines of animals and female "vulvar" symbols through to carved phallic symbols, the extraordinary ivory animal and human statuettes of Central Europe, and (by at least 30,000 BP) remarkably sophisticated cave art (Mellars 1989a, 2001; White 1993, 1997; Bar-Yosef 1998, 2002; Gamble 1999; Clottes 2001; Conard & Bolus 2003).

These forms of expression are not only conspicuously absent from well-documented Middle Palaeolithic contexts in Europe but show a striking correlation with the distribution of various forms of "Aurignacian" technologies across Europe around 43,000-35,000 BP (Mellars 1992, 2001; Gamble 1999; Kozlowski & Otte 2000; Conard & Bolus 2003). One should note a sharp contrast here between the relative suddenness with which these features appear together in the archaeological records of Europe and the much more gradual, mosaic-like fashion with which similar innovations appear in the archaeological records of Africa (McBrearty & Brooks 2000; Deacon & Deacon 1999; Henshilwood *et al*. 2002; Lewis-Williams 2002). Any attempt to explain these patterns in terms of purely indigenous, local evolutionary processes in Europe would need to explain not only the relative scale and rapidity of the cultural changes in question, but also why they occur so much more rapidly and abruptly in Europe than they do in Africa (Mellars 2002).

3. Pursuing further the comparisons between Europe and Africa, there is now unambiguous evidence that many of the conventional behavioural innovations of the European Upper Palaeolithic occur significantly and substantially earlier in several parts of Africa than they do anywhere in Europe. Leaving aside blade technology (which, as noted above, occurs well before the last glaciation in both Europe and Africa) these include:

• relatively abundant and classic forms of endscraper (identical to European forms, and apparently implying new forms of skin-working technology);

• a range of carefully shaped geometric forms - evidently employed as inserts in multi-component armatures, and perhaps implying the appearance of archery;

• extensively shaped bone tools; and

• large quantities of red ochre, including two recently discovered pieces from the Blombos Cave in South Africa showing complex geometrical designs on their surfaces (Singer & Wymer 1982; Knight *et al*. 1995; Henshilwood & Sealey 1997; Deacon & Deacon 1999; McBrearty & Brooks 2000; Henshilwood *et al*. 2002).

All of these features can now be securely documented in the archaeological records of Africa by at least 70-80,000 BP - at least 20-30,000 years before their appearance in Europe. And from the immediately adjacent region of Southwest Asia we now have deliberately perforated marine shells associated with ceremonial burials of anatomically modern humans at the site of Qafzeh in Israel dated to *c*. 90,000 BP, making them by far the earliest personal ornaments so far known (Inizan & Gaillard 1978; Bar-Yosef 2000; Hovers *et al.* 2003). In other words, it is now clear that we have a potential *source* for many of the most distinctive behavioural innovations of the European Upper Palaeolithic much earlier in Africa and the immediately adjacent parts of Southwest Asia than in Europe. How far these innovations dispersed directly with the earliest dispersing populations of anatomically modern humans from Africa (via Asia) to Europe remains to be established (Ambrose 1998; Lahr & Foley 1998; Eswaran 2002). But to ignore this occurrence of distinctively 'modern' behavioural features at a much earlier date in Africa than in Europe would be to adopt a strangely blinkered view of the archaeological evidence as a whole.

4. In this context we should also note what appears to be a more general chronological cline in the pattern of technological innovations across Europe and western Asia (Mellars 1992, 2001). From Southwest Asia there is evidence for a relatively sudden and sharply defined transition from typically Middle to typically Upper Palaeolithic technology (i.e. a proliferation of blades, end scrapers, burins, new "type fossil" forms, together with perforated shell ornaments), clearly dated at the two sites of Boker Tachtit in southern Israel and Ksar Akil in Lebanon to around 45,000-47,000 BP in radiocarbon terms (Bar-Yosef 1998; 2000; Kuhn *et al*. 2001; Mellars & Tixier 1989). Dates for a similar transition in southeastern Europe (as at Bacho Kiro in Bulgaria) seem to centre on *c*. 43,000 BP, while in western Europe there is no evidence for any substantial, analogous shift in technology until *c*. 40,000-38,000 BP (Bar-Yosef 1998; Kozlowski & Otte 2000; Mellars 2000, 2001). If there is indeed a significant chronological cline in the appearance of distinctively Upper Palaeolithic technology from east to west across Europe - and with a much earlier emergence of similar features in Africa - it would accord much better with the hypothesis of a gradual dispersal or diffusion of these technological elements (regardless of whether carried by new populations) than with their totally independent evolution within the individual regions of Europe.

5. Finally, it should be recalled that strong arguments have been advanced from a range of purely archaeological evidence for a major phase of population dispersal across Europe in the earliest stages of the Upper Palaeolithic, in the form of the classic "Aurignacian" technologies (Mellars 1992, 2001; Zilhão & d'Errico 1999; Kozlowski & Otte 2000; Davies 2001; Conard & Bolus 2003). There is hardly space to repeat all the relevant arguments here, but they relate to:

• the remarkable similarities in these Aurignacian technologies extending from sites in northern Israel to the Atlantic coasts of Europe, best reflected perhaps in the distribution of idiosyncratic 'split-base antler point' forms, and contrasting sharply with the diversity of the immediately preceding technologies in the same areas[3];

[3] Current evidence suggests that there were two main routes of dispersal of anatomically modern populations across Europe - one along the Danube Corridor, marked by the "classic" Aurignacian technologies, and the other along the Mediterranean coast, characterized by a range of small "Dufour"

• the apparently earlier emergence of this technology both in southeastern Europe (as at Bacho Kiro and Temnata in Bulgaria) and in the Levant (as in the long succession at Ksar Akil in the Lebanon) than in western Europe;
• the close association of the Aurignacian with all of the most striking features of early Upper Palaeolithic culture - elaborate bone, antler and ivory technology, long-distance exchange networks, and the proliferation of personal ornamentation and various forms of art; and
• the clear association of at least the middle and later stages of the Aurignacian with skeletal remains of fully anatomically modern form and (according to Churchill & Smith) probably also in the earliest Aurignacian levels at Bacho Kiro (Churchill & Smith 2000; Svoboda *et al.* 2002; Conard & Bolus 2003). In short, the Aurignacian presents most if not all the features one might reasonably expect to find as a plausible archaeological signature for the dispersal of anatomically modern populations across Europe (Zilhão & d'Errico 1999; Davies 2001; Conard & Bolus 2003).

Conclusion

My overall conclusion is that, however much credence we may attach to the potential of OIS-3 climatic oscillations to foster shifts or adaptations in the behavioural patterns of later Neanderthal populations in Europe, this still remains very inadequate to explain the total spectrum of radical cultural innovations which characterizes the classic Middle-Upper Palaeolithic transition. Clearly, we cannot dissociate this transition from the well-documented evidence for the dispersal of anatomically modern populations across Europe somewhere within the time-range *c.* 45,000-35,000 BP, and it is inconceivable that this dispersal would not have brought with it new cultural elements derived ultimately from either African or Asian sources. How far this dispersal also brought with it radically new cognitive elements - including the capacity for fully complex language - remains, of course, one of the central issues in modern human origins research.

But an equally inescapable conclusion is that any process of population dispersal - however we envisage this in precise demographic terms - must necessarily entail some degree of contact and interaction between the dispersing populations and the local, indigenous populations across the whole of the relevant geographical range (Eswaran 2002). Again, there is hardly space here to rehearse all of the recent arguments over patterns of apparent "acculturation" between late Neanderthal and early anatomically modern populations in various parts of Europe (Harrold 1989; Harrold & Otte 2001; d'Errico *et al.* 1998; Zilhão & d'Errico 1999; Mellars 1989a, 1999, 2000, 2003). Ultimately, the fate of these arguments will rest heavily on the precision and reliability of the associated dating evidence. The only point I would insist on here is that for the most fully documented example of these apparent acculturation scenarios, the French Châtelperronian, the totality of the available dating evidence (from radiocarbon, TL and ESR methods) leaves no significant room for doubt that the greater part of this development (including the bone and ivory artefacts and animal tooth pendants in the later Châtelperronian levels at Arcy-sur-Cure in Central France) is contemporaneous with the presence of typically Aurignacian technologies and anatomically modern populations in both the adjacent areas of Central Europe and almost certainly on the Mediterranean coast and in northern Spain (Mellars 1999, 2000; White 2001; Conard & Bolus 2003). Indeed, recent dates from early Aurignacian levels in southwestern France (ranging between 35,000 and 37,000 BP: Mellars 2000; Cole 2001) would reinforce the impression of a close juxtaposition of later Châtelperronian and early Aurignacian populations within France itself.

Any discussion of direct interaction or "acculturation" between Neanderthal and expanding anatomically modern populations must of course take account of the closely related notion of a potential "bow-wave" effect of cultural and technological diffusion spreading some way in advance of the dispersing anatomically modern populations (Mellars 1999; Harrold & Otte 2001). The assumption here, quite simply, is that among the final Neanderthal populations across Europe there must inevitably have been certain forms of interaction or cross-communication between adjacent groups. Whether visualized in terms of mating contacts, raw material exchanges or whatever, this could have provided channels of communication for specific elements of technology or other innovations, potentially extending across large areas, and between groups who were only distantly related in demographic terms. These "chains of connection", as Mulvaney (1976) has described them, may have connected adjacent late Neanderthal groups well ahead of the expansion of anatomically or behaviourally modern populations into the areas in question. One critical factor in the rate of dispersal of technological innovations of this kind would presumably have been the relative adaptive *efficiency* of the innovations in question, in comparison with the preceding Middle Palaeolithic technologies. But it is not difficult to see how certain specific features which had strong adaptive advantages (such as improved methods of skin-working as reflected in the appearance of new end-scraper forms, or new forms of bone or antler technology) could have dispersed in this kind of "bow-wave" pattern of technological diffusion some way in advance of the dispersal of the anatomically modern populations into central and western Europe.

Our final reconstruction of the nature and mechanism of the Middle-Upper Palaeolithic transition in Europe is, therefore, unlikely to be entirely simple and straightforward. Certain of the conventional elements in this transition could conceivably have emerged among the later Neanderthal populations by a process of essentially local, internal adaptation to the climatic and ecological pressures imposed by the rapid climatic changes of OIS-3, and related economic, social and demographic pressures. Other features - particularly the dramatic eruption of art, bonework, personal ornamentation and other forms of symbolic expression - are highly unlikely to be entirely indigenous, independent developments, and seem impossible to dissociate from the expansion of anatomically modern populations across the continent. Whether or not

and "Font Yves" retouched bladelet forms (Davies 2001; Mellars 2001). These show interesting parallels with the routes of dispersal of the earliest Neolithic communities across Europe.

this involved a radical change in human cognitive capacities remains perhaps the $64,000 question (e.g. Mithen 1996; Klein 2000). If we accept the accumulating evidence that Neanderthal and genetically modern populations pursued effectively separate lines of evolutionary development over a period of at least 300,000-400,000 years (Krings *et al*. 2000; Beerli & Edwards 2002), then the possibility that there were significant divergences in cognitive capacities over this time span can hardly be ruled out. At the same time, it remains extraordinarily difficult to present a totally detached and objective argument for the relative "intelligence" of the two populations on the basis of the archaeological evidence alone. This is certainly part of what Colin Renfrew had in mind when he referred to "the Sapient behaviour paradox" (1996) in studies of modern human origins.

Acknowledgements

I am particularly indebted to Stephen Shennan, Terry Hopkinson and Brad Gravina for valuable discussion of the points raised in this paper.

References

Ambrose S.H. (1998) - Chronology of the Later Stone Age and food production in East Africa. *Journal of Archaeological Science* 25:377-392.

Anderson-Gerfaud P. (1990) - Aspects of behaviour in the Middle Palaeolithic: functional analysis of stone tools from southwest France. In: P. Mellars (ed.), *The Emergence of Modern Humans: an Archaeological Perspective*. Edinburgh, Edinburgh University Press, p. 389-418.

Bar-Yosef O. (1998) - On the nature of transitions: the Middle to Upper Palaeolithic transition and the Neolithic revolution. *Cambridge Archaeological Journal* 8(2):141-163.

Bar-Yosef O. (2000) - The Middle and Early Upper Paleolithic in Southwest Asia and neighbouring regions. In: O. Bar-Yosef & D. Pilbeam (eds.), *The Geography of Neandertals and Modern Humans in Europe and the Greater Mediterranean*. Cambridge (MA), Peabody Museum of Harvard University, Bulletin 8:107-156.

Bar-Yosef O. (2002) - The Upper Palaeolithic revolution. *Annual Review of Anthropology* 31:363-393.

Bar-Yosef O. & Kuhn S. (1999) - The big deal about blades: laminar technologies and human evolution. *American Anthropologist* 101:322-338.

Bar-Yosef O. & D. Pilbeam (eds.) (2000) - *The Geography of Neandertals and Modern Humans in Europe and the Greater Mediterranean*. Cambridge (MA), Peabody Museum of Harvard University, Bulletin 8.

Barham L. (2002) - Systematic pigment use in the Middle Pleistocene of south-central Africa. *Current Anthropology* 43:181-190.

Beck J.W., Richards D.A., Edwards R.L., Silverman B.W., Smart P.L., Donahue D.J., Hererra-Osterheld S., Burr G.S., Calsoyas L., Jull A.J.T. & Biddulph D. (2001) - Extremely large variations of atmospheric 14C concentration during the last glacial period. *Science* 292:2543-2548.

Beerli P. & Edwards S.V. (2002) - When did Neanderthals and Modern Humans diverge? *Evolutionary Anthropology*, supplement 1:60-63.

Binford L.R. (2001) - *Constructing Frames of Reference: an Analytical Method for Archaeological Theory Building using Hunter-gatherer and Environmental Data Sets*. Berkeley (CA), University of California Press.

Birdsell J.B. (1968) - Some predictions for the Pleistocene based on equilibrium systems among recent huntergatherers. In: R.B. Lee & I. DeVore (eds.), *Man the Hunter*. Chicago (IL), Aldine, p. 229-249.

Bordes F. (1954-55) - Les gisements du Pech de l'Azé (Dordogne). I: Le Moustérien de tradition acheuléenne. *L'Anthropologie* 58:401-432; 59:1-38.

Bordes F. (1972) - *A Tale of Two Caves*. New York (NY), Harper & Row.

Boyle K.V. (1990) - *Upper Palaeolithic Faunas from South-west France: a Zoogeographic Perspective*. Oxford, British Archaeological Reports.

Caramelli D., Lalueza-Fox C., Vernesi C., Lari M., Casoli A., Mallegni F., Chiarelli B., Dupanloup I., Bertranpetit J., Barbujani G. & Bertorelle G. (2003) - Evidence for genetic discontinuity betrween Neandertals and 24,000-year-old anatomically modern Europeans. *Proceedings of the National Academy of Sciences of the USA* 100(11):6593-6597.

Churchill S.E. & Smith F.H. (2000) - Makers of the early Aurignacian of Europe. *Yearbook of Physical Anthropology* 43:61-115.

Clark G.A. (1997) - The Middle-Upper Palaeolithic transition in Europe: an American perspective. *Norwegian Archaeological Review* 30:25-53.

Clark G.A. & Willermet C.M. (eds.) (1997) - *Conceptual Issues in Modern Human Origins Research*. New York (NY), Aldine de Gruyter.

Clottes J. (ed.) (2001) - *La Grotte Chauvet: l'art des origines*. Paris, Seuil.

Cole S.C. (2001) - The Middle to Upper Paleolithic transition in southwest France. *Athena Review* 2(4):47-52.

Conard N.J. & Bolus M. (2003) - Radiocarbon dating the appearance of modern humans and timing of cultural innovations in Europe: new results and new challenges. *Journal of Human Evolution* 44:331-371.

Dansgaard W., Johnsen S.J., Clausen H.B., Dahl-Jensen D., Gundestrup N.S., Hammer C.U., Hvidberg C.S., Steffensen J.P., Sveinbjornsdottir A.E., Jouzel J. & Bond G. (1993) - Evidence for general instability of past climate from a 250-kyr ice record. *Nature* 364:218-220.

Davies W. (2001) - A very model of a Modern Human industry: new perspectives on the origins and spread of the Aurignacian in Europe. *Proceedings of the Prehistoric Society* 67:195-217.

Deacon H.J. (2000) - Modern human emergence: an African archaeological perspective. In: P.V. Tobias, M.A. Raath, J. Maggi-Cecchi & G.A. Doyle (eds.), *Humanity from African Naissance to Coming Millennia: Colloquia in Human Biology and Palaeoanthropology*. Florence, Florence University Press, p. 217-226.

Deacon H.J. & Deacon J. (1999) - *Human Beginnings in South Africa: Uncovering the Secrets of the Stone Age*. Cape Town, David Philip.

Deacon T.W. (1997) - *The Symbolic Species: the Co-evolution of Language and the Human Brain*. Harmondsworth, Penguin Books.

Defleur A. (1993) - *Les Sépultures Moustériennes*. Paris, CNRS.

Delpech F. (1983) - *Les Faunes du Paléolithique Supérieur dans le Sud-ouest de la France*. Paris, CNRS.

Demars P.-Y. (1992) - Les colorants dans le Moustérien du Périgord: l'apport des fouilles de F. Bordes. *Préhistoire Ariégoise* 47:185-194.

d'Errico F. (2003) - The invisible frontier: a multiple species model for the origin of behavioral modernity. *Evolutionary Anthropology* 12:188-202.

d'Errico F., Zilhão J., Julien M., Baffier D. & Pelegrin J. (1998) - Neanderthal acculturation in western Europe? A critical review of the evidence and its interpretation. *Current Anthropology* 39:S1-S44.

Donald M. (1991) - *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition.* Cambridge (MA), Harvard University Press.

Dyson-Hudson R. & Smith A.E. (1978) - Human territoriality: an ecological reassessment. *American Anthropologist* 80:21-41.

Eswaran V. (2002) - A diffusion wave out of Africa: the mechanism of the modern human revolution? *Current Anthropology* 43:749-774.

Farizy C., David J. & Jaubert J. (1994) - *Hommes et Bisons du Paléolithique Moyen à Mauran (Haute-Garonne)*. Gallia-Préhistoire supplément 30.

Féblot-Augustins J. (1993) - Mobility strategies in the Middle Palaeolithic of Central Europe and Western Europe: elements of stability and variability. *Journal of Anthropological Archaeology* 12:211-265.

Féblot-Augustins J. (1999) - Raw material transport patterns and settlement systems in the European Lower and Middle Palaeolithic: continuity, change and variability. In: W. Roebroeks & C. Gamble (eds.), *The Middle Palaeolithic Occupation of Europe*. Leiden, University of Leiden, p. 193-214.

Gamble C. (1999) - *The Palaeolithic Societies of Europe*. Cambridge, Cambridge University Press.

Gaudzinski S. (1999) - The faunal record of the Lower and Middle Palaeolithic of Europe: remarks on human interference. In: W. Roebroeks & C. Gamble (eds.), *The Middle Palaeolithic Occupation of Europe*. Leiden, University of Leiden, p. 215-234.

Gibson K.R. (1996) - The biocultural human brain, seasonal migrations, and the emergence of the Upper Palaeolithic. In: P.A. Mellars & K. Gibson (eds.), *Modelling the Early Human Mind*. Cambridge, McDonald Institute Monographs, p. 33–46.

Gilman A. (1984) - Explaining the Upper Palaeolithic revolution. In: E. Springs (ed.), *Marxist Perspectives in Archaeology*. Cambridge, Cambridge University Press, p. 115-126.

Grayson D.K., Delpech F., Rigaud J.-P. & Simek J.F. (2001) - Explaining the development of dietary dominance by a single ungulate taxon at Grotte XVI, Dordogne, France. *Journal of Archaeological Science* 28:115-125.

Harrold F.B. (1989) - Mousterian, Châtelperronian and Aurignacian in Western Europe: continuity or discontinuity. In: P.A. Mellars & C. Stringer (eds.), *The Human Revolution:Behavioural and Biological Perspectives on the Origins of Modern Humans*. Edinburgh, Edinburgh University Press, p. 677-713.

Harrold F.B. & Otte M. (2001) - Time, space and cultural process in the European Middle-Upper Palaeolithic transition. In: M.A. Hays & P.T. Thacker (eds.), *Questioning the Answers: Re-solving Fundamental Problems of the Early Upper Palaeolithic*. Oxford, British Archaeological Reports International Series 1005:3-11.

Henshilwood C. & Sealy J. (1997) - Bone artefacts from the Middle Stone Age at Blombos Cave, Southern Cape, South Africa. *Current Anthropology* 38:890-895.

Henshilwood C.S., d'Errico F., Yates R., Jacobs Z., Tribolo C., Duller G.A.T., Mercier N., Sealy V, Valladas H., Watts I. & Wintle A.G. (2002) – Emergence of modern human behavior: Middle Stone Age engravings from South Africa. *Science* 295:1278-1280.

Hopkinson T. (2004 in press). Leaf points, landscapes and environment change in the European late Middle Palaeolithic. In: N.E. Conard (ed.), *Settlement Patterns of the Middle Palaeolithic and Middle Stone Age*, vol. 2. Tübingen, Krems Verlag.

Housley R.A., Gamble C.S., Street M. & Pettitt P. (1997) - Radiocarbon evidence for the last-glacial human recolonisation of northern Europe. *Proceedings of the Prehistoric Society* 63:25-54.

Hovers E., Ilani S., Bar-Yosef O. & Vandermeersch B. (2003) - An early case of color symbolism: ochre use by modern humans in Qafzeh Cave. *Current Anthropology* 44:491-522.

Hublin J.-J. (2000) - Modern-nonmodern hominid interactions: a Mediterranean perspective. In: O. Bar-Yosef & D. Pilbeam (eds.), *The Geography of Neandertals and Modern Humans in Europe and the Greater Mediterranean*. Cambridge (MA), Peabody Museum of Harvard University, Bulletin 8:1157-1182.

Huntley B., Watts W., Allen J.R.M. & Zolitschka B. (1999) - Palaeoclimate, chronology and vegetation history of the Weichselian glacial: comparative analysis of data from three cores from Lago Grande di Monticchio (Italy): initial results. *Quaternary Science Reviews* 18:945-960.

Inizan M.-L. & Gaillard J.M. (1978) - Coquillages de Ksar-'Aqil: éléments de parure? *Paléorient* 4:295-306.

Jaubert J. (1999) - The Middle Palaeolithic of Quercy (Southwest France): palaeoenvironment and human settlements. In: W. Roebroeks & C. Gamble (eds.), *The Middle Palaeolithic Occupation of Europe*. Leiden, University of Leiden, p. 93-106.

Keeley L. (1980) - *Experimental Determination of Stone Tool Uses: a Microwear Analysis*. Chicago (IL), University of Chicago Press.

Keeley L. (1988) - Hunter-gatherer economic complexity and 'population pressure': a cross-cultural analysis. *Journal of Anthropological Archaeology* 7:373-411.

Keeley L. (1996) - *War Before Civilization: the Myth of the Peaceful Savage*. Oxford, Oxford University Press.

Kelly R. (1995) - *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways.* Washington (DC), Smithsonian Institution Press.

Klein R.G. (2000) - Archaeology and the evolution of human behavior. *Evolutionary Anthropology* 9:17-36.

Knight C.D., Power C. & Watts I. (1995) - The human symbolic revolution: a Darwinian account. *Cambridge Archaeological Journal* 5(1):75-114.

Kozlowski J.K. & Otte M. (2000) - The formation of the Aurignacian in Europe. *Journal of Anthropological Research* 56:513-534.

Krings M., Capelli C., Tschentscher F., Geisert H., Meyer S., von Haeseler A., Grossschmidt K., Possnert G., Paunovic M. & Pääbo S. (2000) - A view of Neanderthal genetic diversity. *Nature Genetics* 26:144-146.

Kuhn S. & Stiner M. (2001) - The antiquity of hunter-gatherers. In: C. Panter-Brick, R.H. Layton & P. Rowley-Conwy P. (eds.), *Hunter-gatherers: an Interdisciplinary Perspective*. Cambridge, Cambridge University Press, p. 99-142.

Kuhn S.K., Stiner M.C., Reese D.S. & Güleç E. (2001) – Ornaments of the earliest Upper Paleolithic: new insights from the Levant. *Proceedings of the National Academy of Sciences of the USA* 98:7641-7646.

Lahr M. & Foley R. (1998) - Towards a theory of modern human origins: geography, demography and diversity in recent human evolution. *Yearbook of Physical Anthropology* 41:137-176.

Laville H., Rigaud J.-P. & Sackett J. (1980) - *Rock Shelters of the Périgord: Geological Stratigraphy and Archaeological Succession.* New York (NY), Academic Press.

Lee R.B. (1979) - *The !Kung San: Men, Women and Work in a Foraging Society*. Cambridge, Cambridge University Press.

Lee R.B. & DeVore I. (eds) (1968) - *Man the Hunter*. Chicago (IL), Aldine.

Lewis-Williams D. (2002) - *The Mind in the Cave*. London, Thames & Hudson.

McBrearty S. & Brooks A. (2000) - The revolution that wasn't: a new interpretation of the origin of modern human behavior. *Journal of Human Evolution* 39:453-563.

Marshack A. (1991) - *The Roots of Civilization*. Mount Kisco, Moyer Bell.

Mellars P.A. (1973) - The character of the Middle-Upper Palaeolithic transition in south-west France. In: C. Renfrew (ed.), *The Explanation of Culture Change: Models in Prehistory*. London, Duckworth, p. 255-276.

Mellars P.A. (1985) - The ecological basis of cultural complexity in the Upper Paleolithic of southwestern France. In: T.D. Price & J.A. Brown (eds.), *Prehistoric Huntergatherers: the Emergence of Cultural Complexity*. Orlando (FL), Academic Press, p. 271-297.

Mellars P.A. (1989a) - Major issues in the emergence of modern humans. *Current Anthropology* 30:349-385.

Mellars P.A. (1989b) - Technological changes across the Middle-Upper Palaeolithic transition: technological, social and cognitive perspectives. In: P.A. Mellars P.A. & C. Stringer (eds.), *The Human Revolution:Behavioural and Biological Perspectives on the Origins of Modern Humans*. Edinburgh, Edinburgh University Press, p. 338-365.

Mellars P.A. (1991) - Cognitive changes and the emergence of modern humans in Europe. *Cambridge Archaeological Journal* 1(1):63-76.

Mellars P.A. (1992) - Archaeology and the population-dispersal hypothesis of modern human origins in Europe. In: M.J. Aitken, C.B. Stringer & P.A. Mellars (eds.), *The Origin of Modern Humans and the Impact of Chronometric Dating*. London, Royal Society, Philosophical Transactions of the Royal Society, series B, 337(1280):225-234.

Mellars P.A. (1996a) - *The Neanderthal Legacy: an Archaeological Perspective from Western Europe*. Princeton (NJ), Princeton University Press.

Mellars P.A. (1996b) - The emergence of biologically modern populations in Europe: a social and cognitive 'revolution'? In: W.G. Runciman, J. Maynard-Smith & R.I.M. Dunbar (eds.), *Evolution of Social Behaviour Patterns in Primates and Man*. London, Proceedings of the British Academy 88:179-202.

Mellars P.A. (1998) - Neanderthals, modern humans and the archaeological evidence for language. In: N.G. Jablonski & L.C. Aiello (eds.), *The Origin and Diversification of Language*. San Francisco (CA), California Academy of Sciences, p. 89-115.

Mellars P.A. (1999) - The Neanderthal problem continued. *Current Anthropology* 40:341-350.

Mellars P.A. (2000) - The archaeological records of the Neandertal-Modern human transition in France. In: O. Bar-Yosef & D. Pilbeam (eds.), *The Geography of Neandertals and Modern Humans in Europe and the Greater Mediterranean*. Cambridge (MA), Peabody Museum of Harvard University, Bulletin 8:35-47.

Mellars P.A. (2001) - The *Homo sapiens* peopling of Europe. In: P. Slack & R. Ward (eds.), *The Peopling of Britain: the Shaping of a Human Landscape*. Oxford, Oxford University Press, p. 39-67.

Mellars P.A. (2002) - Archaeology and the origins of modern humans: European and African perspectives. In: T.J. Crow (ed.), *The Speciation of Modern* Homo sapiens. London, Proceedings of the British Academy 106:31-48.

Mellars P.A. (2003) - Symbolism, meaning and the Neanderthal mind. *Cambridge Archaeological Journal* 13(2):273-275.

Mellars P.A. (2004) - Reindeer specialization in the early Upper Palaeolithic: the evidence from southwest France. *Journal of Archaeological Science* 31:613-617.

Mellars P.A. & Gibson K. (eds.) (1966) - *Modelling the Early Human Mind*. Cambridge, McDonald Institute Monographs.

Mellars P.A. & Stringer C. (eds.) (1989) - *The Human Revolution:Behavioural and Biological Perspectives on the Origins of Modern Humans*. Edinburgh, Edinburgh University Press.

Mellars P.A. & Tixier J. (1989) - Radiocarbon-accelerator dating of Ksar 'Aqil (Lebanon) and the chronology of the Upper Palaeolithic sequence in the Middle East. *Antiquity* 63:761-768.

Mithen S. (1996) - *The Prehistory of the Mind: a Search for the Origins of Art, Religion and Science*. London, Thames & Hudson.

Mulvaney D.J. (1976) - The chain of connection. In: N. Peterson (ed.), *Tribes and Boundaries in Australia*. Canberra, Australian Institute of Aboriginal Studies, p. 72-94.

Noble W. & Davidson I. (1996) - *Human Evolution, Language and Mind: a Psychological and Archaeological Inquiry*. Cambridge, Cambridge University Press.

Panter-Brick C., Layton R.H. & Rowley-Conwy P. (eds.) (2001) - *Hunter-gatherers: an Interdisciplinary Perspective*. Cambridge, Cambridge University Press.

Pelegrin J. (1990) - Observations technologiques sur quelques séries du Châtelperronien et du MTA B du sud-ouest de la France: une hypothèse. In: C. Farizy (ed.), *Paléolithique Moyen Récent et Paléolithique Supérieur Ancien en Europe*. Nemours, Musée de Préhistoire d'Ile de France, mémoires 3:195-201.

Pennington R. (2001) - Hunter-gatherer demography. In: C. Panter-Brick, R.H. Layton & P. Rowley-Conwy P. (eds.), *Hunter-gatherers: an Interdisciplinary Perspective*. Cambridge, Cambridge University Press, p.170-204.

Pettitt P. & Pike A.W.G. (2001) - Blind in a cloud of data: problems in the chronology of Neanderthal extinction and anatomically modern human expansion. *Antiquity* 75:415-420.

Price T.D. & Brown J.A. (eds.) (1985) - *Prehistoric Huntergatherers: the Emergence of Cultural Complexity*. Orlando (FL), Academic Press.

Read D.W. & LeBlanc S.A. (2003) - Population growth, carrying capacity and conflict. *Current Anthropology* 44:59-85.

Renfrew C. (1996) - The sapient behaviour paradox: how to test for potential? In: P.A. Mellars & K. Gibson (eds.), *Modelling the Early Human Mind*. Cambridge, McDonald Institute Monographs, p. 11-14.

Renfrew C. (2001) - Commodification and institution in group-oriented and individualizing societies. In: W.G. Runciman (ed.), *The Origin of Human Social Institutions*. London, Proceedings of the British Academy 110:93-118.

Renfrew C. (2002) - Symbol before concept: material engagement and the early development of society. In: I. Hodder (ed.), *Archaeological Theory Today*. Oxford, Blackwell/Polity Press, p. 122-140.

Richards M. & Macaulay V. (2000) - Genetic data and the colonization of Europe: genealogies and founders. In: C. Renfrew & K. Boyle (eds.), *Archaeogenetics: DNA and the Population Prehistory of Europe*. Cambridge, McDonald Institute Monographs, p. 139-153.

Rigaud J.-P. (1993) - La transition Paléolithique moyen/Paléolithique supérieur dans le sud-ouest de la France. In: V. Cabrera-Valdés (ed.), *El Origen del Hombre Moderno en el Suroeste de Europa*. Madrid, Universidad Nacional de Educacion a Distancia, p. 117-126.

Rigaud J.-P., Simek J.F. & Ge T. (1995) - Mousterian fires from Grotte XVI (Dordogne, France). *Antiquity* 69:902-912.

Roebroeks W. & Gamble C. (eds.) (1999) - *The Middle Palaeolithic Occupation of Europe*. Leiden, University of Leiden.

Rowley-Conwy P. (2001) - Time, change and the archaeology of hunter-gatherers: how original is the 'Original Affluent Society'? In: C. Panter-Brick, R.H. Layton & P. Rowley-Conwy P. (eds.), *Hunter-gatherers: an Interdisciplinary Perspective*. Cambridge, Cambridge University Press, p. 39-72.

Sánchez-Goñi M.F., Cacho I., Turon J.-L., Guiot J., Sierro F.J., Peypouquet J.-P., Grimalt J.O. & Shackleton N.J. (2002) - Synchroneity between marine and terrestrial responses to millennial-scale climatic variability during the last glacial period in the Mediterranean region. *Climate Dynamics* 19:95-105.

Semino O., Passarino J., Oefner P.J., Lin A.A., Arbuzova A., Beckman L.E., de Benedictis G., Francalacci P., Kouvatsi A., Umborska S., Marcikiae M., Mika A., Mika B., Primorac D., Santachiara-Benerecetti A.S., Cavalli-Sforza L.L. & Underhill P.A. (2000) - The genetic legacy of Paleolithic *Homo sapiens* in extant Europeans: a Ychromosome perspective. *Science* 210:1155-1159.

Shackleton N.J., Hall M.A. & Vincent E. (2000) - Phase relationships between millennial scale events 64,000-24,000 years ago. *Paleoceanography* 15:565-569.

Shennan S. (2001) - Demography and cultural innovation: a model and some implications for the emergence of modern human culture. *Cambridge Archaeological Journal* 11(1):5-16.

Shennan S. (2002) - *Genes, Memes and Human History: Darwinian Archaeology and Cultural Evolution*. London, Thames & Hudson.

Sherratt A. (1997) - Climatic cycles and behavioural revolutions: the emergence of modern humans and the beginning of farming. *Antiquity* 71:271-287.

Singer R. & Wymer J. (1982) - *The Middle Stone Age at Klasies River Mouth in South Africa*. Chicago (IL), University of Chicago Press.

Stiner M.C. (1994) - *Honor Among Thieves: a Zooarchaeological Study of Neandertal Ecology*. Princeton (NJ), Princeton University Press.

Stringer C. (2002) - Modern human origins: progress and prospects. *Philosophical Transactions of the Royal Society of London* B, 357:563-579.

Stringer C.B. & McKie R. (1996) - *African Exodus: the Origins of Modern Humanity*. London, Jonathan Cape.

Svoboda J., van der Plicht J. & Kuzelka V. (2002) – Upper Palaeolithic and Mesolithic human fossils from Moravia and Bohemia (Czech Republic): some new 14C dates. *Antiquity* 76:957-962.

Templeton A.R. (2002) - Out of Africa again and again. *Nature* 416:45-51.

Torrence R. (2001) - Hunter-gatherer technology: macroand micro-scales. In: C. Panter-Brick, R.H. Layton & P. Rowley-Conwy P. (eds.), *Hunter-gatherers: an Interdisciplinary Perspective*. Cambridge, Cambridge University Press, p. 73-98.

Trinkaus E., Moldovan O., Milota S., Bîlga A, Sarcina L., Athreya S., Bailey S.E., Rodrigo R., Mercea G., Higham T., Ramsey C.B. & van der Plicht J. (2003) - An early modern human from the Pes¸tera cu Oase, Romania. *Proceedings of the National Academy of Sciences of the USA* 100(11):231-236.

Turq A. (1999) - Reflections on the Middle Palaeolithic of the Aquitaine Basin. In: W. Roebroeks & C. Gamble (eds.) (1999) - *The Middle Palaeolithic Occupation of Europe*. Leiden, University of Leiden, p. 107-120.

Underhill P., Passarino G., Lin A., Shen P., Lahr M., Foley R., Oefner P. & Cavalli-Sforza L. (2001) – The phylogeography of Y-chromosome binary haplotypes and the origins of modern human populations. *Annals of Human Genetics* 65:43-62.

van Andel T.H. (1998) - Middle and Upper Palaeolithic environments and the calibration of 14C dates beyond 10,000 BP. *Antiquity* 72:26-33.

van Andel T.H. (2002) - The climate and landscape of the middle part of the Weichselian glaciation in Europe: the Stage 3 project. *Quaternary Research* 57:2-8.

van Andel T.H. & Davies W. (eds.) (2003) - *Neanderthals and Modern Humans in the European Landscape during the Last Glaciation: Archaeological Results of the Stage 3 Project.* Cambridge, McDonald Institute Monographs.

van Andel T.H. & Tzedakis P.C. (1996) - Palaeolithic landscapes of Europe and environs, 150,000–25,000 years ago. *Quaternary Science Reviews* 15:481-500.

Vaquero M. (1999) - Intrasite spatial organization of lithic production in the Middle Palaeolithic: the evidence of the Abric Romaní (Capellades, Spain). *Antiquity* 73:493-504.

Voelker A.H.L., Sarnthein M., Grootes P.M., Erlenkeuser H., Laj C., Mazaud A., Nadeau M.-J. & Schleicher M. (1998) - Correlation of marine 14C ages from the Nordic seas with the GISP2 isotope record: implications for 14C calibration beyond 25 ka BP. *Radiocarbon* 40:517-534.

White R. (1993) - Technological and social dimensions of 'Aurignacian age' body ornaments across Europe. In: H. Knecht, A. Pike-Tay & R. White (eds.), *Before Lascaux: the Complex Record of the Early Upper Paleolithic*. Boca Raton (FL), CRC Press, p. 277-300.

White R. (1997) - Substantial acts: from materials to meaning in Upper Palaeolithic representation. In: M.W. Conkey, O. Soffer, D. Stratmann & N.G. Jablonski (eds.), *Beyond Art: Pleistocene Image and Symbol*. San Francisco (CA), California Academy of Sciences, p. 93-121.

White R. (2001) - Personal ornaments from the Grotte du Renne at Arcy-sur-Cure. *Athena Review* 2(4):41-46.

Wiessner P. (1983) - Style and information in Kalahari San projectile points. *American Antiquity* 48:253-276.

Wiessner P. (1984) - Reconsidering the behavioral basis for style: a case study among the Kalahari San. *Journal of Anthropological Archaeology* 3:190-234.

Wobst H.M. (1974) - Boundary conditions for Palaeolithic social systems: a simulation approach. *American Antiquity* 39:1547-1578.

Wobst H.M. (1976) - Locational relationships in Palaeolithic society. *Journal of Human Evolution* 5:49-58.

Wobst H.M. (1977) - Stylistic behavior and information exchange. In: C. Cleland (ed.), *For the Director: Research Essays in Honor of James B. Griffin*. Ann Arbor (MI): Anthropological Papers 61:317-342.

Woillard G.M. & Mook W.G. (1982) : Carbon-14 dates at Grande Pile: correlation of land and sea chronologies. *Science* 215:159-161.

Zilhão J. & d'Errico F. (1999) - The chronology and taphonomy of the earliest Aurignacian and its implications for the understanding of Neandertal extinction. *Journal of World Prehistory* 13:1-68.

Zubrow E. (1989) - The demographic modeling of Neanderthal extinction. In: P.A. Mellars & C. Stringer (eds.), *The Human Revolution:Behavioural and Biological Perspectives on the Origins of Modern Humans*. Edinburgh, Edinburgh University Press, p. 212-231.