Clive S. Gamble

16 The earliest occupation of Europe: the environmental background

The aim of this contribution is to examine some of the environmental issues surrounding the earliest occupation of Europe. The evidence presented both in this volume and at the ESF workshop in Tautavel raised issues about site reconstructions, regional comparisons, the definition of Europe and the impact of different chronological scales for modelling the rate of human evolution and the role of environmental selection. The evidence considered here is oxygen isotope stage 9 and older (>300Kyr), and its archaeology is placed under the Lower Palaeolithic flag of convenience. In this discussion environment is taken to refer to the physical changes to the continent and the effect this had upon plant and animal resources. The social environment of the earliest European hominids is not considered here. However, the colonizing ability of these hominids, which must have involved social factors, is briefly discussed and alternative environmental models are reviewed which explain the timing of colonization.

1. Introduction

Environmental analysis involves many spatial and temporal scales (e.g. Butzer 1982). I draw the distinction here between *local* (or site based) analysis which can, when preservation is good, provide evidence for the day-to-day activities of early hominids and *regional* studies where time averaging due to geological processes often necessitates a long-term view of behaviour. The former can be said to inform us on an ecological timescale about the various ways that hominids dealt with the immediate conditions of existence – weather, food, water, predators and other hominids. The regional scale can, on occasion, address the same immediate selection pressures although with less chronological precision. However, it is widely accepted in Lower Palaeolithic studies that our data at this scale refer to geological (or evolutionary) timescales.[1] These provide us with the opportunity to observe long-term evolutionary processes. The proper use of environmental data when interpreting the Lower Palaeolithic requires that we keep these analytical concepts firmly in mind.

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2. Local environments and hominid locales

2.1. INTRODUCTION

The papers in this volume demonstrate that the local environment of Lower Palaeolithic hominids must be considered as a landscape. The archaeological notion of site as applied to anything but caves has little relevance to the business of understanding hominid behaviour from this period. What we are dealing with are locales within landscapes where the density or preservation quality of material is such that excavation has been deemed worthwhile.[2]

The long-term investigations at Bilzingsleben and neighbouring travertine deposits (Mania, this volume), the Venosa basin (Mussi, this volume), Boxgrove and the Sussex coastal plain (Roberts *et al.*, this volume), the East Eifel volcanic field (Bosinski, this volume), the Cagny sites (Tuffreau and Antoine, this volume), the Manzanares and Jarama terraces and the Guadix-Baza basin (Raposo and Santonja, this volume) point to an analytical scale that is much larger than either the size of any individual area excavated within these landscape projects, or even the estimate of potential deposits for future excavation. This landscape approach is also apparent in the work at the Caune de l'Arago (De Lumley, pers. comm.)[3] and Kudaro (Ljubin and Bosinski, this volume) where the cave deposits provide a means to explore changes in the surrounding catchments.

A landscape approach is also evident in the discussion of why areas as separated as Scandinavia (Holm and Larsson, this volume), the Riano basin in central Italy (Mussi, this volume) and the Ebro depression in Iberia (Raposo and Santonja, this volume) have not produced finds of this period, even though in the last two regions Middle Pleistocene sediments are present. Only at the scale of landscapes is it possible to assess whether material would have survived (Scandinavia), and if so where, or that insufficient research has been undertaken (Ebro) or finally that occupation was never possible for such hominids (Riano).

The size of these landscapes is generally defined by the distribution of similar Quaternary geology and the maintainance of comparable contexts for preservation. For example, the Venosa basin measures 50 × 3 km and is filled to a depth of 30-50 m. The 40 m raised beach of which Boxgrove is a part extends for at least 20 km with sediments preserved in a band of 100-200 m in front of a collapsed chalk cliff. The East Eifel volcanic field covers, albeit intermittently, an area of at least 20 × 25 km, while the Guadix-Baza basin near Granada which contains deep Early and Middle Pleistocene sediments forms an oval of 100 × 60 km (Santonja and Villa 1990).

The European evidence concerning the settlement of these varied landscapes points to two well known 'normal' environments. Firstly, open locales are frequently associated with bodies of water ranging from marine lagoons to river banks, braided streams, lakes (of various sizes), travertine springs, swamps and marshes. For example, the Lower Palaeolithic landscape alongside the Via Aurelia was densely settled. Its many coastal lagoons and back country bogs and swamps provide an example of the ecologically highly productive local environments which hominids preferred (Mussi, this volume). Middle Pleistocene faunas with *Hippopotamus* and *Trogontherium* (giant beaver) are common here and in many parts of Europe. Beaver helped form the local environment at Miesenheim I, which consisted of swamps with patches of forest. Along these overgrown banks of the Pleistocene Rhine hominids hunted and scavenged (Bosinski, this volume).

Secondly, closed locales are represented by caves and rockshelters of varied sizes. In many cases the surrounding topography and catchments for the caves are more diverse in terms of vegetation and the animal resources they support than the open locales.

These two normal environments can be interpreted as possessing above average possibilities for preservation as well as providing an obvious focus for what are seen as key aspects in Lower Palaeolithic survival – shelter, water and hunting opportunities at animal watering places. Deciding whether such normal environments are representative of wider (i.e. away from rivers and caves) patterns of past landuse remains problematic.

These locales also supply information on two main types of 'normal' acivities. These involved the butchery and processing of animals at Isernia Sett. I t. 3a elephant, bison and rhino, Venosa-Notarchirico elephant (Mussi, this volume), Cagny l'Epinette young bovids and equids (Tuffreau and Antoine, this volume), Miesenheim roe and red deer, equids (Bosinski, this volume), Bilzingsleben many taxa but notably rhino (Mania, this volume), Kudaro cave bear (Ljubin and Bosinski, this volume), Arago many taxa but notably musk ox, reindeer and mouflon (De Lumley, pers. comm.) and Boxgrove rhino, deer, bison and an equid (Roberts *et al.*, this volume). The second normal acitivity involved the selection and knapping of stone at these locales. Refitting has been undertaken at many of these sites and in most cases the source of the raw materials has been traced to the local catchment. The distances involved are all less than 80-100 km from the locales and generally under 30 km. The local nature of these lithic catchments is well shown in a recent study of Arago (Lebel 1992). Sometimes the distances were immediate as at Boxgrove (Roberts *et al.*, this volume) where four flint blocks were carried 70m from the collapsed sea cliff to a horse carcass.

On closer examination the normal environments do occasionally raise interpretative problems for some of these normal activities. For example, at Hoxne the in-situ archaeological material was abandoned in a few centimeters of permanent water through which people must have waded (Wymer 1985: 169). The environment in the Lower Gravels at Swanscombe is described by Conway (1970: 60) as a 'muddy pool' which contained the Clactonian 'floor'/midden. The artefacts at Kärlich-Seeufer are found right at the waters edge (Bosinski, this volume), while at Isernia Sett. I t. 3a the mud flat on which the animal bones and artefacts were deposited was covered by a debris flow (Mussi, this volume).

Local conditions such as these provide environmental reasons why the normal activities recovered at these locales, where preservation is generally reckoned as good, do not include huts, pits and post holes even though the material is sometimes in-situ. Our prime data may simply come from either the edge of settlement areas or be some distance from them. However, it may be that similar conditions of deposition and preservation are more widespread than we think and consequently we should not abandon the search for formal campsites in the Lower Palaeolithic. The Bilzingsleben II travertine (Mania, this volume) provides the best, possibly the only, current contender for such a settlement type.

However, the lack of hearths, and their associated patterns of debris accumulation in either cave or open locales, does suggest that we will always be dealing with traces of very different types of settlement traces during this period.[4] In this context the details of the stone built hearth at Solana del Zamborino (Raposo and Santonja, this volume) in the Guadix-Baza basin requires further scrutiny.[5]

2.2. HOMINID ENVIRONMENTAL TOLERANCES

The form of settlement and its regional patterning is important in the context of characterising the environmental tolerances of Lower Palaeolithic hominids. The typical local environments in many parts of Europe show a diverse set of conditions ranging from interglacial to glacial and open to closed forest conditions (Roebroeks *et al.* 1992: Table 1). At the Bilzingsleben II travertine (Mania, this volume) the pollen indicates a diverse, oak-mixed-forest with southern species. This is interpreted as a light, dry oak woodland interspersed with meadows in the immediate vicinity of the hominid locale. Dense forest was only found in the nearby valley and may well have been avoided by the hominids.[6] The lack of hominid traces in the heavily wooded Riano basin of central Italy is contrasted with their presence at Isernia and other Italian locales where the environment has been reconstructed as open woodland (Mussi, this volume). The evidence for thinning of the interglacial forests of eastern England (C. Turner 1970), presumably by fire-assisted hominids, may possibly be a further expression of a typical preferred vegetational environment, that is open, mosaic woodland. The oncolith deposits at the Carpentier quarry, Abbeville, contain pollen which shows that under a temperate climate a mosaic landscape of forest-steppe existed (Tuffreau and Antoine, this volume).

Evidence also exists to show hominids occupying a range of successive biotopes at a single locale. At the Caune de l'Arago these are related to major changes in environmental conditions and involve occupation during glacial, interstadial and interglacial conditions (De Lumley, pers. comm.). At Boxgrove occupation is found throughout the interglacial OIS 13 and into the subsequent major cold phase (Anglian/Elsterian), the most severe in terms of continental ice advance during the Middle Pleistocene (Roberts *et al.*, this volume). Cagny-la-Garenne and Cagny-Cimetière have occupations during full interglacial stages as well as in subarctic and under more continental climatic conditions (Tuffreau and Antoine, this volume). However, these contrasted climatic conditions were not universal in Middle Pleistocene Europe. The Iberian Lower Palaeolithic still proves difficult to order according to a regional Quaternary stratigraphy. One reason is that the difference between interglacial and glacial conditions in this southerly and oceanic part of Europe are much less pronounced than in more northerly or more continental areas.

2.3. PROBLEMS OF ENVIRONMENTAL RECONSTRUCTION

Both the synchronic and diachronic evidence points to potentially wide environmental tolerances for Middle Pleistocene hominids. These understandably are very coarse measures relating to vegetation zones, temperature and the presence of ice. It is therefore unsurprising that controversy exists concerning the ability of these, and later hominids, to exploit particular biotopes, for example the dense interglacial forests (Gamble 1986; Tuffreau 1987, 1990; Roebroeks *et al.* 1992; Conard 1992). One reason for this debate lies in the very qualitative descriptions that exist to describe past vegetation as reconstructed by either pollen or molluscan evidence. Such imprecision reflects the methodological difficulties of palynology where catchment sizes vary from pollen site to pollen site. When this factor is combined with differential pollen rain between taxa it is possible to see why synchronic reconstructions are problematic. In the case of molluscan evidence the patchy nature of modern data on species tolerances, distributions and life histories adds to the problems of environmental reconstruction, particularly at a synchronic scale. Yet it is at the synchronic level that we need precision in order to reconstruct activity in ecological time, since it is at this timescale that selection pressure on hominid behaviour is most pronounced.

2.4. MOSAIC HABITATS

For methodological reasons we can therefore expect that environmental reconstructions of local environments at a synchronic level will continue to typify Middle Pleistocene hominids as tolerant of a wide range of conditions. This suggests that present techniques and forms of analysis are not telling us very much. Auguste (in press) has argued differently. He points out that in northern France the Lower and Middle Palaeolithic records testify to hominid occupation during interglacial, interstadial and early glacial conditions (Tuffreau and Antoine, this volume; Roberts *et al.*, this volume). The last phase saw a great reduction in the number of Palaeolithic finds. This nearly continuous occupation was possible because at all times, he argues, there existed a mosaic of environments rather than undifferentiated vegetation zones. These mosaics are similar to Guthrie's (1984, 1990) model of the mammoth steppe where its 'fabric' is compared to the weave in a plaid, rather than striped, textile.

Two points about these plaid, mosaic environments deserve elaboration. Firstly, such mosaics contribute to *resiliant* environments. Disruption to the environmental

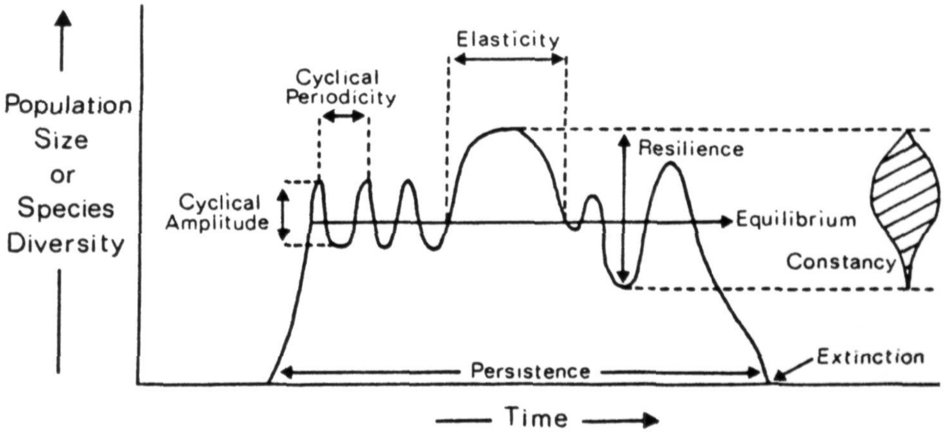

Fig. 1. Properties of ecological stability (from Foley 1984).

fabric in ecological time through fire, storm, overgrazing or volcanic and tectonic activity is quickly patched-up. Recolonization distances are short due to the mosaic structure of a biotope such as Guthrie's mammoth steppe or the open woodlands of some of the interglacials. They do not require climatic change to facilitate conditions for migration in the event that 'repairing' the mosaic is necessary. Therefore resiliant environments tolerate greater amounts of fluctuation (Foley 1984: table 1.2 cf. Fig. 1).

Equally, any local disturbances that might affect hominids could be compensated by short migrations to another part of their range. The alternative, *brittle* environment, has slow recovery times due to many factors such as soil fertility and migration distances for plants and animals.[7] Cyclical disruption in ecological time that may take place on an annual or decade basis will therefore have a potentially greater impact on an omnivore such as a hominid.

Secondly, the mosaic model presents a more *dynamic* view of past environments than is often the case in palaeoecological reconstructions. All too frequently the goal of such reconstructions has been descriptive rather than explanatory. For example, it has been stated on many occasions that early hominids can no more be characterised as red deer hunters than as oak forest foragers. They were not specifically adapted to particular animal or plant communities but rather by the selection pressures that such elements, when combined, exerted on behavioural solutions to environmental problems. It is this interaction which produces the dynamic in human adaptation and which can be explained through the principles of evolutionary ecology (Foley 1984).

However, we are still some way from such analyses. What is now needed is an investigation of those mosaics. This may require a new approach to such standard techniques as pollen analysis since what we require goes beyond the zonal palaeovegetation map (eg. Zagwijn 1992a: Fig. 1), useful as these are, to an internal breakdown of the mosaic components of such broad vegetation types as steppe and steppe-tundra. However, if the mosaic model is to avoid future over-generalisation as a description of Pleistocene vegetation the structure of the plaid (Guthrie 1984: Fig. 13.1) will need quantitative description. This would be comparable to discussion elsewhere of key concepts in hominid palaeo-ecology of refugia (Vrba 1988), dispersal (Tchernov 1992) and colonization (Gamble 1993a).[8]

3. Regional environments and long-term evolutionary processes

3.1. INTRODUCTION

Europe can be shown to be a large enough geographical unit to observe variation in key resources and the impact this had on the structure of regional Palaeolithic records (Gamble 1986). These key resources were vegetation communities and the animals they supported. These varied in predictable ways due to the effect of latitude, longitude and relief on energy capture and its translation into usable food sources for hominids. The regional Palaeolithic records are not expected to vary in terms of artifact types but in terms of the quantity of materials available for study and the degree of continuity in regional occupation through all phases of an interglacial/glacial cycle. The former is a coarse measure of population density while the latter measures changes in behaviour which broadened the hominid niche.

3.2. GEOGRAPHICAL LIMITS

With this model we can begin to see why it is important to have some idea of the limits to Palaeolithic Europe. The debate over the occupation, or not, of non-mosaic interglacial forests may have focused attention on our ability to use static environmental descriptions in a dynamic manner. However, such discussion should not detract from the fact that Middle Pleistocene Europe saw only a partial colonization of the continent. For example, the ESF workshop confirmed (Praslov, this volume) that there are no OIS 9 sites or older on the plains of Russia and the Ukraine.[9] Middle Pleistocene occupation is only found between the Black and Azov seas and not further north. These plains are ringed to the south by evidence for early occupation. The Caucasus provides evidence as at Kudaro I and III, Tsona and Achalkalaki, while recent finds at Dmanisi in Georgia establish a solid Early Pleistocene presence (Ljubin and Bosinski, this volume). Recent research in Turkey and Greece (Darlas, this volume) has also produced Middle Pleistocene evidence. Some of the locales in these southern areas are also at comparatively high altitude, sometimes above 1500 m. Such high altitude sites have not been reported for other parts of Europe. Isernia lies in a landscape where rugged mountains go up to 1400 m but these were much lower, as they would have been in the Caucasus, at the time of occupation (Mussi, this volume).

The eastern unglaciated limits to the European region of Middle Pleistocene occupation therefore seem to be well established. Neither can erosion and the destruction of evidence be suggested as the reason for absence (Praslov, pers. comm.). To the north the limits remain unknown due to glacial scouring of the evidence (Holm and Larsson, this volume). There is no a-priori reason to suppose that the Middle Pleistocene sites of Germany, Belgium, France and England represent the limits of northern occupation (Brinch-Petersen, pers. comm.). The question must be how much further north would population have extended? The only answer will come through a greater understanding of the ecological tolerances of these hominids.

3.3. THE MAMMOTH STEPPE AND MIDDLE PLEISTOCENE HOMINID RANGE

In this respect Guthrie's mammoth steppe (1984, 1990), which links Alaska with western Europe, provides a wider biotope for evaluating the relations between Middle Pleistocene hominids and their environments. Guthrie has correctly characterised Pleistocene biotic communities as 'novel assortments' of elements rather than the common view that coniferous forests or tundras "have a long, complex evolutionary history of fine tuning and are much as they have been since ... time primeval (1984:289)". The mammoth steppe has a considerable antiquity (see below) as an ecologically complex, medium to high latitude suite of vegetation mosaics that produced a diverse fauna of grazing generalists. This depended primarily upon longer growth seasons which were internally varied. Guthrie shows how these can be most clearly differentiated on a north-south, latitudinal transect (1990: 263ff). However, Middle Pleistocene hominids only used a small part of this huge biotope (*ibid*: Fig. 9.12).[10] Their restricted distribution suggests that the mammoth steppe was differentiated, in terms of suitability for hominid use, on a west-east transect. The degree to which the mammoth steppe varied internally has not been discussed in any detail by Guthrie. However, one factor contributing to any such differentiation would have been the pattern of animal migrations into Europe. During colder phases the main mammoth steppe herd animals came from the east while during interglacials taxa migrated into northern Europe from southern Europe (Van Kolfschoten 1992: Fig. 1).

This circumstance suggests that Europe north of the Alps and Carpathians was generally a comparatively rich mosaic environment. This was the situation during the warmer, forested phases as well as the colder open phases. Under both climatic regimes the richness of that mosaic can be defined *in relative terms* by the conditions in the rest of the mammoth steppe. Obviously for Middle Pleistocene hominids the structure of food resources in these mosaics was very different. Key factors would have been prey density, its mobility and reliability as measured by population fluctuations.

Putting this mosaic model into the wider context of the Eurasian/Beringian mammoth steppe, we can see that, irrespective of interglacial or glacial conditions, the controlling factor on the northern and eastern distribution of Middle Pleistocene hominids was the oceanic effect (Von Koenigswald 1992: 45). Only this ameliorating effect could, combined with the zonal distribution of upland and mountain in Europe, have produced the dual mosaic pattern that had the effect of concentrating animal resources in this western arm of the Eurasian landmass.

The details of exactly how the oceanic effect worked and varied in its impact between different glacial/interglacial cycles is still debated. Those concerned with palaeovegetation reconstructions are still divided over the controlling role of either temperature or moisture as the critical element in major vegetation changes (Tzedakis 1993: 438; Zagwijn 1992b; Suc and Zagwijn 1983; De Jong 1988). However, the essential feature of the European vegetation is that speciation during the Quaternary was low to non-existent (Tzedakis 1993: 440). This was probably also the case for the European large mammals. The reason that Europe possessed a dual mosaic structure, rather than alternating plaids to stripes[11] (Guthrie 1984), is that both elements of the biotope repeatedly migrated into Europe rather than evolved within the region. Variation in amplitude of the oceanic effect between oxygen isotope stages controlled these migrations.

3.4. REFUGIA AND MOSAICS

During glacial phases, plant species became locally extinct in northern Europe. Vegetation zones were not depressed south and instead taxa, especially tree species, survived in localised refugia in southern/ Mediterranean Europe from where re-colonization took place in succeeding warmer phases. Animals were also part of these southerly refuges (Van Kolfschoten 1992). From a European perspective, local extinctions in warmer periods meant that the Asian/Beringian mammoth steppe came to form a sort of huge refugia.

The location and composition of the refugia within Europe no doubt varied, due to contingent factors, from glacial period to glacial period. This explains why, although broadly similar patterns exist for each forest re-generation in northern Europe, each interglacial also possesses an individual floral character (De Jong 1988). Moreover, the timing and mixing of the dual mosaics (steppe:forest) produced what in modern animal community terms are very strange associations of animals,[12] but which can be understood in terms of the generalists such environmental structures favour (Guthrie 1984; Geist 1978).

This long term pattern of successive colonizations favoured those areas of northern Europe which were in close proximity to the topographically diverse refuge areas. Re-colonization distances would be short and likewise the timescale for forest regeneration. The reduced effects of seasonality in the west of the continent would also have the effect of more tightly packed vegetation mosaics. On the contrary in the east, outside the distribution of Middle Pleistocene hominids, distances between the plains and the sheltered refuge areas were greater. Seasonality, as measured by intra-annual variation in temperature, would also be much greater and the cells in the mosaics would be more widely spaced. Biotopes in the west would therefore be more ecologically resilient because they were less prone to crashes in animal numbers and faster migration/recolonization rates. The main factor reducing such seasonality is the oceanic effect.

3.5. HOMINID MOBILITY

The discussion has so far suggested that within the European area settled by Middle Pleistocene hominids we can recognise two significant regional habitats – plains and uplands. In her contribution Mussi develops the mosaic hypothesis in relation to one of these habitats, the Italian peninsula. She reminds us that due to topography extensive ecological zonation (stripes rather than plaids) has never been possible and that the hallmarks of a refugia – spatially compact high diversity and exponential growth in plant populations – are commonly found. This would have favoured the persistence of animal species. At a local scale the mosaic principle is picked up in the rich, diverse swamps and lagoons.[13] Mussi elaborates the model to propose that the richness of the Lower Palaeolithic in Italy was linked to these environmental circumstances where, within short distances, foragers were able to take advantage of such conditions.[14] Therefore, the richness of the elements in the environmental plaid, and their proximity, served as a means to reduce risk[15] by moving to alternative, productive resources.

While less extreme in terms of topography, and mitigated by the shorter growing seasons of more northerly latitudes, we can see that locales in Germany (Mania, this volume; Bosinski, this volume), northern France (Tuffreau and Antoine, this volume) and England (Roberts *et al.*, this volume) were also positioned in relation to such mosaic structures. In particular, the use of riparian woodlands would have provided the best opportunities for scavenging and the avoidance of predators (Blumenschine 1986: Table 5.8) particularly along the overgrown banks of the Pleistocene Rhine as at Miesenheim I (Bosinski, this volume). Within reasonable distances there was often sufficient altitudinal variation to produce the conditions for mosaic habitats. However, compared to Italy the distances involved would have been greater and more easily stretched by climatically forced changes to plant and animal communities. If mobility was a key tactic of Middle Pleistocene hominids in combatting risk, then the distance between feeding patches within the mosaic would become critical. While we cannot yet specify such distances it would seem that the absence of these hominids in Scandinavia and the Russian plains would provide case studies to determine what these distances were by examining the mosaic structure of the Pleistocene biotopes in these areas.

4. Long-term changes

4.1. INTRODUCTION

Resilience can be defined ecologically as the amount of fluctuation that can be tolerated, and after which the system can return to equilibrium (Foley 1984:10). The main properties of ecological stability are shown in figure 1 where attention is also paid to cyclical amplitude and periodicity.

The effects of climatic cycles clearly varied in terms of amplitude during the Middle Pleistocene. In Iberia the weak signals have made it difficult to distinguish between temperate and cold stages on the basis of sediments, pollen

Table 1

Occupation of Europe by	**2 Myr**	**1.5 Myr**	**1 - 0.9Myr**	**0.73 Myr**	**0.5 Myr**
Starts at OIS		57	33	19	13
Number of interglacial/ glacial cycles	c. 40	27	15	8	5
Length of cycles mean Kyr range Kyr sd		 56 117 - 38 26.45	 68.2 117 - 38 30.56	 90.5 117 - 47 23.61	 102.4 117 - 84 14.22
Number of stages ≥ OIS 5e core 552A	9*	7*	5	2	2
Number of stages ≥ OIS 2 Core V28-239	15*	13*	9	6	4
Site(s) Author	*Soleilhac* Bonifay 1991 *Orce* Gibert 1992	*Chilhac* Guth *Kärlich* Bosinski *Beroun* Fridrich 1991	*Vallonnet* De Lumley 1988 *Monte Poggiolo* Peretto 1992 *Korolevo* Ranov 1991	*Isernia* Peretto 1991 *Stránská skála* Valoch 1991	*Boxgrove* Roberts *et al.* this volume *Isernia* Roebroeks & van Kolfschoten this volume

* = minimum number estimated from incomplete core data
compiled from Ruddiman *et al.* 1986; Shackleton and Opdyke 1973; Shackleton *et al.* 1988

and faunas (Raposo and Santonja, this volume).[16] By contrast, in England the OIS 12 ice sheet (Anglian) re-diverted the Thames and had dramatic effects on the evolution of this region's landscape. As a result it left deposits which are readily distinguishable from the interglacials which preceeded and succeeded it.

The amplitude of climatic cycles also changed during the Quaternary. De Jong (1988) and Zagwijn (1992b) have shown how the Bavel interglacial at 1 Myr BP saw the first succession in the immigration, spread and decline of forest elements in northern Europe. Prior to this date the interglacials lack such characteristic successions. They attribute this to changes in the intervening cold periods which for much of the early Pleistocene were less severe. Refuge areas may well have been closer while different soil conditions at the beginning of interglacials prevented the spread of acidiphilous elements like *Abies* and *Picea* (Zagwijn 1992b: 587).

Amplitude in the climatic signal had therefore increased. Within the Middle Pleistocene further variation exists with the correlation between high ocean values (Shackleton 1987) and the appearance of *Abies* in northern Europe (De Jong 1988). These extreme interglacials were OIS 5e, 9 and 11 when oceanic climate with high precipitation and warm winters predominated. If these correlations between the deep sea and the pollen records are correct then they describe conditions which pertain to only some 8% of the Middle Pleistocene.

4.2. LONG AND THE SHORT CHRONOLOGY

The importance of long term variation in cyclical amplitude and periodicity for hominid occupation comes to the fore when we consider the environmental consequences of either a long or short chronology for occupying the continent.

In particular there have been attempts (M.-F. Bonifay 1980; Zagwijn 1992b) to link major changes in the European fauna and vegetation to orbital forcing of the Pleistocene climate. This involves both the amplitude of some key cycles (notably OIS 12) as well as changes in the periodicity of these cycles between the Early and Middle Pleistocene.

Adherence to either the long or short chronology for the initial occupation of Europe has fundamental implications for the use of environmental evidence. At one level this means dealing with more, or less, animal taxa (Cordy 1992), a variable number of hominid species, and the different structure of interglacial vegetation cycles the longer the time span for human occupation is extended back beyond the Middle Pleistocene (Zagwijn 1992a: 586).

The climatic cycles recorded in the deep sea record are also the proxy data most commonly used to investigate questions of environmental selection on hominids (Vrba *et al.* 1989; Brain 1981; Prentice and Denton 1988; Gamble 1993a). For example, if a long chronology for the occupation of Europe of 2 Myr, 1.5 Myr, 1 Myr or 900 Kyr is preferred, this will produce different long-term environmental selection as represented by the number, frequency and comparative amplitudes of the oxygen isotope stages. However, if a short chronology of either 730 Kyr or 500 Kyr is adopted then the accumulated effects of the generalised climatic record are very different (see also Foley 1994).

In Table 1 the environmental scale of the interglacial/glacial cycles are examined. If hominids first colonized the continent at 500 Kyr BP then the differences between the length of the cycles was much less, as shown by a lower standard deviation, than would have been the case with an earlier entry. Colonization at 500 Kyr BP was followed by five climatic cycles of very comparable duration and dominated by intermediate environmental conditions (Gamble 1986: table 3.5). Much greater variability would have faced the earliest European hominids if colonization had first occured 730 Kyr BP or earlier (Table 1). But this greater variation in cyclical rhythms has, if a long chronology is favoured, to be seen against a diminution in the frequency of the extreme climatic events. These are the high sea level interglacials (Shackleton 1987) and the large continental glaciations (Zagwijn 1992b) that are so characteristic of the short, 500 Kyr, chronology. If we take this time span as a climatic yardstick for comparing the remaining Pleistocene cycles in relation to either extreme oceanic conditions (stages ≥ OIS 5e) or extreme continentality, as shown by high ice values (all stages ≥ OIS2), we arrive at the following proportions:

Date of first occupation	Number of cycles	*High sea levels & forests* % of cycles ≥ last interglacials (OIS 5e)	*Low sea levels & ice caps* % of cycles ≥ last glacial maximum (OIS 2)
500 Kyr	5	40	80
736 Kyr	8	25	75
900 Kyr	15	33	60
1,5 Myr	27	26	48

The trend revealed by these oxygen isotope data is very clear. The longer cycles of the last 500 Kyr are very different in terms of the frequency of high ocean and high ice conditions than the earlier cycles. Amplitude effects, as measured by environmental extremes, are markedly different. The proportion of extreme conditions decreases significantly the longer the chronology, especially for high sea level interglacials. These are represented by only a quarter of the cycles in the last 1.5 Myr. The higher frequency of continental ice advances is a feature of the shortest chronology presented here for the occupation of Europe.

However, the usual way to analyse these data is not by using the competing claims for the earliest human settlement to mark the divisions, but rather to set the boundaries by studying climatic change in its own right. This is undertaken in Table 2 for the Brunhes and Matuyama Chrons. The latter Chron is only examined back to 1.6 Myr due to the availability of reliable data (Ruddiman *et al.* 1986). The reason for selecting these Chrons as an environmental framework stems from their apparent association with orbital changes which in turn forced climatic change.

Table 2

Brunhes Chron	**0.012-0.787 Myr**
Starts at OIS	19
Number of interglacial/ glacial cycles	
Length of cycles	
mean Kyr	96.71
range Kyr	117- 47
sd 17.02	
Matuyama Chron	**0.736 - 1.636 Myr***
Starts at OIS	63
Number of interglacial/ glacial cycles	22
Length of cycles	
mean Kyr	40.91
range Kyr	45 - 38
sd 2.01	

* Matuyama Chron lasted from 2.47 - 0.736 Myr.
Data only available for 'Pleistocene' section (Ruddiman *et al.* 1986: table 3)

The data in Table 2 reveal a well known aspect of Quaternary climatic cycles (Pisias and Moore 1981; Ruddiman and Raymo 1988); namely that during the Matuyama Chron the dominant periodicity for a full cycle is 41 Kyr. This can be matched to the rhythm of orbital obliquity – the tilt in the earth's rotational axis. The Brunhes Chron is more complex with the period between 900 Kyr to 450 Kyr showing a mean of 54 Kyr for a full cycle, while according to Ruddiman and Raymo (1988:6) the 100 Kyr cycles became dominant after 450 Kyr ago. But even among Pleistocene geologists chronological unanimity is lacking. Prentice and Denton (1988:390) see the transition between the ice budgets of the two rhythms occurring between 900 Kyr and 700 Kyr, with the 100 Kyr cycles dominating the entire Middle Pleistocene/ Brunhes Chron. These are important chronological differences for hominid colonization of Europe, especially if an environmental reason involving climatic forcing is being sought.

When examined for the proportion of high and low sea level cycles we find the following pattern:

Chron	Number of cycles	*High sea levels & forests* % of cycles ≥ last inter-glacials (OIS 5e)	*Low sea levels & ice caps* % of cycles ≥ last glacial maximum (OIS 2)
Brunhes 0.012-0.73 Myr	8	25	75
Matuyama 0.73-1.63 Myr	22	23	32

From these data we can see that the Chrons are very comparable in the proportion of high sea level interglacial cycles. What distinguishes them are the well known, major continental ice advances of the Brunhes. As Shackleton (*et al.* 1988: 685) asks, where are the traces of the Matuyama ice sheets which appeared with a 41 Kyr periodicity but a very low environmental amplitude? A question that has already been addressed in relation to the Middle Pleistocene sequence in Iberia (Raposo and Santonja, this volume).

4.3. A CRITIQUE OF THE QUATERNARY CASE FOR GRADUALISM

Such low impact, high impact differences have still to be assessed in terms of colonization and behavioural change. This may be difficult as those putting forward climatic forcing as an explanation for hominid speciation (Brain 1981; Vrba 1988; Prentice and Denton 1988) have discovered. The correlations remain tempting, but tenuous. Moreover, the differences in climatic cycles and the scale of their continental ice caps in the last 500 Kyr was not the result of changes in earth's orbit but more probably major tectonic activity affecting climate (Ruddiman and Raymo 1988).

As a result the importance of the contribution of these evolutionary, or geological, timescales to human evolution remains unclear. One good reason for this uncertainty is, as discussed above, that evolution takes place on an immediate or ecological timescale. Converting these processes from the general to the specific remains problematic and is accentuated when colonization and behaviour are the main interest.

However, the implications of a short and long chronology do not stop with demonstrating the role of climate in human evolution. Table 1 also points to the amplitude of changes. The longer the chronology for initial occupation the more possible it is to argue that hominids reached Europe during 'easier' climatic times. Although the Pleistocene begins at 2.5 Myr (Zagwijn 1992b) the first significant ice advances take place almost a million years later at 1.6 Myr, which is still the official Pliocene/ Early Pleistocene boundary. Thus, a long chronology allows a gradual view of behavioural evolution. Humans had plenty of time to adapt to the variable frequencies and persistance of conditions of Pleistocene climates as well as the long term trend toward increasingly extreme conditions. Thus the long chronology supports a gradual view of change.

But there is a problem with such simple gradualism. Namely that the mechanisms for behavioural change are never spelt out but instead are regarded as slowly additive and accretional. As a result no independent check exists on the appropriateness of any of the preferred time scales on-offer (Table 1) to produce by gradual means long term change. This imprecision helps to explain why so many versions of the long chronology exist. It is up to the individual worker to set what she/he believes is an appropriate length of time to achieve the advances in technology and culture which archaeologists have revealed. For this reason individual claims for a variety of chronologies persist in the literature for many years and are rarely critically examined because the underpinning argument of gradualism appears to be irrefutable (Roebroeks and van Kolfschoten, this volume).

The argument against a short chronology is therefore usually founded on the requirements of gradual evolution. The assessment of those favouring a long chronology must be that 500 Kyr or even 730 Kyr is too short a period to account for the changes seen both in Europe and worldwide. Yet these estimates, if examined historically, are also relative. For example, Zeuner, following Milankovitch, estimated the length of the European Pleistocene as 600 Kyr (1959:213). Indeed, in *Dating the Past* (1958: figure 80) this figure accounts for human evolution in all parts of the world. Ten years later Oakley increased human evolution seven-fold to 3.5 Myr (1969) and included the Australopithecines, ignored by Zeuner. Oakley's figure has been confirmed. Furthermore, it is now expected, thanks to the molecular clock, that the human chimp split occured some 5 Myr ago and that one day we may find fossils to fill the 4-5 Myr gap.[17]

4.4. THE SHORT CHRONOLOGY; CONTINGENCY OR PROCESS?

However, the short chronology also adopts a gradualistic rather than punctuated approach to the process of change. This prompts us to ask how gradual *is* gradual? Therefore in order to avoid accusations of just being a spoiling argument the short chronology must be evaluated in terms of what it tells us about the goals of Palaeolithic studies, accounting for change and stasis in hominid behaviour, which the long chronology does not. This assessment can best be undertaken by asking questions. We want to know why Europe was colonized at c. 500 Kyr as well as the tolerances, in terms of amplitude and frequency which hominids could cope with.

Alan Turner (1992) has argued that the reason for a more substantial occupation of Europe from 500 Kyr BP onwards is to be found in the changing structure of the large carnivore guilds, well shown at Petralona (Darlas, this volume). Between 600-400 Kyr there was a marked faunal turnover during which the large flesh eaters (*Homotherium* and *Megantereon*) and the carcass destroyers (*Pachycrocuta perrieri* and *P. brevirostris*) became extinct. This left only the leopard, lion, spotted hyena and wolf as Europe's major carnivores. According to Turner this change in the carnivore guild would have greatly improved the conditions for hominid scavenging since the giant hyenas were no longer present to consume carcasses. It may also have improved hunting success now that the flesh eaters (the sabre and dirk toothed cats) had also disappeared. Turner concludes by suggesting (*ibid*: 122) that any hominid occupation prior to 500 Kyr BP would have faced intense competition from the carnivores. While population may have reached the continent it would have been for short periods of time and left little archaeological trace. After 500 Kyr the nature of the archaeological record changes dramatically (Roebroeks and van Kolfschoten 1994), a reflection of reduced selection pressure from previously key competitors.

This same change has been documented by Cordy (1992) who has divided the period from OIS 26 - OIS 2 into eight faunal biozones. The 'hinge' in the faunas falls between OIS 13 and OIS 12 at 440 Kyr BP, with four biozones on either side. The two periods these biozones comprise are each 400 Kyr in duration. What is apparent is the general increase in herbivore diversity, especially among the rhinos, large bovids, ovicaprids and antelopes after OIS 12. The only changes in carnivore diversity involve the decline of the hyenas and large cats.

Table 3 compares the faunal composition of Cordy's (1992) four biozones either side of 440 Kyr. The figures shown are the average number of species for each of the major taxa in the four biozones. This shows, for example, that the number of rhino species doubles in the biozones after 440 Kyr.

	Biozones I-IV OIS 26-13	440 Kyr	Biozones V-VIII OIS 12-2
Mammoths	1.25		1.25
Rhinos	1		2
Horses	1.75 - 2		1.5 - 1.75
Bos	1.75 - 2		2.75
Ovibos	1.5 - 2		1
Ovicaprids	1.25		2 - 2.25
Antilope	0		1.25
Cervus	6.25 - 7.75		5.5 - 6.75
Canis	1 - 1.25		1.25
Vulpes/Alopex	1.25		1.5 - 1.75
Cuon	1.75 - 2		1
Ursus	1.5 - 1.75		2
Hyena	2 - 2.75		1.25
Large cats	2.5 - 3		1

From these data it is possible to argue that community diversity generally increased between the Early and Middle Pleistocene and continued to do so during the Middle Pleistocene. The figures strongly indicate a long-term process of community evolution rather than being contingent upon a short timescale event to shape the European fauna. Such a profound event can be detected in the decimation of the European fauna in the Late glacial/ Holocene transition (Guthrie 1984; Von Koenigswald 1992). The greater community diversity can be linked to the changes in cyclical periodicity (Tables 1 and 2) as indicated by the deep sea cores. A strong link is suggested between the longer cycles, dominated by conditions intermediary between the full interglacial and full glacial and which account for *c.* 60% of the last 440 Kyr. This diversity is probably an indication of the evolution of the highly productive mammoth steppe. Van Kolfschoten (1990) and E. Turner (1991) have shown that in western Germany the first truly glacial faunas occur at Ariendorf 1 with *Dicrostonyx* and *Rangifer*.[18] This assemblage dates to an older phase of the Saalian, probably OIS 8 (303 - 245 Kyr BP) and so immediately after the period covered by the ESF workshop (Bosinski, this volume). This is of interest in terms of human occupation because western Germany currently lacks any occupations dated to OIS 10 and 9. A case might possibly be made that occupation was still intermittent on a regional basis prior to the full establishment of the mammoth steppe. It is therefore tempting to revise Turner's chronology and see the period from 500-300 Kyr as one of hesitant, intermittent occupation on a regional basis between northern and southern Europe, while after

300 Kyr BP occupation strengthens due to the maturation of the full mammoth steppe during the long cold phases of the interglacial/glacial cycles (cf. Roebroeks and Van Kolfschoten, this volume).

5. When and why was Europe colonized so late? A personal conclusion

At the Tautavel workshop there was considerable discussion over the "gates of Europe" as a barrier to settlement. If hominids were present in North Africa (Raynal *et al.*, this volume) at around 800 Kyr BP and in the Middle East and the Caucasus (Bosinski, this volume) by at least 1 Myr BP and probably, in the case of Georgia and Israel, much earlier, why did a further 500-900 Kyr elapse before the uplands and plains of Europe were first colonized?

From a short chronology perspective there seem to be three alternatives. Firstly, that the dates are inflated for the earliest appearance of hominids outside sub-Saharan Africa. A critical review of the claims for ancient findspots throughout the Old World would be clearly welcome, but was beyond the scope of the present workshop. However, our re-assessment of the European data now provides a yardstick against which to measure the various claims from elsewhere for early colonization. One aspect of this scrutiny will involve characterizing the normal environments which preserve evidence of hominid activities in other parts of the Old World. The character of the Palaeolithic record and its critical assessment in terms of chronological and archaeological integrity is clearly a project for future international collaboration.

Such an investigation would only seem worthwhile, however, if we have a framework expressing the degree of chronological precision we deem necessary to settle the issue of when the colonization of Europe and the other regions of the Old World took place. The likelihood of arriving at a consensus view at the level of the individual cycle, of either 41 or 100 Kyr duration (Table 1) seems currently remote. I would suggest, following Bonifay and Vandermeersch' discussion of the physical anthropological evidence (1991: 317), that we should start with 500 Kyr blocks (Foley 1994). Let us then see which block between 0-2 Myr BP provides consistent and verifiable evidence in terms of agreement over the status of artifacts, hominid remains, and dating methods, as well as the integrity and character of those normal environments which preserve our evidence. Having identified which block we should be searching in we can then become more precise, as this volume shows.

But let us assume that the hominids at Sidi Abderrahmane and Dmanisi did indeed wait at the gates of Europe for very long periods of time. This suggests a second, environmental reason to explain the delay. A physical barrier seems the best answer and this could be the straits of Gibraltar, an enlarged Caspian/Black Sea, or the topographically undifferentiated plains of the Ukraine. These barriers do however look extremely permeable given the timescales and climatic changes that took place between 1 Myr and 0.5 Myr BP. They are not the permanent ocean barrier that existed between south east Asia and Australia. It is exactly this permeability which is perhaps the strongest card in the hands of those favouring a long chronology. However this is confusing the likelihood of colonization with its actuality. Hence the concentration of early claims in those areas adjacent to the gates of Europe rather than in the north of the continent. Indeed supporters of early colonization in mediterranean and southern Europe (Table 1) would presumably draw their barrier at the margins of the northern plains or argue, as Turner (1992) has done, for multiple entries that did not lead to a permanent foothold in the continent because of the barrier presented by carnivore competition. But what the long-chronology model needs to address are those very thresholds of archaeological visibility which it uses to support the patchy pre 500 Kyr claims. How do we quantify such an ephemeral presence and compare it with the permanent occupation after 500 Kyr? What are the likely parameters, in terms of artifact densities by time horizon and landscape and region, that would adequately test the model ? These archaeological issues are not addressed by any of the long chronology's supporters. They cannot address them because they have no environmental framework which allows them to investigate hominids as colonizing animals. This framework is apparent among the proponents of the short chronology who are less interested in pursuing an origins paradigm and more concerned with understanding past hominid behaviour.

The barrier view divides Europe. Moreover, it divides Europe along traditional archaeological fault lines. It makes initial colonization look comparable to the Holocene arrival of the farmers who moved first into the mediterranean and only later onto the plains of the north. I prefer a third model which unites Europe, north and south. The reason for such a unified (suitably Maastricht!) view of the Lower Palaeolithic settlement of the continent is based upon the environmental approaches that have been reviewed. I would argue that Middle Pleistocene colonization took place precisely because the complementary environments of plains and uplands existed. The combination of southern plant and animal refugia, faunal migrations from the east, the variable westerly oceanic effect and, at a regional scale, the existence of mosaic landscapes were the necessary conditions for permanent colonization, whether achieved in a single or, as seems most probable, series of colonizing events. We have seen that colonization took place during a long-term trend of increasing faunal diversity. This culminated at the end of OIS 9 with the possible appearance of the mammoth steppe (Guthrie 1990), that was most probably the result of changes in the periodicity and amplitude of the interglacial/glacial cycles. Hominid colonization was therefore part of climatic and biotope changes that took place in evolutionary time and at a continental scale. The limitations on this unified colonization were precisely those which stalled the hominids at the eastern gates of Europe - extreme seasonality in the complementary plains environment. In terms of hominid behaviour this seasonality could only be overcome through greater annual mobility and the fissioning of population. These necessary distances and separation of population in the widely spaced plant and faunal mosaics of the plains could not be supported by the mechanisms available to Middle Pleistocene social systems (Stringer and Gamble 1993; Gamble 1993a,b). As a result populations in the spatially compact regions of the Caucasus, Middle East and North Africa did not expand into Europe. Only with alterations to the seasonality regimes in central and western Europe, which co-incided with changes that were detrimental to the large carnivores, did a match emerge between the scale of the hominids social systems and the spatial structure of resources in the environment which permitted colonization.

One of the urgent tasks which now faces environmental approaches to the Middle Pleistocene is the quantification of the spatial structure of these landscapes, locally, regionally and for the entire continent. Furthermore, we need to agree from which end of this spatial framework we will begin the investigation of hominids as colonizing animals. Do we start small and work up, or begin with the continent and work down to the local environment. The scale I would advocate starts at the level of the continent itself, poorly defined as it may be on its eastern and northern margins. Only at this scale can we examine the proposition *that any one region of Europe could only be colonized if it was colonized at the same time as most of the others*. Elsewhere (Gamble 1986: Fig. 3.1) I have specified nine regions for the study of the Palaeolithic settlement of Europe. Initial colonization starting at 500 Kyr BP can be demonstrated for eight of them. Only the North East region lay vacant during the Middle Pleistocene. Proceeding down the spatial scale we can see how regions and even landscapes were settled. By increasing our resolution we can begin to examine the relationship between colonizing populations, habitat choice and population dynamics which took place over the long-term and at spatial scales which involved continent wide adaptations and which archaeologists have rarely considered. Examining these issues is one reason why the debate between a long and short chronology is important. However, to be meaningful, such a debate should now be based on the premise that the colonizing capabilities of these hominids was not limited solely by environmental conditions but rather by their own organizational responses to the structure of such environments.

notes

1 See Gamble (1993a) for discussion.

2 See Isaac (1981) for a general discussion of Lower Palaeolithic landscapes in terms of scatters and patches of archaeological material. As he points out the patches are what we commonly call sites. A locale combines both terms.

3 Contributions and comments prepared for and presented at the Tautavel workshop, but which are not included in this volume are indicated as 'pers. comm.' in the reference.

4 Compare the Bilzingsleben 'campsite' with the highly patterned evidence from the Late Glacial open locales such as Verberie, Etiolles and Pincevent (Audouze 1987).

5 This locale is also probably younger than 300 Kyr BP.

6 Mania also mentions the common problem of contradictory environmental evidence which can face such precise reconstructions. At Schöningen 12 the molluscan evidence points to open and the pollen to closed terrain.

7 The classic brittle environment is the tropical rain forest which despite enormous biomass, productivity, species diversity and hence ecological stability, nonetheless recovers very slowly if disturbed.

8 Disagreement over the so-called wooden curtain (Roebroeks *et al.* 1992) which did, or did not, limit hominid occupation in Middle and Late Pleistocene Europe may well be resolved in a more productive analysis of differential forest mosaics and how these can be identified from the palaeoecological record.

9 see Aitken this volume for discussion of claims for very early Russian Plain sites on the basis of TL dating.

10 The claims for 500 Kyr BP dates for sites in Siberia (Morell 1994) remain implausible for reasons of science based dating and associated archaeology.

11 Until the special circumstances of the Holocene produced stripe zonation (Guthrie 1984: 263ff).

12 For example musk ox and leopard in Mediterranean France (De Lumley, pers. comm.).

13 See Kelly 1983 for details of the massive biological productivity of swamps and water bodies.

14 See Soffer (1989) for a discussion of this short distance, zonal compression, for Middle Palaeolithic occupation in the Crimea.

15 Defined as the failure to meet dietary requirements.

16 This must have been partly due to the depression of the polar front and gulf stream southwards during the colder periods.

17 Since finishing this paper White et al 1994 have now done just that with the discovery of *A. ramidus* in the Awash valley. To put such finds in context; Oakley placed the occupation of Europe at >500Kyr based on a relative age for the Mauer mandible (1969:300). His careful assessment allowed Europe some 14% of the chronology then alloted to human origins. The various chronologies (Table 1) set against a figure of 5 Myr for human ancestry allow human occupation of Europe 40%, 30%, 20%, 15% and 10% of this time span.

18 This is not however the oldest occurence of *Rangifer* in Europe which extends back at least to OIS12 (Cordy 1992:89).

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Clive S. Gamble
Department of Archaeology
University of Southampton
SO9 5NH Southampton
United Kingdom