Following the Fat:
Food and Mobility in the European Upper Palaeolithic 45,000 to 18,000 BP

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Introduction

Continuous, well-dated, high-resolution records of climate change for the last 100,000 years have recently become available for Europe (Greenland ice cores: e.g. Svensson 2006; Monticchio pollen core: Allen et al. 2000). These have revealed a series of rapid temperature oscillations known as the Dansgaard-Oeschger (D/O) cycles, or Greenland Interstadial (GIS) events, which coincide with the Upper Palaeolithic period in Europe (45,000–12,000 BP; fig. 1). The magnitude of these fluctuations, as calculated by Huber et al. (2006), ranged from eight to fifteen degrees Celsius in as little as 50 years, while the Monticchio records revealed changes of more than ten degrees Celsius in around 150 years (Allen et al. 1999: 142). These substantial oscillations suggest that European Upper Palaeolithic (EUP) groups repeatedly experienced long periods (decades to centuries) of intense cold throughout this interval, with exceptionally harsh winters.

Solar insolation at this time is known to have been greater in July and lower in January as compared to modern values (Berger 1978) indicating

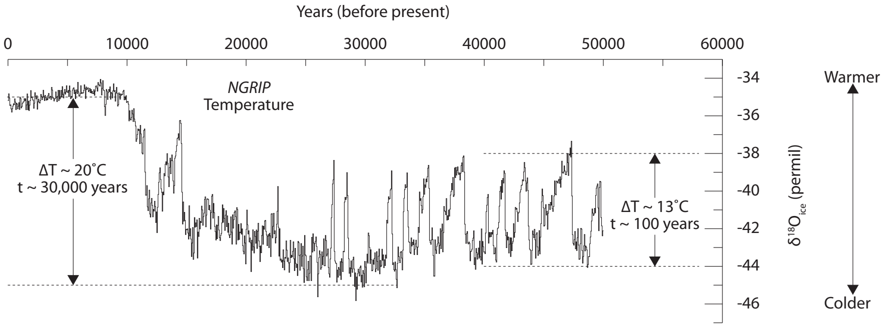

Fig. 1. Chart showing change in $\delta^{18}O$ of the NGRIP icecore, Greenland. The rapid oscillations between 25,000–50,000 BP reflect D/O climate events. The inferred changes in air temperature above where the ice core was deposited are shown (reproduced with permission from Dr Luke Skinner, Department of Geography, University of Cambridge).

enhanced seasonal differences through the year. This pattern has recently been confirmed by moraine scar evidence from ancient glaciers (Denton et al. 2005) and pollen records from within the Arctic Circle (Kienast et al. 2005). Both of these records indicate highly seasonal environments with warm summers and exceptionally cold winters, which would have been particularly pronounced during stadial events.

Groups living at this time would have been forced to adapt to these highly seasonal conditions, which would have impacted upon all areas of life. One such area concerns food acquisition strategies, which are constrained by the location of food resources and their changing availability throughout the year. These factors would have placed heavy constraints upon the mobility strategies of EUP groups, which would have been formed, in part, in response to the changing requirements for obtaining sufficient food throughout the year. This paper, using a combination of archaeological and ethnographic data, expands on this issue by relating mobility patterns to food acquisition in the physical and social landscape of the EUP.

It is to be expected that different strategies for obtaining food existed in different areas, according to the specific ecological setting. As virtually no EUP coastal sites are known, this paper concentrates on inland continental groups and the strategies they may have pursued to meet their nutritional needs. This paper therefore focuses on the Central and

Eastern European Upper Palaeolithic. While the approach adopted here is largely theoretical, it is intended to provide an interpretational basis for the future study and re-evaluation of cold-climate Palaeolithic sites.

Diet in the European Upper Palaeolithic

Before considering the kinds of problems associated with obtaining food in the EUP, it is first necessary to outline the evidence for EUP diets. Despite a great deal of research into this subject, little specific detail can be quoted. This is because of uncertainties surrounding the near-total absence of plant foods and fish remains recovered from Palaeolithic sites, hence the largely theoretical approach of this paper. Because of this problem, the evidence for diet is discussed here at some length, beginning with the question of plant foods.

Plant Foods

Typically, Palaeolithic peoples are considered to have consumed virtually no plant foods, and contemporary cold-climate coastal cultures are indeed known where plant foods constitute less than five percent of the diet (Greenland Inuit approximately four percent; Alaskan Nunamiut approximately one percent; see compiled statistics in Cordain et al. 2002: 44). This demonstrates that plant foods are not strictly necessary for humans to remain healthy. There is evidence, however, that some plant foods were included in the Palaeolithic diet (table 1), including both direct evidence of plant remains and indirect evidence in the form of processing tools. The sparseness of this evidence either indicates that plant foods were not a major part of EUP diets or, more likely, reflects problems of preservation and data recovery at Palaeolithic sites. Here the evidence is interpreted simply as suggesting that Palaeolithic peoples knew how to access and process plant foods, and could have done so if they were available.

The question of availability highlights a major problem in the consideration of Palaeolithic diets—that of the climatic background of individual sites. As has been discussed, the Upper Palaeolithic climate was highly variable, but the full impact of the D/O oscillations on European vegetation is still poorly understood (see Huntley and Allen 2003). Within

Table 1. Examples of European Upper Palaeolithic sites 45,000–20,000 BP with evidence for the consumption of plant foods. This table should not be considered a comprehensive list of the evidence.

Evidence	Date (BP)	Site	Reference
Parenchymatous material from species with edible roots found in a hearth	25,000–27,000	Dolní Věstonice II, Czech Republic	Mason et al. 1994: 52
Microscopic remains of berries and seed plants, also 2 ochre-covered grindstones	15,000	Mezerich, Ukraine	Soffer et al. 1997: 59
Grindstones	18,000	Kostenki IV, 1, Russia	Bosinski 2000: 275
Grindstones	30,000–20,000	Adlerquelle, Germany	Bosinski 2000: 275
Grindstones	30,000–20,000	Sprendlingen, Germany	Bosinski 2000: 275
Evidence for bark peelers	27,000–29,000	Predmostí, Czech Republic	Sandgathe and Hayden 2003: 713

a framework where colder temperature zones advanced south and retreated north with each oscillation, debates remain concerning: the existence and position of glacial refugia (Cheddadi et al. 2006, Willis and Van Andel 2004); the problem of enhanced seasonal temperature variations; and the effect of lower carbon dioxide concentrations on plant biomes (Hernandez Fernandez 2006). These, and many other limitations, make it difficult to speculate about which plants would have been available for consumption by Palaeolithic gatherers. Evidence from rigorous palaeoclimatic modelling experiments have predicted as much as three to six months of snow cover per annum for the non-Mediterranean parts of Europe (van Andel and Davies 2003), substantially reducing plant activity during these times.

Based on this evidence therefore, it thus seems appropriate to assume that Palaeolithic groups consumed at least some plant food, potentially much more than the evidence suggests, however these would only have been seasonally available for gathering during the warmer parts of the year, and hardly at all during the long winter and spring months.

Fish

Other much-debated potential food sources are marine and freshwater fish. This paper is concerned only with inland habitation, and thus marine foods will only be considered with respect to trade (see below). Freshwater fish, however, could have been procured directly by inland groups. As with plant foods, evidence for fish consumption is sparse. Fish bones are seldom preserved on occupation sites, even in modern ethnographic situations where fish are intensively exploited (Hayden et al. 1987: 181). This is because fish waste is commonly subject to intensive disposal at processing stations, by throwing it into the river, burning it or consuming it. It is also true that early excavation techniques would not have detected fish bones in Palaeolithic sites even if they had been preserved. However, sufficient finds have been made from Palaeolithic contexts to suggest that, if fish were brought to sites, survival of the remains is possible (e.g. sites named in LeGall 1992 and Hayden et al. 1987).

LeGall (1992), summarising the evidence for fish at Palaeolithic sites, proposes that from the second half of the Middle Palaeolithic (the Würmian Mousterian), the bones of small freshwater fish appear in sufficient examples to suggest that individuals may have caught single fish on an occasional basis. This behaviour becomes more common during the Upper Palaeolithic, but he concludes that it is not until the Late Glacial (Magdalenian) that fish can be said to be an important element in Palaeolithic diets and only in the Mesolithic does fishing become undeniably large-scale.

These findings are now slowly being replicated by isotopic evidence. Stable isotope ratios in bones carry chemical information about the past diets of animals and humans, and a number of studies have attempted to use this method to investigate the consumption of fish in the Upper Palaeolithic. Hayden et al. (1987) used data from twelve mid to late Upper Palaeolithic humans to suggest that fish were not commonly exploited in the French Dordogne area until the very end of the Upper Palaeolithic and the start of the Mesolithic.

More recent examples include Richards et al. 2001 (analysing nine middle Upper Palaeolithic humans from around Europe) and Richards et al. 2005 (three Late Upper Palaeolithic and Mesolithic humans from Kendricks Cave, England). Richards et al. (2001: 6350) state “by the mid-Upper Palaeolithic, there was relatively heavy use of freshwater aquatic resources in some areas”. However, Drucker and Bocherens (2004) have argued that the quantities of fauna analysed were not sufficient to fully justify this claim, suggesting that freshwater fish are not automatically implicated by the high nitrogen signals observed in the data. Responding to this, Richards et al. then proposed their 2005 findings as the first evidence for major reliance on marine foods, appearing at the end of the Upper Palaeolithic, sparking an ongoing debate in the literature (Bocherens and Drucker 2006, Richards et al. 2006). The only consensus reached is that both marine and freshwater fish were consumed during Late Upper Palaeolithic or Mesolithic times. The existence and scale of any earlier fish exploitation, from an isotopic point of view, remains an open question.

In summary, it appears perfectly possible for fish bones to survive in Palaeolithic sites, despite their small size, and the fact that they have not been found more commonly to date is probably a result of excavation methods as much as preservation problems. Despite this, the available evidence must be interpreted as indicating only small-scale fishing in the EUP. There is no evidence for large-scale fishing activities until the very end of the Upper Palaeolithic, and this conclusion is replicated by the isotopic data. This is perhaps a little surprising, as some freshwater river fish (e.g. carp) would likely have been available year-round, and could have been a valuable source of food in winter and spring. Reasons why fish might not have been more commonly exploited include a lack of fishing technologies, the impact of freezing rivers during the crucial winter season or a social taboo that prevented groups from catching them.

Meat and Animal Products

Given the current evidence suggesting that plant foods were only seasonally available and that freshwater fish resources were largely unexploited, the undisputed bulk dietary component for the central EUP, terrestrial animal foods, can now be considered.[1] The ethnographic evidence discussed above highlights the increasing importance of animal foods as climates get colder (e.g. Cordain et al. 2002). Archaeologically, instances such as the Epigravettian horse-hunting site of Stránská Skála IV (Czech Republic), where at least 12 horses were trapped and slaughtered, indicate the scale of hunting activities (West 1996). This is also reflected in the large numbers of animal bones found on Palaeolithic living sites.

Recent isotopic studies have further suggested that Upper Palaeolithic populations obtained most of their dietary protein from animals (e.g. Drucker and Bocherens 2004). Based on the assumption that harsh winters would have excluded the gathering of plant foods for at least part of the year, this reliance on animal products can be considered to be especially intense during the cold D/O oscillations and from 28,000 to 18,000 BP.

Crucially, this (at least) seasonal reliance on animal foods, particularly on meat, would have created a substantial problem for Palaeolithic groups. The effects of eating too much protein are recorded in Arctic ethnographies (e.g. Stefansson 1913: 140–141) and the physiological risks of protein poisoning are well known (Speth and Spielmann 1983). When carbohydrates (i.e. plant foods) are unavailable, it is possible to dilute a high protein intake with fat. During the summer months, when terrestrial animals are in good condition, this can come from fats deposited within and around the animals' flesh. When most of this fat is lost over the winter and spring seasons, however, the carcasses become too lean (protein-rich) to provide sufficient fat to facilitate the digestion of the meat. In the absence of carbohydrates, an alternative fat-source must be sought to enable the use of animal foods as a primary dietary component. Typically, Inuit groups (e.g. the Greenland Inuit) will address this problem by using large quantities of seal blubber, which enables their annual diet including just four percent plant foods to be maintained during the winter (Sinclair 2007). In the case of inland groups, such as those known from the EUP who did not have direct access to marine foods and do not appear to be exploiting freshwater fish, finding fat sources to sustain them through the winter becomes a major behavioural constraint. It also compounds the seasonal stress noted for plant foods, highlighting winter as a time of extreme food scarcity.

The problem of obtaining enough fat is crucially important and is examined here as a mechanism for exploring group mobility in the past. As noted, both the quantity and location of animal body fat changes throughout the year, according to season. This also varies between species, and in a fat-focused strategy this would impact on patterns of carcass transport and on butchering and processing strategies. The most obvious strategy for obtaining fat is the intensive processing of carcasses,

Table 2. Data published in West (1996), giving the weight of marrow for reindeer (caribou), and zebra (used here as a proxy for the horse).

	Reindeer Weight = 80–150kg Marrow in grams	**Zebra Weight = 250–300kg Marrow in grams**
Humerus	76	5.37
Radius	72	5.13
Metacarpal	42	4.33
Femur	104	6.48
Tibia	128	9.95
Metatarsal	102	8.10
Total	524	39.36

smashing bones open for marrow and boiling bones to release the fat stored inside. Reindeer (caribou, *Rangifer tarandus*) store large quantities of bone marrow fat relative to their body size (table 2), and as such were a particular focus for these activities (e.g. the reindeer at Pavlov, Czech Republic, where not a single long-bone was left intact; Musil 1994). In contrast, horses and bovid bones contain little fat. This might be one reason (in addition to their weight and size) why whole reindeer carcasses were transported to sites while post-cranial bones of horses and bovids, in general, were not. In a rare glimpse of Upper Palaeolithic butchering practises viewed from the perspective of a kill site, West (1996) analysed the fauna from the summer-time horse-hunting site of Stránská Skála IV, dated to *c.*18,000 bp (uncal). The bone assemblage suggested that although most of the post-cranial bones were abandoned at the kill site, almost all of the heads had been taken away. Interestingly, heads are one of the most stable and predictable fat reserves in a carcass because the fats stored in the brain, tongue, nose and lips are among the last reserves to break down during starvation. Especially for horses where there is little marrow or body fat, this makes heads an essential food resource.

Also pertinent to Central and Eastern areas is the suggestion that diets may have been supplemented with huge quantities of mammoth fat. Mammoth is the only terrestrial species that may have stored enough fat or bone grease to fill the role played by seal blubber in modern Inuit diets (mammoth subcutaneous fat layers are variously quoted as anything between 5 to 15cm thick; Haynes 1991: 98). The question of mammoth hunting and these animals' role in Palaeolithic subsistence and society is still hotly debated (e.g. Soffer 1993, Oliva 2003, Svoboda et al. 2005), however their use as a potential fat source remains noteworthy.

A final potential fat source for EUP hunters are small, fur-bearing mammals. It has traditionally been suggested that Palaeolithic groups would not have eaten fur-bearers because they were too small to provide much meat and had almost no fat stores (e.g. Musil 1994). However, some authors have argued strongly that they were consumed (e.g. Charles 1997, West 1997). Fat sources vary considerably between seasons in small animals, constituting over 20 percent of the skinned carcass weight in foxes in late autumn and early winter (West 1997: 52). In an average year, body weight and fat content then remain stable until early spring when they begin to decline (although this would be affected by a poor diet in harsh years). Many sites in Central and Eastern Europe suggest that foxes and other small mammals were hunted, and, although this is usually explained as a fur-gathering strategy, given their crucial winter fat supplies it seems hard to imagine why they would have been ignored as a food source as well.

This discussion has suggested some of the ways in which EUP groups could have been operating a fat-focused strategy. Hunters were clearly fully aware of the importance of fat supplies and where to find them in the animals they hunted. Despite this, it still seems unlikely that groups were consistently able to access sufficient supplies of fat. When carbohydrates are in short supply, diets can include as much as 30 percent protein (e.g. Inuit diets), however most of the remaining 70 percent must come from fat. All of the major prey species in the EUP would have experienced nutritional stress during the winter and spring in the same way that humans did, and their fat supplies would have been continuously diminishing; this would have been especially true during the extended winter suggested for this period.

Following the Fat—The Requirement for Storage and the Implications for Mobility

Groups living in the cold, ice-age climates of the European Upper Palaeolithic therefore faced the problem of regular, recurrent seasonal food stress during the winter and spring, as plant foods became scarcer and crucial fat supplies dwindled. Aspects of this issue have been highlighted before (e.g. Binford 1980, Speth and Spielmann 1983), and only three viable coping mechanisms have been identified: processing carcasses more intensively to extract more fat (boiling bones, etc.); trade or exchange for fat supplies from neighbouring (coastal) groups; and winter storage. The first of these has already been discussed and, based on the evidence for heavy processing of carcasses, it seems certain that this was occurring at maximum efficiency. For marine trade, however, an important point must be made: following an investigation of recent ethnographies, it seems that virtually no modern inland cold-climate hunter-gatherers live year-round without making at least seasonal contact with coastal groups to trade for fat (e.g. Ingstad 1954: 32–36, Stefannson 1913: 526 or examples summarised in Speth and Spielmann 1983).[2] The presence of marine shells in EUP sites across southwestern France indicates contact along the rivers between coastal and inland areas; Mediterranean shells have even been found at Mainz-Linsenberg and Sprendlingen in Germany, 1000km from source (Bosinski 2000: 276). Despite the potential for trade in food goods that this infers, it seems contradictory to argue that substantial quantities of aquatic marine food were transported inland given the lack of evidence for any large scale riverine fishing activities. This is particularly true in Central and Eastern European sites that were further away from accessible, ice-free coastal areas, many of which show no evidence for the transport of marine shells. The use of marine foods in the EUP is therefore unlikely to have contributed significantly to inland EUP diets and is not considered further.

Before the group mobility implied by the marine shells is considered further, the potential for winter storage of food must be considered in detail. Almost by definition this involves the storage of perishable goods in perishable containers, and thus archaeological evidence for Palaeolithic storage is virtually non-existent (some have interpreted pits found in

Eastern European sites as storage pits, while others refer to them as 'trash dumps'; Hoffecker 2002: 226). However, based on the evidence presented above that food would not have been available year-round, and in the absence of any other solution, the presence of some sort of storage mechanism for both plant and animal foods can be inferred as an essential requirement to survival (also posited by Yesner 1984). This argument is also supported by ethnographic evidence that suggests food storage in cold-climate societies is virtually ubiquitous (Binford 1980).

Winter storage affects mobility patterns of groups in several key ways, which will now be explored. As has been discussed, an over-riding concern of EUP groups would have been the massing of foods, particularly fat, to support them during the winter and spring. This would have

Table 3. Table listing some common methods for preserving and storing food for the winter season noted from ethnography. Methods recorded by Ingstad 1954: 119, Stefansson 1913: 139 and Suttles 1968: 63.

Storage technique	**Details**
Smoking of meat, fish and berries	To smoke foods thoroughly, a 'smoke room' would need to be constructed.
Sun drying	Some berries should be cooked before storing, others can be dried straight away.
Rendered fat from fish	Can be turned into oil and stored in vessels. Vessel types attested ethnographically include seal skins, hollow seaweed bags, wooden boxes, and bags made from preserved ruminant stomachs.
Storing in oil	Particularly for berries.
Storing in hardened fat or lard	Particularly for berries and nuts.
Production of pemmican	Pulverised meat mixed with grease and animal fat. This will keep for several years if kept dry.
Storage pits	Holes in the ground, snow or ice, which are then covered over and sealed.
Raised caches	Loads are placed on platforms suspended between trees and covered over with branches/logs. These are much less vulnerable to attack by animals than ground-level caches.
Stone, turf or snow/ice built structures at ground level	These are vulnerable to attack by animals, which Stefannson records as being virtually impossible to prevent—a certain number of losses are considered inevitable when using this method.

involved the intensive processing of both plants and animal carcasses, requiring a huge investment in time and energy (the extent of which can be imagined from table 3). The time involved in intensive processing and the weight of goods that need to be stored, thus effectively imposes a degree of sedentism upon groups, chaining them to processing and storage stations and restricting their mobility from autumn to spring.

Indeed, residential sedentism[3] for cold-climate groups is a well-studied phenomenon ethnographically (e.g. Binford 1980, Watanabe 1968). Binford (1980) compiled an excellent summary of ethnographic evidence to argue that mobility acts as a positioning strategy for groups relative to their resources. When a group begins to cache or store, it almost always creates the problem of having a high bulk of resources in a single location that is not correlated with the distribution of other resources (e.g. fat, dietary salt, water, fuel for fires, wood for tools and tent poles, hides for clothing, flint, cooking and other 'campsite' equipment, etc.). Clearly, this problem is accentuated as the number of critical resources increases, but also as the annual climatic variance widens, because this is likely to amplify changes in resource distribution patterns over the seasonal cycle. In a situation like this, Binford's analysis shows that groups will tend to become more sedentary, moving the resources to the consumers rather than the consumers to the individual resource pockets. Further, the very nature of cold climate survival *requires* material wealth, for example heavy winter clothing, animal skins for tents (requiring over 20 reindeer skins per tent; Banfield 1962), stomach bags for storage, boiling, etc. These items would have been too valuable and vulnerable to decay to risk caching. Rather, such resources must have been transported every time the group moved. Travelling through the landscape as a group, however, is a long and arduous process that is not embarked upon more than is strictly necessary, as shown by the Netsilik Inuit who lack large-scale use of dogs (Balikci 1968: 81). Given the ripening season of many nuts, berries and fruits, plus the very long winters and late springs, groups would almost by necessity have been preparing for winter and beginning to store supplies from as early as late summer or early autumn onwards, as this would have been the crucial time for making winter preparations. On the basis of these arguments, I suggest that inland groups in the EUP would, by necessity, have been sedentary from autumn to spring and that residential mobility throughout the year will have been very low, with as few as one or two moves per annum as standard.

Coupled with this residential sedentism, however, is long distance mobility in two forms—economic and non-economic mobility. In order to provision the main base camp, Binford (1980) describes how small groups of skilled workers periodically leave the site to procure the required resources from around the landscape. They may spend several days or weeks away from site at hunting stations, watching animal movements, hunting and preparing food for transport to the main base camp. Where large, heavy loads are procured, some resources may be cached at points around the landscape, ready for future collection and use. This brings the issue of economic mobility into sharp focus. The long-distance mobility of hunter-gatherer specialists greatly increases as they procure resources for the camp; this is particularly true when 'group' sedentism is greatest, during the coldest times of the EUP. However, this long-range mobility is contrasted with long periods of residential sedentism between expeditions, and with the comparatively low mobility of those who remain in the vicinity of the base camp—in a very practical way, it is the few who procure for the many (see also Laughlin 1968 on 'mobility hierarchies').

Finally, it is also possible to theorise the existence of non-economic mobility. Whallon (2006) reasons that if a group is likely to be compelled to move, then it must know the area it is moving to and that local groups will allow them to forage there—being met with hostility from the locals would be the equivalent of finding no food at all (Whallon 2006: 261). If the food sources are homogenous across a region, a harsh year would affect a very large area and groups could have to travel further to find alternative resources. Of course, there are many reasons why neighbouring groups might stay in contact, for example the maintenance of mating networks or kinship ties, but social connections and an awareness of the social landscape are also important for subsistence. Clearly, these relationships would either offer or negate the potential for trading for food stores, and were likely important for this on a weekly or monthly basis. However, longer distance contacts established between regions or groups in different resource areas may also have been maintained to guard against disaster years. Whallon argues that exactly this pattern is revealed in the EUP, by the movement of non-utilitarian gifts such as ornaments. Symbolic or ritual items such as marine shells are commonly moved distances of over 500km, which Whallon suggests can be interpreted as evidence for reciprocal gift-giving relationships between groups in neighbouring resource areas for the purpose of buffering against bad years. Although the idea that large quantities of marine foods were moving inland has already been rejected, it should be remembered that ethnographic studies predict a scenario where consumers are compelled to move closer to resources, and the ritualised gift exchange can therefore be interpreted as 'agreed permission' for inland groups to set up base camps in distant coastal territories during periods of starvation. Archaeological evidence of these activities would therefore be expected in the vicinity of the coastal adapted sites, now under water.

The very long-distance mobility predicted in this model (initially for individuals building social relationships, and then for the entire group during disaster years), is an almost inevitable consequence of the climatic instability and very cold temperatures that characterised the EUP. Subsistence needs can therefore be interpreted as driving certain mobility patterns on several different levels and scales.

Conclusion

The struggle to obtain sufficient food was one of the most crucial challenges facing Palaeolithic groups, and had a strong influence over group mobility and residence patterns. Despite the paucity of specific evidence for diet in the Palaeolithic, I believe that a good case exists for proposing that the problems associated with obtaining food necessitated a period of residential sedentism during the winter and early spring. The mobility of most group members during this time is likely to have been limited, while specialist hunters and gatherers left camp for planned expeditions to obtain specific provisions. Buffering against disaster years is likely to have been achieved by maintaining contacts between both local and regional groups on a reciprocal, possibly ritualised, basis. While still largely theoretical, the ideas presented in this paper (see also Binford 1980 for further discussion of potential archaeological signals of these behaviours) have aimed to address the question of how Palaeolithic humans might have adapted behaviourally to cold climates. These concepts and ideas provide the potential for investigating the life experiences of Palaeolithic peoples, their daily, monthly and annual routines of mobility and 'living in the landscape'. In so doing, they allow us to refocus our energies into a fully people-centred approach to the Palaeolithic record.

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Notes

1. Here, plant food obtained from animal stomachs is considered as an animal food. The contents of herbivore stomachs are a good source of 'pre-processed' or partially digested plant foods, which would be indigestible for humans as found in the environment. This resource would almost certainly have been exploited in the Upper Palaeolithic.

2. Some occasional exceptions to this rule exist however, for example the Japanese Ainu rely very heavily on fishing salmon from inland rivers (Watanabe 1968).

3. The term 'residential sedentism' is used here to distinguish it from the 'temporary sedentism' associated with hunting or resource gathering sites. These are used as a temporary base for a short period of time, and the mobility associated with them is substantially different to that proposed for main residential sites in this paper.

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