A view to a kill : investigating Middle Palaeolithic subsistence using a optimal foraging perspective

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3 Neanderthal Archaeology

3.1 Introduction

In this chapter I will discuss the behavioural information on Neanderthals provided by the archaeological record, with a focus on their subsistence behaviour. Before going into the interpretation of food remains found at archaeological sites, I will introduce ideas on the influence of mobility strategies on the formation of the archaeological record. This will be followed by a discussion of the hunter versus scavenging debate that was already touched upon in chapter 1. I will then present an overview of the different categories of food remains that have been recovered from Neanderthal archaeological sites and how they are currently interpreted. Archaeological theories and supporting evidence on the existence of a division of labour and differences between Neanderthal and AMH foraging strategies will also be touched upon. In addition to the information provided by food remains, we will look at how the study of Middle Palaeolithic artefacts can illuminate foraging behaviour. The insight gained in Neanderthal foraging behaviour will be combined with the information on Neanderthal biology presented in chapter 2. This information will be used together with Optimal Foraging Theory to produce testable hypotheses on how to interpret Neanderthal foraging behaviours.

3.2 Neanderthal mobility and the study of foraging behaviour

Hunter/gatherer societies are characterized by the fact that they are (almost) all mobile (Kelly 1992). This mobile way of life is caused by the fact that exploitation of an area depletes the available resources. Hunter/gatherers usually operate out of a home-base, exploiting the vicinity of this location. They generally forage no further than 10 kilometres from their camp (*e.g.* Binford 2001, 238, Vita-Finzi and Higgs 1970, 7). When foraging returns diminish, the group moves to another area. Even in situations where it is energetically possible to live at a single location, a mobile way of life is usually more efficient for hunter/gatherers (Kelly 1992, 53). The organisation of mobility has important implications for the formation of the archaeological record, which is important to realise when studying Middle Palaeolithic sites.

Mobility can be organised in distinct ways; the practised mobility strategies are usually dictated by the distribution of resources in the environment. Humans need many different resources, which are not always easily procurable from a specific place. Therefore, systems of mobility will be adopted in order to make sure that a group is provisioned as efficiently as possible with all the resources it needs. In general, the cost of movement is minimised while ensuring high return rates. Binford (1980) has described two extreme patterns which can be seen as the opposite ends of a continuum of ways in which mobility is usually organised.

At one end of the spectrum he recognised "foragers". According to Binford (1980), foragers "map onto resources". Foragers characteristically display a high degree of residential mobility. They operate out of a central place and do not usually store food, but gather what they need on a daily basis. When resources are depleted near the central place, they move their central place to a new area. Scarcity is dealt with by adjusting group size; fissioning to live in dispersed smaller groups when resources are scarce. They produce two types of archaeological sites, base camps that form the centre of activities and "locations", which are places where resources are extracted from the environment. Locations often leave few traces that are archaeologically recognisable; tools are rarely discarded at these sites (Binford 1980, 5-10). This strategy can be summarized as bringing consumers to resources (Kelly 1992, 45).

"Collectors" are characterized by a high degree of logistical mobility: they do not move their base-camp very often, but use expeditionary groups in order to procure the resources they need. These groups travel to areas quite far from the home base, and operate from a special-purpose camp to extract resources which they then transport back to the home base. This strategy is usually adopted in less diverse environments, where resources are dispersed. In this situation it is more efficient to bring the resources to the consumers (Kelly 1992). In this system, there is regular storage of food and a greater diversity of sites. Like foragers, collectors make use of home-bases and locations, but also field camps, from which expeditionary foraging parties operate. Furthermore, there are stations where information is gathered about resources, for example movement of prey animals, and collectors also produce storage facilities or caches (Binford 1980, 10-12).

Theoretically it might be possible to discern how mobility was organised by Neanderthals by looking at diversity of sites in the archaeological record, but ethnographic work has shown that the function of a site often changes over time. For example a site that is used as a home base in one season may be used as a special purpose camp after a residential move of the group has taken place (Binford 1982, 11-14). On the other hand, camps that are only used logistically may retain functional integrity in the archaeological record (Binford 1982, 16). An important observation by Binford (1982, 16) is that there is no necessary relationship between depositional periods and occupational episodes. We can therefore expect that the different occupational episodes will all become incorporated in the same palimpsest. This presents us with problems in periods as remote in time as the Middle Palaeolithic.

Interestingly, there seems to be a correlation between the organisation of mobility and the effective temperature of the area the group lives in. Apparently the lower the effective temperature, the more important logistical strategies become (Binford 1980, 14). Neanderthals were present in a wide range of environments, so they probably shifted between more logistically and more residentially organised systems of mobility. However, because the Pleistocene climate was considerably cooler than present-day climates for long periods of time and because Neanderthals were present mostly around temperate latitudes, following Binford's predictions we would expect Neanderthals to favour logistical mobility.

The archaeological record is hard to interpret with regard to Neanderthal mobility strategies. We know that they were highly mobile. This is illustrated by the fact that they moved raw materials through the landscape over quite large distances; sometimes up to well over a 100 kilometres. Some transfers of up to 300 kilometres are known in the late Middle Palaeolithic of Central Europe and more recently distances of at least 250 kilometres were reported for the site of Champ Grand in France (Féblot-Augustins 1993, Geneste 1989, Roebroeks, Kolen, and Rensink 1988, Slimak and Giraud 2007). Generally, in western Europe, most of the raw materials in Middle Palaeolithic assemblages come from within six kilometres of the site. The zone up to 20 kilometres from the site is generally the source of 5 to 20 percent of raw materials. Materials from more distant sources generally make up no more than one to two percent of the assemblage (Féblot-Augustins 1993, 214-215). Long distance transfers usually concern finished tools that are discarded at the end of their use-life. These are probably tools that formed part of an individual's "personal gear" that was used for quite some time (Kuhn 1995, 23-24). The high percentage of raw materials from within 6 kilometres of the site may reflect raw materials collected in the foraging radius.

In most areas there is a clear difference between Middle Palaeolithic and Upper Palaeolithic resource transfers. In the latter case, transport distances are often greater and quantities transported sometimes larger. In Upper Palaeolithic times raw material is sometimes transported in the form of cores and worked at great distances from their source, contrasting with the Middle Palaeolithic pattern of transporting finished tools. Additionally, in the Upper Palaeolithic, non-utilitarian objects are often also transported over cosiderable distances, like shells for beads (Adler *et al.* 2006, Roebroeks, Kolen, and Rensink 1988). This may be the result of exchange between Upper Palaeolithic people while there are no convincing indications for trade or exchange in the Middle Palaeolithic (*e.g.* Adler *et al.* 2006, Gamble 1999)

The frequency and the organisation of Middle Palaeolithic moves are difficult to distil from the archaeological record. An interesting starting point is Stewart's (2005, 38) impression that Middle Palaeolithic archaeological sites often seem to be located at places of ecological transition. Apparently Neanderthals preferred diverse environments, which enabled them to exploit a large range of resources from the base camp. This was reinforced by the fact that the environment that was present in Europe during much of the Pleistocene, the so-called mammoth steppe, was probably more productive and diverse than the Holocene environments. In the Holocene and presumably also in earlier warm climatic phases, Europe was covered in homogeneous vegetation zones, while the mammoth steppe was characterised by more mosaic vegetation patches (*e.g.* Stewart 2005, 38). This suggests that Neanderthals preferred to minimise the number of residential moves they had to make, while trying to avoid logistical activities by locating sites at places where provisioning of was straightforward. For the Levantine Neanderthal sites, a model of residential stability has been proposed, *i.e.* sites were used for extended periods of time and provisioned in bulk from extractive sites, suggesting that in some areas Neanderthals resorted to logistical mobility (Shea 2003, 181-182). The Mediterranean, an ecologically diverse and productive environment, may have represented an area where most resources could be easily procured from a residential base. Therefore they probably resorted to higher logistical mobility in order to minimise residential moves.

It seems that the southern parts of the Neanderthal range, sites generally have a higher artefact density than in the north. This may reflect more intensive occupation of these sites (Gamble 1999, 201-205). However, in the southern area of the Neanderthal range cave sites are more common than in the north. Caves are an excellent preservational environment and often harbour the remains of multiple occupations. They often yield high concentrations of artefacts that were deposited over a considerable period of time. The differential distribution of cave sites may then bias our impression of the intensity of Neanderthal occupation in the northern and southern parts of their range respectively. On the other hand, in northern caves, larger areas have usually been excavated and caves have been completely cleared in places, suggesting lower artefact densities at these sites than in the south (Gamble 1999, 201-205). This indicates that northern sites were used less intensively and therefore may have functioned in a different system of mobility.

I will assume that Neanderthals used central places. I consider these to be places where the spoils of the range of activities carried out by different group members were exchanged. Although some authors dismiss the idea that Neanderthals used central places (see for a discussion Kolen 1999, Mussi 1999). I think the archaeological record shows beyond doubt that some archaeological sites functioned as a central place. I take the following factors as indications for the function of a site as a central place:

- Site architecture like hearths.
- Large numbers of stone artefacts, reflecting many different stages in the reduction sequence.
- Large amounts of bone material, exhibiting traces of hominin modification and preferably reflecting multiple species of animal.
- Minimal indications of carnivore activity.
- Preferably different spatial location of areas of tool use and discard. The formation of trash middens.

The last criterion is one of Schiffer's important c-transforms; it posits that with more intense use of a location secondary refuse deposits will be formed (Schiffer 1972, 162).

The function of a site also influences which kinds of materials are represented. Central places probably provide the most complete insight in the range of foraging activities that were practised. However, because transport costs are usually minimised, processing of resources at locations in the field influences the representation of different activities at central places. We expect large animals to be more thoroughly processed in the field than small animals for example. With regard to stone tools, raw materials are often worked at the place where they were collected, thus some stages of tool production are underrepresented at central places.

Mobility influences more than the function of sites and which materials end up at which sites though. For example the design of stone tools may be determined to a large degree by considerations with regard to their function in a mobile way of life. In a highly mobile society, people may opt to produce highly versatile tooltypes, thus minimizing the number of different tools that have to be transported. If transport costs are less important, or if activities to which tools are geared are highly important, more specialised tools will be produced (*e.g.* Bleed 1986, Shott 1986).

All in all, the materials we find at archaeological sites are influenced by the way in which societal mobility was organised. We might expect that central places will present us with the full suite of remains connected to subsistence activities, but some activities will be severely underrepresented because of processing activities and so on. Part of the material record connected with subsistence strategies may have been left behind at other locations. Special purpose locations can yield detailed information on specific activities that were performed there, but these sites do not inform us on the importance of the activity within the full suite of subsistence behaviours. For a full picture of Neanderthal foraging strategies we need to be aware that different types of sites can provide complementary evidence.

3.3 Neanderthal archaeozoology

3.3.1 Introduction

Bone assemblages are our principal source of information about Neanderthal subsistence behaviour. In this section I will summarise the evolution of ideas on the interpretation of the archaeological record of Neanderthals. I discuss the implications of the hunting vs. scavenging debate for our interpretations of Middle Palaeolithic bone assemblages. This will be followed by a sketch of the "post-scavenging-debate" consensus, and an overview of current questions and debates in the field of Neanderthal archaeozoology. Moreover, I will present the variety of remains that have been found at Middle Palaeolithic sites, underscoring the variability of Middle Palaeolithic subsistence behaviour. I intend to highlight the most important issues in this field and end up with a basis that can be used in the development of OFT-models.

3.3.2 The hunting vs. scavenging debate

As outlined in chapter 1, research commencing in the 1970's and 1980's has pointed out that reconstructing prehistoric subsistence behaviour on the basis of archaeological bone assemblages is not as straightforward as was once thought. Taphonomic research has shown that hominin activities were often not the only activities that contributed to the formation of bone assemblages found in association with stone tools (*e.g.* Binford 1981, Brain 1981, Isaac 1983). Moreover, even when human involvement in the formation of bone assemblages could be demonstrated, traditional hypotheses about what behaviour was exhibited by these hominins was challenged. Lewis Binford proposed that

Figure 3.1: Map showing the location of the most important sites mentioned in the text: 1 Pakefield; 2 Lynford; 3 Boxgrove; 4 La Cotte de Saint-Brelade; 5 Gröbern; 6 Schöningen; 7 Salzgitter-Lebenstedt; 8 Lehringen; 9 Wallertheim; 10 Taubach; 11 Zwoleń; 12 Il'Skaya; 13 Ortvale Klde; 14 Kebara; 15 Quneitra; Grotta dei Moscerini; 17 Biache-Saint-Vaast; 18 Mauran; 19 Grotte XVI; 20 Combe Grenal; 21 La Borde; 22 Ambrona; 23 Gorham's Cave, 24 Vanguard Cave.

hominin involvement with animal carcasses was not the result of hunting, but probably of a form of marginal scavenging (*e.g.* Binford 1981, Binford 1984).

The research that started this debate was done on very early archaeological sites in Africa. Brain (1981) convincingly demonstrated that South African Australopithecines were not savage killers as previously thought. Careful taphonomic analyses of the caves in which hominin fossils were found led him to the conclusion that they, and the other animals found at the sites, had actually been preyed upon by felines. Binford (1981) meanwhile, had made a strong case for interpreting the bone assemblages at the sites in the Olduvai Gorge as the result of scavenging. These revolutionary studies questioned interpretations about early hominin hunting strategies that been taken for granted for a long time, and led to more critical studies of archaeological bone assemblages.

There were also repercussions for Neanderthal archaeology. The view propagated by Binford was that hunting animals like ungulates, did not occur in prehistory until very recently. Even Anatomically Modern Humans (AMH) in Africa, at Klasies River Mouth, dated from 125 ka to 35 ka, practised scavenging as an important subsistence strategy (Binford 1984, Binford 1985). According to Binford, only small mammals were hunted regularly at this site and hunting only became important in the later part of the sequence (Binford 1984).

Binford also analysed some European sites, namely Torralba-Ambrona in Spain and Grotte Vaufrey and Combe Grenal in France. Torralba, now dated to MIS 12 (Villa *et al.* 2005) had originally been interpreted as a site where early hominins hunted straight-tusked elephants *(Palaeoloxodon antiquus*). Binford (1987) concluded that the representation of bones and the distribution of stone artefacts among them were indicative of elephant exploitation by hominins, but not by way of hunting. He considered this assemblage to be the result of marginal scavenging. A more recent re-analysis of this site indicates that both previous interpretations must be rejected. Taphonomic analysis shows that the co-occurrence of artefacts and bones is the result of several processes, including natural deaths, fluvial action and some hominin activities (Villa *et al.* 2005). At the Grotte Vaufrey, a French Middle Palaeolithic site dated to MIS 6 or 7 (Grayson and Delpech 1994), Binford claimed that the assemblage was also the result of Neanderthals scavenging ungulate remains (Binford 1988). In this case, re-analysis has shown that the statistics he used were faulty and that evidence to indicate that the assemblage was the result of scavenging is absent (Grayson and Delpech 1994). For Combe Grenal, Binford concluded that hunting was practised in the second phase of the Weichselian, up to 45 ka, but only on medium-sized animals; large mammals like horse and aurochs were still scavenged (Binford 1985, 320). This study was never published in detail, and hence cannot be checked.

More recently, Stiner (1994), analysed a number of Italian Middle Palaeolithic archaeological sites and concluded that they provide evidence of a largely scavenging mode of subsistence prior to 50 ka. These assemblages are dominated by head parts, thought to be the parts that are most difficult to exploit for carnivores and therefore the remains that were left to hominin scavengers. Her findings were examined by Mussi (*e.g.* 1999), who concluded that the fact that Stiner's early assemblages were head-dominated, reflected the method of bone collection used during the excavations. Apparently, the excavators focused on determinable anatomical elements, which led to a bias towards head elements (Mussi 1999, 65-66).

These findings illustrate the outcome of the debate. Careful re-analyses of many sites have shown their interpretation in terms of human subsistence strategies to be far from straightforward. Sites often have very complicated taphonomic histories and the final assemblage is the result of various processes, like fluvial sorting, carnivore activity and hominin behaviour. At sites where hominin activities are the most important contributing factor to the accumulation of the bone assemblage, hunting has proven to be the main mode of acquisition of animal matter by Neanderthals. Scavenging on the other hand was only rarely practised, if at all.

3.3.3 Specialised hunting of ungulates

Before and during the archaeological debate on scavenging, there were ecologists claiming that specialised hunting was the only strategy that could logically be practised by hominins: especially by Neanderthals living in environments with long winters, with no vegetable alternatives to meat (*e.g.* Geist 1978, Tooby and DeVore 1987). Moreover, scavenging niches are characterised by fierce competition, not only with other mammalian carnivores, but also with birds, insects and micro-organisms. Mammalian scavengers are dangerous to compete with, since most are also predators. Micro-organisms make carcasses inedible, hence obligate scavengers have digestive defences to deal with rotting meat. Since scavenging is a competitive niche requiring specialisations, it was considered unlikely that hominins ever relied on this strategy (Tooby and DeVore 1987, 221).

As a reaction to the proposition that hominins were obligate scavengers, research into how to recognise sites that were the product of hunting intensified. A number of criteria were proposed. An obvious criterion is that a site should contain evidence for intensive hominin exploitation in the form of cut-marks or bones exploited for their marrow. Another factor deemed important was whether the hunting effort was concentrated on one species, in order to rule out more opportunistic strategies. A further indication as to the manner in which a bone assemblage was formed can be obtained by studying the age-profile of the prey animals. Different age-profiles are indicative of different strategies of acquiring meat (*e.g.* Auguste 1995a, Speth and Tchernov 1998). The composition of bone assemblages can show whether the accumulator had early access to the carcass or not. It is thought that the sequence of disarticulation of a carcass is similar in most cases. Entrails are generally consumed first, followed by the hindlegs and the frontlegs (*e.g.* Potts 1983). Head and foot parts are generally deemed least profitable for carnivores and will therefore be available to scavengers in the largest quantities. Unfortunately, this patterning is not constant, since transport and processing decisions have a large influence (*e.g.* Domínguez-Rodrigo 2002, 9-13).

A natural death assemblage is usually dominated by animals at the weakest stages of life, mostly the very young and old; this is an "attritional" age-profile. Assemblages produced by cursorial hunters tend to mimic this kind of assemblage, since they tend to focus on the weakest individuals (Steele 2002, Stiner 1994). On the other hand, a living population is usually dominated by animals in the "fittest" stages of life, since weak animals are filtered out. A death assemblage resembling the structure of a living population will only occur if a great catastrophe like a volcano or a flood kills every animal in its path (Steele 2002, Stiner 1994). Nevertheless, some predators use strategies that enable them to also target these "fit" age-classes. This is the most rewarding prey since it is in the prime of its life, but it is also the hardest to acquire and the most dangerous, for the same reasons. Ambush hunters usually prefer these prime-aged individuals (*e.g.* Husseman 2003). Only one extant species consistently targets the prime-aged adults of a population when hunting and that is anatomically modern man (Steele 2004, 307, Stiner 2002, 20). Sites that yield evidence for this kind of specialised hunting are generally thought to appear late in prehistory, after 250 ka (Stiner 2002, 34, 37). This pattern may be partly due to the fact that Lower and Middle Palaeolithic sites are usually characterised by a long and complicated taphonomic history. At older sites, taphonomic processes have had more time to blur the archaeological signature originally present. The archaeological record is therefore biased toward the younger sites. On the other hand, some sites where specialised hunting of ungulates was practised, (*e.g.* Mauran, Ortvalde Klde) were formed over a period of several years. The fact that these palimpsests show a narrow focus, and palimpsests from the Lower Palaeolithic often do not, suggests that the character of hominin hunting strategies may have changed between the Lower and Middle Palaeolithic. Specialised hunting of ungulates may therefore be more characteristic of the Middle Palaeolithic.

An early and very famous example of a site dominated by a single taxon is Schöningen, a German site dated to between 400 and 300 ka. The site was located at the edge of a small lake and has been exceptionally well preserved (Thieme 1997). Eight wooden spears were found in association with a bone assemblage containing about 20 horses as well as stone tools. It appears a family group was ambushed here, driven into the marshy edge of a lake and killed. Cut-marks on the bones are ubiquitous and processing of the carcasses was aimed at recovery of meat and marrow. Furthermore, exploitation marks pointing to the exploitation of the hides are also in evidence (Voormolen 2008). The exploitation of meat may not have been very intensive, though. Some elements show low frequencies of cut-marks. This may be caused by the fact that a complete herd of animals was available (Voormolen 2008). This site proves that from the Lower Palaeolithic onwards, hominins were able to ambush herds of large ungulates and despatch them.

Most European sites with a bone assemblage dominated by a single species and showing reliable indications of human hunting date to the last glacial-interglacial cycle (MIS 5-3). The majority of these also exhibit a clearly prime-age dominated age-profile (Gaudzinski and Roebroeks 2000). Prime-aged dominated assemblages have already been demonstrated at least from MIS 6 (Steele 2004, 314). A selection of sites thought to indicate specialized hunting of a single species can be found in table 3.1. The targeted species were dependent on local environment and climate, and range from Caucasian tur (*Capra caucasica*) in the east to Bison (*Bison priscus*) in the western part of their range. As pointed out, for some of these it can be demonstrated that the location was used

Site	Main species	MNI	NISP	Date	Refs	Remarks
Schöningen (De)	*Equus mosbachensis*	20		350 ka	(Thieme 1997, Voormolen 2008)	Lake edge, not prime dominated? (Voormolen pers. comm.)
Wallertheim (De)	*Bison priscus*	52 (59)	861 (1557)	114-108 ka	(Gaudzinski 1995)	Numbers in brackets are numbers with bones not assignable to findlayer included.
Zwoleń (Pl)	*Equus caballus*	38	239	70 ka	(Schild et al. 2000)	At confluence of small and large valley, finds spread over at least 7500 sq. m., only 523 sq. m. excavated.
Salzgitter-Lebenstedt (De)	*Rangifer tarandus*	86	2130	Oerel 58-54 ka	(Gaudzinski and Roebroeks 2000)	At confluence of small and large valley, also mammoth bone tools.
Les Pradelles (Fr)	*Rangifer tarandus*	55	1277	MIS 4-3	(Costamagno et al. 2006)	Cave site, not the hunting location.
Ortvale Klde (Ge)	*Capra caucasica*	33	3021	43-36 ka	(Adler et al. 2006)	Along migration valley.
La Borde (Fr)	*Bos primigenius*	27	410	Last/penultimate interglacial	(Jaubert et al. 1990)	Sinkhole used as trap? Higher MNI using wear stages of teeth.
Mauran (Fr)	*Bison priscus*	83	4150	Early Weichsel	(Farizy et al. 1994)	Few animals taken each year for long period of time. Only 25 sq. m. excavated of estimated area of 1000 sq. m
Il'Skaya (Ru)	*Bison priscus*	51	1334	Early Weichsel	(Gaudzinski 1996)	
Grotte Saint-Marcel (Fr)	*Cervus elaphus*	77	1031	MIS 3	(Moncel et al. 2004)	Cave site, not the hunting location.

Table 3.1: Sites dominated by a single species in the European Middle Palaeolithic.

in a similar way for a long time, with several individuals being taken each year (Adler *et al.* 2006, Farizy *et al.* 1994). The location of some sites points to strategic hunting behaviour by Neanderthals. Salzgitter and Zwoleń for example are located at "natural ambush" locations, at the confluence of small steep valleys with larger ones. Presumably the large valley was used by the prey as migration route and hominin hunters could easily select their preferred prey at such locations (Gaudzinski and Roebroeks 2000, 509-510). These characteristics point to a function as special-purpose locations in Neanderthal mobility systems. They may have been visited repeatedly, but only one specific activity is represented.

3.3.4 Neanderthals and megafauna

The considerable number of sites showing specialised ungulate hunting published in the last decades has shown that Neanderthals were perfectly capable of hunting medium to large sized ungulates. This was certainly the case during the last glacial – interglacial cycle and earlier, as proved by Schöningen. However, more dangerous animals were also an option: for example megafaunal species like mammoth and rhinoceros. There is evidence that Neanderthals were involved in processing carcasses of megafauna. As suggested by an isotopic study (see section 2.6) these species may even have been important constituents of the (late) Neanderthal diet (Bocherens *et al.* 2005). The interpretation of Neanderthal dealings with megafaunal species are not as unambiguous as is the case for ungulates. In exploiting these species, alternative strategies like scavenging may have been more profitable than in the case of smaller species. Actualistic research in Africa has shown that carcasses of megafaunal species provide the best scavenging opportunities for hominins (Blumenschine 1987). Even nowadays in Europe scavengeable resources are available for much longer than in Africa (Fosse *et al.* 2004). In colder glacial climates availability could last even longer, so scavenging carcasses of megafauna may have been a profitable strategy.

The site of Ambrona was already mentioned in the discussion on the hunting vs. scavenging debate. While it does not furnish unequivocal evidence for either hunting or scavenging of straight-tusked elephants, the co-occurrence of elephant bones, some cut-marked and stone tools does show that hominins were sometimes involved in processing carcasses of megafauna. Even though the evidence to link the elephant bones to the stone tools and thus hominin activities is scanty, there are some indications of hominin interference with the bones: one cut-marked cranium and three femora that show anthropic breakage (Villa *et al.* 2005). However, there are sites in Europe where hominin involvement with megafaunal remains was less ephemeral than at Ambrona. Table 3.2 shows a selection of sites yielding evidence of hominin involvement with megafauna.

Site	Species	Date	Remarks	Refs
Boxgrove (GB)	*Stephanorhinus hundsheimensis*	MIS 13	Prime aged, according to anecdote in (Pitts and Roberts 1997)	(Pitts and Roberts 1997, 266-267, Stringer et al. 1998)
Ambrona (Es)	*Paleoxodon antiquus*	MIS 12	Natural elephant deaths, fluvial transport of bones and stones. Some of the artefacts are abraded. Not much evidence to link artefacts and bones; (very few) cut-marks (Villa et al. 2005, 235).	(Villa et al. 2005)
Ebbsfield (Southfleet road) (GB)	*Palaeoloxodon antiquus*	MIS 11	Preliminary report, no NISP, no age. Authors are not certain about hunting.	(Wenban-Smith et al. 2006)
Aridos 1 (Es)	*Palaeoloxodon antiquus*	MIS 9 or 11	1 Individual; hominins had primary access; small stone artefact assemblage	(Santonja et al. 2001, Villa 1990)
Biache-Saint-Vaast (Fr)	*Dicerorhinus hemitoechus*	MIS 7-6	Many individuals; lots of stone tools	(Auguste 1988a, Auguste 1988b, Auguste 1992, Auguste 1995a)
La Cotte de Saint-Brelade (GB)	*Mammuthus primigenius, Coelodonta antiquitatis*	MIS 6	Two levels, both containing remains of multiple individuals; small stone tool assemblages	(Scott 1980, Scott 1986)
Lehringen (De)	*Palaeoloxodon antiquus*	MIS 5e	Much of material destroyed before recording; 1 old individual, few tools.	(Gaudzinski 2004, Thieme and Veil 1985)
Gröbern (De)	*Palaeoloxodon antiquus*	MIS 5e	1 old and diseased individual; possible scavenging; few tools	(Gaudzinski 2004)
Taubach (De)	*Stephanorhinus kirchbergensis*	MIS 5e	Old collection, at best sample of what was originally there. (Gaudzinski 2004) gives different MNI's.	(Bratlund 1999)
Mont Dol (Fr)	*Coelodonta antiquitatis*	MIS 5b	8 individuals. 6 mature. Cut marks on economically important bones	(Auguste, Moncel, and Patou-Mathis 1998, 139-140)
Buhlen (De)	*Mammuthus primigenius*	56-40 ka	Fauna dominated by young and prime-aged individuals.	(Schuurman 2004)
Asolo (It)	*Mammuthus primigenius*	MIS 4-3	1 mature female; associated flint artefacts, no cut-marks	(Mussi and Villa 2008)
Lynford (GB)	*Mammuthus primigenius*	MIS3 beginning	No cut-marks; hunting inferred from selective transport of leg bones	(Schreve 2006)

Table 3.2: Selection of sites pointing to hominin involvement with megafauna.

First, atsome sites scattered throughout Europe a single carcass of an elephant is associated with a stone tool assemblage, while there is no evidence for primary carnivore involvement with the carcass. In some cases it is difficult to determine what the method of procurement of the elephant was. Neither hunting nor scavenging can be ruled out here. The interpretation of sites containing elephant remains is complicated, since at many sites no cut-marks are preserved (*e.g.* Lynford, Asolo, Lehringen). This is partly due to the structure of elephant bones which does not preserve cut-marks well (Scott 1980, 144). Therefore the character of hominin involvement with proboscideans at most sites remains unresolved.

In some cases circumstantial evidence allows us to argue for either hunting or scavenging. For example, at the German site of Lehringen, dated to the Eemian, an elephant carcass was found in association with stone tools and a wooden spear (Gaudzinski 2004, Thieme and Veil 1985). The find of a spear is quite a powerful argument in favour of an explanation in terms of hunting. The skeleton belonged to a 45-year-old male individual, so in this case an older individual was selected instead of a prime-aged individual. Another German site, Gröbern, also dated to the Eemian, yielded the skeleton of a diseased elephant. The position of its bones suggested to the excavators that the skeleton was probably scavenged. Gnaw marks indicate that wolves also had access to the carcass (Gaudzinski 2004, 204).

Other sites yielded the remains of multiple carcasses of megafaunal species, showing that in some cases megafauna was a consistent focus of hominin activities. Two of these sites, Taubach and Biache-Saint-Vaast, will be the subject of a more detailed analysis in chapter 5. At these sites the exploited megafaunal species were rhinoceroses. To illustrate, we will look into the bones identified at Taubach, a site dated to MIS 5e. The site was located in an area where travertine was formed during the Eemian. During this period, the area probably functioned as a salt lick for Merck's rhinoceros (*Stephanorhinus kirchbergensis*). The number of individuals represented in the collection, 44, suggests that this was known to hominins, who repeatedly visited the site. Hunting was focused on juvenile rhinoceroses, possibly in order to lessen the risk associated with the activity. On the other hand, other large and dangerous species were also exploited at this site. The focus of brown bear (*Ursus arctos*) exploitation at the site was on adults. Bear hunting is considered to be very dangerous. The fact that this is ethnographically known to have been the first activity to see traditional methods abandoned in favour of firearms upon their introduction serves as testimony to its risk (Bratlund 1999, 147). Moreover, even when using firearms, it is apparently advisable to use a large calibre gun and fire multiple shots when hunting bears (Charles 1997). Nevertheless, the spear found at Lehringen testifies to the possibility of direct combat.

Using devices like pitfalls and other strategies that minimise direct combat would be advantageous in the successfull hunting of megafauna. In this respect La Cotte de Saint-Brelade is an interesting site. This site is located on Jersey; the layers containing the megafaunal assemblage are dated to the later part of MIS 6 (Scott 1980, 141). Layers 3 and 6 at this site are located at the bottom of a cliff, about 35 metres high (Scott 1980, 153). Both layers contain quite large numbers of mammoth (*Mammuthus primigenius*) bones and smaller numbers of woolly rhinoceros (*Coelodonta antiquitatis*) bones. Some artefacts were found in association with these bones. The bones do not show signs of carnivore activity, while some cut-marks are present. Moreover, some of the skulls seem to have been broken to retrieve to brains (Scott 1980, 150).[2] It seems that these two layers represent two episodes of which mammoths and woolly rhinoceros being driven off the cliff to fall to their deaths, upon which they were exploited by hominins.

Sites that provide evidence of the hunting of megafauna are rare. Many sites offer only minimal indications for hominin involvement with these animals. Some sites do contain large numbers of rhinoceros bones, showing that hunting these animals was not beyond the capabilities of Neanderthals. This is supported by recent isotopic data (Bocherens *et al.* 2005).

3.3.5 Central places: Sites exhibiting the full suite of Neanderthal foraging strategies?

Specific targeting of medium-sized and large mammals has been demonstrated above. Most of the sites mentioned in the previous sections can only be interpreted as special purpose sites. They usually represent specific subsistence activities. The large number of sites showing heavy reliance on only one or a few species is sometimes used to argue that Neanderthals were inflexible foragers and had a low diet breadth (Adler *et al.* 2006, 90). Nonetheless, there are also Middle Palaeolithic sites where multiple activities are represented. The structured use of some of these sites and the indications that they were occupied for long periods of time, lead to an interpretation as central places (sensu Isaac 1978). To illustrate this type of site, I will discuss Kebara cave in Israel, a clear example of a central place that conforms to all the criteria discussed in section 3.2.

Located close to the Mediterranean coast, Kebara has been the subject of archaeological excavations for a long time. Parts of the cave were excavated from the 1930's onwards, and in the 1980s and 1990s extensive excavations with a focus on the Middle Palaeolithic occupation of the cave were carried out (Bar-Yosef *et al.* 1992), dated to between 60 and 48 ka (Bar-Yosef *et al.* 1992, 508). During this period the Levant was occupied by Neanderthals. Furthermore, a Neanderthal skeleton has been found in the cave. This find has been interpreted as a burial. The fossil is very well preserved, yielding the only known "classic Neanderthal" pelvis and the only known complete Neanderthal hyoid bone (Bar-Yosef *et al.* 1992, 528).[3]

The Middle Palaeolithic sequence at Kebara spans several metres of sediment and the bedrock has not been reached in the excavations. The sequence can be divided into two parts. First there are early, ephemeral occupations of the central part of the cave, leaving few bones and artefacts. After an erosional episode, a second phase of Mousterian occupations followed. During this phase, occupation was more substantial, with structured use of the central part of the cave and the accumulation of a bone midden near the north wall. During this phase of occupation more than 3.5 metres of sediment was deposited (Bar-Yosef *et al.* 1992, 501, 531). The industry in the Middle Palaeolithic layers is classified as Levantine Mousterian. This is a Mousterian facies characterised by a high percentage of pointed forms.

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[2] Even Binford was convinced of the absence of carnivore traces on the bones and the presence of traces of human modification pointing to dismemberment (Binford 1981, 287-288).

[3] If we accept *Homo heidelbergensis* as belonging to the same chronospecies as Neanderthals, another complete pelvis and two hyoid bones are known from Sima de los Huesos (Arsuaga *et al.* 1999, Martínez *et al.* 2008). A hyoid body has also been discovered at El Sidrón (Martínez *et al.* 2008).

While the several metres of Middle Palaeolithic sediment accumulated, the space in the cave was used in a fixed and structured manner. Hearths were constructed in the central zone of the cave, probably in excavated pits (Meignen *et al.* 1998, 231). The location of these hearths remained constant for long periods of time. One concentration could be traced through a column of 60 centimetres of sediment, without the bottom being reached (Meignen *et al.* 1998, 229). Such constancy of hearths has been observed at other sites with a long stratigraphic sequence and this sort of behaviour may date back to at least MIS 9 times (*e.g.*Moncel, Moigne, and Combier 2005, 1299). However, constant use of space at a site depends on several factors. First, a change in site function may affect the use of space. Second, the form of caves may change through time, which also affects the place of hearths. Constant use of a hearth spanning multiple burning episodes in one stratigraphic level may thus already signal structured use of space suggesting the use of a site as a central place (*e.g.* Moncel, Moigne, and Combier 2005, Vaquero *et al.* 2001). In addition to the fact that the hearths in the central area of the cave at Kebara were used for long periods of time, the rest of the central area was cleared of bones, as a result they are only found in the hearths and in the midden (Meignen *et al.* 1998, 229). During the later phases of the Middle Palaeolithic occupation, most of the bones, and many of the stone artefacts were deposited in a midden along the north wall of the cave (Bar-Yosef *et al.* 1992, Speth and Tchernov 2001). This suggests that the central area of the cave was used intensively as a living space. It was regularly cleared and the waste was accumulated along the northern wall.

The recovered bone assemblage is large (see table 3.3). Most of it was deposited during the "midden-phase" of the Middle Palaeolithic occupation. The bone assemblage contains abundant traces of hominin modification like burning and cut-marks, but some carnivore damage is present too, in the form of gnaw-marks and etching of bones (*e.g.* Bar-Yosef *et al.* 1992, Speth and Tchernov 1998). Moreover, coprolites and some hyena bones point to the occasional presence of these carnivores. However, hominins were the principal accumulating agent, while carnivores exploited the bones discarded by the occupants of the site. This is shown by the fact that lithics and bones are intermingled in the bone midden. The north wall bone concentrations grade into the ash lenses of the central occupation area. The burnt bones are also found mainly in the midden, while burning took place in the hearths. This shows that the burning took place before the final deposition of the bones (Speth and Tchernov 2001, 64). Furthermore, it is hypothesised that occupation of the site was very intensive and lasted for prolonged periods of time (Shea 2003, 181). This would rule out an interpretation involving hyena denning, since hyena cubs stay close to the den for at least 15 months (Bar-Yosef *et al.* 1992, Speth and Tchernov 1998). If hyenas had transported bones, they would have transported them away from the site. The fact that soft elements are underrepresented and the bias against upper limbs points to significant attrition of the assemblage by carnivores (Speth and Tchernov 1998, 228). Finally, the early Middle Palaeolithic and Upper Palaeolithic occupations show more indications of carnivore activity than the bones of the "midden-phase". During the "midden-phase" skeletal completeness is highest, suggesting that attrition was at a minimum took place during this phase (Speth and Tchernov 2001, 65-67).

The permanent "architecture" in the cave, such as the hearths and the midden suggests that the cave was occupied in a structured, repeated and intensive way during part of its Middle Palaeolithic use-life. This notion is reinforced by the fact that exactly during this "midden-phase" there are the fewest indications for carnivore activities.

All in all, thousands of animal bones have been found in the cave, identification of which is a lengthy process (see changes in NISP given in the following publications Bar-Yosef *et al.* 1992, Speth and Tchernov 1998, Speth and Tchernov 2001, Speth and Tchernov 2003). However, the pattern of Neanderthal faunal exploitation emerging from the bone assemblages has not changed with the increase in number of identified bones; an overview of the identified assemblage is presented in table 3.3.

The main focus of Neanderthal subsistence in Kebara was on gazelle (*Gazella gazelle*) and fallow deer (*Dama dama*). This pattern is common in the Middle Palaeolithic of the Near East. The relative importance of gazelle and fallow deer at archaeological sites appears to have been influenced by climatic developments, with fallow deer more common in moist periods and gazelle better represented in arid phases. This led to the compilation of a Gazella/Dama curve to track climatic fluctuations in the region (Bate 1937), as curve still used nowadays (*e.g.* Speth and Tchernov 2003). The abundance of these species cannot be equated directly to their economic importance; since red deer (*Cervus elaphus*) and aurochs (*Bos primigenius*) are considerably larger than the aforementioned species, their

Species	Number of bones	Percentage	Percentage with “rest” excluded
Gazella gazelle	8121	38.52%	46.75%
Dama dama	4036	19.14%	23.23%
Testudo graeca	2345	11.12%	13.50%
Cervus elaphus	965	4.58%	5.56%
Bos primigenius	826	3.92%	4.76%
Sus scrofa	710	3.37%	4.09%
Capra cf. *aegagrus*	167	0.79%	0.96%
Equus spp.	137	0.65%	0.79%
Capreolus capreolus	64	0.30%	0.37%
Indet/other	3714	17.61%	
Total	21085	100.00%	100.00%

Table 3.3: The Middle Palaeolithic faunal assemblage of Kebara, based on (Speth and Tchernov 2003).

economic importance will have been larger than it seems from the NISP data alone (*e.g.* Bar-Yosef *et al.* 1992, Speth and Tchernov 2001, Speth and Tchernov 2003).

The ages of the gazelle, fallow deer, aurochs, and wild boar (*Sus scrofa*) sample present at the site have been reconstructed by analysing wear stages of their teeth. The gazelle, aurochs and boar samples are prime-age dominated. Their age-profiles fall in the range of prey ages usually associated with ambush hunting by animals. The fallow deer sample in the lower levels is dominated by juveniles, possibly because of the small sample size. In later levels it appears to be dominated by prime-aged individuals (Speth and Tchernov 1998, 231-233).

This picture of subsistence strategies is drawn from a palimpsest of bones from occupations spanning about 12 ka. In later publications, the authors have tried to track changes in the bone assemblage through time. This is difficult as the bone sample they used was collected in two different excavation campaigns that used different stratigraphic strategies. Therefore, only rough conclusions can be reached, based on analysing bone assemblages per 50 cm. spit (Speth and Tchernov 2001, 54-55). This analysis, although not very fine-grained, reveals some interesting patterns.

During the earlier part of the Middle Palaeolithic occupation of the cave, as well as during the Upper Palaeolithic occupation, the gazelle and fallow deer samples are male-dominated. This is interesting for there is an excellent body of data on the yearly behavioural cycle of fallow deer. With regard to gazelle, the data is poorer but their cycle roughly coincides with that of fallow deer cycle (Speth and Tchernov 2001, 58-60). Fallow deer males are in rut during the late summer and early autumn. They do not eat much during this period, so their condition is expected to be poor in autumn and winter. They were probably avoided as prey during these seasons. Females were in poorest condition around the period of fawning, which took place in late April or May. This suggests that the season of occupation in the early Middle Palaeolithic and Upper Palaeolithic was probably in the late spring or early summer, when females would be in poor condition. During the “midden-phase” when females dominate, occupation probably took place in the winter, or maybe the early part of spring (Speth and Tchernov 2001, 68).

Throughout the sequence aurochs and red deer exhibit a steady decline in importance, which cannot be related to climatic changes (Speth 2004, 158). Because of their size, these animals were probably highly prized by hunter/gatherers. Therefore, this pattern is possibly the result of overexploitation of these large species (Speth 2004, 158). Another indication of intensive exploitation of the environment is the fact that juvenile gazelles increase in importance throughout the sequence, while the proportion of older gazelles drops. This may reflect the fact that fewer adults managed to survive into old age and hunters may have had to make do with less profitable juvenile individuals (Speth 2004, 158-159).

The poor representation of larger species of animal is intriguing, since one would expect hunters to concentrate on the largest available species. As argued above, their weak representation may be partly caused by the fact that they had been exploited intensively. Probably not many large animals were available during the time of occupation. On the other hand, because the cave likely functioned as a central place, some of the activities carried out further afield may be underrepresented. In the case of hunting large mammals, this may relate to transport costs. At most Levantine cave sites,

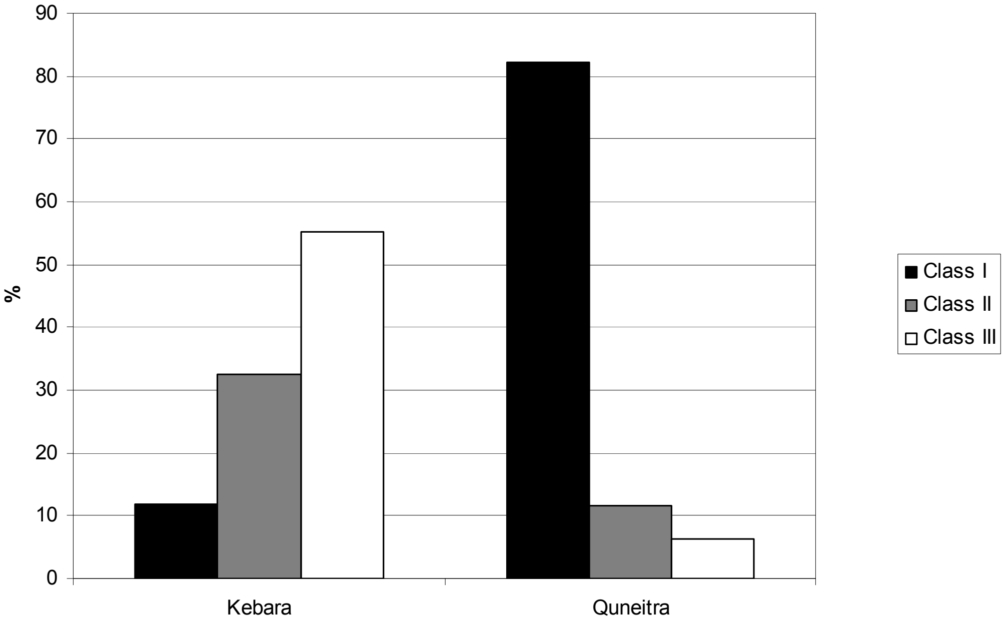

Figure 3.2: Comparison of size classes of the mammal bone assemblages of Kebara (NISP=17371) and Quneitra (NISP=320). Kebara data based on (Speth and Tchernov 2003), Quneitra data and size classes based on (Rabinovich 1990). Size class I: (Rhinoceros, Horse, Aurochs, Red deer)[4]; Size class II: (Fallow deer, Roe deer, Wild boar, Wild ass); Size class III: (Gazelle, Wild goat).

remains of large mammals are rare and fragmented (Rabinovich and Hovers 2004, 303). This can be explained by the fact that it is more rewarding to process large carcasses in the field and only transport the richer parts to the cave. For smaller animals, returning the complete animal to the site to process later may have been more rewarding, since this would give hunters more time to continue hunting (*e.g.* Winterhalder 2001, 22-23).

In the Levant this can be illustrated by comparing the faunal assemblage of a central place like Kebara with that of a hunting camp. Quneitra is an open-air site in the Golan Heights that has been interpreted as a hunting station (Bar-Yosef 1995). ESR dating of the site has yielded an average age of 53.9 ka ± 5.9 ka (Ziaei *et al.* 1990). The stone tool assemblage that was recovered at the site can be characterised as Levantine Mousterian. Finally, it has yielded a small faunal assemblage, which appears to be anthropogenic in origin (Rabinovich 1990). Large bodied animal, in particular aurochs and horse dominate the assemblage. In comparing different faunal assemblages, it is important to realise that hunted species are usually dependant on the site's environment (Rabinovich and Hovers 2004, 303). I have therefore used size categories, as detailed in (Rabinovich 1990, 209). Figure 3.2 illustrates this comparison.

This graph shows that even when a home-base serves as a place where people doing different tasks in society meet and exchange the fruits of their activities, not all activities may be represented evenly. Therefore, the analysis of sites that functioned as central places must be supplemented with information on the context in which these sites functioned, in order to assess the full suite of subsistence activities practised by a group of hunter/gatherers. Some appreciation of the importance of processing in the field can be gained by analysing the representation of skeletal parts of large animals at home bases. In the case of selective transport of remains of these animals to the site, one would expect economically valuable parts, like the hindlimbs to be overrepresented (*e.g.* Chatters 1987, 343, Rogers and Broughton. 2001). On the other hand, if a carcass is filleted, none of its bones will reach the central place (Rabinovich and Hovers 2004, 303). Therefore, we need to consider all the components of a settlement system when studying subsistence behaviour.

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[4] Equids from Kebara have been grouped with class II, since *E. hydruntinus* is the most common equid present (Bar-Yosef *et al*. 1992, 517). However, some *E. caballus* and *E. tabeti* are also present at the site. There is no published data that enables me to distinguish between these species. I chose to classify red deer as a class I mammal, however, since *E. hydruntinus* is grouped by Rabinovich (1990) as size II, this might also be valid for red deer. In that case Kebara has even fewer class I animals.

Ungulate hunting can be expected to be underrepresented among groups using special purpose hunting sites. At central places, toolkits may be produced and maintained, while at special purpose camps we may only see a short period of their use. Furthermore, different provisioning strategies may have been pursued by different members of the group. A central place is expected to reflect the activities of all group members. This makes the study of central places important, especially with regard to the activities of women, who are usually assumed to be excluded from hunting large mammals and whose activities will only very rarely be reflected at other types of site (*e.g.* Kelly 1992, Kelly 1995).

Resources that could be gathered as an alternative to the dangerous activity of hunting large mammals are plants and smaller, less dangerous, animals. Foraging for plant foods is difficult to detect archaeologically, but there are indications that these resources were important in Kebara. We know from anthropology that at temperate and tropical latitudes plant foods usually comprise quite a large part of hunter/gatherer diets (Bar-Yosef 2004, 337). Furthermore, carbonised wild pea seeds were found in the lower levels of many hearths in Kebara and a possible grinding stone was found in the Middle Palaeolithic levels of the cave. Moreover, pistachio nuts, acorns, grass seeds and legumes have been identified in samples (Albert *et al.* 2000, 934, Bar-Yosef *et al.* 1992, 530-531).

Information on prehistoric plant use can also be obtained by looking at phytoliths contained in the sediments of archaeological sites. Phytoliths are silicate bodies that are part of a plant's tissue; they are resilient to degradation and identifiable up to family level. In Kebara, the analysis of the families of plants that were present in the samples suggests that a major proportion of the plants that were brought into the site were used as fuel. Nevertheless, some of the samples located away from the hearths show that significant quantities of plants were also brought in for purposes unrelated to fire (Albert *et al.* 2000, 946).

In view of the fact that the climate was colder than nowadays for much of the Middle Palaeolithic foraging for plant foods was very marginally attested at most sites located at more northern latitudes. Kebara exemplifies that, given the opportunity, Neanderthals exploited this kind of food resource.

The collecting of small animals has recently started to receive attention in Middle Palaeolithic archaeology. It is thought that the exploitation of small animal biomass led to increased population densities (*e.g.* Kuhn and Stiner 2006, Stiner 2001, Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). Exploitation of small animals rises in importance in the Mediterranean from the late Middle Palaeolithic. At Kebara, many tortoise bones are present in the bone assemblage, accounting for more than 11 percent of the total number of identified bones. Moreover, most of the tortoise bones discovered in the early excavations by Stekelis have not yet been analysed and are therefore not represented in that number (Speth and Tchernov 2002, 472). The species represented at Kebara is the spur-thighed tortoise (*Testudo graeca*), which can be found throughout the Mediterranean. This species exhibits a lot of variation in size throughout its range. In general, eastern populations are considered larger than western populations. The weight of the species is estimated by (Stiner 2005) to be between one and two kg., but they can grow significantly larger according to her. The tortoises found at Kebara were used by humans: they are found mainly in the midden concentration and 7.3 percent of the bones shows signs of burning, which is a higher percentage than that encountered in the ungulate sample (Speth and Tchernov 2002, 473). The burnt bones suggest that they were cooked by placing them belly-up in the fire, since most signs of burning are found on the outside of their carapace, while their limbs and plastron show much less evidence of burning (Speth and Tchernov 2002, 474). The collection of turtles represents another kind of activity than the hunting represented by the large mammals found at the cave. This can be classified as gathering rather than hunting, because, aside from their carapace, tortoises do not have true anti-predator defences (Besides urinating on you if you pick them up). The economic importance of this activity must not be underestimated, since even though it concerns small animals, they were obviously collected in large numbers.

Researchers measured the diameter of the tortoise humeri, which is directly proportional to the weight of the tortoises. From this they concluded that Middle Palaeolithic tortoises were significantly larger than Upper Palaeolithic ones, a trend that has been attributed to overexploitation in the Upper Palaeolithic by Stiner (*e.g.* Stiner *et al.* 1999). Tortoises continue to grow their entire lives; therefore heavy exploitation will be reflected in declining dimensions, since the average lifespan of the animals of the population will decrease. However, part of this trend can be attributed to a deterioration of the climate in this period, which resulted in slower growth (Speth and Tchernov 2002). More interesting is the fact that tortoises also show a decline in dimensions during the midden phase of the Middle Palaeolithic, the period of most intense occupation. Again, climate may be a factor in this decline, but overexploitation is a distinct possibility too (Speth and Tchernov 2002, Speth and Tchernov 2003, 17).

Summing up, this site shows that the subsistence behaviours of Neanderthals were not only geared towards the exploitation of one or two species of large mammals. The site shows the exploitation of a broad range of species. Hunting mammals was complemented with collecting tortoises and plant foods, as shown by charred seeds, fruits and analysis of phytoliths. The combined analysis of central places like Kebara and hunting stations that yield evidence on the exploitation of larger mammals, supplementing the bone assemblages from central places, appears to be productive. We can conclude that in the Levant, Neanderthals exploited a broad range of resources. However, in terms of caloric value, hunting of mammals remains the most significant economic activity.

3.3.6 Broad spectrum revolution, division of labour

The exploitation of tortoises and plants at Kebara brings us to an important issue in the study of Palaeolithic subsistence strategies: whether a division of labour was in place in Middle Palaeolithic foraging. If we accept contemporary hunter/gatherers and hunting chimpanzees as a valid analogy we can assume that Neanderthal women did not in general take part in hunting large mammals. This can be combined with the admittedly scant evidence for different musculature in the arms of Neanderthal men and women as discussed in chapter 2. Based on ethnographic parallels we would expect their activities to be geared towards the harvesting of plants and small animals. However, as discussed in a series of papers by Stiner *et al.* these activities are not well represented in the archaeological record (*e.g.* Kuhn and Stiner 2006, Stiner 2001, Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). In this section I will discuss the available evidence for Neanderthal exploitation of resources other than large mammals. Moreover, some of the taphonomic factors influencing recognition of the exploitation of these resources are discussed.

According to Stiner *et al.* (Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999) the exploitation of small animals rises in importance only in the late Middle Palaeolithic. Moreover, Neanderthals concentrated on slow-moving easy-to-catch prey like tortoises and shellfish. These species reproduce very slowly and their exploitation resulted in a drop in prey sizes. Only AMH in the Upper Palaeolithic concentrate heavily on fast moving prey like birds and small mammals. Since small animals and plants present lower return rates per unit, efficient strategies are needed to make exploiting these resources worthwhile (*e.g.* Stiner 2001, Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). Such activities may have been carried out by AMH women, since they are much less dangerous than hunting ungulates. According to Kuhn and Stiner (2006), Neanderthal women probably did not carry out complementary tasks in the realm subsistence, but assisted the men with the less dangerous activities in the hunting domain.

Although the economic role of these resources may appear negligable, their introduction in the hominin diet may have had far-reaching consequences. Since small animals are present in higher population densities than large animals they represent a large total amount of biomass. Moreover, mammals and birds have high reproductive rates. If AMH were able to exploit these species effectively, this enabled them to increase their population density further and bounce back more rapidly from population crashes than Neanderthals (*e.g.* Stiner 2001, Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). This has been proposed as a reason for the replacement of Neanderthals by AMH by Stiner *et al.* It is a problematic proposition to test, since research has traditionally focused on large mammals. Therefore the full extent of exploitation of small animals by Neanderthals remains unclear.

As argued in chapter 1, this provides an interesting illustration of the changing views of the abilities of hominins. In the 1980s it was thought that hunting large mammals would be beyond the capabilities of Neanderthals and even early AMH (Binford 1984, Binford 1985). Hunting of smaller mammals, like rabbits, was deemed to be important however (*e.g.* Binford 1985, 319). Nowadays the hunting of ungulates is well documented for Neanderthals, but evidence for the capture of small fast-moving prey is thought to be rare in their archaeological record. There are good arguments in favour of the current view, however. First there is the fact that this kind of prey is rarely described in site reports, so it may truly not have been important for Neanderthals. Second, the technology required for the efficient capture of such prey, *e.g.* snares and traps, requires a considerable amount of planning, technical knowledge and investment. Third, indications for hominin exploitation of small prey are usually rare. Often the presence of small mammals in cave deposits can be attributed to the activities of carnivores like lynxes or raptors (Hockett and Haws 2002, Lloveras, Moreno-García, and Nadal 2008).

On the other hand there are indications for Neanderthal interference with fast moving small prey. At Kebara for example, birds are represented in the bone assemblage, but have not been studied with regard to subsistence. They are only used for environmental reconstruction, and bone counts are not given (Bar-Yosef *et al.* 1992, 517). Nevertheless, bird bones have been found in the intensively used central area of the cave. This suggests that the bird remains were deposited in the hearths by hominins. Their relative importance is hard to assess however (Meignen *et al.* 1998, 229). This brings us to a fundamental problem in evaluating this kind of hypothesis. The study of small animal bones, or the lack thereof, shows that post-depositional processes and research interests bias our picture of Neanderthal subsistence activities.

Most of the instances of Neanderthal involvement with other resources than large mammals are from the southern part of the range. This is to be expected, since extant hunter/gatherers in tropical and Mediterranean ecozones rely heavily on vegetable foods (Bar-Yosef 2004, 337). Neanderthals show a preference for diverse environments in the European part of their range. The fact that distances between feeding patches in the Mediterranean are generally smaller than further north may have made it an ideal environment for Neanderthals subsisting on a broader diet (Roebroeks 2003, Stewart 2005). Even though the role of plant foods in the north was in all likelihoodsmall, it must be kept in mind that modern Arctic peoples sometimes use plants quite intensively (Arts and Deeben 1981, 98).

Remains of plant foods are hard to detect archaeologically, since they mostly do not preserve very well. In some cases charred plant remains may provide an indication of plant exploitation. As discussed above, at Kebara charred pea seeds, legumes, acorns and pistachio's are present in samples. Pine nuts have been found at Gorham's cave in Gibraltar (Barton *et al.* 1999, 16). This resource may have been available across a large part of the Neanderthal range, even at higher latitudes. Furthermore, it is known to have been a rich source of calories for historic hunter/gatherers, for example in the Great Basin in the United States (Kelly 2001, 49).

Moreover, plants sometimes produce microfossils like phytoliths and pollen, which do preserve well but linking these to Neanderthal foraging strategies is more complicated. Pollen for example are designed to be transported by the wind, so their presence at sites only tells us that specific plants were available, not that they were actually used by Neanderthals. Phytoliths are part of the fabric of the plant so they are not transported widely. Still, care must be taken, since they can be transported into a site by water action for example (Albert *et al.* 2000). Furthermore, they can only be classified in broad groups and usually not at species level (Madella *et al.* 2002). At Amud, in the Levant, study of phytoliths has enabled researchers to conclude that, as at Kebara, plants were introduced in large quantities for purposes other than to serve as fuel. They were also able to determine some specific groups of plants that were exploited by the Mousterians, namely palm trees and figs. Both of these may have been exploited for their fruits (Madella *et al.* 2002, 712).

As discussed previously, small animals have been divided by Stiner *et al.* in two categories, slow and fast moving prey (*e.g.* Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). The exploitation of slow-moving prey, like tortoises and shellfish, is generally deemed to be within the capabilities of Neanderthals. However, the categorisation of small animals in two categories, fast and slow seems a little too simplistic. For example, one of the resources listed by Stiner *et al.* with the slow moving prey is ostrich (*Struthio camelus*) egg. This resource, may not be very fast-moving itself, yet may be quite dangerous to procure, since the eggs will be defended by the parents. Reptiles are also put in the slow moving category by Stiner *et al.* While this is certainly true for tortoises, some sites also yield evidence for the exploitation of other reptiles, like snakes and legless lizards, which are nowhere near as slow-moving as tortoises. Furthermore it has been proposed that these resources only become important in the later phase of the Middle Palaeolithic. This is not an absolute pattern though. For example, at Hayonim cave in Israel, tortoise and legless lizard (*Ophisaurus apodus*) are well represented in levels dated to MIS 7 (Stiner, Munro, and Surovell 2000, Stiner and Tchernov 1998).

It is striking that a resource like shellfish was rarely exploited, even though Neanderthals were present in coastal or near coastal settings. Heavy exploitation of aquatic resources is often equated with behavioural modernity (*e.g.* Bar-Yosef 2004, 138-139), but shellfish exploitation hardly requires very complex behaviour. In the Middle Palaeolithic, shellfish exploitation is in evidence at sites in the Levant, Italy and Gibraltar (*e.g.* Barton 2000, Stiner *et al.* 1999). The scale on which shellfish were exploited is hard to assess. In Grotta dei Moscerini, shellfish exploitation was practised during ephemeral occupations of the cave (Stiner 1994, 194-196). One episode of shellfish collection at Gibraltar also represents a very short visit to the site (Barton 2000). More recent work at Gibraltar has yielded a diversified faunal assemblage, with molluscs accounting for 17% of the identified faunal assemblage (Stringer *et al.* 2008). This shows that mollusc exploitation was incorporated into the standard suite of hominin foraging practices at this site.

The exploitation of aquatic resources will be underrepresented in the archaeological record, due to the fact that sea-levels were lower than at present for about 75% of the duration of the Neanderthal occupation of Europe (Gamble 1999, 104). Many coastal sites will are therefore submerged nowadays. The relatively small importance of shellfish exploitation may also be caused by the fact that the Mediterranean is not a prolific producer of shellfish (Vita-Finzi and Higgs 1970, 2).

Small, fast moving prey species, like rabbits and birds, were supposedly not heavily exploited in the Middle Palaeolithic. Leporid bones are reported at some sites, however if they are present, the possibility has to be considered that they were brought into the site by other animals, like raptors, or lynxes (*e.g.* Hockett and Haws 2002).

Since Stiner first put the issue of small mammal exploitation on the agenda, some evidence that Neanderthals did not leave this category of prey alone has surfaced. Cut-marked rabbit bones are now in evidence from as early as 1.2 mya at the site of Sima del Elefante in Spain (Blasco 2008, 2839). Comparison of the Terra Amata rabbit sample with assemblages formed by various predators shows that predators did not deposit the Terra Amata assemblage. Furthermore, at least one of the rabbit bones exhibits a cut-mark, pointing to a hominin origin for the assemblage (Valensi and Guennouni 2004). Leporids are present in small quantities in Middle Palaeolithic sites in Italy as well (Stiner, Munro, and Surovell 2000). In Spain, exploitation of leporids is also evidenced at several Middle Palaeolithic sites. Likewise ther rodents were exploited from time to time. Their use may not always be related to subsistence though. For example cut-marks on marmot bones found in Riparo Tagliente seem to point to skinning as the main activity performed by the hominins exploiting them. Therefore exploitation may have been geared primarily towards provisioning themselves with fur instead of food (Thun Hohenstein 2006).

Birds also fall in this prey category. According to Stiner *et al.* they only become important in the Upper Palaeolithic. On the other hand, as illustrated by Kebara above, birds are present at Middle Palaeolithic sites. They are frequently used as environmental indicators and often said to be "present" in site reports. NISP data are usually not given. There are some Middle Palaeolithic sites at which birds have been exploited though. Most of these are located in the Mediterranean. However, cut-marked duck bones have also been found at Salzgitter-Lebenstedt in the north (Gaudzinski, pers. comm). Moreover, swan was exploited at Bolomor cave in Spain (Blasco 2008).

Aside from shellfish, aquatic resources are very rare at Middle Palaeolithic sites. This impression is bolstered by isotopic studies (*e.g.* Richards *et al.* 2001) Most of the known examples of exploitation of aquatic resources date to the late Middle Palaeolithic, but there are hints that aquatic resources were exploited earlier on as well. Terra Amata and the Grotte du Lazaret have yielded fish remains for example. At Terra Amata shellfish have also been recovered (Boone 1976, Desse and Desse 1976). Indications for the exploitation of other marine resources are rare too. At Gibraltar marine mammals like the monk seal (*Monachus monachus*) and dolphins were exploited occasionally (Finlayson and Pacheco 2000, Stringer *et al.* 2008).

Freshwater resources are conspicuously absent from Neanderthal sites. This is doubly surprising, as many open-air sites that have been excavated were located in lacustrine or riverine environments. Some animals associated with these environments were exploited though; at Taubach for example cut-marked beaver bones were found (Bratlund 1999). At a few sites, such as the Grotte Vaufrey and the site of Orgnac, large quantities of freshwater fish have been found: (Desse and Desse 1976, Le Gall 1988). At the site of Koudaro I in the Caucasus tens of thousands of salmon bones (*Salmo strutta labrax*) were found. According to the researchers, bears are unlikely to have been the accumulating agent, since they usually eat their prey at the spot where they catch it, and do not transport it (Liobine 2002, 48).

In general, it seems that exploitation of small fast moving prey was indeed rare in the Middle Palaeolithic. However, there are factors that influence our view of this category of subsistence behaviour. First, as pointed out earlier, our research focus seems to centre on the more spectacular, larger prey categories. Second, proving the exploitation of these small species may be more difficult than that of large mammals. Most importantly, their bones are much smaller, which may influence the chances of recovery, especially in older excavations where sieving was not practised regularly. Third, ethnography shows that small animals tend to be subjected to much less processing than larger animals. Usually they are simply eaten whole (*e.g.* Fernandez-Jalvo, Andrews, and Denys 1999). This is supported by the presence of human gnawing marks on rabbit and bird bones at Gorham's cave in Gibraltar (Stringer *et al.* 2008). Finally, non-mammals have a different bone structure that may influence traces of exploitation. Bird bone for example only rarely preserves cut-marks, which is attributed by some to its brittle nature, causing it to break often, rather than exhibit surface modifications (Livingston 2001, 286).

The case of aquatic resources is even more problematic. As pointed out, for 90% of the time, sea levels were lower than they are today and many coastal sites will be submerged. Furthermore, there is a preservation bias against fish bones. They are less dense and therefore more prone to destruction by geological processes. Apparently, fish bones are not present or underrepresented even when the preservation of bone from other taxa is good (*e.g.* Whitbridge 2001, 19). Moreover, some species of fish store fat in their vertebrae, causing the bone to be dissolved by the release of the fatty acids after the fish has died. This problem is particularly serious in fish like salmon and eel, which will therefore be strongly underrepresented in the archaeological record (*e.g.* Beerenhout 2001, 252).

3.3.7 Summary and conclusion

The archaeological picture of Neanderthal subsistence strategies is still far from clear. However, research conducted in the last decades has provided much new and interesting evidence on Neanderthal interactions with animal species. The suggestion that Neanderthals were obligate scavengers has been refuted for the sites where evidence for this strategy was once perceived. An even more powerful refutation of this hypothesis is provided by the ever increasing number of sites where Neanderthal foraging efforts were concentrated on prime aged individuals of a single species. Opportunism cannot explain this behaviour. Neanderthals apparently planned their foraging efforts well, which resulted in their obtaining the most rewarding prey available and in many cases many individuals of this prey. Evidence for planned behaviour is also provided by the fact that Neanderthals often chose strategic locations for this kind of hunting, as exemplified by Salzgitter and Zwoleń and La Cotte de Saint-Brelade. The evidence for this pattern of activity is spread over a large area and at least indubitable for the later part of the Middle Pleistocene. The site of Schöningen suggests that if more early sites with excellent preservation conditions are excavated, the evidence for specialised hunting may be extended further back in time.

Exploitation of megafauna is also in evidence. However, the focus on prime-aged individuals is less clear in this category of prey and a site like Gröbern may represent a scavenging episode. At Lehringen, an old individual was exploited, while in Taubach of hunting focussed on young rhinoceros. On the other hand, sites like Biache-Saint-Vaast do provide evidence for hunting of prime-aged individuals. An obvious explanation for the fact that focus is not merely on prime-aged prey in this category is the fact that these very large animals are also very dangerous. Furthermore, since even young and old individuals still represent a lot of food, return rates will be high regardless of the exploited age-category. Moreover, Lehringen and Gröbern are dated to the Eemian. In this climatic optimum with dispersed resources an encounter strategy could be practised. Since locationsof these animals could be much less accurately predicted than those of herd animals on the mammoth steppe, that probably followed reasonably fixed migration routes, chance encounters may have determined prey choice. If valuable prey was encountered, it was exploited, since continuing tracking might not result in an encounter with better prey.

Site function also plays a role in our perception of Neanderthal subsistence strategies. This was illustrated by comparing kill sites to sites that may have functioned as a central place. Here we see that in places Neanderthal subsistence strategies were more varied than we would have anticipated only on the basis of sites providing evidence for specialised hunting. In many cases the range of exploited species is best represented at the central places. On the other hand, transport decisions influenced the representation of different prey categories. At this kind of site, there is evidence for activities that we would not see at large mammal exploitation sites, such as the exploitation of plants and small animals for example.

The exploitation of small animals may not have been very significant, as exploiting larger prey would be economically more rewarding. As discussed, the extension of subsistence strategies to also encompass this prey category has been the subject of a series of recent papers, mostly by Stiner *et al.* (Stiner 2001, Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). It is thought that the ability to effectively exploit small prey may have been a fallback strategy that was employed when other prey was overexploited. It enabled populations to live at higher population densities and may also have enabled them to recover more speedily from population crashes. Ultimately this practice may have played a role in the replacement of Neanderthals by AMH.

The archaeological record shows that while Neanderthals exploited small prey, this was not a very common activity. Mostly they focused on slow-moving species, which are easy to exploit. However, there are indications for the exploitation of fast moving mammals, birds and maybe even fish. Moreover, the archaeological recovery methods are arguably very biased toward larger animals. Additionally, bias against some non-mammal groups like fish and birds may be even stronger because their bone does not preserve as well. Finally, the scarcity of evidence for exploitation of these species does not enable us to draw many conclusions as to the importance of this kind of behaviour in Neanderthal foraging strategies. However, it does show that these activities were not necessarily beyond the capabilities of Neanderthals.

3.4 Material culture

In addition to bone assemblages, material culture may also be helpful in the study of subsistence strategies. The earliest known stone artefacts from Gona in Ethiopia, dated to 2.6 mya are associated with cut-marked bones, suggesting a close association between the use of stone tools and the consumption of animal tissue from the inception of stone tool use (*e.g.* Domínguez-Rodrigo *et al.* 2005). In this section, emphasis will be on stone artefacts, because they are the most abundant category of finds in the archaeological record. We must keep in mind however, that stone tools represent only a part of the tool spectrum in known ethnographic cases and that these tools function as part of a larger technological repertoire, which in the case of the Middle Palaeolithic, has unfortunately not been preserved as well as the stone component.

Material culture is used in two important domains of subsistence behaviour. First, weapons are used in the acquisition of food items. Second, material culture may play a crucial part in processing food items. Using material culture in processing resources can substantially lower their handling costs and even make available resources whose exploitation would otherwise not be feasible. An obvious example of this is the use of stone tools to get at bone marrow, a practice which may have conferred significant advantages on hominins from the Plio-Pleistocene onwards (Blumenschine 1987). Large amounts of artefacts in Middle Palaeolithic assemblages, like many flakes, scrapers, bifaces and so on, appear to have been used in processing activities. Most of the tooltypes that we encounter appear to have been geared primarily towards processing resources animals and not capturing them (Kuhn 1998, 217).

Tools used in the procurement of animals may be hard to distinguish in the Middle Palaeolithic. Yet, an important contrast between hominins and carnivores is the fact that hominins have no natural weapons to aid them in the capture of animals. Hominins lack the big claws and teeth, and also the ability to attain the high speeds that predators reach when capturing animals (*e.g.* Webb 1989). Therefore, material culture must compensate for the lack of natural “weapons”. In this chapter, I will first delve into the evidence we have for the use of hunting weapons during the Middle Palaeolithic. This will be followed by a discussion on the functions tools had in processing food.

The Middle Palaeolithic is traditionally defined by the use of the Levallois technique in stone tool production. This denotes a specific technique of core reduction, which enabled the knapper to accurately control the form of the product he was knapping. Levallois flakes, blades or points could then be further shaped into specific tool types. This does not mean that the Levallois technique was universally used during the Middle Palaeolithic. It is present at many, but by no means all, Middle Palaeolithic sites, and the relative importance of Levallois products within assemblages varies tremendously. Assemblages of a Lower Palaeolithic (Mode I) character were still produced during this period as well (*e.g.* Stringer and Gamble 1993, 150).

The range of tooltypes that is known from Middle Palaeolithic sites is small compared to later periods (Stringer and Gamble 1993). Moreover, guide fossils clustering in a limited area or time period are largely absent. Many tooltypes are used over large parts of Eurasia for hundreds of thousands of years with no visible development towards newer, more “advanced” types (Gamble *et al.* 2004, 210). Variability between assemblages is based on the percentages of different techniques that are being used in their production and different ratios of the tooltypes. Many explanations for the general character of Middle Palaeolithic stone tool assemblages have been proposed. The variability is attributed to the many considerations that may have played a role in Neanderthal tool production, like economic considerations about raw material use and tool curation.

The fact that Neanderthals made a small range of tooltypes suggests that their technical capabilities were not very great. This is not necessarily true though. Comparison of standardization of Levantine Mousterian (dated to 200 ka, so presumably not produced by AMH) and Upper Palaeolithic burins shows that Upper Palaeolithic toolforms are no more standardised. Therefore, one can conclude that Neanderthals were as good at imposing a form on their raw materials as AMH's (Marks, Hietala, and Williams 2001, 26).

Moreover during the latest stage of Neanderthal existence some interesting patterns occur when one regards the assemblages they produced. In some parts of their range Neanderthals continued to produce Mousterian assemblages, on the Iberian Peninsula for example. In other parts of their range, "transitional industries" have been excavated. These industries were initially labelled Upper Palaeolithic and it was assumed that they were produced by AMH groups. More recently, researchers have proposed the possibility that they were produced by Neanderthals. Most of these industries are not associated with taxonomically identifiable fossils. The Châtelperronian, a blade-based industry from France, has however yielded Neanderthal fossils (Hublin *et al.* 1996, Mercier *et al.* 1991). Similarly, a Neanderthal molar has been found in Greece, associated with an "Initial Upper Palaeolithic" industry (Harvati, Panagopoulou, and Karkanas 2003). There are other similar industries, like the Ulluzzian in Italy and the Szeletian and Bohunician in Central Europe that are sometimes tentatively associated with Neanderthals, even though no diagnostic fossils have yet been found in association. These findings suggest that Neanderthals were capable of behaviour that we would more readily associate with AMH.

Here I will go into Middle Palaeolithic artefacts as constituting a relatively uniform group, even though there is a lot of variation in the composition of assemblages. It is important to keep in mind that some of the variation may be caused by the different functions for which the assemblages were used. The dominant toolforms of most Middle Palaeolithic assemblages are different forms of side-scrapers. Furthermore, denticulates are ubiquitous, other forms present include bifaces, points and Levallois products that may also be modified (*e.g.* Stringer and Gamble 1993, 151).

Studying methods of subsistence through the material culture used in subsistence strategies can be problematic for several reasons. First, we do not know the function of many toolforms. Therefore we cannot measure the importance of different subsistence strategies, by looking at how ubiquitous the different tools used for these strategies were. Since the range of tooltypes was small, we can assume that most tools were used in a very versatile way for a number of different activities. This may be the result of considerations to do with the system of mobility that was practised. If residential moves were frequent we would expect the weight of the transported toolkit to be minimised. Furthermore, specialization of tool production may also be related to the economic importance of the activity for which the specialised tool will be used. If the activity is very important and will take place at a predictable time than tools may tend to be "overdesigned" in order to minimize the chance of failure of the technology. For less important or less predictable tasks it is often not worth the investment to produce overdesigned tools and more versatile tools may be used for the occasion (Bleed 1986).

Interestingly, a correlation between the degree of technological specialization exhibited by groups and the latitude at which they live has been observed ethnographically. Apparently groups are more specialised in more northern latitudes, while more generalised technologies are usually seen closer to the equator (Henrich 2004, 207). Middle Palaeolithic sites do not exhibit such a gradient. This may be due to low population densities which resulted in a small pool of people from which to learn technological skills. Simpler skills may be copied more faithfully in these situations (Henrich 2004). The development of complicated technologies may have been hindered in Middle Palaeolithic societies, which probably consisted of small groups, living in low population densities.

There are a few tool categories that were used as weapons. One very early candidate are the Oldowan manuports. These seem to cluster around certain weights, which would maximize their potential as thrown objects, suggesting a use as primitive projectile (Cannel 2002). A similar use has been proposed for spheroids and subspheroids found in the Olduvai Gorge, whose dimensions are a bit smaller than those of throwing stones known ethnographically. This is to be expected, since the body size of the Oldowan hominins was smaller than the body size of modern humans (Isaac 1987, 13) These implements are well-known from Oldowan times, but they persist up until final Mousterian times in Africa, Europe and the Near East and apparently the dimensions of later spheroids are more like those of the ethnographically known throwing stones (Isaac 1987, 13, Lorblanchet 1999, 117).

However, thrown stones are not the kind of weapon we would expect to be wielded when practising specialised hunting of prime-aged ungulates and megafauna. More advanced kinds of weapons have been found in the archaeological record though. The earliest possible example of spear use is a putative impact mark of a projectile found on a horse scapula at the 500 ka site of Boxgrove in England (Roberts 1999, 378). More famous are the eight wooden throwing spears found at Schöningen, dated between 300 and 400 ka (Thieme 1997). Another example, already mentioned, is the wooden lance found with the carcass of an elephant at Lehringen, dated to the last interglacial (Thieme and Veil 1985). Unfortunately, wood is rarely preserved, so we do not know how ubiquitous these weapons were. Nevertheless, the Schöningen spears appear to have been well-balanced throwing weapons (Rieder 2003). Therefore, their producers were probably experienced in their manufacture.

In addition to rare finds of wooden objects, stone tools may have functioned as weapons. It has been hypothesised that Levallois points were used as spear points. These suspicions were confirmed when in Syria, a part of a Levallois point was found embedded in a vertebra of a wild ass. This find is dated as older than 50 ka and is believed to represent Neanderthal behaviour (Boëda *et al.* 1999). On the basis of kinetic tests it is impossible to distinguish whether this was the result of a thrusted or a thrown weapon, but since the point entered by a parabolic trajectory it is suggested that the weapon must have been thrown. The finding of the Levallois point in an animal bone is a promising discovery, since this is a stone projectile point that we can recover archaeologically. However, Levallois points cannot be seen as projectile points *pur sang*. They were apparently used for a wide variety of purposes. Many points show traces of wear related to butchering, or even working plant foods, suggesting that these items could have a variety of functions (Meignen *et al.* 1998, 234-236, Plisson and Beyries 1998, 7).

Tools classified as points are rare in the European Middle Palaeolithic (*e.g.* Villa and Lenoir 2006). Comparison with African Middle Stone Age assemblages suggests that this may be partly due to the system of classification used in Europe. This system results in many pointed forms being classified as scrapers. Especially the category "convergent scrapers" contains many forms that could very well have functioned as points (Villa and Lenoir 2006, 91-92). Research on these tools from the Near East shows that some of them may have been used as points. At Grotta Breuil in Italy, convergent scrapers were described as showing traces of piercing activities near the point (*e.g.* Lemorini 1992). Moreover, the dimensions of some of these scrapers, together with those of some Levallois points fall within the range of dimensions of ethnographically known points of thrusting spears (Shea 2006, Villa and Lenoir 2006). Therefore, ethnographic data suggests a use as points for thrusting spears.

Furthermore, experimental work and work on paleoindian kill-sites has led to the identification of features that may help in identifying points that were used as weapons. First, bulbar thinning to prepare the point for hafting was often observed. More importantly, damage concurrent with projectile use on pointed forms has been analysed. This takes the form of step-fractures, burin-like fractures and spin-off fractures at the tip of the point (Villa and Lenoir 2006, 112-113). This kind of damage has been observed on Levallois points from sites in the Levant, and more recently in southwestern France and Italy (*e.g.* Hardy *et al.* 2001, Meignen *et al.* 1998, Villa *et al.* 2009, Villa and Lenoir 2006, Shea, 1995 #253).

We know that hafting was practised by Neanderthals, for use-wear analysis that has revealed traces of hafting on stone tools (*e.g.* Hardy *et al.* 2001). More spectacularly, at the German site of Königsaue, two pieces of birch pitch have been unearthed. One of these pieces, probably dating to MIS 5a, exhibits a hominin fingerprint as well as the impression of a flint blade on one end and impressions of wood cells on the other hand, indicating its use as hafting material (Koller, Baumer, and Mania 2001, 386-388). A very recent find are flakes still covered in the tar that was used to haft them, which were discovered scattered between the remains of an 18-19 year old elephant in Italy, dated before MIS 6 (Mazza *et al.* 2006).

The importance of the use as projectiles of convergent scrapers and Levallois points is a subject of discussion. In some cases Levallois points were simply the preferred end-products of stone working and that form does not necessarily indicate their use as spear points. Some researchers think that the use of pointed forms as spear points was so rare as to be negligible (*e.g.* Plisson and Beyries 1998). There are some factors that prompt rethinking this point of view. At Kebara, for example, 35% of the points in the assemblage showed evidence for hafting, suggesting that this function may not have been very rare after all (Bar-Yosef *et al.* 1992). Furthermore the absence of characteristic impact damage does not mean that points were not used as missiles. Experiments have shown that when aimed well, and provided no bone is hit, points will not be damaged. Furthermore, if points are damaged, repairs can be made whereby the damage is removed (Frison 1989). Furthermore, use-wear analysis only shows the last activity that was performed. Ethnographically, examples are known where spearheads are used to butcher prey (Shea 1993). This would lead to a butchering wear (which is common at some sites), while the tool was also used as projectile to procure the animal. This does not solve the problem, however, especially since it cannot explain traces of wood-working on these types. We know that points were sometimes used as weapons, but not always.

Most tools that we know from the Middle Palaeolithic were probably used for processing rather than hunting. However, we do not know the exact activities for which most tools were used. Use-wear studies have been used to gain insight in this, although they generally only differentiate between very broad categories of use. Use-wear studies are sometimes combined with residue analysis; a technique that tries to identify ancient residues on a tool's working edges. This combination may lead to more specific results. Residue analysis only works on tools deposited under very specific conditions. In most environments, residues will deteriorate quickly (Langejans 2006). Such studies were applied to some Middle Palaeolithic sites. They have revealed that the stone tools have been used for a wide range of activities and the processing of many different materials (*e.g.* Beyries 1988, Gijn 1992, Hardy 2004, Hardy *et al.* 2001, Lemorini 1992, Meignen *et al.* 1998, Plisson and Beyries 1998). There is much evidence for wood-working, not only in warm Mediterranean climes, but also at northern sites like Biache-Saint-Vaast (Beyries 1988). Siliceous plants were also worked at some sites (Hardy 2004). Furthermore, there is abundant evidence at many sites for involvement with animal matter, be it bone, meat or hide (*e.g.* Beyries 1988, Gijn 1992, Meignen *et al.* 1998).

An important problem with regard to both use-wear and residue analysis is the fact that post-depositional processes can produce results that mimic traces of use. For instance, "wood-working" polish is also created by friction with wet sediments, not only by processes that leave stratigraphic traces like cryoturbation, but also by minute movements in the matrix (*e.g.* Levi-Sala 1986). Residues on stone tools are assumed to be the precipitate of the prehistoric activities for which they were used. This is not always the case however, they may be modern contaminants. Furthermore, not all contaminants need be modern, they are also present in the sediment and these may also end up on stone implements during deposition (Langejans 2006, Langejans 2007).

The reliability of use-wear and residue studies can be improved when a number of criteria are met. For example, it is important to break down residues on stone tools by location. Residues that could be interpreted as being the result of hafting would need to be located at the base of a stone tool for example. Residues related to tool-use should be located near the edges of the tool. Furthermore, the fact that a residue was related to the use of a tool becomes more probable if there are multiple similar residues on the tool. Single residues can easily be the result of contamination. If multiple, similar traces are present, the likelihood of them being related to the use of the tool increases (*e.g.* Lombard 2005). Moreover, in cases where use-wear and residue analyses were performed independently of one another on the same tools, the results of the analyses tended to corroborate each other (*e.g.* Hardy *et al.* 2001, 10973-10974).

In most cases, plant residues preserve better than animal residues. The importance of plant working may thus be exaggerated in residue-studies (Lombard and Wadley 2007, 161-162). Seeing that plant materials are virtually absent in the rest of the archaeological record, the identification of plant residues on Middle Palaeolithic stone tools still is invaluable. For example, at Starosele in Crimea, 31 artefacts were analysed and plant residue was found on 21 of them (Hardy *et al.* 2001, 10974). This may also indicate that, although sedimentary action can mimic use-wear traces of plant and woodworking, some of these traces do reflect past activities. Use of stone tools on soft plant materials may point to processing of foodstuffs. However, these plants may also have been used as fuel, or for other purposes, such as the construction of shelter and bedding (Hardy 2004, Madella *et al.* 2002). Grinding stones have only been reported in a few rare cases, like at Kebara (Bar-Yosef *et al.* 1992, 531). Therefore, there are only a few indications for the consumption of plant foods through Middle Palaeolithic material culture.

As mentioned, woodworking is attested often by use-wear studies. This may point to the collection of firewood, but, probably also to the use of stone tools to shape wooden tools. The manufacture of a wooden spear is considered to be much more time consuming than manufacturing a stone tip for example (Villa and Lenoir 2006, 106). Tools were frequently used for woodworking are *encoches* and denticulates (*e.g.* Lemorini 1992, 21-22). One could also envisage these tools being used when polishing spear shafts.

With regard to the processing of animal materials, some results of residue analyses are very spectacular. At La Quina, blood residue was found on a stone tool. DNA analysis was performed on this blood and apparently the DNA showed that the blood belonged to wild boar (Hardy 2004, 560). More blood and mammal hair was found on other stone tools, as was one feather fragment of a falconiform bird (Hardy 2004, 555). At sites in Crimea, feather residues of falconiform and anseriform birds in addition to blood residues were found on points that also exhibited traces of hafting. (Hardy *et al.* 2001). These findings are extremely germane to the study of subsistence, especially in view of the debate surrounding the Middle Palaeolithic exploitation of small animals.

Traces of for example hide-working are very interesting for the study of subsistence, since they point to the exploitation of resources from animals other than meat. However, tools for making clothes, like awls and needles, are absent in the Neanderthal archaeological repertoire. With regard to processing animals, use-wear studies usually point to cutting meat, while other traces of wear are sometimes present but not very common (*e.g.* Kuhn and Stiner 2006, 958). On the other hand, as argued in chapter 2, Neanderthals must have been able to insulate themselves somewhat. Skinning marks found on marmots in Italy and bears at Biache-Saint-Vaast, mentioned earlier provide additional evidence for the exploitation of animals because of their fur.

The impact of these artefacts and their implementation in on foraging strategies is difficult to determine. Without stone tools certain foodstuffs would be unavailable to hominins, as in the case of bone marrow. Another resource presenting similar problems may have been tortoises; by using tools, their armour could be defeated, an innovation that probably dates to Oldowan times (*e.g.* Roche *et al.* 1999, Sept 1992). Using tools in order to fillet animal prey was likely an important activity. Technology that enabled better processing in the field, which in turn made exploiting larger prey more efficient by significantly reducing transport costs, would be crucial during the evolution of hominin hunting strategies (*e.g.* Rabinovich and Hovers 2004).

Another category of material that has often been preserved and might have been used as a raw material for artefacts is bone. Bone tools are usually considered as part of the Upper Palaeolithic repertoire, but in the Middle Palaeolithic they were used as well, albeit much less intensively. At many sites bones were used as *retouchoirs* and anvils for flaking purposes (Moncel *et al.* 2004, 279). More formal tools were sometimes also made out of bone. At Salzgitter-Lebenstedt for example, around 30 bone daggers were fashioned out of mammoth ribs and fibulae. Furthermore, a well-made bone point was found at the site (Gaudzinski 1999, Gaudzinski and Roebroeks 2000). In some cases bone was used in a similar way as stone. In Italy for example bifaces have been found, flaked on elephant bone (Gaudzinski 1999, 216). Tools were made from bone but not very commonly.

Furthermore bone was sometimes also used as a combustible. This is not necessarily due to of a shortage of wood, but because bone has different burning properties. Where wood gives a quick burst, bone can simmer for hours (Moncel *et al.* 2004, 279). In the colder periods wood may have been very scarce in Northern Europe. In this situation bone's suitability as fuel may have increased its value for human use and therefore given large animal resources added value. However, bone needs a lot of heat to ignite it in the first place, so just bone will not have been sufficient for Neanderthals when building a fire. Quite large quantities of other material would have been required in order to get the fire started (White 2006, 561-562).

In conclusion, the biggest problem in analysing Middle Palaeolithic stone tools is the fact that no clear link between specific tool types and specific functions can be demonstrated (*e.g.* Bisson 2001, 166). As mentioned earlier, points, that to us seem suited to use as projectiles sometimes show use-wear indicating use in different domains, such as wood-working. This variability of tool use and the uniformity of the stone tools throughout the Middle Palaeolithic have led researchers to posit that tools were used for generalised tasks (Bisson 2001, 166-167). Tools made from other materials are relatively rare, so we do not know exactly how organic materials complemented the Middle Palaeolithic toolkit. The abundance of wood-working residue and wear traces, combined with the well crafted wooden spears from Schöningen do suggest that organic materials were an important part of Middle Palaeolithic culture.

3.5 Other aspects of Neanderthal archaeology

We have now dealt with the two main categories of remains that are found at Neanderthal sites, namely bones and (stone) tools. In this section I will discuss some other aspects of their archaeological record that have not been breached yet. I will briefly touch upon the issues of site architecture and upon some evidence of surprising "high-tech" behaviour found in the Middle Palaeolithic.

Investment in site architecture, especially in northwestern Europe, was minimal. If one is planning to stay at a place for a short period of time, less investment will be put into it; therefore this rarity is at least partly related to the organisation of Neanderthal mobility. At present, there are a few circular stone configurations known from the late Middle Palaeolithic. These are by no means elaborate huts, just small stone circles, or maybe windbreaks (Kolen 1999). Shelter was apparently sought in abris and caves, but in the absence of natural features, it was only very rarely constructed in a way that is visible archaeologically. Shelter in caves may have been quite important for Neanderthals though, for example as a safe haven when giving birth (Mussi 1999, 64-65).

The most common elements of "architecture" at a site in the Middle Palaeolithic are hearths and ash lenses signifying fireplaces. At some sites, there is evidence for differentiation among these. One such example is Abric Romani in Spain. At this site, different kinds of fire features have been identified. For example, there are flat hearths and pit hearths that were constructed in natural depressions. These hearths are believed to have fulfilled different functions. In some cases stones were found in hearths that are believed to be the result of human activities, and may have been used for heat-banking (Vaquero *et al.* 2001). In one case, surviving wood casts in the travertine sediments of the cave enabled the reconstruction of a tripod over a hearth (Vallverdú *et al.* 2005, 168-169). This feature, in combination with cut-marks on bones suggesting the cutting of long strips of meat, has been taken by the authors as a strong indication that meat was dried there (Vaquero *et al.* 2001, 168-169). In Grotte XVI in France smoking of fish has been proposed as function of hearths, since they were in part fuelled with lichen (Wong 2000). At other sites, hearths were used to roast vegetable resources, as mentioned for Kebara and Gorham's cave. In Douara in Syria a hearth with a diameter of 5 metres has been found, containing hackleberry fruits and large quantities of charred plums (Bar-Yosef 1995, McLaren 1998). In the Near East stones do not seem to have been used for cooking and or providing warmth. However, as mentioned above at Abric Romani stones do occur in hearths, therefore this is not an absolute pattern. At many sites burnt bones occur, so cooking of meat was probably also routinely practised.

In addition to providing fire to cook or conserve foodstuffs, another function of hearths is simply to provide warmth. In this regard it is peculiar that hearths or ash lenses are uncommon at Middle Palaeolithic sites. This is even the case at open-air sites in northern France that were occupied during the early part of the last glacial (*e.g.* Locht 2005). This shows that Neanderthal cold-adaptation may really have been critical to their survival, but also suggests that Neanderthals really were capable of providing good insulation (cf. Aiello and Wheeler 2003), even though there is not very much evidence for it. Still, there is good evidence for the exploitation of animals for their fur, as discussed in sections 3.3.6 and 3.4 (Auguste 1995a, Thun Hohenstein 2006).

"High-tech" behaviour seems to be represented by the production of birch pitch for the hafting of stone artefacts. This was already practised before 250 ka (Mazza *et al.* 2006). It requires very precise control of the fire's temperature, which needs to be between 340 and 400 °C for prolonged periods of time. If the necessary heat is not generated, no pitch is produced, but should temperatures rise above 400 °C the tar will be destroyed by charring (Koller, Baumer, and Mania 2001, 393). This points to the fact that, even though most fireplaces show up archaeologically as lenses of ash, Neanderthals were very capable of managing the fire they produced.

In addition to "high-tech" behaviour there is another category of behaviour that is proposed to be characteristic of our own species. This is ritual behaviour, seen as one of the few things that sets *Homo sapiens sapiens* apart from other animals. There is not much to suggest ritual behaviour in the Neanderthal archaeological record. Figurative art is absent for example. On the other hand, there is some evidence for behaviour that we would identify as ritual in modern humans. For example, Neanderthals buried at least some of their dead. However, analysis of the mortality profiles of a large sample of Neanderthals suggests that they practised "differential age related burial" (Trinkaus 1995, 139). In other words, some classes of individuals were more likely to be buried than others. Furthermore, personal ornamentation in the form of beads has been reported at a number of Châtelperronian sites (Zilhão 2007, 24-27). Since the stratigraphic provenance of these ornaments is unclear and they were recovered in old excavations, their attribution to the Châtelperronian is not certain though (*e.g.* Roebroeks 2008, 923).

3.6 Summary and Conclusion

In conclusion, it is safe to say that our best source of information regarding Neanderthal subsistence strategies are the bone assemblages found at their sites. Spears, like those from Schöningen and Lehringen show us that they hunted, but these artefacts are very rare. Stone tools are to some degree enigmatic. They obviously played a central part in Neanderthal lifeways (*e.g.* Kuhn 1998), but many of them were not used in the procurement of the food. Points are an exception, since they do seem to have been used as tips of hunting weapons (Boëda *et al.* 1999, Hardy *et al.* 2001, Villa and Lenoir 2006). This was not their only function however, since they sometimes exhibit use-wear related to other activities, like butchery, or even woodworking (Beyries 1988, Meignen *et al.* 1998). Implementing stone tools in the processing of food will have made exploitation of animal resources much more efficient. Their exact effect on foraging strategies is hard to estimate, however.

The use-wear and residues pointing to plant-related activities of course form a welcome extension of the knowledge about these activities that we had gathered through the discovery of wooden spears and at some sites, like Kebara and caves on Gibraltar, the recovery of roasted seeds and peas. The problem with this line of evidence is that use-wear and residue studies are not infallible. Sedimentary movements can produce gloss similar to that of for example woodworking. Furthermore residues can also result from contamination and there seems to be a preservation bias towards plant residues over animal residues.

The main problem regarding the study of stone tools for subsistence purposes is the fact that there does not seem to be a clear relationship between toolform and –function. Most studies of stone tool types show that similar tools have very diverse types of wear; they are thus not specifically geared towards a single activity. This versatility in tool function may be related to the mobile way of life practised by Neanderthals. When mobility is high, minimising the weight of transported tools becomes an important consideration. This is seen ethnographically, where high degrees of residential mobility correlate with less variable toolkits (Bleed 1986, Shott 1986). On the other hand, ethnographically there is also a correlation between latitude and toolkit variability, with variability increasing with latitude (Blades 2001, 11, Henrich 2004). This correlation seems not to apply to Neanderthal toolkits, which do not appear more variable in the more northern parts of their range and seem generalised compared to modern human toolkits. This may be attributed to the fact that Neanderthals may not have been very logistically mobile, because of the high cost of locomotion they faced. In contrast, most modern human hunter/gatherers living in temperate and cold climates are logistically mobile.

Stone artefacts were part of a larger toolkit, which included tools made from organic materials. These are of course rarely recovered, but provide clues of good technical capabilities. The hafting of stone tools using birch tar is one example, as are the wooden spears found at Schöningen and Lehringen another. Since the manufacture of wooden tools like spears may have been much more time-consuming than the manufacture of stone artefacts (*e.g.* Villa and Lenoir 2006), we must keep in mind the possibility that we are seeing only part of the Neanderthal toolkit. The stone tools may have functioned as expedient, easily replaceable components of the toolkit in which relatively little energy was invested. The wooden component may have been very important with regard to Neanderthal activities and may even have been more extensive than the stone component of the toolkit.

As discussed, at most sites, the absolute majority of stone tools were made of raw materials that can be found within 6 kilometres of the site. This may reflect the inhabitants' foraging radius (sensu Binford 1982). A small proportion, usually not more than 20%, of the tools are made of raw materials from farther afield. These may reflect tools that were produced while staying at a previous central place and that were taken along when a residential move took place. The very small number of tools that are made of raw materials from further afield may be tools that were part of a person's personal gear and "survived" several residential moves (Kuhn 1995, Roebroeks, Kolen, and Rensink 1988). It has been suggested that Levallois points would be especially suited to be part of the personal gear, since they provide a maximum amount of cutting-edge and are therefore well-equipped to deal with a host of unforeseen circumstances (Wallace and Shea 2006).

The finished tools transported over large distances may thus show us the size of the total area that was used by a group. In Western Europe maximum distances only rarely exceeded 100 kilometres (Féblot-Augustins 1993, Féblot-Augustins 1997, Roebroeks, Kolen, and Rensink 1988). However, recently distances of over 250 kilometres were recorded for a site in France (Slimak and Giraud 2007). In Central Europe the maximum recorded transport distance is up to 300 kilometres (Féblot-Augustins 1993, Féblot-Augustins 1997). These distances are greater than the maximum migration distances known ethnographically, which are no more than 200 kilometres (*e.g.* Arts and Deeben 1981, Féblot-Augustins 1993). This may indicate that a Neanderthal band needed a larger territory to subsist on than AMH groups.

The very versatile stone artefact evidence in the archaeological record can be combined with the faunal (and to a much lesser degree floral) remains present at archaeological sites. The faunal remains, as we have seen, suggest sophisticated exploitation of the largest animals around. Prime-aged hunting is in evidence for ungulates throughout the Neanderthal range and to a lesser degree also for megafauna. Evidence for the exploitation of smaller prey is rare in most cases. In the south, slow-moving prey is quite heavily exploited at some sites and fast-moving prey is present at some sites. Post-depositional processes may have influenced the evidence for these activities. However, compared with the large faunal remains present at sites, the economic importance of these activities cannot have been very significant.

We can conclude that Neanderthals were top-carnivores, living in rich environments for the largest part of their existence. Their sites are usually located in the more bountiful parts of the environment (Stewart 2004, Stewart 2005). Furthermore, it has been posited that the Mediterranean environment may have been more suitable for Neanderthals than the more northern parts of the European continent, because its environment is richer and more diverse (*e.g.* Roebroeks 2003). This may be supported by the observation that sites in the southern part of the Neanderthal range, in general yield more finds than those located more to the North (Gamble 1999, 201-205). Together with the heavy reliance on local raw materials, reviewed above, these factors suggest that Neanderthal land-use focused heavily on “magnet-locations” in the landscape. This kind of land-use pattern has been proposed by Binford for Middle Stone Age AMH in Africa (Binford 1984). He saw this kind of behaviour as reflecting hominins with little foresight, whose movement would be tethered to locations where there was a stable supply of the resources they needed (Binford 1984, 262).

Such a focus on magnet-locations becomes very understandable, once we take into account the fact that Neanderthals had to deal with locomotion that was energetically expensive, as mentioned in chapter 2 (Steudel-Numbers and Tilkens 2004). Their foraging radius would have been smaller and therefore the areas around their sites would have been depleted faster than is the case for modern human hunter/gatherers. The consequences of dealing with a smaller foraging radius become more severe since Neanderthal energetic demands were likely higher than those of AMH’s (Sorensen and Leonard 2001, Steegman, Cerny, and Holliday 2002). Therefore it would have been important to minimise the amount of mobility that was practised and maximise the returns they got from the landscape by inhabiting its most productive parts. This strategy seems to have been successful considering the stable use of locations for sometimes thousands of years, as suggested by sites like Mauran, La Borde, Biache-Saint-Vaast, Kebara and others (*e.g.* Roebroeks and Tuffreau 1999, 129). In the south we know many sites, often in caves and abris that may have functioned as home bases. In the north, there are more open-air sites. Some of these were revisited often; others however, show evidence for only short occupations. Most of these sites are quite low-density scatters and structures, like hearths are rare , at these kinds of sites (*e.g.* Locht 2005, 34-35). This shows that not all sites were fixed points in a yearly round that was faithfully adhered to for thousands of years. However, some sites were definitely stable points in the yearly moves.

“Pull factors” for Neanderthals may have included shelter in the case of many abris and caves and animal resources in the case of many revisited open-air sites. This picture is of course coloured by biases. Sites in caves preserve better and archaeologists often look preferentially for cave sites for example. On the other hand, the fact that many open-air sites are low-density accumulations, showing little investment in structures like hearths may support this view. Other factors may be harder to determine in archaeology. For example, in glacial environments, it is very likely that the availability of fuel might have been a limiting factor to Neanderthal presence in areas, more so than for example available biomass (*e.g.* White 2006, 561-562). Another guiding factor for Neanderthal presence might be raw material availability. In general, raw material sources are limited areas in the landscape, while food resources can be found all over the landscape. Therefore mobility systems will have been influenced by raw material sources. Embedded foraging may have included moving to areas rich in a predictable resource, raw material, and foraging in these areas for food resources which would have been as available there as in areas without suitable raw materials (Daniel 2001, 261).

All in all, Neanderthal behaviour remains enigmatic. The virtual absence of innovation, of a succession of different tool types invented, used for some time and phased out in favour of new types is strange since it does seem to characterise all modern human cultures that come after the Neanderthals. It could even be interpreted as showing the absence of the so-called “ratchet-effect”, which is thought to be responsible for the cumulative nature of human culture (Boesch and Tomasello 1998). This could lead to the supposition that Neanderthal cultural transmission was less effective than, or at least different from our own. Glimpses of “high-tech” behaviour from the archaeological record challenge these ideas. The same is true for the seemingly very effective hunting methods that were practised. All in all, the species practicsed a successful way of life that was different from ours in the harsh environment of Pleistocene Europe. In the following chapter I will discuss ways in which we can try to model this behaviour in order to gain further insight into it.