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

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1 Introduction

During human evolution our primate ancestors gradually switched from a diet based mainly on plant foods to one based to a significant degree on animal foods. This shift is thought to have been important in the process of human evolution, some even regard it as critical (*e.g.* Milton 2003). Many important developments in human evolution, like increasing brain-size and changes in life histories, are assumed to have co-evolved with the increasing contribution of animal products to the diet (*e.g.* Aiello and Wheeler 1995, Isaac 1978, Kaplan *et al.* 2000, Kaplan and Robson 2002, Kuhn and Stiner 2006). Theories that make evolutionary links between factors in human evolution, like brain size with other factors like foraging niche, longevity or group size, have focused mainly on comparative studies of primates and ethnographically known hunter/gatherers (*e.g.* Dunbar 1992, Hawkes *et al.* 1998, Kaplan *et al.* 2000, Reader and Laland 2002). The general validity of these theories can be evaluated by testing them on other species in the hominin family. Neanderthals are especially interesting in this respect; we shared a common ancestor relatively recently and their general body plan was similar to that of modern humans. More importantly, they had large brains, in terms of both absolute and relative size (Wood and Collard 1999, 69). If we accept the increasing anatomical and genetic evidence that modern humans and Neanderthals are separate species (*e.g.* Green *et al.* 2008, Hofreiter *et al.* 2001, McDougall, Brown, and Fleagle 2005, Ovchinikov *et al.* 2000, Stringer 2003, White *et al.* 2003), Neanderthals present us with a case of parallel evolution of large brains, the factor that is deemed to be most important in human evolution. This makes the study of the factors responsible for the similar Neanderthal evolutionary trajectory germane to our understanding of human evolutionary patterns in general.

In order to assess the role of the foraging niche in the evolution of large brains and prolonged life-history trajectories, this thesis aims to assess the efficacy of Neanderthal foraging strategies, specifically Neanderthal meat procurement. It has been argued that hunting is a very knowledge-intensive activity practised by modern humans (*e.g.* Kaplan *et al.* 2000). It is also seen as the most "complex" activity that chimpanzees (*Pan troglodytes*) engage in (*e.g.* Boesch 2003). Therefore, studying the knowledge-intensity of the Neanderthal foraging niche and its evolutionary implications for the evolution of larger brains has bearing on the theories as proposed by Kaplan *et al.*, among others since it may yield insight in the validity of their underlying assumptions.

The importance of meat in the lives of our ancestors has been the subject of heated debate within Palaeolithic archaeology. First, the crucial contribution that gathering provides to the diets of many extant hunter/gatherers has been stressed (*e.g.* Dahlberg 1981). Second, the question of how meat was obtained has been debated heatedly (for a review see Domínguez-Rodrigo 2002). Hunting is seen as complicated behaviour and this, combined with meagre archaeological evidence has led some researchers to suggest that only anatomically modern humans (AMH) were able to subsist by regularly hunting large mammals (*e.g.* Binford 1984). Scientists studying Pleistocene ecology on the other hand, have stated that subsisting primarily by scavenging was not a viable option for hominins and hence predicted hunting as the basis of subsistence (Geist 1978, Tooby and DeVore 1987).

Neanderthals occupy a peculiar position in this debate. They are very similar to AMH in general build. Furthermore, they have large brains, on average even larger than those of AMH. Moreover, the research that originally called into question the role of hunting by hominins was carried out at Sterkfontein and Bed I of the Olduvai Gorge, dealing with species at a much earlier stage in human evolution (Binford 1981, Brain 1981). Still, Neanderthals are also alleged to have procured meat mainly by scavenging (*e.g.* Binford 1988, Stiner 1994).

Gathering cannot have been as important to Neanderthals as it may have been to hominins in more tropical environments, since Neanderthals lived at temperate latitudes, where plant foods are not as abundant as in tropical and subtropical environments. Crucially, they are not available year-round (*e.g.* Roebroeks, Conard, and Van Kolfschoten 1992, 551). Moreover during much of the Pleistocene temperatures were lower than today, further limiting the availability of plant foods. Coping with winter conditions and the cessation of primary biological production in this period is an unusual problem for a primate. In addition to a greater reliance on meat to deal with this there are other imaginable solutions. For example, a species could adapt to spending the winter in hibernation, or create stores of food in order to survive this season. Modern-day primates living at temperate latitudes do not hibernate; therefore it seems unlikely Neanderthals did. Food-storage is an option that merits attention however.

Studies of the isotopic composition of the bones of some Neanderthals have shown that their diet consisted mainly of meat (*e.g.* Bocherens and Drucker 2003, Bocherens *et al.* 2005, Richards *et al.* 2000, Richards and Schmitz 2008, Richards *et al.* 2008b). This suggests that Neanderthals solved the problem of surviving the winter by a reliance on meat. However, as important as they are, the isotope-studies do not tell us how they obtained it.

In this respect it is important to note that some of the analyses that advocated the importance of scavenging in Neanderthal subsistence have since been refuted. Binford's (1988) analysis of the Grotte Vaufrey for example, was found to be flawed (Grayson and Delpech 1994). Other analyses, such as one by Stiner (1994) in Italy, did not take the collecting strategies of the excavators into consideration. At some fo the old excavations she analysed only diagnostic bones had been collected, which yielded an assemblage dominated by head parts, considered to be characteristic of a scavenged assemblage (Mussi 1999).

Compelling evidence for hunting has been found through detailed studies of bone assemblages, often done along the lines developed by Lewis Binford. Many Middle Palaeolithic bone assemblages for instance are dominated by prime aged adults, the animals least likely to die from predation, disease etc. This is a characteristic pattern of modern human hunting; it is not seen in other carnivores (*e.g.* Gaudzinski 1995, Gaudzinski and Roebroeks 2000, Steele 2004). Furthermore at many of these sites cut-marks and conchoidal fractures testify to a very intensive hominin exploitation of the fauna present at the sites (Auguste 1995a, Gaudzinski and Roebroeks 2003). There are the spectacular finds of projectile weapons; a number of wooden spears associated with the remains of about 20 butchered horses at Schöningen (Thieme 1997, Voormolen 2008), and a wooden lance found associated with an elephant carcass at Lehringen (Thieme and Veil 1985). In Syria a Mousterian point was found embedded in the vertebra of a wild ass. The direction of the impact suggests a parabolic trajectory, which means that the point probably functioned as the tip of a thrown spear, rather than a thrusted one (Boëda *et al.* 1999).

In recent years, the realisation that Neanderthals were able hunters of big game has led to the development of new hypotheses regarding differences in adaptation between Neanderthals and modern humans. The most influential of these is the hypothesis of a "broad-spectrum revolution" (*e.g.* Richards *et al.* 2001, Stiner 2001, Stiner, Munro, and Surovell 2000, Stiner *et al.* 1999). This hypothesis states that, in contrast to modern humans, Neanderthals did not efficiently exploit fast-moving small game like rodents, birds and fish. Consequently, they would have been unable to maintain the population sizes modern humans could reach in similar areas.

This development in the debate surrounding Neanderthal foraging decisions is remarkable, since during the heyday of the scavenging hypothesis, it was thought that prior to the last glacial, small animals were the only category of animals European hominins were deemed capable of hunting, as Binford (1985, 319) put it:

> *The European sites from the Rissian age (100,000 – 300,000 years ago) exhibit a very different pattern than that noted above. It is my impression that hunting seems most likely indicated for small animals and rodents, particularly rabbits, which are common in such early European sites as Lazaret (Jullien & Pillard 1969) and the earlier Rissian levels of Combe Grenal.*

In order to assess the validity of the hypotheses on co-evolution of intelligence, life-histories and foraging strategies and to evaluate current ideas on the sophistication of Neanderthal hunting strategies, the following research design has been developed.

1.1 Research design

The complete reversal of ideas on Neanderthal foraging strategies during such a short period of time illustrates the need for the development of a reliable methodology with which to interpret archaeological indications for hominin foraging behaviour in an evolutionary framework. This methodology should enable meaningful comparisons of sites from different geographical areas and of different ages. The focus should be on the bone assemblages and not necessarily on the associated tools since the tool spectrum need not necessarily be indicative of the sophistication of the hunting strategies.

A promising perspective is provided by optimal foraging theory. This theory investigates how the need of animals to maximise their fitness influences their foraging strategies. Since foraging is crucial for the survival of the individual, it is assumed that foraging efficiency will be maximised. In addition, efficient foraging can enhance fitness in more ways, for instance because more efficient foraging allows an organism more time for activities related to reproduction (*e.g.* Winterhalder 1987). Since hunter/gatherers have been subject to long periods of selective pressures it is assumed that they are as proficient and skilled as they could possibly be (Winterhalder 2001, 13-14). The application of this method to hunter/gatherers has been criticised by some cultural anthropologists (*e.g.* Ingold 2000). They feel that the application of evolutionary theory to situation with an important role for cultural transmission is problematic, since evolutionary theory is geared to dealing with genetic inheritance. The same goes for the mechanisms of selection. However, optimal foraging models have been successfully applied in a wide array of studies, ranging from the foraging behaviour of insects, to that of hunter/gatherers, to industrial fishing and to surfing the Internet (*e.g.* DiClemente and D. A. Hantula 2003, Dorn 1997, Waldbauer and Friedman 1991, Winterhalder 1987, Winterhalder 2001). These models have been designed not to represent the truth, but are simplifications that can be used to determine what factors are important in foraging choices made by hunter/gatherers (*e.g.* Shennan 2002, Winterhalder and Smith 1992).

Because in archaeology, the data at our disposal is different than in ecological and anthropological studies, this study aims to test whether we can adapt Optimal Foraging Theory in such a way that it becomes applicable to the study of Pleistocene subsistence strategies. An important consideration is that much of the information needed relates to the ecological structure of the environment, which in archaeology often has to be reconstructed. In order to minimise the uncertainties associated with reconstructing important variables, it appears most productive to use a simple model. In this study, I will focus on the Diet Breadth Model. This model predicts which species will be exploited by a given predator in a certain environment and which species will be avoided (MacArthur and Pianka 1966). Whether a species is exploited depends on many factors, such as the caloric value of a resource, the cost of tracking it, anti-predator behaviour of the prey and so on (*e.g.* Ugan 2005, Winterhalder 1987, Winterhalder 2001). If we can highlight which of these factors influenced Neanderthal foraging behaviour, we can gain insight in the way their hunting strategies were organised.

In this study I will adopt a diachronic perspective and focuson the archaeological record of northwestern Europe. For the application of this analysis areas further south, the models would have to be adapted to suit the fact that southern Neanderthals did not possess the same cold-adapted physiology as northern ones (*e.g.* Aiello and Wheeler 2003, 147). Furthermore, the energetic needs of cold-adapted modern humans, and presumably also Neanderthals, are significantly higher than those of individuals from more temperate climes (Aiello and Wheeler 2003, Steegman, Cerny, and Holliday 2002). This may have influenced the foraging tactics practised in these areas. Finally, the role of plant foods was probably more substantial in southern Europe than in northern Europe. Since taphonomic factors preclude analysis of the floral component of the Neanderthal diet, it appears most productive to study sites where the importance of plant foods was in all likelihood small.

I will first introduce the current thinking on the co-evolution of hominin intelligence, life histories and foraging behaviour. This will be followed by an introduction into Neanderthal biology and archaeology, in order to assess this predator's needs and abilities, which are important with regard to the application of the model (chapters 2 and 3). Next, some optimal foraging models will be discussed and hypotheses regarding the Neanderthal foraging niche will be developed (chapter 4). These will be tested by applying them to well-documented sites from the Middle Palaeolithic of Northwest Europe (chapters 5 and 6), and to sites produced by a competing predator, namely the cave hyena (*Crocuta spelaea*) (chapter 7). This will be done to highlight whether the modelled foraging niches of the two predators diverge and in what way. It should then become clear whether the resolution provided by the model is sufficient to provide evolutionary meaningful interpretations of foraging niches.

The archaeological focus will be on two sites, whose rich faunal assemblages span different chronological and climatic periods. This should provide insight in how Neanderthals dealt with the climatic oscillations that characterised the Pleistocene. The focus will be on palimpsest assemblages that were formed over several years, resulting in a time-averaged picture, thus filtering out variations in foraging behaviour due to exceptional circumstances. By so doing I aim to increase the reliability of the analysis in characterising the Neanderthal foraging niche. The environment will be reconstructed based on information from pollen cores, small fauna and geology. Analysis of the behaviour of the species that were present may give us insight in what kind of prey Neanderthals favoured. The species of prey that were targeted and age-structure of the hunted assemblage for example provide important clues as to hunting strategies.

The earliest site that will be analysed is Biache-Saint-Vaast in northern France. This site has been excavated, researched and published reasonably recently (*e.g.* Auguste 1992, Auguste 1995a, Tuffreau and Sommé 1988b). The site was formed during the transition of a temperate phase within the Saalian, Marine Isotope Stage (MIS) 7, to the most recent glaciation of the Saalian, MIS 6 (Sommé *et al.* 1988). The site consists of multiple layers formed during periods characterised by different climatic conditions, from cold boreal to temperate. This site may thus provide insight in the long-term dynamics of Neanderthal foraging adaptations at the transition of MIS 7 to MIS 6.

The second site that will be examined is Taubach in Germany. This site is dated to the last interglacial, the Eemian. Analysis of this site is pertinent in the context of the debate about whether or not Neanderthals were able to cope with the climax conditions of its climatic optimum (*e.g.*, Roebroeks, Conard, and Van Kolfschoten 1992, Roebroeks and Speleers 2002 *contra* Gamble 1986, Gamble 1992, Gamble 1999). Sites of a similar age are known in this region, but these represent only single hunting episodes (Gaudzinski 2004) and will not yield a reliable picture of foraging adaptations if treated in isolation. Taubach was chosen because it has yielded a large assemblage of cut-marked bones, and an abundant natural fauna that can be used to evaluate Neanderthal foraging decisions. Analysis of this site is not unproblematic however, since the bones were collected in the course of travertine quarrying activities in the 19th century. The collection is therefore biased towards diagnostic bones of the larger mammals (Bratlund 1999). The site can be compared to neighbouring archaeological and natural bone assemblages in order to determine how representative the bone assemblage is.

The insights this study gives us into Neanderthal foraging niches will be compared with a similar case-study of two Pleistocene hyena dens containing large bone assemblages from France, namely Lunel-Viel and Camiac. Camiac is dated to MIS 3, while Lunel-Viel is considerably older, dated to around 350 ka (Fosse 1996, Guadelli *et al.* 1988). The environmental data available for Lunel-Viel is unfortunately somewhat poor but the faunal assemblage shows that it was situated in a temperate environment. At Camiac, pollen analysis from hyena coprolites can be combined with the faunal assemblage to reconstruct a mammoth steppe environmental setting. These two sites therefore inform us on hyena behaviour in both temperate and colder periods and provide good comparisons for the archaeological assemblages.

Finally I will evaluate how the application of OFT to the study of Pleistocene foraging strategies can increase our understanding of Neanderthal behaviour. Moreover I will discuss how these results apply to the theories on the evolution of hominin intelligence and life histories.