Chapter 9
A Diachronic Evaluation of Neanderthal Cervid Exploitation and Site Use at Pech de l'Azé IV, France

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Introduction

Several decades of zooarchaeological research focusing on Neanderthal hunting and exploitation of large ungulates have provided a great deal of insight on the dynamic interplay among hominins, their prey, and their natural and social landscapes. Such knowledge helps us better understand the subsistence strategies of Neanderthals and their implications for such factors as site use, mobility, and life history. Sites containing multi-layer stratigraphic sequences of Neanderthal deposits with associated Mousterian artifacts and archaeofaunas that span long ranges of time are particularly good sources for evaluating change and stability in subsistence across this hominin's long existence in Eurasia (e.g., Chase 1986, 1999; Stiner 1994, 2005; Gaudzinski 1995; Blasco 1997; Pike-Tay et al. 1999; Burke 2000; Conard and Prindiville 2000; Beauval 2004; Morin 2004; Rabinovich and Hovers 2004; Speth and Clark 2006; Speth and Tchernov 2007; Steele et al. 2009; Rivals et al. 2009).

The site of Pech de l'Azé IV, France is another such example of an extensive Mousterian sequence that yielded an exceptionally rich archaeological record of Neanderthal occupations (e.g., Bordes 1954; Turq et al. 2011). With three meters of deposits spanning much of the Mousterian, we have roughly 60 kyr of Neanderthal life to evaluate. The study presented here is based on the zooarchaeological remains recovered from the recent excavation campaign and focuses on the Neanderthals' treatment of large cervid prey in three large archaeological horizons that cover most of the stratigraphic sequence. The results show that environmental conditions influenced the abundance of the two dominant prey species across the sequence—red deer and reindeer—but factors relating to nutritional yield likely influenced how Neanderthals transported and processed these prey. The zooarchaeological results are then evaluated in conjunction with data from the lithics and site features in order to understand the use of this site over time and through changing climate regimes.

The Site and Research Background

The site of Pech de l'Azé IV (hereafter Pech IV) is a collapsed cave located in the Perigord region of southwest France. Located at the base of a cliff, Pech IV is one of four caves containing Lower and Middle Palaeolithic deposits that have been excavated over the past century and a half (e.g., McPherron et al. 2001; Soressi et al. 2007). Pech IV was discovered and tested by François Bordes in 1952 (Bordes 1954) and excavated by him between 1970 and 1977. A second campaign of excavations at the site was undertaken by Dibble and McPherron (Turq et al. 2011) between 2000 and 2003 with the aim of clarifying the stratigraphy, collecting samples for dating the sequence, and better understanding site formation processes.

The archaeological sequence at Pech IV is 3 m deep at its thickest point. At the base is Layer 8, which is characterized by Typical Mousterian lithic assemblages and evidence for the extensive use of fire by Neanderthals during these occupations (Dibble et al. 2009). The faunal spectrum is dominated by red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*), indicating temperate, wooded environs. Thermoluminescence (TL) dates from burned flints place the occupations in Layer 8 in MIS 5c (Richter et al. 2010). This is followed by Layer 6 (Levels 6A–6B) containing a lithic industry that is infrequently seen, named the Asinipodian, marked by the production of small flakes (Dibble and McPherron 2006, 2007). Environmental conditions similar to Layer 8 persist through Layer 6 as evidenced by the fauna. The upper level 6A was dated by TL to

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the end of MIS 5 (Richter et al. 2010). Above this are several layers of scraper-rich assemblages (5-4), including rich Quina Mousterian occupations in Level 4A. Scraper production was also markedly high in Layer 4. Reindeer (*Rangifer tarandus*) replaces red deer as the dominant taxon in Layers 5-4, although roe deer still persists in small amounts in Layer 5. Finally, the upper sequence comprises Mousterian of Acheulian Tradition (MTA) inventories lacking scrapers (Layer 3) with small faunal assemblages containing primarily reindeer and *Bos/Bison*.

A study of the fauna from Bordes' first campaign at Pech IV was undertaken by Laquay (1981). His analysis covered most of the same sequence as ours, except for the uppermost MTA horizons. Laquay's results on species representation across the sequence provided a valuable framework for understanding the climatic conditions under which the Pech de l'Azé caves and other regional sites such as Combe Grenal were occupied by Neanderthals (e.g., Mellars 1996). The recent zooarchaeological study of the Pech IV fauna shows the same general pattern of species representation found by Laquay.

Materials and Methods

Approximately 23,000 piece-plotted (>2 cm) faunal remains were recovered from the 2000–2003 excavations at Pech IV. A portion of this material forms the basis of the archaeozoological study presented here, with coarse waterscreen fauna excluded from the analysis except for a sample from Layer 8. Due to extensive fragmentation of the faunal remains overall, the level of identifiability in many layers was less than ideal and as a result many specimens could be placed only in general categories by family or body size.

Bone surface preservation is generally good for the faunal remains across the sequence. Cancellous bone portions and axial skeletal parts are strongly underrepresented in every layer, with the denser elements including teeth tending to preserve well. Statistically significant relationships between bone density and skeletal abundance (element and portion of element) are evident for the red deer and reindeer assemblages from Levels 4A, 4C and 6A. Long bones are overwhelmingly represented by mid-shaft portions and unidentifiable shaft splinters. These specimens consistently show a high degree of fresh breakage, presumably the result of marrow processing, and hammerstone impact marks are common. Stone tool cutmarks are present and in some layers exceptionally high. Every bone specimen was thoroughly examined for the presence of cutmarks using a strong primary light source and 10× magnification. Only clear and unambiguous evidence of bone modifications was recorded.

Evidence for carnivore gnawing is minimal (0.002 %) across the entire sequence. In addition, only 10 carnivore bone or tooth specimens were identified amongst all of the assemblages, indicating that bone collecting carnivores were simply not a factor in the faunal accumulations at Pech IV. Therefore, the assemblages at this site are assumed to be anthropogenic accumulations. The high frequencies of bone modifications such as cutmarks, hammerstone impacts and fresh breakage support this scenario.

The abundance of fauna varied significantly across the sequence of Pech IV, as reflected in the number of identified specimens (NISP) and minimum number of individuals (MNI) per layer (Table 9.1). Since only some of the layers

Table 9.1 Summary of faunal remains from Layers 4, 6 and 8 at Pech de l'Azé IV, expressed as NISP and MNI [in brackets]

	4A	4B	4C	6A	6B	8
Lepus sp. (hare)						1 [1]
Castor fiber (beaver)				3 [1]	1 [1]	3 [1]
Canis lupus (wolf)			2 [1]			2 [1]
Vulpes/Alopex (fox)				1 [1]		
Ursus sp. (indeterminate bear)				1 [1]	4 [1]	
Equus ferus (horse)	6 [1]	2 [1]	5 [1]	79 [3]	104 [3]	8 [1]
Cervus elaphus (red deer)	5 [1]	4 [1]	7 [1]	870 [13]	876 [19]	269 [10]
Rangifer tarandus (reindeer)	207 [4]	95 [2]	828 [19]	22 [1]	3 [1]	3 [1]
Capreolus capreolus (roe deer)	9 [1]	13 [1]	35 [2]	428 [7]	425 [7]	41 [2]
Bos/Bison (aurochs/bison)	1 [1]		1 [1]	26 [1]	17 [1]	
Capra ibex (ibex)				1 [1]		1 [1]
Sus scrofa (boar)				15 [3]	24 [2]	3 [3]
Aves						1 [1]
	228	114	878	1,446	1,454	331

Specimens placed in body size or family categories excluded from this list contained adequate faunal samples for evaluating Neanderthal subsistence, the study presented here will be limited to the assemblages of Layers 8, 6 and 4. Moreover, these layers provide contrasting pictures of environmental conditions and Neanderthal site use. In terms of subsistence, the bulk of this paper focuses on the data for reindeer and red deer only, since these samples were the largest, but evidence for site seasonality also includes data from boar.

Lying on bedrock at the bottom of the sequence is Layer 8, representing occupations that look different from subsequent ones in a number of important ways (Dibble et al. 2009). What sets apart Layer 8 most significantly is the evidence for the controlled use of fire, as indicated by numerous ash lenses and hearth features along with high frequencies of burned lithics and bone. We see indications that shallow hearths were used for fires, cleaned out of their content, reused, cleaned out again, and so on, with the burned refuse subsequently trampled by human occupants. These indications are visible on a macro- and microscale, though the trampling is best discerned in geomorphological thin sections where in situ bone breakage is clearly shown (Dibble et al. 2009: 188–189 and Fig. 7c). In addition to wood and plant remains, animal bones were burned for fuel. As a result of burning and trampling, much of the bone was highly fragmented and thus the majority could only be placed in body size categories. Interestingly, the presence of fire is virtually absent from the entire rest of the Pech IV sequence (Dibble et al. 2009). The fauna indicates temperate conditions with mixed deciduous and conifer forests and is dominated by red deer and roe deer, with small amounts of boar and beaver present as well.

Layer 6 (Levels 6A and 6B) in the lower part of the Pech IV sequence is rich in stone and bone assemblages. The faunal spectrum here is virtually the same as in Layer 8; horse and *Bos/Bison* are more numerous in Layer 6 than anywhere else in the sequence, but are still sparsely represented compared to the cervids. Environmental conditions are presumably similar to those reflected in Layer 8.

Reindeer replaces red deer and roe deer as the dominant taxon higher up in the sequence in Layer 4 (Levels 4A, 4B, 4C). The faunal assemblages from each of the levels are smaller than in Layer 6 and the richness of animal taxa represented is also much lower. Cold and dry environments are indicated by the reindeer, while the presence of horse and a hint of *Bos/Bison* shows that these taxa are present in a variety of climatic conditions.

In this paper, the discussion focuses only on Neanderthal utilization of the predominant species, red deer and reindeer. Although small assemblages of roe deer and sparse remains of large bovids and horse are also represented in these layers, they are not included here due to small sample sizes.

Zooarchaeological Results

In order to understand how Neanderthals exploited large cervids across the Pech IV sequence, and in turn, to begin addressing broader questions about subsistence change and site use, several zooarchaeological datasets derived from the assemblages in Layers 4, 6 and 8 are evaluated. Information on sex and age ratios, site seasonality, skeletal element abundances, and butchery modifications on bones provide insight on the ecological influence on Neanderthal prey choice as well as situational factors that may have played a role in carcass processing decisions.

Sex Ratios

Limited information on the sex ratios of red deer were gleaned from small diagnostic assemblages in Layers 6 and 8, despite the general lack of diagnostic skeletal parts or articular ends for osteometrics across the sequence overall. For example, one neonate and one fetal red deer indicate the presence of at least two females among the 10 adult individuals in Level 6A, while a few fragments of antler point to at least one male. Level 6B yielded a small number of antler fragments but no fetal remains; skeletal elements in this level were generally more robust than in the surrounding levels, probably reflecting at least some males, but there are no quantifiable data to determine more precise sex ratios. The best data come from Layer 8, where red deer canine teeth indicate six females and one male (following methods in d'Errico and Vanhaeren 2002). At least three fetal individuals also support the scenario of a female-dominated assemblage.

Seasonality and Age

Information on season of occupation at Pech IV comes from ageable fetal bone and teeth. An assemblage (NISP = 21) of fetal remains belonging to red deer and boar from Layer 8 and a smaller number of fetal red deer from Layer 6 (NISP = 6) were preserved. These specimens (mostly long bones) were aged as precisely as possible using two sets of comparative fetal red deer skeletons, one of which was approximately half-term (4.5–5.0 months) and the other nearly full-term (7–8 months). Based on the gestation schedule of ~250 days for *Cervus elaphus* with the mating season taking place in September–October and birth in May–June (Habermehl 1985), the comparative skeletons allowed age estimations of the Pech IV specimens within a seasonal timeframe. A single fetal boar radius from Layer 8 was aged using osteometric data from domestic pig long bones at various stages of gestation (Habermehl 1975: Table 14). Both wild boar and domestic pig have gestation periods of 110–120 days and give birth to 5–6 young in spring (Habermehl 1975, 1985). Metrics on the Pech IV fetal specimen indicate a nearly full-term individual, i.e., pointing to death in early spring.

Season of death for reindeer from Layer 4 was determined by means of dental eruption and wear stages of partial toothrows. Deciduous and permanent teeth from the maxilla and mandible were evaluated. The Pech IV specimens were compared to the extensive sample of precisely aged dentition from modern caribou found in Miller (1974). Because *Rangifer* have seasonally restricted mating (autumn) and birthing (late May–early June) periods, their season of death can be accurately determined using comparative specimens of known age. Individuals ranging from 2 to 3 months old (MNI = 1), 12 months old (MNI = 1) and 20–24 months old (MNI = 6) all indicate death in spring and perhaps early summer (the newborn and yearling). The presence of two or more premolars and molars from the same toothrow of these individuals allowed for well-defined season of death data in this layer.

Evaluated together, the season of death data from several prey taxa show that Neanderthal occupation of Pech IV, as well as their ungulate hunting strategies, varied throughout the sequence (Table 9.2). Data from Layer 8 show the site being visited during all seasons of the year, with locally available red deer being hunted during most of these occupations. Both levels in Layer 6 indicate that Neanderthals were elsewhere during the fall but occupying the cave in winter and spring. Similar to Layer 8, it looks as if the prey taxa were available year-round and hunted in most seasons. The cold period Layer 4 shows a much different picture, with occupations and reindeer hunting limited to a seasonally restricted window. These data likely show that reindeer were available locally only during this time period in spring and perhaps early summer, i.e., during their migration. Pleistocene *Rangifer* did indeed migrate long distances like their modern counterparts (Britton et al. 2009) and the fact that other Quina Mousterian sites (e.g., Costamagno et al. 2006; Britton et al. 2011) have yielded reindeer assemblages showing hunting episodes restricted to reindeer migration times in spring or fall suggests that Neanderthals took advantage of the local abundance of this taxon during restricted seasonal periods. This in turn implies that Pech IV was occupied for shorter durations in cold periods, including the Quina Mousterian Level 4A. This scenario is supported by the sparser lithic assemblages in Layer 4, particularly Levels 4A and 4B (Turq et al. 2011).

Table 9.2 Seasonality evidence across the sequence at Pech de l'Azé IV, based on eruption and wear of teeth and fetal bone

	Spring	Summer	Fall	Winter
4A	*Rangifer*	*Rangifer*		
4B	*Rangifer*			
4C	*Rangifer*	*Rangifer*		
6A	*Sus/Cervus*			*Cervus*
6B	*Sus/Cervus*	*Sus scrofa*		*Cervus*
8	*Sus scrofa*	*Cervus*	*Cervus*	*Sus/Cervus*

Ageable skeletal specimens are relatively sparse amongst the Pech IV assemblages, both in terms of teeth as well as unfused skeletal bone. Layer 6 is an exception with a substantial sample of cervid teeth (NISP = 91), in contrast to Layer 8, which contains just four. Layer 4 yielded smaller tooth assemblages (NISP = 65) but they were nonetheless valuable for age and season information.

Mandibular and maxillary teeth of red deer and reindeer were aged based on eruption state and/or wear stages (Miller 1974; Carter 2006) and placed into three age groups: juvenile (from time of birth to prior to loss of deciduous teeth), prime adult (reproductive years of life), and old adult (tooth crown is >50 % worn) (following Stiner 1990). Grouping the data in this way allows us to construct a mortality profile for evaluating whether Neanderthals targeted certain age groups of prey and in turn, if their hunting strategies remained consistent or varied across the sequence at Pech IV.

Both red deer assemblages in Layer 6 show a predominance of prime adults with one or two juveniles and just one old adult in Level 6A (Table 9.3). Based on the evidence we have on multiple seasons of red deer hunting in these levels, we can presume that this taxon was locally available most or all of the year. Pleistocene red deer were not a highly migratory species like reindeer, but instead made limited seasonal movements in the regional landscape (Pellegrini et al. 2008). Perhaps the reliability of this prey animal in the vicinity of Pech IV influenced the more frequent targeting of prime adult individuals by Neanderthals, some of whom had calves younger than a month old.

The data from Layer 4 are quite varied, with more juveniles in Level 4A, all prime adults in 4B, and no clear pattern is visible in 4C. Because the samples are small (3–4 individuals in each level), we should interpret a "focus" on any age group with caution. That said, the varying patterns

Table 9.3 Summary of age groups for reindeer (Layer 4) and red deer (Layers 6) based on teeth (Layer 8 contained no ageable teeth)

MNI by level	4A	4B	4C	6A	6B	8
Juvenile	3	0	2	2	1	Nd
Prime adult	1	0	1	5	5	Nd
Old adult	0	3	1	1	0	Nd

in each level might be specific to hunting this highly migratory taxon. If Pleistocene *Rangifer* migrations were of similar character to those of today, then they would have proceeded in several stages lasting one to two months each, incorporating a calving period, pulses of movement, pauses, the rut, and occasional splits in herd structure (males separating from females with calves) (Burch 1972; Enloe and David 1997). Using these modern data as a framework, the assemblages from Level 4A and 4C, which show a spring through summer seasonal signal, might represent hunting of females and calves (4A) and mixed herds (4C). The prime adults hunted in summer from Level 4B could reflect a migratory phase when the females and calves were elsewhere and Neanderthals encountered barren females and males in the vicinity of Pech IV. Overall, the results from Layer 4 show much more variability than we see in Layer 6, which seems to be the persistent trend in these cold, reindeer-dominated levels.

Skeletal Element Frequencies

The cave of Pech IV was presumably the place to which Neanderthals brought prey animals for processing and consumption, as opposed to the actual kill site. Being the end-point of prey transport (Stiner 1994), caves such as Pech IV therefore provide an opportunity for evaluating transport decisions by hominins. Although the ultimate goal is assumed to have been the transport of as much of the prey animal as possible, we know from ethnographic studies of modern hunter-gatherers that people must sometimes selectively transport certain carcass portions or elements based on nutritional yield (e.g., Binford 1978; Bunn et al. 1988; O'Connell et al. 1988; Bartram 1993). Such decisions are influenced by various factors including the body size of prey, distance to the site, weather or topography and the number of hunters involved (Bunn et al. 1988). In order to evaluate prey transport strategies of Neanderthals at Pech IV, the relative abundances of skeletal elements from red deer and reindeer are considered.

Skeletal frequencies tabulated as MNE (minimum number of elements) are expressed as ratio MAU (minimum number of animal units; Binford 1978) (Fig. 9.1). Because Level 4B is a small assemblage, it has been excluded from the graph. Overall, the posterior axial skeleton (vertebrae, ribs, pelvis) is strongly underrepresented in all levels. Considering that the assemblages from Levels 4A, 4C and 6A were influenced by bone density-mediated attrition, as seen in significant and positive correlations between bone density values and abundance, the lack of the vertebrae and ribs could be purely taphonomic. However, this pattern might reflect the decision to leave the bulky rib and spinal segments behind after having removed the meat. The abundance of heads varies but mandibles are more frequent than crania except in Layer 8.

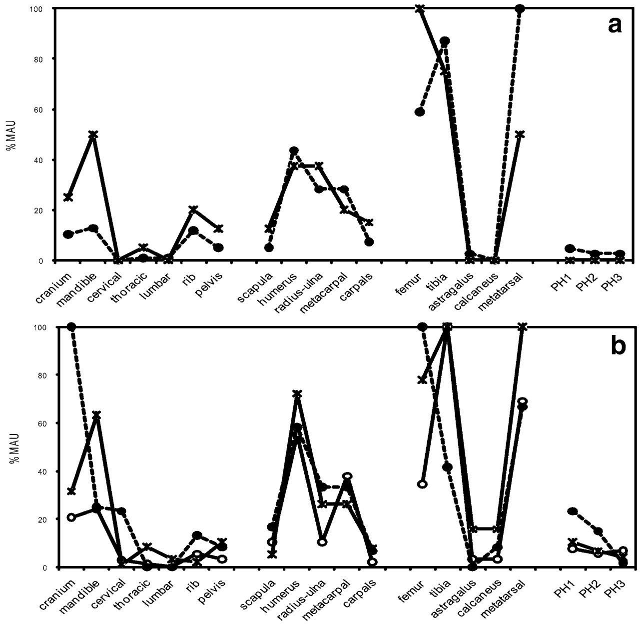

Fig. 9.1 Skeletal element abundance expressed as ratio MAU (minimum animal units). Reindeer from Levels 4A and 4C are plotted in (**a**) and red deer from Layers 6 and 8 are plotted in (**b**)

Whether the discrepancies in skeletal element abundances are the result of transport decisions based on nutritional value can be explored through utility indices. Ratio MAU data from Pech IV are plotted against values for standardized food utility ([S]FUI; Metcalfe and Jones 1988) and standardized marrow cavity volume (Binford 1978). The food utility index averages values for meat, marrow and overall nutritional gain of skeletal elements for this taxon while the marrow index is based on the actual volume of each marrow-yielding long bone shaft; both indices are based on data averaged from modern *Rangifer*. Because the vertebrae and ribs are so poorly represented in the Pech IV assemblages, we limit our analysis to the "high survival set" of skeletal elements (Marean and Cleghorn 2003). These include elements containing thick cortical bone but lacking fragile cancellous bone and include all of the long bone shafts, mandibles, and cranium (Marean and Cleghorn 2003: 34). Because of their better tendency to preserve in the fossil record, these skeletal parts represent the best opportunity for evaluating human subsistence strategies.

A significant and positive correlation exists between overall food utility and skeletal abundance of reindeer in Levels 4A and 4C and red deer in Level 6A (Fig. 9.2). No statistical relationship is seen between marrow cavity volume and ratio MAUs for the long bones and mandible in any level. This is somewhat surprising since the overall frequency of these elements is high, particularly the tibia

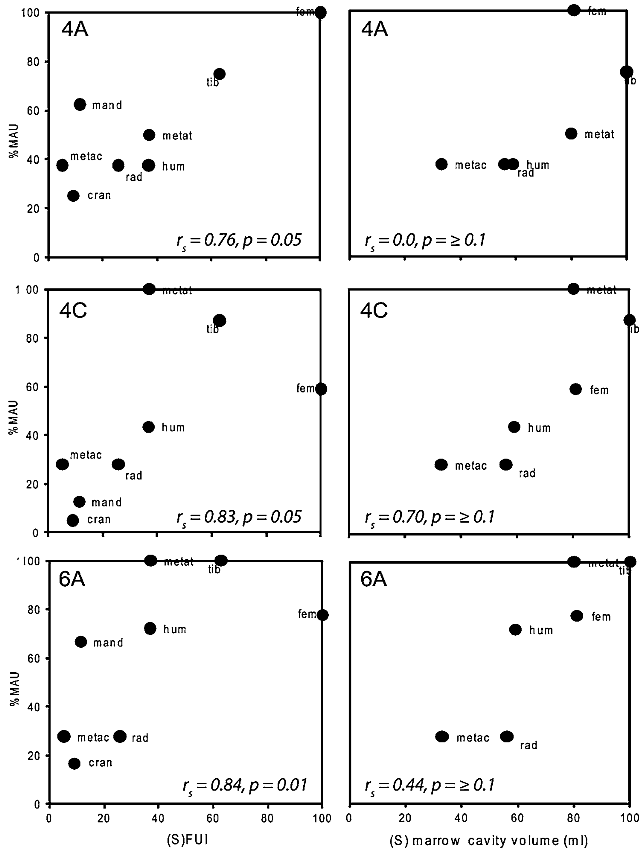

Fig. 9.2 Relation between ratio MAU and the standardized food utility index ([S]FUI) and standardized (S) marrow cavity volume for reindeer in Levels 4A and 4C; and red deer in Level 6A

and the non-meat bearing metatarsal (see Fig. 9.1). This might be in part due to weaknesses in the return rate data on which these utility indices are based, which do not account for every variable involved in the transport of prey (Egeland and Byerly 2005). Therefore, in the case of Pech IV, it is useful to explore more closely the nutritional qualities of marrow specific to skeletal element and time of year (Binford 1978; Morin 2007).

In a reevaluation of Binford's marrow index, Morin (2007) confirmed that the overall quantity of unsaturated fatty acids was the most valuable factor in whether an element was chosen for marrow processing by the Nunamiut, the Alaskan native group that Binford studied (e.g., Binford 1978). With the relevant data recalculated, Morin (2007: Table 4) established the Unsaturated Marrow Index (UMI) to be applied in place of marrow cavity volume. When plotted against the Pech IV ratio MAUs, the UMI shows significant correlations for the assemblages in Level 4C ($r_s = 0.84$, $p = 0.05$) and 6A ($r_s = 0.88$, $p = 0.05$), which likely relate to the higher rank of the femur in the UMI. However, neither index helps us understand the pattern in Level 4C, where the frequencies of tibiae (MNE = 34) and metatarsals (MNE = 39) are extraordinarily high—by a factor of two times or more—in comparison to equally robust humeri (MNE = 17) and radii (MNE = 11). These numbers suggest that the richest marrow bones were selectively transported to the cave in greater quantity than the upper limb elements for further processing. This might relate to the poor physical condition of some of the reindeer, in light of their having been hunted in spring when they tend to be undernourished (Burch 1972; Spiess 1979). Fat stores such as marrow are depleted in such situations, beginning with the upper limb bones (humerus and femur) (Speth 1983). The tibia and metatarsal retain fat longer (Binford 1978; Morin 2007), which may explain the much higher numbers of these elements among the Level 4C reindeer assemblage. Similar fat depletion processes affect other ungulates (e.g., Speth 1983) at least in terms of the proximal-to-distal sequence, so we assume that similar economic-based decisions influenced the higher abundances of tibiae (MNE = 29) and metatarsals (MNE = 20) from red deer in Level 6B versus the humerus (MNE = 16).

Finally, the abundance of heads is important to consider, since they are high-survival body parts but low in nutritional utility and bulky to transport. The reindeer assemblages in Layer 4 show low frequencies of heads; mandibles are the reason for the 50.0 ratio MAU value in Level 4A, although only four individuals are represented here, so this abundance might not be as significant as the value in Level 4C where we have 19 reindeer. Mandibles are frequent in Level 6A, suggesting that the small amount of marrow available in this element was exploited along with the other marrow-rich elements in this level. Moreover, this fits the general pattern in 6A where overall food utility was a factor in subsistence decisions. Crania and mandibles are about equally (and poorly) represented in Level 6B, but interestingly, Level 8 shows both crania and tibiae as most abundant. Perhaps the active use of fire in this level allowed for more efficient processing of the crania for their small amounts of nutrition.

In summary, there appears to be consistency in the relative abundances of the high-survival set of skeletal elements (i.e., the long bones and heads) across the Pech IV assemblages. Even the somewhat robust (but still considered low-survival; Marean and Cleghorn 2003) scapula and pelvis are poorly represented, suggesting that these elements were rarely transported. Carpals, tarsals and patellae are not abundant. It is unlikely that their underrepresentation is taphonomic or a result of collection bias during excavation, since they are generally robust (exception being the patella), diagnostic, and large enough to have been piece-plotted and collected separately during excavation. Therefore, their abundance probably relates to anthropogenic factors, namely that they rarely "rode" along articulated to their respective long bones because the limbs were previously disarticulated and defleshed before being transported to the cave. This corroborates the evidence for the levels in which we see the selective transport of the best marrow bones in much higher frequencies. Level 4C shows the most distinctive discrepancy between relative abundance of certain skeletal elements, pointing to different strategies of carcass transport during these cold period occupations.

Carcass Butchery and Utilization

Neanderthals' exploitation of ungulate prey across the Pech IV sequence is evaluated by means of frequencies of stone tool cutmarks, percussion marks and fresh (i.e., green or spiral) breakage. In order to have comparable datasets, the results are presented for the long bones of red deer and reindeer only (Fig. 9.3; Tables 9.4, 9.5). The actual number of cutmark striations or percussion marks was not counted but instead, the data presented here involve the NISP bearing one or more modifications.

Cutmarks are more than twice as frequent on the reindeer assemblages of Layer 4 in comparison to the lower layers. Since articular ends of long bones are scarce in the Pech IV assemblages overall, the majority of cutmarks are found on the shaft portions, indicating the removal of meat and tissue (e.g., Binford 1981; Nilssen 2000). The reasons behind the abundant cutmarked bone in Layer 4 is difficult to explain, particularly because cutmark production and abundance are not fully understood (e.g., Egeland 2003). If we compare the Pech IV Quina Mousterian (Level 4A) cutmark frequencies to two other known Quina Mousterian reindeer assemblages, the overall pattern is that the numbers at Pech IV are generally high; for example, Jonzac exhibits 20–25 % cutmarks on the long bones (Steele et al. 2009). However, the cutmark frequencies in Level 9 of Les Pradelles range between 30 and 60 % (Costamagno et al. 2006) and are comparable on some long bones to those seen in Level 4A at Pech IV.

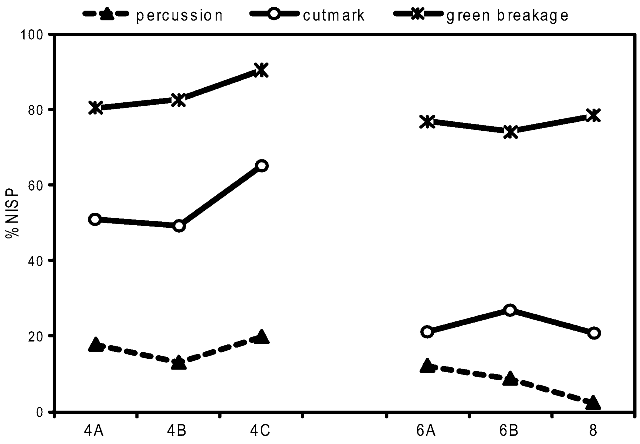

Fig. 9.3 Summary of bone modifications, expressed as %NISP, for reindeer (Layer 4) and red deer (Layers 6 and 8) long bones

A further evaluation of cutmark frequencies focuses on discrepancies between specific skeletal elements or between the meatier upper limbs and meat-poor lower limbs. Similar, overall abundances of cutmarks characterizes the red deer assemblages in Layers 6 and 8 (Fig. 9.4c). This pattern also applies to the reindeer in Level 4C but not in the other two levels (Fig. 9.4a). Levels 4A and 4B reflect differences in utilization of the meatier upper elements (humerus, femur) versus the lower limb elements that hold little muscle mass; perhaps these variations reflect carcass condition (e.g., stiff versus supple) or alternatively, the differences in morphology among each element that lend them to more or fewer cutmarks regardless of butchery effort (Egeland 2003).

Percussion impact marks are similarly abundant across the cervid assemblages (Figs. 9.3, 9.4b–d). These distinctive modifications are produced when a butcher uses a hard hammer such as a cobblestone to break open the long bone for accessing the marrow, although some of the percussion marks are likely lost or obscured by fracture surfaces in the bone. This may be a factor in the low frequency of marks in the Layer 8 assemblage, which was heavily fractured by burning and trampling. The lower frequencies in Layer 6 could be from the loss of preserved diagnostic marks from subsequent breakage but they might also reflect different strategies of processing red deer long bones for marrow. Excluding Layer 8 with its burning and trampling influences, the assemblages in Layer 6 show the smallest mean fragment size (50–52 mm) of green-broken long bones across the Pech IV sequence (for comparison, Level 4A

Table 9.4 Comprehensive summary of bone modifications across the six long bones, expressed as NISP and %(modification)

Level	NISP	Cut	%cut	Percussion	%perc	Green brk	%green
4A	118	60	50.8	21	17.8	95	80.5
4B	69	34	49.3	9	13.0	57	82.6
4C	581	378	65.1	114	19.6	522	90.5
6A	510	108	21.2	62	12.2	392	76.9
6B	508	137	26.9	46	9.1	377	74.2
8	293	61	20.8	7	2.4	230	78.5

Table 9.5 Summary of cutmark and percussion frequencies by skeletal element (long bones only) expressed as NISP and %(modification)

Level	4A			4B			4C			6A			6B			8		
	NISP	%c	%p	NISP	%c	%p	NISP	%c	%p	NISP	%c	%p	NISP	%c	%p	NISP	%c	%p
Humerus	11	27.0	55.0	9	67.0	22.0	50	60.0	26.0	64	28.0	20.0	81	27.0	15.0	51	22.0	0.0
Femur	20	60.0	30.0	11	91.0	27.0	59	61.0	27.0	66	26.0	12.0	65	32.0	9.2	52	23.0	3.8
Tibia	20	40.0	15.0	10	70.0	10.0	108	65.0	32.0	78	22.0	15.0	104	38.0	6.7	60	25.0	5.0
Radius-ulna	28	54.0	3.6	14	36.0	7.1	100	62.0	20.0	66	20.0	4.5	68	28.0	5.9	52	35.0	0.0
Metacarpal	7	71.0	57.0	3	67.0	33.0	42	67.0	31.0	39	13.0	28.0	85	19.0	7.1	27	7.4	0.0
Metatarsal	32	53.0	3.1	22	18.0	4.5	222	69.0	7.7	197	19.0	7.6	105	19.0	11.0	51	5.9	3.9

mean = 62 mm; Level 4C mean = 58 mm). Because ethnoarchaeological data on ungulate carcass processing from the Kua in Botswana revealed a distinct pattern where long bone fragmentation increased with time spent at the processing site (Bartram 1993: 86), we should reconsider the importance of fragmentation in conjunction with bone surface modification data to better understand issues such as carcass utilization and site use (Egeland and Byerly 2005).

Fresh, spiral breakage of long bones is consistent across the Pech IV cervid assemblages but again, Layer 4 shows a slightly different pattern. The frequency of green breakage is higher and long bone fragment length is slightly larger (see above). Spiral breakage is generally attributed to marrow processing activities but it might also result from disarticulation in smaller ungulates (e.g., Stiner 2005). It is interesting to note that the frequencies of spiral breaks, cutmarks and impact marks rise and fall more or less together in the Layer 4 assemblages (Fig. 9.4). What these potential correlations mean is less clear, but the bone modification data together show that butchering and processing of reindeer in Layer 4 differed from these activities on red deer in Layers 6 and 8. The significantly higher frequencies of cutmarks in Levels 4A and particularly 4C may reflect more intensive processing of elements for their nutritional yield, but the time spent on these activities was brief in comparison to the lower layers if we consider that larger fragment size implies less time investment for processing (Bartram 1993).

Conclusion

The long stratigraphic sequence at Pech IV provides a unique opportunity for evaluating Neanderthal subsistence behavior and site use over a long period of time and within variable climate regimes. The faunal spectrum at the base of the sequence (Layers 8 through 6) indicates site occupations during generally temperate conditions with forested landscapes.

Zooarchaeological results from these layers show that the cave was occupied repeatedly during most or all of the year; several temperate ungulate taxa were hunted, although red deer was the predominant prey in these layers. Based on the seasonality data, we presume that this taxon was locally available during much of the year. Marrow-rich long bones are the most abundant skeletal parts in all of these assemblages and were cracked and processed thoroughly for their within-bone nutrients. The lithic inventories in Layer 8 indicate the production of tools on local raw materials. In conjunction with evidence for the controlled use of fire in this layer as well as the faunal data, it looks as if occupations were of longer duration. Minus the evidence of fire,

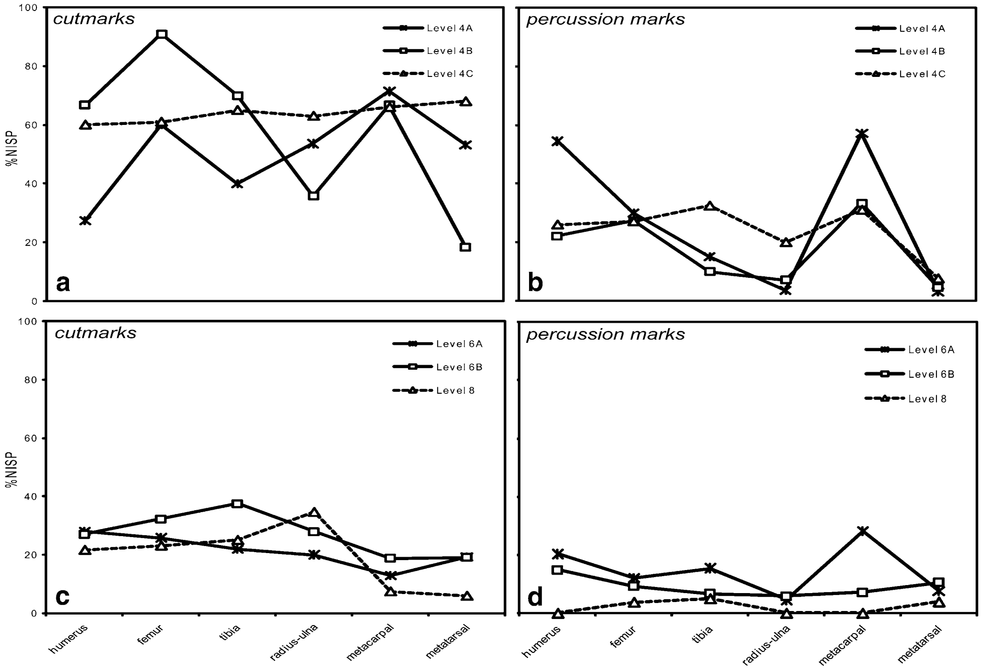

Fig. 9.4 Cutmark and percussion mark frequencies, expressed as %NISP, for each long bone of reindeer in Layer 4 (**a**–**b**) and red deer in Layers 6 and 8 (**c**–**d**)

Layer 6 shows a similar pattern of occupation, with on-site production of small flakes and extensive exploitation of cervid prey. Overall, the temperate layers of Pech IV show remarkable stability in the way the cave was used, suggesting that this locality played an important role in the local settlement system.

The cold period Layer 4 at the end of MIS 4 and beginning of MIS 3 reflects a different character of occupations by Neanderthals. The faunal spectrum is quite limited, with reindeer overwhelmingly predominant, most likely due to climatic factors as opposed to human choice (Grayson and Delpech 2005). Occupations and hunting of reindeer took place in seasonally-restricted windows, likely when this prey species was available locally as it moved through the area on its spring migration. The evidence for focused predation on this seasonal ungulate during its migrations from Layer 4 at Pech IV adds to the number of cold period Mousterian or Quina Mousterian sites in southwestern France showing this subsistence strategy (e.g., Les Pradelles (Costamagno et al. 2006); Jonzac (Steele et al. 2009)). This does not suggest that Neanderthals followed the herds during the year, but instead were knowledgable about the seasonal abundance of a preferred prey animal and took advantage of these opportunities. At other times of the year, Neanderthals presumably hunted the less migratory and more predictable animals such as horse and bison. It remains unclear where hominin groups based themselves during the seasons they were not occupying Pech IV, but all of the evidence from Layer 4 indicates higher mobility. A higher percentage of exotic raw materials is seen in the Quina Mousterian Level 4A, and the overall trend seen in the zooarchaeological data is that reindeer were processed intensively in this level as well as the Typical Mousterian Levels 4B and 4C, with selective transport of the best marrow bones (distal limb). In summary, the picture gleaned from the datasets in Layer 4 shows much less stability in site use in comparison to the earlier occupations, which reflects adaptations by Neanderthals to such factors as climate, ecological conditions, and prey availability.

The record from Pech de l'Azé IV provides valuable new insight on Neanderthal occupations of this site. The extent of its stratigraphic sequence makes Pech IV particularly interesting and further results from the faunal, lithic and geological analyses are forthcoming. In terms of subsistence behavior, the zooarchaeological results presented here support those from numerous other Neanderthal sites (e.g., Boyle 2000; Burke 2004; Speth and Tchernov 2007; Rendu 2010), showing the flexibility and adaptability of this hominin's hunting strategies and utilization of its landscape.

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