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

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5 Biache-Saint-Vaast

5.1 Introduction

The previous chapter set out to develop a way in which the diet breadth model can be applied to the archaeological record. In this chapter and the next, I will test whether applying the model to archaeological assemblages yields satisfactory insights. The focus of this chapter will be the bone assemblage of the French site of Biache-Saint-Vaast.

Biache-Saint-Vaast is an open-air site in the north of France with several occupation levels. These levels were deposited during the transition of Marine Isotope Stage (MIS) 7 to MIS 6. The site was discovered in 1976 during building activities. Excavations took place between 1976 and 1982 (Tuffreau 1988a). The sedimentological sequence of the site consists of fluvial sediments at the base, overlain by Saalian and Weichselian loess. The archaeological levels are found in the higher reaches of the fluvial sediments and in the lower part of the loess sequence (Sommé 1988, Tuffreau 1988c).

The bone assemblage that was excavated at the site numbers over 200,000 specimens, 20,000 of which were identifiable. The majority of the bone assemblage comes from a single occupation level, level IIA (Auguste 1992, Auguste 1993, Auguste 1995a). Many of the bones show cut-marks, demonstrating that hominins played an important part in the formation of the assemblage. Moreover, a large Mousterian assemblage was recovered from the site. Finally, two hominin skulls have been found at the site. Only one of these skulls has been studied. The taxonomic determination of this fossil is not completely clear. It was originally classified as pre-Neanderthal, but shows apomorphies that have led it to be classified as an early Neanderthal or a Neanderthal *sensu lato* in more recent studies (e.g. Dean *et al.* 1998, Hublin 1998, 301, Schwartz and Tattersall 2002). The bone assemblage of the site is dominated by aurochs (*Bos primigenius*) followed by brown bear (*Ursus arctos*) and narrow-nosed rhinoceros (*Dicerorhinus hemitoechus*) (Auguste 1992, Auguste 1993, Auguste 1995a). Interestingly, the representation of the species changes through the archaeological levels. This allows us to study how the analysis using Optimal Foraging Theory (OFT) reflects the changing environmental circumstances.

This site has the advantage that it was excavated relatively recently, using modern excavation methods. This means that in contrast to Taubach, which is the focus of the following chapter, aspects such as the spatial distribution of finds have been studied at Biache-Saint-Vaast (e.g. Tuffreau and Marcy 1988a). These circumstances permit a higher resolution of environmental reconstruction than at Taubach. Unfortunately, only one volume of the monograph has been published to date. The treatment of the bone assemblage in this publication is preliminary and limited to only three levels (Auguste 1988b). Papers have been published on the bone assemblage, but they sometimes contain conflicting data.⁸ Moreover, the bone assemblage of the richest level, IIA, has not been published in great detail.

In this chapter I will first provide the stratigraphic and geological context of the archaeological site. The artefact assemblages of the most important archaeological levels will be presented, after which I will provide an overview of the published bone assemblages. Then I will place the site in its local and regional environmental context. Subsequently I will attempt to apply Optimal Foraging Theory (OFT) to this site. I will endeavour to use OFT to develop a scenario explaining the foraging strategies practised by the site's occupants.

5.2 The site

The site of Biache-Saint-Vaast is located in the *département* Pas-de-Calais in northern France, in the vicinity of the city of Arras. It was discovered in 1976 during the extension of a factory and following the discovery, a rescue excavation was initiated. By the time the excavation got underway, the sediments containing the find levels had already been removed from 1500 m² of the 2000 m² building

⁸ For example, in terms of NISP, (Auguste 1993) provides a percentage of about 50% of Aurochs bones, while in (Auguste 1995a) it is close to 70%.

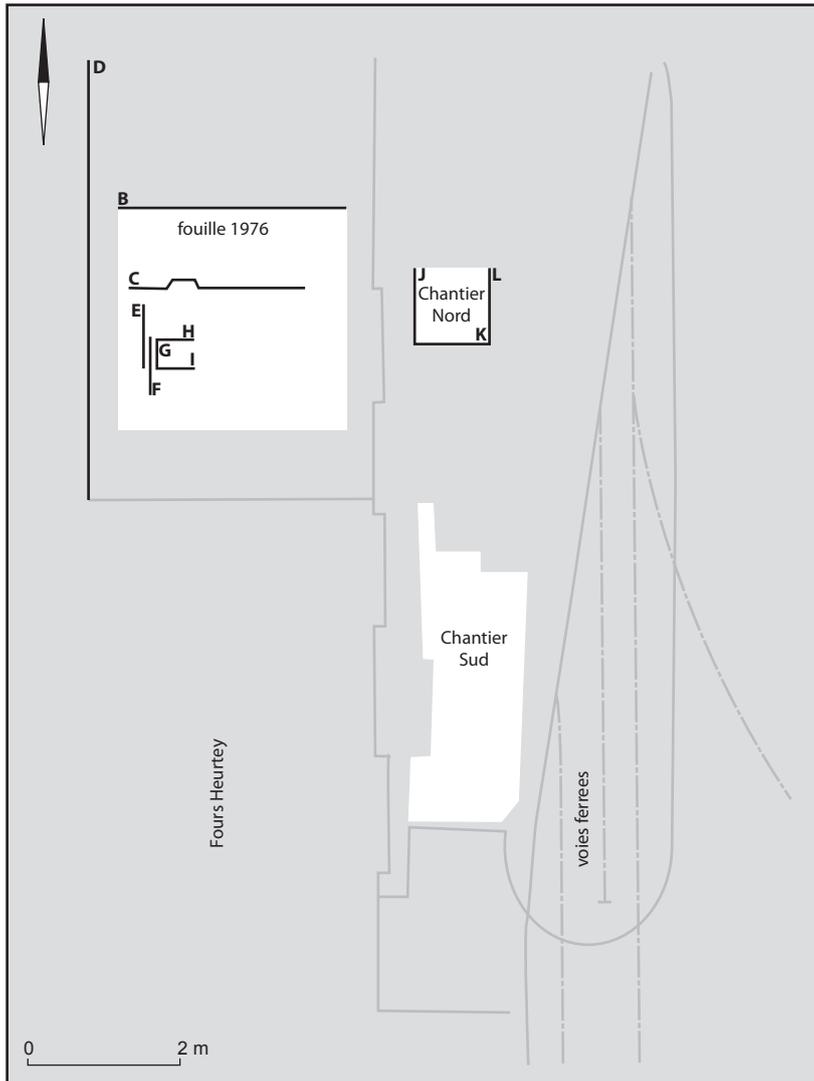


Figure 5.1 Plan of the location of the excavation trenches at Biache-Saint-Vaast. Based on (Tuffreau 1988a, 22).

site (Tuffreau 1988a, 15). From 1977 onwards, a research excavation was started on a neighbouring part of the factory terrain. Up to 1982 about 600 m² was excavated in this project (Tuffreau 1988a, 17-18). In total, three locations have been excavated at the site. One location was excavated during the rescue project in 1976, while during the research project carried out from 1977 onwards two other locations were excavated (see figure 5.1 for a plan of the excavated areas). The archaeological stratigraphy in the different excavation zones is not uniform, due to the complicated geological history of the site.

Geologically, the site is located in the zone where North European plain meets the chalk plateau of the Artois (Sommé *et al.* 1988). A calcareous plateau is located to the northwest of the site. The site itself sits on the edge of a river-terrace in the Scarpe valley. It is situated between 56 and 44 metres above sea-level (Sommé *et al.* 1988, 115).

5.3 Dating

The site is thought to date to an interglacial within the Saalian, MIS 7. This is based on a combination of direct dating, and (bio)stratigraphic factors. Six burnt flint tools from level IIA were dated using thermo luminescence (TL). This yielded an average date of 175 ± 13 ka. This analysis was performed on flints that had been excavated several years previously and must therefore be regarded

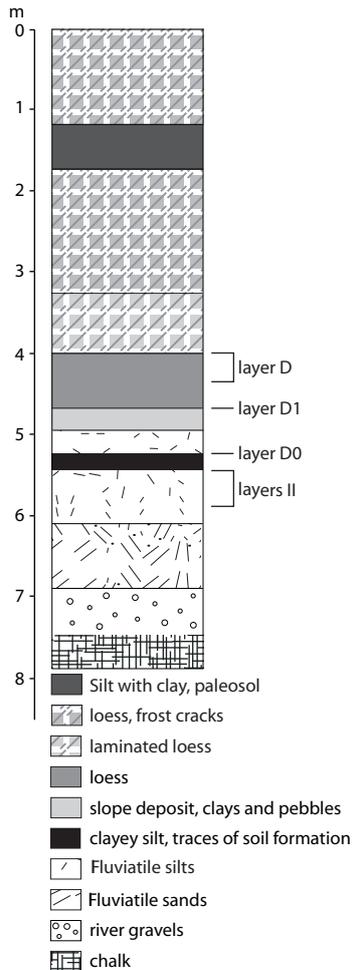


Figure 5.2: Schematic stratigraphic column of Biache-Saint-Vaast, with the position of archaeological levels. Based on (Sommé 1988, 32).

with caution (Louguet-Lefebvre 2005, 101). One of the hominin skulls, found in level IIA, was dated using gamma-ray spectrometry, yielding an age of $253 \pm 53/-37$ ka. A bone from the same level was dated using U-Th; this yielded an age of $182 \pm 46/-31$ ka (Louguet-Lefebvre 2005, 101). MIS 7 is thought to have lasted from 245 until 190 ka. The direct dates therefore roughly coincide with this period (Louguet-Lefebvre 2005, 101). Nevertheless, the combined evidence from the stratigraphic sequence, the pollen-spectra and the malacological and micromammal remains, shows that no interglacial climatic optimum is represented in the archaeological layers.

An important indication for the date of the archaeological levels is the fact that the fluvatile sands the bottom of the sequence, represent a climatic optimum (See figure 5.2 for a schematic overview of the stratigraphic column of the site). This unit contains *Corbicula fluminalis* molluscs (Tuffreau and Sommé 1988a, 311-312). This species is indicative of interglacial conditions, but is not known from the Eemian (Meijer and Preece 2000). Moreover, the *Arvicola* fossils at the site indicate that it is younger than Maastricht Belvédère in the Netherlands, which is dated to MIS 7 (Roebroeks 1986, 86). The archaeological levels document the transition to colder climates, with at least two climatic ameliorations represented in the levels (Tuffreau and Sommé 1988a, 311).

The paleosol just under 1 metre in figure 6.1 also provides vital clues with regard to the dating of the site. This unit, which is only preserved in a small part of the Chantier Sud, is a paleosol which can be correlated to the Sol de Rocourt/Sol de Warneton in the regional stratigraphy. This soil complex is dated to the Eemian interglacial and thus provides a *terminus ante quem* for the underlying layers (Sommé 1988, 34-43). The underlying layers appear to show a fairly continuous sequence of loess deposition, although some erosional events appear to have taken place in the upper part of the sequence (Sommé *et al.* 1988, 116-117). If the loess deposition really was of a continuous nature, this implies that the layers underlying the paleosol date to the second cold phase of the Saalian, MIS 6. This is supported by the fact that the underlying loess contains deep frost cracks (Sommé 1988, 34). The fluvatile units, documenting warmer conditions would then date to an interglacial or interstadial earlier than the Eemian.

The combination of the direct dates with the stratigraphic evidence discussed suggest the site must be dated during the transition of MIS 7 to MIS 6, or during the early part of MIS 6.

5.4 Stratigraphy and archaeological horizons

Multiple archaeological levels have been excavated at the site of Biache-Saint-Vaast (see figures 5.2 & 5.3). The stratigraphy of the site is complex, as a result of tectonic processes and many small faults are visible in the profiles, especially in the *Chantier Nord* (Tuffreau 1988c, 127). Moreover, the succession of archaeological levels in the *Chantier Sud* is different from that of the northern part of the site. I will summarize the information about the stratigraphic sequence here, with an emphasis on the most important archaeological levels.

The archaeological levels are situated in the lower part of the sedimentary sequence. The most important archaeological levels were designated (from oldest to youngest) IIA, II α , II base, D0, D1 and D. The sediments in which level IIA to D0 are situated are fluvatile. They were probably deposited in shallow slow-moving to standing water. Level D1 and D on the other hand, are situated in wind-blown loessic deposits. This had consequences for the preservation of the faunal remains in these levels, which are chemically weathered (Auguste 1988b).

Fluvatile gravels have been deposited at the base of the sequence, on top of the cretaceous chalk substrate. This level is overlain by cross-bedded medium to fine-grained yellowish fluvatile sands containing, chalk granules. This level is capped by fine-grained fluvatile sediments, dubbed “tuff” in the literature and designated as Unit 2b. This unit contains the archaeological levels IIA and, slightly higher II α in the Chantier Nord. In the Chantier Sud it harbours levels H through F (Sommé 1988, 30-31). The unit consists of very calcareous yellowish fluvatile silt, with calcareous

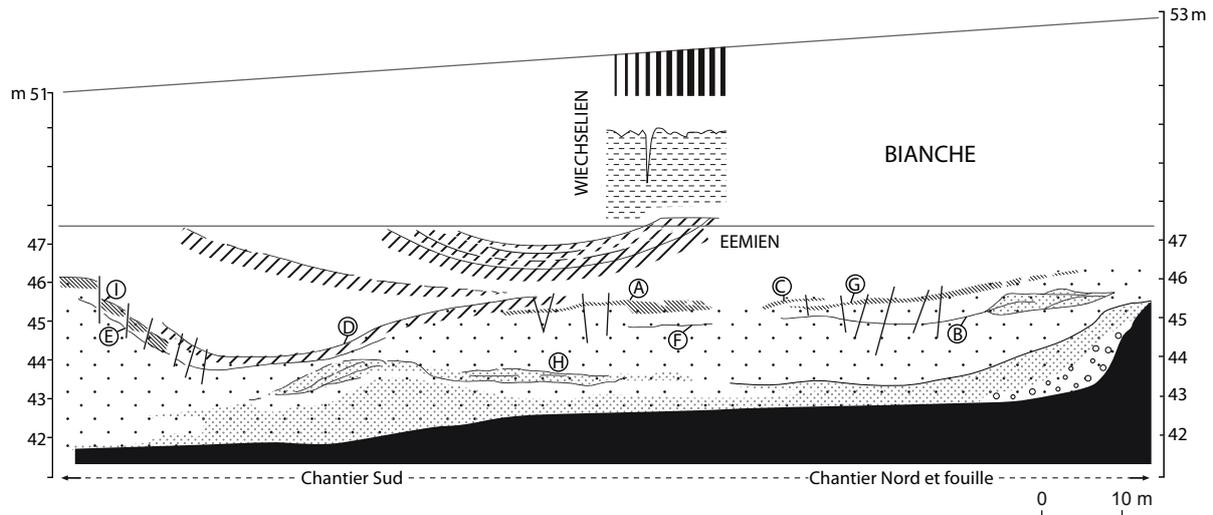


Figure 5.3: Stratigraphic profile of Biache-Saint-Vaast showing the position of the important archaeological levels. Based on (Tuffreau 1988c, 131).

concretions distributed in discontinuous bands. This level was formed by periodic low-energy calcite-rich fluvial sedimentation (Sommé *et al.* 1986, 189).

Unit 2b contains the most important archaeological levels of Biache-Saint-Vaast, among which level IIA, the richest level at the site. This level is in the lowest stratigraphic position in the Chantier Nord. In the Chantier Sud, levels H, G and F were found in lower stratigraphic position, but they did not yield much behavioural information. Level IIA consists of large numbers of bones and flint artefacts, densely packed together. The level is dark in colour, at least in part because of the presence of charcoal in the sediments. This dark colouration has led to the identification of animal hoof prints and one possible hominin footprint in the upper reaches of the layer. It has been excavated over an area of about 150 m² (Tuffreau 1988c, 123). Above level IIA, in parts of the area covered by the rescue excavation and the Chantier Nord bone fragments and flint artefacts have been found. They were separated from the finds of level IIA by sterile sediments. These have been assigned to a different level, II α (Tuffreau 1988c, 123).

Unit 2b is topped by Unit 3 (at a depth of 5 metres in fig. 6.1), a thin unit that shows traces of soil formation. Unit 3 comprises two different facies. They were deposited in different sections of the river bed as the river moved away from the site. The lower facies of this unit, Unit 3a, consists of slightly clayey silt, with a high humic content and showing severe signs of bioturbation, pointing to soil formation (Sommé 1988, 31). Level II base was excavated in these sediments. This layer was present in the whole area of the 1976 rescue-excavation and has been excavated over an area of 340 m² (Tuffreau 1988c, 123-127). Unit 3b has been documented in depressions, mostly in the Chantier Sud (see figures 5.2 & 5.3). This layer is made up of silts, less clayey than those of 3a, grey-brown in colour. This deposit represents a hydromorphous paleosol, which contains the archaeological level D0 (Sommé *et al.* 1986, Tuffreau 1988c). In other parts of the Chantier Sud, level E was recognised. It is in a comparable stratigraphic position as level D0. Level E actually consists of multiple thin archaeological levels. In part of the trench the separate levels are not discernible, they are therefore grouped as one level E (Ameloot-Van der Heijden 1989, Tuffreau 1988c).

In the Chantier Nord, much of the fine-grained fluvial sediments were eroded away by the river. Levels IIA and II base were only present over roughly 20 m² in this trench (Tuffreau 1988c, 237). In the part of this trench where the sediments were still in place, Unit 3a and 3b were observed in sequence. Because both these units are paleosols, they must have been stable surfaces for quite some time. This leads the excavators to conclude that the archaeological level D0 must have been deposited some time after level II base (Sommé 1988, 31).

Above Unit 3 the mechanism of sedimentation changes. Unit 4, a slope deposit consisting of clays and pebbles, filled in the basins that were left in the area after the phase of fluvial sedimentation ended. During this phase of sedimentation, the top of the underlying unit 3 was also partly eroded, and reworked materials from Unit 3 are found in Unit 4 (Sommé 1988, 31). This level is

overlain by a level consisting of silt, but with high proportions of sand and clay, unit 5. This level is distinctly humic. The lower part of the unit consists of a coarse-grained horizon that overlies the tuff in parts of the site and covers the deposits of unit 3 that have been deposited in basins in the old riverbed (Sommé *et al.* 1986, 190). The archaeological level D1 is situated in this zone (Tuffreau 1988c, 129).

Higher up in this unit, the archaeological level D was located (Sommé 1988, 34). Level D1 coincides stratigraphically with a diffuse scatter of small limestone and flint pebbles. Archaeological materials have only been recognised in small parts of this scatter, over an area of about 115m² (Tuffreau 1988c, 129). Level D is separated from Level D1 by sterile sediments of variable thickness. Level D has been impacted by numerous tectonic faults. Its size is about 120 m².

Apart from the D levels, other archaeological levels have been recognised in the Chantier Sud; most of these yielded few archaeological materials and some of them have been partly destroyed by a brickyard that occupied the site before the current factory had been built. Furthermore, their faunal assemblages have not been published in detail (Auguste 1988a, Auguste 1988b, Auguste 1992, Auguste 1993, Auguste 1995a). Because of the absence of information on the faunal assemblage from levels H, G, F, E and D0, these levels will not be considered in the OFT analysis of this study.

The archaeological levels in the fluvial deposits are thought to have been deposited in a short time and to have been buried shortly after deposition. Due to the large amount of material that was discovered in level IIA, the excavators presume that this level was accumulated over the course of multiple episodes of occupation. However, sedimentation was rapid and traces of weathering are absent from the bones. Therefore these episodes must have taken place over a relatively short period of time (Tuffreau 1988c, 131).

5.5 The stone artefacts

The archaeological levels of the site have yielded large stone artefact assemblages, especially level IIA. Since its assemblage is the largest one present at the site, the stone tool technology of Biache-Saint-Vaast has mainly been discussed on the basis of the assemblage from this level (*e.g.* Boëda 1988, Sih and Milton 1985, Tuffreau 1988b, Tuffreau and Sommé 1988a). This should not obscure the fact that the other levels contain lithics too and that these sometimes point to different activities being performed. Additionally, since levels II base, D1 and D appear to represent short periods of occupation, spatial analysis in these levels is thought to reveal the spatial organisation of the activities that were performed there.

In all levels, the great majority of artefacts were made of local flint. It may have been available in the river banks, on or very close to the site. On the other hand, the cortex of the used nodules does not show traces of weathering by fluvial transport, suggesting the exploitation of primary flint deposits. These may have been exposed in chalky taluses in the vicinity of the site, however at the site itself the flint deposits would have been buried under 12 metres of alluvium. Therefore, the exact provenance of the raw material is unclear (Tuffreau and Marcy 1988b, 365).

Only the lithic remains with a clear stratigraphic provenance and a length of more than 30 mm. were studied from level IIA. This results in a studied assemblage of 3231 artefacts weighing 133.43 kg. (Tuffreau 1988b, 171). All but four of the studied artefacts were made out of flint. Although the Levallois method was practised at the site, the Levallois index of the assemblage is not very high (15.71). Another striking characteristic is the high blade index of the assemblage. However, the pieces classified as blades usually have a length/width ratio of less than two. Of Levallois products, 62.21% of the striking platforms was prepared, while this was only 30.78% in the non-Levallois products (Tuffreau 1988b, 171). The percentage of flakes showing cortex on the dorsal side is high (44.9%). Moreover, most flakes were small, with about 80% of flakes being under 40 mm long and only 1% having a length in excess of 80 mm. The large flakes were preferentially selected to be transformed into tools. Moreover, in addition to the size of the blank, elongation of the product also appears to have been an important characteristic in the selection for tool production. In the blanks selected for tool production, this ratio generally exceeds 2 (Tuffreau 1988b).

Technologically, many Levallois products are present in the assemblage, but “classic” Levallois cores with one preferential plane of flake removal are absent (Boëda 1988, 186). Instead Levallois products were produced using either uni- or bipolar cores that yielded multiple overlapping flakes of predetermined form (Boëda 1988, 186-187). This shows that innovations were introduced to the tra-

ditional Levallois method during the late Middle Pleistocene (Tuffreau 1992, 63). This development had consequences for the morphometric characteristics of the blanks produced, most importantly the fact that the length-width ratio of the flakes was increased. However, during the life history of the core the laminar character of the products diminished (Boëda 1988, 213).

Tools are comparatively rare in level IIA. It is thought that the assemblage represents a lightly used industry, because high quality raw materials were present in close proximity of the site (Dibble 1995, 344). In the assemblage, Levallois products were preferentially selected as blanks for tool production. Typologically, Mousterian tools dominate the assemblage. The number of Mousterian tools further increases if the large number of “naturally backed knives” is included. Most of the Mousterian tools are tools with convergent sides (40.20%), followed by single (18.71%) and double (10.23%) scrapers (Tuffreau 1988b, 172). In addition to the Mousterian tools, denticulates are also present in quite large numbers (10.81%). Some *outils de type paléolithique supérieur* like burins and truncated flakes have also been recovered from this level (Tuffreau 1988b, 172).

Although the assemblage is dominated by tool types with convergent sides, many of these tools are not classified as formal points. Levallois points account for 1.24% of the assemblage, retouched Levallois points for 0.87% and pseudo-Levallois points for 1.75%. Mousterian points are more common, they account for 5.84% of the assemblage and 7.89% of the tools are elongated Mousterian points (Tuffreau 1988b, 182). As mentioned in chapter 3, Villa and Lenoir (Villa and Lenoir 2006, 91) have argued that other forms that in traditional typology would be designated as scrapers may well have been used as spear points. They specifically mention convergent and *déjeté* scrapers. Together with Mousterian points these are said to be abundant in the assemblage from level IIA, accounting for 23.39%. Therefore, points, which could be considered to have played a role as hunting weapons may not be as rare in the assemblage as might seem to be the case at first glance. In 64% of the cases, the blanks from which these tools were produced were Levallois products (Tuffreau 1988b, 174). Interestingly, the convergent forms present in the assemblage were very standardised. The excavators think that this may be because they were produced to be hafted (Tuffreau 1992, 65).

The assemblage from level IIA is very much like the Mousterian of Ferrassie type. It has a significantly higher percentage of tools with convergent edges and has therefore been dubbed *Mousterien de type Ferrassie de faciès Biache* by the excavator (Tuffreau 1988b, 178). The emphasis on the production of scraper types is thought to have stimulated the production of elongated products, which caused the high blade index (Dibble 1995, 344).

The assemblage from Level II base was similar to that from Level IIA (Tuffreau and Marcy 1988a, 234). A striking category of finds in this level is a large number of flint nodules, many of which are unmodified. Most of them are also concentrated in a discrete zone of the site. Furthermore, the majority is of poor quality flint. Therefore it is unclear whether this represents some kind of raw material cache, or whether the blocks may have had a different function, such as use as a pavement (e.g. Tuffreau and Marcy 1988a, 233). Some of the smallest nodules found may have been deposited by natural processes. However, many of the blocks are large and heavy and some of them exhibit negatives of flake removals. Therefore, most of the material probably has an anthropic origin. Some other characteristics of the stone assemblage may point to the most likely interpretation of these remains. First, in the debitage category, cortical flakes are very common (17.4%). Second, many cores are “informe” or “casson” (Tuffreau and Marcy 1988a, 234). This may point towards an interpretation of the abundance of unmodified nodules as the result of raw material collection and testing at the site. The shaping of formal cores and production of tools would then have taken place outside the excavated zone.

The spatial distribution of the finds allowed the identification of different zones or activity areas. In addition to the zone dominated by flint nodules, two areas at the site show a predominance of flintknapping remains, while the largest area of the site is dominated by faunal remains (Tuffreau and Marcy 1988a, 259). Taking into account the composition of the lithic assemblage, level II base has been interpreted as representing a level where fauna were dismembered and consumed. Within the fauna-dominated zone, two empty areas were excavated, whose significance remains unclear.

Level D1 yielded a stone assemblage of almost 3000 pieces, dominated by small debitage products. Almost 50% of the flakes has cortex. The Levallois index of the assemblage is low and as in levels D0 and E, Levallois flakes are not preferentially used as blanks for the production of tools. The non-Levallois cores in the level are of limited dimensions and exhausted, prompting the excavators to speculate that raw material provisioning may have been difficult at the time of occupation. In

this respect it is strange that Levallois flakes are so rarely modified in this level. The assemblage has been described typologically as “Mousterian with denticulates” (Marcy and Tuffreau 1988b).

Level D1 contains two concentrations. The richest concentration was found in the southern part of this level. Here, a concentration of Levallois-like debitage and naturally backed knives co-occurs with the majority of the level’s faunal remains. The poorer northern concentration contains a largely empty zone of about 12 m². This zone is bordered by flint nodules that weigh 700 grams on average. This contrasts with the average weight for flint nodules found in level D1 in general, which is 260 grams. This has led the excavators to propose that this empty zone may represent a shelter (Marcy and Tuffreau 1988b, Tuffreau and Marcy 1988b).

Level D yielded a small lithic assemblage. Only two Levallois cores were present in the level, as well as 18 Levallois flakes, of which 15 were broken. Moreover all of these flakes were very small. Only 5 tools were present and these were badly manufactured, with the exception of one Mousterian point. The normal debitage also has small dimensions, 75% of flakes being smaller than 40 mm. All in all, level D represents an ephemeral occupation in view of stone tool deposition. The bone assemblage that was recovered in this level was relatively large, with almost 500 pieces (Marcy and Tuffreau 1988a).

Use-wear analysis has been undertaken on some of the recovered artefacts from Level IIA (Beyries 1988). The results of this analysis are interesting, yet not unproblematic. The results of the analysis can be divided in two categories. Evidence with regard to hafting of tools and evidence with regard to the use of the working edge of artefacts.

Hafting was an important element in the repertoire of tool use represented at the site. Moreover, hafting is restricted to certain types of tools, while other types lack hafting traces. Hafting was practised exclusively on symmetric tools with convergent sides. More importantly, all the short tools with convergent sides were hafted as was 90% of the elongated tools with convergent sides (Beyries 1988, 230). This shows that hafting was important with regard to the functioning of these tools. This may support arguments put forward by Villa and Lenoir (2006) that some of the convergent scraper types may have functioned as spear points.

Strangely, most of the traces of use on the working edges of the tools point to woodworking. Only the short, non-convergent scrapers show wear related to animal butchery (Beyries 1988, 230). This contradicts the hypothesis that many of the convergent tools could have functioned as spear points. It even suggests that most tools did not have any relation to the faunal remains. However, as discussed in chapter 2, traces of woodworking can also be the result of sediment movements (Levi-Sala 1986). As shown by the numerous tectonic faults in the profiles this process was intense at the site. Therefore, this evidence cannot be accepted at face value.

According to (Tuffreau and Marcy 1988b, 306), indications for the use of fire at the site are limited to some pieces of burnt flint and bone that have been found in level II base, while level D1 also yielded a few pieces of charcoal. This statement is contradicted in (Tuffreau 1988c, 123), where it is said that level IIA was clearly recognisable as a dark layer because of the large amounts of charcoal that were present in the level. The use of fire therefore was probably a regular event during the deposition of level IIA, while in the other levels, it was rarely used or absent.

Very striking is the fact that level IIA represents a “lightly used industry” (Dibble 1995), in most other levels there are indications that raw materials were quite scarce. This is shown by the limited dimensions of cores and debitage and the fact that many cores are almost exhausted (Ameloot-Van der Heijden 1989, Marcy and Tuffreau 1988b).

5.6 The bone assemblage

The bone assemblage recovered at this site is large, containing over 200.000 pieces, about 20.000 of which could be determined to species level (Auguste 1988b, Auguste 1992, Auguste 1993, Auguste 1995a). Since the excavation was done in recent years under controlled circumstances, in contrast to sites that were excavated earlier, like Taubach (see chapter 6), recovery of faunal materials was less biased. Unfortunately, there are some problems associated with the bone assemblage from this site. Several papers have been published, providing varying amounts of detail about the bone assemblages per level. Only the bone assemblages of levels D1, D and II base have been published in detail, i.e. listing the Number of Identified Specimens (NISP) of all the identified species (*e.g.* Auguste 1988b, Auguste 1992). The most important problem connected to the study of this site is the fact that the level with the largest bone assemblage, Level IIA has not been published in detail. A number of

publications of the zooarchaeology of this site treat all the bones as a single assemblage, despite the fact that they were recovered in several levels documenting differing environmental conditions (*e.g.* Auguste 1993, Auguste 1995a, Auguste 2003, Auguste and Patou-Mathis 1994). Fortunately, a separate study of the megaherbivores of the site provides additional information about the numbers of identified bones per level (Louguet-Lefebvre 2005). The number of identified bones varies between publications, presumably because as research progressed additional remains were identified.

With regard to the species represented at the site, there are also some problems. Most important is the case of large bovids. Many of the bovid bones could not be determined at species level, but may have belonged to either Bos or Bison. I have not come across the exact numbers of bones determinable to species level for bovids in the assemblage as a whole. However, Bison (*Bison priscus*) has only been mentioned in the species list in (Auguste 1992), while the species lists in (Auguste 1988a, Auguste 1988b, Auguste, Moncel, and Patou-Mathis 1998, Louguet-Lefebvre 2005) only contain aurochs. Other publications like (Auguste 1993, Auguste 1995a, Auguste 2003) do not contain an exhaustive list of the species represented in the assemblage, but they only mention aurochs for the site and not bison. Therefore, I will assume that the large bovid represented at the site is aurochs and that bison is either absent or at least very rare in the assemblage.

The degree of hominin exploitation of the different species at the site as a whole has been researched. However, it is not always quantified, therefore it has been necessary to accept qualitative statements of the archaeozoologists as in: “aurochs bones are more intensively cut-marked than those of rhinoceros.” Moreover, the degree of carnivore damage to the bones is also not quantified. From the information that is presented, it is clear that hominins were the accumulating species at Biache-Saint-Vaast though.

In this section, the focus will be on the information available for the assemblage of the site as a whole and the treatment of the dominant taxa. Only for levels II base, D1 and D are more detailed data available. Therefore these levels will be discussed separately. Analysis of the assemblage as a whole is defensible, since level IIA alone yielded 89% of the identifiable bone materials at the site. Moreover, the levels with the other large assemblages II α (about 5% of the total assemblage) and IIbase (about 2.5% of the total), were deposited in similar environmental circumstances. The large mammal assemblages in these levels are poorer in species, but generally of similar character to the assemblage from level IIA (see table 5.1).

Figure 5.4 illustrates the relative importance of the different taxa in the bone assemblage from this site. Several authors erroneously list bovids as accounting for 70% of the assemblage, following Auguste (Auguste 1995a). Other publications list different values (*e.g.* Auguste 1993, Auguste 1995b), with bovids only accounting for less than 50% of the assemblage. This percentage is also borne out by the actual NISP figures provided by Auguste (Auguste 1995a). Therefore the widely cited value of 70% bovids must be the result of an accounting error. Table 5.1 shows the composition of the faunal assemblage per archaeological level at the site in terms of species. The total number of identified bones is listed as well. It is obvious that level IIA is the most important level both in terms of the number of species identified and in terms of the NISP.

The site is thus dominated by three groups of species. In terms of NISP, bovids account for 50%, bears for 33% and rhinocerotids for 15% of the assemblage. The remaining 15 species account for only 3.5% of the NISP. If we look at the MNI values, the picture changes slightly, as shown in figure 5.5. Aurochs is most important still, followed by bear and narrow-nosed rhinoceros. However, the other species that were represented by small numbers of identified bones increase in importance now.

Changes in species representation occur during the sequence and reflect climatic changes (Sommé *et al.* 1988, 118). In general, the fauna points to a mosaic environment. Some of the species, like cervids and especially wild boar (*Sus scrofa*), which is present but rare, point to the presence of forested areas. Others, like narrow-nosed rhinoceros and equids, point to an open environment (Auguste 1992). With regard to the application of OFI, treating the faunal assemblage of Biache-Saint-Vaast as a single entity is hazardous. Climatic and environmental change may have resulted in altered rankings of the species involved or in the broadening of hominin diet because of changes in search time.

5 BIACHE-SAINT-VAAST

	I	H	G	F	En	IIA	IIα	IIbase	D0	D1	D
<i>Sus scrofa</i>					■	■	■		■		
<i>Cervus elaphus</i>	■					■	■	■		■	■
<i>Megaloceros giganteus</i>		■				■	■				■
<i>Capreolus capreolus</i>					■	■	■				
<i>Bos primigenius</i>	■	■		■		■	■				■
<i>Dicerorhinus hemitoechus</i>	■	■			■	■	■				
<i>Dicerorhinus mercki</i>		■			■	■	■				
<i>Dicerorhinus sp.</i>		■	■		■	■	■				
<i>Coelodonta antiquitatis</i>										■	■
<i>Equus mosbachensis</i>	■		■			■	■		■	■	■
<i>Equus hydruntinus</i>				■	■	■	■				■
<i>Palaeoloxodon antiquus</i>		■		■	■					■	■
<i>Canis lupus</i>						■	■				
<i>Vulpes vulpes</i>											■
<i>Felis silvestris</i>						■	■				
<i>Panthera spelaea</i>						■	■				
<i>Ursus arctos</i>		■	■		■	■	■		■		
<i>Ursus deningeri</i>					■	■	■				
<i>Ursus sp.</i>	■			■	■	■	■		■		
<i>Aonyx antiqua</i>						■	■				
<i>Martes cf. martes</i>						■	■				
<i>Castor fiber</i>		■									
	25	118	7	12	227	18321	1099	514	118	85	105

Table 5.1: Species lists of Biache-Saint-Vaast and total NISP per level. Black cells signify the presence of the species in the level, white cells signify absence. After (Louquet-Lefebvre 2005).

Rhinocerotidae	NISP	Percentage	Ursids	NISP	Percentage
<i>Dicerorhinus hemitoechus</i>	1066	34.3	<i>Ursus arctos</i>	2243	31.98
<i>Dicerorhinus mercki</i>	121	3.89	<i>Ursus deningeri</i>	226	3.22
indet	1921	61.81	indet	4544	64.79

Table 5.2: Number of ursid and rhinocerotid bones determined to species level and only determinable to genus level. Rhinocerotidae after (Louquet-Lefebvre 2005), ursids after (Auguste 2003, 139).

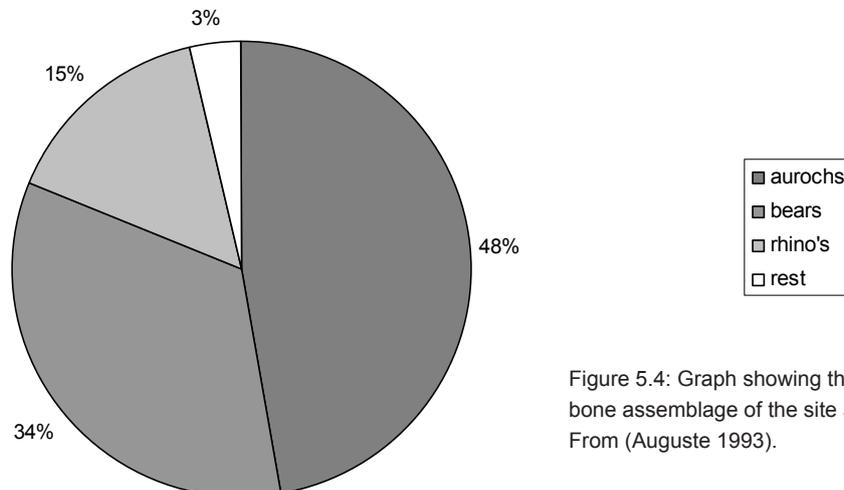


Figure 5.4: Graph showing the composition of the bone assemblage of the site as a whole by NISP. From (Auguste 1993).

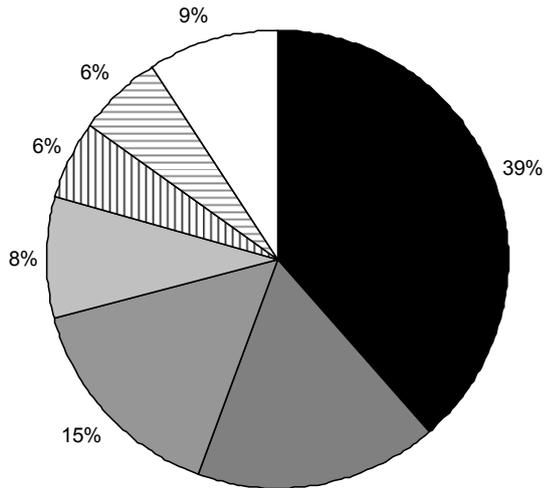


Figure 5.5: Graph showing the composition of the bone assemblage in terms of MNI. After (Auguste 1995a).

An additional problem with regard to the identification of bones to species level is the presence of several species belonging to the same family. This problem is important in ursids and rhinocerotids. Two species of bear and three rhinoceros species are present at the site. The bears that are present are the extant brown bear and Deninger's bear (*Ursus deningeri*), which is the ancestor of the cave bear (*Ursus spelaeus*). In the most important occupation levels, narrow-nosed rhinoceros and Merck's

rhinoceros (*Dicerorhinus mercki/Stephanorhinus kirchbergensis*) are present. In the uppermost levels of the site, woolly rhinoceros (*Coelodonta antiquitatis*) has been found. In both taxa, over 60% of the bones could not be assigned to a specific species (Auguste 2003, Louguet-Lefebvre 2005). (See table 5.2). Similar problems may be expected in the identification of the different species of cervids. Especially large Pleistocene red deer (*Cervus elaphus*) and giant deer (*Megaloceros giganteus*) are sometimes confused (Gaudzinski pers. comm.). However, since the number of bones belonging to species other than bovids, ursids and rhinocerotids is small, problems with regard to the identification of cervids have no significant consequences for this analysis.

Level IIA contains remains of 20 species (see table 5.1), 88.8% of the identified bones comes from this level. The NISP-values of the rhinocerotids and proboscideans from this level have been published and are listed in table 5.6 (Louguet-Lefebvre 2005). The species represented attest to a temperate climate with closed and open spaces in the environment. Species like roe deer and wild boar are characteristic of temperate forests, while species that point to a more open environment like equids and narrow-nosed rhinoceros are also present. Moreover, a large number of carnivore species is present.

Level II α has yielded the second largest bone assemblage. This assemblage represents about 5% of the identified bones of the site, it also yielded one of the hominin skulls found at the site (Rougier 2003). Table 5.1 shows that the number of species in level II α is smaller than in level IIA. Most conspicuous is the fact that the two species of horse are absent in this level. Additionally, most of the carnivores are missing in the assemblage, except for the ursids (Louguet-Lefebvre 2005). Since carnivores are generally rare in faunal assemblages, this is probably an artefact of the fact that this assemblage is smaller than the assemblage of level IIA.

Level IIbase contains the largest bone assemblage that has been published in detail (Auguste 1988b, Auguste 1992), (see table 5.3). Compared to level IIA, the non-ursid carnivores are missing, as are wild boar and straight-tusked elephant (*Palaeoloxodon antiquus*). As in the assemblage of the site as a whole, bovids are the most important group in level II base. They are followed in importance by ursids and rhinocerotids. In Auguste (1992), a larger number of identified bones is listed, but the NISP data are only quantified at family level, not at species level. The percentages in which the different taxa are represented remain roughly the same. The species list in the 1992 paper has also changed slightly, with fallow deer (*Dama dama*) reported in (Auguste 1988b), reclassified as giant deer on account of the remains being too large (Auguste 1992, 55).

The faunal assemblage from level IIbase shows numerous traces of hominin activities (see table 5.4). Most importantly, cut-marks are present on a large number of bones. Furthermore, a small number of bones is calcinated, suggesting they were heated. Moreover, the bones are very fragmented, and the majority of osseous finds from this level are splinters (Auguste 1992, 61). No data on the frequency of carnivore modification on the bones is presented. The data on human modification however, show that hominins were a major agent in the accumulation of the faunal assemblage from this layer.

	Level D		Level D1		Level IIbase	
Species	NISP	MNI	NISP	MNI	NISP	MNI
<i>Rhinocerotids</i>	9	1	19	1	47	3
<i>Equus caballus</i>	24	3	9	1	18	1
<i>Equus hydruntinus</i>	2	3	1	1	7	1
Equid	-	-	1	1	-	-
<i>Bos primigenius</i>	23	2	5	1	27	3
<i>Bos</i> or <i>Bison</i>	12	1	13	3	129	5
<i>Cervus elaphus</i>	10	1	16	1	15	2
<i>Capreolus capreolus</i>	-	-	-	-	7	1
<i>Dama dama</i>	-	-	-	-	1	1
Cervid	4	1	3	1	4	1
Ursid	-	-	-	-	78	4
Canid	2g	1	-	-	-	-
Herbivore	13g	1	-	-	6	5
Others	7	1	18	1	73	0-6
	106		85 ⁹		412 ¹⁰	

Table 5.3: NISP and MNI counts per species for levels IIbase, D1 and D, based on the data in (Auguste 1988b).

Family	NISP	calcinated	cut-marked	% cut-marked
Rhinocerotidae	65	0	9	13.85
Equidae	31	0	1	3.23
Bovidae	207	4	53	25.6
Cervidae	40	0	3	7.5
Ursidae	92	2	38	41.3
Non-attributed	74	0	10	13.51
Splinters	3149	48	123	3.91

Table 5.4: Indications for hominin activities on the bones found in level IIbase. From (Auguste 1992, 64).

In terms of MNI, the represented classes change slightly (Auguste 1992) (see table 5.5). Bears dominate the assemblage with at least ten animals represented, while bovids and rhinocerotids follow with 8 individuals. Auguste (1992, 63), provides a breakdown of the age-structure of the populations in level II base in juveniles, adults and old individuals. Following these categories, adult individuals form the majority in all taxa. This suggests hominin hunting was the major contributing agent in the deposition of this level's faunal remains.

Level D0 has yielded a mammal assemblage indicative of temperate conditions (Louquet-Lefebvre 2005, 109), see table 5.1. Analysis of the malacological and pollen samples from this level points to deteriorating climatic conditions however (Sommé *et al.* 1988, 117). Remarkably, wild boar is present in this layer, while it was absent in II base. Wild boar is a temperate species and its presence, like that of roe deer (*Capreolus capreolus*) suggests that conditions were not too harsh. On the other hand, the precursor of Deninger's bear and *Ursus* sp. are absent in this layer.

Above level D0 the mechanism of sedimentation changes, these levels have been deposited in wind-blown loessic sediments. This has left the bones exposed to weathering processes. These bones have altered surfaces and therefore a study of anthropic traces on the bones is impossible (Auguste

9 Auguste (1988b) mentions 79 determined remains, whereas adding up the numbers in his table leads to 85. This is also the number that Louquet-Lefebvre (2005) lists.

10 Auguste (1988b) writes that there are 397 determined pieces. Adding up the numbers in his table gives 412. Adding up the numbers from tables 16.II to 16.VII also gives 412.

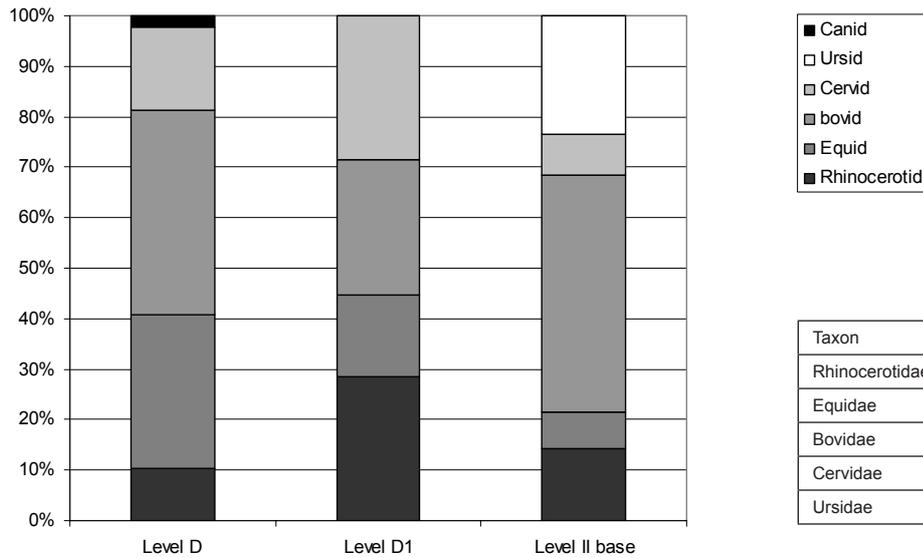


Figure 5.6: Graph showing the taxa represented in level II base according to (Auguste 1988b) and (Auguste 1992).

Taxon	Young	Adult	Old
Rhinocerotidae	1	6	1
Equidae	1	2	1
Bovidae	1	6	1
Cervidae	1	5	0
Ursidae	1	7	2

Table 5.5: Population structure in MNI of the taxa represented in level II base. From (Auguste 1992, 63).

1988b, 150). Moreover, weathering has led to a biased preservation of the bone assemblage: more durable elements, especially teeth, seem to be overrepresented in these levels (Auguste 1988b, 152-153). The association of the bones and the archaeological remains is therefore less secure for these levels than for the underlying levels.

The faunal remains from level D1 were distributed in two spatial concentrations. A rich concentration in the southern part of the excavated area and a poorer, less sharply demarcated northern concentration. The distribution of rhinocerotids and the cervids seems to be limited to the southern concentration, while bovids and equids are more widespread (Auguste 1988b, 151). In the southern concentration, the bones co-occur with a dense artefact concentration. The stone tools suggest knapping activities, but in this concentration, a large number of naturally backed knives is also present. This suggests that dismembering activities also took place here (Marcy and Tuffreau 1988b, 283). The association of lithics and faunal remains is less obvious in the northern concentration. This zone is poorer in archaeological remains and what remains there are, are more widely dispersed here (Marcy and Tuffreau 1988b, 287).

Most striking about the bone assemblage from level D1 is the absence of bears. They are among the dominant taxa at the site, accounting for a third of the total NISP. Moreover they are present in all underlying levels (see table 5.1). Another striking feature is the fact that the species of rhinoceros that is represented in this level changes with regard to the previous level. From level D1 onwards, narrow-nosed and Merck's rhinoceros are no longer present but the cold-adapted woolly rhinoceros appears.¹¹ In addition to these changes with regard to previous levels, roe deer is not present anymore, nor is giant deer. Wild boar, like roe deer a temperate species, has also vanished in this level. Bovids also decrease in importance in this level, while equids and rhinocerotids increase in importance. In all, the fauna thus has a more cold-adapted character than in the underlying levels.

The faunal remains of level D also show a bipolar distribution. This level has yielded a rich northern concentration and a poorer southern concentration. The latter concentration contains mostly small bones that are highly fragmented, while the former contains mostly larger, more complete specimens (Auguste 1988b, 151). The association of the fragmented remains with hominin activities is doubted by Auguste, (Auguste, 151), even though elsewhere he uses the degree of fragmentation of bones (Auguste 1992, 61) as support for hominin interference with the bone assemblage. The larger, northern concentration is spatially associated with a diffuse scatter of lithics, al-

11 The determination of the rhinocerotids in this level has changed in recent years Auguste (1988b) lists narrow-nosed, merck's rhinoceros and *Dicerorhinus* sp. Louquet-Lefebvre (2005) lists woolly rhinoceros for levels D1 and D.

though the densest concentration of artefacts in this level is located more to the south (Marcy and Tuffreau 1988a).

The faunal assemblage in level D is not much different from that of level D1. In terms of represented taxa we see that cervids and rhinocerotids decrease in importance, while equids and bovids increase in importance. The increase of equids in this level and in level D1 is taken to indicate an opening up of the environment. This would fit with a decreasing representation of cervids, since they are mostly associated with more closed environments. The decrease of woolly rhinoceros cannot be explained in this way, since it is thought to have been adapted to cold and open environments.

Louquet-Lefebvre (2005), has studied the megaherbivores represented at the site in detail. She lists the exact numbers of identified megaherbivore bones per level (see table 5.6). Only in level IIA were remains present in sufficient numbers for its quantitative study to have any significance. Nevertheless, the rhinoceros remains from the other levels seem to support the inferences that can be drawn from the remains from level IIA (Louquet-Lefebvre 2005, 114).

Level IIA has yielded 554 teeth belonging to narrow-nosed rhinoceros. These have been used to compile a population structure of the narrow-nosed rhinoceros represented in this level. Louquet-Lefebvre (Louquet-Lefebvre 2005, 114) illustrates her findings with a graph. However, using the data in her appendix, the graph looks different (compare the graphs in figure 5.7 with the data from her appendix in table 5.7). The important difference between the graphs is a differing total number of individuals. Louquet-Lefebvre (2005, 114) mentions an MNI of 41 in the text accompanying the graph, adding up the numbers yields 35. Moreover, using her appendices, the proportion of adult individuals is higher than in the graph she uses, while the number of juveniles and young adults is higher in her graph. The general image from the representation of the different age classes using the data from the appendices is that of an assemblage dominated by infants and young adults.

Species	I	H	G	F	En	IIA	II α	II base	D0	D1	D	Total
<i>Palaeoloxodon antiquus</i>	-	6	-	1	1	13	-	-	-	1	-	22
<i>Coelodonta antiquitatis</i>	-	-	-	-	-	-	-	-	-	22	12	34
<i>Dicerorhinus hemitoechus</i>	1	8	-	3	12	942	77	21	2	-	-	1066
<i>Dicerorhinus mercki</i>	-	3	-	-	4	101	8	4	1	-	-	121
<i>Dicerorhinus</i> sp.	-	9	5	-	52	1703	98	37	17	-	-	1921
Total megaherbivore	1	26	5	4	69	2759	183	62	20	23	12	3164
Total NISP	25	118	7	12	227	18321	1099	514	118	85	106	

Table 5.6: NISP counts of megaherbivores. From (Louquet-Lefebvre 2005, annexe 3a).

Age Class	I	I/II	II	II/III	III	III/IV	IV	IV/V	V	V/VI	VI	VI/VII	VII	VII/VIII	VIII
Number	6	1	1	0	1	4	9 ¹²	4	8	3	1	2	0	0	0

Table 5.7: Number of narrow-nosed rhinoceros teeth per age-class, based on the data from (Louquet-Lefebvre 2005, annexe 2a)¹³.

Indications for hominin activities are present on the bones as well. About 15% of the rhinoceros bones from level IIA show indications of hominin activities in the form of cut-marks and heliocoidal fractures on fresh bone (Auguste, Moncel, and Patou-Mathis 1998, Louquet-Lefebvre 2005). According to Auguste, (Auguste, 162) 623 rhinoceros bones show cut-marks, which amounts to 19.8% of all rhinocerotid remains on the site. Unfortunately, I was unable to ascertain whether there are any indications about which age-classes show traces of hominin activities. Of 108 fractures

12 One tooth (R10296) is from layer IIb.

13 In annexe 2c, Louquet-Lefebvre (2005) lists 9 D3 inf left as the base for her MNI. In annexe 2a, only 8 are listed however.

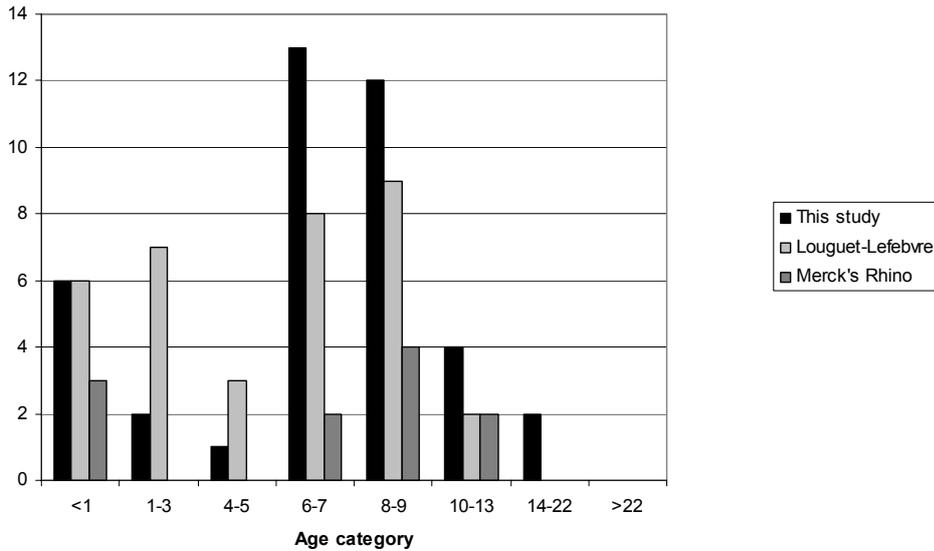


Figure 5.7: Age structure according to graph from (Louquet-Lefebvre 2005, 114) and reconstructed using her appendices. Teeth assigned to two categories were put in the oldest class.

on 98 longbones and longbone fragments from level IIA studied by (Louquet-Lefebvre 2005, 116-118) 37% are of anthropic origin. Breakage patterns differ greatly by bone type. 52% of humeri and 65% tibiae were fractured, while only 21% of radii and 16% of femora were broken open by hominins. Most broken femurs and tibia's show post-depositional breakage (Louquet-Lefebvre 2005, 116, 119). All in all, fragmentation of rhinoceros bones is much less intensive than of bear and bovid bones at Biache-Saint-Vaast (Louquet-Lefebvre 2005, 116).

Traces of carnivore activities are present on about 5% of the rhinocerotid bones. However, four out of the nine fragments with carnivore traces studied by (Louquet-Lefebvre 2005, 122), show cut-marks too and the placement of the latter suggests that hominins had primary access to the carcasses.

Bears are a second important category of prey represented at Biache-Saint-Vaast. Although hunting of bears has long been controversial, the number of remains found at this site and the frequency of traces of hominin exploitation on the bones seems to preclude other interpretations. As shown in table 5.2, 7013 ursid bones have been found, the majority of the identifiable bones belonging to brown bear, the remainder to Deninger's bear, a precursor to the cave bear (Auguste 2003). Deninger's bear was the larger of the two species represented at the site (Auguste 1988b, 147). Furthermore, it is worth noting that the brown bears recovered at the site were significantly larger than their current European homologues (Auguste 2003, 140).

In all, 107 individuals are said to be represented at the site. The population structure for level IIA is illustrated in figure 5.9. It is clear that adults are in the majority in both the brown bear and Deninger's bear categories. Moreover, in brown bears it seems that males are slightly better represented than females. The age profile of Deninger's bear suggests unnatural causes for the accumulation of the bones for this species as well, so we may assume that this species too was exploited by the occupants of the site. In addition, 2496 of the bear bones exhibit cut-marks (Auguste 1993, 55). According to Auguste (1995a, 161) the majority of cut-marks is found on brown bear bones. The placement of the cut-marks reveals some interesting patterns. In terms of absolute numbers of cut-marks, the majority of cut-marks is present on skulls, ribs and humeri. However, if we look at the percentage of a type of bone recovered that is cut-marked, we see that 73% of all ulnae are cut-marked, followed by 65 % of radii, 61% of proximal phalanges, 61% of scapulae and 57% of hip bones (coxal) and humeri. This is taken to indicate that hominins were after the body parts that yielded the greatest amount of meat (Auguste 2003, 139). Additionally, some of the cut-marks on the skulls, mandibles, phalanges and metapodials suggest they were produced while skinning the animal in order to remove the fur (Auguste 2003, 139).

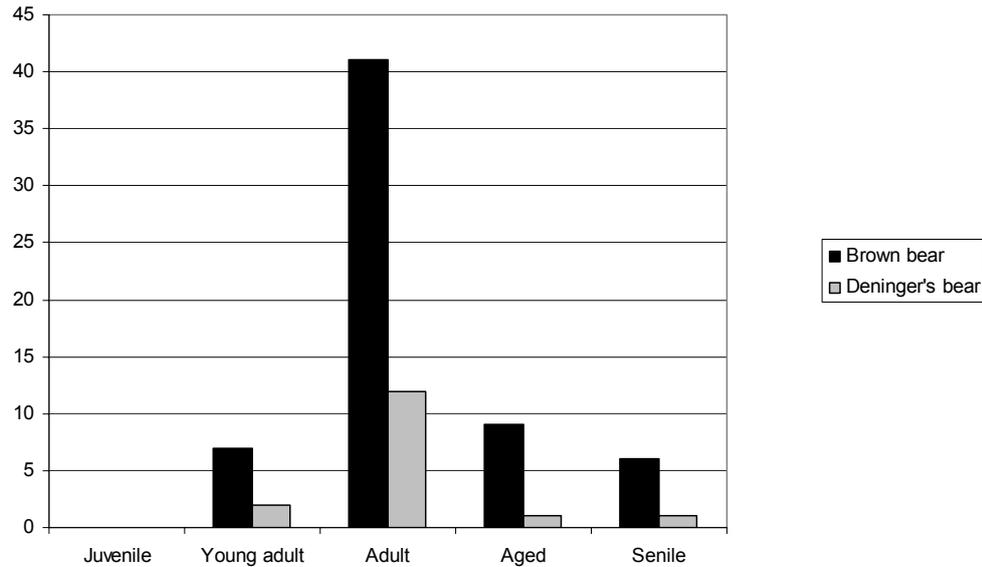


Figure 5.8: Age profile of Deninger's and brown bear from level IIA. Based on data in (Auguste 2003).

Bear bones were also fractured to exploit their marrow. However, reports on breakage patterns are slightly confusing. Louguet-Lefebvre (2005, 116, 123) reports that bear bones are more intensively fractured than rhinoceros bones. This leads her to propose that bears were hunted in spring and that marrow was an important resource because the meat on the animals was very lean in this season. Auguste (2003, 139) studied a few hundred fragments of diaphyses of longbones and found heliocoidal fractures on only 56% of them. According to him, this frequency of breakage is less intensive than that on aurochs bones at the site, which leads him to suggest bear hunting in autumn and a focus of hominins on the fat meat and the fur instead of on the marrow (Auguste 2003, 139-140).

With regard to skeletal part representation of bear bones at the site, many elements that represent little or no nutritional value, like metatarsals and metacarpals, are present in the assemblage. This can be explained by two factors. First, as discussed in section 4.6, different classes of mammals have different numbers of hand and foot bones. Carnivores have five digits, while in herbivores the number of metacarpals/tarsals is reduced, so there are more of these elements to start with. Second, the fact that fur was sought after by the Neanderthals producing this bone assemblage shows that other considerations than pure nutritional value influenced the bone deposition of this species (Auguste 1995a, 161).

Bovids are the dominant group in the assemblage of the site as a whole, representing almost 50% of the total NISP count. In the assemblage as a whole, 196 individuals are represented. The vast majority (145) falls into the "adult" age class in (Auguste 1993, 56-57, Auguste 1995a, 158, Auguste and Patou-Mathis 1994). In some cases, it is also possible to ascertain whether they belonged to male or female individuals. In terms of MNI, males are more prevalent than females with 49 males being represented at the site against 34 females (Auguste and Patou-Mathis 1994, 22). 3072 or 31% of aurochs bones found at the site show cut-marks (Auguste 1993, 55). Moreover, aurochs bones were systematically fractured, apparently more so than ursid and rhinocerotid bones from the site (Auguste 1995a, 161). Most of the cut-marks point to butchery and dismemberment of the carcasses. Nevertheless, some cut-marks on the skull and extremities show that in some cases skinning was also practised (Auguste 1995a, 162).

With regard to the skeletal part representation at the site, all elements of aurochs and of rhinoceros are represented, although the elements of high nutritional value are relatively more numerous (Auguste 1995a, 160-161). The fact that the other elements are present as well suggests that relatively complete carcasses were introduced to the site. Considering the size of these animals, this suggests that they were killed in the close vicinity of the site (*e.g.* Valensi and Psathi 2004, 263).

Cut-marks on other species than bears, rhinoceros and aurochs are said to be rare (Auguste 1995a, 162). For level II base, as pointed out earlier, cut-marks are present on equids and cervids as well, although percentages are quite low when compared to especially bovids and ursids.

An interesting component of the bone assemblage is formed by shed antlers. About 300 shed antlers belonging to red deer (*Cervus elaphus*) and giant deer have been recovered from the site. They appear to have been the focus of collection by hominins and to have been used as retouchoirs (Auguste 1993, Auguste 1995a). Some bones were also used as retouchoirs (Auguste 1993, 59).

On the basis of the cervid remains, the seasons of occupation of the site have been determined. According to Auguste (1995) and Louguet-Lefebvre (2005), antlers of roe deer, red deer and giant deer show that the site was occupied in autumn and in early spring. I assume that they use the presence of shed antlers as indication for an occupation in early spring, since roe deer and red deer shed their antlers at the end of winter. However, since these were collected by hominins they may also have been curated and cannot be taken as an unproblematic indicator of seasonality. Occupation in autumn may be signified by the fact that bears are not exploited for their marrow, but their meat. In early spring, bears would have recently woken from their hibernation and they would be very lean. Consumption of their meat would confront hominins with the problem that the digestion of lean meat would actually take energy instead of supply it (*e.g.* Speth and Spielmann 1983). In this scenario, only exploiting the marrow would make sense. In the autumn on the other hand, bears accumulate fat reserves in anticipation of hibernation and hence exploitation of bear meat would be very rewarding in this season.

The assemblage as a whole represents a clear-cut case of human hunting of aurochs, bear and narrow-nosed rhinoceros. Cervids and equids may have been exploited less frequently, if the cut-marks from level II base reported in (Auguste 1992) can be extrapolated to the other levels. At least 196 aurochs are represented, together with 87 brown bears and 61 narrow-nosed rhinoceros (Auguste 1995a, Auguste 2003, Louguet-Lefebvre 2005). Moreover, cut-marks are abundant on the bones of these species, exploitation of bone for its marrow content is in evidence and the age profiles show an adult-dominated mortality profile in all three cases.

There is more detailed data for the most recent levels. Level II base shows an assemblage like the one recovered from IIA, except for the absence of wild boar and straight-tusked elephant. The modifications on the bones remove all doubt as to the non-natural origins of a large part of the assemblage. Sadly, the bones from levels D1 and D are more weathered and a systematic study of modifications on these bones has not been published. What is striking is that bears are absent in these assemblages, even though they were present in all other levels. The climate was changing during the time of deposition of this level, but bears, especially brown bears seem to be a catholic species that should be able to deal with the conditions suggested by the presence of other animals in the assemblages from these levels. The increase in the number of horse remains and the displacement of species of *Dicerorhinus* by woolly rhinoceros indicates a colder climate. Climatic fluctuations may also have played a role in the composition; however, species lists alone as shown in table 5.1 are not enough to gauge the kind of climate and environment that is represented by the assemblage. Especially the proportions of cervids, wild boar and equids would be interesting to know in this respect.

The site thus represents a place hominins visited for a prolonged period of time. The site therefore gives insight in the ranking of prey that formed the basis of hominin foraging strategies over some time, which is why the application of OFT on the bone assemblage appears to be a productive endeavour.

5.7 The environment

In this section I will discuss the available information regarding the environmental circumstances at the time of occupation of Biache-Saint-Vaast. The sedimentary sequence and the large mammal fauna, both of which have already been discussed in terms of the information they provide about the character of the archaeological occupation, may also provide environmental information. In addition, pollen and molluscs will be used to gain insight into the environment around the site. Pollen data provide information about the character of the vegetation cover in the wider environment, while molluscs indicate the local environmental conditions.

The sedimentary sequence at the site documents the transition from MIS 7 to MIS 6. The different archaeological levels are thus situated in an environment that is gradually becoming colder. However, climatic ameliorations have been documented in the sequence. The sedimentary units are illustrated in figure 5.2; here I will discuss the climatic information we have for the different units in chronological order.

The lowest unit consisting of fluvial gravels did not yield any important climatological information. With Unit 2a, the character of sedimentation changes, and fluvial sands and silts are deposited. The malacological sample in the lowest reaches of Unit 2a contains mostly heavily damaged molluscs that are difficult to identify. Significantly however, in these levels *Corbicula fluminalis*, a species characteristic of warm climatic periods is present (Rousseau and Puissegur 1988, 94).

In Unit 2b, *Corbicula fluminalis* is no longer present. The malacological sample is dominated by species characteristic of aquatic and marshy environments. Moreover, the species that are present seem to indicate a climate that was cooler than today (Rousseau and Puissegur 1988, Sommé *et al.* 1986). This is supported by the analysis of pollen recovered from this level. The percentage of arboreal pollen in the samples is between 55 and 75%. If arboreal pollen are represented by over 10 percent in a pollen spectrum it is taken to signify that the environment was covered by a closed forest. This percentage thus suggests an open environment with stands of trees.

The arboreal pollen is dominated by the "boreal group" of pine (*Pinus*), birch (*Betula*), spruce (*Picea*) and willow (*Salix*). However more temperate species like alder (*Alnus*), hazel (*Corylus*), hornbeam (*Carpinus*), beech (*Fagus*), oak (*Quercus*), lime (*Tilia*) and elm (*Ulmus*) are also present. These species are usually not present during the early part of interglacials, which points to a date at the end of a warm cycle (Sommé *et al.* 1986, 193). In the top part of the unit, the part containing the archaeological level IIA, the molluscs show that the river is moving away from the site. Species indicative of aquatic and marshy conditions diminish markedly. Furthermore, species indicative of forested and semi-forested environments increase in importance. The species in the sample indicate a climate like that of today (Rousseau and Puissegur 1988, 95). This is confirmed by pollen analysis. The arboreal pollen is now dominated by *Quercus*, accompanied by *Fagus*, *Carpinus* and *Corylus*. *Pinus* and *Betula* remain present however (Sommé *et al.* 1986, 193). The large mammal fauna of level IIA shows the presence of forest-dwelling species, but their presence coincides with species that are adapted to more open, steppic environments, like equids and narrow-nosed rhinoceros.

On top of Unit 2, Unit 3 represents a period of soil formation in the fluvial deposits as the riverine influence at the site diminishes even more. This is shown by the fact that mollusc taxa indicative of aquatic and marshy environments drop to about 3.5% of the sample. The climatic indications provided by the samples in Unit 3a, which harbours the archaeological level II base, are similar to those for the top of unit 2b, the species present point to temperate conditions and an environment of largely open forest (Rousseau and Puissegur 1988, Sommé *et al.* 1986).

The interpretation of the environmental indications from level 3b is slightly problematic. This unit contains the archaeological level D0. The mollusc sample recovered here documents a transition to cold climatic conditions. Species indicative of open environments dominate, while species characteristic of forested environments disappear and species indicative of semi-forested areas decrease in importance (Rousseau and Puissegur 1988, Sommé *et al.* 1986). The large mammal assemblage, in which roe deer and wild boar are still represented, suggests that forested areas were still present in the wider surroundings of the site. The pollen sample is not very informative as to the character of the environment during the formation of this level. Only 118 pollen grains have been recovered and of this sample, 63.5% was arboreal. The arboreal pollen was dominated by boreal species; only 20% belonged to temperate species (Munaut 1988, 82).

Unit 4 consists of slope deposits originating from higher up the terrace. It contains reworked sediments from Units 2 and 3 (Sommé 1988, 31). The climatological information from this layer is ambiguous. Micromorphological analysis shows that frost-related features are very pronounced in this unit (Van Vliet-Lanoe 1988, 73). Moreover, remains of pollen and molluscs become rare in the sediments, suggesting that the environment was harsh (Sommé *et al.* 1986, 193). On the other hand, it may represent a relatively short erosional event, which deposited a large amount of sediment (Sommé *et al.* 1988, 99).

According to the pollen analysis, level 5 and therefore the archaeological levels D1 and D were formed during a feeble climatic optimum. Since the pollen counts are very low (Munaut 1988, 84-85), pollen are not a reliable source of information about the environment during the formation of these levels. Therefore I will give precedence to the results of the malacological analysis with regard to the reconstruction of the environment.

On the basis of malacological analysis, the lower limit of Unit 5 appears to represent a period of severely cold conditions. The malacological sample from this stratigraphic unit, containing the occupation level D1, indicates a very open environment. Higher up in Unit 5 the climate improves slightly. The environment during the deposition of the archaeological level D was characterised by a

herbaceous prairie with some stands of trees in the environment (Rousseau and Puissegur 1988, 98). This climatic amelioration is also visible in the loessic deposits of Unit 6 that were deposited on top of Unit 5. By the time Unit 7 was deposited, the environment was completely devoid of trees.

For the most important occupation levels, IIA, II α and II base, we can conclude that the climate during the time of occupation was temperate if a bit colder than today. The pollen indicate that grasses were of moderate importance in the environment. Open forest appears to have been the dominant vegetation type. The circumstances appear to have been more continental than nowadays, with larger seasonal variation in temperature. The character of the vegetation cover may have differed per level, with forest being most important in level IIA, II α showing a humid but open environment and level II base being deposited in a largely open environment but with significant forested areas (Louguet-Lefebvre 2005, 110). It is worth noting that based on cenograms, level II α would have the least tree cover of the three archaeological levels in Unit 2, while horses, traditionally an important indicator for steppe-like environment, are absent here. The environment probably did have an important steppic character, even in level IIA times. This is shown for example by the dominance of narrow nosed rhinoceros over Merck's rhinoceros. The latter was adapted to browsing in forested environments, while the former, with higher crowned teeth and thicker enamel was more adapted to grazing in open environments (Louguet-Lefebvre 2005, Van der Made in press).

During the deposition of level D0, the climate starts cooling significantly and the environment becomes very open. The molluscs indicate an open steppe, where trees are *quasi-inexistent* (Rousseau and Puissegur 1988, 98). The signal of the molluscs may be of mostly local importance: as discussed, the large mammal assemblage indicates the presence of forested areas in the environment.

These malacological data for Unit 5 are supported by the large mammal fauna that were recovered from these levels. The only rhinocerotid present in these levels is the woolly rhinoceros for example. Moreover the importance of equids increases in these levels (Auguste 1988b, Louguet-Lefebvre 2005).

We can thus assume that the earlier archaeological levels at the site were deposited during the latest phases of MIS 7. The occupations of D and D1 were probably formed during a stadial in MIS 6. Pollen cores from the Massif Central document a feeble optimum after the first cold phase of MIS 6 (Reille *et al.* 1998). Moreover a flowstone from Clamouse cave in France shows a period of growth that has been correlated with an amelioration in Mediterranean pollen cores. This amelioration was dated to between 162.3 ka and 169.1 ka (Plagnes *et al.* 2002). This may represent a short period in which occupation of the northwestern areas of Europe took place as documented in two occupation levels at Biache-Saint-Vaast.

5.8 Applying OFT to Biache-Saint-Vaast

I have now discussed the composition of the bone assemblage from the site as well as the environmental circumstances at the time of occupation. On the basis of these data, we will analyse the faunal assemblage using the diet breadth model. The focus of this analysis will lie on the assemblage as a whole. It will be followed by a discussion on the developments with regard to diet breadth in levels II base, D1 and D. I will first construct a ranking of the species that were available for exploitation. This will be followed by reconstructing the population densities in order to gain insight in the encounter rates with the different species. Finally, the handling cost is reconstructed. I will then analyse how well the practised diet breadth is explained by the diet breadth model.

The large mammal assemblages and climatic indicators suggest that these levels were deposited during relatively temperate conditions. The climate was more continental than it is nowadays, resulting in a more open environment, but species like wild boar and roe deer were present in the environment, suggesting an important forest component. The presence of megaherbivores like narrow-nosed and Merck's rhinoceros and straight-tusked elephant may have resulted in the forested areas being structured with tracks and open spaces (*e.g.* Haynes 2006). A rich carnivore guild was also present during these times, with lion (*Panthera leo spelaea*), wolf (*Canis lupus*) and brown bear.

An important aspect with regard to the application of OFT is the function of the site within the foraging system. Level IIA is thought to represent a spot where hominins repeatedly hunted animals in a riverine environment (Auguste 1995a, Auguste 2003). Of the three dominant species, all parts of the skeleton are represented, implying that the site functioned as a hunting location. Because of the size of the species that are present, processing of the carcass at the kill-site is expected to be essential if the spoils are to be transported to a base camp. Consequently, at a site like La Borde (Auguste

1995a, 160, Slott-Møller 1990, 51), elements with high nutritional value are very poorly represented, in contrast to elements of little nutritional value. This site probably represents a kill site from where meat-bearing elements were transported away. At Biache-Saint-Vaast on the other hand, meat-bearing elements from bison and rhinoceros seem to be slightly overrepresented. Moreover, processing of bones evidently took place on the spot, so animals were probably killed in the vicinity of the site. The site probably played a larger role than that of a hunting station, since the meat bearing parts were evidently not transported elsewhere. This, combined with the large amount of lithic materials present at the site, suggests that the site may have functioned as a central place, where animals were processed, but also where toolkits were maintained, using the abundant local flint deposits.

The levels higher up in the sequence show an overrepresentation of teeth and skull parts, especially in level D1 and D. This is partly due to less favourable conservation conditions in these levels (Auguste 1988b, 153). Hominin occupations here were probably more ephemeral, attested by a much lower density of finds compared to level IIA. Level D1 shows knapping activities, but the co-occurrence of the densest lithic concentration containing naturally backed knives with the most significant concentration of bones suggests butchery also took place in this level. In level D, both stone artefacts and bones are represented in low numbers. This level probably represents a very short visit to the site. The composition of the faunal assemblage suggests that the site did not function as a specialised hunting camp during these occupations since no taxon is dominant in the assemblages. Therefore, we can assume that the site does not represent the result of one specialised activity in the repertoire of its occupants. On the other hand, this is not certain. Because the fauna is less clearly associated with hominin activities, some of it may just be background fauna and be unrelated to the occupation of the site. We therefore need to keep in mind the fact that levels D1 and D are of a different character than the preceding levels when analysing them.

As discussed in chapter 4, OFT assumes that foraging decisions are governed by the desire to maximise the takings of hunting activities. First we therefore need to construct a ranking of the available prey species in descending order of their profitability. I assume that Neanderthals focussed their hunting activities on maximising the caloric return rates of their hunting activities instead of other variables, like prestige or rare nutrients. Since weight is a good proxy for caloric value among mammals, I constructed a ranking of the available species based on their reconstructed body weights. This ranking is shown in table 5.8. A problem that was encountered when constructing this ranking is the fact that for some species different authors list widely varying body weight estimates (Brook and Bowman 2004, Louguet-Lefebvre 2005, Pushkina and Raia 2008). In the case of extinct animals, I compared the weights with of extant relatives in order to gauge whether provided estimates are realistic. As a basis I used the weights listed in (Brook and Bowman 2004). In those cases where I rejected their estimates, the source is given in a footnote.

In many species, Pleistocene individuals had larger body sizes than their Holocene counterparts. This is the case in equids for example which show a steady reduction in size throughout the Middle and Late Pleistocene (*e.g.* Eisenmann 1991). Larger body sizes have also been reported for Pleistocene bovids and cervids (Gaudzinski pers comm.). However, body size of these animals also varied in response to more short term developments, like changes in climate (Delpech 1999). In the case of Biache-Saint-Vaast, attention is given to the values reported by (Louguet-Lefebvre 2005), who worked on the assemblage, in order to arrive at a realistic ranking.

When we compare the exploited species with the constructed ranking (table 5.8), we see that narrow-nosed rhinoceros and aurochs are ranked highly. Brown bear is somewhat lower down in the ranking as seventh heaviest species. The near absence of the heaviest species, straight-tusked elephant is striking. All in all, 22 bones belonging to this species have been found at the site. No signs of exploitation have been reported for the bones of this species. We can therefore not assume that the species was important in hominin foraging activities.

The interpretation of the remains of Merck's rhinoceros is complicated. If we assume that bones determined as belonging to *Dicerorhinus* sp. represent similar narrow-nosed rhinoceros and Merck's rhinoceros in the same proportions as the bones that could be determined to species level, this would result in a NISP count of about 330, or about 1.6% of the total Biache-Saint-Vaast assemblage (using the numbers and percentages from Auguste 1993, 56). The representation of Deninger's bear presents us with a similar quandary. If we assume that brown bear and Deninger's bear are represented in the same proportion in the bones that were determinable to *Ursus* sp. as they are in the assemblages that were identifiable at species level, this would lead to a NISP of 650, or about 3% in the total assemblage from Biache-Saint-Vaast (using the data from Auguste 2003).

Rank	Species	Weight	NISP ¹⁴
1	<i>Palaeoloxodon antiquus</i>	5500	22
2	<i>Dicerorhinus mercki</i>	2000	2791
3	<i>Dicerorhinus hemitoechus</i>	1600	317
4	<i>Bos primigenius</i>	600 ¹⁵	9771
5	<i>Ursus deningeri</i>	559 ¹⁶	642
6	<i>Megaloceros giganteus</i>	450 ¹⁷	na
7	<i>Ursus arctos</i>	400	6371
8	<i>Equus mosbachensis</i>	272 ¹⁸	na
9	<i>Cervus elaphus</i>	200 ¹⁹	na
10	<i>Panthera spelaea</i>	195 ²⁰	na
11	<i>Equus hydruntinus</i>	188	na
12	<i>Sus scrofa</i>	89	na
13	<i>Canis lupus</i>	45	na
14	<i>Capreolus capreolus</i>	23 ²¹	na
15	<i>Aonyx antiqua</i>	13 ²²	na
16	<i>Vulpes vulpes</i>	5	na
17	<i>Felis silvestris</i>	5	na
18	<i>Martes cf. martes</i>	1.4	na

Table 5.8: Ranking of species present in the assemblage of Biache-Saint-Vaast. In the NISP-column, for species with na, no NISP figure was available.

Louquet-Lefebvre (2005) analysed all rhinoceros diaphysis fragments from level IIA, for cut-marks and has not distinguished between narrow-nosed rhinoceros and Merck's rhinoceros. It is therefore possible that bones belonging to this species also showed traces of hominin exploitation. Unfortunately, the age-profile (illustrated in figure 5.8) that can be constructed from the data in Louquet-Lefebvre (2005)'s appendix 2a is not conclusive, although it suggests adults are the best represented age-category. According to her, an MNI of at least 30 is needed to lend significance to such a profile. In the case of Merck's rhinoceros the MNI is 10, therefore we cannot lend too much significance to this age-profile. In the case of Deninger's bear, cut-marks are present. Moreover, they show that Deninger's bear bones were processed in the same way as brown bear bones (Auguste 2003, 138). In addition, the age profile provided in Auguste (2003) (see figure 5.8) suggests that the animal population represented at the site did not die of natural causes. Again, the number of individuals on the basis of which this profile was compiled (MNI=16) is too small to derive many conclusions from this profile.

I propose that both species were at least occasionally the focus of hominin exploitation. First, both these species are large and thus probably rare in the environment. However, if we take into ac-

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- 14 In the case of Ursids and rhinocerotids I assumed that the number of bones only determined at genus level consisted of both species in the same proportions as in the number of bones that could be assigned to a species.
- 15 My estimate. According to Van Vuure (2003), aurochs weighed roughly the same as modern bison. The estimate provided by Brook and Bowman (2004) (269 kg.) and Louquet-Lefebvre (2005) (531 kg.) were considered too low. Macdonald (2006) provides the following weights: for American bison (*Bison bison*) females: 545 kg., males 818 kg. For European bison (*Bison bonasus*) males: 800 kg.
- 16 Brook and Bowman (2004) do not list *Ursus deningeri*, so I used the estimate listed in Louquet-Lefebvre (2005).
- 17 Estimate taken from Louquet-Lefebvre (2005). Estimate provided by Brook and Bowman (2004) (700 kg.) is higher than all other estimates I encountered, the estimate from Louquet-Lefebvre seems more reasonable, although Pushkina and Raia. (2008) provide a lower one (387 kg.).
- 18 Brook and Bowman (2004) do not list *Equus mosbachensis* so I used the estimate listed in Louquet-Lefebvre (2005).
- 19 Estimate taken from Pushkina and Raia. (2008) since Brook and Bowman (2004) provides a very high estimate (500 kg.).
- 20 Estimate taken from Louquet-Lefebvre (2005) since the estimate listed in Brook and Bowman (2004) seemed excessive (380 kg.).
- 21 Estimate taken from Pushkina and Raia. (2008), since Brook and Bowman (2004) provide a very high estimate (90 kg.).
- 22 Estimate taken from Louquet-Lefebvre (2005) since the species is not listed in Brook and Bowman (2004).

count the fact that in addition to bovids, ursids and rhinocerotids 15 species are represented at the site and that these species make up 3.5% of the NISP, Merck's rhinoceros and Deninger's bear are well represented. Both species account for several hundred bones. Moreover, cut-marks are present on Deninger's bear and likely occurred on Merck's rhinoceros. On top of this, the age profiles of both species show a dominance of mature individuals.

The targeting of aurochs is to be expected, since it is a highly-ranked species in terms of weight. The dominance of this species over the other targeted species of narrow-nosed rhinoceros and brown bear can be explained in terms of encounter rate. The larger a species, the lower its population density generally is. This means that hominins probably encountered aurochs much more often than narrow-nosed rhinoceros.

Giant deer was not exploited for nutrition. Its NISP is not listed in published articles, but is probably low. Moreover, in this species, as well as in red deer, antlers are overrepresented in the assemblage. A large part of the NISP of this species is therefore taken up by elements without nutritional value (Auguste 1993, 61). This poor representation is unexpected, since larger animals like rhinoceros are represented as well as the smaller brown bear. The species is therefore in the range of species by weight that was regarded as a target by hominins.

Brown bear was slightly smaller than giant deer, but obviously an important species. It accounts for 34% of the assemblage. The exploitation of this species is unexpected at first sight, since a heavier species, giant deer, was not exploited. Still the difference in size between both species is small. Moreover, according to Auguste (2003, 140), the specimens from Biache-Saint-Vaast were larger than modern day brown bears.

As discussed, the distribution of exploitation marks on species, other than on the dominant taxa, is not quantified in published works (Auguste 1995a, 162). Nevertheless exploitation marks on other species are present, but said to be rare. As shown in table 5.4, level II base yielded some indications of exploitation on cervid and equid bones. If these results are applicable to the assemblage as a whole, these species were at least opportunistically exploited in level IIA. In this case it is striking that these species are not present in the assemblage in larger numbers. This cannot be explained by a factor like population density, since these species are expected to be present in much higher numbers than the species that were the focus of intense hominin exploitation activities.

The exploited prey classes show that the ranking of prey on the basis of animal weight is a good predictor of foraging decisions. The focus of foraging was clearly on the heavier species that were

present in the environment. Still, it does not explain all foraging decisions. Most striking is the absence of signs of exploitation on by far the heaviest species available, straight-tusked elephant. In addition, we would expect giant deer to be exploited, since it is heavier than brown bear.

As discussed, the poor representation of some species may be a result of low population densities. It seems for example that Merck's rhinoceros was exploited at Biache-Saint-Vaast. This species was adapted to browsing in forested environments, and its poor representation at Biache-Saint-Vaast may therefore have been caused by its rarity in the vicinity of the site. Possibly, encounters simply did not take place very often, resulting in the small share of bones of this species in the assemblage.

In order to check whether a low encounter rate was the cause of the poor representation of other species, I have reconstructed the population densities of the species that were present in the assemblage. Reconstructing population densities of a Pleistocene community is a difficult endeavour, since some of the species are extinct nowadays and the composition of animal communities in Pleistocene assemblages

Table 5.9: Reconstructed population densities of the species present in the Biache-Saint-Vaast assemblage, using the equations provided by (Silva, Brimacombe, and Downing 2001, 477).²³

Species	Density (ind/km ²)
<i>Palaeoloxodon antiquus</i>	0.075
<i>Stephanorhinus kirchbergensis</i>	0.15
<i>Bison priscus</i>	0.31
<i>Ursus spelaeus</i>	0.384
<i>Megaloceros giganteus</i>	0.413
<i>Ursus arctos</i>	0.19
<i>Equus caballus</i>	0.505
<i>Cervus elaphus</i>	0.717
<i>Panthera spelaea</i>	0.063
<i>Crocota crocuta</i>	0.04
<i>Sus scrofa</i>	1.243
<i>Panthera pardus</i>	0.045
<i>Canis lupus</i>	0.053
<i>Capreolus capreolus</i>	3.119
<i>Lynx lynx</i>	0.118
<i>Castor fiber</i>	3.685
<i>Meles meles</i>	0.331
<i>Lutra lutra</i>	0.616

23 The equations used are: Herbivores: $\text{Log } D = 1.42 - 0.68(\text{Log } M)$; Carnivores: $\text{Log } D = 1.41 - 1.83(\text{Log } M) - 0.34(\text{Log } M^2) + 0.28(\text{Log } M^3)$. No equation is provided for omnivores. I treated Deninger's bear as a herbivore, and brown bear as a carnivore.

has no modern analogues. However, across mammals there is a significant correlation between body weight and population density (*e.g.* Eisenberg 1990, Silva, Brimacombe, and Downing 2001, Silva, Brown, and Downing 1997). This does not explain all variability in population densities, but does seem to be the major variable explaining population densities in mammals (Silva, Brimacombe, and Downing 2001, 475-477). A second important variable is the dietary specialisation of an animal species (Eisenberg 1990, Silva, Brimacombe, and Downing 2001). Based on the population densities of extant mammals, equations have been deduced, which allow the calculation of a species population density, based on its body weight and dietary niche, the two most significant factors influencing the population density. The reconstructed densities are listed in table 5.9.

It is immediately apparent that all exploited species at the site were present at low population densities compared to species that we traditionally view as game, like red deer, boar and equids. Some population densities may be overestimated though. As argued, Merck's rhinoceros may have been adapted to different environments. Therefore its population density may have been lower than estimated in the area since it had to compete with other herbivores that were better adapted to the circumstances surrounding the site, most notably narrow-nosed rhinoceros.

The poor representation of Deninger's bear may have a similar cause. Deninger's bear is the evolutionary precursor to cave bear. Isotopic studies have shown that the latter species preferred foraging in forested areas. Brown bear from the same site on the other hand yielded an isotopic signature that points to foraging in open areas (Bocherens and Drucker 2003). If Deninger's bear shared this adaptation with cave bear, then it may have been at a disadvantage in the open environment surrounding the site.

With regard to straight-tusked elephant, there is no reason to assume that the environment in level IIA times was particularly unsuited for this species. Although it is generally associated with warm climatic phases and woodland vegetation (Stuart 2005), it is thought to have had an intermediate dietary adaptation, with both browsing and grazing contributing to the diet (Palombo *et al.* 2005). Therefore I will assume that this species was not extraordinarily rare during the time of occupation of Biache-Saint-Vaast, but occurred in normal population densities. If this species had been exploited upon encounter we would therefore expect it to be better represented at the site. The population density of this species is expected to be roughly half that of narrow-nosed rhinoceros, yet only 22 bones belonging to this species have been excavated, as opposed to more than 1000 belonging to narrow-nosed rhinoceros. A low encounter rate can therefore not explain the near-absence of this species at the site. The only other possible explanation for its rarity is that, when exploited, the species was thoroughly processed in the field resulting in little transport of proboscidean bones to the site. Since signs of exploitation are rare on proboscidean bones, due to the porous bone surface (Mussi and Villa 2008, Scott 1980), the signs of exploitation could be absent on the small sample. This option cannot be discarded, yet in view of the large number of rhinoceros bones at the site, I deem it unlikely that regular exploitation of straight-tusked elephant result in only 22 bones ending up at the site.

Encounter rate also cannot explain the paucity of giant deer bones in the assemblage. Giant deer is often thought of as a mixed browsing and grazing species whose presence indicates a reasonably open environment (Bratlund 1999, 78). Therefore, the environment of the site suited this species quite well. Moreover, the species is larger than brown bear, which was heavily exploited, so it falls in the range of species that were hypothesised to be worth exploiting by the hominins responsible for the bone assemblage. Because of its herbivorous adaptation it is expected to be present in higher population densities than the smaller but omnivorous brown bear.

If we extrapolate the presence of cut-marks on equids and cervids in level IIBase to the assemblage of level IIA, we can assume that these species (and maybe giant deer too) were exploited. The small number of bones belonging to these species, as well as the reported scarcity of marks on the bones, suggest that the exploitation of these species only took place on rare occasions. The reconstructed population densities are high compared to those of the species that were heavily exploited. Therefore, whether foraging in forested environments or in open environments, hominins are expected to encounter cervids and equids more often than any of the exploited species. This shows that these animals were not exploited upon encounter, but only in exceptional circumstances.

Species	> 300 kg.	Carnivore	Living in group	
			Male	Female
<i>Palaeoloxodon antiquus</i>	+	-	-	+
<i>Dicerorhinus mercki</i>	+	-	-	-
<i>Dicerorhinus hemitoechus</i>	+	-	-	-
<i>Bos primigenius</i>	+	-	-/+	+
<i>Ursus deningeri</i>	+	+	-	-
<i>Megaloceros giganteus</i>	+	-	-/+	+
<i>Ursus arctos</i>	+	+	-	-
<i>Equus mosbachensis</i>	-	-	+	+
<i>Panthera spelaea</i>	-	+	-/+	+
<i>Cervus elaphus</i>	-	-	-/+	+
<i>Equus hydruntinus</i>	-	-	+	+
<i>Sus scrofa</i>	-	-	-?	+
<i>Canis lupus</i>	-	+	+	+
<i>Capreolus capreolus</i>	-	-	-/+	+

Table 5.10: Reconstructed handling cost attributes of the species in the Biache-Saint-Vaast assemblage.

Handling cost is the remaining component of the diet breadth model. This is an important variable in determining the actual return rate of exploiting specific animals. As discussed in chapter 4, this variable depends on both the predator's and the prey's capabilities. In order to estimate how difficult hunting of the available species would be I looked at three important characteristics: prey size, whether the prey species was carnivorous and whether or not the prey species lived alone or in groups. These factors are important determinants of handling costs of species in nature. There is a relationship between a predator's size and the maximum size of the prey it hunts. For a mammal of the same size as a Neanderthal, maximum prey size would be estimated at 300 kg (Radloff and Toit 2004). Lower risk of predation is one of the most important reasons why animals are thought to live in groups (Barnard 2004). And hunting carnivores is considered very dangerous since these animals are equipped to hunt and kill other animals (For a discussion on why I selected these variables, see chapter 4). Table 5.10 lists the handling cost attributes for all species that were present in the bone assemblage.

These attributes explain some of the peculiarities in the spectrum of exploited species. The absence of elephant exploitation can be explained by the fact that they are very much heavier than 300 kg. Of course predators may be able to hunt larger prey than would be expected in light of their size by hunting in groups for example (Radloff and Toit 2004), but this animal is almost 10 times the expected maximum prey size for Neanderthals. Moreover, the females and young animals live in herds, which are harder for hunters to tackle than solitary animals.

This explanation is supported by the fact that in narrow-nosed rhinoceros the focus of exploitation seems to be on juveniles and young adults. The occupants of the site may thus have preferred somewhat smaller animals to full-grown adults. In addition, rhinoceros are usually solitary species.

The poor representation of giant deer cannot be easily explained by these attributes. Females probably lived in groups, which provides an argument against their exploitation. Except during rut, males did not live in groups. Although male giant deer are large animals, they are smaller than aurochs. Male aurochs were preferred over females, possibly since these are solitary creatures, but female aurochs are also well represented in the assemblage. Therefore, hunting giant deer, especially in the case of the males was certainly within the capabilities of the site's occupants.

The exploitation of horses is peculiar with regard to the handling cost attributes, since these animals are large and live in groups, which are hard to corner and despatch. Moreover, hunters will be detected more easily by social than solitary animals since there are simply more individuals that are on the look-out. Exploiting equids is therefore an activity that one would expect to be done in a planned, specialised fashion, while the low percentage of horse bones in the assemblage probably reflects opportunistic activities.

Like giant deer, male red deer probably lived solitarily most of the time; their exploitation is therefore likely to occur in an opportunistic fashion. Females live in herds, although herd size is

smaller than in the case of horses. Moreover, because of the reduced visibility in forested environments, the animals may be more easily ambushed. Taking all these factors together leads to the expectation that opportunistic hunting of cervids is quite feasible, in contrast to hunting equids.

As discussed, the environmental conditions during the deposition of level II base were similar to the conditions represented in level IIA. The species represented in this level are also similar to those of level IIA, except for the fact that wild boar and most carnivores are absent. This is assumed to be a reflection of the smaller sample size. The intensity of hominin use of the animal bones is highest in ursids, followed by bovids and then rhinocerotids. In terms of absolute numbers bovids are the best represented group, followed by ursids and rhinocerotids. Cervids and equids are well represented, accounting for 9% and 7% of the total number of identified bones respectively. As shown in table 5.4, a few of the bones of these groups even show cut-marks. All in all, the situation that is reflected by the assemblage as a whole does not change significantly, although the diet breadth may have increased a little, with cervids and equids being slightly more routinely exploited.

During the accumulation of level D1, the most important development is the disappearance of ursids. The environment during this phase seems to have been much colder and more open than during the deposition of the previous levels. This may account for the absence of Deninger's bear, which was adapted to forested conditions. It is not sufficient to account for the absence of brown bear, which is a catholic species. The presence of red deer and aurochs leads me to assume that brown bear was able to survive in the environment of the site at this time. This development may therefore reflect a drastic change in hominin foraging strategies, in which a dominant species was dropped from the optimal set.

The analysis of these levels was done using the NISP figures provided by (Auguste 1988b). Due to the degree of fragmentation, it should be noted that the MNI's from the levels are low (see table 5.3). We must therefore be cautious in attaching too much importance to the findings from the levels. Both levels were truncated by the construction of the factory, so the faunal assemblages represent only a part of what was originally there (Auguste 1988b, 151). Moreover, the predominance of dental and cranial remains suggests that taphonomic processes have also deleted part of the assemblage. In this analysis I will assume that the species representation in terms of NISP is representative of the original assemblage.

The assemblage is small, so we cannot attach much importance to the increase in importance of rhinocerotids, equids and cervids. The decrease of bovids is dramatic, especially since there is one taxon less represented in the assemblage. It is hard to interpret however. Moreover, the degree to which the bones were exploited by hominins is unclear because they are more heavily weathered than those deposited in lower lying levels. With regard to rhinocerotids it must be mentioned that the represented species, woolly rhinoceros, was significantly heavier than the species present in the older levels. It is said to weigh 2900 kg. by Brook and Bowman (2004) and 2800 kg. by Louguet-Lefebvre (2005).

Level D also contained a small assemblage. It shows a decrease in rhinocerotids and cervids, while bovids and equids increase in importance compared to level D1. The cervids may have become rarer, because of the cold and open conditions, to which they are less suited. This is not sufficient to explain the decrease in importance of rhinocerotids. It is tempting to interpret the developments in terms of new hominin foraging strategies. The increased reliance on equids may signal a specialisation of foraging on animals living in herds that move through the landscape along predictable routes. Concentrating on dispersed solitary animals like rhinoceros may have proved to be a less effective strategy in the now fully open environment. The location of the site at a "t-junction" of river valleys may have placed it at an important spot near migration routes of bovids and equids.

It appears then that the diet breadth of the occupants of the site was narrow. Three species were exploited upon encounter: narrow-nosed rhinoceros, male aurochs and brown bear. The status of Merck's rhinoceros and Deninger's bear is less certain. I assume that they were also exploited when they were encountered, but that they were simply present in smaller numbers and therefore were encountered only sporadically. The exploitation of cervids and equids is problematic. They were certainly not in the "optimal set" of species; otherwise they would be more abundant in the assemblage. However, they were exploited at least occasionally.

This analysis has shown that using OFT to analyse a Pleistocene bone assemblage leads to insight in the factors that played a role in hominin foraging decisions. As pointed out in chapter 4 a ranking based on animal weights is a simplification, yet the species in the "optimal set" in level IIA are large species. Using simple proxies to gain insight in search time and especially handling cost

does point to additional factors that could influence hominin strategies. The developments in levels II base, D1 and D are harder to explain. The bone assemblages are smaller and the occupations were a lot more ephemeral than the occupations represented in level IIA. In level II base we see an increase in the role of cervids and equids with regard to the dominant taxa. It may be that the encounter rate with more highly ranked species decreased, which led to these taxa playing a more important role in the hominin diet.

5.9 Discussion

The bone assemblages of this site document the transition from a warm period to a glacial. The environmental conditions at the site change from a landscape covered by open forest. Climatic conditions were not yet very cold at least during the formation of the lower levels of the site, so issues of insulation and sheltered places for camps were not yet too important. The later levels of occupation represent colder conditions, but the presence of species that are traditionally associated with forested environments, like aurochs, shows that conditions were not extreme. The site is located at a “t-junction” of river valleys, on the northern edge of the valley. The location afforded access to a large area of the low-lying river valleys, which probably served as the major migration routes for both hominins and animals. The sheltered river valleys are also the locations that are likely to have been covered by forest. The exposed plateaux probably had a less lush plant cover, since conditions here were more severe.

Because of the enormous amount of material recovered in level IIA, the excavators do not think that this level can be the result of one occupation. Rather, they interpret the site as the result of repeated occupations of similar character. Other levels, like II base, D1 and D are thought to be the result of discrete occupations. The excellent condition of the bone surfaces in level IIA does suggest that the material was not left exposed for a long time. The bones do not show any signs of weathering at all. Based on actualistic research in East Africa, it is thought that this corresponds to bones having been buried within 5 years. In more northern environments, weathering takes place more slowly (Fosse *et al.* 2004), but influences like carnivore ravaging, trampling and sorting of elements by durability do not seem to have played an important role in the final composition of the bone assemblage. I expect the bone assemblage of level IIA to reflect only a few occupations and not a palimpsest that is the result of activities spanning more than a decade.

The assemblage that is present at the site reflects a stable foraging system relied on three groups of animals: large bovids, ursids and rhinocerotids. Diet breadth was thus small and the focus of hunting was, as expected, on the heavier species available. On the other hand, it is clear that weight was not the only consideration determining foraging decisions. This is shown most clearly by the absence of straight-tusked elephant in the assemblage. Since this species is by far the largest species available to the occupants of the site, one would expect it to have been heavily exploited. I propose that, had it been exploited, even if it was more thoroughly processed in the field than rhinoceros, it would be expected to be better represented at a site with such a huge bone assemblage as Biache-Saint-Vaast.

The simple assumptions that I used to model increased handling cost are very coarse grained. The threshold of 300 kg that I used to classify a species as dangerous is based on the expected maximum prey size for a mammal of the same size as a male Neanderthal. All species in the regularly exploited set are larger than 300 kg. This shows that the occupants of the site had developed ways of dealing with large prey. In mammals, predators are known to be able to increase the maximum size of prey that is successfully hunted by operating in groups (Radloff and Toit 2004). However, the extreme size of the prey that Neanderthals hunted at this site is unlike anything seen in mammalian carnivores. This suggests that Neanderthals were able to hunt in groups in a co-ordinated manner.

Whether animals live in groups or not does seem to be an important consideration but it is clear from both later levels and other Pleistocene sites, like Schöningen that hominins were able to dispatch animals living in herds in the Middle Pleistocene. Therefore, the decision to concentrate on solitary animals is part of a strategy, representing a conscious choice by the foragers. Apparently, the added difficulties of surprising a herd and dealing with the anti-predator behaviours of a herd were not the most optimal choice in the situations represented by the level IIA assemblage.

Modelling search time is a complicated matter. OFT assumes that encounters with animals occur at random. This can be modelled by reconstructing the population densities of the available species. This has proven difficult however. Within mammals, population density and body size are corre-

lated, but at species level, actual densities may differ up to an order of magnitude from the predicted values (Silva, Brimacombe, and Downing 2001, Silva, Brown, and Downing 1997). Therefore, the reconstructed densities can only be taken as a very rough indication of the Pleistocene values. They can indicate in which proportions different species of animals may have been present in the environment. If the site was located at the edge of a range of a species' distribution, the environment may not have been the ideal environment for a species and the population density may have been lower than estimated here.

At Biache-Saint-Vaast this may have been the case for Merck's rhinoceros. Their poor representation in the bone assemblage is hard to explain using OFT, except when assuming that they may have been at a disadvantage in this environment with regard to narrow-nosed rhinoceros. This leads us to a major problem in the reconstructing of the optimal set of prey animals for Pleistocene foragers. Merck's rhinoceros may have been more highly ranked by foragers than narrow-nosed rhinoceros and other well represented species. It may simply not have been encountered very often. This is also the explanation I propose for the rather poor representation of Deninger's bear in the assemblage.

Therefore, high handling costs as proposed reason for the absence of straight-tusked elephant in the assemblage can only be accepted with reservations. This is a very large species that will only have been present in very low population densities, even in environments to which it was well adapted. If the environment of Biache-Saint-Vaast was not optimal for this species, then its populations may have been very thinly spread on the ground. It may thus have belonged in the set of animals that would be exploited on encounter, but during the period of time represented in level IIA it may simply not have been encountered during the times at which the site was occupied.

On the other hand, the assumption that encounters with prey animals happened at random is not tenable for Neanderthals. This was an intelligent species of hominin that was able to observe and learn the types of behaviour exhibited by prey species, it is therefore reasonable to assume that they were able to manipulate their encounter rates with prey species. This is in evidence in the Biache-Saint-Vaast assemblage, which demonstrates a reliance on a small number of prey species, all of which were large and therefore not present in very high numbers. Moreover, they focussed on specific categories of individuals of the preferred species. In aurochs they focussed on adult males, in bears they simply preferred adults, while at least with regard to narrow-nosed rhinoceros they apparently preferred juveniles to young adults. Since this focus of hunting was maintained in a consistent manner over time, resulting in an assemblage in level IIA representing hundreds of individuals, it appears that the occupants of the site were very capable of encountering the preferred prey categories in a consistent manner. I take this as an important argument to support the propositions I have made with regard to the influence of handling cost as the reason for the absence of such species as elephant and lion.

A striking species that is absent is giant deer. I find its absence difficult to explain in terms of search cost, since this species appears to have been well attuned to the environment that is indicated for level IIA. In terms of handling cost, the absence of females is understandable, since they presumably lived in herds. The absence of males is peculiar, however, since these were presumably solitary for most of the year and are heavier than brown bear, a species that was exploited. Two explanations can be proposed. First, the season of occupation may have coincided with the rut. During this time the males presumably lived in harem-groups. Second, the season of occupation may have taken place just after the rut. Males were solitary at this time of year. However, since they apparently do not feed during rut they will have been very lean and their ranking may therefore have dropped. The second hypothesis would agree with occupation in autumn as proposed by Auguste (1995a) and Louguet-Lefebvre (2005). Moreover, in this season, ranking of bear would be elevated since bears would be building fat reserves to survive their hibernation.

5.10 Conclusion

The main level of Biache-Saint-Vaast, level IIA, reflects the result of part of a foraging system that was stable over a number of years. The site has been dated to the period of transition between MIS 7 and MIS 6, reflecting circumstances intermediate between interglacial and pleniglacial. These are exactly the circumstances to which Neanderthals were adapted according to Gamble (1986, 1987).

The hunting activities clearly represent a preference for solitary prey of large size. Narrow-nosed rhinoceros probably reached their maximum size at the age of 9 (Louguet-Lefebvre 2005,

122). Moreover, it seems that young individuals leave their mothers side at about six years of age (Louquet-Lefebvre 2005, 123). This means that we are dealing with hunting of young solitary individuals. These were probably the most vulnerable, since they were not yet very experienced, but no longer accompanied by an adult. Another hypothesis that has been advanced, namely hunting of females and their young, probably in early spring (Auguste, Moncel, and Patou-Mathis 1998, 183) cannot be rejected, since a large number of infants is present and even one pregnant female (Louquet-Lefebvre 2005, 123). On the other hand, high infant mortality is common in nature anyway, so it is possible that (a large) segment of the infants were part of the natural background fauna and not connected to hominin hunting activities. In aurochs and bears, adults formed the focus of the hunting activities that are represented at the site.²⁴ In aurochs, the focus was on males only, presumably since they are solitary and live in small groups, while the females and calves live in larger herds. Moreover, the males represent much more meat, so in terms of caloric value this focus also concurs with the predictions made by OFT.

Of the unexploited species, the absence of giant deer is hardest to explain convincingly. A possible reason may have to do with the season of occupation of the site. There may be one additional factor that can be invoked in explaining their absence while the smaller brown bear was present. Their absence need not be explained by a decreased ranking of giant deer because of seasonal circumstances. Brown bear may have had an increased ranking based on factors other than its weight. First, Auguste has remarked that the position of cut-marks on brown bear bones suggest exploitation of these animals for their fur. This may have given the yield of this species more value than giant deer. Second, the killing of such dangerous animals may have provided prestige for the hunters. This may mean that giant deer was not in the optimal set, because it did not possess such added value. Third, if hunting bears took place in autumn, their ranking would be elevated because of their high fat content.

Level II base shows that equids and cervids were occasionally exploited. Moreover, exploitation marks are said to be present on bones of other species in level IIA. If foraging was practised using an optimal set that was exploited on encounter, one would expect these smaller species to be better represented in the assemblage. They may have been the lowest ranked species, but were probably encountered most often. This may be explained by assuming that foraging activities specifically targeted the highest-ranked species. As discussed in chapter 4, when encountering a low-ranked animal, a forager can evaluate whether the cost of continued foraging for more highly-ranked species would be more productive. Therefore, we can assume that the occupants of the site often decided to leave cervids and equids alone in favour of continued attempts at encountering more highly-ranked species.

The interpretation of developments in levels II base, D1 and D is quite complex. First, these levels do not present a time-averaged insight in activities. They represent short occupations and therefore short-term fluctuations in the environment may influence the represented species. The fact that the assemblages, especially of levels D1 and D are very small makes this problem even more serious.

On the other hand, the disappearance of bears from the diet in level D1 is a dramatic development. However, since the genus is the second best represented at the site as a whole, it is probable that their absence in these small assemblages at least reflects a decreasing importance of bears in the hominin foraging strategies. Deninger's bear is already absent in level D0 and its disappearance may be correlated to the changing climate and the disappearance of forest in the vicinity of the site. In my opinion, certainly in view of the other species that are still present, like aurochs and red deer, the environment was not unsuitable for brown bears at this time. The disappearance of ursids led to a relative increase in importance of all other taxa, except for bovids. This is also a peculiar development, since it was the dominant species at the site as a whole and accounts for a very large part of the bone assemblages of the previous and subsequent occupation. Their drop in importance may simply reflect a temporary decrease in encounter rates. In general, medium-sized ungulates living in herds become more important during the later occupations.

The developments in foraging tactics represent a changing situation, where demands of hominins were probably fulfilled more easily by a different focus of hunting activities. The presence of animals in large herds may have been easier to predict in the open environment. Moreover, herd

24 On the other hand, the method of compiling age-profiles used by Auguste may not be very secure. According to him adults were also the best represented category in rhino, while subsequent research by Louquet-Lefebvre (2005) revealed a focus on the younger adults and juveniles.

size of many animals increases as the environment grows more open (cf. Guthrie 1990). Therefore, herds may have represented increasingly large amounts of meat.

Exploiting species living in herds requires a large group, strategic behaviour and communication in order to co-ordinate the hunt (*e.g.* Farizy *et al.* 1994). However, this is also necessary for a small predator to kill prey as large as they did during level IIA times. In more open environments, hunting solitary and dangerous animals may have been less productive than increasing group size and concentrating on herds of ungulates. The fact that the animals in the herd are smaller than one rhinoceros is compensated by the fact that one can exploit many of them in one go. Moreover, in contrast to bears, ungulates are much less dangerous to hunt.