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

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6 Taubach

6.1 Introduction

Taubach is a travertine site in Germany, located near the city of Weimar. The site became renowned for its archaeological materials in the 19th century. It gained international fame because large amounts of Pleistocene bones belonging to extinct species were found here. The bones at this site are very well preserved and show extensive traces of human modification, in the form of traces of burning and cut-marks (reported in: Bratlund 1999). In addition to the large collection of bones, the site also yielded a distinctive stone tool assemblage. Similar assemblages have also been found at other interglacial sites in Central Europe and the "Taubachian culture" has therefore been defined on the basis of these assemblages (Valoch 1984).

This site allows us to address several important issues. First, the main find horizon of the site is traditionally dated to Marine Isotope Stage (MIS) 5e, the Eemian interglacial. As discussed in chapter 2, the character of human occupation of northwestern Europe during this period is the subject of debate. Some authors have proposed that Neanderthals could not deal with an interglacial climax environment, because available herbivore biomass was low and dispersed, compared to the more open environments of colder periods (*e.g.* Gamble 1986, Gamble 1992). Others attacked this hypothesis, arguing that the paucity of sites dating to this period is better explained by taphonomic factors (*e.g.* Roebroeks, Conard, and Van Kolfschoten 1992, Roebroeks and Speleers 2002). Taubach is one of the few sites that can be studied to address this question. In this chapter we will test whether analysing diet breadth at this site yields insight into the way in which Neanderthals coped with interglacial circumstances. Moreover, we may be able to confirm or reject the predictions regarding Neanderthal foraging behaviour in temperate environments put forward in the previous chapter.

Another issue is the importance of megafaunal species in the assemblage. Like at Biache-Saint-Vaast, rhinoceros is one of the most important animal groups represented in the assemblage. At this site, the dominant species is Merck's rhinoceros (*Stephanorhinus kirchbergensis*). It was slightly larger than the largest extant rhinocerotid, the white rhinoceros. The bones of this species exhibit abundant cut-marks. This site therefore presents us with the possibility to test the idea that specialised hunting of big game is unknown ethnographically (Haynes 2002, 208). From this it has been concluded that foraging for megafauna is never an optimal choice when considering only its caloric value (*e.g.* Wroe *et al.* 2004, 308).

There are some disadvantages connected with a case study of this site however. First, the site was discovered in the 19th century. The presently known collections were also formed in this period, especially in the 1880's and 1890's (Bratlund 1999). Since collectors were focused on identifiable bones and apparently also focused on certain more exotic species, this leaves us with a biased collection of bones (Bratlund 1999, 82-83). On the other hand, some small species are present in the collection, especially the presence of small beaver bones seems to point to the fact that the ratio of present species is probably representative of what was originally present. An additional problem is the fact that recent work has cast doubts on the Eemian age of this site. The dating evidence will be extensively discussed in this chapter. Nevertheless, the consensus view seems to be that the main assemblages from the site must be dated to MIS5e (*e.g.* Behm-Blancke 1960, Bratlund 1999, Gaudzinski 2004, Van Kolfschoten 2000, Roebroeks, Conard, and Van Kolfschoten 1992, Roebroeks and Speleers 2002, Wenzel 2002).

This chapter consists of an introduction to the site and a discussion of the debate surrounding its dating. An overview of the archaeological materials recovered at the site will then be provided, with emphasis on the bone assemblage. Moreover, the environment of the site will be reconstructed in order to provide an overview of the available resources at the time of occupation. This will be followed by a discussion on the information this site provides regarding the foraging strategies responsible for the accumulation of the bone assemblage.

6.2 The site

The travertine complex of Taubach represents a small travertine deposit, covering an area of about 0.2 km^2. It is located in the Bundesland of Thuringia in Germany, close to the city of Weimar. The travertines are located on a terrace bordering the Ilm river valley. The surface of the terrace is located about 7 metres above the valley floor. Archaeological finds were collected during commercial exploitation of the travertines (Bratlund 1999). Taubach was the first known German site that proved human presence in the *Diluvialzeit* (*e.g.* Eichhorn 1909) and became famous because of the large numbers of well-preserved mammal bones found at the location.

6.3 Dating

The traditional date assigned to the site was based on the composition of its mammal assemblage. The mammal species found at Taubach and also at the nearby site of Ehringsdorf, especially the lower travertines at the latter, were thought to be indicative of warm environments and were dated to the last interglacial. However, there are some problems with this date. The lower travertines of Ehringsdorf have been redated and now appear to be older than originally thought. They probably date to MIS 7 (Bratlund 1999, 74, 81). With regard to the large mammal fauna, the lower travertines of Ehringsdorf have yielded the most similar known faunal assemblage compared to that of Taubach (Bratlund 1999, 81). This has led to doubts as to whether the bone assemblage was actually formed during MIS 5e.

As pointed out, the travertine deposits at Taubach are distributed over a small area. Unfortunately, the totality of this area has now been built over, so most stratigraphic information must be obtained from profiles described around the turn of the previous century. One additional profile was described in 1972 (Bratlund 1999, 63-64). From the stratigraphic information and two direct dates obtained in recent years it appears that an Eemian date fits the stratigraphic column of the site *in toto*. However, all sources contemporaneous with the collecting of bones from the site state that the materials were collected from a layer in the lower part of the sequence, below the massive travertines

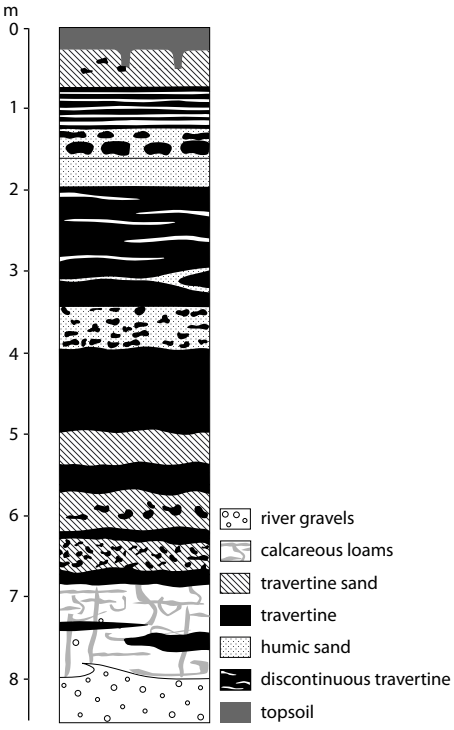

Figure 6.1: Idealised profile of the Taubach travertine deposits. Based on (Steiner 1977, 110).

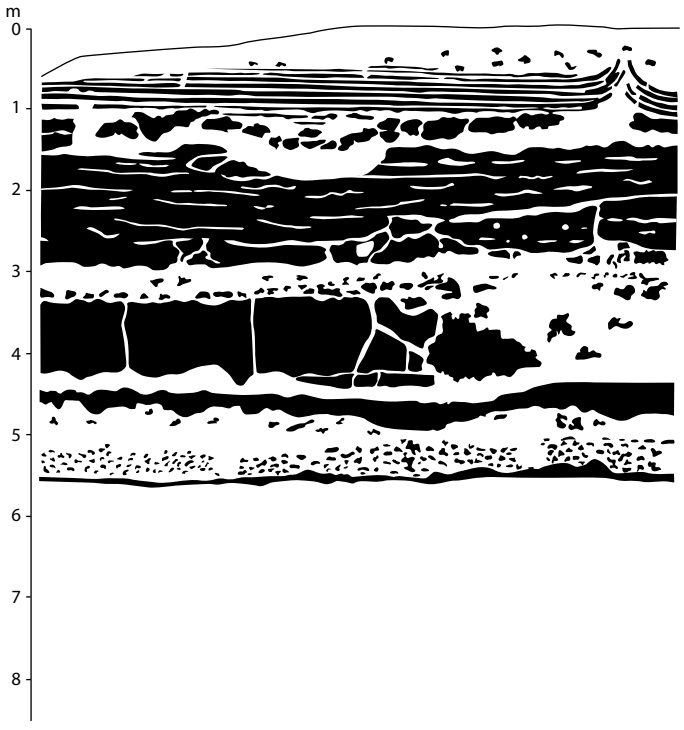

Figure 6.2: Schematic drawing of the profile exposed in 1972 showing Travertine in black. Note the discontinuity in the large travertine bank between 3 and 4 metres. This indicates that the identification of the Werksteindtravertine as a marker horizon may be problematic. Based on (Steiner 1977, 93).

that were the object of exploitation (Bratlund 1999, 67, 69). The samples for the direct dates were taken from a higher part of the stratigraphy. Therefore, the available direct dates only provide a *terminus ante quem* for the formation of the large mammal assemblage. This shows that the Taubachian fossil assemblages do not necessarily represent an occupation during full interglacial conditions.

An idealised stratigraphic column, the Idealprofil, was constructed on the basis of the 1972 profile (See fig. 6.1). Problematic in this respect is the fact that the travertine stratigraphy of the site is very variable. There is no continuous marker horizon available that is present throughout the travertine deposit. Many authors use the thick beds of travertine that were the focus of exploitation (*Werksteintravertine*) the layer between 4 and 5 metres in fig. 6.1, called bed 11 in the literature, as a marker horizon (e.g. Bratlund 1999, Steiner 1977). However, even this layer is discontinuous and grades into travertine sands locally (See fig. 6.2). The descriptions from the time of exploitation describe a layer of sandy travertine, called the Knochensand (bone sand) that yielded the large mammal remains (Bratlund 1999, 67). This is invariably described as a sandy layer situated beneath the indurated travertines (Steiner 1977, 87, 89). Two important things must be noted with regard to the 1972 profile. Firstly, the layers beneath the solid travertine deposits did not yield any bones, so the precise stratigraphic position of the bone sand could not be clarified. On the other hand, a layer of humic sand above the exploited travertines did yield one molar belonging to fallow deer (Dama dama), as well as several bone fragments of longbones. The largest of these fragments was 14 centimetres in length (Steiner 1977, 99-100). This may indicate that there were at least two findlevels at Taubach (e.g. Bratlund 1999, 70). Secondly, the Mollusken sand, Mollusc sand, is described as a separate unit from the layers underlying it, and with good reason, as will be discussed later. However, at the time of bone collection, all layers beneath the *Werksteintravertine* were often collectively referred to as the bone sand (Bratlund 1999, 70).

The available direct dates are two 230Th/234U dates. One sample was taken from the *Werksteintravertine*, yielding a date of 116.000 ± 19.000 years. The other dated sample was obtained from bed 7, the indurated travertine between two and three metres in fig. 6.1, this sample yielded a date of 111.000 ± 12.000 years. Therefore, a date in the Eemian for the upper part of the sequence is well established (Bratlund 1999, 70).

As pointed out, these dates do not prove that underlying bone sand necessarily dates to the same period. We know that travertines in Germany were only formed during warm periods, and they are usually assumed to indicate interglacial conditions. However, their formation need not be restricted to interglacials. Travertine deposits from Stuttgart for example may date in part to MIS 5c (Wenzel 2002, 40). Therefore, some travertine formation could also have taken place during an intra-Saalian warm phase.

In 1972, the excavated profile was sampled for molluscs, among other things. Analysis of the molluscs from lower sandy layers of this profile seem to point to relatively cold environmental conditions. They have been termed a *reliktische Kaltzeitfauna*. This makes an Eemian date problematic (Bratlund 1999, 80). In fig. 6.3, the profile and locations of samples for the analysis of snails are shown. Of interest with regard to the bone sand are the layers between the *Ilmkies*, the river gravels underlying the travertine deposits, and the *Steinbank*, the exploited massive layer of travertine. The samples were studied by (Zeissler 1977). According to her, the samples from the lower part of the sequence in the Mergel represent species indicative of cold and steppic conditions. She interprets the assemblage as a transitional fauna, showing an environment that is getting warmer (samples 901-898, see fig. 6.3) (Zeissler 1977, 155). The same species are also

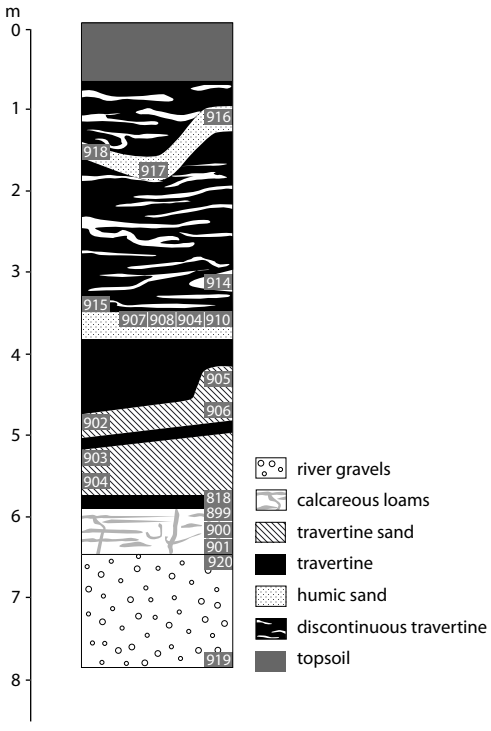

Figure 6.3: Schematic profile with locations of mollusc samples. Based on Zeissler, (1977, 141).

represented in the lower Travertine units, although in these units the number of dry species increases and also woodland species increase slightly (samples 903 & 904, see fig. 6.3) (Zeissler 1977, 155). However, from sample 902 upwards a full interglacial fauna is in evidence. According to Zeissler (1977), this must indicate a hiatus in the lower travertine deposits. Bratlund assumes that the bone collection comes from the layers beneath the mollusc sand and must therefore date to an early phase of the Eemian or a temperate phase of the Saalian (Bratlund 1999, 80-81). However, since often no distinction was made between these sediments at the time of exploitation, at least part of the bone assemblage may have been recovered from the mollusc sand.

The micromammal sample that has been used to date to the site, comes from the layer of humic sand above the *Werksteintravertine* in the Idealprofil, and is inferred to represent full interglacial conditions (Bratlund 1999, 71-72). Therefore the micromammals have been used to date the site to the Eemian (*e.g.* Van Kolfschoten 2000, 2002). However, since the sample comes from a different layer than the large mammal bones this date can only be used as a *terminus ante quem*. Since some tools were recovered from this layer, we can be certain that hominins were present in the area at this period in time. Unfortunately, in the 1972 research, only the river deposits at the base of the sequence and the mollusc sand yielded micromammal remains, not the lower layers of the lower part of the travertine deposits (Heinrich and Jánossy 1977, 401).

Evolutionary trends in large mammal species can also be used to date the site. In the case of Taubach, beaver (*Castor fiber*) and horse (*Equus taubachensis*) teeth have been examined. Unfortunately, this provides a less fine-grained resolution than examination of micromammal fossils would. In the case of the beaver remains they seem to be more advanced than the ones found at Ehringsdorf (Bratlund 1999, 72). The horse sample on the other hand is too small to draw definitive conclusions from, but the remains probably date to before 100 ka (Bratlund 1999, 72-73). A recent analysis of the remains of Merck's rhinoceros has shown that the Taubach fossils were distinctly more advanced than those of the lower Travertine from Ehringsdorf, supporting a younger date for Taubach (Made 2000). A similar point has been made for the giant deer (*Megaloceros giganteus*) remains. According to Van der Made (2003, 376-377) those at Ehringsdorf are significantly older than the Eemian remains, among which those of Taubach.

The large mammal fauna from the site has traditionally been interpreted as signifying warm interglacial circumstances. However, according to Bratlund (1999), a lot of winterhard species are present in the assemblage. She combines this with the indications from the molluscs from the *Mergel* and the lower travertine to date the site to the early Eemian. Because of the mollusc evidence, she theorises that the latest possible date for the assemblage would be during pollenzone 3 of the Eemian (Bratlund 1999). On the other hand, she upholds the possibility of the site dating to an intra-Saalian warm phase.

Unfortunately, accepting a date in the early Eemian is also problematic for the assemblage as a whole. First, there is the possibility that part of the assemblage comes from layers higher up in the sequence, like the mollusc sand. This is made more likely by the presence of Aesculapian snake (*Elaphe* aff. *longissima*) and European pond turtle (*Emys orbicularis*) in the museum collections (Mlynarski and Ullrich 1977). Both of these species need warm environments and are now restricted to more southern parts of Europe. More importantly, a similar argument can be advanced for one of the more important constituents of the assemblage, Merck's rhinoceros. This species shows features that suggest an adaptation to closed environments, especially in comparison to the other known rhinoceros species from this era. Its teeth have lower crowns than that of narrow-nosed rhinoceros (*Dicerorhinus hemitoechus*) and woolly rhinoceros (*Coelodonta antiquitatis*), suggesting more emphasis on browsing than on grazing. Moreover, its teeth have less cementum than these other species, likewise suggesting a specialisation for browsing. This impression is strengthened by the fact that its locomotion apparatus is more gracile than that of the other species suggesting an adaptation to a closed environment. In this respect it is also interesting to note that although the species is always found in interglacial contexts, it never entered Spain. This can be taken as an indication that it could not deal with open environments. The same is suggested by the fact that at those German sites where it occurs together with the smaller narrow-nosed rhinoceros, it is always present in higher numbers. Usually when two similar species co-occur, the smaller one is more abundant. This also suggests that in the vicinity of these sites, closed environments were more abundant than open ones (Van der Made in press, 44-46).

The debate surrounding the site's date is hard to resolve, since the stratigraphic descriptions from the time of exploitation are not very detailed and there was a lot of variation within the Taubach

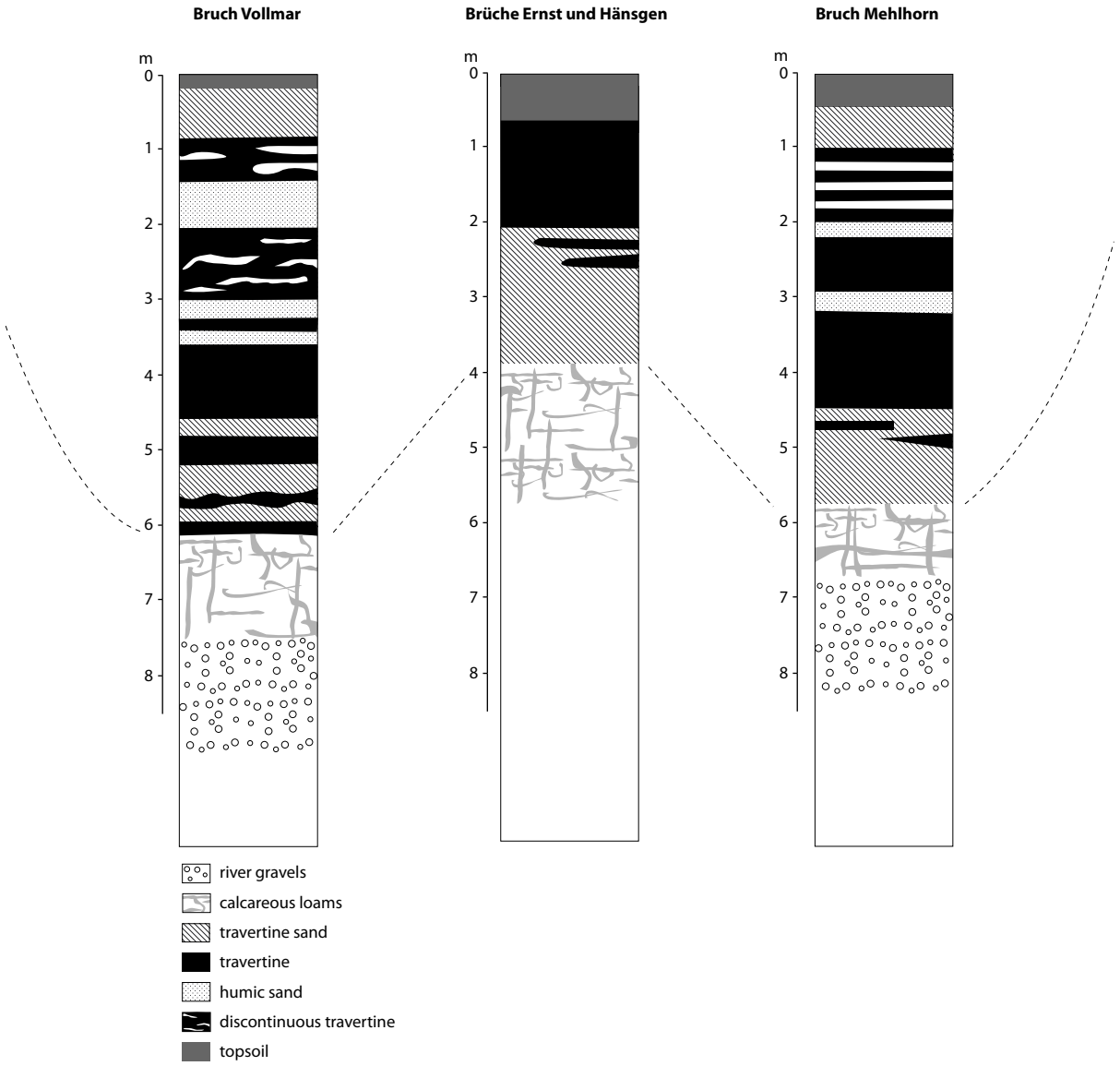

Figure 6.4: Cross section through the Taubach travertine deposits based on old descriptions and the 1972 profile. Note the high position of the bone sand in the Zentralbereich. Based on (Steiner 1977, 111).

deposits, as shown in Figure 6.4. To me, there seem to be three options. First, we can take Bratlund's estimates to be correct. Combined with the data on Merck's rhinoceros we might than assume that the large mammal assemblage dates to the third pollen phase of the Eemian, combining a transitional environment and moderately cold conditions with closed areas in the environment. Another possibility is to assume that most of the large mammal assemblage comes from the mollusc sand. Since this was sometimes grouped together with the bone sand at the time of exploitation this is a possibility. Furthermore, the reptiles in the assemblage do seem to point to the environment being warmer than at present. A combination of these two hypotheses is also a possibility. The warmth-loving species, especially the reptiles in all probability come from the mollusc sand. A large part of the bone assemblage could be from the lower travertine sands. These could date to the early Eemian, or a temperate phase within the later stages of MIS 6.

The third possibility is to assume that the surviving descriptions about the provenance of the bones from the time of exploitation are incorrect. The fauna might then come from the lower humic layer. This is the only layer that yielded stone tools and large mammal remains in 1972. Furthermore, due to the variability of the stratigraphy, as seen in the grading of the Werksteintravertin in travertine sand within a few metres in the 1972 profile (fig 6.2), this might actually fit some of the original

descriptions, where the findlayer is described to be travertine sand, but quite high up in the deposit (cf. Ernst und Hänsgen in fig. 6.4).

I prefer the second possibility for the time being. I think that the combined data from the species that are present in the layers and the travertine deposits warrants dating of these layers within the Eemian rather than MIS 7. The exact position of the assemblage within the pollenzones is a topic to which I will return below when discussing the environment. First I will shortly present the archaeological finds from the site.

6.4 The archaeological finds

As pointed out, this was the first site to be discovered in Germany that yielded evidence of human presence in the *Diluvialzeit*, i.e. the Pleistocene. Indications of human presence were found in the form of *Brandschichten*, charred layers said to contain charcoal and ashes (Bratlund 1999, 67). They have been claimed to represent hearths that show many phases of use (Schäfer 1990, 54). Furthermore, the bone sand and the humic sand above the *Werksteintravertine*, yielded artefact assemblages (Bratlund 1999, 64, 67). Also, many of the bones collected at the site show cut-marks or are charred, testifying that hominins were involved in the accumulation of the bone assemblage (Behm-Blancke 1960, Bratlund 1999). Additionally, some publications report tools made of bone and antler (*e.g.* Behm-Blancke 1960, Valoch 1984). According to Bratlund (1999, 90-91) the ones present in the collection she studied were mistakenly identified as artefacts.

The finds show that hominins were present in the area and that their activities were at least partly responsible for the formation of the assemblages. However, natural factors probably also contributed to the formation of the bone assemblages. The travertine deposits provide an area of excellent preservation and therefore, animals that died of natural causes or were killed by carnivores in the area will also have been preserved (Bratlund 1999, 86-87). Besides, it is apparent that the site represents a palimpsest of many different occupational episodes. This is indicated by the large quantities of bone that were found at the site. Some collectors even described the bone sand as being saturated with fossils (Bratlund 1999, 67).

The artefact assemblage represents a selection made by collectors of these remains of repeated occupations. The character of the bone assemblage is uniform, suggesting that similar assemblages were left during the different occupational episodes. Furthermore, the kind of stone tool assemblage found at Taubach is thought to be analogous to the assemblages of a group of Eemian sites in Central Europe. This has led some researchers to name a culture after this site, the Taubachian (*e.g.* Valoch 1984, 193). All stages of flint-knapping are represented at the site. The amount of knapping debris and natural pieces on the other hand is underrepresented in the surviving collections. On the other hand, the fact that so-called *Trümmerstücken* and artefact made on non-flint materials are present at all suggests the collection methods were less biased than sometimes assumed (Schäfer 1990, 55-56).

The Taubachian has been characterised as a microlithic industry. The artefacts produced are small and there are few formal tools among the assemblages. Raw materials were mostly locally collected and this led to quite high percentages of non-flint artefacts. Moreover, reduction strategies were thought to be quite primitive and Levallois-reduction absent. The cores found at Taubach are of irregular form and of a non-Levalloisian character (see for example Valoch 1984).

This characterisation appears to be faulty and based on biased publications (Schäfer 1990, 61-63). The small size of the artefacts found at Taubach can be attributed to the raw materials used. Most artefacts were made from pebbles found in the gravels of the nearby Ilm River (Schäfer 1990, 57, Valoch 1984, 195). In general, the dimensions of these pebbles were limited. The average length of cores is only 36 mm. However, when comparing Taubach to similar assemblages, like the one found at Ehringsdorf, it does seem that hominins at Taubach were able knappers and managed to reach a higher *Längeneffizienz* than at other sites, i.e. they effectively maximised the length of flakes they produced (Schäfer 1990, 57-58). Furthermore, Taubach seems to show quite high "leptolithisation", meaning that flakes are on average very thin and elongated (Schäfer 1990, 58). Reduction strategies were not as primitive as sometimes proposed. According to Behm-Blancke (1960, 169), the reduction technique resembles the Levallois technique.

Bone working was also considered to be an important feature of the Taubachian. At other sites that have been classified as Taubachian, like Kůlna and Tata, many bone and ivory retouchoirs have been found. At Taubach, because of the collection methods and emphasis on complete and/or

identifiable bones, these may have been missed. On the other hand, a piece of antler with engraved regular lines has been reported from the site. Similar pieces have been found at Kůlna (Valoch 1984, 198). Furthermore, purported antler digging sticks have been recovered at the site. It has been hypothesised that they were used in order to dig pitfalls for the hunting of the large animals found at the site (Behm-Blancke 1960, 205). However, during her study, Bratlund was unable to locate antlers that were convincing artefacts (Bratlund 1999, 90-91). Therefore, this aspect of the Taubachian has not been convincingly demonstrated at this site. Most likely, many of the "artefacts" were naturally damaged pieces of bone and antler that were mistaken for artefacts.

6.5 The bone collection

Since the bone assemblage was collected largely in the 19th century, an important concern is to determine to what degree the collection is representative of what was originally there. Furthermore, it is essential to ascertain the role that hominin activities played in the formation of the bone assemblage. One problematic aspect of the bone assemblage of this site is the fact that the remains are dispersed over many collections. This is because during the height of scientific interest in the site at the end of the 19th century, bones from this site were highly valued palaeontological collector's items (Bratlund 1999, 81). Moreover, before scientific interest in Taubach was stirred, exploitation of the travertine had already started and at the time large collections of bones were dumped in the Ilm River (Bratlund 1999 87, 82).

Still, located at the *Forschungsstation für Quartärpaläontologie* of the *Forschungsinstitut Senckenberg* in Weimar, the largest surviving collection has been surveyed by Bratlund (1999). This collection was accumulated by local scientists with direct access to the Taubach quarries. Therefore, the provenance of the finds in the collection is clear. This does not mean that the collection is unbiased. The collection shows a clear focus toward complete and identifiable bones. This has resulted in a dominance of cranial material and especially of isolated teeth, which make up 34.74% (n=1540) of the collection studied by Bratlund (1999, 85-86). Furthermore, collection choices may be partially responsible for the dominance of Merck's rhinoceros and brown bear in the surviving sample (Bratlund 1999, 82, 151). On the other hand, these species were also reported as being dominant in earlier publications (Behm-Blancke 1960, Bratlund 1999). Therefore, their abundance in these deposits is probably a real phenomenon. This can be taken as an indication that the list of species and their relative

Species	Total fragments	Cut-marked	MNI
Ursus arctos	1537	292	52
Stephanorhinus kirchbergensis (some Dicerorhinus hemitoechus)	1224	99	76
Bovids (Mainly *Bison*, some *Bos*)	533	25	18
Castor fiber	319	10	17
Cervus elaphus	207	2	not provided
Palaeoloxodon antiquus	182		not provided
Equus taubachensis	161	1?	not provided
Sus scrofa	96		not provided
Capreolus capreolus	58		not provided
Megaloceros giganteus	6		not provided
Ursus spelaeus	7		not provided
Panthera leo	5		not provided
Crocuta crocuta	1		not provided
Canis lupus	7		not provided
Panthera pardus	lost		
Lynx lynx	lost		
Meles meles	lost		
Lutra lutra	lost		
Unidentified carnivore	4		
Unidentified	86	3	

Table 6.1: Composition of the Taubach mammal assemblage. After (Bratlund 1999, 84, 86).

abundance in the collection may roughly reflect the original frequencies. If there was a collection bias against smaller, less interesting animals for example, we would expect a small and still extant animal like beaver to be only very poorly represented. Moreover, the pattern of recovery for this species is similar to that of Merck's rhinoceros, brown bear and large bovids. This has resulted in small bones of the hand and feet being very well represented, accounting for 18.2% (n=58) of the beaver material (Bratlund 1999, 130).

The faunal assemblage present at the Forschungsstation für Quartärpaläontologie numbers 4433 pieces. It comprises a very diverse fauna. An overview of the collection is provided in table 6.1. As stated, the dominant species are Merck's rhinoceros and brown bear. Other abundant species are large bovids and beaver. In addition to the species that are present in the collection presented by Bratlund, other species have in the past been reported as hailing from Taubach, these are also listed in table 6.1. Of these, it should be noted that the actual remains are now lost and only those belonging to leopard (*Panthera pardus*) have been published. Moreover, some remains of mammoth (*Mammuthus primigenius*) and reindeer (*Rangifer tarandus*) are present in museum collections that are said to come from the site. They are probably derived from different deposits though (Bratlund 1999, 84). Bratlund did not study the remains of small animals, like birds and reptiles, but they are rare (Bratlund 1999, 84). However, (large) mammals were the focus of collection activities, so the small animals present will have been severely biased against.

Since the spatial distribution of the archaeological finds cannot be studied anymore, the opportunities to conduct taphonomic studies in order to determine what natural processes may have contributed to the formation of the bone assemblage are severely limited. Furthermore, we do not know how the bones were distributed in relation to the artefacts and so-called Brandschichten. Therefore, we can only use modifications on the bones themselves to infer hominin activities (Bratlund 1999, 86-97). In the past, researchers have tried to reconstruct hominin hunting and transport behaviour, based on the bone-categories present in the samples. For example, it was thought that since ribs and vertebrae of Merck's rhinoceros were not represented at the site, they were killed at some distance of the site and brought in. However, this pattern seems to have been a product of the collection methods. Apparently ribs were not very valuable commercially for the quarry workers and thus were not collected. When people started looking for them, apparently ribs were found in abundant numbers (Behm-Blancke 1960, 207). Because of the collection bias, body part representation in the assemblage will not tell us much about Neanderthal hunting strategies, I will not go into this in detail here (for information see Bratlund 1999). Table 6.1 thus provides an insight into what prey species were available. In addition to the information we can glean from the species that were present, we must also keep in mind that plants were available, though we do not know their importance (Behm-Blancke 1960, Wenzel 2002).

The most abundant species present at the site also provide us with most indications for hominin activities. Brown bear (*Ursus arctos*), Merck's rhinoceros, bison (*Bison priscus*) and beaver account for 90% of the sample. Between 6 and 12% of the bones of these species were cut-marked, except for brown bear, which stands at 26% (Bratlund 1999, 91). Another bone modification that can be attributed to hominin influence is charring, which shows that the bone was in very close contact with fire. The charred bone sample is also dominated by Merck's rhinoceros and brown bear (Bratlund 1999, 87). Breakage of bones in order to exploit their marrow content cannot be studied in the assemblage, since collection focused on undamaged bones. However, Tafel XXXVI in (Eichhorn 1909) shows the distal ends of five broken metatarsi of bison, demonstrating that bones were broken for marrow at the site. How regular the behaviour was can unfortunately no longer be reconstructed.

Indications for hominin activities on bones of other species are rare. This is partly due to the collection methods though. Many species are mainly represented by teeth and cranial fragments. They are durable elements and allow for easy species determination. However, they do not yield much information on their role in hominin or carnivore subsistence strategies. Out of 207 red deer (*Cervus elaphus*) specimens in the collection, only 11 are postcranial bones, 67 are isolated teeth and another important group is antlers (n=106). Of the postcranial bones, two, a talus and a phalange, show cut-marks. This means that if we discount the isolated teeth and antler specimens in the collections, about 6% of red deer bones are cut-marked (Bratlund 1999, 91). The collections of bones of other ungulates are small; most species do not show any cut-marks. However, some boar jaw fragments show impact scars, which may indicate hominin involvement with the bones. Horse is also represented mainly by teeth. Of the bones that are present, the meaty parts of the skeleton are underrepresented. However, one phalange exhibits a possible cut-mark (Bratlund 1999, 92).

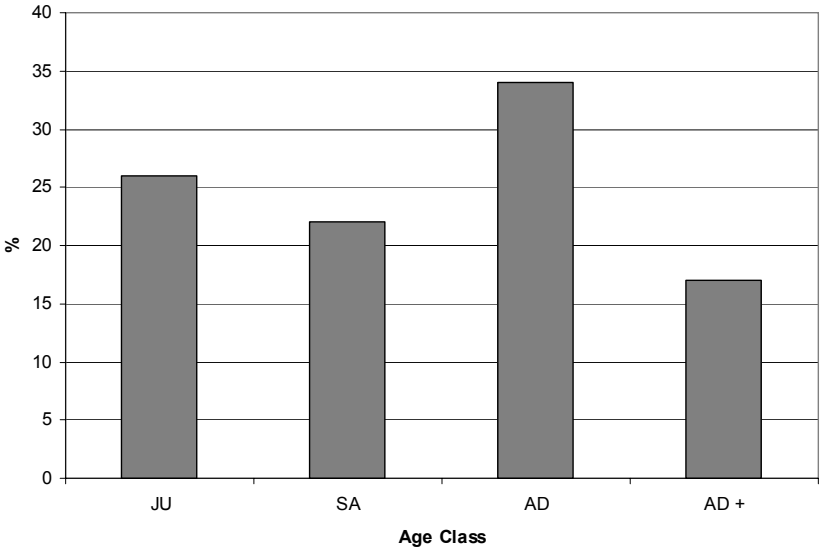

Figure 6.5: Age profile of straight-tusked elephant at Taubach. Data from (Bratlund 1999, 92). Ju: Juvenile; SA: subadult; AD: adult; AD+: Old adults.

Another indication that an assemblage is not a natural sample can be gleaned from the mortality profile of the species present, as discussed in chapter 3. The age-profile of the straight-tusked elephants from Taubach has been used to argue that elephants were hunted at the site despite the fact that cut-marks and impact scars are absent on the bones of the species. Figure 6.5 illustrates the age-structure of the population based on the examination of 99 elephant molars from Taubach. Unfortunately, some of the molars may have belonged to the same individual, affecting the reliability of the data (Guenther 1977, 282). However, it is immediately obvious that this age-distribution does not rerpresent a classic attritional profile, since adults are very well represented. The good representation of juveniles has been used as an argument supporting the fact that the assemblage was hunted (Guenther 1977, 283). Nevertheless, comparison of the Taubach age-profile with those of natural death assemblages shows that if anything juveniles are underrepresented in the Taubach assemblage (*e.g.* Haynes 1985, Haynes 1987). Assemblages with such a good representation of adults at Taubach are rare and it is this factor that in my opinion may be used in support of a hunting interpretation. A similar age-profile is known from the site of Ambrona though (Haynes 1987, 665-666). As discussed in chapter 3, at this site hominin involvement with the elephant assemblage appears to have been minimal. The mammoth site of Hot Springs in the United States provides another example of a natural death assemblage containing more adult and old individuals than would be expected (Haynes 1988, 665). Since a similar age-profile as that illustrated in figure 6.5 may arise in natural circumstances, the age-structure of the population of Taubach provides insufficient support for an interpretation of their remains in terms of hominin hunting.

Not only do the bones of the four most abundant species exhibit cut-marks, these occur patterned at specific locations, suggesting a systemised way of carcass exploitation. This would only be possible if hominins had the control over the carcass and could choose the parts they were exploiting, since already exploited carcasses would require ad hoc exploitation of the parts that were left. Therefore, scavenging is an untenable explanation for the formation of this assemblage.

The species that is represented by the largest number of bones is brown bear. Furthermore, this species exhibits the highest frequency of cut-marks. In terms of the Minimum Number of Individuals (MNI), 52 individuals are represented, making Merck's rhinoceros better represented in that respect. One of the reasons of the overrepresentation of this species in terms of NISP and cut-marks NISP is the abundance of hand and foot bones in the assemblage. As discussed in section 4.6, carnivores have 5 carpals, tarsals etc., while in herbivores these have been reduced in number. Moreover, these are very durable elements and therefore likely to survive in the archaeological record. This means that in terms of NISP, brown bear is overrepresented at this site. In bears, the cut-marks point to a standardised pattern of head removal and tongue extraction. The limbs were heavily filleted, even the paws (Bratlund 1999, 118). Cut-marks are present on 26% of

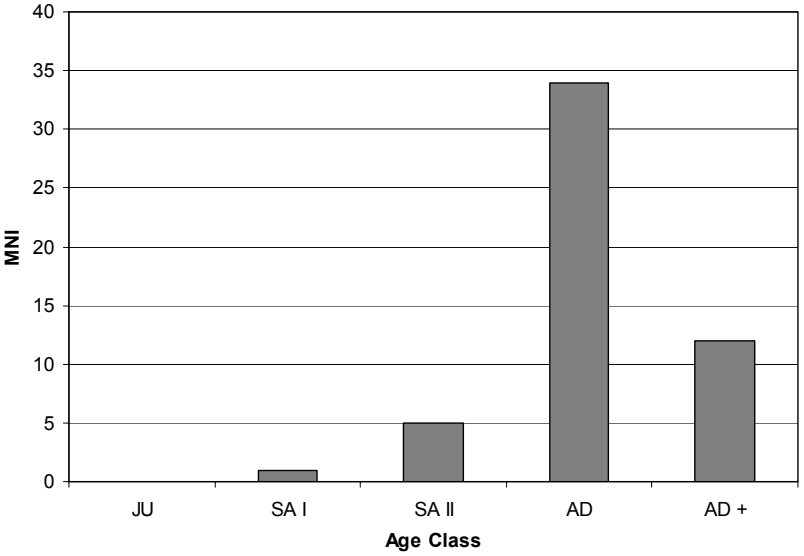

Figure 6.6: Age profile of brown bear from Taubach. Data from (Bratlund 1999, 113). Ju: Juvenile; SA: subadult; AD: adult; AD+: Old adults.

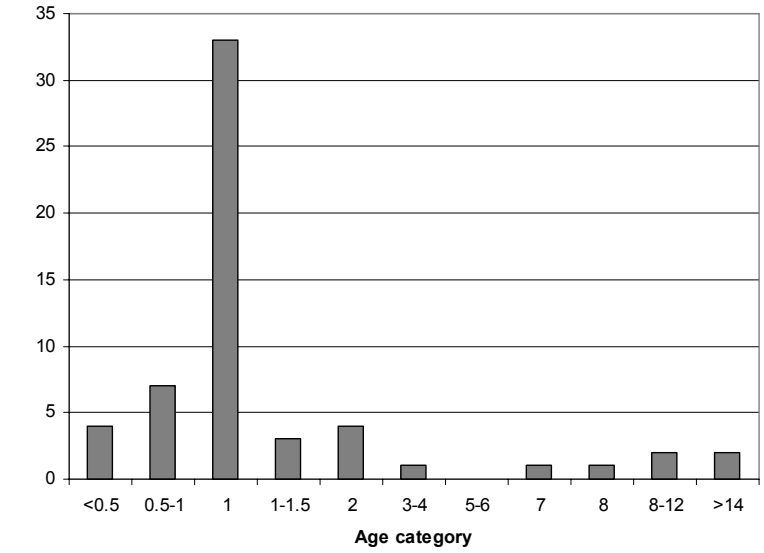

Figure 6.7: Age profile of Merck's rhinoceros from Taubach (N=65). Based on (Bratlund 1999, 100).

all bear bones, a percentage twice as high as in the other species; this is caused by the filleting of the paw bones. This pattern is consistent with fur exploitation of the animals (Auguste 1995a, 162). In contrast to the pattern seen in Merck's rhinoceros, in bears there is no concentration on young individuals, as shown in Figure 6.6 (Auguste 1995a, Bratlund 1999, 112-113). In this species therefore, prime-aged adults are the most heavily represented category.

The most abundant species, with respect to the MNI, represented in the assemblage is Merck's rhinoceros. However, a very small share of the bones classified as Merck's rhinoceros in the collections at the *Forschungsstation für Quartärpaläontologie* is considerably smaller than the rest of the rhinoceros bones (n=28). These probably represent narrow-nosed rhinoceros. As stated earlier, these two species often co-occur. Because the number of fragments is so small, they have been included in the Merck's rhinoceros sample (Bratlund 1999, 93-94). The species is represented by 1224 bones and the MNI has been estimated at 76 (Bratlund 1999, 93, 101). The exploitation of rhinoceros seems to have focused on separating the head from the body and removing the tongue, disarticulation of the carpal-metacarpal joints in the limbs, and filleting the longbones. Even the feet were skinned

and filleted (Bratlund 1999, 107-108). Since the discovery of the site it has been apparent that young individuals dominate the rhinoceros assemblage (*e.g.* Behm-Blancke 1960, 201-203). Bratlund used the dentition of the assemblage to determine the age structure and in the collection studied by her, there were 44 calves, 7 subadult individuals and 25 adults (Bratlund 1999, 100). An age profile of this species is presented in figure 6.7 (Unfortunately Bratlund (1999) uses different age-categories than Louguet-Lefebvre (2005) applies to the Biache-Saint-Vaast assemblage).

The next best represented prey category comprises several species: the large bovids. The bones in the assemblage belong mainly to Bison, two subspecies of which were present: *Bison priscus priscus*, which predominated, and *Bison priscus mediator*. Furthermore, two or three postcranial bones belong to Bos primigenius. Concerning MNI's, adults are again in the majority, they are represented by at least 34 individuals. There are also at least 12 older individuals represented in the assemblage. Furthermore, one young animal and 5 older subadults are represented (Bratlund 1999, 123). The horncores at the site, as well as the majority of the bones belonged to males. Cut-marks are present mainly on carpals, tarsals and phalanges, but they are too small in number to make generalisations regarding the pattern of exploitation (Bratlund 1999).

The final species that shows traces of exploitation is beaver. Only 10 bones of this species show clear cut-marks, so as with the large bovids, a pattern of exploitation is hard to deduce (Bratlund 1999, 130). At least 17 individuals are present in the assemblage. Their age is hard to determine, however, it seems that most individuals represented were older subadults or adults (Bratlund 1999, 130-131).

The material studied by Bratlund and presented here forms only a small remnant of what must originally have been a huge assemblage. The good representation of a species like beaver in the bone assemblage, even with regard to its smaller bones, shows that collection bias with regard to species was not great. Only one species that was mentioned to be present in large numbers in early publications, the straight-tusked elephant, is not very well represented in the assemblage studied by Bratlund. The fauna was even originally named after this species and dubbed antiquus-fauna (*e.g.* Behm-Blancke 1960, Eichhorn 1909). In 1922, Soergel wrote that more than 100 rhinoceroses and more than 70 bears, as well as at least 64 elephants had been found at Taubach (in Behm-Blancke 1960, 204). However, I think this emphasis on elephant might in part be due to its size. If anything, the larger extinct species were specifically collected and should be overrepresented. Therefore, I deem it unlikely that straight-tusked elephant is underrepresented in the studied collection, but more likely that it was given an inordinate amount of attention in early publications.

According to Bratlund (1999, 150), the site may represent a salt lick that was of interest to rhinoceros. The fact that this was an area of higher salinity seems to be supported by the ostracod evidence. The enormous amount of material that was originally present shows that the site represents a palimpsest. As pointed out in chapter 4 this is advantageous with regard to the application of OFT to a site, because we can assume that short-term variations in prey availability have been averaged out.

6.6 The environment

Given the dating uncertainties surrounding this assemblage, reconstructing the environment of the site becomes slightly problematic because environmental differences between the late Saalian and early Eemian pollen phases may have been quite large. On the other hand, the large mammal assemblage also yields information about the nature of the environment. As argued in section 6.3, I will assume that the site dates to the early Eemian. In this section, I will summarise the environmental indicators we have for the site and the wider surroundings and propose a tentative scenario of what the environment of the site looked like at the time of the formation of the archaeological deposits.

The German travertines were formed during warm climatic phases. However, as stated above, some of the travertine build-up may have occurred during interstadials, as well as interglacials. At least we can therefore be certain that the climate was warm during the accumulation of the bone assemblage. The Taubach travertines were formed by warm water welling up at the edge of the Ilm river valley. From the valley's edge, it trickled down to the river. Because of the lowering temperature and pressure after surfacing, part of the calcium carbonate present in the water precipitated, forming the travertine deposits (Speleers 2000, Steiner 1977). The depositional circumstances varied drastically within the area of travertine build-up. Differential precipitation could change the local relief and change the direction in which the water flowed, which had consequences for later travertine

formation. This resulted in differential deposition of travertines and in many horizontal and vertical facies changes (Steiner 1977,112). This means that sandy and indurated travertines were not necessarily deposited in different climatic conditions.

These warm water sources were probably an attractive location for Pleistocene hunter/gatherers. Moreover, these water sources would not freeze in winter. In contrast to most other German travertine deposits, leaf impressions are absent in the Taubach travertines. This suggests that the immediate environment of the area where the water welled up and deposited was open (Steiner 1977, 113). The travertine build-up took place in shallow bodies of water. However, the occurrence of ash-lenses or hearths and land snails in the bone sand suggests that the ponds dried up periodically (Bratlund 1999, 67). The immediate environment of the site was therefore a marshy area, a *Rieselfeld* with streams of water trickling down from the terrace edge to the river valley. The water formed streams and periodically ponds in which the travertine was deposited. The exact configuration of these was very variable and the travertine deposition influenced the shape of the area and bodies of water.

Unfortunately, plant remains and pollen are not known from the deposits. Furthermore, as mentioned, micromammals were not recovered from the bone sand sensu stricto, only from the overlying mollusc sand. Molluscs from the lower layers of the bone sand have been studied however (see fig. 6.3 for a schematic profile with the sampling locations). Their implications with regard to the dating of the site have already been discussed. In this section I will go into the evidence that the molluscs provide with regard to the environment of the site.

Sample numbers 901 upwards to 905 are of interest (see fig. 6.3). Sample 901 is quite small, only containing 35 molluscs, but the other samples under consideration contained several hundred specimens (Zeissler 1977). As discussed previously, the mollusc samples can be grouped in two categories. Firstly, samples 901 to 903 show species indicative of high mountains and continental steppes, indicating a climate that was colder than nowadays. In the other group, from sample 902 upward, warm species are very well represented (Zeissler 1977, 155). This indicates a hiatus in the stratigraphic sequence, since such transitions tend to take place gradually. Furthermore as molluscs have a low dispersal rate, it would take them time after a climatic improvement to establish themselves in the region. From sample 903 onwards they are clearly well established in the region.

Evidence regarding the vegetation of the site is absent. However, at a regional level, studies of pollen can yield important insights in the vegetation present. Cores have been analysed from the sites of Gröbern, Grabschütz and Neumark Nord, which are not too distant from the site. Other sites that were studied include Bispingen from Northern Germany, La Grande Pile in France and Dziewule in Poland (*e.g.* Binka and Nitychoruk 2003, Guiot *et al.* 1992, Kühl and Litt 2003, Litt 1990, Litt, Junge, and Böttger 1996). The pollen-sequence of the Eemian is quite well known and is uniform over large areas of western and central Europe (*e.g.* Kühl and Litt 2003, 206). Pollen cores have demonstrated the successive colonization of Europe by different tree species. The Eemian has been subdivided into pollen stages according to the dominant tree species. Reconstructions of the Eemian climate and environment can therefore be made with reasonable confidence. There is some discussion however, about the stability of the climate in the Eemian and the best method to reconstruct climate based on the pollen cores (Cheddadi *et al.* 1998, Kühl and Litt 2003, Litt, Junge, and Böttger 1996). Characteristic of full Eemian climatic circumstances is the spread of climatically sensitive species like Holly (*Ilex*), Ivy (*Hedera*), Mistletoe (*Viscum*), Box (*Buxus*) and honeysuckle (*Lonicera*) (Litt, Junge, and Böttger 1996, Wenzel 2002). In this study, the early pollen-phases of the Eemian are of relevance.

The following picture can be painted combining the known pollen sequences from central Germany and further afield. (See fig 5. for the pollen sequence found at Gröbern which offers an example of these developments.) The melting of the ice in the late Saalian signals a start of temperate conditions with reasonably high summer and winter temperatures. This warming up is interrupted by the Kattegat-stadial and a return to very cold and dry conditions. This stadial lasts for about 1000 years, after which temperatures rise rapidly (Beets, Beets, and Cleveringa 2006). The earliest phase of the Eemian is characterised by the expansion of pioneer species, most notably birch (*Betula*). Study of varve counts has shown that this phase has a short duration of about 100 years (Kühl and Litt 2003). The second phase of the Eemian is still dominated by pioneer species. In addition to birch, pine (*Pinus*) now becomes important, this phase is therefore known as the *Pinus-Betula* stage. It has a duration of about 200 years. In the third phase of the Eemian, deciduous trees start making their appearance in northwestern Europe. The most ubiquitous of these species is oak

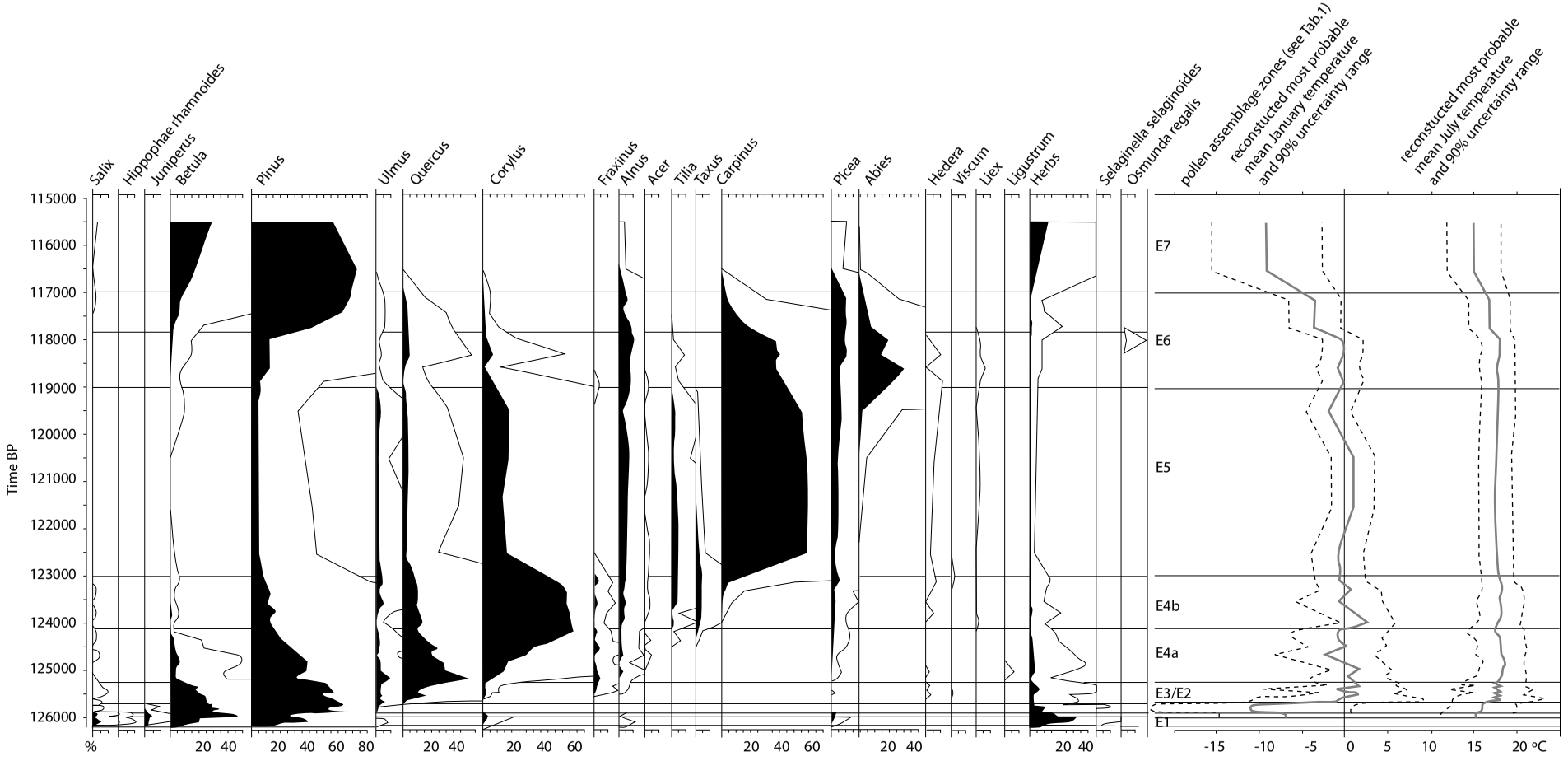

Figure 6.8 Simplified pollen diagram of Gröbern. Redrawn after (Kühl & Litt 2003, 207).

(*Quercus*), which is why this phase is dubbed *Pinus Quercetum mixtum*. Other species of tree present are ash (*Fraxinus*) and elm (*Ulmus*). This phase lasts for about 450 years (*e.g.* Kühl and Litt 2003, Litt, Junge, and Böttger 1996). The later phases show the subsequent expansion of dominance of hazel (*Corylus*), then hornbeam (*Carpinus*) and fir (*Abies*). These phases have a longer duration than the earlier pioneer phases. The *Corylus* phase lasts about 2200 years, the *Carpinus* phase about 4000. Then the climate cools somewhat in the later part of the Eemian. Fir and spruce (*Picea*) make their appearance in the sixth phase. This phase lasts about 2000 years. The seventh and final pollen stage of the Eemian also lasts about 2000 years and is again dominated by pine (Kühl and Litt 2003, Litt, Junge, and Böttger 1996).

As said, most archaeological finds at Taubach probably date to the earlier pollen phases. The combination of the mollusc evidence with the presence of species requiring relatively warm environments like the pond turtle might point to a date at the end of the pioneer phases, in phase three when deciduous trees already become important in the pollen-diagrams. However, reconstructions of the January and July temperatures show that temperatures increased very steeply in the first pollen phase with mean January temperatures already at 0 degrees for Bispingen and La Grande Pile. It is thought that the highest July temperatures of the interglacial were reached in the early stages of the Eemian. This is shown by the early appearance of many thermophilous taxa (*e.g.* Binka and Nitychoruk 2003, 164). In pollen phase three mean January temperatures were higher than today with an average of +2 °C at Gröbern and July temperatures of 17-18 °C (see right hand columns in figure 6.8 (Kühl and Litt 2003, 210)). It seems therefore that climatic circumstances improved drastically from the earliest phases of the Eemian onwards. Temperatures rose steeply already in the first phase of the Eemian and the highest temperatures were reached in the Quercus phase of the Eemian. The absence of a climax fauna in the mollusc remains can therefore be explained as the result of a lag effect due to low dispersal speeds.

With regard to the occupation of Eemian environment, it is important to know how closed the environment was, since it has been proposed that Neanderthals could not deal with a densely forested environment. An important indicator for the openness of the environment is the ratio between arboreal and non-arboreal pollen. Traditionally, values of non-arboreal pollen of 10% and lower are interpreted as evidence for closed forest. On the other hand, the relationship between the amount of non-arboreal pollen and environmental openness is not very straightforward and would ideally be supplemented by additional environmental data (*e.g.* Svenning 2002, 135). In the Gröbern diagram, during the first pollen phase of the Eemian, non-arboreal pollen represent over 20% of the pollen spectrum. This decreases during phase 1 reaches about 10% during phase 2, only to drop to very low levels during the last part of phase 2. From pollen phase three up until the end of pollen phase 7, non-arboreal pollen values are lower than 10% (Litt 1990). This suggests that the environment of Gröbern was covered with forest from at least phase 2 of the Eemian. The forest became ever more closed during this period and was definitely closed from phase 3 onward.

In recent years, there has been discussion about how closed European interglacial forests were before humans started to have an impact. Based on the proportions of arboreal and non-arboreal pollen in pollen cores they were thought to have been closed. However, based on some of the herbivores that were present during these periods, it has been proposed that the environment contained more open spaces than indicated by the pollen evidence. These open spaces were created and maintained by large herbivores. This would have resulted in a woodland pasture type of vegetation (*e.g.* Birks 2005, 154).

This discussion has been resolved by looking at the Holocene situation. In this period, oak and hazel were important constituents of the European flora. They need canopy openings in order to reproduce. The question is whether treefalls would provide enough openings in order for these species to regenerate. In the Holocene, this was the case because in Ireland and in Zealand in Denmark, large herbivores were absent, while proportions of oak and hazel in pollen cores were similar to those in the rest of Europe (Birks 2005, Svenning 2002). Therefore, for the Holocene, the discussion seems to be settled in favour of a more closed environment. The fact that hazel and oak remain present in reasonably large percentages in the pollen spectra suggests that treefalls and fire may have provided enough openings in the canopy for them to reproduce. Furthermore, there are some niches, like steep slopes for hazel and poor acidic soils for oak where they do better than the competition, so they may have maintained a presence in these niches that is reflected in the pollen cores (Svenning 2002, 139). Finally, beaver is a species of animal that was present in the Holocene and that produces open patches in the landscape along streams. This species feeds on trees and has

been known to fell trees with diameters of up to 1 metre (Collen and Gibson 2000, 443). This species may therefore have created open spaces in Ireland and Denmark.

In the Eemian, we have a different situation because more large herbivores are present. At Taubach, we are dealing with elephants, two species of rhinoceros, giant deer and horses in addition to the traditional European herbivores like aurochs, bison and deer. A review of pollen research of interglacial sites in northwestern Europe shows that most lakes that sampled an upland environment show evidence of a closed environment. However, some areas, like river valleys show higher amounts of non-arboreal pollen, up to 40%. The same seems to be true for sites with poor soils such as calcareous uplands and sandy areas (Svenning 2002). Moreover, the composition of Eemian forests was slightly different from the Holocene ones. Most important is the fact that the role of the European beech (Fagus sylvatica) was smaller in the Eemian than in the Holocene. Beech is a plant that is particularly shade-loving: it grows in dark forests and young specimens do not grow well in light conditions. However, in the Eemian the main shade-producing trees seem to have been hornbeam and fir. These species need lighter conditions during their phase as young trees (Wenzel 2002, 48). Therefore, we can assume that the Eemian forests were closed, but that open spaces were present and to a larger degree than in the Holocene.

The presence of certain species of animal in the assemblage allows us to draw some conclusions about the specific environment at Taubach. First, there is the aforementioned European pond turtle; this species'presence at the site points to the summer temperatures being quite high (18° C in July) and winters being mild, and at least to winters without prolonged periods of severe frost (*e.g.* Van Kolfschoten 2000). Furthermore, the presence of wild boar may be significant. This species range limit is now on the northern European plain, which points to it being at least in part climatically restricted (Van Kolfschoten 1995, 78). The fact this species is present at Taubach suggests that it cannot have been much colder at the time of the deposition of the assemblage than it is nowadays.

Some species present require a forested environment. I already discussed Merck's rhinoceros as a forest indicator. Straight-tusked elephant is also usually found with forest indicators (Bratlund 1999, 78). Of the extant fauna, roe deer, wild boar, beaver, brown bear, lynx and badger are forest indicators (Bratlund 1999, Svenning 2002). On the other hand, some species present prefer open environments. Important among these are narrow-nosed rhinoceros and horse. Lion and hyena also avoid dense forests nowadays, although they do live in woodlands (Bratlund 1999, Svenning 2002). In this respect it is important to note that the traditional forest indicators are much better represented at the site than indicators of open environments. A quick inventory of the environment suggests mosaic vegetation near the site, with a dominance of woodland environment, but also open spaces.

A species that would have had enormous influence on the environment would have been the straight-tusked elephant. Elephants are nowadays considered keystone species that actively modify their environments and by these modifications also influence the actions of other species in the environment (*e.g.* Haynes 2006). Firstly, elephants feed in bulk: on average African elephants consume about 150 to 250 kg. every day. This would have a great impact on the vegetation. Furthermore, elephants actively influence the landscape by building mineral licks and maintaining waterholes (Haynes 2006, 27). At Taubach these activities may have been important for the direct environment of the site. Another species that would have an important influence on the area directly surrounding the site is beaver. The presence of beaver may have resulted in an absence or a decrease in the number of trees in the immediate vicinity. However, this species needs woody vegetation to feed and it rarely feeds further than 100 metres away from water (Collen and Gibson 2000, 443). Therefore we can conclude that, even though leaf impressions are absent at Taubach, in the wider environment forest was the dominant type of vegetation.

The immediate environment of the site has been described as savannah-like because of the absence of leaf impressions (Steiner 1977, Steiner and Wiefel 1977). However, we may assume that forest was the dominant vegetation type in the wider environment. From Eemian pollen phase 2 onwards, the environment at nearby sites seems to be quite closed. Nevertheless, the Eemian forests in general were of a slightly less dense character than in the Holocene. At Taubach this impression is reinforced by the presence of horse, some narrow-nosed rhinoceros and straight-tusked elephant.

6.7 Applying OFT to Taubach

After presenting an overview of the environment and the bone assemblage of the site we will analyse the data using the methodology of diet breadth described in chapter 4. At this site the interesting problem is to see how Neanderthals dealt with forested environments where biomass is mostly locked up in tree trunks and leaves (*e.g.* Binford 2001, 106). Actual mammal biomass is very low, less than 0.5 tonne per kilometre in European temperate forests. More open environments may offer much more herbivore biomass for human hunter/gatherers to exploit (Delpech 1999, 22). Biomass may have been slightly higher in the Eemian than in the Holocene, because the forests had a more open character, but the proportions of arboreal and non-arboreal pollen at nearby sites leave no doubt that the dominant vegetation type was forest.

An important factor we need to consider when analysing the diet breadth at the site is the site's function. As pointed out in chapters 3 & 4, transport decisions may have an important influence on which bones end up at which sites. Debates as to whether the animals were killed on site or were transported to the site from some distance have taken place in the past. The processing of all skeletal parts is strongly suggestive of a kill site. Furthermore, the presence of hearths at kill sites is not uncommon in the ethnographic record, so their presence need not be an indication of the site functioning as a central place (Bratlund 1999, 135).

As argued, because of the very large amounts of material recovered, the site probably represents a palimpsest formed over a long time. Another indication for this is the fact that bears and rhinoceros live solitarily nowadays. Many different episodes of exploitation must therefore be represented. According to (Bratlund 1999, 135), sustainable exploitation of both bears and rhinoceros would allow at most 4 or 5 kills per year. In view of the amount of material of these species recovered at the site, we can conclude that the assemblage reflects a long history of occupations. This is especially true since the collection Bratlund studied represents only a fraction of the original assemblage. Therefore we can assume that the site exhibits a time-averaged ranking of animals and short-term fluctuations in ranking will have been averaged out.

Based on animal weights, we would expect the heaviest species to be the most high-ranked one and the less the species weigh, the lower they would be ranked. Table 6.2 gives an overview of reconstructed body weights of the animals found at Taubach. If the ranking used by Neanderthals were based on body weight alone, we would expect Neanderthals to exploit a number of the heavier species. Since body weight is inversely related to population density (*e.g.* Silva, Brown, and Downing 1997), the heaviest species are expected to be quite rare. Therefore, a number of species would need to be exploited in order to lower encounter rates sufficiently to ensure a steady supply of food.

With regard to the currency used by the hominins responsible for the Taubach assemblage, a few things can be noted immediately. It is clear that this ranking does not explain all the exploitation patterns seen in the Taubach assemblage. As pointed out in chapter 4, this ranking based on animal weight alone is a simplification. Still, weight does seem to be an important criterion among hunter/gatherers when selecting prey. From this ranking it is clear that at Taubach the exploited species, except for beaver, were among the heaviest in the environment.

On the other hand, the heaviest species, straight-tusked elephant, may not have been exploited. The bone sample of the species does not show indications of hominin involvement, bar one charred piece (Bratlund 1999, 87). However, the species was apparently considered an important constituent of the site in early publications and its presence in the collections was interpreted as the result of hominin hunting (*e.g.* Behm-Blancke 1960). As stated above, it has been argued that the sample is dominated by young individuals, like the sample of Merck's rhinoceros (Bratlund 1999, 92). However as shown by Fig 6.5, this pattern is much less pronounced than in the Merck's rhinoceros sample. Although we do not see a "classic" attritional mortality profile in this species, it is based on a small sample. Moreover, since traces of exploitation are absent, I do not think this provides a convincing argument for the hunting of straight-tusked elephant.

Nevertheless, taking caloric value as currency they would be expected to be the highest ranked species and to have been exploited on encounter in traditional OFT models. Moreover, the species is represented by quite a large amount of material, while as the heaviest species it would be expected to be present in the lowest population densities. This can be partly explained by taphonomic factors. Their bones are the largest and collection was therefore probably biased in favour of their recovery. Furthermore as an exotic species they may have received even more attention than would be expected solely on the basis of their size.

Rank	Species	Weight	NISP
1	*Palaeoloxodon antiquus*	5495	182
2	*Stephanorhinus kirchbergensis*	2000	1224
3	*Bison priscus*	687[25]	533
4	*Ursus spelaeus*	500	7
5	*Megaloceros giganteus*	450[26]	6
6	*Ursus arctos*	400	1537
7	*Equus caballus*	335	161
8	*Cervus elaphus*	200[27]	207
9	*Panthera spelaea*	195	5
10	*Crocuta crcocuta*	69	1
11	*Sus scrofa*	89	96
12	*Panthera pardus*	60[28]	lost
13	*Canis lupus*	45	7
14	*Capreolus capreolus*	23[29]	58
15	*Lynx lynx*	20	lost
16	*Castor fiber*	18	319
17	*Meles meles*	10	lost
18	*Lutra lutra*	7	lost

Table 6.2: Reconstructed ranking of the species represented at Taubach, according to animal body weight.

Other heavy species whose bones do not show traces of exploitation are giant deer and cave bear (*Ursus spelaeus*). On the other hand, these species are rare in the assemblage, so we cannot be sure that they would not have been exploited when encountered. One of the explanations for the absence of these indications on their bones could be that they were very rare in the environment and were therefore almost never encountered. Therefore, their bones did not end up at the site in greater numbers. It seems that giant deer was a mixed feeder, browsing as well as grazing, but it is usually found in combination with indicators of an open environment (Bratlund 1999, 74). Furthermore, their big antlers would at least have prevented male giant deer from moving through dense woodland (Stuart *et al.* 2004, 684). Cave bear appears to be a species that can cope with a closed environment, so there is no reason to assume that it was rare in the area (Bocherens and Drucker 2003, 5). Therefore, its absence from the diet may have other causes.

Adopting weight as currency, the exploitation of Merck's rhinoceros is to be expected. It is the second heaviest species in the environment, weighing in at 2000 kilos,. Both hunting using traps and confrontational hunting have been documented ethnographically for rhinoceros (Bratlund 1999, 138-141). Merck's rhinoceros was slightly larger and heavier than the modern African white rhinoceros. Older calves, which form the majority of the MNI at Taubach, were probably independent of their mothers, if their life-histories resemble those of extant species of rhinoceros. They would be about two-thirds of the size of the adults (Bratlund 1999, 142-144). Since traps do not preferentially select for age classes (Bratlund 1999, 143), at least the rhinoceroses will have been captured by confrontational hunting. The behaviour of rhinoceroses has been subject of much discussion. They are often said to be dangerous, but with a view to modern African rhinoceros this seems exaggerated (Bratlund 1999, Despart-Estes 1991).

Bison is also among the heaviest species in the environment. Moreover, the focus of exploitation was on adult males (Bratlund 1999, 149), which are considerably heavier than the females. This species is thus among the highest ranked available prey species. Moreover, adult males are the individuals most likely to be encountered alone; therefore hunting them may not be as dangerous as hunting a herd of females (Bratlund 1999, 150).

The exploitation of brown bear, ranked as the 6th heaviest species, was intensive. It is represented by a large number of individuals and almost 300 brown bear bones exhibit cut-marks. Hunting brown bear is nowadays considered to be very dangerous. Ethnographically it is known that as soon as guns became available, traditional methods of bear hunting were usually rapidly abandoned in favour of hunting with and guns. Many of the traditional methods were focused on two specific things: keeping the bear from fleeing and preventing the bear from focusing on specific targets.

25 Estimate taken from Macdonald (2006). The weight provided by Brook and Bowman (2004) is quite low (523 kg.) 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. Since males were the focus of hunting at Taubach this estimate is used.

26 Estimate taken from Louguet-Lefebvre (2005). The estimate provided by Brook and Bowman (2004) (700 kg.) is higher than all other estimates I encountered, the estimate from Louguet-Lefebvre (2005) seems more reasonable, although Pushkina and Raia. (2008) provide a lower one (387 kg.).

27 Estimate taken from Pushkina and Raia. (2008), since Brook and Bowman (2004) provide a very high estimate (500 kg.).

28 Estimate taken from Pushkina and Raia.(2008), since Brook and Bowman (2004) provide a very high estimate (90 kg.).

29 Estimate taken from Pushkina and Raia. (2008), since Brook and Bowman (2004) provide a very high estimate (30 kg.).

Spears were then used to kill it (Bratlund 1999, 147). In addition to the danger of catching it, eating bear meat may also have been dangerous. Since bears scavenge a lot of meat, many of them are infected with the porkworm, a parasite that can cause prolonged illness and even death in humans (Bratlund 1999, 147). Bratlund hypothesizes that bears may have been hunted when they appeared at a kill site to scavenge the remains of previous hominin kills (Bratlund 1999, 150).

Brown bears have a yearly activity cycle that can point to the likely season of their exploitation. In winter, brown bears hibernate, in late winter and early spring they have exhausted their winter fat stores and are very lean. Therefore, from an OFT perspective their ranking in this season will be quite low and exploitation unlikely. In autumn however, they will be building up fat reserves in order to survive the winter. At this time, their caloric value will be at its highest. On the other hand, the ranking used by a predator is based on more than caloric yield. Killing these animals during hibernation would also be an interesting option, since this would considerably lower the risk and possibly the search time associated with the hunt. The problem with this possibility is the fact that I deem it unlikely that the bears hibernated in the travertine field itself. Therefore, their bones would have been transported to the site from the denning sites. It would seem more logical to process the animals on the spot instead of transporting them. In that case one would expect to see a clearer focus on meat-bearing parts at the site and fewer hand and foot bones. Since this did not happen, we may assume that the bears were hunted in the vicinity of the site.

In autumn, if bears are amassing fat reserves they are more likely to try and scavenge hominin kills as hypothesised by Bratlund. Moreover, it is likely that they would also be aggressive and were more likely to attack hominins themselves during this period (e.g. \Quammen, 2005, 305-306; http://www.mala.bc.ca/www/discover/rmot/project.htm). Therefore, encounter rate with this species will be elevated. In combination with their aggressive behaviour this may have led to Neanderthals preferentially killing them in this season.

The exploitation of red deer is problematic. It is present in reasonably large numbers in the assemblage and two of the remains bear cut-marks. This indicates that there was at least some interference of hominins with bones of this species. On the other hand, the species was not heavily exploited. This is quite strange, since it is a large herbivore that has been exploited at many sites during the Palaeolithic (*e.g.* Steele 2004). On the other hand, it is a lot lighter than the other exploited species, therefore in normal situations it was probably not in the set of exploited species.

The number of red deer bones found at the site is not only lower than that of the other exploited species, but it is also severely biased. 106 of the pieces are antlers, of which 11 were unshed and 57 were shed. Another 67 pieces were isolated teeth, which do not usually bear signs of exploitation. This makes the significance of red deer exploitation even harder to assess, since the bones that might reveal exploitation are underrepresented. The smaller species yield similar assemblages and their bones do not show uncontroversial signs of exploitation (Bratlund 1999, 91-92).

In the case of red deer we must assume that the species was not very important to hominins. The fact that a smaller species like beaver is better represented in the assemblage shows that we cannot attribute the paucity of red deer bones wholly to a collection bias. The shed antlers and many of the bone fragments may well be part of the natural background fauna, since for example male cervids apparently spend the winters in low lying areas rich in water sources where winter kills are often significant. Because many of these animals die near sources of water trampling of their remains was probably commonplace. This may be an additional factor why there is a dominance of cranial bones, teeth and antler fragments among the cervids (Barnosky 1985, 340, 343).

The exploitation of beaver, which is one of the smallest mammals present in the assemblage, is striking. Caloric value alone cannot explain the presence of large amount of beaver material in the assemblage. This intuitively seems to be a clear example of a species being exploited for nonfood yields, i.e. its fur. On the other hand, beaver meat is apparently of great nutritional value, due to high concentrations of proteins, minerals and poly-unsaturated fatty acids (Jankowska *et al.* 2005). Furthermore, in autumn, its nutritional value and thus its ranking increases because large amounts of fat are stored in the tails (Macdonald 2006, 144). Only ten cut-marks were found on beaver bones. Most of these seem to point to disarticulation and filleting. However, three cut-marks on mandibles seem to be the result of skinning of the animal (Bratlund 1999, 132).

In order to gain insight in the diet breadth that was practised at Taubach, we also need to calculate in the encounter rate and handling cost of the available species. As with Biache-Saint-Vaast, the encounter rate of the species will be modelled by reconstructing their population densities using the correlation between body size and population density provided by Silva, Brimacombe, and Downing

(2001). Handling cost will again be modelled by looking at whether species were carnivores or not, body size of species and whether species lived in groups or solitarily.

Population density determines what the encounter rate of a species was, but the encounter rate of a species cannot be used to predict its exploitation. The diet breadth model states that the most highly ranked species will always be exploited. When their encounter rate is low, species will be added to the optimal set, but highly ranked species will not be dropped from the set (MacArthur and Pianka 1966). Estimating population densities for a Pleistocene animal assemblage with extinct species is speculative. It appears that 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 determining mammal population densities (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). I have reconstructed the population densities for the species represented in the Taubach assemblage (table 6.3) using the equations provided by Silva, Brimacombe, and Downing (2001, 477)[30]. It must be realised though, that these are only rough estimates of average population densities. Population densities can vary tremendously between populations of a species, for example because of circumstances in the local habitat. The numbers here reflect the expected population density for a species with a specific body weight and diet, in their typical habitat. If Taubach was at the edge of a species' range, this may have had important consequences for its population density.

As can be seen all the exploited species, except beaver, have quite low population densities. Moreover, the extent of beaver habitat in the environment was limited, consisting of the Ilm River and the wetland area where the travertine was forming. Therefore the beaver population in the area that was exploited from this site may not have been very large. Furthermore, in the case of bison and rhinoceros a specific sex and age class of the population was targeted, further limiting the number of available prey animals. If we assume that Neanderthals exploited an area up to 10 kilometres away from the site, as modern day hunter/gatherers do (*e.g.* Vita-Finzi and Higgs 1970), this area would contain a rhinoceros population of about 48 animals in the 314 km^2 of territory available to them. As argued earlier, the territory was probably smaller due to locomotion costs being 30% higher in Neanderthals than in modern humans. If we assume an exploitation distance of maximally 7 kilometres from the site this would amount to a territory of 154 km^2. In that case the rhinoceros population in the territory would probably number around 23 or 24 animals. Because of their selectivity in age class, only a few animals would be available for exploitation. Bison, of which only the adult males were exploited, presents a similar situation.

Diet breadth was thus narrow and the species that were exploited were present in low population densities. This leads to the supposition that despite low population densities and dispersed resources (cf. Gamble 1999, 228-229), the hominins responsible for the Taubach assemblage were able to manipulate the encounter rates with suitable prey well. They were apparently able to predictably encounter and dispatch juvenile rhinoceros, adult male bison, adult bears and beaver, without having to add other more common species to the diet. In view of the reconstructed population densities, targeted exploitation of elephants becomes less likely. They are present at half the density of Merck's rhinoceros. Therefore, if

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

Table 6.3: Reconstructed population densities for the species present in the Taubach assemblage.

30 The equations used are: Herbivores: Log D = 1.42 – 0.68(Log M); Carnivores: Log D = 1.41 – 1.83(Log M) – 0.34(Log M^2) + 0.28(Log M^3). Since no equation is provided for omnivores, I decided to treat brown bear as a carnivore and wild boar as a herbivore. I used the weights supplied by Brook and Bowman (2004).

they had been exploited one would have expected this species to be better represented in the assemblage.

In the case of rhinoceros and bears, 4-5 kills of a population per year is the maximum for sustainable exploitation of a population according to Bratlund (1999, 135). Given the fact that the collection Bratlund studied represents only a fraction of the original assemblage, the site must reflect a successful hunting strategy that was in use for a long period of time. The exploitation of this area was prolonged and represented an economically very efficient strategy of meat acquisition.

In addition to the encounter rate, another important consideration on whether to exploit animal species is their handling cost. As explained in chapter 4, this represents the combined effect of the hunting and processing skills of the hunter and the anti-predator skills of the prey. High handling cost lower the overall return rate. Therefore, handling cost may influence the ranking of prey species. In order to get an indication of handling cost I scored the animal species on the basis of a few characteristics. The modelling of handling cost using these characteristics aims to show whether they influenced a species' handling cost. If species that score positive for the characteristics are nevertheless exploited we can conclude that Neanderthals possessed strategies to deal effectively with their impact on a species' handling cost.

Very important in the handling cost is the risk associated with hunting dangerous animals. I designated carnivorous species to be extra risky. I assume that they are more dangerous to hunt than herbivores. I assigned cave bears to the carnivores since they fall within the order of carnivores and they did possess carnivore "weapons", like claws and large teeth. Another attribute that I correlate with hunting risk is the size of the animal. I also assume that larger animals are more dangerous than smaller ones. I took a weight of 300 kilo's as a threshold, above which animals get a "danger bonus". This is the weight of the expected maximum size of prey for a mammalian carnivore of the same weight as a Neanderthal. A third variable is whether animals are solitary or whether they live in groups. I assume that animals living in groups hold a greater advantage when faced with predators than solitary animals. This is because in a group chances of early perception of predators increases and because animals moving in a group will usually have to be isolated before a kill can be attempted. Table 6.4 summarises the scores.

Species	Size	Carnivore	In group	
			Male	Female
Palaeoloxodon antiquus	+	-	-	+
Dicerorhinus kirchbergensis	+	-	-	-
Bison priscus	+	-	-	+
Ursus spelaeus	+	+	-	+
Megaloceros giganteus	+	-	-	-
Ursus arctos	+	+	-	+
Equus caballus	+	-	-	-
Cervus elaphus	-	-	+	+
Panthera spelaea	-	+	+	+
Crocuta crocuta	-	+	-	-
Sus scrofa	-	-	-?	+
Panthera pardus	-	+	+	+
Canis lupus	-	+	+	+
Capreolus capreolus	-	-	-	+
Lynx lynx	-	+	-	-
Castor fiber	-	-	+	+
Meles meles	-	+	?	?
Lutra lutra	-	+	?	?

Table 6.4: Handling cost attributes. Species that are marked with + in categories are deemed to have increased handling cost due to their size, carnivorous "weapons" or social structure.

In this table, brown bear is ranked as dangerous because it is a carnivore. Since it is over 300 kilos it also qualifies for the "weight bonus". Cave bear also scores as dangerous because of its size and because it is a carnivore. However, since cave bear is even larger than brown bear it may have been more dangerous, even though this is not expressed in table 6.4. This can be a reason why it was left alone. Merck's rhinoceros and male bisons are both very large animals, but are also solitary. Furthermore, in the case of Merck's rhinoceros concentrating on juvenile individuals diminishes the danger of hunting them.

Male elephants only score positive for the "weight bonus". On the other hand, as they are more than twice as heavy as Merck's rhinoceros, we can hypothesize that these animals were simply too large and dangerous. The Neanderthals responsible for the bone assemblage focussed on juvenile rhinoceroces presumably to lower the risk to themselves. Juvenile elephants are found in the maternal herds and are therefore well protected. Full-grown solitary males are the largest and most dangerous individuals around and will probably have been left alone for that reason.

This does not apply to male giant deer however. They are ranked in between the exploited species of bison and brown bear. There are a few reasons why they may not have been as highly ranked by hominins as the ranking on the basis of weight suggests. Firstly, in the males, which presumably lived solitarily, 10% of the weight is represented by the antlers (Macdonald 2006, 725). Therefore the actual ranking on the basis of edible weight may have been lower. Furthermore, although the species was both a grazer and a browser, its presence traditionally taken as an indicator for an open environment (Bratlund 1999, 78). It may therefore not have coped well in the increasingly forested environments of the Eemian. The reconstructed population density may thus be an overestimation. If this species was comparatively rare it may not have been worthwhile to add to the Neanderthal repertoire the behaviours and strategies needed to predictably encounter and kill it.

The selection of brown bear over cave bear may be at least partly explained by the difference in size. Brown bear is highly ranked but a little smaller than the cave bear. Furthermore, in contrast to the more herbivorous cave bear, brown bear is a carnivore that is known to eat humans, even nowadays. This may have provided an extra incentive to hunting it. Cave bear may have been less aggressive to Neanderthals upon encounter, but more difficult to kill and therefore left alone. Moreover in the season when brown bear is at its most aggressive, autumn, its ranking may also be higher than normally since its fat content is very high at this time because it is accumulating fat for its hibernation. Another reason is the fact that bear may be a good candidate for non-food yields. The heavy processing of its paws in evidence at both Taubach and Biache-Saint-Vaast has been attributed to processing of the animal for its fur at both sites (Auguste 1992, Auguste 1995a). One would expect cave bears to be exploited during the early parts of their hibernation, since handling cost is low at that time. This has been observed at the Balver Höhle for instance (Kindler 2008). If this behaviour was practised, bones were not transported to the site of Taubach.

The exploitation of beaver is unexpected on the basis of its ranking. Arguments in favour of hunting them may be that they were also more highly ranked than one would anticipate on the basis of weight alone, since their ranking increases because of non-food yields. Another reason may be that they were probably present at the site itself, since the travertines were forming in a swampy area. Therefore, search time may have been reduced to almost zero, therefore enabling high post-encounter return rates.

Red deer remains a problematic species. Two bones exhibit cut-marks, showing hominin involvement at least on occasion. The traditional diet breadth model assumed that a species is either in the optimal set and exploited on encounter, or it is not and is always left alone. This does not seem to have been the case with red deer, which had higher population densities than the other exploited species and must therefore have been encountered with some regularity. More refined OFT models, like the contingency model (Bettinger 1987, 133), state that a species will only be exploited if the gain to be had from exploitation of this species will be higher than the expected cost of continued tracking for the highest ranked species (see chapter 4). If the hunters operated following the second rule than the exploitation of red deer may have been quite rare. Rhinoceros, bison and brown bear are heavier and more highly ranked than red deer, the expected cost of continued tracking may in many cases not have been too high and the expected gains from these species were (much) higher. In this scenario, red deer may only have been exploited on very unsuccessful hunting expeditions.

The diet breadth of the hominins responsible for the Taubach assemblage was thus quite narrow. Only four species were routinely exploited. For both rhinoceros and bison ranking on the basis of weight does seem to be a sufficient explanation for their inclusion in the diet. The exploitation

of brown bear, beaver and the minor involvement with red deer are harder to explain. Peculiar too is the fact that cave bear and giant deer were not included in the optimal set. Especially male giant deer seem to have shared many characteristics with rhinoceros and bison. Its exclusion may have been caused its scarcity in the environment. It went extinct in the Holocene interglacial and may not have been able to deal well with interglacials. Furthermore during the autumn, the hypothesised season of occupation at Taubach, their ranking may have dropped due to weight loss during rut.

As said, brown bear does represent quite a large amount of meat, but is a dangerous species. In addition to weight, some arguments in favour of this species' exploitation may be brought forward. First, it provided an added bonus in the form of fur. Second, its ranking may have been higher seasonally because of a high fat content. The exploitation of beaver may also have been related to its fur. Furthermore, if it resided at the site in the ponds where the travertine was being formed, its search cost may have been very low, which may have increased its ranking.

6.8 Discussion

How can we interpret these patterns of exploitation in terms of hominin foraging strategies? First, because of the preponderance in the assemblage of species indicative of a forested environment, we can argue that Neanderthals were able to deal with Eemian forested environments characterised by dispersed animal resources (contra Gamble 1992, Gamble 1999). Moreover, they did so by exploiting a small set of species, suggesting that hunting of these species was done efficiently enough to meet the needs of Neanderthals.

There are some reasons to assume that life was different for Eemian hunter/gatherers than for groups living in colder conditions. The most striking thing about the animals exploited at Taubach is that the main focus is on very large, solitary animals. In the Weichselian, it appears that at many sites the dominant species were ungulates living in large herds (see for example the overview provided by Grayson and Delpech 2006). As proposed in chapter 4, this might be caused by the fact that hunter/gatherers in the Eemian operated in smaller bands than in periods when herbivore biomass was more readily available. When operating in small groups, concentrating on solitary animals is probably a more productive strategy than trying to deal with a large herd of animals.

Reducing group size is one of the possible solutions to dealing with conditions in which resources are dispersed and their location hard to predict. I think the situation in an interglacial would have provided a powerful feedback mechanism for restricting Neanderthal group size: Large herds moving predictably through the landscape were rarer than in colder conditions. Therefore, the potential for supporting larger aggregations of hunters was also diminished. In order to deal with this, residential mobility may have been increased. When residential moves are made before return rates in a certain area drop too far, larger groups may still be supported (*e.g.* Binford 2001, 239-241). Furthermore, again, because of locomotion costs the territory exploited from a central place was radically smaller than that of modern day hunter/gatherers. This increased the need for higher residential mobility. Decreasing group size will result in slower depletion of resources around a base camp. Furthermore, in forested environments the total amount of biomass available to human foragers is lower than in savannah or steppe like environments (Delpech 1999), so the Eemian landscape offered a lower carrying capacity for human groups than environments in colder periods did.

The narrow diet breadth, focused on very large animals at Taubach reflects a hunting strategy geared towards high yields. However, because of the low population densities that these animals have in general, it may also have been a high-risk strategy. These risks were apparently well buffered, otherwise diet breadth would have been greater. The buffering mechanism is unclear. It may be that females foraged for plant food at least during warm seasons. Plant foods certainly were available during the Eemian; at the site of Rabutz, some burnt hazelnet shells were found (Wenzel 2002). At the nearby site of Neumark Nord, charred plum seeds and acorns were recovered (Roebroeks pers comm.). They are unknown for Taubach though. Another possibility for women's foraging may have been concentrating on small animals, like the beavers found at the site.

However, manipulating the encounter rate with the animals probably also lowered the risk of this hunting strategy. Bratlund (1999) suggested that the site was a magnet-location for rhinoceros because it probably functioned as a salt lick. Furthermore, since it was on a terrace overlooking the Ilm-river valley it may have been a strategic place to observe movements of other animals, since river valleys were more open environments than most of the rest of the landscape during intergla-

cials. The manipulation of encounter rates with prey is another domain in which females may have contributed to the foraging effort. As proposed by Kuhn and Stiner (2006), females may also have assisted males in the less dangerous aspects of hunting large mammals. In the Eemian environment, with its low prey visibility, female tracking may have been an important contribution to the manipulation of encounter rates with prey. It appears that female tracking skills may substantially influence male hunting success in modern day hunter/gatherers (*e.g.* Biesele and Barclay 2001). In a situation as at Taubach, where diet breadth is very narrow, ensuring a frequent enough encounter rate is very important, making the female contribution to tracking prey potentially essential.

Another way to buffer uncertain foraging returns would be by increasing diet breadth. However, smaller animals would also be dispersed and encounter rates would be unpredictable. Moreover, in comparison to larger animals, processing costs would be relatively high. Furthermore, in closed environments, herd size of social herbivores is lowered (*e.g.* Guthrie 1990, 155). Consequently whereas a focus on herd animals in colder periods might enable hunting parties to kill a significant number of animals in one encounter, this would be much less productive in the Eemian. Therefore, even though herds have a greater chance of spotting predators early and have a good defence mechanism because they are in a group, their maximum yield would have been drastically lowered in the Eemian. Finally, returns would drop faster than in contemporary hunter/gatherers because of higher locomotion costs for Neanderthals. Therefore, broadening the diet may have been counter-productive.

On the other hand, the diet was broadened at least occasionally, as evidenced by the cut-marks on red deer bones and the putative exploitation marks on horse and boar. If the hunting episodes represented at the site took place mostly in autumn, as hypothesised earlier, cervids, especially males may be ranked lower than expected on the basis of body weight. Apparently stags do not feed often during rut and by autumn will have lost significant amounts of weight. Thus hunting cervids like red and giant deer may not have been very profitable in autumn (*e.g.*, Barnosky 1985, Speth and Tchernov 2001). Therefore, during certain seasons broadening the diet may have been a more interesting proposition than during others. Still, the bulk of material suggests that only a narrow set of species provided the mainstay of the diet. Moreover, specific categories of these species were targeted, narrowing diet breadth even further.

This suggests that the Taubach assemblage must represent the activities of small groups of hominins over a long time. In reaction to the warm climate and more dispersed unpredictable resources, Neanderthals themselves probably became more dispersed as well. They skimmed off the largest animals in the landscape, making a few kills per episode and then moved on to a different territory. According to White (2006), if Neanderthals needed 3000 kcal/day, they needed to procure 1.85 kilos of fat rich meat per day. With a return rate of 60% a reindeer could feed a group of 10 for 3 days and a horse for 6 days. A reindeer weighs about 86 kilos according to Pushkina and Raia (2008). The animals on which Neanderthals focused at Taubach may have been rare, but one kill would supply them with food for a considerable period of time. Concentrating on smaller but still unpredictable resources would, in the long run, not yield a steady enough flow of food.

Of course hunters employ other considerations than animal weight alone in order to select their prey. In the exploited set, brown bear and beaver may have provided non-food benefits to hunters because of their fur. Both of these species also have elevated rankings in autumn, because they store fat for the winter at this time of year. Furthermore, in the case of brown bear, the killing of these animals may have had additional benefits because this eliminated direct competitors.

There is also another value that prey may have lent to its dispatcher that I have not yet treated extensively in this chapter: prestige. As pointed out in chapter 4, meat can be used as a socio-political currency in hunter/gatherer societies. Hunting large and dangerous animals may in this case be important in showing off ones good qualities. Bratlund (1999, 150-151) has indeed proposed this as a reason for the emphasis on Merck's rhinoceros and brown bear. There is one problem with this hypothesis however: if prestige was an important consideration, especially when hunting brown bear, one would expect cave bear to be well represented at the site as well, since it is much larger than brown bear. The fact that this species was not exploited suggests that prestige may not have been an important consideration in prey selection.

6.9 Conclusion

Interpreting a site like Taubach with a long history of research is complicated. First, it must be recognised that there is a clear bias towards complete and identifiable bones. However, since even small bones of a small species like beaver are well represented, the bias does not appear too severe. Furthermore, the preponderance of dental elements and cranial parts although certainly partly attributable to the collection preferences at the time of exploitation is probably also partly caused by trampling, an important process near contemporary waterholes and springs.

Unfortunately, the date of the site is not fully certain. Most of the faunal evidence points to this site being younger than Ehringsdorf. Furthermore, the site was accumulated over quite a long period of time, yet shows a narrow diet breadth, which points to a stable environment. In unstable environments, species would be added to and dropped from the optimal set regularly as encounter rates of the highest ranked species fluctuated. This leads me to hypothesize that the site was formed during a climatically stable period of time. Whether this is an intra-Saale warm phase or the Eemian does not make much difference for the interpretation of the foraging behaviour represented in the assemblage. A date in the Eemian, probably no earlier than phase three seems most logical.

The local environment of the site was open, as shown by the absence of leaf imprints at the site. However, the preponderance of species associated with forested environments and analysis of pollen cores from nearby sites suggest that the wider environment was dominated by forest. Again, because of the long period of time reflected in the assemblage we can safely conclude that Neanderthals were able to maintain a lasting occupation of the Eemian forests. This is underlined by the fact that a level dating to the climax phase of the Eemian was found to contain stone tools during research in 1977.

The focus on large solitary animals suggests that Neanderthals probably hunted in small groups. This may also explain why the very largest animals, elephants, and also adult rhinoceros were avoided. Group sizes may have been too small to tackle these prey. Lowering group size seems a logical reaction to the fact that there was less food available in the environment compared to colder periods. Furthermore, resources were dispersed, and less predictable. Three other Eemian sites are known, they are single carcass sites (Gaudzinski 2004). This seems to be a reflection of animals being randomly scattered in the environment. Only at a magnet location like Taubach could a palimpsest develop. The fact that large animals are well represented at the site seems to suggest they were not killed too far from the site. If the so-called *Brandschichten* represent hearths, this investment in "site-furniture" may point to longer occupations. Additionally, even while the collection methods were biased, a lot of production waste is present in the collections of artefacts (Schäfer 1990, 56). This suggests that the site functioned as a convenient campsite for hominins from which they exploited the nearby environment.

In terms of diet breadth, the exploitation of adult male bison and subadult rhinoceros seems logical. After elephant they represent the heaviest animals available. They are both solitary and therefore more easily hunted than for example female bison. Brown bear exploitation is dangerous, but it may have presented advantages in the form of fur and, in autumn, high fat content. Furthermore from ethnography it is clear that hunting large and dangerous animals brings status and therefore social advantages to hunters. In this case, these large animals are also direct competitors and even pose a threat to hominins, therefore hunting them may have brought hunters a significant amount of prestige. Females may have foraged for plant foods and also beaver, which does not seem such a dangerous adversary. Moreover, it may have been present directly on the site, which would ensure high return rates. This species may also have been hunted preferably in autumn, because of elevated fat contents.

In conclusion, this chapter has shown that Neanderthals were able to deal with forested interglacial environments. Moreover, they managed to subsist on a small set of species and only specific categories of individuals of these species for a prolonged period of time. This suggests that they had arrived at a stable foraging adaptation. It appears that in this case, they settled on the largest animals in the environment, with the exception of elephant. It is likely that this necessitated living in smaller social groups than in open environments and with a higher degree of residential mobility.