BODIL BRATLUND

TAUBACH REVISITED

In the latter half of the 19th century the Taubach travertines provided a considerable amount of well preserved bone and antler material for palaeontological study. Although the palaeontological potential of the locality had been known for several decades, the heyday of scientific interest was in the period 1870-1900 following the first archaeological finds. In particular, the years 1878-1888 are considered to represent the most important phase of acquisition of fossils and artefacts (Steiner 1977).

Taubach is part of a series of travertines found along the valley of the river Ilm in Thuringia, SE-Germany. From the NW this series comprises the travertine deposits now in the town of Weimar and, further to the SE, the large travertines of Ehringsdorf. The deposits near the village of Taubach, situated about two kilometres SE of Weimar, are the smallest occurrence, covering only about 0.2 km^2. Today, the area is densely built-over, the former quarries have been filled, and no open profiles remain for study.

According to the traditional palaeontological view the Taubach deposits *in toto* ought to be dated to the last Interglacial (cf. Heinrich 1994). The reports on the Middle Palaeolithic stone artefacts do not contradict this (Schäfer 1993) and recent U-TH-datings made on blocky travertine from the upper section of the sequence indicate that at least parts of the travertines were deposited during the Last Interglacial (Brunnacker et al. 1983). According to eye witness accounts from the 19th century the samples of large mammal material did, however, come from the lowermost beds of sandy travertine.

In 1870 the first stone artefacts were recovered and only a few years later more comprehensive find layers in the sandy travertine showed an association of animal bones and stone artefacts. The residues of hearths were noted on several occasions in the quarry profiles. This led to the generally accepted interpretation that the Taubach finds were the traces of hunting camps and that the large mammal remains represented bone waste and artefacts from these camps.

The faunal material gathered from the Taubach quarries comprises several species with beaver, bison, straight-tusked elephant, brown bear and rhinoceros as the most common animals. The unusual abundance of Merck's rhinoceros, and especially of very young individuals, was regarded by Soergel as the logical outcome of specialized hunting techniques using pitfalls to catch the animals (Soergel 1912 and 1922). This interpretation of the finds has since then recurred unquestioned in the Taubach literature.

The present study attempts an archaeozoological investigation of the two best documented collections of large mammal remains from Taubach still available. It is, however, clear that these collections do not allow the same level of inquiry as bone samples from recent, controlled excavations. Of primary concern is therefore an assessment of the possible information potential in a bone sample heavily biased by collectors' choices. Secondly, the modification traces, i. e. cut marks, are analysed and possible exploitation patterns for the different species evaluated.

Recent representations of subsistence patterns in the Middle Palaeolithic have tended to play down the importance of active big game hunting, in particular the hunting of bears and rhinoceroses has been questioned (Leney and Foley 1999; Guérin and Faure 1983). Since exploitation of rhinoceroses and bears is an important part of the Taubach legacy, a more detailed discussion of the evidence for the hunting of these two animals has been included.

THE SITE

GENERAL STRATIGRAPHY

The most recent comprehensive presentation of the site is the monograph »Das Pleistozän von Taubach bei Weimar« edited by H.-D. Kahlke and published in 1977 (Kahlke 1977a). Here, different authors pre-

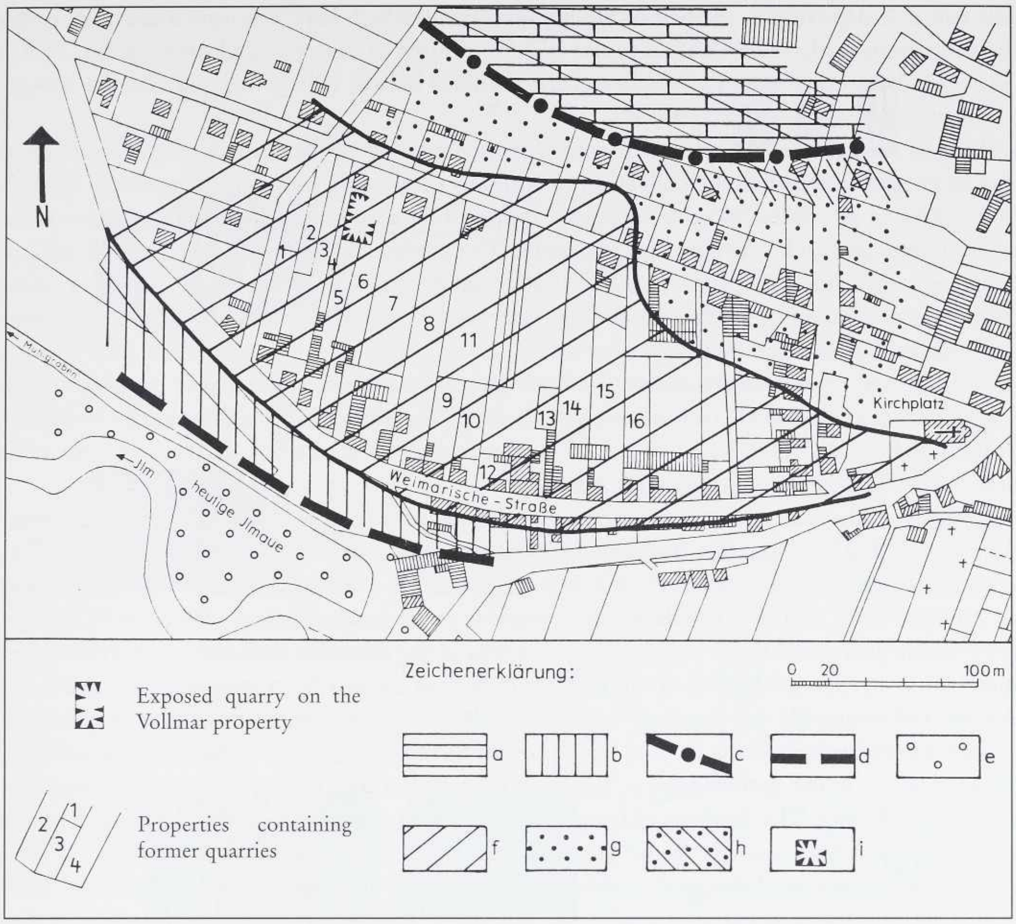

Fig. 1 Map of the Taubach travertine (after Steiner 1977, Abb. 2).

sent their analyses of the palaeontological finds, and references to these chapters will, not surprisingly, occur repeatedly in the following. The history of investigation has been treated in detail by Walter Steiner and Heinz Wiefel and in a second chapter the geological profiles recorded from the site are discussed by Steiner (Steiner and Wiefel 1977; Steiner 1977). The following summary of the information concerning the setting, stratigraphy and research history of Taubach is to a large extent based on these two contributions.

Taubach is a comparatively small travertine occurrence and unlike the large deposits found in the area, e. g. Ehringsdorf, characterized by a high proportion of friable or »sandy« sediments. The entire travertine complex is estimated to cover a mere 0.2 km^2, occurring as a lens shaped deposit on the north-eastern side of the Ilm river valley. To the west and south the boundary of the deposit is seen as a slightly protruding terrace. At the time of exploitation, the difference between the terrace and the bottom of the river valley was estimated at approximately 20 ft (Götze 1892). From the terrace bluff the deposits extend uphill to a maximum width of approximately 150 m (fig. 1).

The village of Taubach is built on the terrace and the main street follows the boundary of the river valley side of the deposit. This street was from an early date lined with houses behind which the quarries were found. The exploitation of the Taubach travertine in the 19th century was organised in a series of small independent enterprises, each one exploiting one of several parallel strips of land extending uphill from the houseplots, so to speak in a system of backgarden quarries.

The most valuable deposit was the bed of blocky travertine, which here was only a few meters thick and could be followed as a distinct horizon in the middle of most of the recorded profiles, fig. 2 (cf. Steiner 1977). Also of importance was the friable travertine found below, which was quarried for use as scouring powder or white sand for housefloors.

The working of the quarries is best documented for the later half of the 19th century, simultaneous with the phase of greatest interest in the collection of Taubach fossils. However, contemporary field observations on profiles or structures have mainly been reported by simply giving the name of the quarry, i. e., the owners name, and lack more precise locations. The exploitation of the travertines lasted up to the turn of the century when the quarries closed down one by one. Today, the quarry sites have been filled up and the area is covered by a residential neighbourhood. Only marginal parts of the travertine deposits remain and no profiles are kept open for study.

In 1972, occasioned by the International Taubach-Burgtonna conference, it was possible to open and sample a section near the northern boundary of the deposit, formerly belonging to the Vollmar quarry. The profile has been analysed by Steiner (1977) and compared to the few existing records of sections elsewhere in the Taubach travertines, figs. 2 and 3.

The stratigraphy of the quarried area comprises three basic units: At the top is a non-homogeneous upper unit composed of friable travertine interbedded with thin plates of compact travertine, which, in places, may be consolidated into a blocky structure. It is underlain by a bed of cemented travertine, approximately 1 to 2 meters thick, and by a friable, sandy travertine at the base assuming a depth of $^1/_2$ to $2^1/_2$ m containing travertine gravel and small blocks. The thickness of the recorded sections varies, from approximately 7 meters in the reopened profile of the Vollmar quarry in the north, to approximately 3-$3^1/_2$ meters in the older and unfortunately not precisely located profiles from the quarries further to the southeast. The lower, sandy travertine bed seems to have been present throughout the site. The blocky travertine is seen as a marker horizon in the quarried areas, although in some profiles it may thin out and appear as plates or lenses of small blocks. The deposits of friable or gravelly travertine extend laterally uphill, well beyond the occurrence of blocky travertine in the quarry area (Ziegenhardt 1962; Steiner 1977).

Götze (1892), who presented descriptions of two measured profiles from working quarries in different parts of the site, summarized the stratigraphy as follows: » Was die Art der Schichtung anlangt, so ist sie fast völlig eben und horizontal, ohne bemerkenswerte Störungen, und zwar erstrecken sich die Schichten, wie die Lage der Gruben zeigt, über ein ziemlich grosses Areal. Sie bestehen fast ausschliesslich aus Travertin in den verschiedensten Formen, vom feinsten Sande bis zur festen Werkbank« (Götze 1892, p. 369).

The upper part of the travertine sections varies greatly in thickness and as already mentioned displays a complex succession of sandy, friable and compact travertine layers. In two of the recorded profiles, including the Vollmar-profile, »humic« sandy travertines have been found. The lower layer (bed 9 of Steiner 1977) tops the bed of cemented, blocky travertine, and is overlain by a bedded, more or less compact travertine (bed 7 of Steiner 1977).

The lower »humic« sandy travertine in the Vollmar profile (bed 9 of Steiner 1977, fig. 3) has provided the recently analysed samples of micromammals (Heinrich 1994) and molluscs (Zeissler 1977), that indicated an Eemian age for the deposit. The material used for the existing two U-Th-dates from Taubach was taken from the compact travertine immediately above and from the blocky travertine just below this layer (Brunnacker et al. 1983; cf. Steiner 1977). The results support an Eemian date for this part of the Taubach profile.

Furthermore, investigations of the material from the lower »humic« bed 9 did provide some unidentified bone fragments, a molar of *Dama dama* and 32 flint artefacts. Unfortunately, this small sample did not comprise any diagnostic tool types (Steiner 1977, Abb. 13-14).

The field work in 1972 did not bring about any new bone finds (or artefacts) from the lowermost beds of friable, sandy travertine (beds 15-19 according to the Vollmar-profile, Steiner 1977, p. 90). Notable in this part of the profile was, however, the presence of molluscs (esp. in bed 15, a. k. a. »Molluskensand«) as well as the often quite intensive black or reddish-brown stainings from manganese precipitation and oxidation of the travertine (Steiner 1977, p. 91).

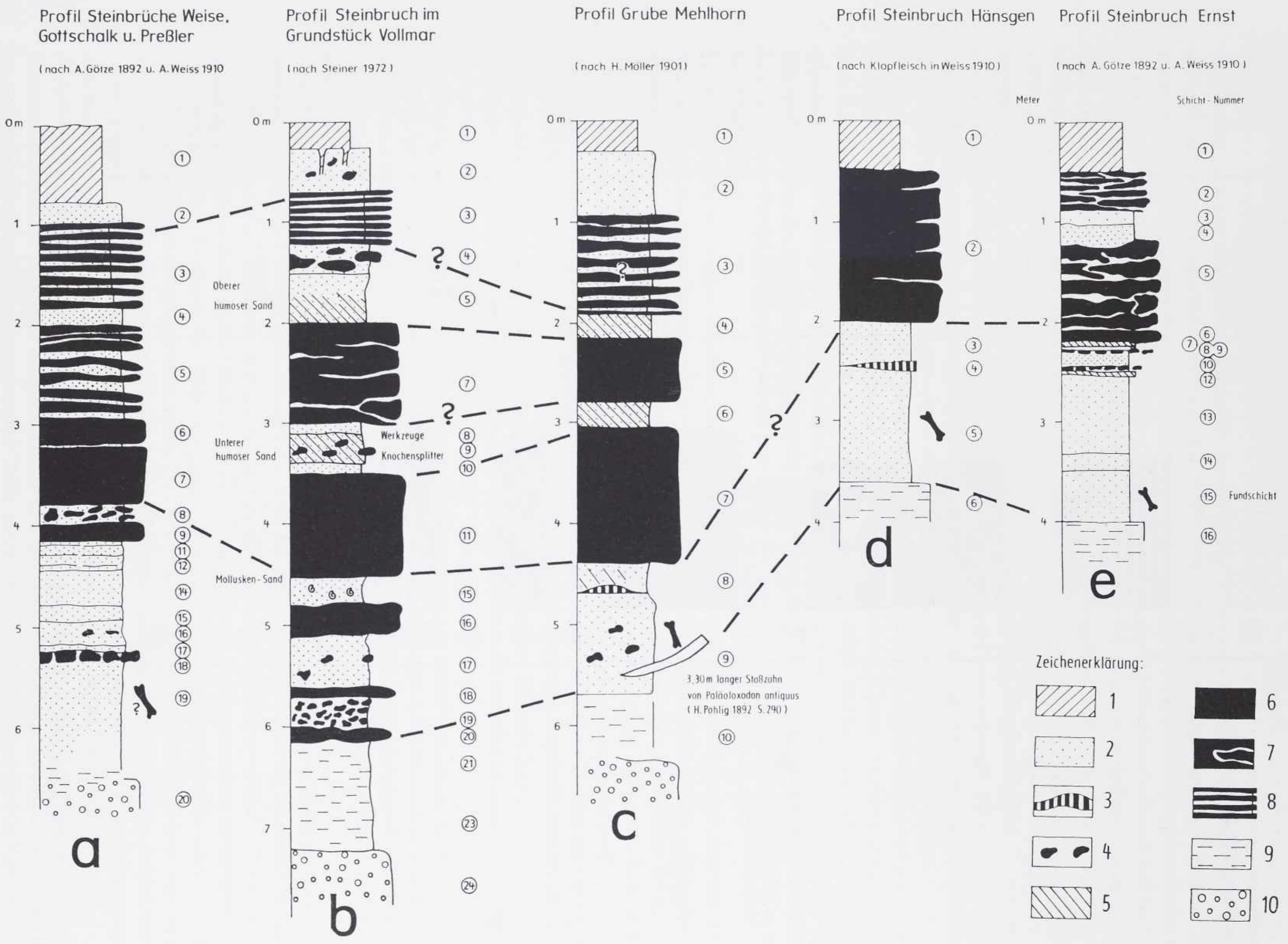

Fig. 2 Survey of the profiles recorded from the Taubach travertine (after Steiner 1977, Abb. 3). – 1 Topsoil. – 2 Friable travertine. – 3 Charred layer. – 4 Blocks of indurated travertine. – 5 Friable travertine with humic component. – 6 Indurated travertine. – 7 Indurated travertine with cavities. – 8 Indurated travertine in plates. – 9 Sands and silts. – 10 Gravel.

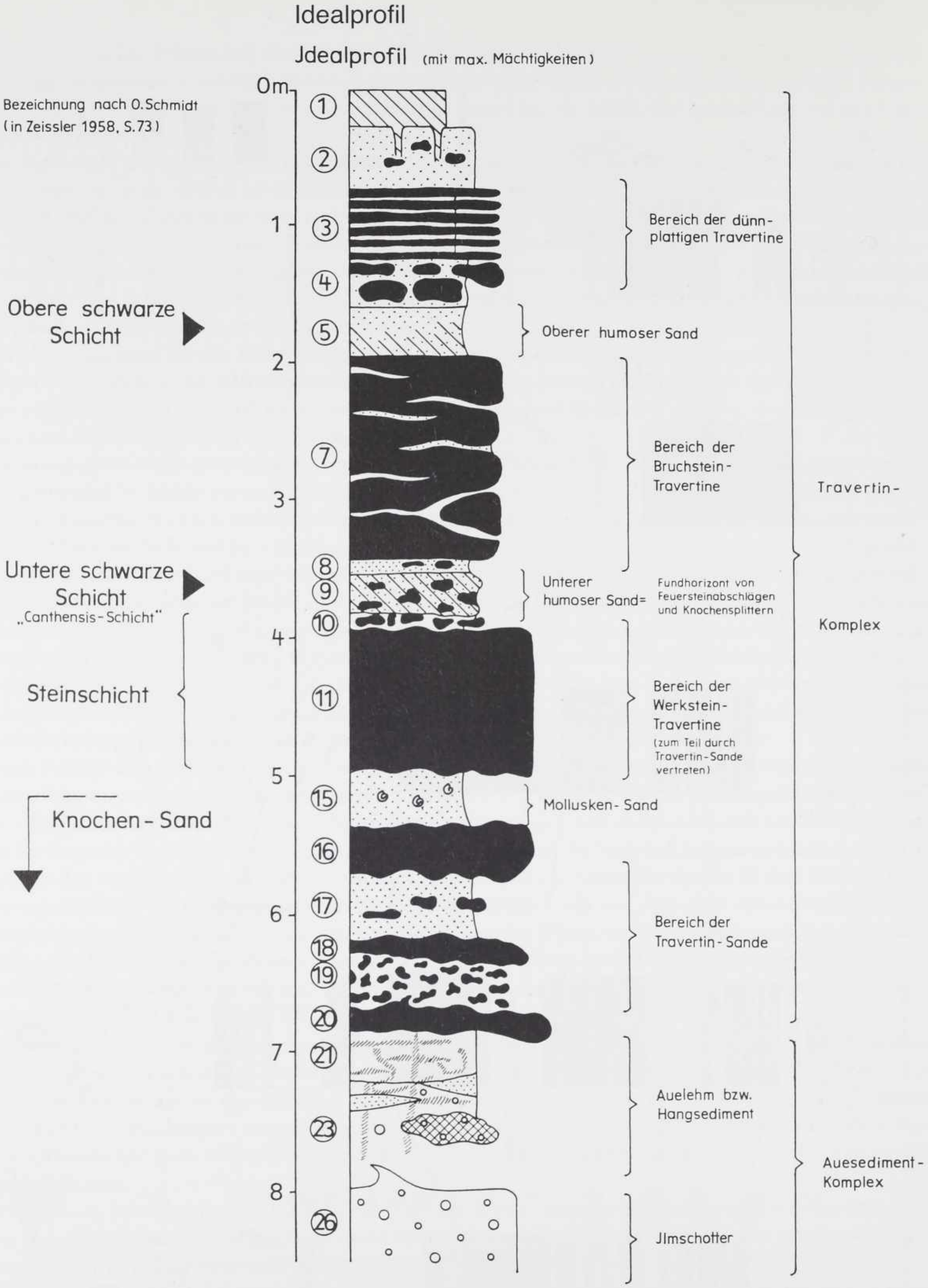

Fig. 3 Ideal profile for the Taubach travertine, based on the Vollmar profile (after Steiner 1977, Abb. 19).

THE »BONE SAND«

In all written sources surveyed by the author the lower friable, »sandy« travertine situated below the unit of blocky travertine is reported to be the find layer providing the bones of large mammals for which Taubach became renowned, as well as the flint artefacts and the hearth layers. In the older records this part of the deposits goes by the colloquial name: »Knochensand«, i. e. »the bone sand«. Bones and teeth are noted as abundant. The travertine sands are in places close to being saturated with fossils (Müller 1902). Since 1870 stone artefacts were repeatedly reported from the lower sandy travertine. The first publication of Taubach artefacts was in Portis' monograph on Merck´s rhinoceros in 1878 (cf. Steiner and Wiefel 1977). The charred layers (»Brandschichten«) comprising charcoal, ashes, artefacts and animal bones observed by several researchers also came from this part of the profile (cf. Klopfleisch 1883; Götze 1892).

From at least four of the quarries charred layers or »hearths« have been reported. Their relation to the dispersion of stone artefacts and modified bone and antlers in the travertine led Götze (1892) to the conclusion that the Taubach finds had not been redeposited, but are found in primary position.

The first description of what should be considered a hearth feature under destruction was provided by Klopfleisch (1883). In Quarry Hänsgen (a. k. a. Hänschen) he noted a layer of ashes and bones extending 1.5 m into the travertine sand. Fire-reddened pieces of travertine, charcoal and charred bones were also found. Near the charred layer, fractured bones and flint artefacts were noted as abundant. Both in this profile and in the second occurrence at the Quarry Mehlhorn the charred layer is positioned at the interface of the friable, bone sands and the overlaying mollusk-rich bed (Klopfleisch 1883; Möller 1900; Steiner and Wiefel 1977).

Götze (1892) reported other occurrences of charred layers among one of which was observed by the quarry owner Sonnrein in his quarry. Another was an agglomeration (»kompakte Masse«) of charcoal and ashes, described to be 30 cm long, 15 cm broad and 8 cm thick, observed by Götze in Quarry Ernst. Götze also offers an interesting and critical discussion on the questions of whether these finds could be considered to be in primary or secondary position and how they might have ended up in the bone sand.

Portis was the first to explain the dynamics of the »travertine sand« formation. To him they were precipated in a lake formed by the dammed river Ilm fed by carbonate-rich small streams originating as springs in the neighbouring slopes made of mollusk-rich limestones (Muschelkalk). The algae (Characeas) helped to build up travertine beds. A later Ilm erosion formed travertine terraces such as those at Taubach and near Weimar.

Based on his observations in the Taubach quarries Götze proposes a modification of this simple picture since the presence of algae and reeds at different levels in the travertine indicates to him a series of waterbodies at different levels during the build-up of the travertine. Also, the presence of both land- and water snails in some of the sandy layers suggested that parts of the lake could have fallen dry periodically (Götze 1892).

The observed charred layers have obvious consequences for the interpretation of the travertine formation since they occurred in the lake at least 100 m from its shore. To Klopfleisch the first described hearth area showed that the basic sandy travertine had at least temporarily (perhaps seasonally) been dry land thus allowing a settlement phase between the two lower layers of sandy travertine. Götze does, however, point out that the case is not that simple, since the finds did not occur only on the lowermost sand layer, but in this layer and at different depths. The lowermost sand layer showed the occurrence of both land- and water snails, algae oogonia (»Characeen Kapseln«), and, besides other finds, yielded gnawed bones, coproliths and a few hyena bones. Klopfleisch's basic idea of alternating wet and dry travertine surfaces is considered generally correct as the best explanation of the finds (Götze 1892).

It may be mentioned that the alleged connection between the various travertine occurrences along the Ilm river hindered the progress of research for several decades, since both archaeological and other finds were treated as belonging to the same entity. Also, more spectacular finds from the Ehringsdorf travertines helped to shift the interest away from the almost completely worked out Taubach quarries.

Because of the damage done by quarrying, recent field work had to be restricted to corings or, in one case, to analysis of a temporarily opened profile on the northern outskirts of the travertine field.

According to corings made by Ziegenhardt (1962) the find-bearing, lower sandy travertine is present at the base in every surveyed part of the deposit. The grains of the sediment are rounded and sorted, the minor blocks or gravel occurring in the deposit are rounded as well. To Ziegenhardt, the lower, friable travertine sands are the clastic deposit (calcarenite) of riverine alluvial origin. The source of the sands remains undetermined. The blocky, indurated beds of the upper travertines, on the other hand, precipitated in a series of small bodies of water. The calcarenites present in the upper parts of the Taubach complex do not show the same degree of sorting and abrasion as the basal bed of sandy travertine and were most likely subjected to only local transport.

The Taubach complex is considered to cover the time from the Warthe-phase of the Saalian and the entire Eemian until the beginning of the Vistulian (Weichselian). The alluvial silts underneath the basal, sandy travertine are thus considered to be formed at the very transition to the interglacial climate, whereas the travertines above »without exception« belong to the full Interglacial (Ziegenhardt 1962, p. 1048).

In Steiner's interpretation of the Taubach exposures (Steiner 1977) no difference is seen between the depositional environment of the lower, friable sandy travertine and the indurated one. The travertines are formed in a series of shallow ponds and/or trickling water areas (Rieselfelder) fed by carbonate rich waters deriving from the springs originating in the mollusc limestone (Muschelkalk) of the northern slope of the Ilmgraben. The possibility for settlements on the drier areas near watering places, which had the character of warm springs and in the winter did not freeze, is noted as important for the hunting strategies of prehistoric hunters.

An important point made by Steiner is that the lack of leaf and seed impressions in the Taubach travertine indicates an absence of bush and tree vegetation in the vicinity. The site surroundings are described as steppe-like (steppenartig), the presumed reason being the greater exposure to westerly winds than at the neighbouring travertine sites of Ehringsdorf and Weimar (Steiner 1977, p. 113).

The stone artefacts recovered from Taubach have recently been analysed by Schäfer (1993). The approximately 900 examined artefacts could be referred to at least five, but probably as many as eight different quarries. Based on a survey of published material as well as on unpublished museum notes the horizontal dispersal of the finds was reconstructed as a zone streching for at least 150m in the E-W direction at a distance from what is considered to be the Eemian shore of the Ilm of approximately 50-100m. According to Schäfer, the dispersal of artefacts within the deposit suggests a human presence predominantly during the earlier stages of sedimentation. Frequently repeated, short stays, where the exact location of sitesvaried in response to the changing hydrology and travertine sedimentation, are considered more likely than prolonged intervals between the visits (Schäfer 1993). An Eemian date for the Taubach deposit and finds *in toto* is not questioned by Schäfer (1993).

Many different types of antler and bone artefacts have been claimed for Taubach. The artefact status of several of these was disputed from the beginning. The subject is discussed separately below, however, it must be noted here, that no single Taubach piece, whether bone or antler, studied by the author has qualified as a tool.

The faunal material treated does, with a few exceptions, show the excellent surface preservation distinguishing Taubach finds from the other travertine finds in the region. The sizes of the larger pieces, like intact limb bones of rhinoceros or bison, imply a relatively thick bed of travertine sand, this alone making the lower bone sands a more likely place of deposition than the varied succession of sands and thin plates of travertines in the upper beds of the complex.

Frequently the bones show oxidation or manganese staining. According to the more detailed profile descriptions such patinations are characteristic for the lower sandy travertine.

The colour of the bones seen in the recent fractures is a creamy white to very light brown, which in the porous juvenile bone fragments may appear as darker, more greyish tones. Several specimens (especially from rhinoceros and bear) do display a reddish, slightly violet-tinted brown, similar to the colour of a subrecent heated bone. Some of the teeth show a crackled and probably heat-dried structure. Distinctly charred bones are present as well, and were, as mentioned, from an early date considered to prove that the Taubach assemblage represented the waste of hunting camps (Götze 1892). The traces of burning or heating show by themselves only that some of the bones happened to lie near a fire, and in case of the black, charred pieces that this happened before they had been completely mineralized. The reported connexion with the charred layers of ashes and red-burned limestone from the lower sandy travertine does thus appear quite credible.

THE DATING OF THE FIND LAYER

Geological evidence

The correlation of elements recorded in the old profile sketches with the recent Vollmar exposure is indeed often speculative. However, the transfer of conclusions based on the investigations of a single profile (Vollmar) and corings at the fringes of the deposits to general relevance for the entire travertine area does also involve the risk of undue simplification.

One point is that the complexity of the deposits in Taubach can be readily perceived from the varied structure of the travertines in the profiles, whereas the indurated deposits at other travertine localities, like that at Ehringsdorf, may give a superficial appearance of being more homogeneous and litho-stratigraphically simpler than they actually are.

In Taubach one of the great drawbacks is the lack of an easily recognisable, continuous marker horizon. The bed of the indurated, blocky travertine (»Werksteintravertine«, Bed 11) may be a good substitute, although it is apparently often discontinuous (cf. Ziegenhardt 1962).

The exploitation of the indurated travertine was, moreover, one of the most important goals in the quarrying activity. We may thus assume that it was present in most of the quarries where the bones were collected.

The few existing photos and legible profile sketches (Steiner & Wiefel 1977; Steiner 1977) imply a distinct, massive, indurated travertine layer present in at least the southern half of the sequence. Two later corings (Ziegenhardt 1962) show here a marked difference in the depth of indurated travertine within only 20m (T10: 85% resp. T11: 18%). This phenomenon does, however, agree well with the observations at the reopened Vollmar exposure further north, where the indurated blocky travertine grades into gravelly sands within a distance of a few meters.

The ruins now left of the Taubach travertines comprise mainly the uphill gravelly, sandy extensions of the deposits to the north, northeast and east of the indurated, blocky travertine (cf. corings by Ziegenhardt 1962). Which part(s) of the entire suite most likely correspond to the gravelly sands in the marginal deposits, can not be solved by a simple comparison of the sections. The exact uphill extension of the lower sandy travertine, the bone sand, is thus not entirely clear.

The early notes on Taubach suggest that the very massive occurrences of bone fossils were in the downhill sections of the deposit, closer to the river (cf. Schäfer 1993 and Müller 1902), i. e. in the parts which were exploited relatively early in time and where the archaeologically interesting features were noted. Götze observes in 1892, that »Während die dem Terrassenrande zunächst gelegenen Gruben die reichsten Funde geliefert haben, nehmen letztere nach der Höhe zu sehr ab, so dass, wie gesagt, ein Versiegen derselben bevorsteht, da der vordere Terrassenrand, bis auf die Hausgrundstücke ziemlich abgebaut ist.« (Götze 1892, p. 367).

The Vollmar exposure in the northwestern corner of the deposit has provided most of the stratified material for the recently published investigations of micromammals, molluscs etc. The results are relevant to the discussion on the dating and the environment of the large mammal fauna. Using this information does, however, obviously involve a tacit downhill extrapolation of observations made at the Vollmar quarry site to the more likely main find areas 100-200m to the southeast.

For the following discussion it is necessary to recapitulate the main stratigraphical units from the so called ideal profile of Steiner (1977), fig. 2 and 3. The most important units are, from the top, the Bruchsteintravertine (Bed 7); the lower humic layer or *canthensis*-layer (Bed 9), the indurated, blocky or »Werkstein«-travertine (Bed 11), the mollusc sand (Bed 15) and the bone sand (in the Vollmar exposure below a thin layer (16) of indurated travertine). In the »quarry vernacular« the term »bone sand« was apparently used for all sandy travertines underneath the workable, indurated blocky travertine, i. e. the mollusc-rich upper part was not always specified as a different deposit.

Several radiometric datings have been measured for Thuringian travertines (Brunnacker et al. 1983). Two 230-Th/234-U dates are available for Taubach, both made on indurated, blocky travertine from the Vollmar profile. The results are as follows: Sample T Tau 9 from Bed 11 (»Werksteintravertine«) – 116.000 ±19.000 years and Sample T Tau 8 from Bed 7 (indurated travertine) – 111.000±12.000 years (Brunnacker et al. 1983). These results support an Eemian date for the upper part of the Taubach travertine sequence. Unfortunately, no radiometric determinations are available for the bone sand.

Faunal indications

Invertebrate fauna

The rich ostracod fauna from Taubach was analysed by Diebel and Pietrzeniuk (1977). The samples from the Vollmar exposure indicate an environment characterized by springs, spring-brooks and ponds. Species typical for local springs are prominent in the samples from the silty topbeds of the river up through the different travertine beds. In the lower sandy travertine first indications of a weak salinity are found, which becomes marked in the mollusc sand (Bed 15), and fades out through the blocky travertine and the lower humic sand (Bed 9) (Diebel and Pietrzeniuk 1977).

Samples from other parts of the deposit could not always be correlated precisely with the stratified samples from the Vollmar exposure. Older samples marked »ironstained sand« or »bone sand« from now destroyed central parts of the deposit, Quarries Sonnrein and Ernst, in the collection of O. Schmidt did, however, show the same abundance of the salinity indicators, *Candona angulata* and *Cyprinotus salinus*, as the mollusc sand layer. A sample from the top of the lower sandy travertine taken in one of the recent borings by Ziegenhardt (T 26), sunk near the northern limit of the distribution of the indurated blocky travertine, also had a high frequency of these two species.

Unfortunately, the ostracod communities do not supply any precise age indications for Taubach within the Pleistocene (Diebel and Pietrzeniuk 1977). The stratified ostracod samples, however, indicate that the sequence: lower bone sand – (saline) mollusc sand – blocky travertine, constitute a recurrent pattern in the profiles from different parts of the deposit.

Zeissler (1977) has provided a comprehensive study of mollusc faunas in Taubach, and in the course of her study accomplished the most detailed stratigraphical analysis of the Vollmar profile so far presented. One of the most notable results is that the two major ecological changes shown by the mollusc communities are found *within* the geological units (»layers«) observed during fieldwork. The ecological changes are thus not synchronous with clear sedimentological changes regarding the type of travertine seen in the profile.

The malacological information can only be summarized briefly here. From the base up, the Taubach sequence shows a succession of alluvial silts followed by the lowermost travertine layers, including the travertine bone sand *sensu stricto*. Despite minor differences between the beds this part of the profile reflects the same type of open and moderately humid environment. The mollusc species belong to the continental steppe or to high mountains, the faunal spectrum is summarized by Zeissler as a »reliktische Kaltzeitfauna«.

The following upper part of the sandy travertine, the mollusc sand or »Belgrandia-Layer«, shows an entirely different picture. Species preferring swamps and ponds dominate. Forest species become more abundant from this layer up through the indurated, blocky travertine and the lower humic layer, the »*canthensis*-layer«.

The mollusc sand shows a high interglacial climax fauna immediately above the temperate fauna of the beds below. According to Zeissler such a complete change in the mollusk community without any trace left of transitional, intermediate faunas can only reasonably be explained by a depositional hiatus.

The interglacial climate indicated for the mollusc sand can be followed further up into the lower humic layer, Bed 9 according to Steiners description, the so-called »*canthensis*-layer«. The species *Helicigona banatica* (previously known as *Campylaea canthensis)* characteristic for this layer is considered to be an indicator of the climax of the Eem interglacial (Zeissler 1977). Above Bed 9 i. e., the *canthensis*-layer *s. s.*, a relatively thin, light gray zone is found, which shows a different mollusc community. A corresponding zone is also mentioned in Schmidt's field notes and several of his samples can be consulted. The relatively low number of species may, according to Zeissler, indicate that the light gray zone was only locally present and the material derived from a relatively limited source area (Zeissler 1977).

The second change in the environment can be observed in the difference between the *Canthensis*-layer (9) and the light gray layer (Bed 8), as the species preferring swamps and open waterbodies disappear. This may, however, only indicate changes in the local hydrology, as the persistence of woodland species, even higher up in the profile, suggests a very slow process of climatic deterioration (Zeissler 1977).

Mania (1977) analysed a mollusk sample from Bed 9 in the Vollmar exposure and arrived at a different conclusion. According to Mania, the thanatocoenosis from Bed 9 does not belong to the *Helicigona-banatica*-Horizon, but should be older and probably belongs to an earlier, still relatively dry, continental phase of the Eemian before the optimal woodland phases. This opinion is, however, based on a very limited sample counting of approximately 1000 specimens belonging to 40 different species (Mania 1977). Zeissler's four samples from the same layer comprised 11,018, 10,859, 9,200 and 9,415 specimens respectively and provided a total of 78 species. A comparison of the large samples shows clearly the variation in the relative frequencies of individual species. For example, the chronologically significant species, *Helicigona banatica*, was in all samples but the highest number of fragments (50), was actually found in the smallest sample of 9,200 molluscs (c.f. Zeissler 1977, tab. 3.) Zeissler's conclusions concerning the ecology and dating are based on the analysis of a series of very large samples encompassing the entire Vollmar profile, and may thus be followed here.

The collections of O. J. Schmidt mentioned above included a few samples of molluscs from other areas of Taubach. They were analysed by Zeissler in an earlier study, although field notes and stratigraphical information were very limited. An exact correlation with the details of the Vollmar exposure is difficult; both upper and lower humic layers and the bone sand are, however, indicated (Zeissler 1977).

The preoccupation with Bed 9 and the Vollmar exposure may appear lengthy. It should, however, be noted that the artefacts from this layer represent the only archaeological horizon recently documented from Taubach, and that conclusions of different disciplines concerning the dating of Bed 9 were presumed to apply for the entire Taubach sequence.

Mammal fauna

Recently, Heinrich (1994) has presented a synopsis of the biostratigraphical evidence relevant for the relative dating (Altersstellung) of Taubach and other Thuringian Pleistocene travertines. Here Taubach is assigned to the Eemian on the basis of an analysis of a sample of micromammals from Bed 9. Older finds of beaver and horse are also included in the argument.

The *Arvicola*-population from Taubach shows traits similar to well dated Eemian samples, and according to Heinrich this, supported by the previously mentioned U-Th-dates of the indurated travertine, places the entire site firmly in the Eemian (Heinrich 1994, 260). Since the micromammal sample comes from Bed 9 (the lower humic layer) and the large mammal fauna belongs to an entirely different stratigraphical unit, this conclusion can not be followed as uncritically as it is presented.

The beaver and horse remains are, however, also considered to possess chronological significance, albeit far less diagnostic than the micromammals. For the beavers from the Thuringian sites, biometric data reflecting evolutionary changes in the construction of the premolars indicate the following succession: Bilzingsleben, lower travertine of Ehringsdorf and Taubach. In other words, the beavers from Taubach appear to be more evolved than the ones from the lower travertine of Ehringsdorf (Heinrich 1994).

The weighting of such observed differences may, however, differ considerably. In an earlier, very detailed study on the Taubach beavers the same traits were reported by Kretzoi (1977), who in his concluding remarks writes: ». . . daß sämtliche Meßergebnisse, die an – nicht allzu wenigen – Zähnen der beiden Populationen erzielt werden können, dafür sprechen, daß von den »Biberschichten« beider Fundstellen die von Ehringsdorf etwas älter sein muß als diejenige von Taubach. Dabei ist der Unterschied aber so gering, daß mehr von einer – wenn auch nicht absoluten – Gleichaltrigkeit gesprochen werden kann.« (Kretzoi 1977, p. 398).

Regarding the horses, Heinrich quotes similar observations based on the analysis of teeth from the papers of Musil (1977) and Eisenmann (1991). However, only Eisenmann goes as far as to ascribe the horses from Taubach and the lower travertine of Ehringsdorf respectively to an entirely different species status. The differences noted between samples of Middle Pleistocene horse remains in Europe are not considered by all experts to justify the large number of species names currently in use.

As mentioned above finds from the travertines of Ehringsdorf and Taubach were for long considered to be of the same date and origin, and consequently both samples went under the name of *Equus taubachensis*. The first more detailed comparison of the samples has been presented by Musil (1977).

He characterizes the horses from Taubach as quite large and with teeth showing several progressive traits, but no atavistic or primitive features. He further compares the teeth to the horse material from Ehringsdorf. Here two samples of horse teeth are considered: the so called second group of horse remains, which comes from stratified excavation in the upper part of the Lower travertine (UT) and the so called first group, comprised of old finds of teeth considered to be from the lowermost part of the Lower travertine. This latter group is characterized by primitive traits and a contemporaneity with the second group is deemed impossible.

Concerning the Taubach teeth it is concluded that no great morphological differences exist between these and the second group from Ehringsdorf; there are, however, too few Taubach finds for a detailed study. Regarding the metrical data the Taubach teeth were found to be slightly smaller than the second group from Ehringsdorf, but there is a notable overlap between both samples. The differences between the Ehringsdorf UT and the Taubach horses are thus according to Musil a matter of smaller average size in the Taubach sample but without distinct morphologically differing traits.

Between Taubach and the first Ehringsdorf group, both clear metrical and morphological differences are apparent.

Musil concludes that a complete identity between the Taubach and the Ehringsdorf horses could not be established, and that the name *Equus taubachensis* should be reserved for the horse remains from Taubach (Musil 1977).

Vera Eisenmann has (1991) presented a comprehensive study of the metric data from European Quarternary horse finds. On the basis of the size and proportions of teeth and metacarpals she distinguished between large ante-Würmian and smaller Würmian horses. Furthermore, the tooth proportions are used to characterize three different morphotypes with horses of different sizes found in each of them. The type I which a. o. comprises *Equus taubachensis* is noted to be found usually in temperate climatic conditions. According to Eisenmann (1991) *Equus taubachensis* is found in the travertines of Taubach and Weimar, as well as in Abri Suard, the LAM (Loess Ancien Moyen) of Achenheim and in several British sites of an ante Ipswichian date.

To summarize, the Taubach (and Weimar) finds are, if the Eemian date should be correct, very late for this type of horse. The majority of finds are placed before 200 ky and may belong to a major temperate event (interstadial or »ante-Ipswichian interglacial«).

The horse finds from Ehringsdorf UT are regarded by Eisenmann to belong to a different type, namely the type II horses, and within this group to the species *Equus chosaricus*. It is noted that the type II horses appear in cold faunas, the Ehringsdorf UT being the only temperate exception.

Eisenmann's presentation shows that horses of the same type (I) and general size class as found in Taubach are present in Western Europe at an earlier date than the Eemian, and may occur parallel to the II. type found at Ehringsdorf. A notable decrease in size is found after approximately 100.000 (Eisenmann 1991), but for the preceding time a considerable variation is apparent.

A more conservative opinion than Musil or indeed Eisenmann concerning the Pleistocene horses is advanced by Forsten: »The origin of *E. germanicus* is probably to be sought in the large caballoids of the middle and early late Pleistocene, variously called *E. achenheimensis*, *E. taubachensis*, *E. steinheimensis* REICHENAU, *E. chosaricus* GROMOVA, *E. insulidens* SAMSON and *E. mosbachensis* REICH. – abeli ANTONIUS. It is uncertain whether these »species« can be differentiated from one another.« (Forsten & Ziegler 1995, p. 12). Based on cases of sympatry Forsten considers three caballoid species to be possible since the Middle Pleistocene (*E. mosbachensis*, *E. germanicus* and *E. caballus*) (Forsten 1988). These species are considered to have partly overlapped chronologically and are seen as three lineages of successively smaller body size. The oldest example of sympatry given is Sveduv Stul, where a larger, *E. mosbachensis-germanicus* is recognised besides a smaller *E. caballus* (Forsten 1988).

Eisenmann on the other hand lists 8 different species most of which are found before approximately 100.000 BP. Notably only *E. germanicus* is mentioned for the period 100.000 to approximately 15.000 BP (Eisenmann 1991). In other words, there are currently considerably different opinions between specialists concerning the history of the caballoid horses in Europe.

Considering the quality of the available samples and the often minute differences pleaded to justify a species identification, I fully share Forsten's scepticism. At present a tentative subdivision in three general morphological types of Middle and Late Pleistocene horses appears better founded than the large number of species names currently in use for the European horses.

Surveying the arguments put forward concerning the status of the Taubach horses, the situation may be summarized thus, that the Taubach and Ehringsdorf UT horses in all likelihood derived from two different populations, but whether these furthermore represent two different species is not clear. Also, even when there is no perfect identity between the two geographically neighbouring samples, this should not necessarily give the Taubach sample a very late, i. e. Eemian, date, since horses of the same general type and size range may be encountered as early as or even at an earlier date than the Ehringsdorf UT.

For the purpose of the present discussion it may be noted that both the beavers and the horses from Taubach appear to come from different and, possibly, somewhat younger populations than the ones found in the lower travertine in Ehringsdorf. How the biometric observations translate into chronological distance is, however, still an open question.

Relative dating of Taubach

In the late 19th century it would probably not have been an exaggeration to describe Taubach as one of the most important palaeontological sites in Central Europe. Steiner and Wiefel (1977) have summarized how the interpretation of the stratigraphical position of Thuringian travertines developed in relation to the expanding knowledge of the Quaternary in general. Important for Taubach is here in particular, that its fauna at an early date played a notable role in the development of the system of alternating warm and cold faunas recognized as indicators of glacials and interglacials.

Both Portis and Pohlig were thus of the opinion that the travertine faunas indicated a temperate (mäßig warmes) climate and thus had to belong to an interglacial (Steiner and Wiefel 1977). In a further development of these ideas Wüst (1908) defined the so-called Antiquus-fauna (after *Elephas antiquus* Falc.) as characteristic for the interglacial. For the following two decades a more precise placement of the Thuringian travertines within the Eemian or any of the interstadials of the last Glaciation was under discussion. Concerning Taubach, Soergel (1926) concludes that the main find layer should preferably be placed in the maximum of the Eemian or last Interglacial (Steiner and Wiefel 1977).

Regarding the stratigraphical position of Taubach among the Thuringian travertines, Steiner (1977) follows the time honoured opinion that the lower part of the Ehringsdorf and Weimar travertines are Eemian in age. The discussion thus concerns the possible positioning of Taubach in the Eemian (or at an even later date), since a relative date for Taubach somewhat later than the lower travertine at Ehringsdorf is noted as consistent with the conclusions from different papers presented at the Taubach Colloquium 1972.

The stratigraphical relationship between Taubach and the Ehringsdorf lower travertine has been a matter of some debate. Until recently both have been considered of an Eemian date, mainly based on the occurrence of what was regarded to be the typical high-interglacial forest fauna at both sites, and the observed faunal differences generally being considered too insignificant for any greater difference in age. It is thus evident that the contributions to the Taubach symposium (1977) have been prepared under the expectation of the so-called high-Eemian date for Taubach (as for Ehringsdorf); however, more than one of the papers finds reason to caution this view (cf. a. o. the contributions by Steiner, Zeissler, Musil and Kretzoi [1977]).

Absolute dating of the Ehringsdorf travertines has recently brought a new momentum to this discussion. Several datings with central values lying around 200ky, produced by U-TH as well as ESR techniques, indicate a pre-Eemian age for the lower travertine (UT), whereas the upper travertine has fairly consistently shown dates later than 150ky (cf. Mania 1993). It is however clear that these results should be considered with caution. The samples from both the upper as well as from the lower travertine contain single dating results that seem to fit the other group better, and when regarding the central values only, one may be tempted to see a considerable overlap. As Brunnacker et al. (1994, 243) concluded, the U-TH datings: »sind geeignet, ein im Vergleich zu Taubach und Burgtonna deutlich höheres Alter für den UT von Ehringsdorf zu bestätigen und auch für den OT wahrscheinlich zu machen«, but also »dieser Aussage kommt aber offenbar Relevanz mehr im Sinne einer sog. relativen Chronologie als in jenem direkter Altersangaben zu«.

When the full range of variations is considered 11 out of the presently available 13 datings (U-Th or ESR) from the lower travertine can be clustered between 190 to 210ky or slightly later, with only two results being conspicously later. For the samples from the upper travertine one result would lie in the 190-210ky range, but all 7 (possibly 8) others can be placed at ca. 150ky or later (Mania 1993).

Considering species representation it is not difficult to perceive why the finds from Taubach and from the lower travertine at Ehringsdorf were for a long time regarded as being biostratigraphically close to each other. The species lists for the larger mammals from Taubach and from the three main stratigraphical units in Ehringsdorf, the lower travertine (UT), the »pariser« horizon (P) and the upper travertine (OT) are summarized in table 1. Considering species representation, Taubach fits the lower travertine sample remarkably well. The two samples have fifteen species in common. The bison material would add one further species, but differences may be encountered here on the subspecies level. A much-needed detailed reconsideration of the large bovid material from the Thuringian travertines would be helpful, but this is beyond the scope of the present study.

Concerning beaver and horse, the minor differences cited above would indicate that Taubach and Ehringsdorf include at least different forms of these animals, even if the findings may not be considered by all specialists sufficient to justify the existence of different subspecies or species. Both samples show a further four species which are not shared.

For the upper Ehringsdorf travertine sample, the ten species (possibly eleven, if horses are included) shared with Taubach are also found in the lower travertine. Only one species, *Panthera leo*, is found only in Taubach and the upper travertine. Two species of martens are recorded only in Ehringsdorf.

Species	Taubach bone sand	Ehringsdorf		
		UT	P	OT
Elephas antiquus	x	x		
Stephanorhinus kirchbergensis	x	x		
Sus scrofa	x	x		
Lynx lynx	x	x		
Dama dama	x	x		
Crocuta crocuta	x	x	x	
Ursus arctos	x	x		(x)
Cervus elaphus	x	x		x
Alces latifrons	x	x		x
Meles meles	x	x		x
Canis lupus	x	x		x
Ursus spelaeus	x	?		x
Capreolus capreolus	x	x	x	x
Megaloceros giganteus	x	x	x	x
Stephanorhinus hemitoechus	x	x	x	x
Bison priscus med.	x	?		x
Bison priscus priscus	x			
Bison priscus ssp.		x		
Castor fiber T	x			
Castor fiber E		x		
Equus chosaricus		x		
Equus taubachensis	x			
Equus cf. *taubachensis*				x
Bos primigenius	x			
Panthera pardus ssp.	x			
Lutra lutra	x			
Cyrnaonyx antiqua		x		
Vulpes vulpes		x		
Ursus thibethanicus		(x)		
Mustela sp.				x
Martes martes		x	x	x
Panthera leo or cf. *spelaea spelaea*	x			x
Mammuthus primigenius	(x)			x
Rangifer tarandus	(x)		(x)	(x)
Coelodonta antiquitatis			x	

Tab. 1 Fauna of Taubach and Ehringsdorf (after Heinrich 1994).

In Taubach the majority of bones come from eight species: *Stephanorhinus kirchbergensis, Ursus arctos, Elephas antiquus, Sus scrofa, Cervus elaphus, Bison priscus, Castor fiber*, and *Equus taubachensis*. Whereas the presence of other species on the list may be due to the recovery of only one or two bones or teeth, and thus includes an element of chance, these eight appear far too frequent for this. Consequently the absence, in particular of *Stephanorhinus kirchbergensis, Elephas antiquus, Castor fiber* and *Sus scrofa* from the upper travertines at Ehringsdorf may indicate a significant difference between the two faunal samples (cf. Kahlke 1975).
Similar co-occurrences of species as in Taubach (Merck's rhinoceros, narrow-nosed rhinoceros, straight-tusked elephant, brown bear, lion, red deer, bison, horse, lion etc.) are met in other European sites, e. g. in the complicated Middle Terrace complex of the Thames estuary (Ilford) which is placed in a temperate episode at approximately 200ky between the Ipswichian (Eemian) and the Hoxnian interglacials (Sutcliffe 1985). It may be noted that the same type of horse is found at Taubach and at these »ante-Ipswichian« sites (Eisenmann 1991).

In Northern France the important sites Biache-Saint-Vaast and Montières, showing temperate species representations similar to Taubach, have been attributed to the OIS 7 (Auguste 1993; 1995).

In a recent survey of the palaeontoloy of Ehringsdorf Mania has pointed out that the fauna, including the mollusc fauna, and the travertine flora contain elements indicating a mediterranean-sub-continental character, differing from the more »oceanic« influenced Eemian interglacial (Mania 1993). Furthermore, the bears studied by Kurtén support an age earlier than the Eemian, since the rare *Ursus thibetanicus* is not as yet known from such late find contexts in Europe and both the brown bears and the cave bears tend to be more in accordance with early forms (Kurtén 1975; in Mania 1993). Mania concludes that the entire Ehringsdorf travertine sequence represents a single climatic cycle, where at least the lower travertine is older than the Eemian and belongs to an »intra-Saale«-interglacial. Several examples are given, e. g., Neumark-Nord, where this interglacial has been identified, and these occurrences as well as Ehringsdorf are placed in the temperate oxygen isotope stage 7 (of approximately 245-186ky) (Mania 1993).

In a recent survey of the palynological evidence from the area Litt (1994) has firmly rejected the existence of an intra-Saalian interglacial and concludes that the interglacial found at Neumark-Nord (as well as in the profiles from Gröbern and Grabschütz) are in fact Eemian in age. Furthermore, a certain »subcontinental tendency« found in the early phases of this interglacial (and assumed to indicate a difference from the classic Eemian, cf. Mania 1993) is regarded by Litt as a regional trait characteristic for the area. The development of the summer and winter temperatures in these earlier vegetation phases (Pollenzone E3: fir-mixed oak forest phase and Pollenzone E4: mixed oak hazel-forest phase, *sensu* Litt 1994) will thus show a fairly rapid increase in the mean July temperature to about 20°C but with the winters still cold. Later in the Eemian (Pollenzone E5: hornbeam phase), the mean January temperature will rise to above 0°C accompanied by greater humidity and falling summer temperatures (Litt 1994, 162 and fig. 50).

Discoveries of importance for this discussion have recently been reported from the huge exposures in Schöningen, Niedersachsen. Here the existence of six major climatic cycles since the Elster glacial can be demonstrated, comprising three cycles (Schöningen, Zyklus I-III) in the Holstein complex between the Elster and Saale glacials, an intra-Saalian interglacial (Zyklus IV), the Eemian (Zyklus V) and the Holocene (Zyklus VI). Regarding the earlier stages, Schöningen I has been identified as the Holstein Interglacial, whereas the following Schöningen II, named »Reinsdorf Interglacial«, represents an hitherto unknown interglacial considered to be identical with Bilzingsleben II, dated to approximately 350-412ky. From Schöningen III, correlated with the Dömnitz-Interglacial, a dating of approximately 320ky is available (Thieme 1998).

The intra-Saalian Interglacial (Zyklus IV) will thus be placed between this date and the beginning of the Eemian nearly 200 ky later at approximately 130ka. As pointed out by Mania for the dated lower travertine at Ehringsdorf and for Neumark-Nord, the temperate stage OIS 7 of approximately 245-186ka represents an acceptable time frame for this intra-Saalian Interglacial.

A detailed description of the palaeobotanic and ecological development of this interglacial is not yet available. Even very general plots of the deep sea curve indicate, however, three consecutive temperate episodes within the OIS 7, a pattern which – given the limitations of radiometric dating – represents a warning against too simple biostratigraphic correlations (cf. Martinson et al. 1987 and Dansgaard et al. 1993).

Returning to SE-Germany, it may be noted that other travertine sites with faunal assemblages have also been dated by U-TH, including the Weimar park travertine and the travertine beds at Burgtonna. The results indicate an association with the last Interglacial for both sites. For Burgtonna three dates are available: 101±8ky, 104±ky and from the lowermost part of the profile, 111±7 ky (Brunnacker et al. 1983). Recent analyses of the mollusc fauna (Mania 1978) and the micromammals (Heinrich 1994) support an Eemian date.

The composition of the large mammal fauna found at Burgtonna shares several elements with both Taubach and the lower travertine finds from Ehringsdorf; however, the species list is somewhat less com-

Species	Ehringsdorf UT	Taubach bone sand	Burgtonna travert
Elephas antiquus	x	x	x
Stephanorhinus kirchbergensis	x	x	x
Sus scrofa	x	x	x
Ursus arctos	x	x	x
Cervus elaphus	x	x	x
Dama dama	x	x	x
Crocuta crocuta	x	x	x
Capreolus capreolus	x	x	x
Stephanorhinus hemitoechus	x	x	x
Bison priscus *med.*	?	x	x
Bison priscus priscus		x	
Bison priscus ssp.	x		
Megaloceros gigant.	x	x	
Alces latifrons	x	x	
Meles meles	x	x	
Canis lupus	x	x	
Ursus spelaeus	?	x	
Lynx lynx	x	x	
Castor fiber T		x	
Castor fiber E	x		
Equus chosaricus	x		
Equus taubachensis		x	
Equus sp.			x
Panthera leo spelaea or cf. *spelaea*		x	x
Vulpes vulpes	x		x
Cyrnaonyx antiqua	x		
Martes martes	x		
Ursus thibethanicus	x		
Bos primigenius		x	
Panthera pardus ssp.		x	
Lutra lutra		x	
Felis silvestris			x
(*Equus hydruntinus*)			x)
Mammuthus primigenius		(x)	
Rangifer tarandus		(x)	

Tab. 2 Fauna of Taubach, Ehringsdorf (UT=Lower travertine) and Burgtonna (after Heinrich 1994).

prehensive (tab. 2). Of the total fifteen species recorded, ten are shared with both Taubach and Ehringsdorf, and one further may possibly be included since the Burgtonna horses have as yet not been identified to species. One species is shared only with Taubach, one only with Ehringsdorf and one or possibly two are found only at Burgtonna. Of the eight core species from Taubach only the beaver has not been recorded in Burgtonna.

Just as for Taubach the similarities between Burgtonna and the lower travertine at Ehringsdorf are evident, so are the differences from the fauna recovered from the upper Ehringsdorf travertine. Apparently, the combination of large animal species found at Taubach, is not sufficent in itself to pinpoint a chronological position of the site. We may rather be dealing with an expression of particular environmental conditions, which, in a more or less generalized form, could occur recurrently.

It is in this respect particularly unfortunate that the only two species for which morphological, and thus possibly chronological, differences have been noted between Taubach and the lower Ehringsdorf travertine have not been recovered in sufficient quality from Burgtonna for comparative analysis. On this basis it is thus impossible to argue whether or not the finds from the Taubach bone sand should be closer to the Eemian of Burgtonna or to the earlier Ehringsdorf assemblage.

This excercise, however, illustrates some methodological problems in relation to relative chronology. For the Thuringian finds we may be allowed to disregard several otherwise important variables, like geographical and topographical setting, immediate site environment and to a certain degree the preservation factor. All three sites are embedded in travertines and lie in the same southeastern, continental area bordering the European Plain.

Since the beginning of travertine exploitation these assemblages have been fitted into patterns of environmental change of increasing detail. Unfortunately the schemes are often loaded with a ballast of tradition. When, e. g., the existence of an interglacial before the last glaciation is recognised and at least partly defined on the basis of a particular assemblage (in this case Taubach), it may later become an overwhelming task to question anew this age assignment even in the light of new information.

A perhaps more productive approach will be to take a look at the climatic indications given by the fauna itself. These are necessarily only hints, since the recent geographical distribution of the relevant species has been greatly influenced by the activities of modern man. The winter tolerance of a species may be more informative here than the summer preferences.

At first glance, those Taubach animals for which there are modern representatives now living in Europe or North America, seem to be dominated by cold tolerant or winterhard animals. These include brown bear, beaver, elk, wolf and lynx, today thriving in Northern Scandinavia, and due to both physical and behavioral adaptations able to tolerate both short growth seasons and lack of broadleaf forest. With the exception of elk, they are also found far south in Eurasia, where insular occurrences, often in mountain refuges, must be considered an artefact of present-day human settlement.

The now barely surviving species, bison and wild horse, can cope with continental winters, both in the forest and in the prairie. In the past they were in fact some of the most prominent animals on the glacial tundra-steppes.

Wild boar, red deer, roe deer, aurochs, otter and badger, on the other hand, seem to constitute a more temperate group. For wild boar, roe deer and red deer, the snow depth in relation to carnivore activity is an important factor limiting the northern distribution. If winter forage is available they may also thrive outside the broadleaf forests.

Considering the extinct species both steppe rhinoceros, hyena, cave bear, lion and giant deer could be expected in a medium-temperate rather than a cold type of environment. At least steppe rhinoceros and giant deer seem to be animals of open land.

This leaves straight-tusked elephant and Merck's rhinoceros for consideration, both of which have mostly been found in Europe in association with broadleaf forest and thus have been regarded as important indicators of optimal interglacial, or more correctly optimal forest conditions (Stuart 1991).

Both are very large animals and can be characterized as browsers. This, and their enormous size, would suggest a bush-dominated or very open forest allowing a rich undergrowth as optimal territory. According to Fortelius et al. (1993) the dentition and head posture of Merck's rhinoceros suggests a predominantly browsing mode of feeding, whereas the concave limb joints would suggest movement in a predominantly closed forest or woodland environment.

Perhaps the best living parallel for the Taubach elephants is the modern African elephant. This species is found in a variety of environments ranging from dense jungle through savannas to semi-desert conditions, giving rise to several slightly different forms or subspecies.

Their home ranges vary from 15 to 3000 km^2 depending on carrying capacities, population densities and other factors, and can be exploited in an irregular, nomadic as well as in a more regular migratory way (Gautier et al. 1994).

The occurrence of elephants will thus in many areas be strictly seasonal and dependent on the availability of suitable food for the large herbivores. For the Indian elephants, considerable movements have also been recorded. The live weight of a straight-tusked elephant has been estimated at approximately 9 tons (Stuart 1991), by comparison recent African elephants can weigh 3 to 7 tons. There is no *a priori* reason to assume that straight-tusked elephants were less mobile than their present day counterparts and it seems probable that the presence of elephant herds near Taubach would be both temporary and seasonally limited occurrences.

Contrary to this, all recent species of rhinoceros are more or less sedentary and, except for unsettled subadults, they stay in the same territory throughout the year. For the adult rhinoceroses, movements over longer distances seems to occur only as a response to extreme conditions like drought, forest fires etc. The recent species, however, survive only in tropical or subtropical regions and may (like recent elephants) not be perfect analogies for the Pleistocene species.

It is quite possible that the Pleistocene *Stephanorhinus* sps. had more flexible responses to their seasonally more varied environment. The size of these animals will probably have been comparable to or somewhat larger than the 2.5 to 3 tons of the recent South African white rhinoceroses, and the need for extended stands of bush or scrubs, particularly for winter browse, must have been considerable.

The later history of the *Stephanorhinus* sps. suggests the optimal interglacial forest conditions were not an imperative requirement for this animal. The latest dated occurrence of *S. kirchbergensis* in Central Europe is found in Kulna cave in layers dated to 69 ± 8 ky, or near the oxygen isotope stage (OIS) 5a/4 boundary (Rink et al. 1996). OIS 5a has been correlated with the Odderade Interstadial (Litt 1994), a temperate period which does not reach the climatic level of the Eemian.

Stephanorhinus kirchbergensis shows some later, rare occurrences at Aurignacian sites in southern Europe, with extinction for this species (and *S. hemitoechus*) occurring some time after approximately 20 ky (Stuart 1991).

To which degree these rhinoceroses were tolerant of winter conditions is impossible to say. It is, however, conspicuous that several of the other animals found at Taubach are now at home in the northernmost Palearctic regions.

Due to exceptionally good conditions of preservation, the development of the Scandinavian fauna after the last Glacial can be followed in more detail than it is the case for areas further south on the European Plain. If, for a moment, we consider only the species for which there are modern representatives, a combination of the species found in Taubach with bison, elk and wild horse occurring next to red deer and wild boar would most likely be found in the Preboreal or birch-fir phase of the early Postglacial, or, in other words, in the transitional stage between the tundra of the Lateglacial and the more densely forested phases of the Postglacial. The characterisation of the mollusc fauna from the bone sand as »reliktische Kaltzeitfauna« (Zeissler 1977) would not contradict this interpretation.

One particular problem concerns the correlation of the different relative or absolute chronological scales currently available. Even for one of the best known chronozones, the last Interglacial, the estimates of its duration have altered greatly in the last few years. An apparently straightforward term like »last Interglacial maximum« or »high-Eemian«, popular in the earlier literature must now be handled with care (cf. Dansgaard et al. 1993).

For the later Pleistocene, the periodisation based on the fluctuations in the oxygen isotope curves has been increasingly popular in the literature and approximate datings are more often presented in terms of oxygen isotope stages than palaeovegetational phases. In many cases no actual arguments are presented, why a correlation with local relative chronologies based on geological or palynological observations should be allowed, except for an apparent best fit with the currently accepted pattern of changes between cold and temperate. Radiometric datings may help to correlate the proposed schemes of climatic change, but much critical research remains to be done. As the preliminary results from Schöningen show, even the number of major climatic cycles relevant for the continent may till now have been imperfectly understood.

If, for the sake of this discussion, the OIS scheme is employed, the last Interglacial is now generally seen as equivalent to one of the rather short peaks of high sea levels, 5e, whereas the previous (intra-Saalian) interglacial would comprise as many as three consecutive peaks of higher sea levels parted by two relative lows in the oxygen isotope stage 7 (Martinson et al. 1987). It is, therefore, quite possible to have more than one occurrence of established temperate faunas within this period. Apparently, no significantly temperate episodes can be detected for the intervening periods (but cf. Dansgaard et al. 1993).

DISCUSSION

To recapitulate the stratigraphical information, the friable »bone sand« constituted the find layer for the large mammal material, as well as for the artefacts and archaeological structures observed and collected at Taubach in the late 19th century. The finds occurred within as well as on this layer.

The molluscs indicate a »reliktische Kaltzeitfauna« for this layer and consequently not too long after a cold phase.

The available litho-stratigraphic, biological and sedimentary data from the friable, clastic calcareous or travertine sands (a calcarneyte) containing Middle Palaeolithic deposits indicate a low energy depositional environment, most probably an extensive shore of a shallow lake located in an internally drained basin. The presence of intact snail shells of both lacustrine and terrestrial species (Götze 1892, 371), as well as generally perfect preservation of bone surfaces, point to rapid burial and frequent fluctuations of the lake reflecting seasonality of the run off. The latter indicates a limited vegetational cover of the slopes, possibly a steppe.

A dramatically differing picture is seen in the immediately overlaying molluscs sand, probably a coquina of a shallow, brackish, but rich and staple lake or pond. The warm fauna of the bed suggests full interstadial conditions (Zeissler 1977) and imply a depositional hiatus underneath, most probably a truncation of the topbeds of the bone-bearing, sandy travertines. Again, the depositional environment changes radically with the appearance of the indurated, blocky travertines formed by carbonate precipitation in the carbonate rich lakes/ponds. Bed 9, found between beds of indurated travertine, contains micromammal and mollusc faunas belonging to full interglacial conditions of the Eemian (Zeisler 1977; Heinrich 1994). This radiometrically bracketed horizon may consequently be considered to be the *terminus ante quem* for the »bone sand« finds. The occurrence of flints in Bed 9 indicates a second Middle Palaeolithic settlement phase.

Traditionally, the large mammal fauna from Taubach has been considered as a typical full interglacial fauna dominated by forest species. There is thus an apparent lack of environmental agreement between the mollusc signal and the large mammal fauna recovered from the bone sand.

The above-problem opens the question of contemporaneity of the bone sand, the molluscs, the archaeological features (charred layers), and the large mammal bones. As Götze has pointed out, the bone sand should be considered the main find layer. The preservation is excellent for the bones, and the intact bone surfaces indicate a swift burial. Abundant cut marks on the bones, as well as burned bones indicate an association with human settlements. The excellent preservation of molluscs and bones in the travertine sand matrix clearly point to a low energy shore environment of a shallow, relatively small seasonal lake. The mixture of lacustrine and land species reported by Götze from the sands (1892) fits this proposition well. Also, the briefly mentioned burned layers show that the bone sand at least perodically fell dry. For the two best described occurrences a stratigraphical position on top of the bone sand is indicated, i. e., underneath the so-called mollusc sand (Klopfleisch n. d.; Möller 1901). The hearths, therefore, should be considered contemporary with a late phase of the bone sand deposition.

Unfortunately, it is now impossible to say whether the stratigraphical position of these two charred layers is representative for the settlement traces at large. Judging from sketches of the working quarries they are most likely located near the northern limit of the find area.

It is not unlikely that the large mammal fauna was more cold tolerant than previously considered. If so, a developing interglacial with comparatively cold winters but warm summers and ample vegetation could have been acceptable for both mammals and molluscs.

Considering the stratigraphy and the species representation from the »bone sand« the theoretically latest possible date might then correspond to one of the earliest vegetational phases of the Eemian, Pollenzone E1 (birch-phase), E2 (fir-birch-phase) or perhaps even E3 (fir-mixed oak forest-phase) *sensu* Litt (1994), well before the Interglacial was fully developed.

For the time earlier than the Eemian the closest parallel to the Taubach fauna is provided by the lower travertine in Ehringsdorf. Small morphological differences for some species can be interpreted as indicating a slightly younger date for Taubach, but precisely how these differences should be translated into an absolute time scale is unclear. The lower Ehringsdorf travertine may thus be taken as a *terminus post quem*. New radiometric datings of this travertine indicate that it came into existence in the intra-Saalian interglacial, probably corresponding to OIS 7. The apparently rather long OIS 7gives no less than three consecutive temperate maxima to choose from, but the detailed correlation between continental vegetational-stratigraphical phases and the fluctuations of the deep sea curve is still not very well resolved, even if it may often be seen treated as a straightforward matter. It is, in this connection, particularly unfortunate that the Taubach travertine has not yielded any significant plant remains and thus no means of relating the site directly to the palaeobotanic database from the region.

MATERIAL

In the late 19th century Taubach fossils were a very popular collectors' item. As a matter of fact they were so popular that finds from other localities near Weimar, Ehringsdorf and Süssenborn were imported and sold as Taubach fossils (Pfeiffer 1910).

Apparently, a selection of Taubach finds was at this time considered a »must« and small samples of a few dozen to a few hundred bones or teeth were included in several European museum or private collections. Götze (1892) mentions the characteristic surface preservation of both flints and bones from Taubach, which is »ein glücklicher Umstand, denn die reichen Schätze des Naturwissenschaftlichen Museums zu Weimar an diluvialen Knochen von verschiedenen Fundstellen sind leider aus Mangel an pekuniären Mitteln so wenig sorgfältig aufgestellt, dass sie meist ohne Angabe des Fundortes, ohne Etikett, bunt durcheinander liegen. Bei dieser Gelegenheit sei bemerkt, dass man jetzt wo die Funde in Taubach nicht mehr so häufig sind, Zähne von *Elephas trogontherii* Pohl. (während für Taubach *Elephas antiquus* charakteristisch ist) und andere Knochen aus den Kiesgruben von Süssenborn nach Taubach importiert, um dem Mangel abzuhelfen, aber trotz des Bleichens und anderer Manipulationen sind sie dennoch gut zu unterscheiden. Derartige Fälschungsversuche erregen natürlich berechtigtes Misstrauen gegen einen im Germanischen Museum zu Jena befindlichen menschlichen Backenzahn, den Prof. Klopfleisch von einem Grubenarbeiter erhielt« (Götze 1892, p. 372).

During the present study of the Taubach bones some of the still surviving minor samples had also survived, but it was repeatedly noted that a large part, if not all, of the items ascribed to Taubach, had arrived in the museum collections through donated private collections or purchase from professional dealers. However historically interesting the neatly handwritten notes accompanying the bones often were, and although the information, seen together with the excellent surface preservation of the pieces, made a Taubach origin very likely, it was regarded as improper to include this material in any quantitative analysis. For the present study only the material from the collections now stored in Bereich Quartärpaläontologie, Weimar, has been considered. This provides by far the largest single sample of Taubach finds, and must be regarded as being the one with the clearest provenance.

A further consideration was that the smaller museum collections appeared somewhat biased towards Merck's rhinoceros at the cost of the other species occurring at Taubach. As Taubach won fame early in palaeontological circles for its abundance of unusually well preserved rhinoceros remains, this may simply be a consequence of the intension to preserve exemplary material for study.

In 1910 Pfeiffer presented a list of collections known to hold finds from Thuringia. For the 20 private or public collections from Germany the site names are in most cases specified, and Taubach (and the Saalfeld caves) appear to be the most popular localities. Pfeiffer's general comments on the state of the collections should thus have relevance for the Taubach material: »Recht deutlich tritt in den Sammlungen die Individualität des Sammlers hervor; in der einen Sammlung sind gewisse typische Knochenspaltungen häufig, die in einer zweiten gänzlich fehlen. Viele unersetzbare Fundstücke sind sehr schlecht konserviert« (Pfeiffer 1910, p. 43).

As will be shown later, even in the first hand samples treated here, fragment frequencies for different species are considerably biased by collectors' preferences. Before proceeding, the most relevant observations concerning the find circumstances can be summarized briefly.

The reports from Taubach related research indicate that most, if not all, of the surviving fossils were gathered within a relatively short period of time during the late 19th century. According to Steiner & Wiefel (1977) the period from 1870 to 1900, and here especially the years 1878-1888, must be regarded as the most productive in terms of field work and collectors' activities. The sudden surge of scientific interest in Taubach was prompted by the recognition of stone artefacts in 1871 and a few years later by reports on the so-called »charred layers« in the bone rich sandy travertine. Important finds are here the charred bones and teeth of Merck's rhinoceroses and straight-tusked elephants, which were considered to prove hunting and exploitation of a diluvial fauna by man.

A human tooth found in 1887 (and a second one in 1892) are, although the find circumstances were disputed from the beginning (cf. citation above), generally accepted as further proof for the presence of hominids in Thuringia as early as the last Interglacial (Nehring 1895, fig. 1-2). For their time the finds from Taubach were thus welcomed as the earliest evidence of a human settlement in Europe. Considering the fact that the fame of the locality was so closely related to the quality of the archaeological remains, one may be allowed to wonder why the fieldwork was only reported in casual notes, and why no extensive excavations of structures were ever published.

As mentioned above the main findlayer, i. e. the »bone sand«, comprised traces of archaeological structures, which with all due caution may be interpreted as site floors. Despite the recorded association of charcoal, artefacts and fragmented animal bones within the socalled »burned layers«, apparently no attempts were made to preserve documented, complete samples of material from these structures. The collection procedures are largely undocumented, even for the preserved Weimar material.

Hugo Möller, the conservator of the Museum in Weimar, however, communicated some important observations in this respect: »Außer den heute nicht mehr festzustellenden, der Wissenschaft leider verloren gegangenen Knochenmengen, die man in den 60er Jahren bedauerlicherweise aus Unkenntnis wagenladungsweise in Taubach in die Ilm versenkte und von denen erst unlängst wieder, bei Baggerarbeiten einiges zu Tage gefördert wurde, erwähnt Pohlig die Reste von mindestens 100 Individuen des *Rhinoceros Merki,* die auf dem nur wenigen Quadratruten großen Platze gefunden worden seien, so daß letzteres sonach Hauptgegenstand der Jagd des alt-divilualen Urmenschen gewesen zu sein scheint. Von *Elephas antiquus* seien 40 (NB bis Febr. 1891) bezw. 50 (NB bis Herbst 1891) von eben daher nachweisbar und etwa gleich groß werde die Zahl der Reste je von Bären, Bison, Hirsch und Biber sein.« (Möller 1900, p. 50).

In short, considerable amounts of fossiliferous travertine had already been exploited, before systematic research took a serious interest in the deposits. Furthermore, the increase in recorded elephant remains within only half a year is remarkable. How the number of individuals from the different species represented by the fossils were calculated is not communicated, and some estimates may possibly be slightly optimistic.

However, compared to the number of individuals represented by teeth and mandibles in the small surviving sample treated here, i. e., 76 for Merck's rhinoceros and 44 for the brown bear, such very high original numbers do not appear unlikely.

A second consideration is the alarming discrepancy between the number of individuals which can be calculated on the basis of jaws and teeth versus all types of postcranial skeletal elements. The fundamental lack of postcranial material in the surviving sample as opposed to what could be expected from the documented minimal number of individuals supports the suspicion of an initial selection of the fossils. Consequently the value of conclusions based on the relative abundance of the different skeletal parts should not be overestimated. Again Möller´s observations are important: »Die schon von Portis und später von Götze gemachte Beobachtung, daß unter den Knochen der zahlreichen Individuen des *Rhinoceros Merki* noch keine Rücken- und Lendenwirbel und nur vereinzelte Bruchstücke von Rippen gefunden wurden, da diese schwer transportabelen und schlecht zerlegbaren Teile wohl am Orte der Jagd liegen bleiben, kann hier nicht gegen v. Fritsch´s Annahme hervorgehoben werden, denn diese Beobachtungen sind nicht im vollen Umfang zutreffend. So wurden beispielsweise nach Weiss in Taubach Rippen in großen Mengen gefunden, wurden jedoch als wertlos weggeworfen, da sie nicht präpariert werden konnten.« (Möller 1900, p. 52).

We must thus accept the fact that bone fragments, which were not considered of value, i. e., of palaeontological value, were thrown away during the field work, and we must assume that this practice was not limited to ribs and vertebrae only. The material incorporated into the collections was consequently biased from the very beginning.

The sample analyzed here comprises two collections of the formerly Museum f. Vor- u. Frühgeschichte in Weimar and of the Halle-Geiseltal Museum. Without going into detail about the events that finally brought the material to the Bereich Quartärpaläontologie (of the Geological Department of the University of Jena) it must be mentioned, that both museum collections were established by scientists - working in the area, who had direct contact to the quarries in Taubach and thus were able to build up collections of so to speak »first hand specimens«. By now this is the best, if by no means ideal, source material available.

The analysis here focuses on archaeozoological questions. Thus presentation of palaeohuman modification of the faunal material forms one of the central issues. This should provide a long overdue addition to the already published palaeontological investigations (Kahlke [ed.] 1977). For all questions specifically relating to the palaeontology of Taubach, species identification, measurements, relation to other assemblages etc., the reader is referred to these specialist reports. As detailed palaeontological analyses of all different faunal groups both lie outside the author's field of experience and are not the scope of this study, species determination presented in the specialists reports will generally be followed.

However, species identification for every fragment listed in the tables has been checked, and in a few cases corrections and additions to the previously published data were necessary.

The tables presented here are based on registration of the Taubach sample from the Bereich Quartärpaläontologie, Weimar. It includes bone fragments, which, by themselves, are not suitable for a strict, palaeontologially valid identification to species or subspecies level, and thus have previously been passed by in silence. For example, all rhinoceros remains are listed under *Stephanorhinus* sp. and presence of the species *S. hemitoechus* besides the dominant *S. kirchbergensis* is noted in the text. This imprecision was deemed unavoidable, in order to fully integrate the relatively scarce postcranial material, including a large quantity of juvenile and young subadult bones in the survey. A similar case is presented by the remains of large bovids. Most of the identified fragments belong to the genus *Bison*, but a few pieces document the presence of *Bos* in the sample and as is well known, several skeletal elements pose serious problems concerning a clear species identification to either *Bison* or *Bos*.

All pieces were identified as precisely as possible to anatomical position. For postcranial bones, the general age classes were estimated. Teeth and jaws were likewise referred to age classes based on tooth replacement and wear. When possible, corresponding chronological ages were estimated. Due to possibi-

Species	Fragments	Isolated Fragments	with cutmarks teeth
Merck's rhino (and narrow-nosed rhino) *Stephanorhinus* sp.	1224	99 (8.09%)	368 (30.07%)
Brown bear *Ursus arctos*	1537	292 (19.00%)	417 (27.13%)
Large Bovid *Bison priscus* (and *Bos primigenius*)	533	25 (4.69%)	176 (33.02%)
Beaver *Castor fiber*	319	10 (3.13%)	158 (49.53%)
Red deer *Cervus elaphus*	207	2 (0.97%)	67 (32.37%)
Straight-tusked elephant *Palaeoloxodon antiquitatis*	182	–	110 (60.44%)
Wild horse *Equus taubachensis*	161	1?	138 (85.71%)
Wild boar *Sus scrofa*	96	–	49 (51.04%)
Roe deer *Capreolus capreolus*	58	–	38 (65.52%)
Giant deer *Megaloceros giganteus*	6	–	–
Cave bear *Ursus spelaeus*	7	–	6 (85.71%)
Cave lion *Panthera leo*	5	–	3 (60.00%)
Hyena *Crocuta crocuta*	1	–	1 (100.00%)
Wolf *Canis lupus*	7	–	5 (71.43%)
Unidentified Carnivore	4	–	4 (100.00%)
Unidentified Bone fragment	86	3	–
Total:	4433	431	1540 (34.77%)

Tab. 3 Faunal representation in Taubach sample (N).

lities for a relatively precise aging and the consequently more detailed breakdown of the material, the calculation of the minimal number of individuals (MNI) for each species was mainly based on isolated teeth and jaw fragments. However, in some cases it was necessary to supplement these estimates with counts from the postcranial material, when major age classes appeared severely underrepresented or absent in the dental material. The results for each species are summarized below. Corresponding, more detailed, tables are found in Appendix A and B.

In the surviving sample Merck's rhinoceros (*Stephanorhinus kirchbergensis*) and brown bear (*Ursus arctos*) are the two most frequently encountered species (tab. 3). Of the recorded 4,433 fragments 1,224 are from rhinoceros and 1537 from brown bear, i. e., teeth and bone remains belonging to these animals together make up more than two third of the total sample.

For the remaining third large bovids (*Bison priscus*/[*Bos primigenius*]) with 533 fragments and beaver (*Castor fiber*) with 319 fragments can still be regarded as fairly common, while *Cervus, Equus, Palaeoloxodon, Sus* and *Capreolus* are present, but comparatively rare, altogether providing no more than 704 fragments or less than one sixth of the total sample.

Giant deer (*Megaloceros giganteus*) is rare too, only 6 fragments can be determined to this species. Remains of large carnivores other than brown bear are also uncommon. One to three fragments can be ascribed to each of the following species *Ursus spelaeus, Panthera leo cf. spelaea, Crocuta crocuta* and *Canis lupus*.

It should be noted that identifications of several other carnivores: *Panthera pardus, Lynx lynx, Meles meles* and *Lutra lutra* are mentioned in the older Taubach literature. Only for *Panthera pardus* have the fragments in question been analysed and published in detail. Unfortunately, these pieces as well as the teeth and bones documenting the three other species must be considered as lost (Hemmer 1977).

The few existing remains of mammoth and reindeer from Taubach (as concluded by Kahlke 1977) most certainly come from a different part of the deposit than the *Stephanorhinus*-sample, and they have not been included here. The scarce fragments of birds, amphibia and micromammals are not included either (cf. Jánossy 1977; Mlynarski and Ullrich 1977; Heinrich and Jánossy 1977).

In addition to teeth and bone fragments, identified to skeletal elements and species, 86 unidentifiable pieces are present. Most of these are small cranial or postcranial bone fragments of large mammals and they include several mostly unfused and damaged epiphysis fragments from very young animals. The very low percentage, approximately 2%, of unidentified fragments in the sample would probably diminish further, if the corresponding identified bones could be located. The small number of unidentified fragments in the surviving sample represents in all probability little more than the unavoidable minimum of debris due to transport and storage.

The composition of the sample is not only unusual with respect to the very low percentage of unidentified fragments. The low number of severely damaged bones as well as the frequency of different skeletal elements suggest an extensive collection bias for several species (tab. 4).

Unbroken or lightly damaged bones	1799	(40.58%)
Isolated teeth	1540	(34.74%)
Fragmented bone	1094	(24.68%)
	4433	(100.00%)

Tab. 4 Fragment types of Taubach sample.

For all species isolated teeth constitute a high proportion of the recovered material. *In toto*, 1,540 or 35% of all pieces are isolated teeth or – a minority – fragments of teeth. For excavated samples such high frequencies are usually encountered only from assemblages where a very strong fragmentation rate or a chemically unsuitable sediment has minimized the possibilities for an identification of normal bone fragments – neither of which appear to have been the case in Taubach.

Unbroken or only superficially damaged bones are the most abundant type, constituting 1,799 or 41% of the total, and the fragmented remaining sample, 1,094 or 25%, is dominated by readily identifiable pieces, like undamaged articular ends of broken longbones or jaws with more or less complete toothrows.

The fractures in the postcranial material are predominantly fresh, probably caused during excavation before the fossils could dry and stabilize. Only a few bones in the sample show definite ancient impact points, which were possibly related to planned marrow fracturing. Consequently, the present sample does not allow a qualified study of fragmentation patterns, but in a few cases particular aspects can be mentioned.

Surfaces of the Taubach bones are remarkably well preserved. The high quality of the surfaces of the fossils is due to the friable structure and »sandy« texture of the main findlayer, the so called »Knochensand« or »bone sand«. Contrary to specimens recovered from beds of compact, blocky limestones like nearby Ehringsdorf, the Taubach finds in general show undamaged bone surfaces comparable in quality to macerated bones; and apart from the application of stabilizing waxes the bones appear to have been subjected to only a minimum of professional preparation procedures.

Recent scratches and breakage are not uncommon, but given a rather rough recent history of collection and transportation this is to be expected. It was, however, fairly easy to differentiate between modern scratches and ancient cutmarks even under 2× magnification. Cutmarks are distinct, narrow lines or bundles of cuts consistent with the edges of small stone flakes found at the site. The study of cutmarks will probably be less influenced by the recovery bias, but it will of course not supply the same level of information as surveys of more varied material from recent, controlled excavations.

Before presenting the following presentation of cutmarks it may be said that the frequencies found for the bone fragments (tab. 5) are at the same level as those encountered in younger, excavated Stone Age kill sites. Even if it can not be proven that all animal remains incorporated into the assemblage resulted

Species	bone Fragments	bone fragments with cutmarks
Merck's rhino (and narrow-nosed rhino) *Stephanorhinus* sp.	856	99 (11.58%)
Brown bear *Ursus arctos*	1120	292 (26.07%)
Large Bovid *Bison priscus* (and *Bos primigenius*)	357	25 (7.00%)
Beaver *Castor fiber*	161	10 (6,21%)
Red deer *Cervus elaphus*	34	2 (5.88%)
Straight-tusked elephant *Palaeoloxodon antiquitatis*	72	–
Wild horse *Equus taubachensis*	21	1?
Wild boar *Sus scrofa*	47	–
Roe deer *Capreolus capreolus*	16	–
Giant deer *Megaloceros giganteus*	2	–
Cave bear *Ursus spelaeus*	1	–
Cave lion *Panthera leo*	2	–
Hyena *Crocuta crocuta*	–	
Wolf *Canis lupus*	2	–
Unidentified Bone fragment	86	3
Total	2777	431

Tab. 5 Bone fragments in the Taubach sample (all recorded fragments minus teeth and antler fragments).

from hunting and exploitation by man, at least for some species like rhinoceros and brown bear, a clear connection with the archaeological finds can be established.

The huge number of animals represented by the calculated MNI values (especially when the earlier estimates of bone waste thrown away immediately after excavation are considered) would indicate that the finds from the »bone sand« are a conglomerate of the site refuse from individual »sites« accumulated through a very long period of time.

To summarize, the material treated here cannot be compared to recently excavated, controlled assemblages. It is a secondarily biased selection from a palimpsest of preserved site refuse and, most likely, also of some natural components.

BONE MODIFICATION

Considering the frequencies of bone fragments relative to teeth and antlers it becomes clear that the collection bias has greatly influenced the possibilities for an evaluation of the exploitation patterns, at the species as well as at the carcass level.

Except for a few observations held in most general terms (cited above) we do not have any information documenting a connection between the bones and the Middle Palaeolithic finds from the bone sand. The enormous amount of faunal remains gathered (and quickly discarded) from the bone sand (c.f. Möller cit. above) before any attention was given to archaeological finds and structures, might in itself inspire some scepticism concerning the assumption that the small preserved sample of bones and teeth should exclusively represent hominid site waste.

First and foremost the travertine area must be seen as a place with excellent preservation conditions for bones, teeth and antler. Secondly, it was apparently a place where several large mammals passed by, thus making it a logical location for kill sites, but at the same time also a place where animals could die of natural causes or be hunted by carnivores, and their skeletal remains incorporated into the findlayers.

Since no detailed site documentation provides a direct link between the bones and the archaeological finds and structures, one of the objectives of this study is to see whether traces of modification on the bones can support the assumed connection, and perhaps even give some indications of the extent to which natural components – in addition to the culturally modified ones – have contributed to assemblage composition.

CHARRED BONES

The occurrence of charred bone fragments was first noted in connection with the so called »burned layers«, which in all probability were the remains of hearths placed directly on the travertine sands. As these structures clearly indicate a dry surface they served as one of the more important arguments for the existence of settlements, at least on a temporary basis, in the travertine area, and were consequently important for the reconstruction of the surrounding environment.

The present sample comprises two types of heat altered bones. For charred parts of the bone they have been heated to a charcoal black and the charred area may have been a center of whitishgrey burned bone. Charring indicates that the fragments have been in close contact with a fire at a time when the bone was still fresh and contained a large amount of organic remains. In consequence they substantiate the assumed connection between the archaeological structures and the bone assemblage.

In the available Taubach sample 56 pieces showed traces of charring (tab. 6). The majority of the charred bones, 24 and 25 fragments, are from the two animals dominating the sample, rhinoceros and brown bear respectively.

Charred fragments	
Rhinoceros	24
Bear	25
Large bovid	2
Red deer antler	1
Elephant	1
Unidentified bone	3
Sum:	56

Tab. 6 Charred fragments.

The remaining pieces represent bones from bison, elephant or not unidentified species. A single piece of red deer antler has been charred. The small sample does not indicate any preference for species or type of bone. It may thus reflect simply accidental charring of bones near the hearths.

The second type encountered can be described as bones showing symptoms of heating. These comprise a more or less pronounced colouring to a violet-tinged redbrown, which can be associated with heat-cracks in bone or teeth. It is thus more difficult to delineate this group of bones towards the rest of the material than the more easily defined charred pieces. A conservative estimate is that approximately 10% of the bones show this form of discolouration.

A reddish colour and cracking can appear on subrecent bone which has been moderately heated still in a fresh condition , e. g. on parts of bones protruding from a roast.

The Taubach pieces, however, show a more uniform colouration.

In the descriptions of the aforementioned »charred layers« it was also noted that the travertine sand showed a red colour from the heat. The red-brown bones are thus more likely the product of moderate heating in the travertine sand. They may well represent older and to some extent already chemically altered fragments lying embedded in the sand under the hearths.

However, the heated pieces are important regarding some of the alleged artefacts from Taubach. One of the more prominent artefact types discussed in the earlier Taubach literature are picks made of bear jaws. Portis (1878) identified impact points on bison bones, and suggested bear jaws as a suitable artefact, since these were numerous in the assemblage and the size of the canine fitted the hole in the bone. Pfeiffer (1910) contended that the many »worn« canines from Taubach should necessarily have had a kind of use, but he was unable to experimentally replicate the suggested method of marrow-cracking.

Some of the bear jaws which could be reviewed here show breakage or splintering of the protruding canine. In the severe cases this damage was fully consistent with the crazed breakage pattern found on heated and dried bones or teeth. In addition, similar crazed breakage was found on rhinoceros cheek-teeth, which by the way, were also claimed as artefacts. None of the bear jaws showed any distinct traces which could indicate their use as an artefact.

The exemplary specimen for a bear jaw with use wear shown by Eichhorn in the 1909monograph on the artefacts from Taubach (Eichhorn 1909) has a canine with the typical crazed breakage pattern. Judging from this and the survey of the material still available, it may be presumed, that the »jaw picks« mentioned in the earlier literature, in all probability represent jaw fragments with the exposed canines damaged by heat.

GNAWED BONES AND ANTLERS

Another source of confusion has been the misidentification of gnawed or naturally broken bone and antler fragments as artefacts.

Based on feeding experiments conducted in the Schönbrunn Zoo Zapfe (1939) was able to give a review of the typical end-products of bones subjected to hyena gnawing, and compare his findings with fossil material. In his study the widespread misinterpretation of gnaw-damaged bone-fragments as human made artefacts is commented. In particular, presentations by Pfeiffer (1910 and 1912) are the subject of critique. Concerning Taubach it is important to note that several types of alleged bone artefacts could be identified as gnawed bones. This concerns e. g. the so called »Glockenschaber«, which were identified as humerus fragments, and the alleged lamps and beakers made of pelvis fragments represent little more than the acetabulum.

As gnawed fragments were recognized as a particular sort of fossil at the time of collection, it is very likely that these are underrepresented in the present sample. In particular, the more exotic hyena gnawed pieces may have been selectively extracted. Another aspect is that the present collection is biased towards undamaged and readily recognisable pieces. None of the gnawed bones found here was damaged to a degree impeding identification and for most pieces gnawing-damage was relatively superficial. The heavily damaged pieces, which must have been present once, will likely have been sorted out, perhaps already at the quarry. The frequency of gnawed bones presented here is thus likely to be depressed and biased towards lighter gnawmarks.

In the present sample carnivore gnawing is most common (tab. 7). This type of gnawing is found on 84 pieces of bone (1,9% of total bones) as well as in one case on a red deer antler. Gnawing possibly by deer occurs on seven pieces of red deer antler. Rodent gnawing is found on seven antler pieces and on two bone fragments, one from bear and one from rhinoceros.

Carnivore gnawing is found on a variety of species. Most common is rhinoceros. 51 pieces or 4,2% of all bones from this animal bear gnaw marks. Scapula, humerus and tibia are most commonly attacked, in particular the distal ends of the bones. Gnawing appears fairly evenly distributed across the skeleton on the larger bones (Appendix C).

Bone gnawing:			
Sum total:	large carnivore	5	
	medium carnivore		77
	small carnivore	2	
	carnivore gnawing		84
	rodent		2
	Sum:		86
Antler gnawing:			
Sum total:	carnivore	1	
	cervid		6
	cervid + small rodent		1
	small rodent		6
	Sum:		12

Tab. 7 Gnaw-marked fragments.

With only 17 pieces or 1,1% of the bear bones the brown bear has fewer gnaw marked bones. The lower percentage may be explained by the dominance of small bones from the paws in the material, and thus fewer longbone pieces available. The proximal end of the ulna supplying eight of seventeen gnawed pieces, represents the most commonly gnawed fragment.

The large bovid material includes seven gnawed bones. Beaver, elephant, wild boar and lion have supplied a few gnawed bones each.

The Taubach material comprises a wide range of carnivores, all of which could have been involved in bone gnawing. The prime suspects are hyenas and wolves, as these species usually take a strong interest in the bones of their prey carcasses or in those left behind from the kills of bears or lions.

Based on feeding experiments with zoo animals Haynes (1983) has offered a comparative study of the bone damage inflicted by hyenas, wolves, bears (both kodiak and black bears) and lions.

According to this study lion gnawing can be characterized by »the rough and irregular marking left by biting on or through cancellous bone of the epiphyses. These marks are wide, deep, and countable, and are inflicted by the large cheek teeth« (Haynes 1983, 169). Similarly, damage from bear gnawing is considered distinct from damage caused by canids and hyenas, since the broader cheek teeth of bears grind down and crush cancellous bone as well as planing or shearing it off. However, bear gnawing, like hyena or wolf gnawing may leave distinct furrows or score marks across cancellous tissue (Haynes 1983, 168). It was moreover noted that bears usually do not gnaw heavily after the soft tissue is gone or dried. In the Taubach material none of the bones corresponded to the descriptions (or illustrations) of gnaw damage by lions or bears.

For hyenas Haynes points to the numerous furrows and tooth impressions inflicted on the trabecular bone, also inside the shaft of the bone. These are described as »generally cone-shaped and round bottomed measuring about 3-5 mm wide at the widest point and 3 to 5 mm deep, if made by adult hyena« (Haynes 1983, 166). The basic difference to wolf gnawing lies in the degree of tooth crushing and scratching. The scratches made by wolves may be about 1 mm deep and 2 to 3 mm wide.

Different aspects of bone damage by hyenas have been described by numerous other authors, most notably actualistic studies by a. o. Zapfe 1939, Blumenschine 1986 and Marean et al. 1992. These studies have mainly focused on aspects of taphonomic relevance for the evaluation of early hominid sites in Africa as well as for cave sites of the Lower and Middle Palaeolithic in Europe and the Near East. Bone damage by wolves has had less attention, even though the field studies by Haynes (1981) have proven very relevant for Stone Age studies in Northern Europe.

For the Taubach material the carnivore gnawing was dominated by two distinct types of modification. The more comprehensive damage, listed as »large carnivore« displays broad furrows and cones typical for adult hyena gnawing. This type of gnawing was found on five bones, all from rhinoceros. Considering the selection procedures already noted for the Taubach material, hyena gnawed bones may well be underrepresented in the present sample.

Much more numerous was gnawing by a »medium carnivore«, which was found on 77 out of 84 damaged bones. This bone damage resembles the traces left by wolves. It is, however, not entirely clear, whether bone gnawing by young hyena cubs could result in similar marks.

Similarly, two bones apparently gnawed by a small carnivore could have been damaged by a wolf cub or cubs of any of the smaller carnivores, fox or badger, recorded from Taubach.

Gnaw damage by wolves can be seen on bones from several different species, including rhinoceros, bear, bison, elephant, wild boar and lion. It is quite possible that some of the damaged bones originate from wolf kills or from scavenging of deceased animals. In seven cases, however, the gnawed bones also carried cut marks indicating that wolves had access to kills already exploited by humans. Two bones are from adult bears and five bones come from young calves of rhinoceros as well as from full grown animals.

The possibility that both humans and wolves scavenged on the carcasses appears very unlikely, given the indications for active hunting discussed in more detail below.

The carnivore damage to the otherwise well preserved bones furthermore indicates that both wolves and hyenas had access to the carcasses before burial in the travertine sands, and that the time interval between kill and burial of the bones can not have been overly long. Given the relatively large amount of cutmarked fragile but undamaged bones from very young rhinoceroses in the sample, it appears that carnivores had few opportunities to appropriate bone waste from the sites.

Gnawing by small rodents was found on two bones and seven antler fragments. The antlers represent four shed antlers, two fragments, and one piece still attached to the skull. The latter piece as well as six others, three shed and one unshed antler as well as two fragments showed traces of gnawing most likely from deer. Damage by both rodent and the deer gnawing was very limited unlike the comprehensive damage which can occur on antlers after even a few months of exposure on a surface. This again suggests that parts of the material were accessible, but for a limited time only.

ALLEGED ARTEFACTS

Especially in the early days of discovery several types of bone and antler fragments were claimed to be crude artefacts.

The most prominent types were the bear jaw »hatchets«, scrapers of beaver jaws, antler picks or hammers and beakers (or spoons) of the pelvic acetabulum of different species (cf. Götze 1892, fig. 6-11).

The bear jaws surveyed in this study carried intact canines as well as canines damaged by heating and rarely by fractures. None of the jaws showed any traces of work or wear polish. It is at present impossible to ascertain the degree of mechanical damage to bones in the original assemblage. Since lack of intentional modification does not support the alleged artefact status the bear jaws can only be regarded as the product of fracturing and natural damage. Similarly, the beaver mandibles only showed regular breakage.

The same pertains to the pelvis fragments. For damaged bones, be they fractured or gnawed by hyenas, the acetabulum is the most solid part and the one most likely to survive.

None of the antlers surveyed showed any kind of wear or intentional damage, not even cut marks. The majority of the fragments represent antler bases and a short piece of the beam, a type of robust fragment quite common in natural assemblages. In most cases dry fractures occurred, showing that the antlers did not break in fresh condition. In a few cases, however, green, splintering fracture scars indicate that relatively fresh and flexible antlers had been broken. This can be caused by trampling as well as several other natural factors. The shape of the antler fragments showed the typical position for natural breakage, namely in the middle of the curve(s) of the beam.

Besides these fragment types, Götze (1892) mentions a few pieces which, judged from the description, may indeed be artefacts. None of these finds could be located. A bone awl, with traces of wear, could possibly originate from Neolithic settlement layers above the travertine, whereas the origin of a piece of trabecular bone with two notches is more difficult to place.

Several other fragments shown in the older literature are obvious examples of marrow fracturing or natural kinds of bone fracturing, but unfortunately these original pieces are no longer available.

To summarize, the survey of Taubach material in the collections of the Bereich Quartärpaläontologie and the Museum in Weimar as well as smaller samples in the Archaeological Institute of the University of Jena and museums in Berlin and Basel could not trace any artefacts. All recurrent forms could be attributed to natural breakage patterns. The only clear indication for modification by man were examples of intentional fracturing, including marrow fracturing of longbones, and abundant cutmarks.

CUTMARKED BONES

As already mentioned the bones under study represent a pitifully small sample of what was available at the quarries in the 19th century. Moreover, the sample seems to be seriously biased in favour of teeth, jaws and unbroken bones. This means, first, that fragmentation patterns can not be studied in any significant detail, and secondly, that other traces of modification, notably cut marks, might have reduced overall frequencies compared to samples, where more pieces of filleted *and* marrow-fractured bones are abundant. For the Taubach samples evidence for cutmarks provides the best, direct means of establishing a connection between Middle Palaeolithic tools and the bones.

Patterns of cutmarks and thus inferences for planned carcass exploitation could be established for only four species, rhinoceroses, bear, bison and beaver. For all species bones and bone fragments are available from all major sections of the body, even though some parts are rare.

For these species the overall frequency of cut marked bones lies between 6 and 12% out of all bone fragments (tab. 5) with the exception of brown bear where cut mark frequency is nearly 26%. This suggests that individual variations in sample composition may greatly influence the occurrence of cut marked bones. For the brown bear more than two-thirds of all cutmarked bones belong to small, intact bones of the hand or foot.

Based on the cutmark patterns as well as other factors such as age composition and behavior we infer that the remains of these four species will predominantly represent intentionally hunted prey. This part of the Taubach material will be dealt with in more detail in the following chapter.

Altogether rhinoceros, brown bear, bison and beaver represent 2,494 or nearly 90% of the total 2,777 bone fragments from Taubach. None of the other species is represented by more than 72 bone fragments (straight tusked elephant), and only one species, red deer, shows cutmarked bones (tab. 3, Appendix A-B). Concerning red deer the composition of the fragment samples is severely biased. Of a total of 207 fragments, 67 (32%) are isolated teeth and 106 (51%) are antlers, comprising 11 unshed and 57 shed antlers, and 30 antler fragments.

The bone fragments include 11 fragments of cranium and mandibula, 4 carpals, 10 tarsals, 3 from the metapodials and 5 phalanges, but not a single piece from upper limb bones or the postcranial axial skeleton. The two cutmarked bones are a talus and a first phalange respectively .

The roe deer material has even fewer postcranial fragments. Of 58 fragments 38 are single teeth, 2 are shed antlers and another 2 are still attached to cranial fragments. Of the remaining 16 bones 8 are from the mandibula and 8 are tarsal bones.

For the wild boar this situation is even more pronounced. Only one postcranial bone, a tarsal, is found among 96 fragments. The remaining material is made up of 49 teeth, 7 maxilla- and 39 mandibula fragments. These pieces comprise only the necessary minimum of bone to keep a complete or partial complete cheek tooth-row together. On some of these jaw pieces impact points can be observed.

When available, these three species usually constitute a large part of hunted Stone Age bone assemblages, also where larger animals like aurochs or elk are present. Compared to e. g. Mesolithic sites with comparably good preservation about eight to ten times the number of jaw fragments can be expected as a minimum for the identified, postcranial bones. Another detail is that all three have high quality marrow bones making unbroken longbones, or intact jaws, a rare occurrence. The postcranial bones most likely to be found intact are the small and fairly massive carpals, tarsals and phalanges, in other words the bones which dominate in Taubach apart from jaws, teeth and antlers.

On the basis of the available material it is not possible to show convincingly that hunting of red deer, roe deer or wild boar took place at Taubach. It will, however, be very difficult to explain the representation of skeletal elements for these three species without assuming that a severe selection against fragments other than teeth or antler, or against any type of broken bones, has taken place. In all probability the frequency of fragments from these three species has been seriously inflated by secondary collection procedures. It is now impossible to reconstruct the frequency once present in the original assemblage, and, consequently, the species' importance as prey can not fully be evaluated any more.

Concerning the red deer material, shed antlers are very frequent in the sample. Of a total of 106 antler fragments, 61 were from shed antlers, 34 represented fragments and only 11 still had skull fragments attached. Since none of the pieces shows any traces of intentional damage, not even cut marks, is it quite possible that these finds represent natural background and do not, or only to a limited degree, belong to the archaeological material.

The equid material poses similar problems. Out of a total of 161 fragments, 138 are teeth. Of the 23 remaining bone fragments one is a mandibular piece and 17 belong to the lower front or hindleg. The meatier parts of the carcass are barely represented with one fragment each of the humerus, tibia and patella, and two of the femur. One first phalange may possibly have a transversal cutmark. All in all the horse material also appears to have suffered under a biased selection of material. Similarly, the horses can not be unreservedly included in the list of exploited species.

The few remains of giant deer seem to echo the skewed bone representation of the other cervids: 4 antler fragments, a mandibula fragment, a phalange and a carpal bone are present, and the remains have to be included in the group of possible prey animals.

The straight-tusked elephant shows a more comprehensive sample of skeletal elements than the other rarer animals. The dental material indicates the presence of all ages from infants to very old elephants. According to Guenther (1977) the material can be divided into four age groups: 26% calves, 22% subadults, 34% adults and 17% very old elephants. This mortality pattern, with a very high frequency of young animals, was already interpreted by Soergel as indicating hunting of elephants at Taubach (Guenther 1977).

The 72 bone fragments fairly represent all body parts (Appendix B), but not a single piece shows cutmarks or other traces of modification by man. Therefore the elephants can not be linked directly to that part of the assemblage which represents animal carcasses clearly exploited by man. As noted by Soergel and later by Guenther the dominance of young elephants would, however, be consistent with hunting.

As noted above, many originally reported remains of several species of carnivores can no longer be found. In the available material only brown bear is abundant and shows high frequencies of cutmarked bones.

The large carnivores for which fragments remain, comprise cave bear, hyena, wolf and cave lion. All of these are only represented by a few bones and teeth of little value for the interpretation of exploitation patterns (Appendix B). Since brown bear seems to have been killed by man on a regular basis, it is quite conceivable that other large carnivores would be hunted too. The few available fragments could, however, just as well originate from natural deaths accidentally incorporated into the assemblage.

Rhinoceros

The majority of the 1,224 rhinoceros bones and teeth from Taubach belongs to Merck's rhinoceros, *Stephanorhinus kirchbergensis.* The finds, however, also comprise a single adult P4 of the right lower jaw from another species of rhinoceros, the narrow-nosed rhinoceros, *Stephanorhinus hemitoechus* (Kahlke 1977).

It has been questioned lately whether this tooth belongs to the bone sand assemblage. Kahlke (1977 b; 1995) considers the upper travertine layers to be a more likely provenance for this find.

In the course of the present investigation it was, however, noted that the rhinoceros jaws and teeth included a small sample of conspicuously small size, showing morphological details pointing to the narrrow-nosed rhinoceros rather than Merck's rhinoceros. These differences had obviously caught the eye of an earlier researcher since the fragments had been sorted out and stored separately. This part of the material has, however, not been mentioned in any of the later published surveys of the Taubach fauna.

The small sample consists of four corpus fragments of the lower jaws, two right and two left, with deciduous teeth showing little or no wear and in three cases, also the enamel shell of an unerupted M1. The jaws thus belong to the same age class of young subadult individuals as the majority of the rhinoceros material from Taubach. The bone surface shows the same excellent preservation as the other Taubach fragments. None of the jaw fragments carry cut marks or traces of charring or gnawing.

The sample furthermore includes several single teeth: from the lower jaw 4 deciduous and 4 permanent cheek teeth (including the right P4) and from the upper jaw 2 deciduous and 14 cheek teeth and tooth fragments.

These teeth are clearly smaller than the average. Their shape appears longitudinally somewhat compressed and with sharper, more V-shaped valleys than seen in the larger teeth, both deciduous and permanent, from the Taubach assemblage.

In a recent review of the genus *Stephanorhinus*, Fortelius, Mazza and Sala (1993) recorded differences in both non-metric characters and dental dimensions between the four extinct taxa. Unfortunately, deciduous teeth were not included in the study. For the permanent dentition the large size of teeth from Merck's rhinoceros compared to all other *Stephanorhinus* sps. was noted, and concerning the tooth shape the tendency to narrow, V-shaped valleys in *S. hemitoechus* differing from the more open and U-shaped valleys of the teeth of *S. kirchbergensis* was pointed out. At the same time, however, the authors

Rhinoceros						
	JU-SA I		SA II-AD			
cranial	83	6.79%	55	4.50%		
postcranial	216	17.58%	502	41.05%		
	299	24.37%	557	45.54%	= 856	69.91%
				+Dentes	368	30.09%
				tot. N	1224	100.00%

Tab. 8 Rhinoceros. Frequency of cranial vs. postcranial fragments (JU: juvenile, SA I: young subadult (»yearling«), SA II: older subadult, AD: adult, SA/AD: fragment belonging to either older subadult or adult).

Rhinoceros			
	Sum	Cutmarks	Function:
Cranium	15	2	filleting, disarticulation
Maxilla	8	1	filleting
Mandibula	115	11	filleting, skinning
Dentes	368	–	
Atlas	27	6	filleting, disarticulation
Axis	10	1	filleting
Vert. cerv.	37	6	filleting
Vert. thor.	20	1	filleting
Vert. lumb.	1	–	
Sacrum	–	–	
Vert. caud.	6	1	
Costa	3	2	filleting
Sternum	–	–	
Scapula	55	4	filleting, (disarticulation)
Humerus	29	4	filleting, disarticulation
Radius	29	3	filleting
Ulna	26	6	filleting, disarticulation
Carpalia	28	3	disarticulation
Mc 2	17	6	filleting, (skinning)
Mc 3	13	5	filleting, (skinning)
Mc 4	17	1	filleting, (skinning)
Pelvis	14	3	filleting
Femur	16	4	filleting
Patella	19	–	
Tibia	36	8	filleting
Calcaneus	17	6	disarticulation
Talus	20	–	
Tarsalia	14	1	disarticulation
Mt 2	10	3	filleting
Mt 3	18	2	filleting
Mt 4	9	3	filleting
Phalanges	174	6	disarticulation
Sesamoidea	32	–	
Div. ep.	21	–	
Sum:	1224	99	

Tab. 9 Rhinoceros. Survey of identified fragments and exploitation traces.

had to conclude, that »none of the distributions of the non-metric characters studied allow absolute identifications, as all are more or less variable among species. There are, however, distinct patterns within the variation which allow comparisons between the species, and, presumably, between sufficient large samples from different localities« (Fortelius, Mazza and Sala 1993, p. 80).

It is thus highly probable, that the above mentioned small sample of teeth and jaws belongs to the narrow-nosed rhinoceros. It is, however, clear that reliable distinction especially between juvenile and subadult specimens is not possible at present.

If the MNI values based on small teeth and jaws are considered, the possible share of this species will be three, or possibly four calves (of the dominating age class I, see below) and two older subadult or adult rhinoceroses out of the total of 76 individuals estimated for the Taubach assemblage. In other words, they would constitute a rather small percentage of the rhinoceroses from the site, and apparently do not differ significantly in the pattern of age classes and fragment types from the remains of Merck's rhinoceros.

Considering the postcranial material from Taubach the remains of rhinoceros calves will likely comprise some bones of narrow-nosed rhinoceros juveniles. Due to their large size all bone fragments from adult rhinoceroses could definitely be identified as Merck's rhinoceros.

Fragment representation

In the following study all the rhinoceros remains are treated together. The material is clearly dominated by bones and teeth which can be confidently determined as Merck's rhinoceros.

As mentioned above a small fraction presumably belongs to narrow-nosed rhinoceros. Even in an optimistic estimate, however, the share of fragments of this species ought to be less than 1% of the total number of rhinoceros fragments.

As for the other species at Taubach the rhinoceros remains comprise a large number of single teeth. About 30% of all rhinoceros fragments are teeth (tab. 4). The remaining bones fall into two general age groups. Approximately 24% or 299 fragments are from young calves (JU-SA I), and 46%, or 557 fragments are from older subadult to adult animals (SAII-AD). A larger fraction of the calf remains comes from the head of the animal.

When attributed to age groups the frequency of head-fragments, in particular the lower jaw, varies greatly relative to the postcranial fragments (tab. 10).

It has often been noted that the high number of fragments from young rhinoceroses are one of the characteristics of the Taubach assemblage. This needs a little modification: the calves are very well represented among the mandible fragments, but severely underrepresented by all postcranial skeletal elements.

Concerning the postcranial bones a much larger fraction has been recovered from adult or older subadult animals than from calves. More than a third of these fragments did not allow a more precise age estimate than subadult or adult.

Several parts of the skeleton found in relatively high numbers among the adult remains are not, or just barely, represented among the calf bones. Most notably, for the calves there is a complete lack of vertebrae and ribs. Fragments from the axial skeleton, with the exception of complete or fragmented atlas bones, are not too well represented for the older animals either.

Considering the bones from the frontleg and the hindleg, only metacarpals and metatarsal are more numerous from calves than from older animals. For the pelvis, femur and tibia the number of fragments from calves is the same or close to that found for adult animals. For the other skeletal elements calf remains appear to be severely underrepresented.

Compared to the adult rhinoceroses the calves seem to have suffered a higher degree of bone loss. The young bones may have been more susceptible to mechanical damage, whether caused by pre-burial fracturing, trampling or carnivore gnawing or, later, from rough excavation procedures, thus producing fewer postcranial pieces of an acceptable quality for the collections.

A more detailed review of the rhinoceros material is found in Appendix A. The material from young calves is composed to a very high degree of complete bones, or, more correctly, complete diaphyses without (unfused) epiphyses. The fragments from older animals often represent intact bones as well. Several pieces are, however, fragments of longbones with only one of the articular ends present and parts of the diaphysis.

To summarize, the fragments from young calves are clearly dominated by jaws and metapodials, whereas the bone fragments from older animals are more evenly distributed over the skeleton.

As has been noted repeatedly the composition of the present sample is undoubtedly severely biased due to selective collection in the field and the museum.

In the present sample the dominance of teeth, jaw fragments, and complete or only lightly damaged bones strongly suggests that the collectors main interest was to recover specimens of paleontological interest. We may thus assume that the jaws and teeth were preferentially sought out, and that the age class

Rhinoceros N.	JU	SA I	SA II	SA/AD	AD
Cranium	4	-	-	8	3
Maxilla	3	1	-	1	3
Mandibula	JU/SA I 75		10	12	18
Atlas	-	-	-	27	-
Axis	-	-	4	-	6
Vert. cerv.	-	–	8	-	29
Vert. thor.	-	-	2	-	18
Vert. lumb.	-	-	-		1
Sacrum	-	-	-	-	-
Vert. caud.	-	-	-	-	6
Costa	-	-	-	3	-
Sternum	-	-	-	-	-
Scapula	2	4	1	43	5
Humerus	3	5	4	10	7
Radius	4	5	3	14	3
Ulna	6	-	1	14	5
Carpalia	-	6	4	18	-
Mc 2	3	9	3	-	2
Mc 3	2	9	1	-	1
Mc 4	4	7	-	4	2
Pelvis	JU/SAI 7		-	7	-
Femur	3	4	1	2	6
Patella	-	-	3	16	-
Tibia	4	11	3	16	2
Calcaneus	-	3	7	-	7
Talus	-	1	3	16	-
Other tars.	-	2	1	11	-
Mt 2	5	3	-	-	2
Mt 3	6	7	-	2	3
Mt 4	2	1	1	2	3
Phalanges	23	45	15	91	-
Sesamoidea	-	-	-	32	-
Others	JU/SA I 20		-	-	1
Sum:	74	123	75	349	133
	102				

Tab. 10 Rhinoceros. Bone fragment distribution on general age classes.

distribution as well as MNI estimates (Minimum Number of Individuals) calculated on the basis of these finds fairly represent the original assemblage. Jaws of older animals are more often fragmented, and rarely present the intact toothrows available from the young mandibles. Fragmentation could have led to some loss of dental material, and underrepresentation of older subadult and adult rhinoceroses must be assumed to some degree.

Concerning the postcranial material the selected bones may actually comprise the majority of fragments usually found suitable for MNI estimates, but an unknown fraction is irretrievably lost, and – as noted by Möller (cit. a.) – some sections of the skeleton have suffered more than others under the excavation selections. Consequently, the relative frequency of skeletal parts can not be used for any detailed, comparative analysis of exploitation patterns, whether between species from Taubach or in relation to other site assemblages.

Mortality and MNI

The high number of jaws and bones from rhinoceros calves has often been emphasized as one of the characteristics of the Taubach assemblage. In his studies concerning the hunting practices of the Stone Age, Soergel (1912, 1922) presented general mortality patterns from selected Pleistocene sites, and provided detailed discussions about their value as possible indicators for hunting practices. The predominance of young calves in Taubach was interpreted as the result of hunting using pitfalls. Besides references to some selected observations on rhinoceros behaviour Soergel's argumentation for this particular hunting method implied a rather dismal view of the technological capabilities of prehistoric man.
In his survey from 1922 age class distribution based on tooth eruption and wear seen in lower jaw fragments resulted in four age groups:

very young:	55,4% (deciduous dentition, M1 not worn)
young:	16,0% (jaws with lightly worn M2)
adult:	16,0% (permanent dentition)
old	12,6% (very worn permanent dentition).

The actual number of fragments studied is not given (Soergel 1922, p. 131). The present survey has delivered fairly concordant estimates, indicating that a selective loss of material has not occurred since 1922.
The analysis of mortality profiles is a widely discussed subject, both concerning the theoretical implications as well as more practical issues often involving actualistic studies in the field. In particular when extinct species are concerned, questions emerge regarding e. g. the lifespan of the species, the degree of intraspecific ontogenetic variation and, not least, the minimum sample size required for analysis. Regarding the last point, the Taubach sample is more than adequate compared to the minimum of 30 units recommended by Lyman (1987).
In palaeontological studies two basic types of naturally occurring mortality patterns are recognised, namely »normal« or »attritional« mortality, where animals of the very young and very old age classes are overrepresented relative to their live abundance, and »catastrophic« mortality, where successively older age classes are represented by fewer and fewer individuals. Theoretically, the latter form should reflect a »frozen« living population, thus showing the age profile of all individuals, who up till the catastrophe had survived the »normal« mortality (Lyman 1987).
As already noted by Soergel (1922) the mortality pattern found for the rhinoceroses, as well as for several other species in the Taubach assemblage is very different from any pattern which could be expected from natural causes. The dominance of calves older than the most vulnerable young age classes and the almost complete absence of old individuals is different from a typical attritional pattern. Similarly, the general scarcity of adults from the reproductive age classes indicates that it does not fully reflect a functioning, living population, but rather a selection bias for younger age classes.
In the present study mandibles and other dental material were sorted according to age classes using aging criteria presented by Hitchins (1978) and Goddard (1970) for the African black rhinoceros (*Diceros bicornis*).
Separation of age classes is based on tooth wear and eruption of cheek teeth. The allocation of mean chronological ages was established on the basis of dental records of wild living rhinoceroses with known ages, since it was found that captive rhinoceroses showed a retarded growth rate (Goddard 1970). In a comparison between dental records of wild living black rhinoceroses from populations in Kenya (Tsavo National Park) and South Africa (Hluhluwe Game reserve, Zululand) some of the Kenyan specimens showed abnormalities, whereas others provided a good fit with the Zululand data (Anderson 1966; Goddard 1970).

Rhinoceros Cutmarks:	JU	SA I	SA II	SA/AD	AD
Cranium	1			1	
Maxilla		1			
Mandibula		7	3		1
Dentes					
Atlas				6	
Axis					1
Vert. cerv.			4		2
Vert. thor.				1	
Vert. lumb.					
Sacrum					
Vert. caud.				1	
Costa				2	
Sternum					
Scapula			1	2	1
Humerus	1			2	1
Radius		3			
Ulna	2		1	2	1
Carpalia				3	
Mc 2	1	4	1		
Mc 3	2	3			
Mc 4		1			
Pelvis	1			2	
Femur	3	1			
Patella					
Tibia	1	7			
Calcaneus		1	3		2
Talus					
Other tarsalia			1		
Mt 2	1	2			
Mt 3	1		1		
Mt 4	1		2		
Phalanges				6	
Sum:	14	31	17	28	9

Tab. 11 Rhinoceros. Distribution of cutmarked bones on general age classes.

Age estimation criteria developed by Hillman-Smith et al. (1986) for white rhinoceros (*Ceratotherium simum*) indicate a timing of the tooth eruption similar to the black rhinoceros. Examples for tooth wear (Hillman-Smith 1986, fig. 3; Hitchins 1978, fig. 2-6) show that the wear patterns for the younger age classes are very similar.

More detailed reports on the ontogenesis of single calves are available. However these refer to captive animals or calves born in zoos (Dittrich 1967; 1972 and 1974; Bigalke et al. 1950; Wallach 1969; Schaurte 1966).

Unfortunately, similar studies of dental development are not available for Asian rhinoceroses. Likewise, data on timing of epiphyseal fusion for all species are a desideratum. The observed retarded growth rate for captive animals suggests that both live measurements and skeletons from young rhinoceroses reared in zoos or parks might provide misleading data.

The Taubach material comprises both jaw fragments and a large number of single teeth. In many cases teeth were isolated from the jaws, obviously due to recent loss during excavation or storage. In order to

Rhinoceros – Dentes, inf.:

	SIN			DX		
	Alveole	isol. Dens	Diff.	Alveole	isol. Dens	Diff.
D1	36	7	-29	21	9	-12
D2	21	15	-6	11	9	-2
D3	22	11	-11	15	10	-5
D4	29	19	-10	19	16	-3
Dx		1			9	
M1	4			3		
	>			>		
M2	1	> 16	+4	3	> 19	+4
	>			>		
M3	1			3		
P2	6	6	–	4	4	–
P3	4	4	–	5	9	+4
P4	5	5	–	5	3	+2

MNI: Mandibula: JU/SA I: 44
SA (II): 7
AD: 11
Dentes: no additional

Rhino – Dentes, sup.:

	SIN			DX		
	Alveole	isol. Dens	Diff.	Alveole	isol. Dens	Diff.
D1	2	5	+3	–	2	+2
D2	1	2	+1	–	3	+3
D3	4	2	+2	–	4	+4
D4	–	4	+4	–	4	+4
Dx		1			–	
M1	2	4	+2	–	6	+6
M1/M2	7				10	
M2	1	4	+3	–	7	+7
M3	–	6	+6	–	9	+9
P2	2	6	+4	–	6	+6
P3	2	12	+10	–	4	+4
P3/P4	8			4		
P4	3	6	+3	–	8	+8

MNI: Maxillafr.: JU/SA I: 6
AD : 5

MNI: Dentes: JU/SA I: 8 (sin D1: 3 max. + 5 isol. (D2:5)
AD: 13 (sin P3: 1 max. + 12 isol. (+P3/P4)

Dentes:

Fragments, inf/sup.: 36 fr.

Tab. 12 (a-b) Rhinoceros. Frequency of empty alveoles and isolated teeth recorded in the material.

obtain a correct MNI for the dental material the number of empty alveoles was compared to the number of corresponding single teeth.

For the upper jaw isolated teeth were able to add several individuals to the MNI estimates based on maxilla fragments (tab. 12). Based on isolated teeth, as well as on teeth from maxilla fragments, MNI estimates for the upper jaw are as follows: eight juvenile or young subadults and thirteen adults. In total a minimum number of 21 rhinoceroses can be estimated, an estimate almost twice as high as the MNI obtained from maxilla fragments alone.

The highest MNI estimate, a total of 62 rhinoceroses, was estimated according to mandibula fragments (tab. 13). Here many empty alveoles for deciduous teeth could not be compensated through the addition of single teeth. Only for the permanent dentition was a small surplus of isolated teeth found. The material did not, however, suffice to supply any new individuals for the mandible.

Rhinoceros mortality:		
Age class	Approx. in years	MNI:
I	1/2 or younger	4
II	1/2-1	7
III	1	33
IV	1 1/2	3 (MI erupting)
V	2	4
VI	3-4	1 (M2 erupting)
X	7	1 (M3 erupting)
XI	8	1
XI-XIV	8-12	2
XV+	14 or older	2
X+	7 or older	4
Sum:		62

Tab. 13 Rhinoceros mortality (age classes after black rhinoceros studies by Goddard 1979 and Hitchins 1978).

Concerning the age estimates the younger mandible pieces mostly comprised complete rows of cheek teeth back to the cavity for the crown of MI. Jaw fragments from older animals often represented segments of the corpus with a few teeth only, thus making age estimates less precise.

Like the black rhinoceros, Merck's rhinoceros is considered to be a browser, thus supporting the use of the recent analogy. The size differences are, however, considerable. Grown-up black rhinoceroses may weigh at most 1,3 tons, whereas Merck's rhinoceros in all probability would have been at least as large as the South African white rhinoceros of 2 to 2,5 tons. It is clearly also disputable whether estimates of chronological ages can be transferred from living species to extinct ones.

In this case, however, it is used only as an attempt to construct a relative, but still detailed, mortality profile for the Taubach material.

In the table 13, the material is summarized according to MNI estimates for mandibula fragments of each age class.

The dominant group are very young subadults, defined by fully erupted deciduous dentition and a developed, but not yet erupted M1 in the jaw. Compared to black rhinoceroses the Taubach rhinoceroses of this age group show the same or slightly less tooth wear. The recent age estimates would indicate that these rhinoceroses are youngsters of about one to one and a half years of age.

Younger calves are relatively rare, as are the slightly older subadults. The adult age classes are very rare and only two individuals could be estimated to be more than approximately 14 years of age.

We do not have reason to believe that the teeth and jaws of calves were preferentially sought out. Rather, if a selection of the dental material took place, we would expect specimens showing examples of the permanent dentition to be recovered at the cost of the juvenile material. It is, however, the impression that the adult jaw material has suffered more under fragmentation, and consequently the older age groups may be somewhat underrepresented.

Considering the postcranial material it can be seen that the mandibles have given an inadequate representation of the frequency of older subadults and adults. For the atlas the estimated MNI for the bones from older subadults or adults is 25 or more than double of the mandible value, tab. 14. The high atlas MNI is supported by the scapula, which perhaps might add a further grown up rhinoceros to the sum. Since the scapula results are very dependent on estimates of relative size, the atlas MNIs are preferred.

When the MNI estimates from mandibles and atlas are combined, the rhinoceros material represents a minimum of 44 calves, 7 subadults and 25 adult or older subadult rhinoceroses. Using the chronological ages from the black rhinoceroses these would be described approximately as 4 newborn or only few months old, 40 calves a half to one-and-a-half years old, seven older subadults up to approximately 4 years of age and 25 adult or nearly grown up subadult rhinoceroses.

RHINOCEROS:
MNI N:

Cranial.
MNI N: 44 JU/SA I, SA (II) 7, AD 11 (mandibula)

Axial.
MNI N: 25 SA/AD (Atlas)

Max. MNI N:		
	JU/SA I:	44
	SA (II):	7
	SA/AD :	25
		76 ind.

Postcranial specif.

	MNI N				
	JU	SA I	SA II	SA/AD	AD
Atlas	–	–	–	25	–
Scapula	2	2	1	23	3
Humerus	2	3	3	5	4
Radius	3	3	3	7	2
Ulna	4	–	1	9	2
Carpalia	–	1	1	3	–
Metacarpus	3	5	2	3	2
Pelvis	5	–	–	4	–
Femur	2	1	1	–	3
Patella	–	–	2	9	–
Tibia	2	7	3	7	2
Calcaneus	–	3	4	–	4
Talus	–	1	2	8	–
Other tarsalia	–	1	1	3	–
Metatarsus	5	4	1	1	3

Tab. 14 Rhinoceros. Estimated MNI N (Minimum Number of Individuals, based on total n).

Postcranial skeleton

Due to the lack of comparative skeletons with documented age data the rhinoceros bones have been tentatively sorted into five general age groups. The sorting of the postcranial material was based on an assessment of bone density as compared to the mandibles, for which more precise age estimates could be obtained, epiphyseal fusion, including the pattern of the unclosed metaphysis surfaces, and size as compared to adult specimens of the same bone.

The partitioning of the material into adult vs. juvenile (Kalhke 1977) used formerly has thus been replaced by a slightly more detailed one, where the term juvenile (JU) is reserved for the tiniest calves only.

Mandibles of the age group I, from calves younger than 6 months of age, belong to this group. Several of the bones ascribed to this juvenile group will, – judging from the porosity of the bone and their small size, most likely represent neonates or calves at most a month or two old, and some may possibly be from well developed foetuses.

The next group comprises the young subadults (SA I), corresponding to the mandibles of the age classes II to III or animals from about 6 months to $1^1/_2$ years of age. In this group bones are included which bear juvenile traits, like the still porous bone surface seen in the aged mandibles, and general lack of epiphyseal fusion, and lie in size between that of the neonates and approximately half of the adult size. The demarcation between this group and the older subadults (SA II) is arguably not as well-defined as it could have been if a series of reference skeletons had been available for study.

The actual number of fragments, which could be argued as belonging to the younger or the older subadult group, would probably lie below five, so that this imprecise sorting may still be preferred to a loss of information.

The older subadults will in all probability cover the mandibula age groups IV to VI or subadults between $1^1/_2$ and 4 years of age. The upper limit towards the adult group is defined by the presence of unfused symphyses in bones of adult or near adult size and compactness. The adult group (AD) requires fully fused epiphyses and compact bone surface. Compared to the mandibula age profile this would correspond to the animals represented in the age class X (approximately 7 years of age) or older animals. (The age classes VII to IX are not represented in the mandibula material.)

Since some bones (e. g. scapula) have very early epiphyseal closure and in other cases, the fragments found simply did not comprise the latest closing epiphyseal areas of the bone, it was necessary to establish a special group for the pieces where an age estimate was not feasible. Bones and bone fragments, which judging from their size and compactness would be from either adult or nearly grown-up subadults are thus gathered under the indeterminate age class (SA/AD). This group might comprise bone fragments as young as the mandibular age class VI.

Considering the postcranial material from the calves the MNI values are consistently low, showing only a fraction of the MNI counted from the jaws, tab. 14. The highest MNI estimates are nine individuals for both tibia and metatarsus and eight for metacarpus. As mentioned, atlas and scapula score the highest MNI for the older rhinoceroses, but regarding the rest of the skeleton the MNI counts are the less than half. The second highest MNI estimates are from humerus, radius, ulna and tibia, which showed the presence of at least twelve individuals. As already indicated, the bone loss, especially for the calves, has been considerable.

The tentative sorting of the rhinoceros bones into the age groups JU, SA I, SA II, AD and SA/AD was done before the age profile based on the comparative data from recent black rhinoceroses (*Diceros bicornis*) was produced. It was thus interesting that the general pattern seen in the tables of postcranial bones appeared to be repeated in the age profile from the mandibles, namely: some juveniles, an abundance of very young subadults, a few older subadults and some adults.

The results from the cranial and the postcranial material can be compared in more detail. The main difference is that the postcranial material providet a higher minimum number of individuals (MNI) for the adult/old subadult group than shown by the mandibles.

From the mandibula (including teeth) a minimum number of 44 juvenile or young subadult individuals (age classes I-III) was calculated. Of the 8 older subadult individuals only one belonged to the age class VI, the rest to the classes IV and V. The remaining 10 adult individuals were all from age class X or higher, thus leaving a gap for the classes VII to IX.

A minimum of 25 individuals could be identified for the atlas, all of which must be from adult or subadults of nearly adults size. On these figures the latter group of 25 rhinoceroses should account for at least the 10 fullgrown adults, but only one old subadult, indicated by the more precisely aged mandibulae. In the postcranial material there are thus found the remains from a minimum of 14 rhinoceroses of adult size in addition to the ones identified from teeth and jaws.

To summarize: when the information from jaws and postcranial skeleton is combined, the total MNI count for the rhinoceros material is: 44 juvenile or young subadult, 7 older subadults and 25 adult or old subadults, in total 76 individuals.

Survey of cutmarked bones

Mandibula

Eight out of the 10 cutmarked mandibles are from juvenile or very young subadult individuals, one belongs to an older subadult and one is from an adult animal.

The 8 juvenile pieces all belong to the most common type of mandibula fragment. This comprises the corpus from a more or less damaged *pars incisiva* and the *pars molaris* back to a fracture near the cavity for the developing M1. The older subadult is represented by one of the rare pieces where both the left and the right corpus part of the same jaw is present. The adult piece similarly includes left and right parts of the same jaw, but only back to the premolar section of the toothrow.

Ramus fragments or whole mandibles comprising the posterior part of the jaw are rare and the few available pieces did not carry cutmarks. The scarcity of ramus pieces may help to explain the very low percentage of cutmarked mandible fragments for *Stephanorhinus*, since marks associated with the filleting of the cheek muscles and severing the head often contribute most of the cutmarks for this bone.

Only two of the cutmarked corpus fragments have marks in more than one place. Normal are one or two linear marks or a bundle of three or more semi-parallel short marks within $1^1/_2$-2 cm of the bone surface.

The 8 juvenile pieces show marks which can be interpreted as traces of skinning and of filleting, more specifically of cutting out the tongue. Two pieces have each a slightly oblique cut across the lower margin of the corpus, probably from skinning. To this group may be added a piece, which shows an oblique cut on the lower part of the lateral side in the same position below the D3 (pointing in the direction of the D2). Two pieces show a longitudinal cut line on the lateral border of the D2 alveolus from detaching the lips of the animal. In one case this type of cutmark is combined with a bundle of longitudinal cuts on the inner side of the jaw. These are found in the middle of the corpus below D2-D3, and may be interpreted as cuts from detaching the tongue.

Similar longitudinal marks on the inner side of the corpus are found in a slightly more posterior position on the subadult piece, this time combined with a bundle of vertically directed slashes below D4. Still on the inner middle side of the corpus one juvenile piece shows a bundle of oblique marks positioned below D3-D4 (pointing towards D3), and another has a single vertical line below D3. The adult fragment shows a series of vertical cutmark on the inner side of the *pars incisiva*.

All these may be considered traces from cutting of the tongue.

Only one juvenile fragment shows cutmarks which can be related to another kind of defleshing procedure. In this case a bundle of oblique marks (pointing towards the coronoid process) are found on the lateral side of the cavity for the developing M1. These marks are most probably associated with the filleting of the cheek muscles further back.

Cutmarks on the inner side of the jaw related to the detaching of the tongue were thus found on both juvenile, older subadult and adult individuals. Only the more numerous juvenile fragments show filleting of the cheek and traces of the initial skinning procedures.

Cranium, including maxilla fragments

Due to the scarcity of maxillae, and the almost complete lack of *ramus* pieces from the mandibles (and any kind of cranial fragment) the butchering procedures used for the head of the rhinoceroses can not be described in detail.

Only one maxilla fragment from a juvenile shows an oblique cut on the *pars alveolaris*, just above the D2. The position corresponds to the similar marks on the mandibula and the interpretation may be the same: a trace of removing the lip muscles.

A fragment from an adult or older subadult cranium shows clear cutmarks. The small size of the piece prevented a precise determination as an undamaged cranium was not available for comparison. Most probably the piece should be located near the zygomaticum and represent traces of cheek defleshing.

The only juvenile cutmarked piece comprises an almost complete *occipitale* of a very young rhinoceros calf. Two light cutmarks are found across the protuberantia almost exactly in the center of the bone. Vertebrae from juveniles are unfortunately not present in the sample. The cutmarked *occipitale*, however, shows that cutting off the head of the rhinoceroses was a common practice applied to the young as well as to the more bulky, adult carcasses.

Vertebrae

As already mentioned the sample has vertebrae from adult or older subadult animals only. The first vertebrae, atlas, is a common find and, as a matter of fact, supplies the highest number of individuals for the older age classes.

Six atlas vertebrae carry cutmarks (Pl. 3, 1-2), 5 of these occurrences are found on the ventral side and only one on the dorsal side of the bone. The dorsal cutmarks can be attributed to filleting. They are found in the center of the left *ala* as a series of cuts lying parallel to the medial plane but gradually the posterior end of the marks fans out towards the left side to an approximately 45° angle with the medial plane.

The ventral marks comprise both filleting and sectioning traces. In three cases, one on the left and two on the right side, transversal cutmarks found on the ventral rim of the anterior articular surfaces can be related to disarticulation of the head.

Two occurrences of transversal cutmarks found on the right *ala* and near the posterior articular surface to the axis may have a similar interpretation, but could also be related to filleting of the neck.

One subadult or adult axis has a distinct cutmark running obliquely over the left dorsal side. This, as well as the marks found on a further six cervical, one thoracic vertebrae and one caudal vertebrae (all from adult or older subadult animals) can be attributed to filleting.

Longitudinal to slightly oblique cutmark bundles on the side of the *arcus* are found (on the left side) on a subadult and (on the right side) on two adult and a subadult, cervical vertebrae.

Some cervical vertebrae show several types of marks: one (from a subadult) has several longitudinal (i. e. anterior-posteriorly) directed marks on the left side of the *arcus* combined with a nearly vertical cut down from the caudal *incisura vertebralis*. Another, adult vertebra shows longitudinal cutmark bundles on both the left (two) and right (one) as well as vertical cuts on the left side below the caudal *incisura* and the *arcus* respectively a longitudinal cut near the posterior end of the dorsal surface.

A single cutmarked thoracic vertebra from a subadult shows several nearly vertical cuts on the left side of the base of the *spina*. A caudal vertebra has a minor longitudinal cut laterally.

Ribs

Two fragments of the *corpus* part of ribs from adult or subadult animals have cut marks on the lateral surface, one shows a single bundle of oblique cuts near a healed fracture, the other several marks criss-cross over the surface.

Upper forelimb

Four scapulae, all from adult or older subadult rhinoceroses, have cutmarks on the lateral side of the bone, which can be interpreted as traces of filleting and in one case possibly sectioning of the front leg.

For two of the bones extensive cutmarks are found on the lateral surface of the *corpus* both before and behind the *spina*; in one case, a right scapula, the cuts are at an approx 45° angle to the *spina*, in the other, a left scapula, one mark runs parallel to the *spina* with several others crossing it at an right angle.

For two other scapulae several cuts are found on the lateral side of the *collum* just below and behind the distal end of the *spina*. One right scapula shows three distinct cuts or groups of cuts reaching down from the posterior border towards the anterior edge of the *tuberculum*, all marks lying in an approximately 45° angle to the *spina*. The other, a left scapula, has only one concentration of marks, where the lowermost lies transversally to the *spina* and the following are found in a fan-shape opening above and behind it. For the last two bones the cuts may have helped in the sectioning as well as the filleting of the leg, but no clear disarticulation marks near the articular surface have been found.

For the humerus (Pl. 4, 1-2) cutmarked bones of both young and old animals are available. One juvenile has two oblique marks on the distal third of the anterior side of the diaphysis, and an adult right humerus has transversal marks on the medial side of the distal third of the diaphysis, both probably caused by filleting.

An adult or older subadult right humerus shows marks from disarticulation of the distal joint in a bundle of short marks across the medial, distal border of the condyle (*trochlea*). A similar type occurs on the distal epiphysis of a left humerus from an adult rhinoceros. Here three bundles of marks are found on the medial side, two very near to the rim of the condyle and all lying nearly parallel to it. Further up, on the distal third of the diaphysis, transversal marks are found on the medial as well as on the anterior side, and on the anterior side of the proximal third a few longitudinal marks are seen. The adult humerus thus displays both filleting and disarticulation marks.

Three radii, all belonging to juvenile or young subadult calves, have cut marks from filleting on the diaphysis. For a left radius the marks are limited to a few transversal cuts across the distal third of the diaphysis on the posterior side near the open symphysis. The two other humeri, both from the left side, have more types of cutmark. On one specimen, oblique (proximal-lateral to distal-medial) marks are found on the anterior side proximally near the scar for the *tuberositas* and in two cases on the midshaft. The other has similar cuts near the *tuberositas*, but the oblique cuts in the diaphysis have changed direction (to proximal-medial to distal-lateral) and are found on the middle shaft respectively on the distal third of the diaphysis.

The cutmarked ulnae comprise one bone from a young calf as well as four from older individuals. The one left calf ulna displays a series of longitudinal marks on the proximal third of the diaphysis on the medial side near the border of the *facies* for the radius.

The bones from older animals are all from the right side of the body. Two ulnae show transversal marks across the *processus anconaeus*, i. e. on the anterior border of the olecranon directly above the proximal articular surface. Another, from an adult, has a bundle of longitudinal marks on the posterior margin of the distal epiphysis. Alle three cases appear to be indicating disarticulation of the proximal respectively the distal joint.

One further piece has cutmarks in three positions indicating filleting of the bone: two times across the lateral part of the olecranon behind the articular surface as well as medially on the proximal third of the diaphysis.

Lower forelimb

Three carpals have cut marks, which in all three cases can be interpreted as related to disarticulation of the proximal joint. Two adult sized, right *os carpi tertium*, have small bundles of marks on the proximal margin of the posterior *processus*. A right *os carpi ulna* from a young subadult has a single cutmark across the anterior surface.

All three metacarpals are represented among the cutmarked bones (Pl. 5, 1-2), Mc 2 with six, Mc 3 with five and Mc 4 with a single bone. Most often, cutmarks are only found once in one position on each bone. With the exception of a right Mc 2 from an older subadult, all cutmarked pieces from this bone are from young calves.

The youngest, a left Mc 2 from a small juvenile, shows several longitudinal or slightly oblique cuts on the middle third of the medial-dorsal side of the bone. Another left Mc 2 from a young subadult has a single oblique cut in the same position. The remaining bones all have cutmarks on the palmar side of the diaphysis. Of the young subadults two, a left and a right Mc, have several small transversal cuts across the middle and the upper third of the diaphysis respectively, whereas a further right Mc has two oblique marks on the upper third of the diaphysis. The single Mc 2 from an older subadult shows two somewhat curved parallel marks across the palmar side of the diaphysis just above the distal epiphysis. With the exception of the latter piece, which can be from disarticulation, the marks can most likely be related filleting and/or skinning of the feet.

Five Mc 3, all from young animals, show cut marks. One, a right metacarpal from a very young calf shows two bundles of short tranversal cutmarks across the middle and the distal third of the dorsal side of the diaphysis respectively. A similar bundle of marks is found on two left metacarpals on the dorsal side of the bone just below the proximal articular end, whereas a bundle of slightly oblique marks in two cases, on a left and a right Mc 3 respectively, are found on the palmar side of the proximal third of the diaphysis. All of these can be connected to filleting and/or skinning of the feet.

The cutmarked left Mc 4 of a calf shows a similar cut across the palmar side of the upper third of the diaphysis, but also cuts on the dorsal side of the bone. The most prominent is a long oblique cut reaching nearly from the medial side of the proximal end down to the lateral side of the distal third of the diaphysis. A parallel cut goes from the edge of the proximal articular end but reaches only a centimeter or so down on the diaphysis. The latter cuts can be interpreted as skinning marks, whereas the former is probably related to filleting.

Upper hindlimb

Three pelvis fragments, one from a calf and two from older rhinoceroses carry cutmarks. The youngest piece is the unfused segment of ischium from the left side of a pelvis. On the inner, medial side several longitudinal marks from filleting are found. A fragment comprising the left acetabulum of an adult sized pelvis has transversal cutmarks across the inner, medial side of the pubic bone, whereas a similar piece from the right side has cutmarks across the anterior surface of the ilium just above the acetabulum. The marks can be atributed to filleting of the pelvis.

All four cutmarked femur fragments are from juvenile or young subadult rhinoceroses. Two right femora have longitudinal cutmarks on the distal third of the diaphysis on the anterior and on the medial and anterior side respectively. A third has two groups of transversal marks on the anterior side of the distal third of the diaphysis, whereas a fourth has this same type of marks but in addition longitudinal marks on the medial side and a transversal mark on the medial margin of the *collum* just below the open symphysis for the *caput*. With the possible exception of the latter all marks found on femora can be atributed to filleting.

As for the femur, all cutmarked tibias are from young calves. Most common are transversal or slightly oblique bundles of marks found on the diaphysis. For two left tibias the marks are found midshaft on the lateral side, whereas another left bone has the marks on the medial side. Of a further three left tibias the cut marks are located on the distal third of the tibia, in two cases on the anterior and for one on the medial side. A right tibia shows cut marks on the medial-posterior margin of the proximal third of the diaphysis. Another right tibia has relatively short longitudinal marks on the posterior side of the proximal third of the diaphysis. All can be attributed to filleting.

Lower hindlimb

Of the tarsalia the most commonly cutmarked bone is the calcaneus. For most only a single mark or small group of marks on the *tuber* is found.

A left calcaneus from a young calf has a transversal cut across the lateral side of the *tuber*. Of the remaining bones from adult or older subadults two, a left and a right, have transversal cuts across the posterior margin of the *tuber*. Another left and right bone have the marks across the anterior margin, whereas a single left calcaneus has cutmarks on both the medial and lateral side of the *tuber*.

Other tarsals carrying cutmarks are two cuboids (*os tarsale quartum*) from older subadult or adult rhinoceroses. The left bone has transversal cuts across the posterior side and the right bone has similar marks across the anterior surface. A right cuneiforme (*os tarsale tertium*), (Pl. 5, 3-4) most likely from an older subadult, has likewise transversal marks across the anterior surface. All marks found on the tarsals appear to be connected to disarticulation of the foot joint.

The anterior marks both consist of a series of particularly deep, repeated cuts and appear to be more powerful than necessary for a severing of fresh and directly observable ligaments. They may possibly be related to attempts at disarticulation of the joint before skinning.

The cuts on the metatarsals show the same dominance of short transversal or oblique marks and were often found in bundles on the diaphysis.

Three Mt 2 from young calves have cutmarks. On one left metatarsal a single transversal cut is found on the dorsal side of the middle third of the diaphysis, whereas two, a left and a right bone, have oblique marks (lateral down to medial) on the plantar side of the proximal third of the diaphysis.

A right Mt 3 from an older subadult has the same type of oblique marks and in the same position as seen on the Mc 2's. The other, a left metatarsal from a calf, shows a bundle of transversal cuts on the dorsal side of the bone near the proximal end.

Two left Mt 4's, from a calf and one of the older subadults respectively, both have a bundle of longitudinal to slightly oblique cutmarks on the plantar side of the bone, just below the proximal articular surface. Another left metatarsal from a presumably adult animal has a bundle of tranversal cuts on the lateral side near the proximal articular surface.

The cuts found on the third and fourth metatarsals near the proximal articulation may possibly be related to sectioning of the foot, but can also be related to filleting, just as can the remaining marks from the diaphysis.

The phalanges have not been separated by front- or hindleg, but are treated as one group. Very few of these bones, which all belong to older subadult or adult animals, have cutmarks.

All three cutmarked first central phalanges have marks across, or in one case, going obliquely over the anterior side of the bone; one bone has in addition a short cut across the lateral side. One second central phalange has several cuts across the anterior side, whereas two lateral phalanges have cuts over the lateral side of the bone.

Indications of rhinoceros exploitation

Despite the relatively low number of cutmarks on the rhinoceros bones repetition of the same type of mark and thus a certain degree of patterning can be found. Moreover, this may be seen across the age groups. We may therefore sketch some of the elements of rhinoceros butchering even if this process can not be followed in detail.

One reason for this incompleteness is that the lack of epiphyses makes it very difficult to document the sectioning of carcasses for the juvenile and young subadult animals. This situation is a little better for the older rhinoceroses, but, in general, the impression remains that cut marks which can be associated solely with disarticulation tasks like severing of the ligaments across a joint or cutting in between bones, are rare compared to filleting marks.

The interpretation of the rhinoceros cutmarks is based on a general knowledge of large mammal anatomy and supplemented by the relevant anatomical illustrations and has not been replicated on recent rhinoceros carcasses. Previous experience in the field strongly suggests that experimental work of this kind would, more likely than not, reveal the need for some modification of the theoretical interpretations.

The cutmarks have been interpreted in terms of three major functions: skinning, sectioning and filleting. These three slots may not cover the full range of butchering activities, and in some cases the marks may be ambigous and not so readily fit in even this simplified system.

Filleting marks are here a collective term for all cut marks indicating the removal from the bones of soft, edible tissue and not just meats and fat from the larger joints. A number of factors influencing the frequency of filleting marks can be imagined, reaching from anatomical details, over carcass characteristics like temperature and dryness to the workers experience and choices.

Other obvious problems are that clear skinning marks may be limited to a few bones only, leaving the filleting marks to indirectly indicate this activity. Also, the same type of cut which severs the ligaments over a joint may play a major role in the filleting, whereas the opposite may rarely be the case.

As can be gathered from the presentation above the same types of marks may be found on both young and old rhinoceros bones. Due to differences in skeletal representation some of the recorded tasks, tab. 11, can not be documented for the young calves but only for the older age groups and vice versa.

Regarding the young calves (JU and SA I) the following activities have been observed:

For the head: skinning and filleting, including extraction of the tongue, as well as disarticulation, removing the cranium from the neck.

For the forelimb: filleting of the longbones and disarticulation of the carpal-metacarpal joint(s). The metacarpals indicate skinning as well as filleting of the feet.

For the hindlimb: Filleting of the pelvis and the longbones. Disarticulation of the tarsal-metatarsal joint(s). The metatarsals show filleting of the feet as well.

In the older age groups, adult and older subadults (SA II to AD), similar activities are shown by the cut marks:

For the head: filleting, including extraction of the tongue, and disarticulation between the cranium and the first vertebrae.

For the neck: filleting of the vertebrae.

For the frontleg: filleting of the scapula and the longbones. Disarticulation betweeen the distal humerus and the lower longbones and possibly also disarticulation between scapula and humerus. On the lower leg the disarticulation of the carpal joint has left traces on both carpals, distal ulna and proximal metacarpals. The latter also show filleting of the feet.

For the hindleg: filleting of the pelvis and disarticulation of the tarsal-metatarsal joint(s). Filleting of the feet is shown by marks on both metatarsals and phalanges. Some of the marks on the latter bones may be from skinning.

With the one exception noted above the marks show precise and economical workmanship consistent with working in fresh, soft tissue.

MNI N vs. MNI C

As previously mentioned the biased Taubach sample is not very well suited for quantitative comparisons with assemblages from more controlled excavations. To a certain extent this is also true for intra-sample comparisons between different skeletal elements.

In order to achieve an estimate of the exploitation rate shown by the present sample, the MNI results for the bones were employed. With the same methods a corresponding estimate, MNI C, was produced using only the cutmarked bones as a database. The relation between the normal MNI, here called MNI N, and the MNI C thus shows the minimum number of animals, which could be found for the sample, and the minimum number of these inviduals for which handling by homonids could be documented (tab. 15).

Rhinoceros: MNI N/MNI Cutmarks					
Cranial Mandibula MNI N: 44 JU/SA I, 7 SA (II), 11 AD MNI C: 6 JU/SA I, 3 SA (II), 1 AD					
Postcranial specif.	MNI N/MNI C				
	JU	SA I	SA II	SA/AD	AD
Atlas	–	–	–	25/6	–
Scapula	2/–	2/–	1/1	23/1	3/1
Humerus	2/1	3/–	3/–	5/2	4/1
Radius	3/–	3/3	3/–	7/–	2/–
Ulna	4/1	–	1/1	9/2	2/1
Carpalia–		1/–	1/–	3/2	–
Metacarpus	3/1	5/3	2/1	3/–	2/–
Pelvis	5/1	–	–	4/1	–
Femur	2/2	1/1	1/–	–	3/–
Patella	–	–	2/–	9/–	–
Tibia	2/1	7/6	3/–	7/–	2/–
Calcaneus	–	3/1	4/2	–	4/1
Talus	–	1/–	2/–	8/–	–
Other tars.–	–	1/–	1/1	3/–	–
Metatarsus	5/1	4/1	1/2	1/–	3/–

Tab. 15 Rhinoceros. Estimated MNI N/MNI C. (Relation between Minimum Number of Individuals, based on total n and on n of cutmarked specimens respectively).

The postcranial skeleton shows a wide range of variation, going from no cutmarked specimens to identical values for MNI N and MNI C. For the greater part of the skeletal elements the MNI C is about a quarter of the MNI N. A few bones, where filleting could not be expected to leave traces, e. g. the patella, are not surprisingly only represented by the MNI N.

For others the scarcity of cutmarked bones is harder to explain, especially when serious discrepancies appear between the age classes. One such case is the scapula, where none of the young have cutmarks and only a small fraction of the older, three out of 27 had marks. This may possibly be explained by anatomy, since it should be possible to remove the muscles from this flat bone by pressing and lifting rather than cutting down against the bone surface. The values found for the tibia are harder to explain. Here the relation between MNI C and MNI N for the calves is that seven out of nine show exploitation marks. Contrary to this the MNI C for the twelve older rhinoceros is zero, despite the fact that the bone fragments from this age group often comprise the epiphyses, and so theoretically should have a greater chance of contributing disarticulation marks.

Considering the head and neck, the atlas bones from the older rhinoceroses seem to follow the general pattern having a MNI C of six out of 25 MNI N. For the head the greater values for all age classes are based on mandible fragments. Here the MNI C seems to be greatly underrepresented, in particular for the calves, where only a MNI C of six, out of MNI N of 44, could be found. This discrepancy may be explained by the dominance of corpus fragments in the material.

Pathologies

Nine permanent teeth show varing degrees of enamel hypoplasia.

In seven teeth, including crowns of a superior P2 dx, P3? sin, P4 sin, M2 sin as well as fragments of a superior P4 or M1 and and two inferior molars, the hypoplasia is seen as horizontal bands of pitted, lacelike enamel. This type of hypoplasia is linked to episodes in the development of the individual, but the defect may have several possible causes (cf. Pindborg 1982). Hypoplasia has been studied most extensively for humans and it has been difficult to link hypoplasias to specific episodes of disease (Hillson 1993). Some of the more common causes of linear hypoplasia, which could be relevant for young rhinoceroses, are periods of malnutrition or diseases causing a fever.

The position of the pitted band in the four intact tooth crowns varies. As seen on the buccal side of the tooth, it is in the P2 and M1 approximately $1^1/_2$cm over the lower border of the enamel, in the P3? and P4 it is higher up, 2 to 3 cm above the border. Where the full breath can be seen, the band is approximately 2 cm high.

Following the age classes of black rhinoceros (Goddard 1970; Hitchins 1978) the teeth can theoretically be from as few as two or three different animals: one, where the hypoplasia developed in the M1, while in age class II, possibly III, one, where the buds of P2 and P3 where affected, while in age class IV and possibly a third, where the P4 was damaged slightly later in age class V.

It was impossible to fit the teeth (and fragments) together, so they may in fact represent more individuals. In all cases the episodes of bad health have occurred while the calves were less than approximately two years old.

Two teeth show a more localized hypoplasia. On one, a superior P1 sin, about one cm^2 of the buccal side of the crown lacks enamel. In a more pronounced case, a superior M1 sin (Pl. 3, 3-4), the enamel production has stopped over more than half of the buccal side of the tooth and on a smaller area on the lingual side. This hypoplasia can best be explained by a localized infection, affecting the animal as a calf of less than one year of age.

Soergel (1922) mentions a similar case of pitted hypoplasia in a rhinoceros jaw from Ehringsdorf, but he was unable to find any parallels. Likewise no similar cases of rhinoceros hypoplasia can be found in the extensive cataloque of Colyer (1990).

The right mandible of an adult, and probably quite old, rhinoceros shows a severe osteitis (Pl. 6 1-3). The *pars alverolaris* for the molars and posterior premolars is affected, and the infection has prompted the formation of secondary bone tissue over a large part of the corpus.

Brown Bear

Bones and teeth of brown bear form the most numerous group of finds in the Taubach material. They belong to a very large form of brown bear, *Ursus arctos* L. (Kurtén 1977).

Fragment representation

The bear remains are clearly dominated by teeth, jaw pieces and small, unbroken bones belonging to the paws, tab. 16. Of the 1,537 fragments, 417 pieces, 27,1%, are single teeth, and fragments of the maxilla or mandible contribute 113, or 7,4%. Bones belonging to the paws, carpals, tarsals, metapodia, phalanges and the smaller sesamoidea comprise 830 pieces, or 54,0% of the total. With the exception of the patella, which is unusually common, supplying 56 fragments or 3,6% of the total, bones from the axial skeleton and the upper part of the legs are comparatively rare. Excluding patella, fragments from these areas contribute only 121 pieces, 7,9% of the total bear material. Radius and ulna are here the best represented, with 16 respectively 23 fragments.

URSUS:	Function	Sum	Cutmarks
Cranium	3	-	
Hyoid	1	-	
Maxilla	46	5	filleting
Mandibula	67	16	filleting, skinning
Dentes	417	-	
Atlas	9	6	filleting, disarticulation
Axis	1	-	
Vert. cerv.	4	-	
Vert. thor.	9	3	filleting (disarticulation)
Vert. lumb.	2	2	filleting, disarticulation
Sacrum	1	-	
Vert. caud.	12	-	
Costa	-	-	
Sternum	1	-	
Os penis	1	-	
Scapula	2	-	
Humerus	13	5	filleting
Radius	16	3	filleting
Ulna	23	12	filleting
Carpalia	111	28	filleting, disarticulation
Mc 1	15	6	filleting (skinning?)
Mc 2	12	8	filleting (skinning?)
Mc 3	18	11	filleting (skinning?)
Mc 4	9	9	filleting (skinning?)
Mc 5	14	8	filleting (skinning?)
Pelvis	3	3	filleting
Femur	12	1	filleting
Patella	56	-	
Tibia	3	-	
Fibula	5	-	
Calcaneus	40	19	disarticulation (skinning?)
Talus	44	2	disarticulation
Other tars.	52	10	disarticulation
Mt 1	23	10	filleting (skinning?)
Mt 2	18	11	filleting (skinning?)
Mt 3	19	12	filleting (skinning?)
Mt 4	21	18	filleting (skinning?)
Mt 5	11	4	filleting (skinning?)
Mp. fr.	5	-	
Phal. I+II:	1	1	
Phal. I:	153	59	filleting
Phal. II:	116	20	skinning (filleting)
Phal. III:	115		
Sesamoidea	33	-	
Sum:	1537	292	

Tab. 16 Bear. Survey of identified fragments and exploitation traces.

Complete longbones are a rarity, most pieces comprise only one of the articular ends and more or less of the diaphysis. A more detailed catalogue of the brown bear remains can be found in Appendix A.

According to Kurtén (1977, tab. 3) the measurements of the permanent canini indicate that both sexes were about equally represented.

Mortality

With the exception of a mandible fragment showing an erupting M3 and a single M3 at the same stage of development, there are no signs of young bears in the material. According to Dittrich (1960) the M3 erupts at about one year of age.

A few molars without clear traces of wear suggest the presence of some ol-

URSUS: N	SA I	SA II	SA/AD	AD
Cranium			3	1
Maxilla				46
Mandibula	1			66
Atlas				9
Axis				1
Vert. cerv.		2		2
Vert. thor.		1		8
Vert. lumb.		1		1
Sacrum				1
Vert. caud.		5		7
Costa				
Sternum			1	
Os penis			1	
Scapula			2	
Humerus			10	3
Radius		4	7	5
Ulna			7	16
Carpalia			111	
Mc 1			15	
Mc 2			12	
Mc 3			18	
Mc 4			9	
Mc 5			14	
Pelvis				3
Femur		3		9
Patella			56	
Tibia			2	1
Fibula			5	
Calcaneus				40
Talus			44	
Other tarsalia			52	
Mt 1			23	
Mt 2			18	
Mt 3			19	
Mt 4			21	
Mt 5			1	
Metapodia, fr.			5	
Phal. I+II			1	
Phal. I			153	
Phal. II			116	
Phal. III			115	
Sesamoidea			33	
Sum:	1	16	884	219

Tab. 17 Bear. Bone fragment distribution on general age classes.

der subadult bears. Similarly, the number of postcranial bone fragments with open symphyses is very low, in total only 16 fragments. The bear material, however, comprises a large number of fragments, where a lack of epiphyses or an early fusion in the particular type of bone, makes it impossible to discern between adults and nearly grown-up subadults. Thus, more than two thirds of the postcranial fragments can not be determined more precisely than to older subadult or adult.

The dental material provides more detailed information. The maxilla and mandible fragments had as a rule suffered severely from recent loss of teeth. Many of these are probably still present in the

URSUS – Cutmarks:

	JU	SA I	SA II	SA/AD	AD
Cranium					
Maxilla					5
Mandibula					16
Dentes					
Atlas				6	
Axis					
Vert. cerv.					
Vert. thor.			1		2
Vert. lumb.					2
Sacrum					
Vert. caud.					
Costa					
Sternum					
Scapula					
Humerus				3	2
Radius			1		2
Ulna				1	11
Carpalia				28	
Mc 1				6	
Mc 2				8	
Mc 3				11	
Mc 4				9	
Mc 5				8	
Pelvis					3
Femur					1
Patella					
Tibia					
Calcaneus					19
Talus				2	
Other tarsalia				10	
Mt 1				10	
Mt 2				11	
Mt 3				12	
Mt 4				18	
Mt 5				4	
Phal. I+II					1
Phal. I					59
Phal. II					20
Phal. III					
Sum:			2	147	143

Tab. 18 Bear. Distribution of cutmarked bones on general age classes.

collection of isolated teeth, but since the roots of the teeth were often damaged, refitting was not attempted.

Contrary to the situation for the rhinoceros material it was found that the jaw fragments could only contribute a few individuals to the ones already indicated by the isolated teeth. These teeth are all from the permanent dentition.

Consequently, only a rather crude estimate of the age classes was possible based on the wear in isolated teeth. Here the latest erupting molars, the M2 superior and the M3 inferior, were selected and sorted according to the degree of wear, tab. 19. The sorting was limited to four groups: without wear, slight wear (the cusps flattened and spots of dentine exposed), medium wear (the dentine exposed on up to half of the surface), and severe wear (more than half of the dentine exposed).

URSUS:				
M2 sup:	sin		dx	
	maxilla	isolated	maxilla	isolated
no wear	2	2	2	
light wear	4	4	5	7
medium wear	6	8	11	11
very worn	1	5	2	10
MNI:	SA I	SA II	AD	AD+
	–	4	34	12
M3 inf:				
	sin		dx	
	mandibula	isolated	mandibula	isolated
no wear		2	2	4
light wear	5	7	4	3
medium wear	5	4		7
very worn	1	2		6
MNI:	SA I	SA II	AD	AD+
	1	5	21	6
MNI (total): 52 individuals				

Tab. 19 Bear. Tooth wear on superior M2 and inferior M3.

Summarily, the dental material indicates a minimum of one subadult bear, four (possibly) five nearly adult and 46 adult bears. Of the latter group at least 12 must have been quite old when they died.

It can be questioned whether the bear material now available really is representative for the mortality pattern. It is for example quite likely that young and easily damaged bones are underrepresented. However, there is a complete dominance of teeth from the permanent dentition in the collection of isolated teeth, and an overall agreement with this in the postcranial material, where bones from adult or almost adult bears prevail.

Judging from the tooth wear there is a clear dominance of prime adults followed by some mature, if not senile, animals.

As seen for the rhinoceros material, the targetting of a specific age group is indicated.

Cutmarked bones

Cranium

The cranial fragments from brown bear are predominantly pieces from the maxilla comprising a more or less complete *pars alveolaris* for the cheek teeth. All three types of cut marks found are located near the base of the broken zygomatic arc just above the first and second molar.

Two right maxilla fragments have only one type of mark, namely a single cutmark running parallel to the alveolar rim just above the anterior part of the second molar. On a further right maxilla a similar type of mark is found, only slightly further up across the base of the zygomatic arc.

Two others, a left and a right maxilla, have this type of mark and in addition a bundle of oblique cuts across the anterior side of the base of the zygomatic arc.

All marks can be related to the filleting of the muscles and soft tissue of the cheek and lips.

Mandibula

The lower jaw has a high percentage of cutmarks. The fragments all comprise more or less of the corpus with at least parts of the *pars alveolaris* for the cheek teeth. Complete mandibles or pieces comprising the ramus and a part of the corpus are less frequent than corpus fragments without the ramus preserved. This naturally influences the frequency of marks since the fossa for the masseter muscle is one of the most frequently marked spots on the jaws (Pl. 7, 1-2). Most cut marks are situated on the lateral side of the bone.

Sixteen mandibula fragments, all from adult animals, had cutmarks. In total, 37 incidences of cutmarks were found, which in the preliminary registration fell into 22 different types, depending on the precise anatomical position and the direction of the cutmarks. Of these 10 were recurrent types, which showed up on 2 to 6 different bones. Six out of sixteen mandibula fragments had only one mark, five had cutmarks in two different places and five had three or more different types of cutmark.

Two mandibles, a left and a right, have only one type of cut mark, a vertical bundle of marks on the buccal side on the lower half of the corpus below the M2. This mark may have played a role in skinning as it is situated just behind the lips; but since several cuts have been applied in the same place, a more likely explanation is that the marks have been caused by severing of the muscles and tendons of the lips and cheek.

A left mandibula has a longitudinal cut on the buccal side just below the rim of the *pars alveolaris* for the molars, again this can best be connected to filleting of the anterior part of the jaw. The longitudinal cuts found on the buccal side of a left mandibula before the *foramen mentalis* can be equated with a similar function.

Moving to the posterior part of the bone one right mandibula fragment has a longitudinal cutmark just below the ventral rim of the *fossa masseterica* (*crista mandibulae rostralis*). This type of mark is the single most frequently occurring type, found alone or in combination with others on six different bones.

The mark can be attributed to filleting, more precisely the extraction of the large *M. digastricus*.

Only one mandibula fragment, from the left side, has vertical marks in the lower half of the *fossa masseterica*. Again this mark will be from filleting, but this time of the *M. masseter*.

A right mandible has marks only on the lingual side of the corpus: one vertical bundle of marks below the diastema and another just behind the alveole for M2. Both can be connected to filleting of the tongue and inner musculature of the jaw.

In two right mandibula fragments the previously mentioned mark on the lower rim of the *fossa masseterica* is combined with a series of short oblique cuts on the anterior rim of the *fossa* just behind the molar and with a bundle of marks across the lower rim of the *processus articularis* respectively. This latter mark will come from a cut from below up through the throat and, like the other marks, will besides filleting help in the extraction of the tongue.

A left mandibula shows a vertical bundle of marks on the lingual side of the corpus below the first molar from extraction of the tongue as well as longitudinal marks on the buccal side of the rim of the *pars alveolaris* below the first and second molar from filleting of the cheek.

Another left mandibula fragment has cutmarks in two places, short bundles of marks across the anterior rim of the *fossa masseterica* and a longitudinal cut in the fossa itself, both presumably from filleting of the cheek.

Cutmarks in three positions are found on a left mandibula fragment: longitudinal cuts on the lower rim of the fossa, as well as a vertical cut behind these and generally longitudinal marks across the anterior rim of the fossa, all showing filleting of the cheek.

Another left mandibula repeats the longitudinal marks on the anterior and lower rim of the fossa, but has in addition longitudinal, slightly oblique marks on the corpus just in front of the fossa as well as vertical cuts below the second molar. All marks can be attributed to filleting of the cheek.

A right mandibula shows marks in four different positions. On the lingual side vertical marks are found below the first molar and an oblique cut is situated on the lower half of the corpus further behind, both being from extraction of the tongue. On the buccal side oblique cutmarks in the fossa following the lower rim come from filleting, whereas a few short cuts across the ventral rim of the corpus, approximately below the M2, can be interpreted as skinning marks.

The same type of skinning marks are found on a left mandibula fragment along with several marks on the ramus, on the anterior rim of the fossa, short and vertical in the upper half of the fossa and longitudinal in the lower half, as well across the lower rim of the *processus articularis*. The marks show skinning procedures as well as filleting of the jaw.

A left mandibula fragment shows several often deep longitudinal marks on the lateral side of the bone on the posterior half of the corpus and on the rim of the *fossa masseterica* as well as in the fossa itself. In addition cutmarks are found across the anterior rim of the fossa just behind the M2 as well as on the lingual side of the *processus articularis*. All in all the pieces seem to have been subjected to vigorous attempts at filleting.

Vertebrae

Six atlas bones of bears carried cutmarks; the majority of marks are transversal cuts across the ventral side of the bone.

Two bones have bundles of transversal cutmarks on the ventral side, across the rim of the left anterior articulation as well as across the right side of the ventral arc. On another piece these marks are combined with a bundle of longitudinal cuts on the left wing. One atlas has transversal marks on both the left and the right rim of the anterior articulation as well as two distinct bundles of marks across the left wing.

One atlas shows a single bundle of transversal cutmarks on the left side of the arc, similar to the cuts found on the articular rim but a little further down.

Only one piece has marks on the dorsal side. Here a single cut across the dorsal arc is combined with long oblique (anterior-right to distal-left) cuts over the left respectively the right side of the arc.

The majority of the transversal marks, in particular those found near the anterior articulation, can be attributed to cutting off the head of the animal. The longitudinal cut marks and those found on the wing are more likely the product of filleting.

Two thoracic vertebrae had cut marks. The two vertebrae were pathologically fused across the *corpora* and can be treated as one piece. On the right side the anterior vertebrae show a vertical cut on the right side of the arc as well as several vertical cut marks along the posterior rim of the corpus, both apparently related to an attempt at parting the fused vertebrae.

A few oblique marks found on the left side of the pathological bone bridge joining the vertebrae will have had the same function. Both vertebrae have a series of short, vertical marks on the left side of the arc running from just behind the anterior *processus articularis* of the first vertebra to the posterior process of the second. These are combined with several longitudinal and oblique marks on the left side of the arc. All in all most of the marks can be related to attempts at cleaning and severing the two abnormal vertebrae rather than normal filleting.

Two lumbar vertebrae, both from adults, have cutmarks. One has short, longitudinal marks on both the anterior and posterior articular processes of the left side, as well as transversal marks across the left, anterior process. Another vertebra has several longitudinal cuts on the left side of the arc, and one short cut on the right side of the base of the spina. There, as well as on the right anterior articular process is found a bundle of short, transversal cuts. The longitudinal cuts will probably be from filleting, whereas some if not all of the transversal ones will rather be from attempts at disarticulation.

Upper forelimb

Five humerus fragments, all from the distal end of the bone, show cut marks. Two, a left and a right fragment, have short cutmarks across the medial epicondyle, from severing of the joint. For the left fragment these marks are combined with longitudinal marks on the anterior side of the lateral crista, probably from filleting.

A right fragment has a bundle of short, transversal marks on the diaphysis just above the distal epiphysis on the medial side of the bone. Two left humeri have the same type of cutmark combined with longitudinal cuts on the diaphysis just above the *fossa olecrani*. These marks all can be attributed to filleting of the front leg.

Two left radius fragments have slightly oblique cutmarks on the lateral side of the diaphysis close to the proximal epiphysis.

On a right radius fragment from a subadult animal of near adult size (distal epiphysis is missing) short longitudinal cuts are found posteriorly on the proximal third of the diaphysis. The marks found on the radii can all be connected to filleting.

The ulna was well represented as both fragments and intact bones and had the most cutmarked specimens of all longbones. The marks are found on and near the proximal articular end and can all be attributed to filleting of the front leg. The twelve cutmarked bones are all from animals of adult size. Seven are from adult animals, and five cannot be estimated more precisely than adult or older subadult due to damaged olecrani.

The most common type of cut mark consists of several longitudinal to slightly oblique marks on the concavity of the medial side of the olecranon. These are found alone on three left and one right ulna.

A right ulna has these marks and further down on the medial side longitudinal cuts on the proximal third of the diaphysis. For a left ulna these two types of mark are combined with anteriorly positioned oblique marks.

Longitudinal to slightly oblique marks on the proximal third of the medial diaphysis are found on three bones, all from the right side. One left ulna here has tranversal marks across the diaphysis.

Oblique marks on the proximal third of the diaphysis, but on the lateral side, can be seen on a right ulna fragment. A left ulna has this kind of marks on the middle of the diaphysis.

Lower forelimb

– Carpals

Several carpals carry cut marks, most numerous are single marks on the protruding *os carpi accessorium* (Pl. 8, 1-2). Concerning the accesssorium there are notable differences between bones from the left and the right side of the body: all seven bones from the left side have cutmarks in two or more places whereas on the right side this is the case for only two bones and the remaining nine only have one mark.

Beginning with the latter group most marks are transversal cuts across one of the sides of the posterior process of the bone. On the right *accessorii*, three have marks across the dorsal side and two across the ventral side, whereas on three the cuts are on the medial side. Only on one piece does the cut go along the medial side of the bone.

This type of longitudinal cut is combined on one further piece with a tranversal cut on the dorsal side.

On one bone two transversal cuts are found on the ventral side immediately below the rim of the articular surface and further up on the lateral edge of it.

The seven left *accessorii* have different combinations of marks, most comprising transversal cuts on the dorsal or ventral side of the process.

One bone has tranversal cuts on both the dorsal and the ventral side, another has besides these also a longitudinal cut on the medial side and a tranversal cut on the ventral side near the rim of the articular surface. The latter type is also found in combination with transversal cuts across both the medial and the dorsal side. One bone has transversal cuts on the medial as well as the ventral side.

Transversal cuts on the lateral side of the bone near the rim of the articular surface are found on two bones, combined with a transversal cut on the medial side respectively on the ventral side. Transversal cuts on the medial and the dorsal side combined with a transversal cut near the rim of the articular surface on the dorsal side are found on one bone.

Three left and one right *os carpi radiale, carry* cutmarks. In all cases only one mark is found, namely a tranversal cut across the dorsal side of the posterior process.

A left and a right *os carpale primum* were among the cutmarked carpals. In both cases short oblique marks were found on the medial side.

A left *os carpi ulnare* shows a few vertical marks on the lateral side crossing the proximal articulation.

Since the *accessorium* protrudes posteriorly some of these cuts may have been inflicted during skinning. More likely is, however, that they were produced during the disarticulation and filleting of the paws, where apparently the work was done more from the medial than from the lateral side. Considering the marks on the other carpals these can be attributed to the filleting and dismembering of the paws.

– Metacarpals

All five metacarpals are represented among the cutmarked bones.

The metacarpals will be treated below, together with the metatarsals.

Upper hindlimb

The pelvis fragments are limited to pieces comprising the acetabulum and the parts of ilium, pubis and ischii respectively. One right fragment has a small bundle of marks across the lateral side of the base of the ilium. Two left pelvis fragments both show marks on the lateral side running parallel to the medial rim of the corpus of the pubis just above the acetabulum. One of these has in addition transversal cutmarks across the caudal rim of the ischium.

A single femur fragment from the right side contributes to the cutmarks. There a bundle of marks is found on the proximal end situated between the *caput* and the *trochanter major*.

For both the pelvis and the femur fragment the cutmarks can be attributed to filleting.

Lower hindlimb

– Tarsals

A total of 19 calcaneii carry cutmarks. In all cases the marks are only found in one location on each bone and the majority are situated on the lateral or anterior side of the bone.

Marks going obliquely across the lateral side of the *tuber*, more or less corresponding to vertical cuts following the direction of the tibia, can be seen on one left and three right calcaneii.

One calcaneus carries oblique marks perpendicular to this type on the medial side of the bone. These marks may be related to skinning of the bears.

The remaining marks are all in positions where a relation to filleting and disarticulation is the most likely.

On the lateral side of the bone cut marks crossing the rim of the articular surface towards the talus are found on five left calcaneii. Short marks across the *tuber* are found on the posterior side of one left and two right calcaneii. On the anterior side of a right calcaneus short marks are seen across the *tuber* as well as across the rim of the articular surface of a right calcaneus. One right calcaneus carries bundles of short longitudinal cuts on the posterior side of the top of the *tuber*. On the medial side of the bone short cutmarks on the *sustentaculum talii* are seen on one left and two right calcaneii.

Only two right talii have cut marks, these are found across the right and the left side of the bone.

– Metapodials and phalanges

Both metacarpals and metatarsals show a high frequency of cutmarks and often marks are found in more than one postion, most often involving different sides of the bone, tab. 20-21.

In several cases the marks can be characterised as repetitive types, involving several bundles of semi-parallel marks across the diaphysis, situated only 5 to 10 mm apart. This type of mark is most commonly found on the palmar or plantar side of the bone and can be attributed to the filleting of the tough tissue of the pads.

The marks have been registered according to position and direction. Longitudinal marks following the direction of the diaphysis were rare and found only on the anterior and palmar/plantar sides of the bone. Possibly some of these were inflicted during skinning, but they may also be variations of the filleting marks.

No. pr.	Mc I		Mc II		Mc III		Mc IV		Mc V		sum:
bone	s	d	s	d	s	d	s	d	s	d	
1	2	–	–	1	5	5	3	2	2	5	25
2	1	3	–	3	1	–	1	1	1	2	13
3	1	–	2	2	–	–	–	–	–	–	5
4	–	–	–	–	1	–	–	–	–	–	1
Bones:	4	3	2	6	7	5	4	3	3	7	44
No. pr.	Mt I		Mt II		Mt III		Mt IV		Mt V		sum:
bone	s	d	s	d	s	d	s	d	s	d	
1	2	1	5	4	3	–	4	7	1	1	28
2	2	3	1	1	3	3	2	2	1	1	19
3	2	–	–	–	1	1	2	1	–	–	7
4	–	–	–	–	–	1	–	–	–	–	1
Bones:	6	4	6	5	7	5	8	10	2	2	55

Tab. 20 Bear. Frequencies of single and multiple occurrences of cutmarks on metapodials.

The transversal or oblique marks are the most abundant group testifying to the meticulous filleting of the paws, tab. 22. Marks on the palmar/plantar side of the bone are the most numerous, and the more severe types showing traces of repetitive cutting along the bone dominate (Pl. 8, 3-4). Marks on the palmar/plantar side of the bone are commonly found singly. Where different types of marks are found on the same bone one is usually positioned on the palmar/plantar side.

Regarding the toe bones, both the first and the second phalange carry marks, tab. 23. As for the metapodials, transversal or oblique marks over the palmar/plantar side of the bone are the most common for the first phalanges, but marks on the sides of the toe bones (lateral/medial) are here also common, and marks on the anterior side are relatively rare (Pl. 9, 1-2).

The cutmarks found on the metapodials and the first phalanges show ample evidence of the filleting of bear paws.

Contrary to this the second phalanges often carry marks across the anterior side of the bone. Since no mark was encountered on the abundant third phalanges the transversal marks on the second toe bone may be related to skinning (and disarticulation) rather than filleting.

Indications of bear exploitation

To summarize, the cutmarks found on the bear bones show both skinning marks and traces of filleting and disarticulation. The majority of the marks were related to filleting, in particular the paws were subjected to a meticulous extraction of soft tissue.

The following activities have been observed:

For the head: filleting, including extraction of the tongue, as well as skinning was documented.

For the vertebral column: disarticulation of the cranium-atlas joints, and filleting of vertebrae. Possibly also attempts at disarticulating two fused vertebrae.

For the forelimb: filleting of the longbones, and intensive filleting of the paws. Disarticulation of the carpal joint(s) and probable skinning marks on the metacarpals.

For the hindlimb: filleting of pelvis and femur. For the paws the same intensive filleting as seen in the forelimb, as well as disarticulation and, less often, indications of skinning.

As for the rhinoceros material the marks indicate working in fresh carcasses, the detailed filleting of the paws, however, appears to have been tough work necessitating several cuts per square-centimeter of bone and flesh.

Occurrence of all transversal or oblique marks. Repetitive marks in ( )					Occurrence of all longitudinal cutmarks	
Bone	anterior	palmar/plantar	lateral	medial	anterior	palmar/plantar
mc 1 sin	–	6 (3)	-	–	–	2
mc 1 dx	2 (1)	1 (1)	2 (1)	1 (1)	1	–
mc 2 sin	4 (1)	2 (2)	–	–	1	–
mc 2 dx	6 (1)	7 (4)	–	–	1	–
mc 3 sin	5 (2)	5 (4)	–	1 (1)	1	–
mc 3 dx	1	4 (3)	–	–	–	–
mc 4 sin	2	3 (2)	–	–	–	–
mc 4 dx	–	4 (3)	–	–	–	–
mc 5 sin	3	1	–	–	–	–
	2	5	2	–	–	–
Sum:	25 (5)	38 (22)	4 (1)	2 (2)	4	2
mt 1 sin	1	7 (5)	1	2	–	1
mt 1 dx	1	4 (3)	1	1	–	–
mt 2 sin	2 (2)	5 (3)	–	–	1	–
mt 2 dx	1 (1)	5 (4)	–	–	–	–
mt 3 sin	2 (2)	10 (4)	–	–	1	1
mt 3 dx	3 (1)	9 (7)	–	–	1	–
mt 4 sin	5 (2)	8 (5)	–	1 (1)	2	1
mt 4 dx	2	12 (7)	–	–	–	–
mt 5 sin	1 (1)	2 (1)	–	–	–	–
mt 5 dx	1 (1)	1 (1)	1	–	–	–
Sum:	19 (10)	63 (39)	3	4 (1)	5	3

Tab. 21 (a-b) Bear. Occurrence of all recorded cutmarks on metapodials.

MNI N/MNI C

Several elements of the bear skeleton are not very well represented in the present sample, tab. 24-25. Consequently, both the MNI N and the MNI C estimates are more variable than seen for the rhinoceroses. Again the patella is frequent, but no bones carry cutmarks. Many of the rarer types of bone share this trait, but here an element of chance can not be excluded.

When we concentrate on those skeletal elements for which the MNI N has been calculated to 10 or more individuals, the share of MNI C is usually quite high. For both ulna, carpals, metacarpals, calcanei and metatarsals the MNI C is about half or more of the MNI N. Talii and the remaining types of tarsals have relatively low shares of cutmarked bones. If, however, all tarsal bones are combined, the high MNI C from the calcaneus brings this group closer to the frequencies of the other common elements.

Despite a slightly lower MNI N of nine the atlas has a comparatively high frequency of marked specimens providing a MNI C of six, or more than half of the MNI N.

For the jaws the high MNI based on isolated teeth can not be directly compared to the MNI C of six from the mandibula. The corresponding MNI N from mandibula fragments will not be more than 30, but still the MNI C share is relatively low.

Combinations of cutmarks on metapodials

Position of transversal or oblique marks, not combined with other types. a. single, b. repetitive

Bone	anterior		palmar/plantar		lateral	medial
	a	b	a	b		
mc 1 sin	-	-	-	1	-	-
mc 1 dx	-	-	-	--	-	-
mc 2 sin	-	-	-	-	-	-
mc 2 dx	-	-	-	1	-	-
mc 3 sin	1	-	1	2	-	1
mc 3 dx	1	-	1	3	-	-
mc 4 sin	1	-	-	2	-	-
mc 4 dx	-	-	-	2	-	-
mc 5 sin	1	-	-	1	-	-
mc 5 dx	2	-	2	-	1	-
Sum:	6	-	4	12	1	1
mt 1 sin	-	-	-	1	-	1
mt 1 dx	-	-	1	-	-	-
mt 2 sin	-	1	2	2	-	-
mt 2 dx	-	-	1	3	-	-
mt 3 sin	-	-	2	1	-	-
mt 3 dx	-	-	-	1	-	-
mt 4 sin	-	-	1	3	-	-
mt 4 dx	-	-	2	5	-	-
mt 5 sin	-	-	-	1	-	-
mt 5 dx	-	-	-	1	1	-
Sum:	-	1	9	18	1	1

Position of longitudinal marks, not combined

	Anterior	Palmar/plantar
mc 1 sin	-	1

Combinations of two transversal or oblique marks

	palmar/plantar		repetitive +		pa/pl. a+	Other
	same	pa/pl. a	ant.	med.	ant.	
mc 1 sin	-	1	-	-	-	-
mc 1 dx	-	-	-	-	1	med+lat.
mc 2 sin	-	-	-	-	-	-
mc 2 dx	-	-	1	-	2	-
mc 3 sin	-	-	1	-	-	-
mc 3 dx	-	-	-	-	-	-
mc 4 sin	-	-	-	-	1	-
mc 4 dx	1	-	-	-	-	-
mc 5 sin	-	-	-	-	-	ant. +lat.
mc 5 dx	-	-	-	-	1	pa/pl a+lat.
Sum	1	1	2	-	5	3
mt 1 sin	-	1	-	-	1	-
mt 1 dx	1	-	-	1	-	ant.+lat.
mt 2 sin	-	-	-	-	1	-
mt 2 dx	-	-	-	-	-	-
mt 3 sin	-	1	1	-	-	-
mt 3 dx	1	1	-	-	-	-
mt 4 sin	-	-	-	-	-	-
mt 4 dx	-	-	-	-	1	-
mt 5 sin	-	-	-	-	1	-
mt 5 dx	-	-	-	-	-	-
Sum:	2	3	1	1	4	1

Combinations of three transversal or oblique marks

	palm/plant.		repetitive +	Others
	same	same + ant.	ant. + ant.	
mc 2 sin		–	1	–
mc 2 dx		1	–	–
Sum:		1	1	–
mt 1 sin	–	–	–	pa/pl a + med. + med.
mt 3 dx	–	1	–	–
mt 4 sin	–	–	–	ant. + ant. + med.
Sum:	–	1	–	2

Combinations of one longitudinal mark and one transversal or oblique

	palm/plant. anterior	repetitive + longitudinal palm/plant.	other
mc 1 sin	–	1	
mc 1 dx	–	–	ant. + lat. long.
Sum:	–	1	1
mt 1 sin	–	1	–
mt 2 dx	1	–	–
mt 3 sin	–	–	pa/pl a. + ant. long.
mt 4 sin	–	2	–
mt 4 dx	–	–	pa/pl a + post. long.
Sum:	1	3	2

Combinations of one longitudinal mark and two transversal or oblique.

	Palmar/plantar	repetitive +		Pa/pl. single +
	ant. + ant. long.	ant. + pa/pl. long	pa/pl. a. + pa/pl. long	ant. + ant long.
mc 2 sin:	1	–	–	–
mc 2 dx:	–	–	–	1
mt 3 sin	–	–	1	–
mt 3 dx	–			1
mt 4 sin	–	–	–	1
mt 4 dx	–	1	–	–

Combinations of one longitudinal mark and three transversal or oblique

mc 3 sin: Palmar repetitive + anterior repetitive + anterior + anterior longitudinal

Tab. 22 (a-b-c) Bear. Combinations of cut mark types on metapodials.

Pathologies

Among the bear bones specimens with bony changes in the joints, arthrosis, were not uncommon. Given the high number of very old bears in the material this finding will not be surprising.

More severe cases of joint disease includes a right and a left proximal femur, possibly a pair, where the caput shows beginning eburnation. Two phalanges, a first and second phalange, were firmly fused.

During the registration of the material two seriously affected vertebrae were found. The bones, a 13th and a 14th thoracic vertebrae, were located in different parts of the storerooms and under different registration numbers, but were seen to fit together across a recent fracture in a strong bony bridge formed between them. The find has been published as a case of *osteochondrosis intervertebralis* and *spondylosis deformans* by Kierdorf and Kahlke (1998).

Combinations of cutmarks

No.	Ph. I	Ph. II
1	39	16
2	19	3
3	2	1
Sum:	60	20

Position of all marks on Ph. I

	anterior	palm. /plant.	lateral/medial
Transversal:			
proximal	4	10	2
middle	7	5	17
Oblique:			
proximal sin	–	5	–
proximal dx	–	17	–
Longitudinal:			
proximal	2	1	–
middle	7	3	3

Position of all marks on Ph. II

	anterior	palm. /plant.	lateral/medial
Transversal:			
proximal	7	2	
middle	7		2
Oblique:			
proximal sin		1	
proximal dx		2	
Longitudinal:			
proximal	2	1	
middle			
			1

Tab. 23 (a-b) Frequencies of single and multiple combinations of cutmarks and occurrence of all recorded cutmarks on phalanges I-II.

Another »refitting« shows the right Mt 2 to 5 of the hindpaw of a strong bear (Pl. 9, 3). The diaphysis of the metacarpals indicates some bone inflammation, possibly due to a blow or similar damage to the paw.

Large Bovids

The majority of the bovid remains belongs to *Bison priscus.*

The subspecies *Bison priscus priscus* will probably be the more numerous, but also *Bison priscus mediator* is present as shown by a well preserved cranium fragment (Flerov 1977; Kahlke 1995). (This piece has not been included the database).

The later revision (Bratlund 1995) did, however, show that the Taubach material also comprised remains of aurochs. Two, possibly three, postcranial bones can be referred to *Bos*, whereas the rest is *Bison* or can not be determined to either species with full confidence.

It is clear that the large bovid material from Taubach will in the near future need a throrough and critical palaeontological re-evaluation. This task is, however, beyond the scope of the present study.

URSUS
MNI N

Cranial:
M2 sup. + M3 inf.

MNI N:	SA (I?)	SA II(?)	AD	AD+
	1	5	34	12

MNI N: 52 total (dentes)
MNI C: 9 AD (mandibula)

Postcranial specif.:

	MNI N		
	SA II	SA/AD	AD
Atlas	–	9	–
Scapula	–	2	1
Humerus	–	4	2
Radius	2	5	4
Ulna	–	3	9
Carpalia	–	17	–
Metacarpus	–	12	–
Pelvis	–	–	2
Femur	2	–	4
Patella	–	29	–
Tibia	–	1	1
Fibula	–	3	–
Calcaneus	–	–	21
Talus	–	24	–
Other tarsalia	–	11	–
Metatarsus	–	16	–
Phal. I	–	8	–
Phal. II	–	6	–
Phal. III	–	6	–

Tab. 24 Bear. Estimated MNI N (Minimum Number of Individuals, based on total n).

Fragment representation

Like the rhinoceroses and bears, the recovered remains of large bovids are dominated by single teeth, providing 176 or 33,0% of the total number of fragments, tab. 26. Bones from the fore- and hind foot are also numerous, including sesamoidea; these contribute 195 fragments or 36,6% of the bovid material. Horn cores and other cranial fragments, and even mandibles are relatively scarce, only 45 fragments, or 8,4% of all, from the heads were present. Nor are vertebrae and bones from the upper part of the legs very numerous and the longbones are most often represented by fragments. These parts of the skeleton are represented by 117 fragments or 22,0% of all bovid remains.

Bones and teeth which can be confidently contributed to young animals are rare (tab. 27). Seven bone fragments and one tooth indicate the presence of at least two young subadult calves. About 80% of the bovid bones cannot be aged more precisely than that they belong to either adult or nearly adult animals. The few bones which could be aged more precisely suggest that older subadults are relatively rare. This is supported by the dental material.

According to Flerov (1977) the horncores in the material are from males, whereas other skeletal elements indicate a small proportion of females.

URSUS
MNI N/MNI C

Cranial:
M2 sup. + M3 inf.

MNI N:	SA (I?)	SA II(?)	AD	AD+
	1	5	34	12

MNI N: 52 total (dentes)
MNI C: 9 AD (mandibula)

Postcranial specif.:

	MNI N/MNI C		
	SA II	SA/AD	AD
Atlas	–	9/6	–
Scapula	–	2/–	1/–
Humerus	–	4/2	2/–
Radius	2/1	5/–	4/–
Ulna	–	3/1	9/6
Carpalia	–	17/13	–
Metacarpus	–	12/5	–
Pelvis	–	–	2/2
Femur	2/–	–	4/1
Patella	–	29/–	–
Tibia	–	1/–	1/–
Fibula	–	3/–	–
Calcaneus	–	–	21/10
Talus	–	24/3	–
Other tarsalia	–	11/3	–
Metatarsus	–	16/8	–
Phal. I	–	8/3	–
Phal. II	–	6/1	–
Phal. III	–	6/–	–

Tab. 25 Bear. Estimated MNI N/MNI C (Minimum Number of Individuals, based on total n and on n of cutmarked specimens).

Mortality

On the basis of an appreciation of the wear of the lower M3 a tentative age distribution can be presented, tab. 28. A single worn milk molar shows the presence of one young subadult. For the older age classes the informations from single teeth and teeth still in mandible fragments are combined.

From the right jaw come three molars which are not or only lightly worn, indicating subadult animals which died close to the time of eruption. For the remaining worn teeth the crown heights would suggest that ten younger or middle aged and two very old adults are represented in the material. Three teeth were broken and the wear cannot be estimated. The total minimum number of individuals based on the dental record is 18 animals.

The corresponding MNI estimates for the postcranial material are: 2 young subadults, two older subadults and four adults. To this can be added a minimum of 9 subadult or adult animals. The total for the postcranial material is 17 animals. Not surprisingly the highest MNI values are found for bones from the feet. The identified bones would indicate the presence of one subadult or adult *Bos* among the bisons.

Both the teeth and the postcranial bones indicate a dominance of prime adults, with very few young or very old animals included in the sample.

BISON:

	Sum	Cutmarks	Function
Cranium	12	–	
Os cornu	11	–	
Maxilla	1	–	
Mandibula	21	–	
Dentes	176	–	
Atlas	5	–	
Axis	2*	–	
Vert. cerv.	19	1	disarticulation
Vert. thor.	17	2	filleting, disarticulation
Vert. lumb.	3	1	filleting, disarticulation
Sacrum	2	–	
Vert. caud.	5	–	
Costa	–	–	
Sternum	–	–	
Scapula		–	
Humerus	15	1	filleting
Radius	7	1	filleting
Ulna	5	–	
Carpalia	21*	3	disarticulation
Metacarpus	11	–	
Pelvis	3	1	filleting
Femur	12	1	filleting
Patella	4	–	
Tibia	4	–	
Fibulare	2	–	
Malleolare	8	–	
Calcaneus	12	3	disarticulation
Talus	27	5	disarticulation
CT	23	–	
T 2+3	3	–	
Metatarsus	8	–	
Phal. I	16	–	
Phal. II	18	6	disarticulation (filleting?)
Phal. III	17	–	
Sesamoidea	35	–	
Div. Ep.	2	–	
Sum:	533	25	

* includes one fragment of Bos.

Tab. 26 Large bovids. Survey of identified fragments and exploitation traces.

Young calves may be underrepresented due to their fragile bones. Considering that many bones of young rhinoceroses of approximately the same size have been recovered and that both the teeth and the postcranial material of the bovids show the same results, it seems unlikely that the frequency of calves has been severely depressed.

Compared to the three other fairly well represented species, rhinoceros, bear and beaver, the discrepancy between the MNI estimates for the dental material and the postcranial bones is less pronounced for the bovids. The bovid remains show a nearly perfect fit between the results from the two sources, whereas the other animals have far higher MNI estimates for the teeth and jaws compared to the postcranial material.

Bison: N	SA I	A II	SA/AD	AD
Os cornu			11	
Cranium			12	
Maxilla			1	
Mandibula			21	
Atlas			5	
Axis			2*	
Vert. cerv.		6		13
Vert. thor.		5	1	11
Vert. lumb.				3
Sacrum				2
Vert. caud.				5
Scapula			4	
Humerus			15	
Radius		2	5	
Ulna			1	4
Carpalia			23*	
Metacarpus			11	
Pelvis			3	
Femur	1	1		10
Patella			4	
Tibia	1		2	1
Fibulare			2	
Malleolare			8	
Calcaneus	2		10	
Talus			27	
Centrotarsale	1		22	
T 2+3			3	
Metatarsus			8	
Mp-epiphysis	2			
Ph. I			16	
Ph. II			18	
Ph. III			17	
Sesamoidea			35	
Sum:	7	14	287	49
* includes one fragment from Bos			**284**	**51**

Tab. 27 Large bovids. Bone fragment distribution on general age classes.

Cutmarked bones

Despite a fair representation of different body parts the bovid material has yielded comparatively few cutmarks, tab. 26. All cut marked pieces belong to postcranial bones or bone fragments, which were either determined to *Bison* sp. or belonged to the large group of skeletal elements for which definite criteria for the determination to either *Bos* or *Bison* are lacking.
With the exception of two calcanei, all cut marked bones are from adult or older subadult individuals. The majority of cut marks is found on carpals, tarsals and phalanges.

Vertebrae

One cervical vertebra (one of the vertebrae III, IV or V) from an adult shows several cutmarks across the dorsal side of the right posterior articular process. Most likely they document an attempt at sectioning the spinal column, but a joint purpose of severing muscle tissue can not be excluded.

Tab. 28 Large bovids. Tooth wear. Posterior crown height measurements of inferior M3 in Bison.

N	posterior crown heigth mm	wear stage
1	57,2	no wear
2	55,5-51,	light wear
12	47,3-35,6	medium wear
3	22,7 or less	very worn

Two cutmarked thoracic vertebrae are both from older subadult animals. One shows only a single bundle of vertical cutmarks on the left side just behind the lateral process. On the other piece similar marks are found behind the lateral process just below the posterior *incisura* on both the left and the right side of the bone. These marks may be associated with the cutting off of the rib. On the latter piece more cuts are found on the right side of the bone: two marks run anteriorly-posteriorly across the base of the spine and an oblique mark is found on the *corpus*, both from filleting of the axial skeleton.

The last cutmarked vertebra is a fragment of an adult, lumbar vertebra. A bundle of vertical cutmarks is situated behind the posterior articular surface on the left side of the bone and may be connected to an attempt at severing the spinal column, but can also have played a role in filleting.

Upper forelimb

On a fragment comprising the distal third of a right humerus from an adult or older subadult, a small bundle of cuts, most likely from filleting, is found on the posterior side of the lateral condyle.

A fragment from an adult or older subadult comprising the proximal articular end of a left radius has a single mark obliquely (medial-proximal to lateral distal) across the anterior side below the epiphysis. Likewise this mark may most likely be linked to filleting of the frontleg.

Lower forelimb

Three carpals all from adult or older subadult bovids have cut marks. A right *os carpi radiale* has transversal cuts across the lateral side of the bone. Similar transversal cuts are found on the lateral side of a right *os carpi ulnare*. A further bone of this type has a bundle of vertical cuts on the lateral side of the edge of the distal articular surface. In all cases the marks can be attributed to dismembering of the forelimb.

Upper hindlimb

A pelvis- respectively a femur-fragment both from the right side of the body of adult or older subadult animals show cutmarks.

The pelvis fragment shows a deep mark on the ischiadicum immediately below the acetabulum, going obliquely (anterior-lateral to posterior medial) across the bone, and parallel to this a second mark higher up on the middle of the anterior ilium.

The nearly intact femur has two concentrations of slightly oblique cutmarks lying parallel to or crossing the *linea aspera*, situated just below the *trochanter minor* respectively on the middle third of the diaphysis.

The cutmarks found on both bones are attributed to filleting of the hindleg.

Lower hindlimb

The single most numerous group of cutmarked bones are the tarsals, where three calcanei and five tali (Pl. 10, 1-2) show traces of handling by man.

Two right calcanei come from younger subadult animals. One has two cuts across the lateral side of the *tuber*. The other has also marks on the lateral side of *tuber*, but these are directed lenghtwise, and accompanied by several transversal cuts across the anterior side. These marks will most likely have to be attributed to severing of the ligaments of the joint and thus to sectioning of the foot joint.
A left calcaneus from an adult shows lengthwise marks on the lateral side parallel to and on the anterior articulation. These marks can similarly be connected to disarticulation.
The cutmarked tali are all from adult or older subadult animals. All cutmarks are situated on the medial side of the bone. For four calcanei the marks consist of bundles of marks lying in an approximately 45° angle (proximal-posterior to distal-anterior) with the articular surface for calcaneus. Two bones, a left and a right talus, have only one bundle of cut marks, whereas a left talus shows two and a right one three concentrations of cuts. A right talus falls outside the pattern since the marks, two long cuts and a bundle of shorter ones, are directed lengthwise, semi-parallel to the articular surface for the calcaneus. Nevertheless all marks found on bovid tali can be attributed to the disarticulation of the joint.

Phalanges

Six second phalanges from adult or older subadult animals bear cut marks.
One has a single cut across the anterior side of the diaphysis, whereas for two a single cut or bundle on the anterior side is accompanied with cuts across the medial and the lateral side respectively. Another has two bundles of cuts across the anterior side. For one, transversal cuts across the lateral side are com-

BISON
MNI N

Cranial:

	JU/SA	SA II	SA/AD	AD	AD+
Dentes:	1	2	2	10	2

MNI N: 17 total

Postcranial.

	MNI N			
	SA I	SA II	SA/AD	AD
Atlas			5	
Scapula			2	
Humerus			9	
Radius		2	1	
Ulna			1	2
Carpalia			5	
Metacarpus			8	
Pelvis			2	
Femur	1	1		4
Patella			3	
Tibia	1		1	1
Malleolare			6	
Calcaneus	2		8	
Talus			15	
Os centrotarsale			13	
Metatarsus			4	

Tab. 29 Large bovids. Estimated MNI N (Minimum Number of Individuals, based on total n).

BISON
MNI N/MNI Cutmarks

Cranial:
MNI N: 17 SA/AD (Dentes)

Postcranial.

	MNI N/NMI C			
	SA I	SA II	SA/AD	AD
Atlas	–		5/–	–
Scapula	–	–	2/–	–
Humerus	–	–	9/1	–
Radius	–	2/–	1/–	–
Ulna	–	–	1/–	2/–
Carpalia	–	–	5/2	–
Metacarpus	–	–	–	8/–
Pelvis	–	–	2/1	–
Femur	1/–	1/–	–	4/1
Patella	–	–	3/–	–
Tibia	1/–	–	1/–	1/–
Malleolare	–	–	6/–	–
Calcaneus	2/2	–	–	8/1
Talus	–	–	15/3	–
Os centrotarsale –	–	–	13/–	–
Metatarsus	–	–	–	4/–

Tab. 30 Large bovids. Estimated MNI N/MNI C (Minimum Number of Individuals, based on total n and on n of cutmarked specimens).

bined with a longitudinal bundle of cuts on the anterior edge of the proximal articular surface. One talus has a single longitudinal cut on the posterior side near the proximal end.
These cuts can be related to the severing of ligaments in the feet, but they may possibly have helped in the more detailed filleting of the foot.

Bovid exploitation

The comparatively small number of cutmarked bones will of course not show the full spectrum of butchering. However, they still suffice to indicate some elements in the exploitation of these large carcasses.
For the column: filleting, and possibly also disarticulation.
For the forelimb: filleting (of the humerus) and disarticulation of the carpal joint(s).
For the hindlimb: filleting (of the pelvis) and disarticulation of the tarsal joint(s). Distally also disarticulation and possibly filleting of the toe bones.

MNI N/MNI C

In consequence of the low number of bones the relation between MNI N and MNI C does not contribute information to the extent seen for the better represented species, tab. 29-30.
Most cutmarked bones are found for the larger tarsals. Both calcaneus and talus have a MNI C of three, and a MNI N of 10 respectively of 15.

Beaver

According to Kretzoi the Taubach beavers belong to the subspecies *Castor fiber spelaeus* v. Münster 1833 (Kretzoi 1977). The differences to the modern beavers in respect of size and dental development will probably be neglible for an investigation of the exploitation.

Fragment representation

The beaver follows the normal Taubach pattern since single teeth constitute a large part of the material, 158 or 49, 6% of the total number of fragments, tab. 31. Fragments from the head are here limited to two maxilla and 33 mandible pieces, this being 11,0% of the total. Considering their small size, bones from the hand and feet are surprisingly well represented, supplying 58 or 18,2% of the material. Similar to the other species fragments from the axial skeleton and upper part of the legs are comparatively rare; only 68 or 21,3% of the material belong to these areas of the skeleton.

Despite their much smaller size the general pattern of recovery is the same for beavers as for the rhinoceroses, bears and bovids.

The beaver bones have been tentatively sorted into age groups, tab. 33. Most of the bones belong to older subadult or adult beavers, but their age can not be more precisely estimated. Depending on their state of epiphyseal fusion most of the remaining bones can be attributed to either adult or nearly fully grown subadults. A few fragments indicate the presence of somewhat younger subadult animals.

Not surprisingly the highest MNI estimates are found for the teeth; based on the occurrence of the superior P4 in the material, a minimum of 17 beavers are present.

CASTOR:	N	Cutmarks	Function
Maxilla	2	–	
Mandibula	33	3	skinning, filleting
Dentes	158	–	
Vert. cerv.	2	–	
Vert. thor.	1	–	
Vert. lumb.	7	–	
Sacrum	2	–	
Vert. caud.	11	1	disarticulation
Costa	1	–	
Sternum	–	–	
Scapula	7	–	
Humerus	5	–	
Radius	2	–	
Ulna	9	2	filleting
Metacarpus	2		
Pelvis	4	1	filleting
Femur	10	2	disart., filleting
Patella	2	–	
Tibia	5	1	filleting
Calcaneus	8	–	
Talus	6	–	
Other tarsalia	2	–	
Metatarsus	6	–	
Metapodia, fr.	6	–	
Phalanges	28	–	
Sum:	319	10	

Tab. 31 Beaver. Survey of identified fragments and exploitation traces.

CASTOR: N				
	SA I	SA II	SA/AD	AD
Maxilla				2
Mandibula				33
Vert. cerv.		2		
Vert. thor.		1		
Vert. lumb.		5		2
Sacrum		2		
Vert. caud.		6	1	4
Costa			1	
Scapula			7	
Humerus	1	2	1	1
Radius			2	
Ulna	3	2	4	
Metacarpus			2	
Pelvis	1	1	1	1
Femur	3	4	1	2
Patella			2	
Tibia		2	3	
Calcaneus		6	2	
Talus			6	
Other tarsalia			2	
Metatarsus		1	5	
Metapodia, fr.		4	1	1
Phalanges			28	
Sum:	8	38	69	46

Tab. 32 Beaver. Bone fragment distribution on general age classes.

CASTOR: MNI N:				
Cranial.				
	SA/AD			
Dentes:	17			
Postcranial.				
	MNI N			
	SA I	SA II	SA/AD	AD
Scapula			5	
Humerus	1	1	1	1
Radius			1	
Ulna		2	1	2
Metacarpus			1	
Pelvis	1	1	1	1
Femur	2	2	1	2
Patella			1	
Tibia		2	2	
Calcaneus		5	1	
Talus			5	
Metatarsus		1	1	

Tab. 33 Beaver. Estimated MNI N (Minimum Number of Individuals, based on total n).

For the postcranial material fewer individuals are represented, tab. 33. Combining the results from femur and calcaneus the minimum number of individuals from the postcranial skeleton will be: two young subadults, five older subadults, two adults and one adult or subadult animal, in total no more than ten beavers. There has in other words been a considerable loss of beaver bones.

Cutmarked bones

No more than ten of the beaver bones carried clear cut marks.

Mandibula

Two left and one right mandibles, which judging from their size all belong to adult or nearly fully grown animals, have cutmarks.

One left mandibula shows two short, oblique cuts on the lateral side below the cheek teeth, one in a direction parallel to the anterior border of the jaw and the other perpendicular to this. The other has several oblique cuts on the lateral side below the diastema directed approximately at right angles to the anterior border.

The right mandibula shows several oblique marks in the same position, but here the direction of the cuts is the opposite as they are lying parallell to the anterior rim of the jaw. On the medial side of the *pars alveolaris* for the cheek teeth a single lengthwise cut is found.

The cutmarks found on the lateral side of the mandibulae may come mainly from skinning, but may also have played a role in the filleting of the cheek. The medial cut found on one specimen can be related to filleting, or more particularly to the extraction of the tongue.

Vertebrae

One caudal vertebra shows two transversal cuts across the posterior articular processes, which can be attributed to sectioning of the tail.

Upper forelimb

Two ulnae both from subadult beavers have cutmarks. On the left one a cutmark goes across the lateral side of the middle third of the diaphysis, on the right piece a bundle of transversal marks is located across the posterior edge of the base of the olecranon. Both can be related to filleting of the frontleg.

Upper hindlimb

One pelvis fragment from the left side shows a single cut line on the ischium immediately below the acetabulum, presumably from filleting.

Two left femora, one from an adult and one from a subadult beaver have cutmarks. The older one shows a profusion of marks on the anterior side of the diaphysis, on the upper half crossing the diaphysis and on the lower half running lengthwise. In addition oblique cuts (anterior-proximal to posterior distal) are found on the middle of the diaphysis on the medial side.

The subadult femur (Pl. 10, 3-4) has two cuts running length wise after each other on the anterior side of the diaphysis. More prominently a series of very deep marks across the bone is found between the *trochanter major* and the *trochanter tertius.*

Both bones show cutmarks from filleting, in the latter case supplemented by not too successful attempts at cutting off the hindleg.

One right tibia from an adult has a single cut across the medial side of the lower third of the diaphysis.

CASTOR:
MNI N/MNI Cutmarks.

Cranial.
MNI N: 17 SA/AD (Dentes)
MNI C: 2 AD (Mandibula)

Postcranial.

	MNI N/MNI C			
	SA I	SA II	SA/AD	AD
Scapula	–	–	5/–	–
Humerus	1/–	1/–	1/–	1/1
Radius	–	–	1/–	–
Ulna	2/1	1/1	2/–	–
Metacarpus	–	–	1/–	–
Pelvis	1/1	1/–	1/1	1/–
Femur	2/–	2/	1/–	2/–
Patella	–	–	1/–	–
Tibia	–	2/–	2/1	–
Calcaneus	–	5/–	1/–	–
Talus	–	–	5/–	–
Metatarsus	–	1/–	1/–	–

Tab. 34 Beaver. Estimated MNI N/MNI C (relation between Minimum Number of Individuals, based on total n and on n of cutmarked specimens).

Exploitation of beavers

The few cutmarks suffice to show:
For the head: skinning as well as filleting.
For the tail: disarticulation between two vertebrae of the tail.
For the forelimb: filleting (of the ulna).
For the hindlimb: filleting (of pelvis and longbones) and disarticulation.
The peculiar positioning of the cutmarks on a subadult femur (Pl. 10, 3-4), can best be explained by a mistake in the positioning of the cuts. In all probability the protruding *trochanter tertius* has been mistaken for the *trochanter major* and the cuts have been accordingly positioned too low.
Due to the low, and probably not representative, number of cutmarked bones from beaver, the highest MNI C is two, found for the mandible, tab. 34.

Discussion

A general comparison of cut mark frequencies between excavated assemblages is a near impossible endeavour, since so many factors influence their detection. Just to mention a few; differences in soil conditions for preservation, excavation methods, recovery and storage choices will be able to obliterate or change the frequencies of marks before we have a chance to put the bones under the magnifying glass.
Even in large, well preserved assemblages, where all bones have been scrutinized under magnification and where the taphonomic analysis indicates that the bones are from exploited prey, only a fraction will carry marks. Based on the Stellmoor and Meiendorf reindeer assemblages a reasonable expectation would be 30-35% of the recovered fragments (Bratlund 1999). In Stellmoor the highest MNI N/MNI C rate was found for the atlas, where 50% of all bones were cutmarked (Bratlund 1996).

Only a few large Middle Palaeolithic assemblages have undergone systematic taphonomic studies, including a search for cutmarks. These may, however, show different prey preferences than Taubach, e. g. wild horse and bison in La Quina (Martin 1907). In several other cases, where species specialisation, mortality and fragment representation together with local topography indicate kill sites, e. g. Wallertheim (for bison) and La Cotte de Saint Brelade (for woolly rhinoceros and mammoth), Zwolén (for woolly rhinoceros, bison and wild horse) cut marks are absent or too few to be significant for interpretation (Gaudzinski 1992; Callow and Cornford 1986; Schild et al. in press).

The best parallel so far to Taubach in respect to species representation and preservation is the open-air site of Biache-Saint-Vaast, which has been dated to OIS 7. Here the faunal assemblage consisted principally of adult individuals. It was dominated by narrow-nosed rhinoceros, aurochs and bears, both brown bear and bears of the *spelaeus*-lineage. Other species present were Merck's rhinoceros, roe deer and red deer. The horse material comprised the remains of both a caballoid horse and of *Equus hydruntinus* (Auguste 1992).

This recently excavated material did of course give a better starting point for a detailed analysis of bone modification and the relationship of the faunal remains to the archaeological levels and site structures. The different levels indicate several occupation-phases; as at Taubach fractured, charred and cutmarked bones are found. The better representation of bones from the axial skeleton and fragments of the longbones at Biache contribute substantially to higher frequencies of cutmarked bones than seen in the Taubach sample, namely 19% for rhinoceroses, 35% for the bears and 31% for aurochs (Auguste 1993, tab. 2). Unfortunately the tables do not allow the construction of MNI C estimates for Biache.

Similar to Taubach the MNI-based mortality tables in Biache show a clear dominance of adult bears and adult large bovids, with young animals barely represented. For the rhinoceroses, however, Biache shows a different distribution since here adults also dominate clearly, with juveniles and subadults contributing only about a third of the individuals (Auguste 1995).

Considering the cutmark frequencies the Taubach sample may thus fully qualify as residue from a kill site. Even if the present sample is not as clearly monospecific as many other hunting sites and the relative abundance of the different species probably distorted, the targetting of specific age groups shown for the bears, rhinoceroses and bovids clearly indicates active hunting. For several of the other species the post-excavational bone loss has left only inconclusive samples, but at least regarding the elephants active hunting would be consistent with the juvenile dominated mortality profile.

It is impossible to discern whether all fragments in the sample belong to site waste, or if bones from natural deaths have contributed. In the light of the mortality profiles and the relative abundance of cutmarked bones it should be safe to conclude that bone waste from kill sites dominates and that the contributions from natural deaths of large or medium sized mammals will probably be neglectable.

The few observations of archaeological structures from the bone sand (see above) indicated that the bones were scattered around the perimeter of hearths and concentrations of ashes and artefacts. As pointed out by Götze (1892) these were not the only find spots, since the »bone sand« throughout was rich in bones.

Detailed ethnoarchaeological field studies on the actual treatment of the carcasses of hunted prey are not very abundant. Some of the most interesting studies have centered around the meat acquisition, by scavenging as well as active hunting, of the Hadza (O´Connell and Hawkes 1988; Bunn et al. 1988; O'Connell et al. 1992). Without doubt the Hadza will come to play the same role for Lower and Middle Palaeolithic studies as the Nunamiut have already done for the Final Palaeolithic. One may regret the narrow reference frame, but still see it as positive that at least this much information has been saved.

An important feature of the Hadza hunting economy is how transport choices condition the bone assemblages of both kill sites and base camps. Dependent on factors, which can not be archaeologically controlled, like the distance between camp and kill, number of helpers available, time of day etc., the number of meat packages containing bone would vary greatly. For very large animals, e. g. giraffe, a fully exploited carcass might contribute from as little as three ribs up to a nearly complete skeleton to the base camp assemblage (Bunn et al. 1988). At the kill site bones can be abundant, but due to Hadza transport practices (and the action of secondary consumers) bones of smaller prey (which in fact is killed more often) will be significantly underrepresented. Also, it is pointed out that various skeletal elements differ by species, but independently of body size, in their probability of abandonment at kill sites. Considering the largest prey, for buffalo the axial parts are likely to be left before the limbs, whereas for giraffe head, neck and lower limb bones may be abandoned first (O'Donnell et al. 1992).

Hunting is practised both by encounter and as intercept hunting. The majority of kill sites are single event locations marked only by bone scatters and often a hearth. Exceptions are intercept hunting stands used in the dry season near springs or channels. At intercept sites bones are likely to form palimpsests with dense concentrations at well shaded locations and in re-used hunting blinds. Regarding large game (eland or larger) the spatial distribution of bones from processing the same carcass can be considerable, involving several clearly defined bone clusters and hearths (O'Donnell et al 1992).

Considering Taubach in this light the first observation is that the presence of hearths is not equivalent with the site being a base camp. The presence of several small stone tools suitable for filleting and cutmarked bones showing local processing of all parts of the carcass, including heavy, but not very productive parts, like the feet and mandibles, would apparently fit a kill-butchering site better than a base camp.

The most common species animals at Taubach are brown bear or Merck's rhinoceros. If their behavior resembled modern bears and rhinoceroses, this means an abundance of prey animals with a predominantly solitary life style. Modern rhinoceroses may aggregate in small groups around focal points (see below) like salt licks or preferred places for wallows or dust-baths, and it is quite possible that the travertine sands would provide one of the latter amenities. This would, however, only mean that the population of rhinoceroses from several square kilometers around the site would have home ranges overlapping at this point. For both bears and rhinoceroses, a too massive local disturbance, including killings, would probably lead to a temporary scarcity of these animals.

A sustainable exploitation of rhinoceroses and of bears would probably not amount to more than four or five kills a year, perhaps even less. The high estimates of the minimum number of individuals for both of these species consequently indicate the repeated use over time of the kill-butchering site at Taubach. When the large amounts of lost faunal remains (cf. Möller cit. above) are considered, Taubach may well represent centuries of repeated use. The palimpsest nature of the site, and the limitations of the recovered faunal sample prevent the identification of the subsistence economy of any single occupation phase. Available game and hunting preferences may well have alternated between seasons and years, with the now apparently dominating rhinoceros and bear remains being only a part of the picture.

The recovered fauna does not show any clear seasonal indications. The single bear yearling can be estimated to have died in the spring. Provided that the climate made hibernation necessary, the hunting of bears could have been most important in the warmer seasons. The antler material includes both shed and unshed antlers, but their association with the archaeological assemblage is not entirely clear. If the Merck's rhinoceros lived in an climate with unfriendly, cold winters a more pronounced seasonality would theoretically be a benefit. For all recent species, however, including the African rhinoceroses which face serious dry seasons, births are recorded at all times of the year and without any pronounced peaks in their distribution.

HUNTING IN THE MIDDLE PALAEOLITHIC – AND IN THE RECENT PAST.

The question of Middle Palaeolithic hunting practices has been the subject of a methodological debate for several decates.The discussion of hunting practices is, however, also an expression of a much wider issue, namely the appreciation of the mental and technical abilities of Neanderthal man.

As to the mental abilities of the Neanderthals, since the first suggestions by Binford (1981; 1984; 1985;

1988) that they were mentally and technically not able to hunt large mammals and, therefore, inferior to modern humans, the world split into two halves; those who support Binford's views and try to back it up with new arguments (e. g Stiner 1994) and those who challenge this view (e. g. Chase 1989; 1990).
Recently, Hayden has presented a detailed re-evaluation of the arguments and data which have been presented as indications of the different postulated physical, mental and cultural incapabilities of Neanderthal man (Hayden 1993). His conclusions are that important characteristics such as e. g. sophisticated technology and economically rational behavior can indeed be attributed to the Neanderthals. The often stressed difference between the Middle and the Upper Palaeolithic should be seen rather in terms of technology and economy, and here not least in the aspects concerning the social organization of resource procurement and ownership.

Concerning the interpretation of faunal assemblages Binford's ideas have been criticized both in terms of the theoretical approach, but also, more importantly, regarding his taphonomic interpretations of specific bone assemblages as proof of scavenging. Recent re-evaluations of the faunal data from Torralba (Villa 1990) and Grotte Vaufrey (Grayson and Delpech 1994) do not support this interpretation.

Most recently, Marean (1998) has presented a comprehensive critique of the evidence for scavenging by Neandertals and early modern humans. For the five site which have been used to argue for scavenging: Klasies River Mouth, Combe Grenal, Grotta Guattari, Grotta dei Moscerini and Grotte Vaufrey he shows that in the first four cases all longbone shafts and other fragments difficult to identify were discarded at excavation, and that for Grotte Vaufrey only easily identifiable shaft fragments were included in the analysis (by Binford). The critera proposed by the advocates for scavenging are: scarcity of cut marks on bone shafts, presence of carnivore tooth marks and a skeletal element pattern dominated by bones of the head and feet. Marean shows that the collection bias at the five important sites »systematically shapes the skeletal element and surface modification patterning in ways that make the assemblage appear to fit a model of scavenging, when in fact the main determinant of the patttern is the bias of the flawed samples« (Marean 1998, p. 111). Consequently, »the conclusion is, that there is no reliable evidence for scavenging by Neandertals or early modern humans« (Marean 1998, p. 111).

This however, does not exclude the possibility that scavenging occasionally did occur especially during the temperate periods of the Pleistocene. As illustrated by the studies on Hadza economy (Bunn et al. 1988; O'Donnell et al. 1992) passive as well as confrontational scavenging can give an important contribution to the total meat procurement of modern humans.

It has been argued (cf. Bratlund 1999) that many (if not most) of the Middle Palaeolithic assemblages from Western Europe do not meet the minimal requirements of assemblage integrity and preservation for an informed discussion of the full range of faunal exploitation. In particular, many cave stratigraphies can be seriously questioned and the relatively small samples of bones are often inconclusive. The few well preserved open-air kill sites clearly point to active and planned hunting, not only of medium-sized prey but also of megafauna and large carnivores.

Many of the Middle Palaeolithic sites have produced a generalized fauna. However, as Chase (1989) points out, in several assemblages one species outnumbers all others indicating a planned exploitation of the natural resources. Most commonly the dominating species are reindeer, horses or large bovids which can be assumed to have been present as herds or smaller groups of animals. Regarding the large bovids the comprehensive study by Gaudzinski (1992) shows that sites spezialising in the exploitation of bison or aurochs are encountered over long periods of the Middle Palaeolithic and are distributed over vast geographical distances.

Concerning the Taubach material the interpretation implying the active hunting of large bovids would thus correspond to the commonly accepted picture of Neandertal procurement activities. Regarding the hunting of megafauna or large carnivores, which in Taubach are represented by the rhinoceroses and the brown bears, several authors have expressed more or less explicit reservations. One reason for this reserve is that the remains of megafauna at many sites is limited to a few bones or teeth, which, seen critically, could come from scavenging just as well as from hunting. Another important factor is the widespread disbelief in the organizational and technological capabilities of Neandertals.

Thus, Stringer and Gamble (1993) conclude, that »while there are innumerable artist's reconstructions of Neanderthals throwing rocks at mammoths and killing adult male bison and woolly rhinoceroses with flimsy-looking spears and gnarled clubs, we believe there is scant evidence that this was either a regular occurrence or the likely method of killing such large animals (Stringer and Gamble 1994, p. 163).

Concerning prehistoric hunting of rhinoceroses Guérin and Faure (1983) have strongly argued against the possibility of active hunting. Interestingly, their starting point is also the drawings, e. g. of Z. Burian from 1962, depicting Palaeolithic hunting scenes, and these are for several reasons deemed unrealistic.

The more optimistic stance, expressed in the earlier classic works by, among others, de Mortillet, Lindner and Soergel, which can be seen as the inspiration for these drawings, thus suffers an indirect, and not quite justified critique.

Guérin and Faure (1983) have, however, gone beyond the point of bland scepticism and endeavoured to present a series of concrete arguments against rhinoceros hunting. They can be briefly summarized as follows:

a. The weapons available to the Middle Palaeolithic as well as later Stone Age hunters were insufficient. Specifically, it is postulated that spears or lances armed with stone points have less penetrating power than iron points, and consequently, that the few ethnohistoric examples of natives hunting rhinoceroses with iron-pointed spears are irrelevant for a discussion of Palaeolithic hunting.

b. The authors have surveyed the rhinoceros material in the majority of the West-European Palaeolithic sites (referring to Guérin 1980) but have never found wounds due to weapons, nor »de trace absolument indubitable de décarnisation ou de décepage (Guérin et Faure 1983, p. 34).

The mentioned reference (Guérin 1980) constitutes a palaeontological survey of rhinoceros material predominantly from sites in France, Italy and Spain. Curiously, the Taubach material is not included in this database.

c. The rhinoceroses are in general considered too aggressive and too well protected by their thick skin to be of interest for the insufficiently armed Stone Age hunters. It is, however, seen as possible that carcasses of dead rhinoceroses could be scavenged, or that animals caught in natural traps, or old or badly wounded would be killed, likewise »qu'il ait parfois réussi à abattre des individus très jeunes après les avoir séparés de leur mère est par contre tout à fait possible mais cela n'a du arriver qu'exceptionellement.« (Guérin and Faure 1983, p. 35.)

Considering a and b, the postulated lack of suitable armament is highly doubtful. Recent experimental work has often shown the sharpness and high penetrating power of flint points. The most important drawback is their brittleness and tendency to break on impact, whereas metal points can be used again and again. The latter quality is, however, not unimportant when confronting dangerous prey like rhinoceroses and bears and can in itself motivate the use of iron points. Experiments using spears armed with Levallois points on large to medium-sized animals (but for obvious reasons not including rhinoceroses) showed, that these weapons achieve deep penetration and massive internal injuries (Shea 1993). The outstanding finds from Schöningen have produced finely shaped wooden hunting spears dated to about 380 to 400 ky in association with stone tools and horse bones with butchery marks (Dennell 1997; Thieme 1996 and 1997). Even without stone points these and the finds from Lehringen and Clacton indicate planned and successful hunting by early man.

Microwear analysis of stone tools from several Levantine Mousterien sites indicates the use of hafted spear points by Neanderthals and by early modern humans (Shea 1993). Unfortunately, the stone tools recovered from Taubach only comprised one possible point, making similar investigations impossible.

The observation that no hunting lesions were observed in the West-European Palaeolithic rhinoceros material, does not in itself indicate a lack of hunting. Fractures with imbedded fragments of points are extremely rare finds even for the later time periods, and are dependent on extremely good conditions of preservation. For the fairly numerous Lateglacial and Postglacial specimens from Northern Germany and Denmark it can be seen that ribs and vertebrae have the highest frequencies of wounds. In many assemblages these bones are often poorly preserved, or have in older excavations been discarded already on the site. Moreover, many of these fractures are very small and will only be detected during specialized studies of microtraces, where the bones are examined under magnification (Bratlund 1999). It is a slightly uncomfortable thought, that exactly the bones with the greater chances of showing hunting fractures were the first to be discarded during the fieldwork at Taubach.

The postulated complete lack of cutmarks or other utilisation traces on West-European rhinoceros material must be regarded with extreme scepticism. Qualified statements concerning the frequency of cut marks presuppose that the material has been studied under magnification and that the surface preservation is considered. Well preserved and recently studied samples, like Taubach and Biache (Auguste 1993; 1995) show quite high frequencies of utilisation marks on the rhinoceros bones.

The notion of rhinoceroses being too aggressive and dangerous for active hunting, however, needs further examination. Summarizing the discussion of the colloquium »The Role of Early Humans in the Accumulation of European Lower and Middle Palaeolithic Bone Assemblages« Gaudzinski and Turner (1995) observe that the two groups of proponents could be summarily described as the ecologically oriented »sceptics« versus more anthropocentrically oriented »possibilists« arguing that modern forms of behavior could be projected into the distant past.

Concerning the discussion of rhinoceros hunting I will argue that the projection is already there: The notion of what can be readily accepted, and what will be treated with disbelief. Our assumptions concerning the range of possible options for what Neanderthal man could possibly do have already been narrowed down by our European, historical load of information. Against this background critical, or at least comprehensive, presentations of ethnohistorical data can open a door and help us to see a wider range of possible methods of large game exploitation.

ETHNOHISTORICAL NOTES ON RHINOCEROS HUNTING

The records of rhinoceros hunting without the use of firearms are not very numerous. There are, however, a few interesting examples.

Alexander, who travelled in Africa at the beginning of the 19th century, is remarkable for being one of the few authors showing a genuine interest in the African people he met. Concerning rhinoceros hunting his observations show that different methods, traps as well as confrontational hunting using spears (assegais), were in use, the one not excluding the other. The prey is occasionally specified as black rhinoceros, but mostly only mentioned as rhinoceros.

Pitfalls used by the »Boschmen« are encountered on different occasions, and in one case described in more detail:

»We now saw miles of hedges, about three feet high, laid to direct the wild animals to pit-falls placed here and there for them; the pit-falls for the rhinoceros were four feet deep and four broad, with branches and leaves over them, and were consequently not large enough to take in his whole bulk, but were only sufficient for his fore legs, which the people said was the best way of securing him, as his legs once in, they have no purchase with which to raise his body.« (Alexander 1838, vol. 2, p. 125).

Hunting with lances is mentioned more often. So does one of the Boschman »guides, when asked to tell »the most wonderful thing he saw in his life«, recount a hunt where two rhinoceroses, a mother and her calf, were killed, each with a single lucky throw of an assegai (Alexander, bd. 2, p. 118). Hunting blinds are described at one of the stations of the expedition called Bull's Mouth Pass:

»The valley at first was very narrow and rugged, with loose stones and bushes. Pathways cleared through the stones by the feet of wild beasts, led along the course of the river; and here and there, close to these paths, were circular enclosures of loose stones, about three feet high only, behind which the Boschmen had been in the habit of concealing themselves to hurl their lances into the bodies of the rhinoceros and other animals as they passed.« (Alexander 1838, bd. 2, p. 9).

More rarely firearms are mentioned. One hunter may have a gun whereas other participants bring assegais (Alexander 1838, bd. 2 p. 13).

The rhinoceroses are treated with some respect for their physical power. The preferred hunting tactic is to try a shot, by gun or assegai, and quickly enter a tree to avoid a charging rhinoceros. If necessary, a new assault may be attempted (Alexander 1838, bd. 2, p. 13-15, p. 56-57, p. 119). At least one fatal encounter is related where a hunter fell from a tree and was trampled to death by the rhinoceros (Alexander 1838, bd. 2, p. 59). Alexander summarizes the tactics seen on his expedition thus:

»In general, the moment a hunter fires at a rhinoceros, or hurls a lance at him from behind a rock or tree, he runs off as fast as he can, and if his gun is heavy, he drops it the better to escape to a place of safety, and from whence he can watch the movements of the rhinoceros«. (Alexander 1838, bd. 2, p. 4).

Burchell (1822) has also described the use of pit falls as one of the more important hunting methods of the bushmen. He mentions pit systems, one to two miles long, where pitfalls alternate with obstacles made of trees and branches in the vicinity of Klaarwater. The pits are here not specifically made for rhinoceroses, like the ones described by Alexander, and much larger, about six times three feet and three feet deep, and often furnished with a pointed pole at the bottom (Burchell 1822, p. 281).

Burchell's advice to the European sports hunter engaging a rhinoceros is rather different from the Bushman tactics described by Alexander above. Rhinoceros hunting takes a dangerous turn when the animal charges, if so, it is important that the hunter shows composure and »calmly waits, until the furious animal charges, and then jumps to one side and lets it pass. Then he can gain enough time to reload his gun, before the rhinoceros faces him again.« (Burchell 1825, p. 95).

An even earlier source, Barrington, mentions natives hunting rhinoceroses with spears, the hunters steal upon the rhinoceros »and wound him with their javelins mostly in the belly, where the wound is mortal«. (Barrington 1810, p. 259).

Sparrman, who travelled to southern Africa in the late 18th century can also tell of rhinoceros hunting: »Die hottentottischen und kafferschen Jäger pflegen schlafende Elefanten und Nashörner leise zu beschleichen, und ihnene mehrere Wunden auf einmahl mit diesem Spieß [the assegai] zu versetzen. Darauf gehen sie der Spur des Thiers einen oder einige Tage nach, bis es sich verblutet hat, oder an den Wunden gestorben ist.« (Sparrmann 1784, cit. after Störk 1977).

Besides spearhunting and traps rhinoceros hunting involving the use of dogs or saddlehorses are reported for other parts of Africa. Also poisoned arrows or spears and elaborate traps hindering the animal's movements or wounding it with falling spears have been used (Barrington 1810; Baker 1872 and 1890; Kandt 1905; Anonymous 1930; Jeannin 1936; Störk 1977).

When the sources cited above specify the prey, the references have, in most cases, been to hunting of black rhinoceroses.

Spear hunting is, however, also reported for the larger white rhinoceroses in the then Belgian Congo by Lang (1920). On the occasions where Lang was an eye witness rhinoceroses were killed by spears thrown as they charged past the hunters. The white rhinoceros was regularly killed for meat, and on one of the reported occasions the hunter followed by Lang killed his 29th rhinoceros. (Lang 1920, p. 80).

Considering the utility of the African rhinoceroses the estimates are very variable. Lang (1920) points out that the digestive organs of the white rhinoceroses are enormous and compares the body to a living »steamboiler«, with the rest of the carcass being but bone and sinew, with surprisingly few large muscles: »this is a serious defect in the eyes of meat hungry natives, and even the hide, roasted and boiled like meat, is not a sufficient compensation, and so in their songs they bitterly complain of it.« (Lang 1920, p. 87).

On the other hand the rhinoceroses formed a prominent part of the animals killed to support the expeditions in southern Africa, as mentioned by among others Alexander (1838), Baldwin (1894) and Andersson 1856. According to Andersson one white rhinoceros bull could be reckoned as equivalent to three oxen in the »bush cuisine«.

Estimates of the taste and quality of rhinoceros meat vary greatly, (compare e. g. Alexander 1838; Giebel 1855; Baker 1890; Fitzsimons 1920), but the tongue is considered a delicacy.

Besides shooting from the back of elephants, there was still a method employed by the English sportsmen and, earlier by high ranking Indians, which is largely responsible for the decimation of the rhinoceros population: the Indian rhinoceros was (and unfortunately still is) often trapped in pitfalls furnished with pointed poles at the bottom. The use of pitfalls, also in the reserves of the present day, is employed to obtain the valuable horns (Kinloch 1904; Gee 1948).

Regarding the East-Asian rhinoceroses both spearing and the use of pitfalls as well as more sophisticated traps are reported.

Again eyewitness accounts are sparse, and some quite fanciful tales reappear time and again in the literature. One example of the latter is the method of hunting elephant by spearing them in the foot, or using firewood to virtually roast a rhinoceros alive in its mudbath, recounted from Malaysia (Begbie 1834, p. 7-8, but cf. de Morgan 1885).

Mouhot (1864) was in Laos able to participate in a rhinoceros hunt, were the animal was killed using a bamboo spear armed with the horn of a swordfish. The hunter faced the rhinoceros bull, and when it opened its jaws, thrust the spear in to a depth of »some feet«. The dying rhinoceros rolled over, vomiting blood, and was finished by a cut to the throat. This act was reserved for Mouhon, as a honour to a special guest (Mouhot 1864, p. 148).

This way of killing rhinoceros is later recounted by Moura (1883), probably based on Mouhots account.

In Borneo the Punans are reported to spear-hunt the rhinoceroses:

»The Punans, who hunt without dogs (which in fact they do not possess) will lie in wait for the rhinoceros beside the track by which he comes to his daily mud-bath, and drive a spear into his flank or shoulder, then, after hastily retiring, they track him again, and find an opportunity of driving in another spear or a poisoned dart through some weak spot of his armour.« (Hose and McDougall 1912, p. 145).

Krohn (1927) comments on the Dyak rhinoceros spear as a highly developed and very efficient weapon: »it is the weapon of choice, as compared to the rifle, in seeking to dispatch an infuriated rhinoceros in the tangled mass of vegetation in which this animal finds his lair in Central Borneo«.

In Sumatra Bickmore (1868) noted systems of pitfalls, eight to ten feet long, three wide and three to four deep, which were made for rhinoceroses. Hunting with lances or pitfalls are also recorded by Collet (1925), and from the Malayan peninsula a more elaborate spring spear trap, using a bent branch of a tree furnished with a spike, is mentioned (Skeat and Blagden 1906).

In a comprehensive study of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) in Malaysia Hubback (1948) discusses the heavy losses due to poaching using pitfalls. These were often found around salt licks, but also near well defined trails and were of about the same dimensions as described by Bickmore (cit. above.) Some indigenous hunting for meat had been done before, but the most devastating overexploitation took place at the beginning of the 20th century, and was caused by professional poachers supplying foremost the horn, but also other rhinoceros parts to the Chinese pharmacies. At Hubbacks time of writing many pit systems were out of use (for lack of rhinoceroses), and the pit remains could be estimated to be about 20 to 30 years old.

A later field study by Borner (1979) of the now extremely rare species in Sumatra is also concerned with the still ongoing poaching. He found three different kinds of rhinoceros traps in use. Most common was the spear trap, where a spear fixed in a heavy pole is suspended above the rhinoceros trail, and triggered to fall down on the rhinoceroses back. According to local estimates less than half of the speared rhinoceroses can later be found. In addition are used normal pitfalls and a knife trap, which wounds the animal in passing.

The spear traps are considered the most harmful, since in addition to the killed rhinoceroses many animals are wounded, and escape only to die in the jungle. As also noted by Hubback for the pitfalls, the traps are not checked very often, so as not to drive the rhinoceroses away, and they kill randomly old and young. The minimum loss of wounded rhinoceroses is estimated by Borner to about 50%, van Steenis et al. (1938) estimate more than 100 animals were sacrificed to obtain 15 horns.

Borner describes the rhinoceros' use of overlapping home ranges, which use the same focal points, most importantly salt licks and wallows. These focal points are occupied by a single bull, but visited by several cows and their calves. The trap systems are often found around such focal points, leading to a much higher capture rate for the females. Consequently, the use of these systems have devastating effects on the entire rhinoceros population.

As Hubback (1948) observed from trails the calf is just as often moving behind the cow as in front of it. The traps thus often catch a young rhinoceros without horns, but also in the cases when the cow is killed, the result is disastrous for the orphan.

To summarize, there is evidence of both spear-hunting and the use of pitfalls for both African and Asian recent rhinoceroses. Except for the specialized poaching of the East-Asian Sumatran rhinoceroses using traps (where the intensity with which it is conducted is a very recent phenomenon) no information of skewed patterns of mortality favouring one sex or particular age classes has appeared. The skewed pattern here is, however, rooted in a particular territory system.

For the spearhunters referred to above deliberate choices of prey are rarely mentioned, and it seems that in several instances rhinoceroses had not been the specified target for the hunting excursions. The spearhunters kill both young and old, males and females alike, and the kills appear to be determined more by encounters and luck, than detailed planning.

DISPOSITION AND BEHAVIOR OF RECENT RHINOCEROSES

For the Indian rhinoceroses living in the swamps of the Kaziranga reserve Ullrich (1964) could observe a system of private and communal paths. The private paths led to individual territories, where an adult (cow or bull) resided. Communal paths between territories led o. a. to wallows or ponds where up to 9 rhinoceroses could be observed at the same time.

Ullrich notes, that out of the 12 times he was attacked during the fieldwork, cows with calves were responsible for 8 attacks, and bulls only for four. When the cow attacks the calf stays behind her, but runs before her when fleeing. Undisturbed, the calves most often walked in front.

Laurie (1982), who studied the Indian rhinoceroses in the Chitawan valley of Nepal, found that the ranges of adult rhinoceroses differed in size and location, but were not exclusive. Even among the breeding males no true territoriality was found, but only some degree of range exclusivity. No specific breeding or birth season was found. There were, however, slight birth peaks at the beginning of the year and in the autumn.

According to Foster (1960) the South African white rhinoceros is not an aggressive animal, and he is critical of the host of unauthenticated stories of Europeans or natives being chased by rhinoceroses.

Both Kingdon (1984) and Ritchie (1963) mention that the calf of the white rhinoceros goes in front of the mother, but that a calf of a black rhinoceros follows behind. These observations are, however, not undisputed.

Lang only found smaller groups af white rhinoceros in the Belgian Congo:

»Often troops of five included, besides the adults, a calf, a threequarter grown and another still youthful member. In spite of well pronounced climatic seasons there is neither a rutting nor calving period, and at any time throughout the year young may be seen. They walk either ahead of or behind the mother, and contrary to general belief, this surely is not a characteristic distinction between the white and the black species; but in case of danger the calf invariably precedes (Lang 1920, p. 89).

Stockley (1948) reports that young calves of black rhinoceroses often posed a problem for the wildlife photographer, since they have a much better eyesight and are much more inquisitive than the mother. The calf would often spy the photographer long before its parent and run nearer, bringing the mother to rush in to support her child. This, however, only pertains to very young calves, after about 18 months of age the cows seemed less prone to support the straying calves.

For both the white and the black rhinoceros females the extent of their range is determined by the resources of the area, and shared with other females, or small groups of subadult or non-territorial bulls. Breeding is continous, but possible mating peaks occur at the end of the dry season. The subadult calves are rejected as three to four year olds, and will mostly team up with another subadult. Dominant white bulls occupy small territories, but may journey out of these to reach e. g. a waterhole. The black rhinoceros bulls seem to have more loosely defined ranges (Kingdon 1984; Owen-Smith 1975).

For both species waterholes and places for wallows and dust-bath are focal points, reached by well defined paths, where many rhinoceroses may be encountered at the same time. The importance of mud- or dust-baths is underlined for both the white and the black rhinoceroses species, and such baths are normally undertaken once a day. Droughts have killed large numbers of both rhinoceroses, and during dry conditions rhinoceroses from a large area may concentrate around permanent waterholes (Kingdon 1984).

Black rhinoceroses are reported by most authors as solitary or associating in groups of two or three animals. Both males and females are found solitary. Groups may include a bull besides female and calf or juvenile (Roth and Child 1968; Ritchie 1963).

Ritchie (1963) characterizes the white rhinoceros as »a dependable and well-mannered beast, whereas the black rhinoceros is »irritable and explosive, and capable of vicious and vindictive action without provocation.«. (Ritchie 1963, p. 54). He does, however, qualify this view based on field observations in Kenya, where the »temperament« of the rhinoceroses is seen as conditioned by different types of interference. In bush covered areas where the rhinoceroses have been hunted »from time immemorial« by natives using poisoned arrows the result is a truculent animal ready to charge instantly in order to survive. Flight would here mean an arrowshot and death. Contrary to this the rhinoceroses living in more open areas with the pastoralist Masai are left undisturbed, unless a rare individual happens to attack cattle or people at a waterhole in which case he is promptly speared. »A race of peaceable well-behaved animals has thus grown up, always ready to retire unless provoked beyond endurance«. (Ritchie 1963, p. 59) Ritchie (1963) feels confident that most charges by black rhinoceroses especially by those not used to humans are commenced by the animal approaching out of curiosity, but that this may develop into charging if the animal feels too insecure to retreat.

INTERPRETATIONS OF THE TAUBACH RHINOCEROS EXPLOITATION

As mentioned above information about the behavior of recent rhinoceroses has already played an important role in our picture of Pleistocene hunting. All of the recent species are close to extinction, and the most informative sources can indeed be considered historical, describing populations and living conditions which no longer exists. It can be argued, that since both Merck's rhinoceros and the narrow-nosed rhinoceros are extinct species, we will never know exactly how they lived, and how Neandertal man acquired them. This has, however, not hindered many archaeologists from having an opinion, and in some cases even presenting this in quite categorical statements. Since so many of the Stone Age faunal assemblages are, to put it politely, inconclusive, and all without exception need an interpretation to come to life, there is ample room for discussion. As was suggested above, many of our reservations against the thought of active rhinoceros hunting appear to stem from European, late historical tradition. The purpose of the foregoing short compilation of information on the habits of living rhinoceroses is to see whether some of the parallels employed earlier in the interpretation of Taubach, may not, in fact, be too limited. The aim is not so much to establish a »How to be a rhinoceros«handbook, as to be inspired by the variability.

The Taubach material is dominated by remains of Merck's rhinoceros, which has been estimated to be larger than any of the living species, including South African white rhinoceroses. The adults have been estimated to be about 2 to 2.5 m at the withers, whereas the largest white rhino bulls have been measured to 1.85 m (Guérin and Faure 1983; Kingdon 1984; Heller 1913). Merck's rhinoceros can, however, be imagined as a slightly more slender animal.

Using dental age data from another browser, the black rhinoceros, the Taubach sample was estimated to be dominated by calves about one to one-and-a-half years old, with infants and older calves (as well as grown-up animals) being relatively rare. The general picture of the frequencies of the age classes is probably accurate, although the older animals may possibly be slightly underrepresented. It is, however, quite likely that the chronological ages are not fully correct. It would not be surprising if an animal nearly double the size of a black rhinoceros needed a somewhat longer period of growth. What matters here is that the Taubach calves fall in an age class where they are likely to have been part of a mother-calf group, but are old and large enough to no longer be under the mother's constant surveillance.

In the field guide for age estimation of white rhinoceroses developed by Hillman-Smith et al. (1986) white rhinoceros calves of about one year of age are shown as having attained approximately two-thirds of their mothers height at the withers. Merck's rhinoceros calves of the same age can, per analogy, well have been quite large prey.

Soergel's (1912, 1922) interpretation of the age distribution of rhinoceroses in Taubach as being due to trapping in pitfalls, was inspired by two things. First, pitfalls constituted a sufficiently low level of technology to be entrusted to in the hands of Neandertals. After all, these humans were at his time of writing still depicted as primitive »ape-men«, and in every respect considered to be very far from recent men. The interpretation of naturally broken antlers as picks or digging sticks, provided the tools at the site, and could thus be used as supportive evidence. Secondly, the rhinoceros calves were postulated to walk before their mothers and thus, logically, to have a much higher chance of dropping into the pits. Soergel was inspired by the same accounts of the use of pitfalls around wallows in Java, where the pit systems proved frighteningly efficient despite their technological simplicity.

Among later generations of archaeologists this neat picture has remained quite influential. It does, after all, employ the same types of argument as can be observed in recent discussions of faunal exploitation, the present one included, namely: an estimate of the available technology, the recognition of an unnatural age distribution and information on ethnologically known hunting practices and the behavior of recent representatives of the animals in question.

Gaudzinski and Turner (1996) noted that my »detailed study of the same material in 1995 provides confirmation of the same factors which Soergel employed as arguments for human hunting, but beyond this and even with an exact set of data the mode of acquisition of the modified carcasses remains speculative. It becomes clear that even after 20 years of analytical deliberation we still do not possess an appropriate methodology for the identification of Palaeolithic hunting strategies« (Gaudzinski and Turner 1996, p. 155). I do not fully agree with this statement. As exemplified by Taubach, but also seen in several other cases of re-evaluated old assemblages, there has been progress. The progress does, however, manifest itself in the movement away from very definitive interpretations towards the recognition of how often multiple causes may lead to similar end products, and that the interpretations necessarily will contain an element of speculation. This awareness has, however, also led to a more critical approach to the faunal samples presented for study, and we may be much more willing now than a generation ago to accept, that a bone sample may not answer all our questions conclusively, no matter how much time and intellectual energy we invest in the analysis.

Returning to Taubach and Soergel's suggestion of hunting rhinoceroses using pitfalls at least two of the arguments need reconsideration. The first and simplest argument is that recent rhinoceros calves do not always move before their mothers and that the notion that Merck's calves should have done so is simply a postulate. (As a matter of fact the pit systems or other traps supplying the horntrade in Asia should hardly have been so popular if only hornless youngsters were caught.) That the Neandertals were fully capable of using more advanced hunting methods has been discussed above.

Pitfalls have, however, been widely in use both for the Asian and the African rhinoceroses, as well as for other forms of large game. It appears to have been a cost-effective hunting method in areas where the soil conditions supported stable or even slippery walls for the pits. It is to be doubted that the travertine sands would allow the construction of pits with firm, steep sides. In a wider area around the travertine, clays and other solid soils would be present and pit systems with a long use-life could have been constructed. To make a contribution to the Taubach faunal assemblage, however, a considerable effort would have been necessary for the transport of the carcass of very heavy prey to the travertine area, when these could just as well have been butchered close to the traps.

Thus, hunting by pitfalls can not explain the mortality profile of the rhinoceroses, nor is it in agreement with the finds of bone concentrations and hearths in an extended area of friable travertine. For a broader view of the hunting practices at Taubach the other abundant species need to be incorporated into the discussion.

RHINOCEROS HUNTING – THE EUROPEAN BACKGROUND

The populations of the five recent species of rhinoceros have all suffered greatly from hunting, and later poaching, during the last two hundred years. From about the middle of the 19th century into the first decades of the 20th the hunting of large game, including rhinoceroses, was a popular sport for well-off European gentlemen. As a matter of fact the word »sport« was at this time synonymous with hunting, and, *notabene*, hunting for the pleasure of doing so, without regard of a material gain.

The majority of the records of rhinoceros hunting can be found in the rather extensive literature describing travels and »sports« in Africa and Asia. Of the 82 references to rhinoceros hunting surveyed in connection with this study, 27 can be characterised as zoological reports concerned with the life and preservation of the rhinoceroses, while 25 were more general geographical works noting e. g. the wildlife and local customs of exotic countries. The remaining 30 were travel accounts, where explorers and big-game hunters describe their »travels and adventures«. This sample of references is by no means exhaustive, but as the target for the search was actually to find descriptions of rhinoceros hunting by the local, native peoples, the known omissions are mainly in the department of big-game hunter's books. The three groups are not sharply defined, for example Heller (1913), which actually is a zoological report, includes sections on rhinoceros shooting that could have been part of any big-game hunter's diary.

The travel accounts are about a third the work of explorers, where the main focus is on the descriptions of the new country. Hunting is here primarily a way of supporting the expedition and securing its survival, e. g. Alexander 1838, and not the primary purpose of the endeavour. In the remainder, big-game hunting for sport is one, and often the only, reason given for the travel.

The typical author can be characterised as a young, economically independent European man, most often from England or France, travelling to the colonies to enjoy the sport. The accounts of the most interesting episodes are concentrated around the technical and practical procedures and may often almost give the impression of a military report, giving a step by step account of the movements of the prey and the hunter. Intermittently, especially when the travels are longdrawn, proceedings are more casually related. Two examples, both taken from Baldwin's »African hunting« (1894) relating his adventures in South Africa may illustrate this:

»August 1st. – We were ploughing our way through long, heavy wet grass and scrubby thorn trees, when an old rhinoceros cow got up slowly from behind a thorn-tree, and, after giving me a good stare, advanced slowly towards me. I had only my small rifle, my gun-carrier being about twenty yards behind me with my No. 9. I beckoned frantically to him to come on, but he seemed very undecided. At last, however, being a plucky little fellow, he came up, threw the gun at me, case and all, and ran up a tree like a monkey. I lost no time in getting the gun out of the cover, and gave the rhinoceros a ball in the chest. She turned round in double quick time, panting like a porpoise. I followed, but a Kaffir cur prevented me from getting very near, so she got away.« (Baldwin 1894, p. 99).

Several days later, in between comments on a broken wagon axle, buffaloes, and the weather, the description is more limited:

»We saw a quantity of game yesterday, and killed four rhinoceroses and two giraffes, and altogether had the finest sport since leaving the house.« (Baldwin 1894, p. 211).

The observations in these books are clearly limited in scope to the special interests of the European traveller and his peers at home. One of the common features is that the natives accompanying the hunters are described by their functions as carrier, trackers, the villagers etc., but rarely have a name, let alone a personality.

Native hunting methods are seldom described more than cursorily. In general, more attention is given to the fact that the natives are interested only in the meat and, where these parts have a market value, the horns and skins of the rhinoceros. Contrary to this, the European traveller hunts solely for sport, or, when necessary, to supply his carriers with meat so that the expedition may proceed. When native hunting is mentioned it is mostly critically, so for South Africa (Coryndon; Baldwin) and West Africa (Foa):

»I never saw a country as this is for losses; you cannot reckon on anything, and live stock is a most precarious property. I lost two valuable oxen yesterday in pitfalls, both breaking their necks as they were going to the river to drink; if it had happened to a Boer, he would have taken two Masara children in their stead, as we had told the Masaras to open all their pitfalls and traps during our stay, and they had neglected to do so.« (Baldwin 1984, p. 318).

»It is a curious fact that under the skin of the two animals which I shot I found six native bullets., which the Rhinoceroses must have carried about with them for years; two of these bullets were of hammered iron and four were of lead. This remarkable fact is decidedly in favour of my argument that it is impossible to *preserve* the very few remaining specimens, as the natives of course do not look at the matter from the same point of view as savants at home; they want meat, and when they shoot or trap an animal, which is luckily seldom, they do not preserve the skin.« (Coryndon 1894, p. 332).

»Dans L'Afrique orientale de 1880 à 1890, ont abattu des centaines de Rhinocéros en quelques mois. Le commerce s'en méla, vendant la corne et le cuir, et les marchands armèrent des équipes entières de chasseurs indigènes qui dépeuplèrent rapidement la région au sud du Zambèze. Partout, du reste, les indigènes font la guerre aux Rhinocéros comme aux Eléphants dans le but de se procurer de la viande, nourriture dont ils sont extrêmement friands. Ce qui a été tué d'animaux pour ce seul motif est incalculable!« (Foá 1907, p. 406).

A regular feature is the description of the eagerness with which the natives secure the meat of killed prey, furnished with more or less subtle indications of both the white hunters higher ethical stade, and his superior abilities as a provider. The first point has been expressed most clearly by Couperus hunting in Java:

»Le vrai chasseur ne chasse pas pour manger, mais cela n'empeche pas qu'il aime beaucoup à bien diner du produit de sa chasse, . .« (Couperus 1887, p. 314).

The estimates of hunting African rhinoceroses of both species may appear contradictory, with several writers indicating how dangerous the animals are, and others considering them easy to shoot. It is, however, apparent, that the more experienced big-game hunters with a firsthand knowledge of rhinoceroses tend to play down the popular notion of rhinoceroses being ferocious opponents. For example Coryndon (1894) writes that:

»Both rhinoceroses are easy to shoot, and it is a small wonder that when a long train of carriers have to be fed, or when natives are hunting for a supply of meat to carry back to their kraals, rhinoceroses were shot in preference to buck, wary and difficult to stalk as they are and as a rule more tenacious of life.« (Coryndon 1894).

Augiéras (1935) summarizes the most important points in his book »La Grande Chasse en Afrique«, namely, that on one hand rhinoceros hunting:

»Elle présente des analogies avec la chasse à éléphant, mais elle est beaucoup plus facile. Le succès est même assuré dès que le chasseur est sûr des traces fraîches, avec vent favorable, et c'est cette facilité qui est cause de la raréfaction rapide du rhinocéros. C'est un animal stupide qui se défend mal. (Augiéras 1935, p. 62).

On the other hand, the rhinoceroses might become dangerous, in that they charge after being provoked, and in rare moments apparently spontaneous, unprovoked attacks may occur.

»Toutes les bêtes fuient naturellement à l'approche de l'homme, même le lion. L'attaque spontanée est l'exception (rhinocéros quelquefois), et encore est-elle généralement provoquée indirectement par une circonstance fortuite ou un cas particulier ...« (Augiéras 1935, p. 44).

The descriptions of rhinoceroses as aggressive and bad-tempered puts an undue focus on the sheer possibility of a sudden shift from apparently docile prey to attacker. The more qualified summaries, cf. Ritchie 1963 above, can be compared to the popular presentations, where the rhinoceroses play the role of the exemplary »brute«. This role has an age-old tradition, and may even be encountered in fairly recent books, for example black rhinoceroses are quite eloquently described in Stockley's »African camera hunts« (1948, p. 27):

»Sulky, stupid, bad-tempered, and uncertain, rhinoceros start their life, after a 15-month period of gestation, already endowed with a pronounced offensive spirit«.

In the sportsmen's literature of the late 19th and early 20th century it is emphazised that the killing of the game is the job of the European hunter, and implications of a lack of interest and courage in the native helpers are abundant. The descriptions of the reactions of the native helpers when approaching or facing the rhinoceroses, tend to show those reactions, that can be interpreted as cautious and fainthearted, like staying behind or fleeing, cf. Baldwin, cit. above, thus indirectly highlighting the white hunters own composure in the face of danger.

In this behavior we find repercussions of the duelling ideal, where one of the central elements is the ability to coolly confront the opponent. Despite the early abandonment in England of the duel as a means of solving conflicts of honour, it was still practiced on the continent during the 19th century, and the perceptions of a gentleman's courage and his responsibility to uphold the »male dignity« of his class was still of paramount importance. It has, as a matter of fact, been suggested that the British devotion to »sports« was a compensation for the inability to indulge in duels, thus providing an outlet by which young men could exhibit their nerve and courage »with the empire's population of big game awaiting their challenge«. (Kiernan 1988; Frevert 1995).

In the surveyed references the majority of the attacking rhinoceroses belong to the black rhinoceros, with white rhinoceroses a distant second. With the exception of the Indian rhinoceros, the already rare Asian species are rarely mentioned. The black rhinoceroses are apparently to a large extent responsible for the rhinoceros' bad reputation for aggressiveness. Ritchie's observations, that the rhinoceros' behavior can be conditioned by local hunting practices and that charges may be trickered from insecurity, are important in that they may explain many allegedly unprovoked attacks.

Most of the described rhinoceros charges can be explained by preceding severe provocations, ranging from a hunter shooting at or otherwise attacking the animal, to the camera man purposely approaching a cow with a small calf. In other situations people apparently happen to be in the way of animals already on the run. Measured by the extent and intensity of the text spent on these encounters, it does, however, become obvious that a rhinoceros »situation« both provides a more fascinating subject and a better background for some courageous posing, than the slaughtering of ever so many fleeing animals.

Another point is that a charging rhinoceros does not play by the rules of the European duel. The indigenous tactics described for both African and Asian spearhunters, namely of immediately retreating to a tree or other secure position after the spear has been used, and then surveying the developments from there, would involve a behavior unbecoming for a gentleman. The stories of encounters with attacking rhinoceroses emphasizing the dangerousness of the animals recounted in the sportsmen's diaries, and retold later in the wider popular literature in Europe, may thus owe very much to calculated provocations of the rhinoceroses on the one hand, and on the other to the reluctance of the European guests to adapt to less risky tactics in these confrontations.

HUNTING BROWN BEAR

The majority of the available written records of bear hunting, whether utilitarian or primarily for sport, involve the use of modern firearms. This may not be surprising since the accounts of large mammal hunting to a very large extent relate the exploits of 19th or early 20th century European or North-American gentlemen, and thus the interest is centered around their sports and travels. Other distance weapons, like the bow and arrow, may be briefly mentioned as being used or, more often, formerly in use by the native hunters encountered.

Apparently, a shift from traditional weapons to rifles in the hunting of bears and other dangerous animals often happened very quickly and as soon as firearms became available. Moreover, it can be inferred from later accounts that this transition must often have taken place during the first contacts, well before detailed descriptions of the traditional material culture were found relevant. In ethnographic and ethnohistorical research there has been a notable interest in the beliefs and ceremonies governing the relationship between man and bear in different cultures, but concerning mere practical matters like hunting tactics and weaponry the records are very limited.

Concerning the European brown bear the spread of firearms after approximately 1600 AD meant not only a sudden change in hunting practices but also a rapid decline in the bear population. From the 16th century dramatic scenes of men killing bears using spears, swords or clubs occur in as diverse places as church paintings and illustrations to books on travel or sport hunting by the nobility. The woodcarvings from the »Neuw Jag unnd Weydwerck Buch« (Frankfurt a. M. 1582) are particularly informative, showing bears attacked by packs of large hunting dogs and men on foot or horseback using a spear or sword to kill the animal. When compared to the illustrations of wild boar hunting from the same book, the tactics and weapons appear identical. In both cases the use of a pack of heavy hunting dogs (mastiffs) to distract and hold the prey is essential, and a broadbladed, short spear (Saufeder) is the main weapon. (Troels-Lund 1908).

The described type of hunting practices is not unlike the then widespread practice of »baiting«, or arranged fights between bears and other animals. In many cases »hunting« for the European nobility meant merely the killing of captive animals in game parks. For curiosity's sake it can be mentioned that one of the entertainments provided for Elizabeth I. during her visit to Kenilworth in 1575 involved a collection of mastiffs let loose onto thirteen bears, a show described by a contemporary as »a sport very pleasant« (Thomas 1983, pp. 147).

From Northern Scandinavia the few accounts of bear hunting using spears relate to the traditional Sami practice of killing denning animals. As late as 1780 the complicated ceremonial surrounding the killing of a bear and the later treatment of the carcass could be observed in Lappland by L. L. Læstadius.

Concerning bear hunting itself, however, the practices are only briefly related: in the autumn the denning site is noted, but the bear is left there quietly until spring. In March-April, while there is still snow, a group of hunters attacks the hibernating bear killing it with spears. In the days after the kill, the bear is skinned and the meat utilized following a strict set of ceremonial proceedings believed to do honour to the animal. One of the important points is that the bones must not be damaged, they are instead collected after boiling and carefully buried, ideally in an anatomically correct position (von Düben 1873).

In British Columbia bears were hunted on a regular basis by the Upper Stalo indians. Black bear meat was considered the favorite, whereas grizzly was less used as being more difficult to obtain. Black bears were hunted using trained dogs, which pursued the bear until it tired and the hunter could come up and kill it using a spear or arrows. Pitfalls with sharpened stakes inside the hole were used both for deer and bears, and deadfalls were constructed for bears as for the smaller fur-bearing animals. Hibernating bears could be killed in their retreats using spears.

For grizzlies it is noted that dogs were of little use. A rather hazardous hunting method reported for grizzlies involved the use of pointed bones, which should be placed in the mouth of the attacking bear. While the bear fought the pointed bone the hunter could kill it with a spear (Duff 1952).

Further south, in northeastern California, both black bear and grizzly were hunted by the Modoc people. The usual weapon was the bow and arrow, dogs might be used for black bear hunting.

Black bears were usually teased out of the den with poles and shot with arrows, when they emerged. Whereas black bear hunting was a more individual effort, grizzlies were pursued by several hunters in what according to the description was considered more of a sport. One of the best runners would get the bear to chase him and thus lead it along a route where other hunters with bows and arrows were posted. When the bear had been hit several times it was finally tracked and killed (Farmer, pers. comm.)

From Greenland a few accounts of the traditional way of hunting polar bear with lances are available. According to Fabricius (1812) for the hunting of polar bears the eskimo prefers »the same hunting equipment as for seals and other marine animals and in particular the bear will be killed instantly with the large lances, of several in company and preferably when they meet it swimming, for on the ice it often has much more endurance and breaks many lances for the eskimo; therefore, when they meet it on the ice with a dog sledge, they let the dogs loose to help in the pursuit, and while it protects its hindquaters against them by sitting down to offer resistance it will more easily become the prize of the hunters, who then have the opportunity to lance it.« (Fabricius 1812, author's transl.).

As late as 1895 Eivind Astrup could report examples of traditional polar bear hunting with lances from Smiths Sund, i. e. the Thule district. He had participated in Robert Peary's North Greenland expeditions in 1891-92 and in 1893-94 and was, only a year later, able to publish a memoir of his travels.

He includes here some accounts of hunting episodes as related by the eskimo hunters themselves. The most important area for polar bear hunting was the ice of the Melville Bay, south of Cape York. The bears were pursued with dog sledges before the dogs were let lose to confront the bear and the hunter could atttack it with a lance and hopefully kill it. His informants are characterized as renowned hunters. In the stories related in detail by Astrup, dramatic complications occur. In one the bear unexpectedly turns, and the lance directed to the heart and ribcage instead hits the shoulderblade and is broken by the furious bear. The hunter is attacked and wounded, but miraculously saved by two other hunters entering the scene and shooting the bear with a gun.

In another encounter the bear is shot with arrows before it is wounded with a lance. Again the lance breaks, but the wound and the attacking dogs finally exhaust the bear. In a last anecdote the hunter relates how on encountering a bear he improvises a lance using his metal knife and the shaft of a sealing spear. Unfortunately the knife loosens when the bear is hit and the wounded animal flees with one of his most valuable possessions (Astrup 1895).

At the arrival of the expedition only one of the eskimo was found to possess a rifle. Commenting on reindeer hunting, which was an important means of support for the expeditions, it is mentioned that several of the eskimo required rifles from the two expeditions:

»At our arrival the first time to these coasts in 1891, (the reindeer) was still predominantly hunted using bow and arrow; at our departure in 1894 these tools were totally abandoned, and in the near future they will surely be seen only in the showcases of a few ethnographical collections (Astrup 1895, p. 130, author's transl.).

The same might have been said for the bear hunting lances.

The references quoted above come from different continents and time periods. Nevertheless there seems to be wide agreement in the use of large dogs to keep the bear occupied, thus enabling a single hunter to do the kill. Large dogs can in this respect be imagined to have been a technological improvement comparable to the introduction of firearms. The situations mentioned above, indicate two important aspects of bear hunting tactics: to keep the animal from fleeing and to keep it distracted by a swarm of attackers, so that it will not concentrate on one opponent. A weaponry consisting only of spears or lances is thus not *per se* a hindrance for confrontational hunting of large bears.

A greater danger may in fact have been the porkworm (*Trichinella spiralis*) which can cause severe, prolonged illness and even death. Greer (1972) examined heads or complete carcasses from hunter's kills of grizzly in Montana, and found that *Trichinella* occurred in 67% of 37 animals. The most infested parts sampled were the tongue and the masseter muscles. The cutmarks found on the Taubach mandibles do in fact testify to the consumption of these parts.

Relatively high infestation rates have also been reported for brown bear in Russia and for Greenland polar bears, whereas black bears have relatively low rates. Infestation rates seems in nature to be connected to scavenging for food. Thus carnivores and omnivores with a habit of scavenging (including domestic dogs and pigs in many parts of the world) consistently show the highest local infestation rates (Kim 1983).

Grizzlies studied in Yellowstone were observed to travel several miles for a »ripe« carcass, and scavenging was determined as their most important source of meat. Especially prior to or immediately after hibernation the bears can be easily attracted to carcasses, leading to the use of baits by hunters (Craighead and Craighead 1972). On encounter, wounded bears and mothers with cubs are considered the most dangerous to approach.

Recent bear densities are dependent on the carrying capacity of the area and, to a high degree, on local hunting pressure. Some of the highest densities were found in the USSR, 1-3 bears per 10 km^2. Higher, but very local densities have been found for Kodiak bear (McTaggart Cowan 1972).

CONCLUDING REMARKS

Judging from the information of the available sample the faunal remains at Taubach are dominated by the remains of hunted animals.

The extensive bone accumulations at Taubach indicate repeated and successful use of the locality for large game hunting over a long time period. We can furthermore assume that the majority of the large game animals was killed and butchered more or less on the spot in the travertine area.

That Taubach seems to fit well into the role of a kill-butchering site where bones of local kills accumulated over time does not, however, mean that the functions of the site could not have been extended temporarily. The described hearth areas, for example, appear somewhat extensive for stops of only one day's duration, and the presence of minor prey like the beavers would indicate that smaller trapped (or speared) game was on occasion brought in from the surrounding area. One conceivable scenario would be that a successful killing of very large game prompted the movement of the homecamp, if such a thing existed, to the killsite with a somewhat longer stay following.

There are, however, good reasons why recent hunters tend to leave the site of large game kills. First of all, staying overnight near a fresh carcass will involve the risk of severe confrontations with large carnivores, and this in a situation where the carnivores have all the tactical advantages. A planned retreat taking as much of the useful parts of the carcass as possible will then be a more economical and less risky solution. A second point is that constant human activity will in most cases disturb the game animals, thus making an otherwise favourable hunting spot less productive. The hunter's dilemma is, in other words, to ensure as many encounters as possible, where the game animals are placed in a tactically favourable situation and, at the same time, avoid that the reverse should happen to himself in the confrontations.

Considering only the large game, we have indications of active hunting focusing on particular fractions of the prey populations: subadult rhinoceros calves, adult bears of both sexes and adult male bison. This is, however, as far as the information of the bone sample takes us. The really interesting questions of how the hunting practices, which led to these patterns, were organized and which methods and tactics were employed lies beyond this. But, rather than leave the interpretation there we may indulge in a little informed guesswork on the basis of the recent parallels, well knowing that this is speculation involving a lot of »ifs« and »could bes«.

One question is, what brought the animals to the area of »sandy« travertine in the first place. The travertine area could have provided a fairly easy route to watering places, but with a small river nearby, water can hardly have been a limited resource. There should have been plenty of other situations along the Ilm, where the animals had ready access to water. We may in fact assume that other favourable kill sites lined the river.

Another resource attracting game animals from wide areas are occurrences of concentrated mineral salts in so called »salt licks«. The studies of ostracods indicate that water with higher than average salt concentrations appeared in the »bone sand«, but first became a marked feature in the »mollusk sand« above the findlayer and receded again higher up in the Taubach travertine profile. So far no strong salt concentrations can be linked to the findlayer.

The travertine area can be pictured in the »bone sand« phase as an extensive bed of powdery or sandy, friable travertine, where the exact relation between wet and dry areas changed seasonally and probably also from year to year depending on the local springs. It is possible that the friable travertine was especially suitable for wallows or, when dry, for dustbaths, and consequently provided an attraction particularly for the rhinoceroses and to a lesser extent the bisons and elephants.

As noted above for the recent species of rhinoceros, spearhunting as well as catching in pitfalls were both widely used hunting techniques. The use of spears has been documented for the Middle Palaeolithic, whereas the use of pitfalls is harder to prove.

A variety of other types of traps was employed in recent times for catching rhinoceros or other large game and the technology of Neandertal man may have been no less sophisticated in this respect. If we narrow the discussion down to pitfalls vs. spearhunting, the latter does appear to be the more relevant technique for Taubach. The nature of the sediment argues against the idea of local pitfalls in the travertine area, and the abundance of cutmarked bones, including those from the less productive sections of the carcasses, would indicate that the kills and the butchering actually took place there.

The rhinoceros material contains a small number of older individuals, showing that hunting of calves was a favoured, but not exclusive, activity. If the rhinoceroses at Taubach followed the behavioural pattern of one dominant bull monopolizing a focal point, in this case a wallow, where the cow-calf pairs from the surrounding areas gathered, the local frequency of calves in relation to grown-ups would be relatively high, and the possibility of encountering young animals greater here than in the area at large. Even under these circumstances random kills would hardly give more than approximately equal numbers of calves and older rhinocerosse and not produce the overrepresentation of youngsters seen in the bone material.

Considering the young rhinoceroses, the peculiar overrepresentation of young subadults can not at present be explained to full satisfaction. One possibility (inspired by the black rhinoceroses) is that this age class was still inquisitive and impulsive, but no longer under the mother's constant surveillance and protection. A hunting tactic which capitalized on the calf's curiosity to approach and wound it before the cow took notice might over time give a higher frequency of killed youngsters.

The bovid material is on the contrary dominated by adult males, which actually could have provided more dangerous adversaries than the rhinoceroses. Adult bulls are, however, the animals most likely to be encountered alone, and might consequently have been more vulnerable than a whole group of bovids.

Considering the brown bears, the simplest way to attract large adult bears to the travertine area would be to leave whatever remained of a rhinoceros or bison carcass and then retreat for a day or two. The bear hunting episodes summarized above indicate that the essential points in the spear or lance hunter's tactics are a) to prevent the bear from fleeing and b) to prevent it from focusing on individual attackers. Confronting a large bear is not a riskfree endeavour, but should on the other hand not be an impossible task for a well co-ordinated group of hunters.

It is a question, whether our way of viewing Stone Age hunting practices is not too fixed on the strictly utilitarian aspects.

Rhinoceros and bear hunting at Taubach may, after all, not be a typical subsistence activity, but rather belong in that end of the spectrum where the hunters test the limits of their capabilities.

A recurrent observation from the recent rhinoceros or bear hunters is that these animals, in combination with their practical carcass value, represent the highest odds the hunter can hope to overcome. Besides the meat, skins and other readily quantifiable goods, the ability to kill these large and potentially dangerous animals brings the hunter a considerable amount of prestige in his community and thus a shortcut to many of the other good things in life.

One of the »Boschmen« encountered by Alexander during his travels in Southern Africa pointed this out very clearly:

»I showed them a looking-glass the first they had seen, and they seemed pleased with their own looks; and one of the men, about forty years of age, now discovered for the first time that he had a beard on his chin, and with which he seemed proud. I asked him what was that of all other things he wished for in the world – was it plenty of wives, of children, of cattle, of sheep, of clothes, or a good hut? and he answered, "the rhinoceros, and to get it easily."« (Alexander 1838, bd. I, p. 289).

SUMMARY

The stratigraphical position and the dating of the large mammal fauna recovered from Taubach have been evaluated, with the conclusion that the findlayer, i. e. the »bone sand« bed, is a separate entity, different in character from the upper part of the travertine profile and separated from this through a depositional hiatus. The hitherto undisputed dating of the entire Taubach travertine to the maximum of the Last Interglacial is based on information from the upper part of the profile. This dating does thus represent a *terminus ante quem* for the »bone sand«. The precise dating of this bed is not clear, an early phase of the Last Interglacial or a temperate phase of the preceeding intra-Saalian Interglacial may both be possible.

The faunal material recovered from the »bone sand« in the late 19th century has been surveyed in respect of modification traces and mortality patterns. The results support the long-standing interpretation of Taubach as a substantial Middle Palaeolithic kill-butchering site. The now apparent dominance of remains of Merck's rhinoceros and brown bear may, however, be partially due to collector's bias.

For four species, Merck's rhinoceros, brown bear, bison and beaver, cutmarks testified positively to exploitation by man. For the other animal species found at Taubach the bone samples were too small and inconclusive in respect of modification traces. For some of these, e. g. the elephants, the mortality patterns are more consistent with killsite residue than accumulations of natural deaths.

Evidence for the hunting of rhinoceroses has long been a part of the Taubach legacy. Active hunting of megafauna by Neandertal man has, however, lately been questioned and deemed improbable by several authors. The available written sources describing hunting of recent rhinoceroses have been surveyed with the conclusion that scepticism concerning rhinoceros hunting in the Middle Palaeolithic is rooted in a European, historical set of prejudices and supported neither by ethnographical nor by archaeological sources.

APPENDIX A
N and MNI

Abbreviations

pr: proximal (articular end)
di: distal (articular end)
dia: diaphysis
ol: olecranon
mf: (open) metaphysis
ep: epiphysis
mp: metapodium

Mercks rhinoceros / (Narrownosed rhinoceros)
Stephanorhinus kirchbergensis / (Stephanorhinus hemithoecus

Cranial:

	JU	SA I	SA II	SA/AD	AD
Cranium:	4			8	3

	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
Maxilla:	2	1	1				1		2	1
			JU/SA I		SA II		SA/AD		AD	
Mandibula:			s+d		s+d		s+d		s+d	
Symphfr.			1				5			
			s	d	s	d	s	d	s	d
Corpus			38	34	8	2			9	9
Ramus			1	1			2	5		

Sum:	SA I	SA II	SA/AD	AD
N:	75	10	12	18

Dentes: 368

MNI: 44 JU/SA I, SA II 7, AD 11 (mandibula)

Postcranial:

Axial

	JU	SA I	SA II	SA/AD	AD
Atlas:					
intact	-	-	-	19	-
sin $^{1}/_{2}$				2	
dx $^{1}/_{2}$				6	
Axis			4		6
Vert. cerv.		8		29	
Vert. thor.		2		18	
Vert. lumb.					1
Sacrum					
Vert. caud.					6
Costa				3	

Sum:	JU	SA I	SA II	SA/AD	AD
N:	-	-	14	30	60

MNI: 25 SA/AD (atlas)

Anterior:

Scapula:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact		2		1				4		
di + 2/3			1	1		1	14	14	3	2
di + 1/3			1				5	2		
di										4

Sum:	JU	SA I	SA II	SA/AD	AD
N:	2	4	1	43	5
MNI:	2	2	1	24(23)	3

Humerus:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact									2	3
di-mfpr					3	1				
mf-mf	1	1		1						
di + $^{2}/_{3}$							2	2		
mf + $^{2}/_{3}$		1	1	2						
di							3	1		
dimf			1							
pr									1	1
dia-fr.								2		
Sum:	JU		SA I		SA II		SA/AD		AD	
N:	3		5		4		10		7	
MNI:	2		3		3		5		4	

Radius:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact									1	2
pr-dimf					2					
mf-mf	3	1	1	2						
pr							2	1		
pr + $^{1}/_{3}$			1				1	3		
pr + $^{2}/_{3}$			1				5	2		
di mf						1				
Sum:	JU		SA I		SA II		SA/AD		AD	
Sum: N:	4		5		3		14		3	
MNI:	3		3		3		7		2	

Ulna:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
mf-mf	1	3								
pr+ol+dia									2	
pr÷ol							2			
pr÷ol+dia						7	3			
pr÷mf	1	1								
dimf+dia						1				
di								2		
dia-fr.									2	1
Sum:	JU		SA I		SA II		SA/AD		AD	
N:	6		-		1		14		5	
MNI:	4		-		1		9		2	

Carpalia:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
radiale						1	1			
intermedium			1	1						
ulnare				1	1		3	2		
accessorium			1		1			3		
primum										
secundum							1			
tertium			1					3		
quartum				1		1	2	2		
quintum							1			
Sum:	JU		SA I		SA II		SA/AD		AD	
N:	-		6		4		18		-	
MNI:	-		1		1		3		-	

Metacarpus	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
Mc 2	2	1	4	5	2	1				2
Mc 3	1	1	5	4		1				1
Mc 4	1	3	4	3			3	1	1	1

Sum:	JU	SA I	SA II	SA/AD	AD
N:	9	25	4	4	5
MNI:	3	5	2	3	2

Posterior.

Pelvis:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
acetabulum							2	4		
ischii	5	2						1		

Sum:	JU	SA I	SA II	SA/AD	AD
N:	7	-	-	7	-
MNI	5	-	-	4	-

Femur:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact										1
mf-mf	1	1		1						
pr+dia									1	
prmf-dia			1							
caput									2	
di+dia									2	
dimf+dia	1			1						
di ep.						1				
dia-fr.				1				2		

Sum:	JU	SA I	SA II	SA/AD	AD
N:	3	4	1	2	6
MNI:	2	1	1	-	3

Patella:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact					1	2	9	7		

Sum:	JU	SA I	SA II	SA/AD	AD
N:	-	-	3	16	-
MNI:	-	-	2	9	-

Tibia:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact										2
mf-mf	2	2	4	4						
compl. ÷pr			3				1			
mfpr					1					
mfpr+ $^{2}/_{3}$					2					
di + $^{2}/_{3}$							1	2		
di + $^{1}/_{3}$							3	4		
di							3	1		
dia-fr.								1		

Sum:	JU	SA I	SA II	SA/AD	AD
N:	4	11	3	16	2
MNI:	2	7	3	7	2

Calcaneus:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact									3	4
÷ep		3		3	4					

Sum:	JU	SA I	SA II	SA/AD	AD
N:	-	3	7	-	7
MNI: -	3	4	-	4	

Talus:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
intact				1		2	1	8	8	

Sum:	JU	SA I	SA II	SA/AD	AD
N:	-	1	3	16	-
MNI:	-	1	2	8	-

Other tarsalia:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
centrale			1	1	1			1		
primum							1	1		
secundum										
tertium								2		
quartum							3	3		

Sum:	JU	SA I	SA II	SA/AD	AD
N:	-	2	1	11	-
MNI: -	1	1	3	-	

Metatarsus:	JU		SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d	s	d
Mt 2	5		2	1					2	
Mt 3	5	1	3	4			1	1	2	1
Mt 4	1	1	1			1	1	1	3	

Sum:	JU	SA I	SA II	SA/AD	AD
N:	13	11	1	4	8
MNI:	5	4	1	1	3

Phalanges:	JU	SA I	SA II	SA/AD
intact	23	45	15	91

	JU	SA I	SA II	SA/AD	AD
mp-fr. :	2 (JU)				
di ep:		18 (JU/SA I)			
di fr. :					1 (AD)
Sesamoidea:				32 (SA/AD)	

Brown bear
Ursus arctos

Cranial:

	SA/AD	AD			SA (I)	
Cranium	3					
Hyoid			1			
		s		d		
Maxilla:		21		22		
			s+d			
			3			
Dentes sup.		77		83		
			s/d			
			5			
					s	d
Mandibula:		32		27		1
			s+d			
			7			
Dentes inf.		92		91		
			s/d			
Dentes sup/inf.			69			

Sum:			
	maxilla:		AD: 47
	mandibula:	SA (I): 1,	AD: 66
	dentes:		AD: 417

MNI:

M2 sup:	sin		dx	
	maxilla	isolated	maxilla	isolated
no wear	2	2	2	
light wear	4	4	5	7
medium wear	6	8	11	11
very worn	1	5	2	10
MNI:	SA I	SA II	AD	AD+
	-	4	34	12

M3 inf:	sin		dx	
	mandibula	isolated	mandibula	isolated
no wear		2	2	4
light wear	5	7	4	3
medium wear	5	4		7
very worn	1	2		6
MNI:	SA I	SA II	AD	AD+
	1	5	21	6

MNI (total): 52 individuals.

Postcranial:

Axial.

	SA II	SA/AD	AD
Atlas		9	
Axis			1
Vert. cerv.	2		2
Vert. thor.	1		8
Vert. lumb.	1		1
Sacrum			1
Vert. caud.	5		7
Sternum		1	
Costa			
Os penis			1
Sum:	SA II	SA/AD	AD
N:	9	10	21
MNI:		9	

Anterior.

Scapula	SA/AD		AD	
	s	d	s	d
di		2		
MNI:		2		

Humerus	SA/AD		AD	
	s	d	s	d
pr.			1	2
di +dia		2		
di	6	2		

Sum:	SA/AD	AD
N:	10	3
MNI:	6	2

Radius:	SA II		SA/AD		AD	
	s	d	s	d	s	d
intact					3	1
pr-mf		1				
pr+$^{2}/_{3}$			4	1		
pr			1	1		
di					1	
di ep.	2	1				

Sum:	SA II	SA/AD	AD
N:	4	7	5
MNI:	2	5	4

Ulna:	SA/AD		AD	
	s	d	s	d
intact			1	
pr+$^{2}/_{3}$			4	3
pr+$^{1}/_{3}$			1	4
pr			1	2
pr÷ol+$^{2}/_{3}$	2	3		
pr÷ol	2			

Sum:	SA/AD	AD
N:	7	16
MNI:	3	9

Carpalia:	SA/AD	
	s	d
scaphoid	15	14
pisiforme	13	17
trapezoideum	3	4
ulnare	7	5
pyramidale	5	6
magnum	5	6
trapezium	5	6

Sum:	SA/AD
N:	111
MNI:	17

Metacarpus:	SA/AD	
	s	d
Mc I	9	6
Mc II	4	8
Mc III	9	9
Mc IV	6	3
Mc V	2	12
Sum:	SA/AD	
N:	68	
MNI:	12	

	s/d
Fr. Mp	5

Phalanges:	
Ph. I+ Ph. II	1
Ph. I	153
Ph. II	116
Ph. III	115

Sesamoidea:	s/d
	33

Posterior.

Pelvis:	SA/AD		AD	
	s	d	s	d
Acetabulum+			2	1
Sum:	SA/AD		AD	
N:			3	
MNI:			2	

Femur:	SA II		AD	
	s	d	s	d
pr.			2	3
caput			2	1
caput ep	2	1		
di				1
Sum:	SA II		AD	
N:	3		9	
MNI:	2		4	

Patella:	SA/AD	
	s	d
intact	27	29
Sum:	SA/AD	
N:	56	
MNI:	29	

Tibia:	SA/AD		AD	
	s	d	s	d
intact				1
di + $^{2}/_{3}$	1			
di + $^{1}/_{3}$		1		
Sum:	SA/AD		AD	
N:	2		1	
MNI:	1		1	

Fibula:	SA/AD	
	s	d
di + $^{2}/_{3}$	1	
di + $^{1}/_{3}$	1	1
di	1	1
Sum:	SA/AD	
N:	5	
MNI:	3	

Calcaneus:	AD	
	s	d
intact	21	19
Sum:	AD	
N:	40	
MNI:	21	

Talus:	SA/AD	
	s	d
intact	20	24
Sum:	SA/AD	
N:	44	
MNI:	24	

Other tarsalia:	SA/AD	
	s	d
cuboideum	7	6
naviculare	11	10
cuneif. 1	5	1
cuneif. 3	8	4
Sum:	SA/AD	
N:	52	
MNI:	11	

Metatarsus:	SA/AD	
	s	d
Mt I	16	7
Mt II	9	9
Mt III	10	9
Mt IV	9	12
Mt V	4	7
Sum:	SA/AD	
N:	92	
MNI:	16	

Large bovids
Bison priscus / (Bos primigenius)

Cranial:

	SA/AD
Cranium	12
Os cornu	11

Maxilla:			SA/AD			
			s/d			
			1			
Dentes sup.	JU/SA				AD	
	s/d				s/d	
	4				84	
Mandibula	JU/SA		SA/AD		AD	
	s	d	s	d	s	d
	1		4	6	5	5
Dentes inf.	1	2			40	45

m3 inferior	s isolated	d isolated
light wear	1	1
medium wear		1

M3 inferior:	s mandible	 isolated	d mandible	 isolated
no wear				1
light wear				2
medium wear	1	5	4	6
very worn	1	1	1	1
damaged		1		2

MNI:	JU/SA	SA II	SA/AD	AD	AD+
	1	3	2	10	2
Sum: 18					

Postcranial:

Axial.

	SA II	SA/AD	AD
Atlas		5	
Axis		2*	
Vert. cerv.	6		13
Vert. thor.	5	1	11
Vert. lumb.			3
Sacrum			2
Vert. caud.			5
Sum:	SA II	SA/AD	AD
N:	11	8*	34
MNI:		5	

Anterior.

Scapula	SA/AD	
	s	d
di+ $^2/_3$ dia		1
di	2	1
Sum:	SA/AD	
N:	4	
MNI:	2	

Humerus		
	SA/AD	
	s	d
di+ $^2/_3$ dia	1	2
di+ $^1/_3$ dia	1	1
di	7	3
Sum:	SA/AD	
N:	15	
MNI:	9	

Radius:				
	SA II		SA/AD	
	s	d	s	d
pr			1	
pr+ $^1/_3$ dia			2	
dia-fr.			1	1
di ep	2			
Sum:	SA II		SA/AD	
N:	2		5	
MNI:	2		(+1)	

Ulna:				
	SA/AD		AD	
	s	d	s	d
pr	1		2	2
Sum:	SA/AD		AD	
Sum: N	1		4	
MNI:	1		2	

Carpalia:		
	SA/AD	
	s	d
radiale	4	1
intermedium	3	2
ulnare	5*	2
c 2+3	3	1
c 4	1	1
Sum:	SA/AD	
N:	22 (+1 Bos)	
MNI:	4 (+1 Bos)	

Metacarpus:			
	AD		
	s	d	s/d
intact	7	1	
di	1	1	1
Sum:	AD		
N:	11		
MNI:	8		

Posterior.

Pelvis:		
	SA/AD	
	s	d
comprising acetabulum	2	1
Sum:	SA/AD	
N:	3	
MNI:	2	

Femur:	SA I		SA II		AD		
	s	d	s	d	s	d	s/d
intact					1		
pr					1		
caput					2	4	
caput ep				1			
di					1		1
dia-fr.	1						

Sum:	SA I	SA II	AD
N:	1	1	10
MNI:	1	1	4

Patella:	SA/AD	
	s	d
intact	1	3

Sum:	SA/AD
N:	4
MNI:	3

Tibia:	SA I		SA/AD		AD	
	s	d	s	d	s	d
intact					1	
di			1			
dia-fr.	1			1		

Sum:	SA I	SA/AD	AD
N:	1	2	1
MNI:	1	1	1

	SA/AD	
	s	d
Fibulare	1	1
Malleolare	2	6

Sum:	SA/AD
N:	10
MNI:	6

Calcaneus:	SA I		AD	
	s	d	s	d
intact			8	2
without epiphysis		2		

Sum:	SA I	AD
N:	2	10
MNI:	2	8

Talus:	SA/AD	
	s	d
intact	15	12

Sum:	SA/AD
N:	27
MNI:	15

Other tarsalia:	SA I		SA/AD	
	s	d	s	d
Centrotarsale	1		13	9
T 2+3			2	1

Sum:	SA I	SA/AD
N:	1	22+3
MNI:	1	13

Metatarsus:	SA/AD		AD		
	s	d	s	d	s/d
intact			1		
pr	1				
di+ dia			1	1	
di			1	2	1

Sum:	SA/AD	AD
N:	1	7
MNI:		4

	SA I
	s/d
Metapodia ep	2

Phalanges:	SA/AD
	s/d
Ph. I	16
Ph. II	18
Ph. III	17

	SA/AD
	s/d
Sesamoidea	35

Beaver
Castor fiber

Cranial:

	SA/AD		AD	
			s	d
Maxilla:				2
Mandibula:			17	16
	s/d			
Dentes sup/inf.	158			
P4 superior	s	d		
	17	17		
N:	34			
MNI:	17			

Sum:	maxilla:	AD:	2
	mandibula:	AD:	33
	dentes:	SA/AD:	158

MNI: 17 SA/AD

Postcranial:

Axial.

	SA II	SA/AD	AD
Vert. cerv.	2		
Vert. thor.	1		
Vert. lumb.	5		2
Sacrum	2		
Vert. caud.	6	1	4
Costa			1
Sum:	SA II	SA/AD	AD
N:	16	1	7
MNI:		2	

Anterior.

Scapula		
	SA/AD	
	s	d
di + $^1/_3$	5	2
Sum:	SA/AD	
N:	7	
MNI:	5	

Humerus								
	SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d
pr.							1	
di +dia						1		
dimf+dia	1		1	1				
Sum:	SA I		SA II		SA/AD		AD	
N:	1		2		1		1	
MNI:	1		1		1		1	

Ulna:

	SA I		SA II		SA/AD	
	s	d	s	d	s	d
pr+dia	1	2	1	1	2	1
di					1	

Sum:	SA I	SA II	SA/AD
N:	3	2	4
MNI :	2	1	2

Radius:

	SA/AD
	s/d
pr.	1
dia.	1

Sum:	SA/AD
N:	2
MNI:	1

Metacarpus:

	AD	
	s	d
		4
MNI:	1	

Posterior.

Pelvis:

	SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d
Acetabulum		1		1				1
Os ischii					1			

Sum:	SA I	SA II	SA/AD	AD
N:	1	1	1	1
MNI:	1	1	-	1

Femur:

	SA I		SA II		SA/AD		AD	
	s	d	s	d	s	d	s	d
intact							2	
mf-mf	2	1	1					
dia-dimf			1					
dia-fr.					1	1		
di ep.				2				

Sum:	SA I	SA II	SA/AD	AD
N:	3	4	1	2
MNI:	2	2	1	2

Patella:

	SA/AD
	s/d
intact	2

Tibia:	SA II		SA/AD	
	s	d	s	d
pr. mf+$^{1}/_{3}$	2			
pr + $^{2}/_{3}$				2
di+$^{1}/_{3}$				1

Sum:	SA II	SA/AD
N:	2	3
MNI:	2	2

Calcaneus:	SA II		SA/AD	
	s	d	s	d
intact				1
÷ep	5	1		
fragment			1	

Sum:	SA II	SA/AD
N:	6	2
MNI:	5	1

Talus:	SA/AD	
	s	d
intact	1	5

Sum:	SA/AD
N:	6
MNI:	5

Tarsalia:	SA/AD
	s/d
cuneiforme	2

Sum:	SA/AD
N:	2
MNI:	-

Metatarsus:	SA II		AD	
	s	d	s	d
intact		1	1	4

Sum:	SA II	AD
N:	1	5
MNI:	1	1

	SA II	SA/AD	AD
	s/d	s/d	s/d
Metapodia, fr. :	4	1	1

	SA/AD
	s/d
Phalanges:	28

APPENDIX B

Red deer, *Cervus elaphus*

	N	Cutmarked
Antler,		
not cast	11	
cast	61	
fragment	34	
Cranium	6	
Maxilla	1	
Mandibula	4	
Dentes	67	
Carpalia	4	
Calcaneus	3	
Talus	6	1
Centrotarsale	1	
Mt 2		
Mpfr.	1	
Phal. I	3	1
Phal. II	2	
Phal. III	1	
Sum:	207	2

Straight-tusked elephant, *Palaeoloxodon antiquitatis*

	N
Cranium	7
Maxilla	2
Mandibula	12
Dentes	122
Vert. thor.	9
Vert. fr.	5
Vert. caud.	1
Costa	10
Humerus	1
Ulna	1
Carp./Tars.	2
Mp.-fr. 2	
Pelvis	2
Femur	2
Patella	4
Phalanges	7
Uident:	5
Sum:	194

Wild horse, *Equus taubachensis*

	N	Cutmarked
Mandibula	1	
Dentes	138	
Humerus	1	
Metacarpus	3	
Pelvis	2	
Patella	1	
Tibia	1	
Calcaneus	1	
Talus	2	
Metatarsus	1	
Phal. I	4	
Phal. II	3	1?
Phal. III	3	
Sum:	161	1?

Wild boar, *Sus Scrofa*

	N
Maxilla	7
Mandibula	39
Dentes	49
Talus	1
Sum:	96

Roe deer, *Capreolus capreolus*

	N
Antler,	
not cast	2
cast	2
Mandibula	8
Dentes	38
Calcaneus	1
Talus	7
Sum:	58

Giant deer, *Megaloceros giganteus*

	N
Antler	4
Mandibula	1
Carpalia	1
Phalanges	1
Sum:	7

Cave bear, *Ursus spelaeus*

	N
Cranium	1
Mandibula	
Dentes	6
Sum:	7

Cave lion, *Panthera leo*

	N
Dentes	3
Tibia	1
Phal. II	1
Sum:	5

Hyena, *Crocuta crocuta*

	N
Cranium	1
Sum:	1

Wolf, *Canis lupus*

	N
Maxilla	1
Mandibula	1
Dentes	5
Sum:	7

Unidentified fragments

	N
Sum:	90

APPENDIX C

Gnaw-marked bones and antler fragments.

Rhinoceros

mandibula	post.	medium carnivore	2
mandibula	corpus	medium carnivore	3
scapula	prox.	medium carnivore	2
scapula	dist.	large carnivore	1
scapula	dist.	medium carnivore	5
scapula	pr. +di.	medium carnivore	1
scapula	middle	small rodent	1
humerus	prox.	large carnivore	1
humerus	prox.	medium carnivore	1
humerus	dist.	large carnivore	1
humerus	dist.	medium carnivore	7
humerus	pr. +di.	medium carnivore	1
ulna	prox.	medium carnivore	2
radius	prox.	medium carnivore	3
radius	dist.	medium carnivore	3
femur	prox.	large carnivore	1
femur	prox.	medium carnivore	1
patella		large carnivore	1
tibia	prox.	medium carnivore	1
tibia	dist.	medium carnivore	3
tibia	pr. +di.	medium carnivore	5
calcaneus		medium carnivore	1
talus		medium carnivore	4
mt 2	dist.	medium carnivore	1
Sum:	large carnivore		5
	medium carnivore		46
			51
	rodent		1
Sum total:			52

Ursus

humerus	dist.	medium carnivore	3
radius	prox.	small rodent	1
ulna	prox.	medium carnivore	8
femur	prox.	medium carnivore	1
patella		medium carnivore	1
calcaneus		medium carnivore	1
mt. 3		medium carnivore	2
ph. II		medium carnivore	1
Sum:		medium carnivore	17
		rodent	1
Sum total:			18

Other species

Bison

vert. cerv.		medium carnivore	1
vert. thor.		medium carnivore	1
humerus	dist.	medium carnivore	2
tibia	prox.	medium carnivore	1
talus		medium carnivore	2
Sum:	medium carnivore		7

Castor

calcaneus		small carnivore	1

Cervus

antler	not cast	bite, (cervid?)	1
antler	not cast	bite, (cervid?) + gnawing, small rodent	1
antler	cast	bite, (cervid?)	3
antler	cast	gnawing, small rodent	4
antler-fragm.		bite, (cervid?)	2
antler-fragm.		bite, (carnivore)	1
antler-fragm.		gnawing, small rodent	2
talus		small carnivore	1

Elephas

vert. thor.		medium carnivore	1
patella		medium carnivore	1

Sus

mandibula	corpus	medium carnivore	1

Panthera

tibia	pr. +di.	medium carnivore	1

Unidentified large mammal

fragments		medium carnivore	3

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