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Ancient hunters, modern butchers : Schöningen 13II - 4, a kill-butchery site dating from the northwest European Lower Palaeolithic
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Citation

Voormolen, B. (2008, March 19). *Ancient hunters, modern butchers : Schöningen 13II - 4, a kill-butchery site dating from the northwest European Lower Palaeolithic*. Retrieved from <https://hdl.handle.net/1887/12661>

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ANCIENT HUNTERS, MODERN BUTCHERS

Schöningen 13II - 4, a kill - butchery site dating from the northwest European Lower Palaeolithic

PROEFSCHRIFT

ter verkrijging van de graad van Doctor
aan de Universiteit van Leiden,
op gezag van Rector Magnificus prof. mr. P. F. van der Heijden,
volgens besluit van het College voor Promoties
te verdedigen op woensdag 19 maart 2008
te klokke 15.00 uur

door

Boudewijn Voormolen

geboren op 12 juli 1968
te Rotterdam

Promotiecommissie

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Ancient Hunters, Modern Butchers

Schöningenen 13II-4, a kill-butchery site dating from the northwest European Lower Palaeolithic

PhD thesis, Leiden, 2008

Boudewijn Voormolen

ISBN 978-90-9022830-3

Design and layout

Pieter Mineur

Drawings

Boudewijn Voormolen, and completed for print by Medy Oberendorff (unless otherwise specified)

Photographs

Boudewijn Voormolen, and Jan Pauptit (unless otherwise specified)

Printed by

PrintPartners Ipskamp B.V.

Subject headings

Palaeolithic archaeology, Lower Palaeolithic, European Lower Palaeolithic, taphonomy, archaeozoology, Palaeolithic hunting, hunting versus scavenging debate, early hominid subsistence behaviour, archaeological resolution.

ANCIENT HUNTERS, MODERN BUTCHERS

Schöningenen 13II-4, a kill - butchery site dating
from the northwest European Lower Palaeolithic

Dedicated to all victims of human lust for power and greed.

ACKNOWLEDGEMENTS

As early as 1994 I became acquainted with the rescue excavations of Palaeolithic sites in the Schöningen lignite mine. I was given the opportunity to study the bone remains found at the Schöningen 12b site which resulted in my MA-thesis and which introduced me to taphonomic research of faunal assemblages. Excavations at the 13II-4 locality were already under way and soon yielded the spectacular finds of the wooden spears. After seeing some of the bone remains from the 13II-4 site for the first time, it was instantly clear to me that these could be as important as the spears. Therefore it was a great honour for me when part of the preserved bone remains were made available to carry out my PhD research. This thesis presents the results derived from this research. The process of writing and finishing this thesis took longer than was planned and expected. I want to apologize to those waiting for the results all that time. This is the place to express my thanks and gratitude to those persons who contributed to the completion of this study and who were important to me personally during completing it.

It was Wil Roebroeks who inspired and persuaded me to specialize in Palaeolithic archaeology and he has been an inspirator ever since. I admire his critical in-depth and multidisciplinary approach to the research field and I am grateful for the opportunities he gave me as well as for his understanding of me as a person. Thijs van Kolfschoten invited me to research faunal remains taphonomy and gave me the chance to develop my knowledge on vertebrate taphonomy; I should like to thank him for this and for the support he gave me. This research would not have been possible without the cooperation of Hartmut Thieme, the Schöningen project leader. I should like to thank him for giving me permission to study the material as well as for his support while studying it and the pleasant times we had during my Hannover visits. Already during my MA-thesis research, Sabine Gaudzinski helped me with getting acquainted with taphonomic research of bone remains. Her assistance and helpful comments have been important and an inspiration to me, as were her critical and supportive remarks on drafts of this thesis which helped me to complete it. During the finishing stages Manuel Domínguez-Rodrigo provided me with very helpful comments and suggestions. I should like to thank him for this as well as for the nice communications we have had. Lewis Binford is one of the most inspiring researchers of Palaeolithic archaeology. His work was the first I got to know when I started my study in archaeology and it was his work that provoked the

debates on early hominid subsistence behaviour which also form the context for the present thesis. It was therefore an honour for me to present to him some first results of this research during discussions in Leiden. I should like to thank him for these discussions and for his inspiring contributions to the research field.

I benefitted from help, support and information provided by numerous persons. I am grateful to and want to thank: E. Turner, M. Levine, A. Verpoorte, K. van Gijssel, R. Corbey, M. Langbroek, M. Oberendorff, O. Yates, D. de Loecker, K. Fennema, B. Morang and A. Ramcharan. Family members and friends were important to me during the research because of their support and discussions about various topics, thank you: L. Voormolen, E. Mink, A. and I. Voormolen, J. and J. Porsius, H. Janssen, A.-K. Hermkens, R. Machiels, I. Toet, P. Folkersma, and D. Fontijn.

Special thanks go to Pieter Mineur for helping me with the design and completion of the manuscript, being my climbing partner for many years and being a good friend. Two friends supported me up to the last minute. Stefan Molenaar was always available for discussions and brainstorming sessions about various topics and he supported me in various ways during the past decade. His support means a lot to me and I'm very grateful for this and for his friendship. I am also very grateful for my friendship with Yannick Henk, I hope to enjoy his sense of humour and to experience our drinking, discussions and hardcore music listening moments for a long time to come. I cannot express enough my gratitude to Barbara Porsius. Barretje, I thank you for letting me see other aspects of life, for keeping trust in me and for finding me.

Last but not least, there are several persons who I would like to be here during the completion of this research but who are not able to attend. Gerda Voormolen-Bekker, your love and trust will always remain the greatest source of inspiration to me. Dick Bekker, thank you for your support and our philosophical discussions which we will continue at the other side. Peer, I will remember. Arie van Deijk, I hope you've found your peace. Mâcha, knuffel!





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1 INTRODUCTION: THE EUROPEAN CONTEXT AND THE HUNTING VERSUS SCAVENGING DEBATE

“And, although the record is incomplete and speculation looms larger than fact, for those who would understand the origin and nature of human behaviour there is no choice but to try to understand “Man the Hunter” (Washburn and Lancaster 1968, p. 303).

The 1995 discovery of the supposed wooden hunting spears at the Lower Palaeolithic site of Schöningen 13II-4 gave an important impetus to the debates on European early hominid subsistence behaviour. Back then, in particular many Anglo-Saxon researchers believed in more marginal subsistence strategies for early hominids, like passive or active scavenging or at most hunting of small to medium sized mammals, instead of active and systematic hunting of large game. In the European Lower Palaeolithic record, faunal assemblages with unambiguous hominid subsistence indicators are indeed scarce. Most of the available sites with faunal remains yielded reworked assemblages from unstable contexts and with badly preserved bone material. A hunting mode of subsistence was indeed virtually impossible to deduce from these assemblages but neither could a scavenging mode of subsistence be reconstructed with certainty. Because of the lack of well-preserved sites and straightforward zooarchaeological data, the debates on early hominid subsistence behaviour therefore often remain very speculative. Apart from the sensational preservation of wooden tools at the Schöningen 13II-4 site, also the associated bone remains appeared to be perfectly preserved. Moreover, most of the encountered bone remains appeared to be from horses. Although the spears provoked inferences on possible horse hunting by the Schöningen hominids, the bone remains should provide the most direct evidence on subsistence strategies associated with the site. As this thesis will demonstrate, a study of part of the Schöningen 13II-4 faunal assemblage indeed provided data very relevant to the debate. Prior to presentation and analysis of the Schöningen data, this chapter provides a brief outline of the debate on early hominid subsistence strategies in Palaeolithic archaeology, as well as a brief survey of the available evidence from Europe.

1.1 Shifting models, of early human subsistence strategies

More than a decade ago, Cartmill (1993) outlined the place of hunting within western history. Hunting, “ [...] by definition an armed confrontation

between humanness and wildness, between culture and nature [...]” (Cartmill 1993, p. 30), is, in his reading, considered by many workers as a measure of humanness. Palaeolithic archaeology constitutes a continuous search for degrees of humanness throughout the Plio–Pleistocene epoch. As such, the history of Palaeolithic behavioural models is one of shifts on the scales of nature to culture and from primitive to complex. Throughout the history of Palaeolithic research, hunting as a way of obtaining meat, as well as meat itself, played a key role within the set of cultural traits used to determine scores on behavioural scales. Especially within Anglo-Saxon Palaeolithic archaeology, hunting and meat-eating early hominids have been firmly on the research agenda, were cast out later, but are recently experiencing a comeback.

Within Anglo-Saxon research on human origins, Raymond Dart was among the first to launch a model on the role of meat and predatory behaviour in human evolution (in Europe early accounts of Palaeolithic faunal assemblages already focused on hunting subsistence modes, see for example the work of Soergel *Die Jagd der Vorzeit*, from 1922). His accounts of the supposed ‘Predatory Behaviour of *Australopithecus*’ were based on the co-occurrence of the fossil Taung skull and abundant animal remains. According to Dart part of the bone remains associated with the fossil skull represented australopithecine weaponry used to hunt and kill not only animals but also members of their own kind (Cartmill, 1993; Dart, 1949). Dart had to defend this theory fiercely against researchers believing in a more vegetarian lifestyle of *Australopithecus* and researchers proposing alternative causes for the co-occurrence of animal bones and the Taung skull (Cartmill, 1993; Dart, 1956). In the early 1980s a new study of the nature of the *Australopithecus* assemblages was presented by Brain (1981). Dart’s account of the ‘Predatory Osteodontokeratic Culture of *Australopithecus*’ was adopted and highly popularised by Robert Ardrey:

“Upon this deeply buried, complex primate instinctual bundle were added the necessities and the opportunities of the hunting life [...] The creature who had once killed only through circumstance killed now for a living” (Ardrey 1961, p. 316-317).

Ardrey became Dart’s promotor by popularising a predatory and territorial hunting way of life as being the characteristic of human nature (Ardrey, 1961,



1976). The 'hunting way of life' and the 'primate instinctual bundle' were going to be core subjects in early hominid behaviour research. Primatology together with ethnography would be the sources providing parameters to recognise and to determine 'Human Uniqueness' and the degree of 'Cultural Complexity' (Cartmill, 1990).

New spectacular finds of ancient artefact and bone-yielding occurrences in Africa had to be explained within an evolutionary framework. The manufacture of stone tools, habitual bipedality, and the accumulation of faunal remains were unknown behavioural traits to primate ethologists.

Comparative studies of non-human primates and hunter-gatherers were used to establish differences between behavioural elements, and, "because of the great behavioural gap between man and his nearest relatives, some reconstruction of behaviour was possible" (Washburn and Avis, 1958; Washburn and DeVore, 1961, 103; italics added). The early human archaeological record could partly fill in this 'behavioural gap' providing insight into behavioural evolution. Such an approach led Washburn and DeVore to conclude:

"We see two stages of behavioural evolution separating the apes from Homo sapiens. The first of these is that of the australopithecines of the Lower Pleistocene. Although these forms were bipedal and tool making, there is little to suggest that their social life was very different from that of apes or monkeys. They were probably primarily vegetarian, and the small-brained young could have matured rapidly. Perhaps only the rudiments of the human way of life were present. But, by the Middle Pleistocene, large-brained men who hunted big animals were present, and this may well have been the period during which the distinctively human attitudes on hunting, territory, and the family originated. At least the biological and economic problems that ultimately led to the social customs of today had their roots in the hunting societies of half a million years ago"
(Washburn and DeVore, 1961, p. 103).

Washburn and DeVore proposed a later date for the emergence of this distinctly human hunting behaviour than Dart and Ardrey. There was, however, a consensus about putting emphasis on the hunting way of life in relation to the evolution of modern human social behaviour. Hunting was being presented as a condition or driving force for the existence of territorial behaviour and family bond social structures. The 'how hunting made us human approach' was further extended and highlighted during the 'Man the Hunter' symposium in 1965 (Lee

and DeVore, 1968). Here William Laughlin presented hunting as an integrated biobehavioural system with biological implications onto the gene and species level:

"Hunting is a way of life, not simply a 'subsistence technique', which importantly involves commitments, correlates, and consequences spanning the entire biobehavioral continuum of the individual and of the entire species of which he is a member [...] and [...] In this sense, hunting was the school of learning that made the human species self-thought"
(Laughlin, 1968, 304, p. 320).

In a paper by Washburn and Lancaster (1968), a comparable "biological bases for killing incorporated into human psychology" was defended, a supposed human characteristic already central in the work of Ardrey (1961). According to the authors 'a hunting way of life' had been the 'prime mover' in shaping both the biological and the cultural package of mankind. Following earlier work (Washburn and Avis, 1958; Washburn and DeVore, 1961), they emphasised a set of 'ways of life' involved with hunting, namely: sexual division of labour, co-operation, planning, knowledge, technical skill, and the orderly sharing of food. Especially this last mentioned behavioural element would frequently reappear in the work of another participant of the symposium, archaeologist Glynn Isaac. Isaac, working on the earliest African archaeological sites, already adopted the 'home-base concept' (Washburn and DeVore, 1961), as a behavioural interpretation of "horizontally and vertically concentrated archaeological debris, labelled occupation floors". Although indications for early hominid hunting were considered to exist, Isaac explicitly did not rule out a prominent role of scavenging and gathering as being part of the earliest subsistence modes (Isaac, 1971, 1978). The abundant bone remains at Pleistocene African sites though, were considered to be proof of an increasing amount of meat in early hominid diet. This led Isaac to conclude that as with modern hunter-gatherers, some kind of division of labour would have been necessary; men bringing in the meat while women could concentrate on protecting and fostering offspring. Division of labour should have made necessary the existence of a home base, providing a place for safety and food sharing (Isaac, 1978). The sharing of exploited food at a fixed base within the landscape would have been the condition for the emergence of social 'superstructures' unknown to other primate species. This emphasis on meat consumption and a carnivorous way of life provoked some researchers to establish comparisons with non-human 'social carnivores' (Schaller and Lowther, 1969; King, 1975).



“When a pack has young in the den, the mother and one or 2 other members usually remain with the pups while the rest seek prey. The returning hunters feed those adults as well as the pups. The wild dog society thus has a division of labour [...] Lions give the impression that the evolution of their social system is incomplete in that it includes co-operation in hunting but not in sharing of the prey”
(Schaller and Lowther, 1969, p. 335).

It was thus inferred that the coexistence of co-operation in hunting, a division of labour and sharing of prey were the conditions for a fully developed social system.

Summarised, the characteristics of a fully developed social system were to be found among modern hunter-gatherers, while the roots of certain social aspects were already detectable among non-human primates and other social carnivores. The procurement of meat and the social system involved with meat consumption were considered to be crucial to the evolution of social structures and the human species. If hunting did not make us human, than at least meat sharing did.

At the start of the 1980s two important books were published, ‘The Hunters or the Hunted’ by C.K. Brain (1981), and the pioneering work ‘Bones, Ancient Men and Modern Myths’ by Lewis Binford (1981). Both books presented a critical taphonomic approach to the Palaeolithic faunal record, differing from the approaches of the previous decades. Brain tackled the predatory behaviour of *Australopithecus*, previously postulated by Dart and followers, by inferring that the fossil faunal assemblages were rather the result of carnivore activities and non-hominid taphonomic processes. Binford presented a methodological framework accompanied by an actualistic overview of trace and pattern creating non-hominid agents, as well as an ethnographic account of traces and patterns left by human butchering and consumption activities. Central in Binford’s approach was the establishment of actualistic middle-range research to explore the relationship between the dynamic (present) and the static derivatives (archaeological signatures). According to Binford, static patterns could only be recognised and understood through observation of present dynamics in order to discriminate one agent from another (Binford, 1981, p. 26). Ignorance of the multicausal and ambiguous nature of assemblages would lead to inferences of the past fed by premises and assumptions, resulting in ‘story telling’. Following this framework and making use of his actualistic observations and derived data, Binford conducted a critical reanalysis of the ancient

African Olduvai Gorge sites, and concluded:

“The methodology outlined has led to certain conclusions about the character of the past, importantly about the behavior of our early hominid ancestors. The picture one gains from the analysis of the Olduvai materials is a far cry from many of the romantic pictures that have been advanced”
(Binford, 1981, p. 294).

The composition of the Olduvai faunal assemblages pointed towards an ambiguous history, involvement of both carnivores and hominids in the formation of the assemblages. More important though, the hominid subsistence strategy Binford was able to reconstruct pointed towards a scavenging mode of subsistence. According to Binford, the Olduvai hominids were making use of carnivore leftovers, especially lower legs containing bone marrow, and:

“There is no evidence supporting the idea that the hominids were removing food from the location of procurement to a base camp for consumption – and more importantly - No evidence for base camps exists. Similarly, the argument that food was shared is totally unsupported - and further - There is no evidence supporting the argument that the hominids at Olduvai Gorge were hunting” (Binford, 1981, p. 294; *emphasis added*).

Binford would hold on to this new model of early hominid behaviour and work out the different aspects in future publications (Binford, 1983, 1984, 1985, 1987). Isaac, proved to be sensitive to Binford’s conclusions and adjusted his research strategies (Isaac, 1983). From then on, he put more emphasis on formation processes and the relationship between archaeological patterning and the behavioural context. Researchers were provoked to ground their opinion on early hominid subsistence behaviour with empirical data and actualistic research on diagnostic traces of hominid involvement, which resulted in what has been called ‘cut mark mania’. The co-occurrence of artefacts and faunal remains as a reflection of hominid subsistence and involvement had to be proven instead of assumed.

Originally the hunting versus scavenging debate concentrated primarily on the African archaeological record. Although, Binford had already touched upon some European sites in his ‘Bones’ book, his 1985 account of early hominid subsistence behaviour throughout the Pleistocene took the debate into Europe. Binford’s conclusions were clear:



"Given differences in geography and environment the patterns from the northern temperate zone appear remarkably similar to the pattern seen in South Africa. At present the inevitable conclusion seems to be that regular, moderate- to large-mammal hunting appears simultaneously with the foreshadowing changes occurring just prior to the appearance of fully modern man. According to the principle laid down by Gilbert and Sullivan, "you can't be your own grandpa." Systematic hunting of moderate to large animals appears to be part of our modern condition, not its cause" (Binford, 1985, p. 321).

Binford's model was adopted by a range of researchers, including Clive Gamble who reviewed European early hominid subsistence behaviour in his 'Man the Shoveler' paper (Gamble, 1987). Gamble considered early hominids to be present in Northern Europe only during early glacial temperate and cold environments. The problem for surviving hominids in such environments would be the long winters, and "the problem during the winter was quite simple how to get a meal?" (Gamble, 1986, 1987). According to Gamble, the solution to this environmental stress was taking advantage of natural storage in the environment. Natural storage was considered to be provided by natural deaths, carcasses would be preserved by frost and snow cover and thus exploitable for hominids. Gamble postulated that the previously discovered wooden artefacts at Clacton and Lehringen, which were considered to be wooden spears, were probably used as 'snow probes' to search the snow for frozen carcasses instead of being proof of hunting by early European hominids (Gamble, 1987). This resource exploitation model led Gamble to deduce some implications concerning the behavioural capacities of the early hominids:

"The major problem lies in searching the area in enough detail to find carcasses. This calls for a labour-intensive foraging strategy. Large group size is essential to this strategy because resources are hidden in rivers, cracks in the ice, mired, under snowdrifts, and in loess banks. Any sexual division of labor according to task is therefore unlikely because it is the number of searchers that is important in pursuing this strategy [...] However, the food management strategy was such that the tactics could be applied to any potentially inhabitable subregion. Prior knowledge of the landscape in great detail was not necessary [...] The winter area of the home range was the core area of settlement but did not form a 'site' as the term homebase so often implies. Repeated use of caves as thawing-out locations and refuges from carnivores led to some concentrations of material, but these were not home bases" (Gamble, 1987, p. 92-94).

Although Gamble called his work an "exercise in speculation", (1987, p. 95), his, as well as Binford's, early hominid behavioural framework was widely used and extended within Palaeolithic archaeology during the following years.

Almost a decade later the Schöningen 1995 discoveries of wooden throwing spears gave an important impetus to the debate on early hominid subsistence behaviour. Because the spears were inferred to be unambiguous hunting weapons, the well-established "marginal scavenger model" for early European hominids was immediately questioned (Dennell 1997; Thieme 1997). Soon, known Lower and Middle Palaeolithic faunal assemblages with possible indications for early hominid hunting were highlighted. During the past decades Palaeolithic archaeology had been dominated by approaches focusing on archaeological periods as such. The Lower and Middle Palaeolithic periods being representative of archaic hominid behaviour while the Upper Palaeolithic would signal the appearance of modern human behaviour (Mellars and Stringer, 1989; Stringer and Gamble, 1993; Stringer and McKie, 1996). Already some researchers tended to give more attention to similarities and gradual shifts between these periods (Domínguez-Rodrigo, 2002; Gamble and Roebroeks, 1999; Gaudzinski, 1999; Hayden, 1993; Kolen, 1999; Marean, 1998; Marean and Assefa, 1999; Mussi 1999; Roberts, 1999; Roebroeks, 2001; Roebroeks et al., 1988, 1992). This more 'gradualistic approach' led to new (re)analysis of important Palaeolithic sites with faunal remains, questioning the previously inferred scavenging model of early European hominids of the Lower and Middle Palaeolithic which was never adopted by continental European researchers and remained an Anglo-Saxon model. Using the analytical frameworks initiated and developed by Lewis Binford during his reanalysis of the Palaeolithic record during the 1980s, recently researchers encounter more and more similarities between Lower and Middle Palaeolithic faunal assemblages and those from more 'modern' contexts. Especially for the Middle Palaeolithic, faunal data in support of Neandertals being specialised in obtaining meat and bone marrow has been accumulating (cf. Boëda et al., 1999; Gaudzinski, 1995, 1996, 1998, 1999; Gaudzinski and Roebroeks, 2000; Grayson and Delpech, 1994; Marean, 1998; Marean and Assefa, 1999; Roebroeks, 2001; Speth and Tchernov, 1998). Evidence from the Lower Palaeolithic however is scarce and inferences are often based on circumstantial evidence or on comparative studies. For the Palaeolithic record postdating MIS 7 the obtaining of animal products through hunting now seems to be supported by



archaeological data. For the pre-MIS 7 Lower Palaeolithic record though, early hominid subsistence modes remain difficult to recognise and even hominid involvement with bone remains is often difficult to establish (Gaudzinski and Turner, 1996, 1999). The availability of unambiguous faunal assemblages providing evidence for monospecific exploitation of animals or systematic meat and marrow procurement, comparable to those documented for the post-MIS 7 record is still meagre (see below).

1.2 A brief survey of the available evidence from the Lower to Middle Palaeolithic of Europe

Hominid use of faunal products can be traced as far back as the earliest archaeological sites in Europe. Extensive reports on archaeological faunal assemblages especially dating from the earliest part of the European Lower Palaeolithic are however not well represented or are selective in the amount of data which is presented. To facilitate a referential framework for the present study of the Schöningen 13II-4 assemblage, a brief summary of part of the available Lower and Middle Palaeolithic faunal assemblage data is provided. Dating of Pleistocene sites is not without problems and age estimates often vary widely. Therefore sites have been grouped by age ranges restricted by Marine Isotope Stages correlated with the subdivision of the northwestern European Quaternary (see Figure 1.2). See Figure 1.1 for a map of Europe with the sites mentioned in the text.

Among the oldest European archaeological sites with preserved faunal remains which are believed to yield hominid induced butchering traces are the pre-MIS 13 sites of Atapuerca Gran Dolina TD6 in Spain, Isernia La Pineta in Italy, and the MIS 13 site of Boxgrove in Great Britain. A small excavated area in the Atapuerca Gran Dolina cavity yielded 1056 identifiable bone specimens representing 11 mammalian taxa including hominid remains. In total 150 bone specimens yielding butchering marks have been counted deriving from all mammal categories, including *Homo* sp. (Díez et al., 1999; Fernández-Jalvo et al., 1999). Traces of carnivore gnawing are considered to be limited and point to a small, fox-like, carnivore. According to the researchers all types of butchering traces have been observed ranging from cut marks caused during skinning, dismemberment, filleting, scraping prior to marrow processing and impact scars from bone marrow processing. Cut marks from filleting dominate among the butchery traces. The butchered animal remains, including butchered remains of *Homo*, are believed to be transported into the cave by hominids and show a wide range of ages and species. The open-air site of Boxgrove, Great Britain, is well known because of its high age and the presence of beautiful handaxes and perfectly preserved flint scatters found on a

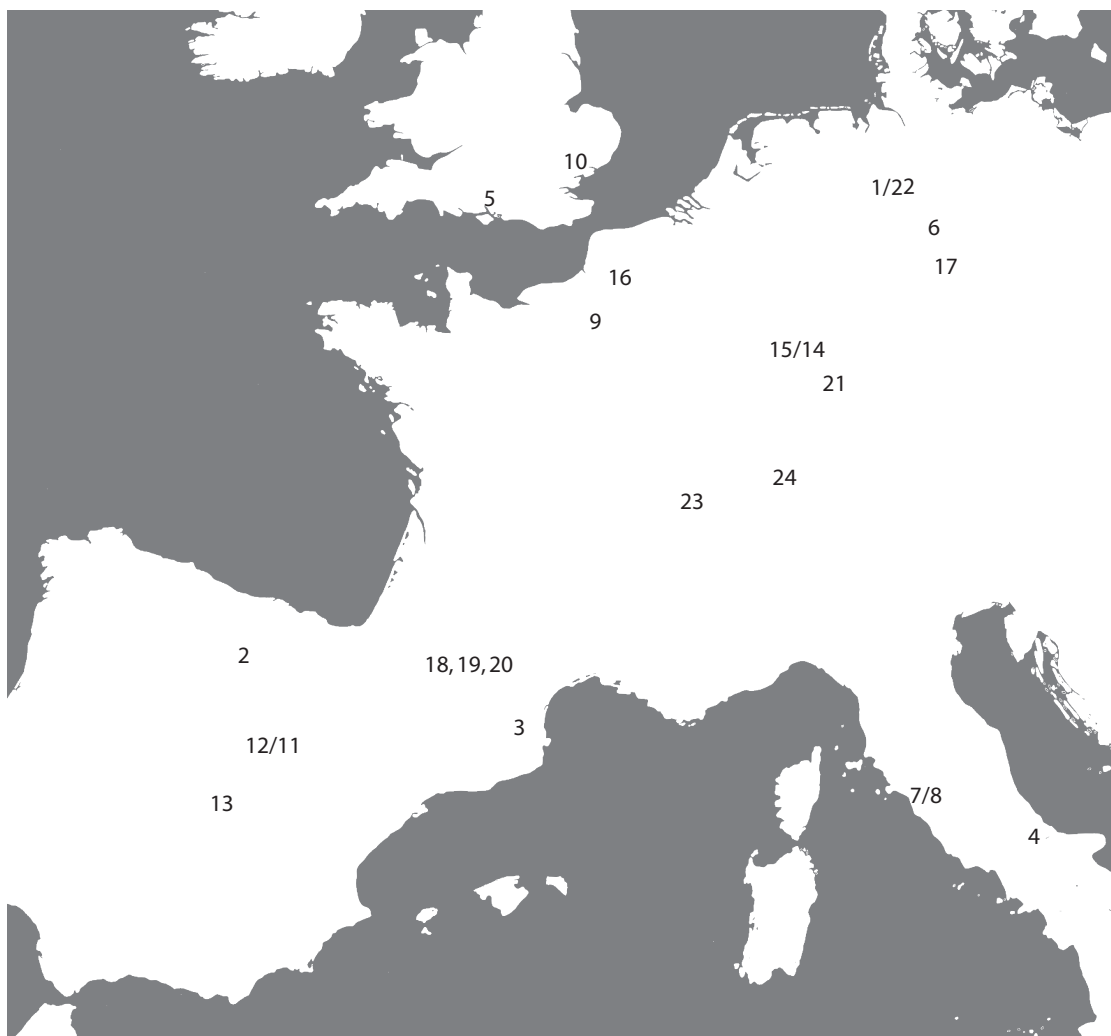
lagoonal palaeosurface of about 500 Kyr ago. Depositional events at Boxgrove have been sealed off by fast covering intertidal silts (the famous Unit 4b Slindon Silts). Though bone preservation at Boxgrove is not excellent, enough bone remains survived to recognise hominid involvement with encountered faunal remains convincingly. At least six mammalian species have been found to be yielding hominid induced butchering traces (Parfitt and Roberts, 1999). The whole spectrum of butchery related traces has been claimed by the researchers, ranging from cut marks created during skinning, dismemberment, filleting, scraping of long bones and impact scars resulting from bone marrow processing. The so-called 'horse butchery site' from the Q2 GTP 17 locality is believed to represent the remnants of a single horse-butchered event. Although having survived very fragmented, the horse bone remains present yielded abundant cut marks and indications of bone marrow processing (Parfitt and Roberts, 1999). An inferred spear-wound fracture on a horse scapula could indicate the use of spears like those found at Schöningen. Moreover, the butchering evidence and the observation of carnivore gnawing marks overlapping and obscuring cut marks support primary hominid access to animals, possibly by hunting (Roberts, 1999; Parfitt and Roberts, 1999). Hominid involvement with faunal remains found at the Italian open-air site of Isernia La Pineta is mostly inferred from systematic bone marrow processing of especially bison, *Bison priscus*, bones. Other mammals represented at the site are amongst others rhino and elephant. The identification of cut marks is difficult because of severe post-depositional abrasion of bone surfaces. The total number of identified bison individuals is high and believed to exceed 100 (Kraft, 1997).

Several Middle Pleistocene sites with archaeological faunal assemblages dating from and around the MIS 11 to MIS 9 stages provide data on hominid involvement with faunal remains. The French cave site of La Caune de l'Arago possibly provides the oldest example of a single species dominated assemblage. Within Level L of this cave site a faunal assemblage dominated by remains of reindeer, *Rangifer tarandus*, has been encountered (Moigne and Barsky, 1999). Reindeer remains dominate the assemblage from this level with 75%, representing the remains of 40 individuals. The faunal assemblage from Level L is believed to have been buried very rapidly, limiting the amount of depositional events (possibly just one season), and post-depositional damage like carnivore gnawing has been recorded on only 5% of the bone remains. Cut marks from butchering have been observed and



Figure 1.1: Simplified map of Europe with the locations of archaeological sites mentioned in the text.

- 1 Schöningen
- 2 Atapuerca
- 3 La Caune de l' Arago
- 4 Isernia la Pineta
- 5 Boxgrove
- 6 Bilzingsleben
- 7 Castel di Guido
- 8 La Polledrara
- 9 Gagny
- 10 Hoxne
- 11 Torralba
- 12 Ambrona
- 13 Aridos
- 14 Miesenheim
- 15 Kärlich
- 16 Biache-Saint-Vaast
- 17 Taubach
- 18 Mauran
- 19 La Borde
- 20 Coudoulous
- 21 Wallertheim
- 22 Salzgitter Lebenstedt
- 23 Solutré
- 24 Hauterive-Champréveyres



systematic marrow processing of bones from adult reindeer individuals has taken place. The site of Bilzingsleben, Germany, is believed to date from the Holsteinian. The site yielded bone remains of at least 20 mammalian species including hominid remains (Mania, 1990, 1995b). Bones bearing cut marks have been identified and bone marrow processing has been inferred. Of interest are the claimed bone tools from Bilzingsleben. Among these are a handaxe-like tool manufactured out of elephant bone and flaked bones possibly used as some kind of chisel. Also over 225 red deer antler parts have been collected at the site, which are claimed to represent antler tools (Mania, 1990). Although some tools are less convincing, undoubtedly hominids did use animal products for the production of tools at Bilzingsleben. Use of bone for the manufacture of tools has been encountered at several sites stemming from the Lower Palaeolithic. Bifaces made out of elephant bone and modification of bones of various species for example have been discovered at the sites of Castel di Guido and La

Polledrara, both in Italy (Gaudzinski, 1999; Gaudzinski and Turner, 1999; Villa et al., 1999). The French site of Cagny-l'Épinette, from the Somme river terrace, yielded 1501 bone remains representing at least 8 mammalian species. Archaeological level I1 of this site is dominated by remains of aurochs among which are some bone specimens with cut marks. At Cagny cut marks have further been observed on deer remains (Tuffreau et al., 1995). In Great Britain the site of Hoxne yielded bone remains of a diverse spectrum of mammalian species. Hominid involvement has been proved to be present by the identification of cut marks caused during dismemberment and filleting of carcasses as well as traces of bone marrow processing (Stopp, 1993).

At several Middle Pleistocene sites hominid involvement with faunal remains can be proven only on isolated butchery indicators or the association of artefacts with faunal remains. For example the sites of Torralba, Ambrona and Aridos in Spain yielded



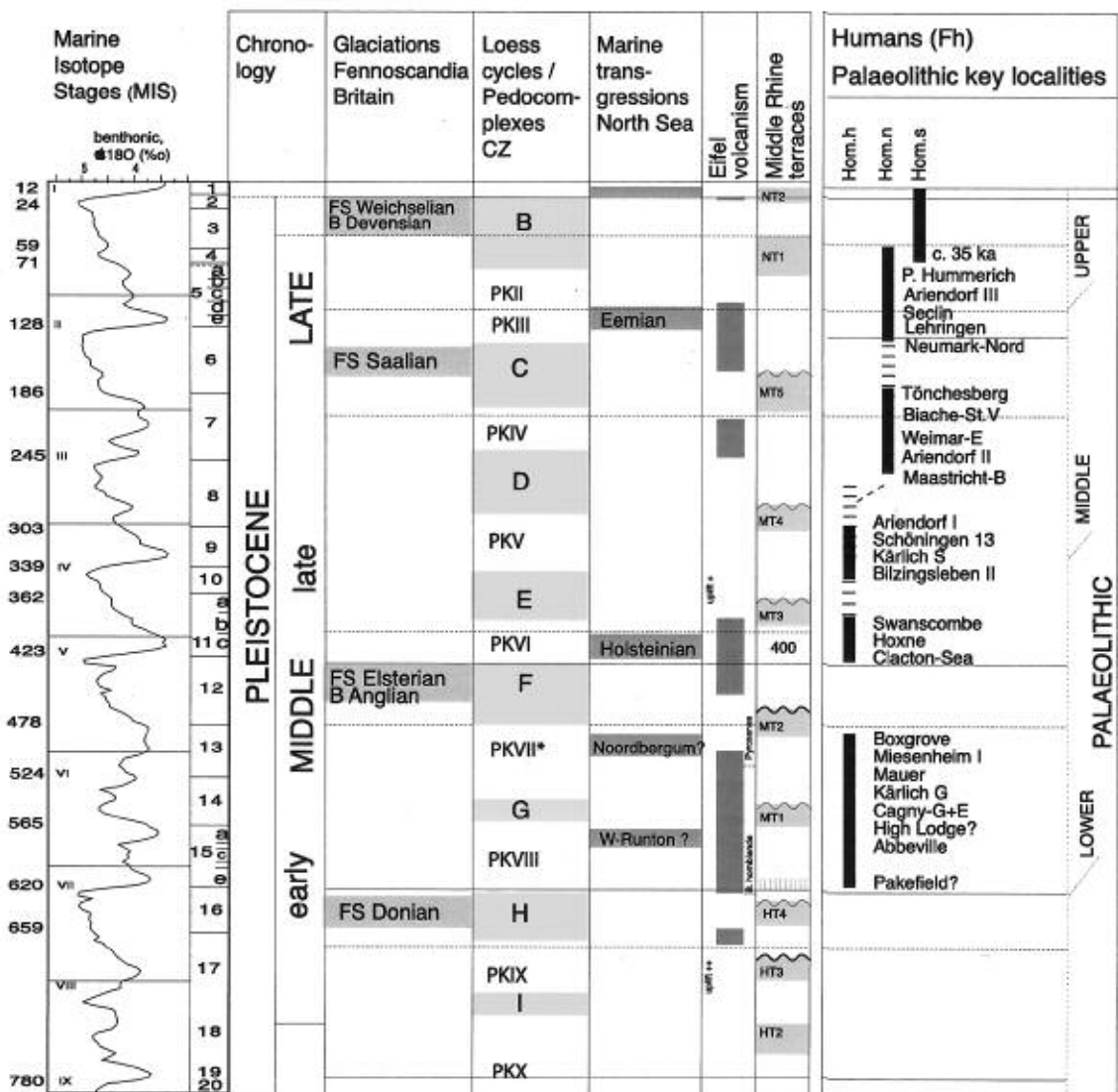


Figure 1.2: Subdivision of the Middle and Late Pleistocene for Northwest and Central Europa with correlated Palaeolithic sites including Schöningen 13 (13II-4), modified after Van Gijssel, 2006, p. 96-97, Figure 6.3.

levels with elephant remains associated with flint tool assemblages, of which Aridos 1 and 2 represent single elephant carcass sites. The faunal assemblages from the sites have been proven to be too ambiguous and too complex to reach reliable conclusions on hominid involvement with the remains or subsistence behaviour, although for Ambrona a marginal scavenging scenario has now been contested (Villa, 1990; Villa et al., 2005). Three other examples come from Germany. The site of Miesenheim₁, ascribed to MIS 13, yielded both stone artefacts and faunal remains from several mammalian species. Only one impact scar possibly inflicted during bone marrow processing by hominids has been observed, while cut marks have not been recognised (Gaudzinski and Turner, 1999; Turner, 1995). Kärlich-Seeufer, a site dating from the MIS 13 to MIS 11 time range, yielded a faunal assemblage associated with stone artefacts found within a former lakeshore context. Remains of elephant dominate the faunal assemblage but

hominid induced traces have not been recognised. The assemblage has been proven to be reworked and time averaged with hominid presence just being only a small part of its taphonomic history (Gaudzinski, 1995b). Conclusions on the faunal assemblage from the site of Schöningen 12b are comparable to those derived from Kärlich-Seeufer. The Schöningen 12b site also was situated in a former lakeshore context and is dated to the Holsteinian. Although a few bone remains yielded traces indicating hominid involvement with faunal remains, no conclusions could be drawn on hominid subsistence behaviour. The Schöningen 12b assemblage represents multiple depositional events and actors, being a reworked and palimpsest site (Voormolen, 1997). From the post-MIS 9 time range, but especially from MIS 7 and onwards, some more specific data on hominid involvement with faunal remains are available. An important faunal assemblage comes from the MIS 7 site of Biache-Saint-Vaast, France. The faunal assemblage found at this site contains aurochs



(69%), bear (16%), rhino and deer (Auguste, 1995). Among the identified bear individuals adults dominate. Moreover the bear remains exhibit cut-marked bone specimens among almost all identified skeletal elements and cut-marked metapodials indicate skinning of bears for fur. Remains of aurochs exhibit a whole range of butchering traces, cut marks from dismemberment, filleting, scraping and bone marrow processing (Auguste, 1995). Indications for skinning of bears for fur also come from the Eemian travertine site of Taubach in Germany. At least 11 mammalian species have been encountered at Taubach with as dominating species bear and rhino (Bratlund, 1999). High Minimum Number of Individuals (MNI) values on both rhino (MNI=76) and bear (MNI=52), a predominance of pre-adults among the rhino individuals and a dominance of adults among the bears together with high cut-mark frequencies are believed to reflect a hunting mode of subsistence of the Taubach hominids (Bratlund, 1999; Soergel, 1920). From the late Eemian to the early Weichselian there are several sites with a monospecific presence of species. The French sites of Mauran, La Borde, and Coudoulous as well as the German site of Wallertheim are dominated by bovids (David and Farizy, 1999; Farizy et al., 1994; Gaudzinski, 1995a, 1996; Jaubert, 1999). Study of bone remains derived from only a small excavated part at the site of Mauran yielded an MNI of 98 for bison, with bison bone specimens comprising 99% of the studied faunal remains. The total number of expected bison individuals from this site is estimated to be around 4000 and is interpreted to represent the remains of multiple bison hunting events spanning a considerable time period (David and Farizy, 1999). Bone surfaces at Mauran are mostly poorly preserved and the identification of cut marks was difficult, those registered however point to filleting and dismemberment of bison carcasses. Bone marrow processing could be recognised on the repeated presence of impacted areas on bison long bones (Farizy et al., 1994). Systematic and standardised bone marrow procurement of bovid bones has also been documented at the site of Wallertheim, Germany (Gaudzinski, 1995a, 1996). At Wallertheim 11 mammalian species have been identified with bison and horse being the dominating species with 77% and 20% respectively. Of all species only bison remains exhibit traces of hominid modification. The identified bison individuals are dominated by adults. Hominid-inflicted traces are primarily represented by impact scars on marrow bones, only some bison bone specimens yielded cut marks from butchery (N=6) (Gaudzinski, 1995a, 1996). The faunal assemblages from the French sites of La Borde and Coudoulous also are dominated by bovids, aurochs at

La Borde but bison at Coudoulous. The aurochs remains at La Borde represent about 40 individuals. Cut and/or impact fracture marks could not be quantified properly because of bone surface erosion. The La Borde aurochs mortality profile is dominated by prime-adults though and believed to testify to intentional focused hunting activities (Gaudzinski, 1996; Jaubert, 1999). At Coudoulous bison remains dominate with 98%, yielding an MNI of 94 from only 20 square metres. This, together with observed cut marks, impact fractures and a catastrophic mortality profile for bison makes Coudoulous comparable to other bovid dominated sites believed to represent Middle Palaeolithic specialised bovid kill sites (Gaudzinski and Turner, 1999; Jaubert, 1999). Another important site showing single species dominance is the (early) Weichselian (MIS 5-3) site of Salzgitter Lebenstedt (Gaudzinski and Roebroeks, 2000). At Salzgitter not bovids but reindeer, *Rangifer tarandus*, dominate the faunal assemblage with 70%, and showing minor carnivore gnawing marks (12%) but abundant cut and impact marks induced by hominid butchery. Among the reindeer at least 86 individuals are represented, mostly adults. Butchery and bone marrow processing of reindeer by hominids has been proven to be systematic and focused on adult reindeer individuals (Gaudzinski and Roebroeks, 2000). The Salzgitter site also yielded some bone tools, namely several modified mammoth ribs and a bone point (Gaudzinski, 1999).

This brief survey of documented Lower to Middle Palaeolithic faunal evidence shows that straightforward indicators for hominid involvement with faunal remains exist from the earliest European sites and onwards. Most straightforward evidence comes however from the post-MIS 9 record. From MIS 7 and onwards the occurrence of faunal assemblages yielding monospecific exploitation of biomass with cut marks and systematic bone marrow processing seem to differ from the record available from the preceding period. But, as stated by Gaudzinski, 1999:

“Further research will have to show whether the differences in faunal accumulations, before and after OIS 7, simply reflect deficiencies in our information base, or a behavioural change in the way early humans interacted with animal resources” (Gaudzinski, 1999, p.227).

As with the incorporation of ethnography and primatology during the 1960s, recently biological and physiological models are being incorporated in Palaeolithic research. Models developed from these disciplines predict a high meat intake for early hominids to cope with energy requirements for the growth of the brain (encephalisation) during the



hominid evolutionary trajectory. A high-quality diet of meat and animal fat would be necessary to cope with these energy requirements with hunting being the most efficient and likely strategy (Aiello and Wheeler, 1995; Milton, 1999). Stable isotope studies of Neandertal skeletal remains from Middle Palaeolithic contexts are in agreement with predicted high meat intakes inferring that Neandertals most likely were extremely carnivorous (Bocherens et al., 1999). Neandertal skeletal anatomy further indicates extremely high activity levels when compared to modern human skeletons, which could be related to high mobility foraging causing high energy demands (Sorensen and Leonard, 2001). For the post-MIS 7 Palaeolithic record this is now supported by archaeological and faunal assemblage data pointing to hunting and systematic butchery being part of European hominid behaviour. High-energy requirements related to brain growth are however predicted to increase severely from about 500,000 years ago (Aiello and Wheeler, 1995; Aiello, 1998). As such, high-energy intakes are predicted for hominid groups present already during the initial occupation stage of northwestern Europe. From the pre-MIS 7 record some data already suggest this could be the case but straightforward evidence is lacking. As stated by Gaudzinski and Turner, 1999:

“The methodological dilemma of taphonomical research is illustrated by the fact that a single wooden spear from the German site at Schöningen gives a clearer indication of human subsistence tactics during the Lower Palaeolithic than any number of taphonomically analysed faunal assemblages from the same period” (Gaudzinski and Turner, 1999, p.389).

This thesis presents a set of data derived from part of the Schöningen 13II-4 faunal assemblage, associated with the wooden spears, which in my opinion are very relevant to the debate, as I hope to show in the next chapters.



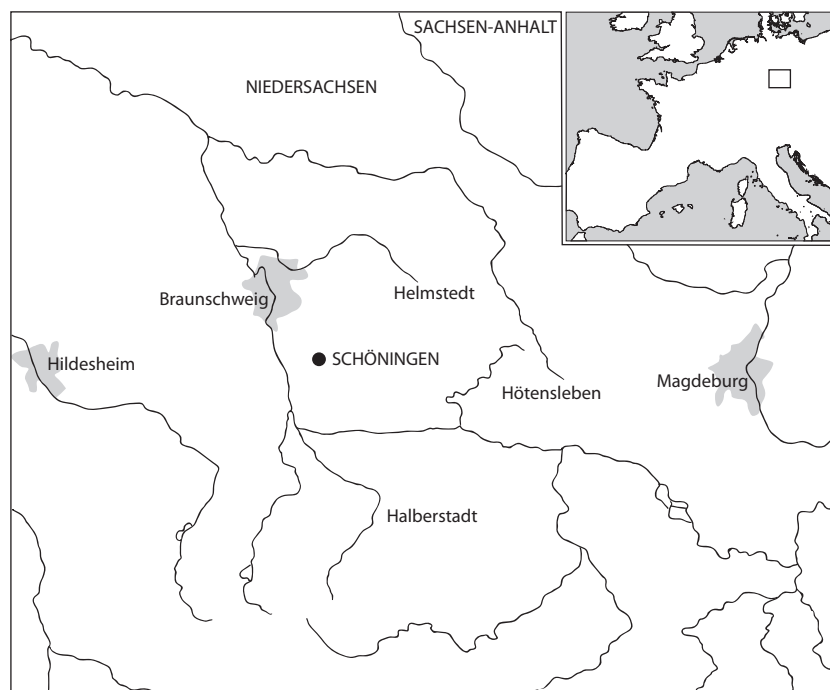
2 THE LARGE MAMMALIAN FAUNAL SAMPLE FROM THE SCHÖNINGEN 13II-4 LOWER PALEOLITHIC SITE

2.1 The archaeological and geological context of the Schöningen 13II-4 faunal sample

Since 1983 archaeologists are surveying two lignite quarries, exploited by the Braunschweigischen Kohlen Bergwerke AG (BKB), situated between Helmstedt and the small town of Schöningen near the former frontier between West- and East-Germany in Niedersachsen (Figure 2.1.1). The lignite quarry surveys focus on archaeological sites endangered by mining and are carried out by the Niedersächsisches Landesamt für Denkmalpflege of Hannover, Germany. From the start of the project numerous rescue excavations of archaeological sites from a wide variety of archaeological periods have been supervised by Dr H. Thieme and Dr R. Maier (Thieme and Maier, 1995). In the southern part of the Schöningen lignite quarry, during prospection of a newly exposed part, the Lower Palaeolithic site of Schöningen 12b was discovered and excavated during a few months (Thieme et al., 1992). Two findbearing layers from the Middle Pleistocene Reinsdorf Interglacial were exposed at the site and the excavations yielded about 1000 faunal remains, several hundred flint artefacts and wood remains (Thieme et al., 1992, 1993; Thieme and Maier, 1995). This site yielded the first signs of possible Lower Palaeolithic wood working. Three apparently worked silver spruce branches with a diagonal groove at one end were interpreted as indicative of hafting of flint tools (Thieme, 1997;

Thieme and Mania, 1993). The mammalian faunal remains from the site were assumed to be the remains of hunted and butchered animals (Thieme, 1997, 1999; Thieme and Mania, 1993; Thieme and Maier, 1995). However, detailed taphonomic analysis of the Schöningen 12b bone remains revealed a complex taphonomic site history lacking sufficient data on hominid-induced signatures from which subsistence behaviour could be deduced (Voormolen, 1996, 1997; see also Chapter III). During the first half of 1994 attention was focused on the newly discovered site of Schöningen 13I. This site yielded both faunal remains and flint artefacts. The site is referred to originate from the Holsteinian Interglacial and would be the oldest discovered Schöningen site thus far (Thieme and Maier, 1995). During the second half of 1994 another site was discovered within the geological sequence subscribed to the Reinsdorf Interglacial. This site, Schöningen 13II-4, has from then on been the subject of detailed excavations. Originally it was a rescue excavation, but was extended after the first finds of wooden artefacts in 1995. The wooden artefacts, which soon appeared to be wooden spears, were made public by an article in Nature, which facilitated continuity of the excavations (Thieme, 1997). In 1998 a total of 2500m² had already been excavated and in 2006 a total of 3200m² had been reached (Thieme, 1999, 2005, 2006 pers.comm.).

Figure 2.1.1: The geographical location of Schöningen.



Now, in 2007, the excavations at the locality are still continuing and are concentrating on lower archaeological levels, pre-dating the spear horizon. The unique conservation properties of the geological context together with the inferred high age of the deposits makes the locality one of the most important of the known European Lower Palaeolithic archaeological sites.

In the course of the excavations an impressive number of archaeological finds has been recorded which were distributed along a former lakeshore. The most spectacular finds undoubtedly are eight wooden spears (Figure 2.1.2). They appear to reflect remarkable technological skill. With the exception of spear no. 4, the spears are systematically manufactured from the toughest parts of spruce, *Picea* sp., each specimen from an individual trunk. Technologically the spears appear to be standardised, with the maximal thickness and weight at the front and tapering towards the back (Thieme, 1997). These characteristics resemble the properties of modern



javelins used in athletics. Experiments with copies of the archaeological specimens by experienced javelin throwers demonstrate that the spears have excellent flight properties and were likely especially made for throwing purposes (Steguweit, 1999). Apart from the wooden artefacts, several hundreds of flint artefacts have been recorded among which are tools, mostly various scraper types and retouched flakes (Figure 2.1.3). In the course of 1998 also more than 1200 resharpening flakes and retouch spalls were collected (Thieme, 1999, 2005). The excellent conservation of organic materials, being the result of highly calcareous groundwater, led to the survival of numerous bone remains probably exceeding 25,000 bone specimens (Thieme, 1999, 2005). The presence of fireplaces has also been inferred. Local patches of cracked and coloured earth parallel to the main find concentration on the lakeshore are believed to have been caused by open-air hearths. Although these features still have to be examined in more detail, the finds of a wooden pointed stick with burning traces and several burned bone fragments are in support of the former presence of fire (Thieme, 1999).

The brown coal quarries in which the Schöningen sites have been encountered are positioned in two sedimentary basins, the *Helmstedter Randsenken*, on the flanks of a 70 kilometre long salt dome, the *Helmstedt-Staßfurter Antikline*. The base of these basins are formed by Mesozoic deposits followed by Tertiary deposits. In the western basin, where the Lower Palaeolithic sites have been found, and on top of the

Tertiary deposits a Quarternary sedimentary sequence is preserved (Lietzow and Ritzkowski, 1996; Thieme and Maier, 1995). The Quarternary deposits are situated in six erosional channels believed to represent different climatological cycles (Mania, 1996). The sedimentary contents of the second of these erosional channels consists of a sequence of mud and peat layers and has been attributed to the Reinsdorf Interglacial. The base of this limnic, sedimentary sequence is situated on top of a calcareous basin fill, which is underlain by Elsterian moraines and late glacial gravels (Mania, 1995a; Thieme et al., 1993; Thieme and Mania, 1993). The Reinsdorf sequence comprises alternating layers of organic muds, loams and peat, and represents the remnants of falling and rising lake levels. A series of five sedimentary sequences is present: each phase represented by fine-grained sediments of silt, mud and gyttja facies, which were deposited in former lakes (Figure 2.1.4). Peat was formed during falling of lake levels or when vegetation had overgrown the lake (Van Gijssel, 2006). The site of Schöningen 12b was found just above the lowermost, first level of the sequence and therefore predates the Schöningen 13II-4 sites findbearing deposits which originate from the fourth lake level of the sequence.

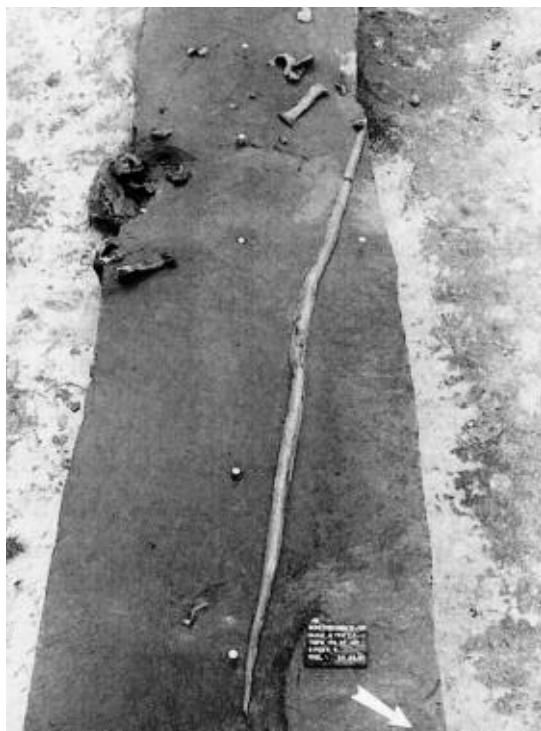


Figure 2.1.2: Two of the Schöningen 13II-4 wooden spears found still embedded in the sedimentary context with surrounding bone remains, photos Thieme, 1999, p. 473, Abb.16.



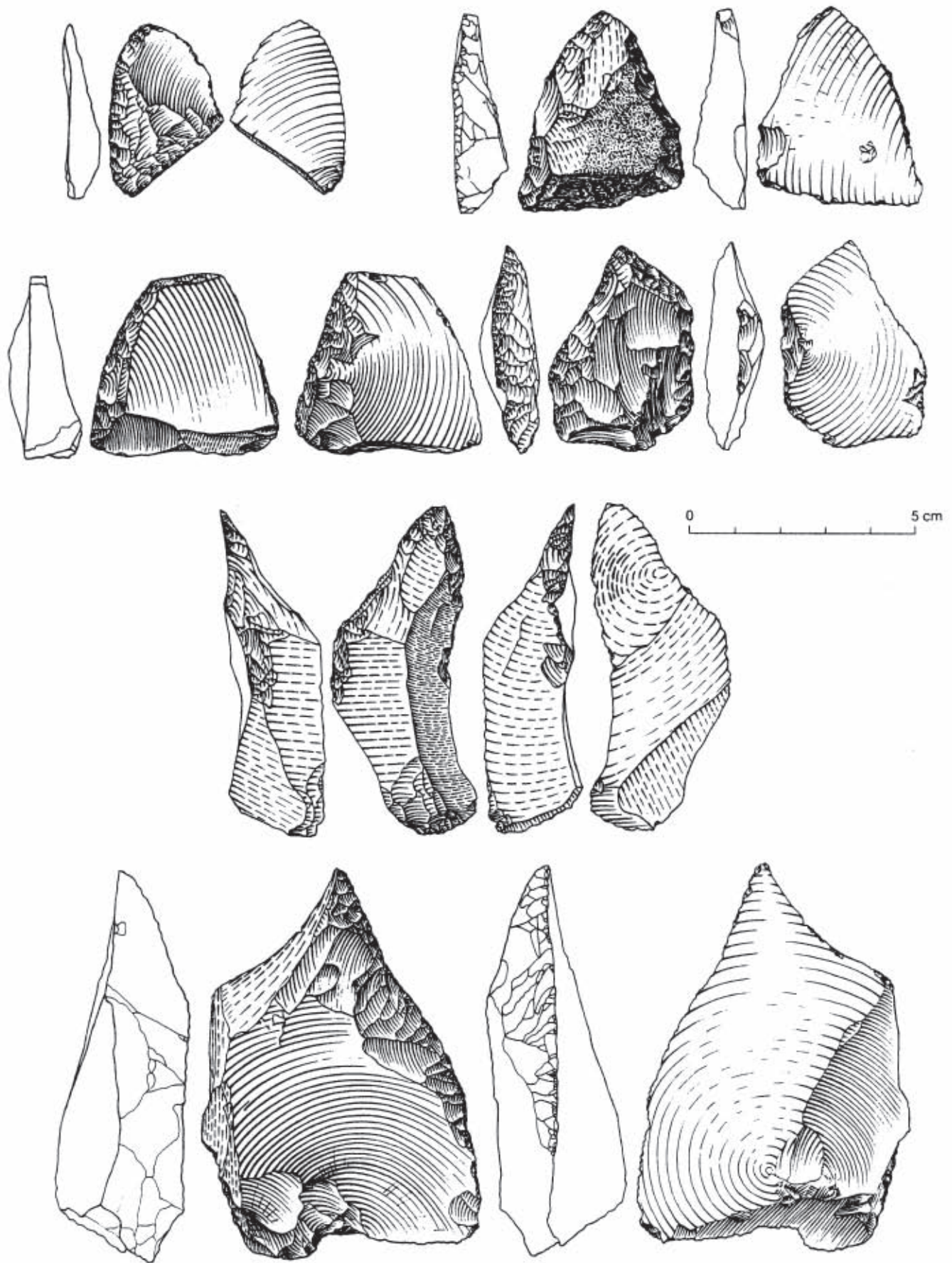
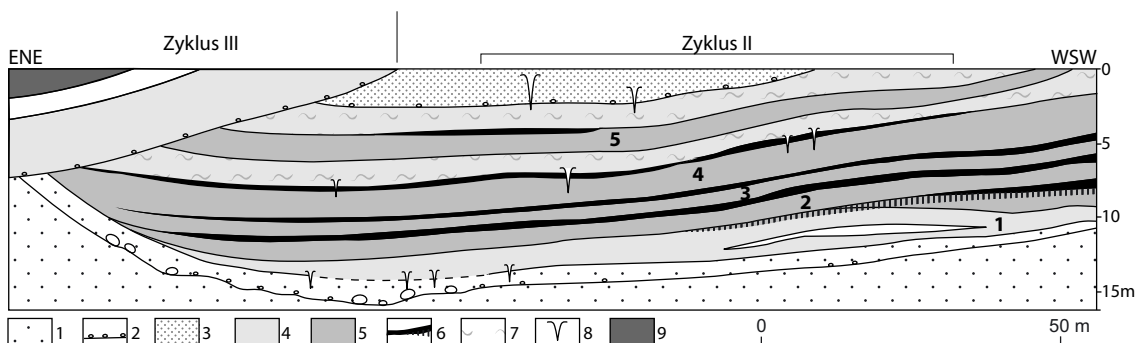


Figure 2.1.3: Several flint scraper types from the Schöningen 13II-4 stone artefact assemblage, taken from Thieme, 1999, p. 468, Abb. 12.





Figure 2.1.4: The site of Schöningen 13II-4 on the isolated sediment island during the initial excavations in 1995 (above). Below, a schematic drawing of the recorded Reinsdorf sequence comprising alternating layers of organic muds, loams and peat, which represent the remnants of falling and rising lake levels. A series of five sedimentary sequences is present, each phase represented by fine-grained sediments of silt (no. 4 in the legend), mud (no. 5), and gyttja facies (no. 6), which were deposited in former lakes. The site of Schöningen 13II-4 originates from lake phase number 4. Taken from Thieme, 1999, p. 467, Abb. 7.



Palynological studies of the lake deposits indicate that the oldest (lower) peat levels can be correlated with an early interglacial phase and an interglacial maximum, while the younger (upper) levels represent cool temperate, end interglacial, contexts (Urban, 1995a, 1995b). In the uppermost part of the sequence frost structures appear, followed by deposits of sands and gravels, which have been interpreted as dating to the following Fühne glacial phase according to the terminology used by Mania et al. (Mania, 1993, 1995; Thieme et al., 1993; Thieme and Mania, 1993). Palynologically the Reinsdorf Interglacial differs from the Holstein Interglacial (Urban, 1995a, 1995b). The faunal assemblage from the Reinsdorf sequence contains amongst others the beaver *Trogonterium cuvieri* and the vole *Arvicola*

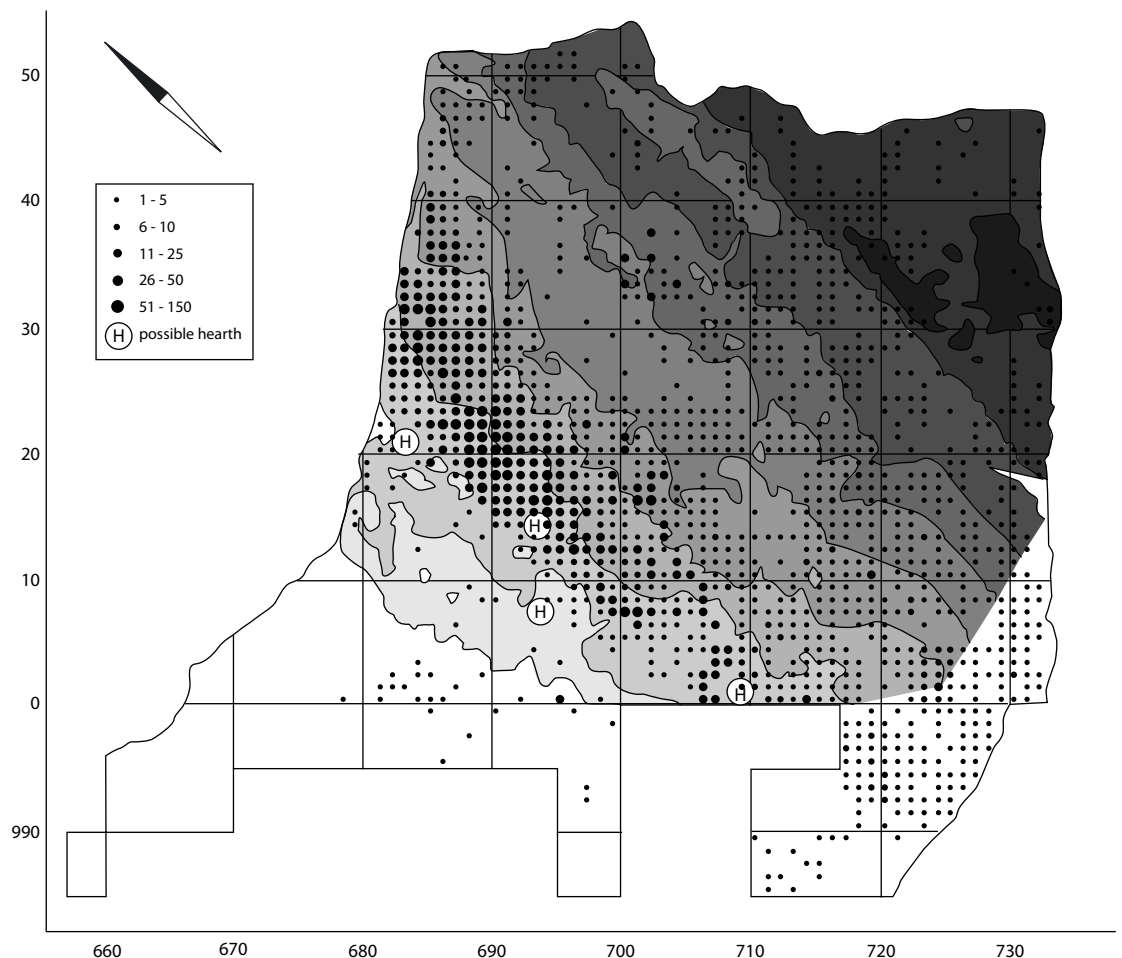
terrestris cantiana which also occurs in the fauna from the Lower Palaeolithic site of Bilzingsleben, Germany, formerly correlated with the Holstein Interglacial (Van Kolfschoten, 1993, 1995). Opinions on the correlation of the Reinsdorf Interglacial with Marine Isotope Stages differ. Both MIS 9 and 11 have been put forward, with a suggested age range of between 300,000 to 450,000 years BP (Mania, 1993, 1995a, 1996; Thieme 1999; Urban, 1995a, 1995b). The available data on palynology, the small mammal fauna and thorough comparisons with other documented stratigraphies from this part of Europe suggest MIS 9 to be the most likely stage to be correlated with the Reinsdorf Interglacial sequence, pointing to an age somewhere between 300,000 and 350,000 years (Van Gijssels, 2006; see Figure 1.2).



The Schöningen 13II-4 archaeological finds were found distributed along a former shallow water lakeshore within the Reinsdorf sequence phase four deposits. On the site three main sedimentary units could be discerned, from bottom to top: A layer of calcareous silts representing the former bottom of the lake (Layer C), higher up these silts become organic and constitute a layer of humic silts (Layer B) which is overlain by a layer of peat representing former stagnating shallow water (Layer A). Most of the recovered archaeological finds were distributed throughout Layer B and some vertically into the top of Layer C (Thieme, 1999, 2005). Horizontally the find distribution follows the former lakeshore with a clear concentration of material present within a zone of about 10 metres wide parallel to the shoreline (Thieme, 1999; Figure 2.1.5). The excavation of the 13II-4 findlayer is now in the finishing stage and the total amount of excavated bone remains has been estimated to be over 25,000 specimens (Thieme, 2005). Most of these remains have been stored in cold storage rooms due to a lack of funds and personnel necessary for conservation and registration. Most of the bone remains which were excavated during the initial excavation stages in 1994 and 1995 have been preserved and stored. These remains are mostly derived from excavated square metre blocks in the

main concentration area (Figure 2.1.5) and have been analysed during this study. The number of bone remains available for this research approaches 5000 and thus represents an estimated maximum of 20% of the overall site collection. From this sample, the discovered complete horse and bovid skulls have been excluded, as at the time of study these were stored at the laboratory for restoration and were therefore not available for a detailed analysis. The bone material that was studied was stored in boxes and all the pieces collected in the field were present, including even the smallest bone fragments. During two brief studies of part of the available material at the Niedersächsisches Landesamt für Denkmalpflege in Hannover, Germany, the primary characteristics of the assemblage were examined. Two visits to the Landesamt, in 1999 and 2001, revealed that the bone material was in an excellent state and hominid-induced butchering traces seemed easily recognisable. Because of the excellent preservation of the material and the importance of Early Palaeolithic subsistence data, it was decided that a taphonomic study conducted on this Schöningen 13II-4 faunal sample should be executed with special attention to butchery traces and patterns. A sample of nearly 20% of the total excavated amount was believed to be sufficient to get an impression of the overall

Figure 2.1.5: Schematic representation of the excavated Schöningen 13II-4 area (grid in metres) with palaeorelief of the top of Layer C (shaded, with darker shades representing higher areas), and the find distribution/density (black dots) at the end of 2003. The mapping of the density of finds includes all individually recorded objects except bone fragments < 5 cm; modified after Thieme, 2005, p. 121, Figure 8.3.



character of the site. A more extensive study of the available material was therefore initiated and executed over a period of several months in 2001 at the Faculty of Archaeology at Leiden University, The Netherlands.

Due to the fact that it was known that the studied bone material represented only 20% of the total bone assemblage, no spatial analysis of bone remains was executed. No thorough analysis or publication of geological profiles and the flint assemblage of the site have been executed so far. At this stage it is therefore not possible to include a broader discussion on the archaeological context of the Schöninggen 13II-4 faunal sample.

2.2 Research questions

Pilot studies of part of the Schöninggen 13II-4 faunal sample at the Hannover archaeological depot indicated excellent preservation of the excavated bone remains. The bone surfaces appeared to be intact and signs of bone weathering or abrasion were limited. A survey of the material on skeletal element abundance indicated that both strong and vulnerable skeletal elements were represented. The assemblage was thus expected to provide a good opportunity to study actor-related bone surface modifications and skeletal element abundance. Moreover, butchering traces created by stone tools, being present in the form of cut marks, were frequently encountered and extreme fragmentation of long bones indicated processing of marrow containing elements. Hominid-induced traces of bone modification therefore should be registered as detailed as possible.

The Schöninggen 13II-4 faunal sample was expected to provide important information about the taphonomic history of the Schöninggen 13II-4 site. The research focused on the following research questions and parameters.

Hominid involvement in the assemblage formation history should be detected through the recognition of specific hominid-induced traces and patterns like:

- ▶ Butchering marks such as cut marks inflicted during disarticulation, meat removal, tendon removal, and skinning of animal carcasses.
- ▶ Impact notches and impact scars, created during processing of bone marrow by fracturing marrow-bearing bones.
- ▶ Skeletal element or body part frequencies indicative of the selection, transport or discard of animal parts, yielding favoured products.

- ▶ The use and modification of bones to be used as tools.
- ▶ A single species dominated taxonomic composition of an assemblage due to specialised hunting.
- ▶ Prime age mortality profiles indicating focused and specialised hunting of mature, nutritionally rich, animal individuals.

If detected these parameters should be used to make inferences about hominid subsistence behaviour involved in the formation of the faunal assemblage. The main questions which should be answered are:

- ▶ Being an assemblage with good preservation properties, does it provide information on early hominid subsistence behaviour and on taphonomic processes being more straightforward than that documented for most Lower Palaeolithic bone assemblages previously documented?
- ▶ Do the hominid induced butchery traces indicate systematic or/and standardised carcass treatment and specific animal product directed butchery?
- ▶ Do the faunal remains provide information on hominid induced signatures indicative of hunting of large mammals, as being inferred from the finds of supposed hunting spears, and being in contrast with the widely adopted early hominid scavenging model?

The possibilities of identifying indicators of hominid subsistence behaviour depend heavily on the resolution that a faunal assemblage has to offer, it being the end product of a possible long taphonomic trajectory. The identification of indicators of hominid behaviour can be considered to depend largely on the degree of influence of non-hominid activities and processes. Therefore, the assemblage should be checked regarding:

- ▶ The amount of preservation and collection of cut mark bearing bone parts.
- ▶ The preservation, and collection, of impact notches and impact scars bearing bone parts (often long-bone shaft fragments).
- ▶ The presence, or survival, of a representative sample of all originally present skeletal elements, including the more vulnerable bone parts. Checking for bone density mediated destruction by either chemical processes or carnivore activity.
- ▶ The presence and degree of influence of obscuring post-depositional bone surface damage like bone surface weathering, carnivore gnawing, sedimentary abrasion, polish or chemical abrasion.



2.3 Variables, methods and the analytical procedure of the taphonomic study

The taphonomic study of the Schöningen 13II-4 faunal sample should be especially concerned with providing information on hominid behaviour and questions about archaeological resolution. Taxonomic determinations more detailed than the genus level have been neglected in favour of the collection of quantitative data on skeletal element representation and detailed analysis of butchering traces. If readily apparent, taxonomic distinctions were made, but no study of osteological measurements to make a distinction between species is provided. Nor was a study of dental wear patterns to age individuals carried out. This decision follows from a known absence of a large part of the dental elements originally found at the site. These dental elements are still in position in complete skulls and mandibles found at the site but at the time of study they were being preserved at the laboratory and thus not available for study. Some of the discovered mandibles and mandible parts were however present in the studied sample. They have been investigated for the presence of butchering traces and are included in the analysis. The knowledge of dental elements being only partly present within the available sample compelled me not to undertake age estimates on dental wear because this would not be representative for the complete studied sample. Only age estimates on post-cranial skeletal elements have been performed based on epiphyseal fusion stages and one estimate on a juvenile mandible with deciduous molars has been undertaken. Age estimates included in this study should be viewed as merely an indication of what to expect when the complete faunal assemblage from the Schöningen 13II-4 site will be analysed in the future.

a 25 x 25 centimetre grid. Although vertical, Z-coordinates have been taken on individual finds, these could not be used during this study. The corresponding individual Z-coordinates had to be found individually in the original field documentation, which was a very time-consuming job. The horizontal grid, X and Y, coordinates of individual finds are included in their findnumbers however and these could easily be used for analytical purposes. Also, during the study no recorded digitised geological profiles were available to project individual finds by sedimentary layer. It was therefore decided to limit the use of information on the distribution of finds to horizontal data and their 'in-the-field' description of the sedimentary layer of origin.

Organic preservation is excellent at the site and during the excavations of the Schöningen 13II-4 site, material was collected meticulously. Bone remains of even the smallest size have been gathered and were available for study. In this study all available bone specimens larger than approximately two centimetres have been analysed and described by use of a coded database structure. For every bone specimen as many variables as recognisable were recorded, with a maximum number of 47 variables. Table 2.3.1 shows a summary of the database structure used to record information on bone specimens. Some of the variables shown are in reality divided into several sub-variables. Especially registration of skeletal elements has been done in detail. In the case of specific long-bone shaft parts, these have been given separate codes to facilitate precise counts of skeletal elements and individuals. Signs of modification traces on bone specimens have been divided into separate categories of taphonomic actors, such as carnivore indicators, hominid indicators, weathering, sedimentary damage and chemical processes. The parameters on which different actors and related traces have been identified as well as methods used to calculate indices will be described in more detail below.

Table 2.3.1: Main structure of the Schöningen 13II-4 database used to describe the examined bone remains.

During the excavations at the Schöningen 13II-4 site the finds were collected in square metre units. On a more detailed level of individual finds, also the location within a square metre was recorded by using

Schöningen 13II-4 summarised database structure

Contextual data	Modification data	Hominid data	Zoological data	Carnivore data	Additional data
Findnumber	Weathering stage	Cut mark type	Genus / Taxon	Gnawing type	Fragment refits
X- & Y-coordinates	Abrasion	Cut mark orientation	Skeletal element	Gnawing pattern	Anatomical refits
Square no.	Chemical modification	Butchery activity	Body side	Gnawing location	Special features
Layer	Fracture type	Cut mark code	Body part		
		Impact scar type	Element part		
		Impact scar association	Age indicator		
		Impact code	Sex indicator		
		Impact scar sizes			



2.3.1 Pre- and post-burial damage: Bone weathering and bone surface alteration

The condition of the Schöningen 13II-4 bone material can be called excellent. The fine-grained sediments, soaked with highly calcareous groundwater in which the bone remains were sealed, have provided good conservation circumstances. Nevertheless, to check for pre-burial climatic alteration due to surface exposure of bone remains, the degree of weathering should be determined. For the recognition and description of the degree of bone weathering, weathering stages ranging from 1 to 4 after Behrensmeyer (1978) and Lyman (1994) can be used. Differences in bone preservation characteristics encountered on the studied bone material were however more gradual than those described in these conventionally used descriptions. Differences in bone preservation mostly appeared to be limited with only a small part of the bone specimens clearly being less well preserved than most of the remains (see Section 2.4). The main difference in preservation of the studied bone specimens which could be observed was the degree of crack development (see Table 2.3.2, and Figures 3.2.1 and 2.3.2 for examples). Much of the bone specimens exhibit just the initial presence of split lines visible on the bone surfaces, while most specimens exhibit developed split lines with very slight to some cracking of the bone on these split lines. The amount of cracking is also related to the type of bone, with flat bones being less compact and therefore cracking much easier than compact long-bone shafts (see for example the horse scapula in Figure 2.5.5 for more severe cracking). Clear signs of

rounding of edges of cracks on split lines have not been observed and neither could apparent differences in preservation of the cortical bone surfaces between split-lined and cracked bone specimens be detected. The difference between the development of split lines and cracking on split lines therefore most likely is related to either sediment pressure acting on the water-soaked bone remains or post-burial drying of the originally water-soaked bone remains causing shrinking and cracking of the bone cortex (see the photographs of bone specimens in Sections 2.3.4 and 2.3.5 for a range of very little split-lined to more split-lined bone specimens which is believed to result from post-burial drying and shrinking). Post-burial drying of bone remains can be explained by dehydration of the findlayer sediments. Prior to quarrying the mining area was drained by the mining company to facilitate the digging operations. Also, after the discovery of the site a sediment island containing the site was left within the lignite quarry while the surrounding area was dug away by mining. This led to complete dehydration of the sediment island as it became cut off from the surrounding sediments. During the excavations, the excavators had to wet the top sediments with water to prevent the bone remains from destruction by exposure to dry circumstances. Bone remains displaying no split lines, some split lines and some cracking on split lines have been grouped as weathering characteristics Group A, representing bone specimens exhibiting characteristics pointing to an absence of surface exposure pre-burial weathering or at most very slight pre-burial weathering. Also a weathering characteristics Group B has been distinguished

Table 2.3.2: Descriptions of weathering stages conventionally used (on the left) and descriptions of bone preservation characteristics encountered during the Schöningen 13II/4 study (on the right).

Description Behrensmeyer 1978; Lyman 1994	Description of observed bone preservation Schöningen 13II/4
Stage 0: Greasy, no cracking or flaking, perhaps with skin or ligament/soft tissue attached (bone still moist).	
Stage 1: Cracking parallel to fibre structure (longitudinal), articular surfaces perhaps with mosaic cracking of covering tissue and bone (split lines begin to form).	Group A: No cracking or flaking, some split lines begin to form.
Stage 2: Flaking of outer surface (exfoliation), cracks are present, crack edge is angular.	Cracking parallel to fibre structure (longitudinal), split lines are well developed.
Stage 3: Rough homogeneously altered compact bone resulting in fibrous texture; weathering penetrates 1-1.5 mm maximum, crack edges are rounded.	Group B: Cracks penetrate the bone, crack edges are angular, perhaps some splinters of bone loose on surface.
Stage 4: Coarsely fibrous and rough surface; splinters of bone loose on surface, with weathering penetrating inner cavities; open cracks.	Cracks penetrate inner cavities, open cracks, perhaps splinters loose on surface; bone fragile, perhaps falling apart.
Stage 5: Bone falling apart in situ, large splinters present, bone material very fragile.	



representing bone specimens exhibiting signs of moderate to extreme weathering. Bone specimens with extremely developed cracks causing the bone to almost or already falling apart are included in Group B. Among this group are also bone specimens exhibiting flaking of outer cortical bone surfaces, so-called exfoliation. The encountered specimens with flaked bone surfaces exhibit some loss of cortical splinters following developed cracks but those cortical parts still being present showed that the outer cortical surface in most cases remained unaltered. Summarised, the gradual differences in bone preservation of most of the Schöningen 13II-4 bone remains indicate limited variation in weathering caused by pre-burial surface exposure to climatic influences. It can be concluded that pre-burial surface exposure for at least most of the bone remains was very limited, which points to rapid burial of the deposited bone remains at the find locality.

Apart from bone weathering characteristics, the bone material has been examined for signs of post-burial modifications. The presence of polish on the cortical surface and rounding of fracture edges can be an indication of movement and transport of bone remains and thus also of the co-presence of material of different origin or contexts. Because of the fine-grained sedimentary matrix of the bone assemblage, severe polishing or rounding of bone remains however was not expected.

Signs of post-burial damage on the bone material has been divided into four categories:

- ▶ Bone specimens exhibiting slight rounding of fracture edges or polish on bone surfaces.
- ▶ Specimens with prominent rounding of fracture edges.
- ▶ Bone specimens of which the surfaces show striations which could be caused by movement within coarse-grained sediments or by processes like trampling.
- ▶ Diagenetic modification, represented by traces of root-etching and chemical dissolution of bone surfaces.

Dissolution caused by decalcification of the bone's cortical surface was most frequently encountered (see Section 2.4). Decalcification was recognisable by the presence of dissolution pits on the bone surfaces (see Figure 2.3.2). Pronounced root-etching on bone surfaces also has been observed but was very limited. Etching by plantroot acids, or acidic metabolites deposited by mycelial fungi (Domínguez-Rodrigo 2006, pers.comm.), resulted in spaghetti-like patterns etched into the cortical surface of some bone specimens. Many of the bone remains show discolouring signs on their surfaces representing decaying plant remains, likely caused by organic processes encasing the remains in the peat from which most of the bone remains originate (see Figure 2.3.1).

Figure 2.3.1: Close-up of the cortical surface of a long bone shaft lacking signs of weathering but showing discolouring from decaying plant remains.

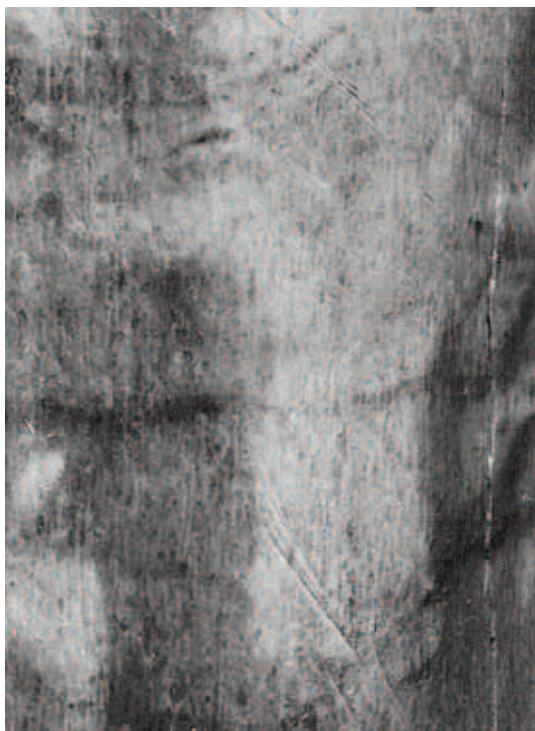


Figure 2.3.2: Close-up of the cortical surface of a long bone shaft exhibiting drying cracks and showing slight decalcification and dissolution pits. Photos by J. Paupit, Leiden.



2.3.2 The calculation of representation indices

All examined bone remains of the Schöningen 13II-4 faunal sample have been described with coded variables stored in a relational database and analysed with the use of the SPSS statistical package. All counts on both skeletal elements and traces on bone remains are expressed in several (representation) indices. This section provides the methodological background on which these indices have been derived.

NISP

The most basic index on the number of examined bone specimens which has been used is the Number of Identified Specimens, or NISP. The NISP normally refers to the number of bone specimens as identified to belong to a certain taxon or skeletal element (Lyman, 1994). Throughout this study the NISP is used as the number of described and counted bone specimens identified to belong to a certain category. If NISPs are presented, the accompanying category to which the counts refer, have been specified in the tables or text. Categories can range from being identified to taxon, skeletal element, bone part, weathering stages, to the category indeterminable. The NISP can be suffixed with ‘-gnawed’, ‘-cut-marked’ or ‘-impacted’. NISP-gnawed refers to the number of bone specimens identified to belong to a certain category and bearing traces of carnivore gnawing (see also Section 2.3.3). NISP-cut-marked refers to the number of bone specimens identified to belong to a certain category and bearing cut marks inflicted during butchery (see also Section 2.3.4). NISP-impacted refers to the number of bone specimens identified to belong to a certain category and bearing impact scars, or conchoidal flake scars, inflicted during marrow-processing of bones by hominids (see also Section 2.3.4). All three suffixes are also used in combination with the indices following below and signify the same. If just %, %gnawed, %cut-marked or %impacted are given in tables, these have been derived from NISP counts. A %gnawed indicates the NISP bearing gnawing marks expressed as a percentage of the overall NISP of a certain category.

MNE

The Minimum Number of Elements, or MNE, stands for the minimum number of a particular skeletal element determinable in the studied sample. MNE counts are derived by looking at the minimum number of specific skeletal elements accounted for by the observed complete elements together with element parts. Apart from the overall MNE, a division is made in the MNE-sin, minimum skeletal elements from the left side of the body, and the MNE-dex, the minimum number of elements from the right side of

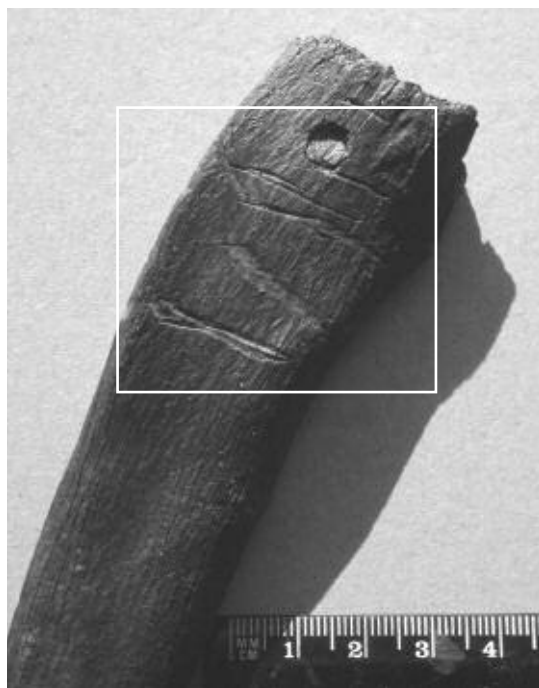
the body. In this study, registration of skeletal fragments has been done in detail. During a short survey of the material prior to the present analysis, fragmentation of much of the skeletal elements, especially long bones was apparent. Moreover, the repeated presence of diagnostic element fragments was observed. It was therefore decided to provide diagnostic element parts with separate codes, thus to facilitate precise counts on represented elements. For long-bone fragments the shaft area, from proximal via medial to distal, of origin has been recorded to derive frequencies on long-bone shaft parts (cf. Marean and Bertino 1994; Marean and Spencer 1991). Also long-bone shaft fragments have been coded separately according to the presence of diagnostic features like muscle attachment areas or crests (see the chapters on individual horse skeletal elements). By summing element parts with overlapping diagnostic element features, the most accurate MNEs could be derived. Moreover, it becomes possible to present MNE counts on element parts, like a MNE-epiphysis or MNE-diaphysis.

MNI

From the highest MNE-sin or -dex, the Minimum Number of Individuals, or MNI, is calculated being the highest predicted number of individuals to account for the observed skeletal elements. From the MNI, the Percentage of Number of Individuals, or %MNI, can be derived. The %MNI is calculated by taking the skeletal element yielding the highest MNI value from which the MNI values for the other elements are being expressed as a percentage of this highest MNI. A variant of the %MNI is the Percentage of Survival, or %SURV. In this study, the %SURV index has been preferred, and will be used more frequently than the %MNI. The %SURV, originally developed by Brain (Brain, 1981; Lyman, 1994), uses the highest derived MNI to predict the expected number of specific skeletal elements to be present. The advantage of using the %SURV is a more detailed impression of the representation, or under-representation, of skeletal elements and body parts. The %SURV provides a comparison between the predicted MNE and observed MNE for skeletal elements on the highest identified MNI. Often it is more difficult to arrive at MNI values for certain skeletal elements although MNE values can be relatively precise. For example damaged vertebrae and ribs often cannot be exactly determined as to their location within the vertebral column and rib case. If two thirds of the element is present though, an MNE can be derived. Hence the %SURV is a more precise representation of the skeletal elements actually observed.



Figure 2.3.3: The distal end of a horse rib exhibiting a carnivore tooth puncture associated with shallow and sharp tooth scores. Photo by the author.



2.3.3 Carnivore activity signatures

The influence of carnivores on the survival and composition of archaeological faunal assemblages has often been proven to be severe. The identification of possible carnivore activity and the degree of influence of carnivores on an assemblage therefore is an important analytical step. Carnivore ravaging of carcasses often leads to the deletion of skeletal element parts and the distortion of skeletal profiles (Binford 1981; Domínguez-Rodrigo, 1999, 2002; Marean and Bertino, 1994; Marean and Spencer, 1991). Moreover, traces created by carnivore gnawing can mimic and distort traces induced by hominid butchery (Binford, 1981; Lyman, 1994). Frequencies on detected carnivore traces in the studied Schöningen 13II-4 sample are provided in following chapters. Here the parameters and criteria on which carnivore traces have been identified will be dealt with.

Four main types of carnivore-inflicted traces on bones have been discerned, following Binford (1981). Gnawing on hard compact bone parts, like long-bone shafts, can be detected by the presence of *scores* and *pits*. Pits can be described as the imprints of pointed carnivore teeth left in the cortical surface of bones during repeated biting. Pits are often associated with scores, which are in fact scratches created by dragging teeth over the cortical bone surface. Repeated biting on softer bone parts, like the cancellous epiphysis of bones, often results in *punctures*. Punctures are the result of carnivore teeth penetrating the bone cortex and entering the cavity. *Furrows* result from chewing on soft cancellous bone parts, which leads to grooving and the destruction of the cancellous mass.

Figures 2.3.3 and 2.3.4 provide examples of carnivore scoring and puncturing encountered in the Schöningen 13II-4 sample. Carnivore gnawing features like pits, punctures and scores on well-preserved bone remains are relatively easy to discern. The distinction between impact notches and conchoidal flake scars, created during long-bone shaft breakage by either carnivores or hominids can however constitute a problem (Binford, 1981; Capaldo and Blumenschine, 1994; Fisher, 1995; Lyman, 1994; White, 1992). To get more grip on the role of these agents with regard to bone breakage, a more contextual approach can be conducted. During this study three contextual parameters have been used: *Placement of traces*, *Patterning of traces* and *Association of traces* (abbreviated as PPA data). For example, carnivore breakage of bones can result in the presence of cortical impact notches and conchoidal flake scars on fracture edges. Apart from the morphology of carnivore-related impact notches and scars, often less wide and more puncture-like when compared to those created by hammerstones (Capaldo and Blumenschine, 1994), the co-presence with pits and scores near the notches or distributed on the bone bearing the notch could indicate carnivore involvement (Binford, 1981; Blumenschine, 1988; Fisher, 1995; Voormolen, 1997). Compared to hominid marrow procurement and related bone breakage, carnivore-induced breakage is expected to be less systematic in nature with impact notches and scars being more randomly distributed (see below for inferences on hominid marrow procurement). The placement of carnivore traces is therefore important to document.





Another reason for thorough documentation of gnawing traces is the possible deletion of hominid butchery marks. For example, carnivore destruction of nutritional rich long-bone, articular, ends leads to the destruction of stone-tool cut marks created during dismembering of joints. An absence of dismembering cut marks can be an artefact of carnivore activity. This study therefore presents frequencies of carnivore gnawing traces on specific bone parts to facilitate PPA inferences. Inferences on the frequencies and meaning of studied PPA data will be presented in following chapters. The degree of influence of carnivore activity on the survival of skeletal elements thus should be checked for. PPA data provide a measure of carnivore activity, but should be supplemented by a check of possible destruction of skeletal elements. Analytical procedures have been developed to check bone assemblages for bone-density mediated destruction. Widely adopted is the use of CT-scans of skeletal element parts to derive direct values on Bone Mineral Densities (BMD-scans) for different mammalian species (Lyman, 1984, 1994). Bone density scan site values can be compared to representation indexes (like the %MNI and %SURV) for corresponding bone parts to check for possible relationships between bone density and representation within assemblages. Different mammalian species yield different values on CT-bone mineral scans and therefore the method is only applicable to species-specific skeletal elements. For the Schöningen 13II-4 sample, bone-mineral density studies for horses were available and have been used. It was decided that the number of survived bovid and deer bone specimens were too few for reliable statistical comparisons.

2.3.4 Hominid activity signatures

Much has been written about the recognition of hominid induced traces on bone remains. Especially the identification of stone tool inflicted cut marks has been the subject of fierce debates. Proper identification of cut marks is heavily dependent on bone surface preservation and modification by other than hominid agents. Distinction between stone tool created marks and striations caused by sedimentary abrasion or trampling has to be done thoroughly because of strong morphological similarities (Behrensmeier et al., 1986; Oliver, 1989; Olsen and Shipman, 1988). Some researchers have pointed out the need of high magnification, even scanning electron microscopy, examination of marks (Behrensmeier et al., 1986; Shipman and Rose, 1983). Others believe the identification of cut marks should be possible without or only with the use of low magnification, supplemented with what I have



Figure 2.3.4: The proximal shaft part of a deer tibia exhibiting carnivore scoring and furrowing created during gnawing off the proximal epiphysis (findnumber 715/24-2). Photo by J. Paupit, Leiden.



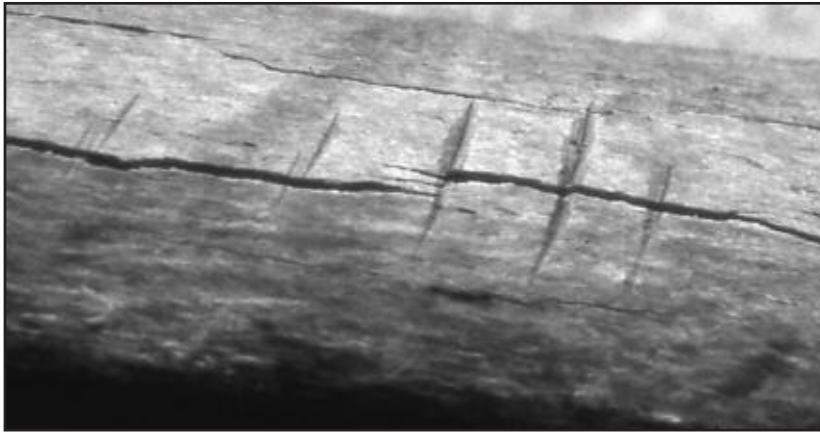
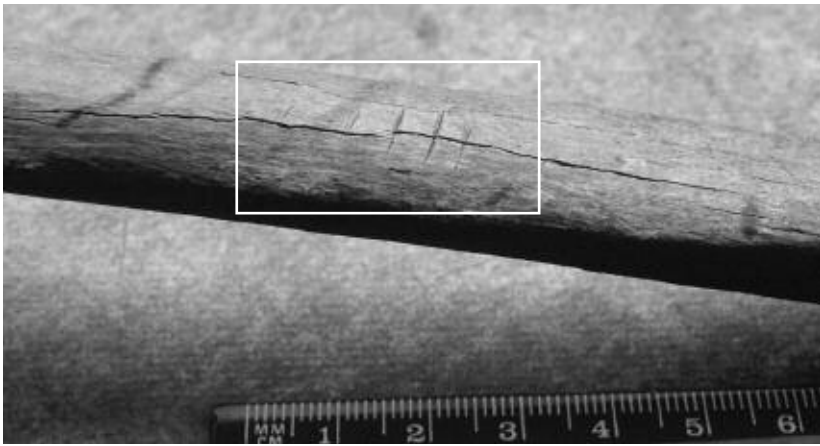


Figure 2.3.5: Short but deeply incised cut marks on the lateral side of a Schöningen 13II-4 horse rib. Photo by the author.

termed PPA (Placement Pattern Association) data, comparable to what has been termed a ‘configurational approach’ (see Fisher, 1995, and Lyman, 1994, for an outline of this debate). This is the view adopted in the present study. This chapter provides the framework used to identify and distinguish hominid-induced cut marks and traces of hominid bone-marrow procurement encountered in the Schöningen 13II-4 sample. Also, an interpretative framework on the relationship between static butchering traces and the inferred butchering dynamics creating these traces is presented. Individual butchering trace observations, descriptions and frequencies on trace-yielding bone remains are provided in following chapters. Due to the excellent bone surface preservation of the Schöningen 13II-4 bone remains, stone tool-inflicted cut marks could be identified relatively easy.

Cut marks

Several characteristics and criteria were used to distinguish stone tool-inflicted cut marks from striations created by non-hominid agents. The criteria used to identify and discern cut marks are provided in Table 2.3.3.

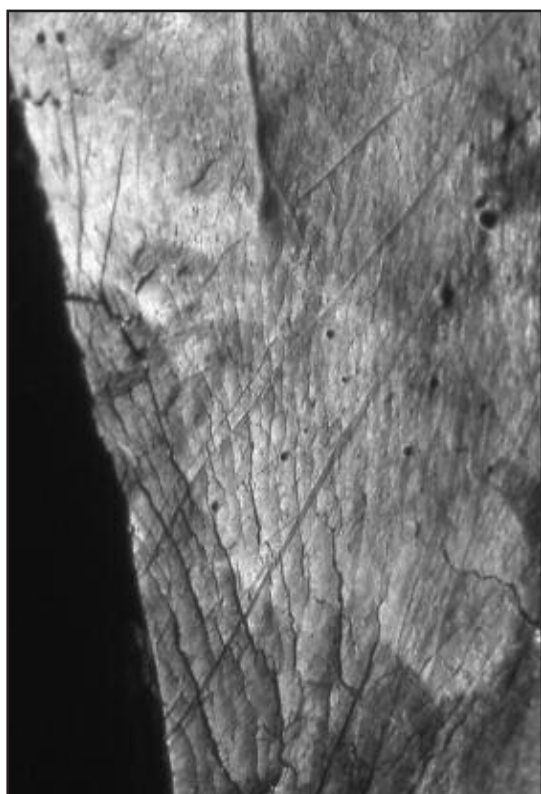
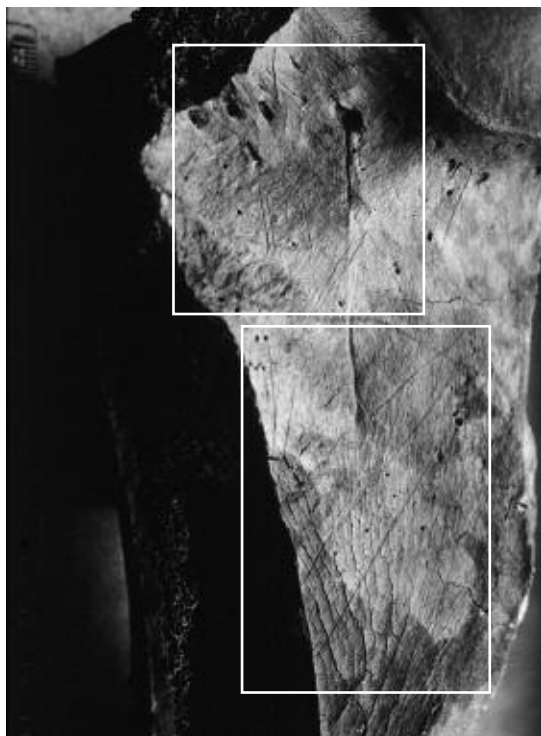
Three main types of cut marks created during butchery by hominids have been distinguished among the Schöningen 13II-4 bone remains:

- 1 Short cut marks, often clustered and sometimes isolated.
- 2 Long cut marks, often straight and parallel and sometimes curvilinear.
- 3 Clustered dragged or scrape-like, mostly shallow marks.

Much of the encountered cut marks exhibit a clear V-shaped morphology with most of the time tapering ends, being wider and deeper in their midsections than at their ends. Especially the short, or chevron (cf. Binford, 1981), type of cut mark bears these characteristics. Often this is related to placement of the marks on curve-shaped bone parts. During the slicing movement of a static, sharp stone tool edge, it will slice the highest bone parts deeper (see Figures 2.3.5 and 2.3.13 for an example of this effect). On flat levelled bone parts the same effect can be the result of the use of stone tools with convex edges (Stopp, 1993). The inner edges of sharply incised marks are straight and smooth, pointing to a fast movement of a sharp and hard edge. Some cut marks exhibit tilted V-shapes from which an oblique position of the responsible tool can be deduced. Encountered carnivore teeth scores are much wider, exhibiting mostly shallow U-profiles and a dragged, instead of incised, appearance. Some observed carnivore scores are however sharp in appearance but actually lack the V-shaped base and display irregular, instead of straight, trajectories (see Figures 2.3.3 and 2.3.4). The second type of encountered marks are long cut marks. This type of cut mark morphologically ranges from V-shaped to a wider angular shape (see Figure 2.3.6 for an example). The edges of these long marks are straight and steep. Although their trajectory sometimes is curvilinear and long, their morphology remains homogeneous and therefore differs from scores created by carnivores, which are shorter and more irregular in shape. Sedimentary scratches or striations caused by trampling are believed to be shorter, more irregular and perhaps more importantly are more randomly distributed (see below). A third type of mark believed to be of hominid origin constitute the clustered dragged or scrape-like, mostly shallow, marks. These marks appear in clusters and are present on certain bone parts only. Contrary to carnivore scoring which embraces a number of individual striations even distinguishable when clustered, these traces are densely clustered in patches covering bone surface parts locally. Within the patches, multiple striations are visible with parallel trajectories, indicating some kind of denticulate edge of the responsible agent (see Figure 2.3.7 for an example). Sedimentary abrasion has been considered as a possible cause for this type of striations. However sedimentary striations have been



encountered, though only in very low numbers. Observed clusters of sedimentary scratches show a range of morphological diversity of striations within one and the same cluster, ranging from broad and straight to narrow and curvilinear (see Figure 2.3.8). Moreover, both the sedimentary context from which the bone remains originate together with PPA data on this type of trace (see below) makes a sedimentary cause unlikely.



Main criteria used to distinguish cut marks on the Schöningen 13II-4 bone remains

Morphology of cut marks

- ▶ Mostly straight and elongated grooves.
- ▶ Mostly V-shaped and sharply incised.
- ▶ Ends of marks are often tapered.
- ▶ A shoulder effect and/or barbs may be present.
- ▶ The edges of the groove may contain multiple fine parallel striations oriented longitudinally.

Placement of cut marks

- ▶ Cut marks should occur parallel or sub-parallel to one another, as a result of repeated action at one location.
- ▶ The morphology of the parallel associated marks should be equal, as they should be caused by the same agent.
- ▶ Cut marks do not follow the relief of the marked bone surface, depressions will be ignored due to the inflexibility of the stone tool edges.
- ▶ Cut marks are mostly sets of parallel linear incisions.

Anatomical location of cut marks

- ▶ Cut marks are most likely to occur at locations where detachment of ligaments or muscles is necessary, in order to dismember particular anatomical units.
- ▶ Cut marks are likely to occur at locations where meat is filleted from bone or at other locations associated with the systematic procurement of specific animal products.

Table 2.3.3: Main criteria used to distinguish cut marks present on the surfaces of Schöningen 13II-4 bone remains, drawn up after: Binford 1981; Fisher 1995; Lyman 1994; Shipman and Rose 1983; Stopp 1993; White 1992.

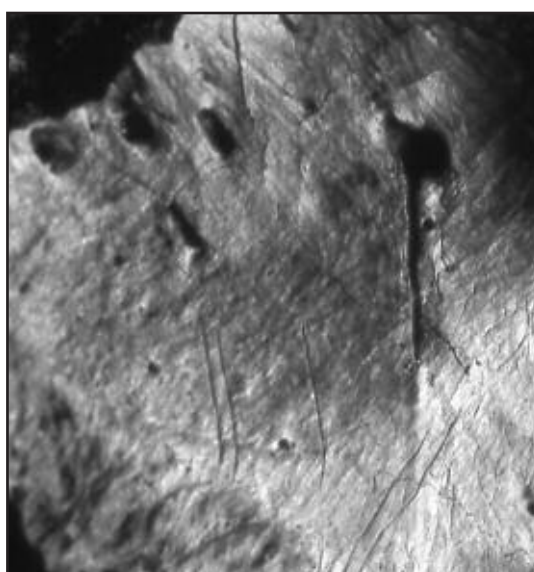


Figure 2.3.6: A Schöningen 13II-4 proximal horse femur exhibiting short dismembering cut marks (small rectangle) and long filleting/defleshing cut marks (large rectangle) (findnumber 690/22-13). Photos by the author.



Figure 2.3.7: A Schöningen 13II-4 long-bone shaft fragment exhibiting short clustered and dragged scrape-like clustered traces overlapping the short ones (close-up) believed to be created by stone tools. Photos by the author.



Impact notches and impact scars

Apart from cut marks created by stone tools, another distinctive hominid-induced butchery mark is well represented in the Schöningen 13II-4 faunal sample. Impact notches and scars created during bone breakage are abundantly present in the studied sample and solely observed on marrow-bearing skeletal elements, i.e. mandibles and long bones. The terms impact notch and impact scar in fact refer to a set of features. A good description of this type of mark is provided by Capaldo and Blumenschine, (1994, p.730);

“We began our study by defining notches as semicircular to arcuate indentations on the fracture edge of a long bone that are produced by dynamic or static loading on cortical surfaces. This force removes a single bone flake or a nested series of flakes, leaving a negative flake scar that extends through the entire thickness of the bone onto the medullary surface”.

The cortical view of an impacted area on a long-bone fracture edge shows the impact notch, an indentation caused by the impact removing part of the fracture edge and cortical surface. The medullary view of the impacted area shows a flake scar, or conchoidal flake scar, left by the detached flake. Each of these features provides two variables to measure for analytical purposes (see Figure 2.3.10 for a schematic representation of impact scar features used to take measurements). Measurements on impact scars encountered in the Schöningen 13II-4 sample will be

provided. Details and analysis of encountered impact notches and scars are provided in Section 2.5.6. Also well represented in the sample are bone flakes detached during bone breakage (see Figure 2.3.9).

Bone flakes often exhibit a striking platform (part of the impacted cortical surface of the bone, leaving the impact notch) and bulbs of percussion.

Measurements on bone flakes have been taken to compare with measurements on impact scars and are provided in the Appendices. Often a distinction between impact scars derived from dynamic loading and those derived from static loading is made (Binford, 1981; Capaldo and Blumenschine, 1994; Fisher, 1995; Lyman, 1994). Dynamic loading impacts can be recognised by their conchoidal features, almost identical to percussion features present on flaked flint (see Figure 2.3.9 for a beautiful example from the Schöningen 13II-4 assemblage, and Figure 2.4.1). Impact notches derived from dynamic loading are believed to be more arcuate in form and impact flake scars tend to be broader than scars derived from static loading (Capaldo and Blumenschine 1994; Oliver, 1993). Dynamic loading should be associated with hammer stone-induced bone breakage. Marrow bone destruction by carnivores is believed to be more static of nature. Carnivores breaking bones will increase pressure by biting the bone until it collapses, which results in more puncture-like, less arcuate, cortical impact notches (Capaldo and Blumenschine, 1994; Fisher, 1995; Lyman, 1994). The flake scars tend to be less smooth but more hackled. Also, repeated



static biting by carnivores on long-bone parts during breakage often results in so-called chipped edges with multiple smaller notches (see Binford, 1981, for examples). Most of the encountered impacted long-bone parts in the Schöningen 13II-4 sample yielded single and paired impact notches or only part of an impact notch or flake scar. Both impact notches, scars and bone flakes often bear the characteristics of dynamic loading impacts.

During the study, a statistical comparison between flake scars and bone flake measurements has been considered to check for statistical correlation. However, often series of detached impact flakes have been observed. In several cases adhering flakes were still present in impact notches on long-bone fragments. This observation points to a methodological problem concerning the use of bone flake measurements to compare with impact flake scars. Only the last detached bone flake leaves the flake scar encountered on the impacted bone fragment. To derive reliable comparisons, bone flakes should therefore be sorted on their order of detachment. This can only be achieved by intensive refitting of bone flakes and is a huge job which was not executed during the present study but will be an interesting job for future research. Nevertheless measurements on impact notches, scars and bone flakes are provided in Section 2.5.6 in the discussion on observed butchery traces on horse bone remains.

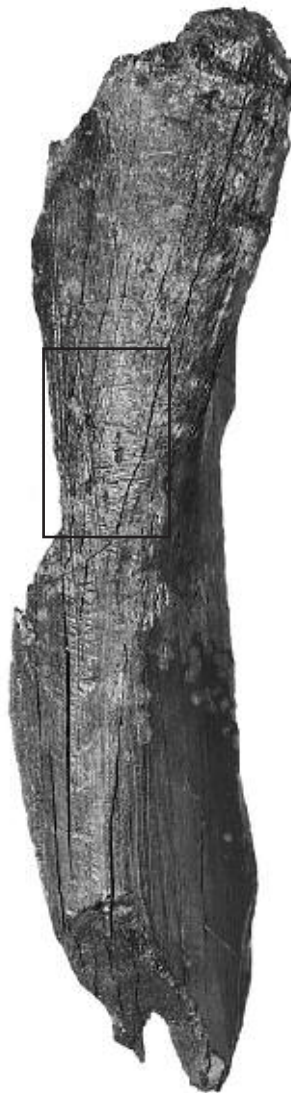


Figure 2.3.8: A deer long-bone shaft fragment exhibiting bone surface damage and densely clustered striations believed to be indicative of a non-hominid actor overlapping stone tool scraping marks (see Figure 2.6.2) (findnumber 715/24-2). Photo by J. Pauptit, Leiden.



Figure 2.3.9a: Long bone shaft fragment exhibiting paired medullar conchoidal flake scars caused by dynamic impacts during bone marrow processing by hominids (findnumber 691/36-1). Photo by the author.

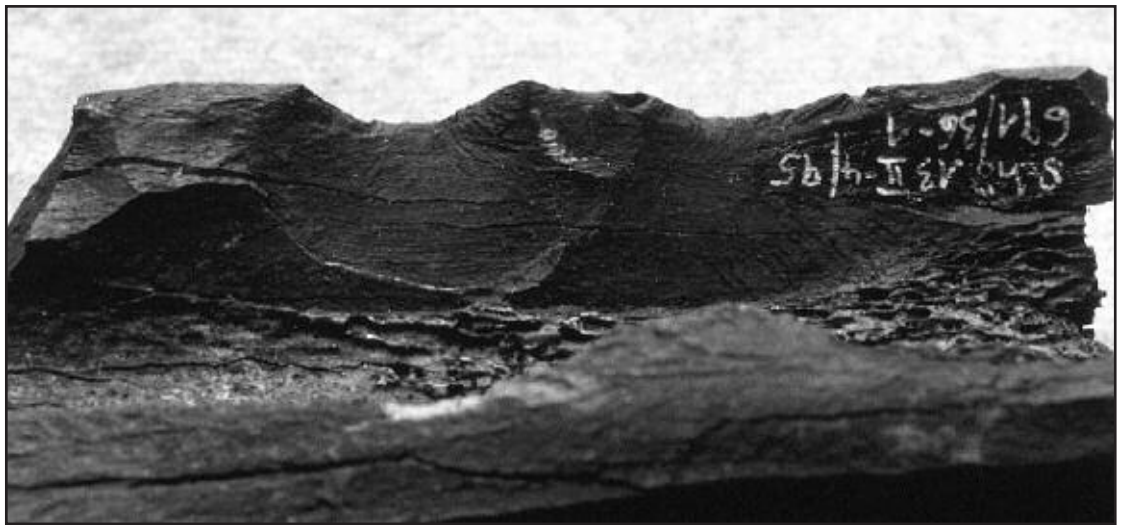
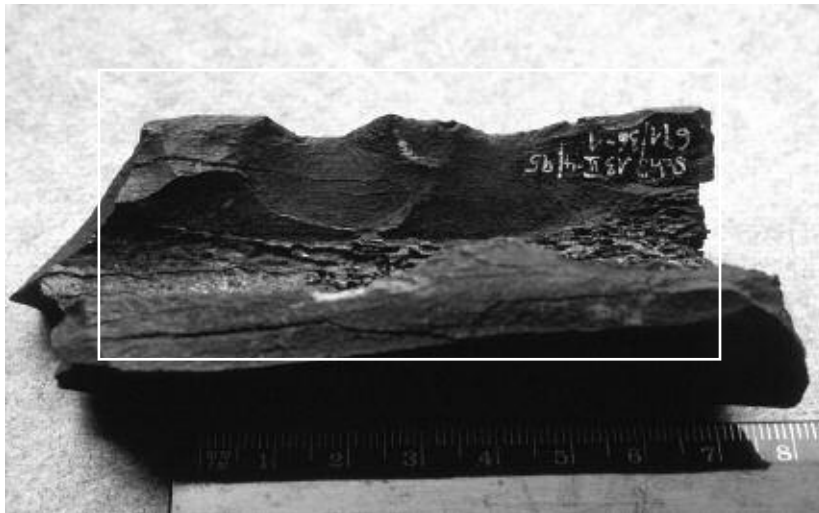


Figure 2.3.9b: Example of an encountered bone flake created by dynamic impacting of long bones during marrow processing (findnumber 685/36-15). Photo by the author.



2.3.5 Placement Pattern Association (PPA)

The primary characteristics of bone modifications encountered in the Schöningen 13II-4 sample believed to be induced by different agents have been outlined in the preceding chapter. Here contextual information on the Placement, Patterns and Association (PPA) of bone modification traces will be provided to derive inferences on the actors and possible underlying behaviour. The summarised frequencies of encountered traces among all studied bone remains from the Schöningen 13II-4 sample are presented in Tables 1 & 2 in the Appendices Frequencies and information on the distribution of traces among specific skeletal elements of the different mammalian taxa will be provided in following chapters. Of all 4630 recorded bone specimens, 13% exhibit carnivore gnawing traces, 18% bear cut marks believed to be induced by stone tools, and 17.7% of the remains exhibit characteristics of intentional bone breakage like impact notches or scars.

Carnivore gnawing

Traces induced by carnivores are the least encountered. In total 604 bone specimens bearing traces of carnivore modification have been registered. Of these, 126 carnivore-gnawed specimens could not be attributed to mammalian taxa. The highest percentages, exceeding 20%, of carnivore gnawing traces have been found on axial elements like the vertebrae, ribs and pelvis, but also on scapulae, the calcaneus-astragalus unit and phalanges. Most encountered carnivore damage comprises tooth scores, pitting and punctures on weak bone parts like the extremities of vertebrae, ribs and long-bone articular parts. On vertebrae, gnawing damage concentrates on the dorsal ends of the dorsal spines, while of ribs the distal ends most frequently have been gnawed (Figure 2.3.3). Of the 709 recorded rib corpus fragments, 24.2% (NISP=172) bear pronounced gnawing traces indicating the destruction of a number of ribs by carnivores. Mostly though gnawing damage on elements is minor and often only a single or several tooth scores or pits are present. Of the gnawed scapulae, the edges of the scapula blade have been gnawed and the same is true for the pelvis, of which the edges of the ilium and ischium blades bear gnawing traces. Severe carnivore destruction of these elements has not been observed.

The amount and location of gnawing damage points towards minor to moderate utilisation of carcasses by carnivores (Lyman, 1994; Haynes, 1980). Only a bovid metatarsal part, displaying heavy scores associated with a series of impact notches, scars and

shaft breakage, could possibly point to the involvement of a larger more destructive carnivore. Conspicuous damage pointing to the destructive nature of for example hyena ravaging has not been observed. Bone specimens belonging to marrow-bearing bones, long bones and the mandibula, yielded gnawing percentages below 15%. This is in line with the low number of observed long-bone parts bearing concrete evidence of shaft damage or destruction to facilitate carnivore marrow consumption. The presence of punctures or notching on fracture edges believed to be of carnivore origin have been recorded in 36 cases, being 0.7% of the overall assemblage. Long-bone shaft damage in the form of teeth scores and pitting has been recorded in 45 cases, accounting for 0.9%. Cortical impact notches on long-bone shaft fragments associated with carnivore tooth marks have been recorded in only 11 cases, 0.2%. Of the in total 19 encountered complete marrow-bearing bones only one, a horse femur, has been modified by carnivores. One bone fragment leached by digestive acids has been discovered. This specimen is proof of bone consumption and excretion by carnivores. Most encountered gnawing traces point to light to moderate utilisation of carcasses by carnivores. Unambiguous proof for marrow-bone destruction by carnivores is very limited. This together with the characteristics of encountered gnawing traces point towards a medium-sized carnivore, likely wolves (Binford, 1981; Haynes, 1983; Lyman, 1994). Based on the observed gnawing traces and gnawing patterns, destructive influence of carnivores on the overall assemblage appears to be limited. However, if bone remains subscribed to different mammalian taxa are grouped and compared, some differences can become apparent which could be related to differences in the nature of carnivore involvement and possible differences in taphonomic histories of certain assemblage components. The different groups therefore will be

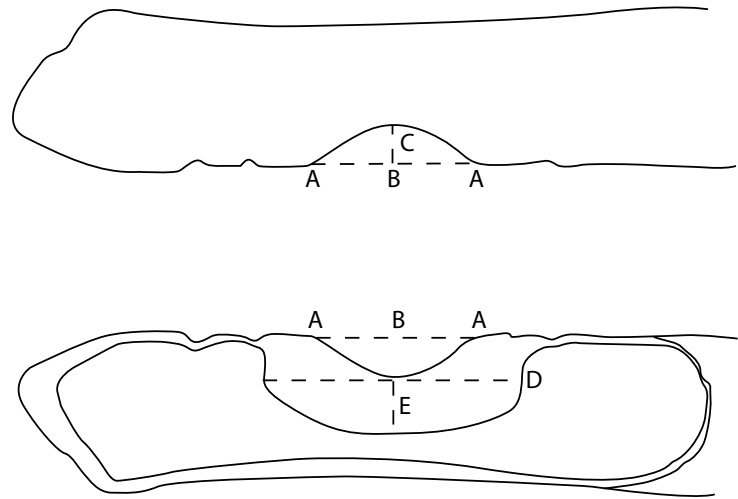


Figure 2.3.10: Schematic representation of an impact area on a long-bone fragment showing main features used for descriptions and measurements, taken from Capaldo and Blumenschine 1994, p. 733, Figure 3. Cortical view above and medullary view below. A to B: Impact notch and maximum notch breadth. B to C: Notch depth. D: Flake scar and maximum flake scar breadth. E: Flake scar length.



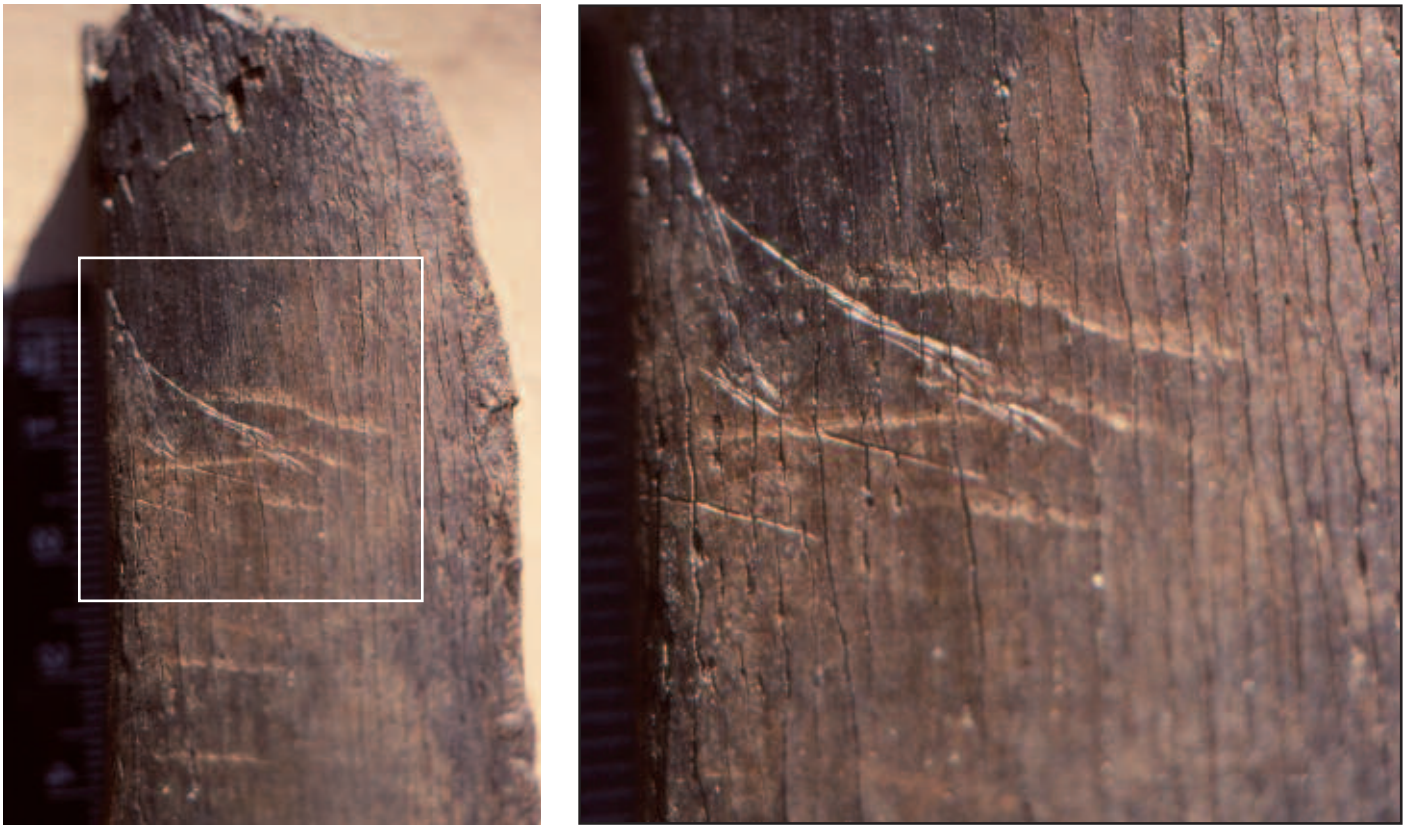


Figure 2.3.11: A horse thoracic vertebrae dorsal spine exhibiting carnivore tooth scores overlapping and obscuring stone tool inflicted cut marks from filleting (findnumber 687/24-3). Photo by the author.

the subject of separate analysis on possible carnivore influence to be compared (see the following sections). Very important with regard to questions on carnivore versus hominid involvement are the 8 encountered bone specimens yielding carnivore teeth scores overlapping hominid-induced cut marks! Figure 2.3.11 shows one clear example of carnivore scoring superimposed on cut marks present on a horse thoracic vertebrae spine. Also, traces believed to be induced by hominids outnumber those ascribed to carnivores. From this a primary role for hominids is suspected, with carnivores having a secondary role with regard to carcass remains. This topic will be explored further in the sections on the separate species remains.

Butchery traces

Bone remains yielding cut marks believed to be inflicted by stone tools during butchering by hominids are best represented, and encountered on 18% of the remains (Table 2 in the Appendices). The morphological distinction of cut marks created by stone tools has already been touched upon (Table 2.3.3). Cutting by making use of a stone tool is believed to result in cut marks occurring parallel or sub-parallel to each other due to a repeated movement at a specific location while cutting. Although in the Schöningen 13II-4 sample, bone specimens yielding isolated single cut marks have been observed, bone remains yielding multiple and parallel cut marks dominate. Often the marks not

only are placed parallel to each other but they are also remarkable evenly spaced (see Figures 2.3.5 and 2.3.6). An assemblage of marks created during butchering of carcasses is expected to yield function-related placement and patterning. The location of cut marks should be related to the detachment of ligaments, dismemberment of joints, and the removal of meat mass (Binford, 1981; Fisher, 1995; Lyman, 1994; Stopp 1993; White, 1992). The placement of encountered cut marks in the Schöningen 13II-4 sample can be functionally explained. Observed short cut marks mostly occur near former joint areas at locations of ligament connections and on or near muscle attachment areas on bone shafts. Longer cut marks most frequently can be found on levelled, flatter, skeletal elements or on lesser-curved long-bone shaft parts (see Figure 2.3.6). Cut-marked long-bone parts with a presence of both short and long cut marks provide an explanation for the different appearance of both types. Short, mostly clustered, marks are transversal or slightly oblique oriented to the long-bone axis, or shaft, while long cut marks are strongly oblique to parallel oriented to the shaft. Filleting of long bones with the use of a static stone tool working edge is expected to leave deep short cuts on strong curving bone parts if slicing transversal to the bones axis or on high relief muscle attachment areas. Filleting of the same bone at latter areas and with the tool held oblique or parallel to the bones axis will create longer cut marks due to longer tool on bone contact. Much of the documented Schöningen 13II-4



cut mark locations are in agreement with those documented for younger and modern butchered faunal assemblages. A large part of the reported butchering traces for example are comparable to those documented by Binford (1981) during his ethnographic Nunamiut caribou butchery studies. Descriptions on cut mark placement and functional explanations on specific cut-marked skeletal elements are provided in sections below.

The morphology and placement of encountered cut marks led to the definition of two main cut-mark groups to be associated with specific butchery activities, *Dismembering* marks and *Filleting / Defleshing* marks. The first group comprises cut marks present near former joints, articular or epiphyseal parts, associated with dismembering activities. These are mostly the short type of cut mark, present either solitary or clustered, but associated with cutting joint ligaments. The second group comprises both short and the longer type of cut marks. Within this group a distinction is made between filleting and defleshing. Filleting has been defined if the location and pattern of the marks are to be associated with the removal of meat mass. However, especially the long curvilinear and scraping-like mark types often are only locally present on skeletal elements, on both meat-yielding and non-meat-yielding parts. For example, horse metapodials, radii and the tibiae have low meat values while cut-marked bone specimens from these elements are well represented. The combined presence of filleting and scraping-like marks was encountered almost entirely on marrow-yielding elements. The only exception is one part of a horse rib showing scraping-like marks and polish. The highest percentages of scraped bone specimens from marrow-containing bones are not on the most marrow-rich elements though. Horse metapodials and radii score highest on scraped bone fragments. Apparently effort has been put into cleaning, or defleshing, these elements despite their low meat yields. Between the horse hide and the surfaces of these elements little tissue is present. Complete defleshing of these elements possibly was accomplished much easier by a scraping tool or extremely oblique held cutting tool, and could explain the longer and more scraping-like nature of encountered cut marks. Of interest in this context is the observation of clusters of scraping marks obscuring cut marks (see Figure 2.3.7,). This feature indicates that scraping-like use of tools followed cutting, to complete the removal of the tissue adhering to the bones, like the removal of the periosteum. This could be related to the detachment of bones to facilitate the removal of meat, skin, removal of tendons or marrow processing. The reason

for this effort put into cleaning bones cannot easily be explained and will be explored further.

Marrow procurement

Marrow containing skeletal elements yielded, apart from ribs, the highest cut-mark percentages in the Schöningen 13II-4 sample. The co-presence of meat as well as marrow for these skeletal elements could have led to higher butchery intensity. The presence and characteristics of encountered impact notches and scars already has been outlined. Impacted areas resulting from bone breakage are composed of an impact notch and a cortical flake scar left by a flake removed by dynamic direct impacting. Impact notches and scars are located either on long-bone shaft or near epiphyseal shaft areas and along the lower rim of encountered horse mandibular corpi. Documentation on encountered impact locations among the horse marrow-bone remains point towards the repeated use of similar impact areas on certain elements. The systematic use of similar impact areas led to the creation of comparable marrow bone parts and fragments. Counts and descriptions of these impact locations and recurrent presence of certain bone parts are provided in the sections on individual skeletal elements. The systematic nature of bone breakage is regarded to be an important feature for the recognition of hominid bone-marrow processing (Farizy et al., 1994; Gaudzinski, 1996; Oliver, 1993).

Unambiguous data indicative of bone breakage by carnivores is believed to be scarce in the Schöningen 13II-4 sample (see above). Carnivore gnawing traces associated with impact notches and possible carnivore-inflicted impact notches are minimally represented. Part of the encountered marrow bone parts yielding impact scars are associated with other than carnivore induced traces. They are the scrape-like tool marks and an association of long curvilinear scratches in concentrations together with mostly angular shaped small pits interpreted as percussion marks or pits (cf. Blumenschine and Selvaggio, 1988; Fisher, 1995; White, 1992). Also, bipolar impact areas have been observed, with a large impact notch present on one side of a long-bone specimen and a smaller impact notch on the opposite side of the specimen (see the following sections for concrete numbers on bone specimens yielding associations of these traces). These specimens could be an indication of the use of an anvil during bone breakage. Details and analysis on encountered impact notches and scars are provided in Section 2.5.6.



Miscellaneous

The observed concentrations of curvilinear scratches and clustered pits constitute an interesting feature. If present on large long-bone parts, these traces are only present locally while the rest of the bone often is lacking other signs of modifications (see Figure 2.3.12 for an example). For the most part these traces are not directly comparable to traces inflicted by carnivore gnawing and morphologically they are comparable to the observed scrape-like marks. However, some scratches approach the characteristics of carnivore teeth scores (see Figure 2.3.12, close-up; scratches in the centre). The encountered pits are clearly clustered and restricted to a small area and overlap and obscure the scratches. Two possible explanations for this feature have been postulated. These features could represent impacted bone areas which did not fracture under the battering of a hammer stone, and they form the key to observed

impact notches associated with scraping-like marks. Or possibly the bone has been used as retoucher for the reshaping of stone (flint) tools used during butchery.

Some encountered bone remains in the studied Schöningen 13II-4 sample exhibit traces of modification different from most encountered. A rib corpus fragment yielded a series of sharply incised cut marks on the border of the medial, inner, side (Figure 2.3.13). An exact determination of the mammalian species from which the rib derived could not be established. Based on the size and morphology, the rib fragment is believed to derive from either a small-sized horse or a deer. Of the 123 encountered cut-marked rib parts in the sample, only this specimen has been cutmarked on the inner medial side. The lateral side of the specimen lacks modifications.

Figure 2.3.12: Cluster of scrape-like scratches and patch of overlapping percussion pits on the lateral side of a distal horse tibia which could be associated with bone-marrow processing by hominids or use of the bone for the retouching of stone tools during butchery (findnumber 693/19012). Photos by the author.



Among the observed butchery marks in the studied sample, this specimen thus represents an exception. If originating from deer this could be related to different carcass treatment when compared with the butchered horse remains of which almost all cut-marked rib parts originate.

A specific kind of modification traces has further been found to be present on several horse metapodials and one bovid metapodium. These traces are restricted to metapodials and consist of impacted and flaked edges on the epiphyseal condyles, likely caused by percussion. In total 6 distal horse metapodials (3 metatarsals and 3 metacarpals) exhibit these traces, which consist of flaking, pitting and slight rounding of the lateral and medial epiphyseal condyle edges (see Figure 2.3.14 for some examples of these specimens). On one proximal horse metacarpus and one proximal bovid metatarsus a similar kind of damage was encountered. Possibly these elements have been used as a battering tool or retoucher

during stone tool production or curation. An alternative explanation for this kind of damage could be a specific type of butchery damage created during dismemberment of the metapodials from the adhering phalanges by hitting them loose on a stone anvil. The repetitive nature of the pitting and flaking traces together with slight rounding of the condyles point to a more intensive and lasting use of battering on a hard subject though. Therefore use of these elements as tools facilitating stone tool production or curation seems the most likely explanation. These inferred bone tools strengthen the assumption that also the percussion-like damage observed on horse tibiae is related to stone tool production or curation (see Figure 2.3.12). Also recently reported from the assemblage are bovid radii, but not examined during this study, yielding abundant traces pointing to a use as tools (Thieme, 2005). The documented specimens could provide important data on Lower Palaeolithic bone tool use and should be incorporated in a separate study during future analysis of the complete Schöningen 13II-4 faunal assemblage.

Figure 2.3.13: A rib, possibly deer, corpus fragment with a series of sharp incised and spaced cut marks on the medial (inner) side (findnumber 689/22-37). Photos by J. Pauptit, Leiden.





Figure 2.3.14: Three examples of distal horse metapodials showing battering damage on the epiphyseal condyles probably created by hammering during stone tool production or curation (findnumbers: 684/29-43; 697/17-4; 684/27-4). Photos by the author.



2.4 Composition and preservation of the studied faunal sample

The examined Schöningen 13II-4 faunal sample totals 4626 registered bone remains larger than two centimetres. Of all studied bone remains, 1665 specimens (36%) could not be determined to a specific animal genus level (Table 2.4.1). Only 464 bone specimens (27.8%) within this category though could not be identified as belonging to specific skeletal elements. Based on the proportions of the mainly small rib and long-bone fragments, it can be inferred that most parts belong to the horse category but this could not be established with certainty. With over 60% of the total sample and over 94% of the taxonomically determined bone material, horse, *Equus* sp., remains are by far the best represented. In total 2809 bone specimens have been attributed to the genus *Equus*. It concerns a relatively large horse, most probably the Middle Pleistocene species *Equus mosbachensis* (van Asperen, 2003; van Kolfschoten, 1993, 1995). Remains of the same species have been encountered at the older Schöningen 12b site, which dates from the same Reinsdorf Interglacial period (van Kolfschoten, 1995; Voormolen, 1997). The presence of a few smaller horse dental elements indicated the possible presence of the smaller wild ass, *Equus hydruntinus* (Thieme, 1999). However, no skeletal material of this species could be identified during this study. A following survey of the sample on specific taxonomic data also did not yield clear indications of the presence of more than one species of the genus *Equus* (van Asperen, 2003).

Apart from horse remains, a total of 92 bone specimens have been ascribed to bovids, which is only 2.02% of the studied bone assemblage. Two bovid species likely are represented among the remains, *Bos primigenius* and *Bison* sp. The presence of *Bos* has been established on a complete metacarpus found together with a *Bison* metacarpus (van Kolfschoten, pers.comm.). No detailed study of the taxonomic nature of other elements or element parts was conducted. Material belonging to bovids could easily be separated from that from Equids by their morphology and size. Among the sample are 60 bone specimens ascribed to the genus *Cervus*. Some skeletal elements, like tarsal bones unit and a cervical vertebrae, as well as the morphology of the antler parts present point to red deer, *Cervus elaphus*. Most Cervid bone specimens could however not exactly be determined and thus the material is assigned to the genus group *Cervus* sp.

Taxon/Category	NISP	%	Taxonomic group	NISP	%
<i>Equus</i> sp.	2809	60.70	<i>Equus</i> sp.	2809	94.80
<i>Cervus</i> sp.	60	1.30	<i>Cervus</i> sp.	60	2.00
<i>Bos</i> sp.	1	0.02	<i>Bos/Bison</i> sp.	92	3.10
<i>Bos/Bison</i> sp.	91	2.00	Total	2961	99.90
Taxon indet.	1665	36.00			
Total	4626	100.00			

Table 2.4.1: Composition of the Schöningen 13II-4 faunal assemblage sample in determined specific categories, table on the left. Composition of the assemblage grouped per taxonomic group, table on the right.

Fragment origin	NISP	%
Cranium	36	2.2
Mandibula	51	3.0
Dental	49	2.9
Os Hyoideum	2	0.1
Cervical vertebrae	6	0.3
Thoracic vertebrae	9	0.6
Lumbar vertebrae	2	0.2
Vertebrae fragments	83	5.0
Costae fragments	338	20.2
Scapula	2	0.1
Humerus	4	0.2
Radius	1	0.1
Ulna	2	0.1
Pelvis	4	0.3
Patella	1	0.1
Tibia	2	0.1
Metatarsus	2	0.2
Metapodium	3	0.2
Phalange	1	0.1
Humerus/Femur	1	0.1
Radius/Metapodium	1	0.1
Carpal/Tarsal	1	0.1
Long bone fragm.indet.	165	9.8
Long bone flake/spall	435	26.3
Indet. fragment	464	27.8
Total	1665	100.0

Table 2.4.2: Composition of the taxonomically indeterminable bone remains category.



Rib fragments and long-bone flakes dominate the taxonomically indeterminable category followed by long-bone fragments (Table 2.4.2). Ribs as well as vertebrae and cranial parts represent vulnerable skeletal elements. Weathering and sediment compaction can easily lead to fragmentation of these elements, which often is indicated by Dry Bone Fractures causing fragmentation. The recorded long-bone fragments are characterised by Green Bone Spiral Fractures pointing to dynamic breakage while in a fresh state. Long-bone fragments have been distinguished from long-bone flakes/spalls because of being a circular shaft part, while flakes/spalls are only small long-bone shaft cortical fragments. Such cortical fragments were classified as a flake on the presence of a bulb of percussion and impact ripples often accompanied by a scar of a previously removed flake. If absent, a cortical fragment has been classified as a long-bone spall. Of the 435 taxonomical indeterminable long-bone flakes/spalls in total 322 specimens (74%) have been classified as flakes and 113 specimens (26%) as spalls. On 16% (52 specimens) of the flakes, butchering cut marks could also be observed on the, often small, cortical outer surface facet of the flake. Together with the frequently observed percussion notches on long-bone shaft parts (see Sections 2.3.4 and 2.3.5), it can be inferred that the encountered cortical flakes are the product of dynamic loading shaft breakage during marrow procurement executed by hominids.

Differences in weathering among the Schöningen 13II-4 faunal remains appeared to be gradual with only some exceptions clearly being more weathered than most of the remains. Of 4275 bone specimens the amount of weathering could be determined. Most of these remains, N=4157 (97.2%), fall into the defined weathering characteristics Group A, being not to slightly weathered (see Section 2.3.1 and Tables 2.3.2 and 2.4.3). Specimens with flaking of outer surfaces, exfoliation, and/or extreme cracking are scarce and when encountered these specimens were placed in the weathering characteristics Group B, representing moderate to severely weathered bone specimens, accounting for only N=118 (2.7%). Behrensmeyer (1978) relates weathering stages to exposure time. With regard to the Schöningen 13II/4 bone material, it will suffice to conclude that the material has probably not been exposed for long on the palaeo-surface. Weathering is very limited and differences are gradual, pointing towards rapid burial.

Table 2.4.3: Frequency distribution of the studied bone remains over the two defined weathering characteristics groups.

Weathering:	Group A	Group B	Total
NISP	4157	118	4275
%	97.0	2.7	99.7

Slight rounding of fracture edges or surfaces has been encountered on 184 bone specimens (4%), while prominent rounding was recorded for only 22 bone specimens (0.5%). Bone surfaces showing severe presence of striations, which are not believed to have been created by hominid or animal agents and most likely have been caused by movement within grained sediments or by trampling, were discovered in 63 cases (1.4%). The rare presence of especially prominent rounding on bone specimens indicates relatively stable burial circumstances for the studied assemblage. Some rounded fractures being present though, indicates that at least some movement of bone remains has occurred. Because of the lakeshore context of the bone assemblage, some influence or movement by water should be expected. Diagenetic modification is represented by root-etching and dissolution of bone surfaces. Dissolution caused by decalcification of the bone's cortical surface was most frequently encountered, on 74 specimens (1.6%). Pronounced root-etching on bone surfaces has been observed in only 4 cases (0.1%). Summarising, it can be concluded that exposure of the bone remains to pre-burial weathering and post-burial modification factors was limited, which facilitated the recognition of bone surface modifications induced by other actors.

2.4.1 Fragmentation and dispersal, checking for post-depositional displacement

Although having been recorded in the field, during study of the Schöningen 13II-4 faunal remains sample detailed data on the vertical position of bone remains were not directly available. Therefore information on the spatial distribution of the remains had to be extracted from available X and Y coordinates and their layer of origin. The remains have been grouped by layer of origin and weathering characteristics group to check for differences possibly related to sedimentary units (Table 2.4.4). Of 79.8% (N=3694) of the bone remains the layer of origin was recorded, and of 73.4% (N=3399) both the layer of origin and the amount of weathering could be determined. No striking differences became apparent in the distribution of weathering groups between sedimentary layers. Because of the lakeshore context in which the bone remains have been found, movement through some water activity could have caused dispersal of remains. Constant flow of water can also lead to loss of skeletal elements which are susceptible to water movement. However, because of the peaty character of Layer B, the main find-bearing layer, the sediments point to stagnating and still water, the loss of water-susceptible skeletal elements is not suspected. Therefore differences in



representation between different skeletal elements likely is not related to water activity and other causes will have to be looked for.

During study of the remains, refits on both Dry Bone Fractures (DBF) caused by weathering and sediment pressure and on Green Bone Fractures (GBF) created during bones were fresh and greasy have been looked for. An extensive and thorough refit study on the bone material however has not yet been conducted and refits were only looked for within a range of about four square metres. Encountered refits on DBF and GBF fractures as well as the establishment of anatomical refits is very promising. A future extensive bone refit programme on all Schöningen 13II-4 remains could yield interesting and important data on the archaeological site formation processes and hominid behaviour and therefore should be conducted.

Fractures and especially the refitting of fractures can be used to check for horizontal and vertical displacement. While Green Bone Fractures (GBF) can be related to actors and behaviour, mostly not to post-depositional disturbance, refitting of Dry Bone Fractures (DBF) should give insight into post-depositional dispersal. DBF fractures have been encountered on 24% (N=1109) of the studied bone specimens, against 47.3% (N=2188) for GBFs. DBF fractures thus are prominently present in the assemblage while bone weathering is limited. Sediment pressure and deformation will therefore likely have been a major factor in creating the observed DBFs. Of all described fractures among the horse remains (N=1862), the largest taxonomical group, the amount of observed DBF comprises 35.1% (N=655) against 64.8% (N=1207) for Green Bone Fractures. But, 541 of all recorded Dry Bone Fractures (82.6%) developed on the vulnerable vertebrae processes and on ribs. The overall low degree of weathering on horse elements apparently led to weakening and the existence of DBF mostly only on the weakest parts of skeletal elements. Sediment compaction and deformation would have led to fracturing of these weakened parts after which some horizontal and vertical displacement would have occurred. In total six refit units on DBF fractures have been documented. The largest refitted horizontal DBF distance is about 75 cm, all others measure from 25 to 50 cm. Of interest is the refit on a DBF between a bovid rib fragment from the transitory Layer A/B and a fragment from the transitory Layer B/C. This refit unit indicates post-depositional vertical displacement ranging from the base of Layer A to the top of Layer C. All encountered GBF refits (see Figure 2.4.1 for two examples) however have been

encountered within one and the same layer or between the B and B/C Layers at most. The maximum horizontal distance between GBF refits measures 75 cm. Among the encountered anatomical refit units (see the following sections on the different taxa for more details on these refit units), there is one fit between skeletal elements derived from Layers B and C. All other units come from within Layers B and C, or between Layers B and B/C. Summarised, the accomplished refits indicate that concerning GBF and anatomical refits a relationship exists between bone material from Layers B and C. The DBF refits indicate horizontal post-depositional displacement of minimally 75 cm and vertical displacement ranging from the top of Layer B to the top of Layer C. Of the 3695 to layers ascribed bone specimens, 3146 specimens (85%) derived from Layers B and B/C. These layers provided most of the bone material which was vertically distributed by post-depositional influences, like deformation of the water soaked sediments, up into Layer A and down into Layer C.

Layer	Weathering: Group A	Group B	Totals
A	115 (96.5%)	4 (3.3%)	119
A/B	153 (97.4%)	4 (2.5%)	157
B	2326 (97.6%)	55 (2.3%)	2381
B/C	529 (97.4%)	14 (2.6%)	543
C	199 (100%)	-	199
Total	3322	77	3399

Table 2.4.4: Table showing weathering degree of the Schöningen 13II-4 bone remains by their layer of origin.



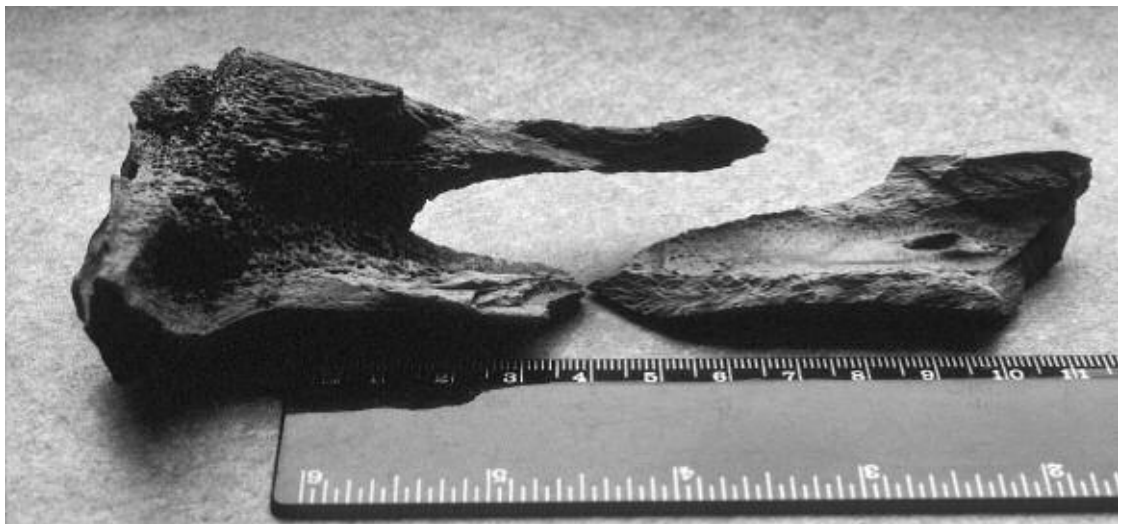


Figure 2.4.1: Examples of encountered refits on Green Bone Fractures among the Schöningen 13II-4 bone remains. Photos by the author.

Above: Refit of a horse humerus distal shaft fragment with the distal condyle (findnumbers 687/45-1 and 687/45-2).

Below: Refit of shaft parts of a horse metapodium yielding impact notches and impact flake scars caused during marrow processing (findnumbers 694/22-4 and 694/22-6).



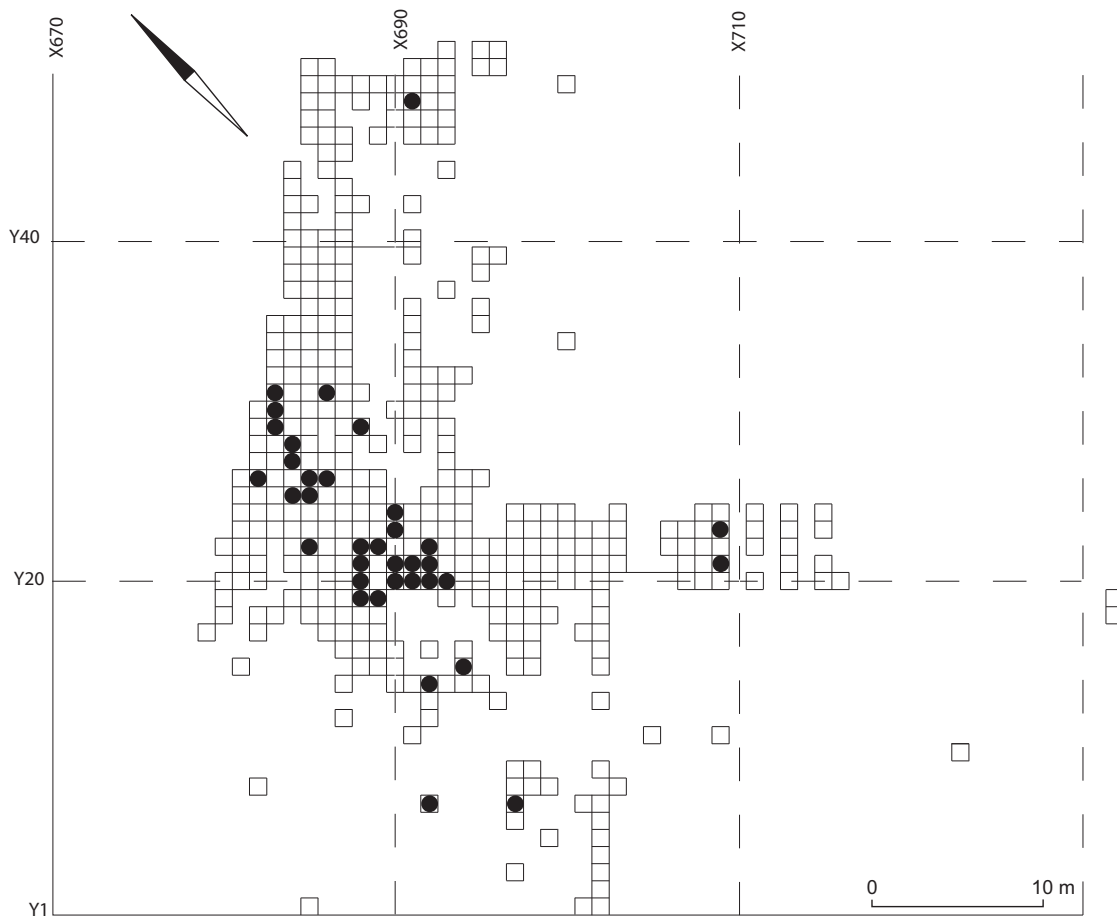


Figure 2.4.2: Map of the Schöningen 13II-4 excavation area with highlighted (black spots) squares yielding anatomical refits on skeletal elements. Each square represents an excavated square metre from which bone material was collected and studied in the present study.

2.5 The horse remains

2.5.1 Preservation and documentation of the horse material

In total 2809 examined bone specimens have been identified as belonging to horses, *Equus* sp. Bone surface preservation of the horse remains in general appeared to be excellent. Of the remains for which the amount of weathering could be registered 98% has been subscribed to weathering characteristics Group A, being not to very slightly weathered. Only 2% exhibits signs of moderate to more severe weathering, in accordance with weathering characteristics Group B (Table 2.5.1). Differences in weathering are gradual and bone weathering exhibits a homogeneous spectrum among the horse remains. Over 95% of the horse remains lack any signs of post-depositional bone surface damage. Some rounding

features have been observed on horse bone specimens consisting of shining cortical surfaces and some rounding of fracture edges. About 2.8% (NISP=78) of the remains exhibits slight rounding of fracture edges. Only five (0.2%) horse bone specimens display more severe signs of rounding of fracture edges or cortical surfaces. Among the horse remains are 42 specimens (1.5%) yielding surface damage in the form of striations probably related to movement within sediments or friction between materials within the same depot. Three specimens (0.1%) yielded both rounding of fracture edges and striations on their cortical surface. Only one bone specimen exhibits traces of root-etching on the cortical surface. Bone surface damage caused by local decalcification dissolution of the cortex was encountered on 52 specimens (2%).



Table 2.5.1: The horse bone remains by weathering characteristics group.

Weathering Characteristics Group	NISP	%
Group A	2541	98
Group B	52	2
Total	2593	100

The anatomical position of largely complete or complete horse elements like vertebrae and ribs could be exactly determined. Concerning long bones, diagnostic characteristics of the bone were used to derive representation indices as reliable as possible. Shaft parts with for example characteristic muscle attachment areas and ridges were coded separately to derive the most exact MNE and MNI counts of long-bone shafts and elements. The counted cranial material only constitutes skull fragments; though complete skulls have been found they were not available for study.

For horse skeletal elements a number of 1165 elements have been derived from a total of 2422 identified bone specimens, which means a fragmentation degree of close to 2:1. The following sections present all the bone specimens subscribed to specific horse skeletal elements. Descriptions are provided on representation indices, frequencies and descriptions on diagnostic bone modifications and full descriptions on encountered butchering traces.

2.5.2 Horse skeletal element specific analysis

2.5.2.1 Cranium

Although some cranial fragments (N=15) of horse skulls have been found among the studied material, in fact most cranial material constitutes the complete skulls found during the Schöningen 13II-4 excavations. The skulls have however not been available for this study due to their restoration at the Hannover laboratory. The collected specimens and the encountered low number of cranial fragments during this study proves that activity directed at fragmentation of horse skulls was apparently minimal. One cranial fragment has been encountered yielding a clear cut mark which could be related to skinning of the skull.

At the end of 1998, after the excavation of 2500 square metres, already 17 complete horse skulls were recovered (Thieme, 1999). In the stages of the excavations during the writing of this thesis, a total of 20 complete horse skulls have been documented (Thieme, 2005). This number is in remarkable agreement with the highest MNI count of 19 on horse post-cranial material derived from this study (see following sections). This match suggests that

although the material presented in this study represents only part of the excavated square metres and bone material, it probably is a good representative sample of the total excavated assemblage.

2.5.2.2 Mandibula and Hyoid bone

Complete horse mandibles have been documented which are still associated with the skulls. Horse mandibles which have been found in the studied sample were fragmented in almost all recorded cases though, only two complete mandibles have been encountered. One of these two was an adult male, as proven by the presence of a pair of large canines. Two foal mandible parts have been encountered, accounting for a juvenile MNI of 1 on horse mandibles. The juvenile mandibula still has the deciduous pre-molars and molars, pointing to an age of 4 to 6 months at a maximum; it has been fragmented on DBF and does not show any proof of butchering or marrow-processing by hominids.

Carnivore gnawing traces on mandible parts are minimal and constitute the local presence of scores, while destructive carnivore activity on mandibles is lacking. In total 6 mandible parts have been gnawed, pointing to a gnawed MNE of 4 and a gnawed MNI of 3. Traces induced by butchering hominids are abundant though. The MNE on cut-marked mandible specimens is put at 15 with a cut-marked MNI of 8 and for impacted mandible specimens an MNE of 10 and impacted MNI of 5 was calculated (Table 2.5.2). Of 87 isolated dental elements it could be established whether they derived from the maxilla or mandible. Of these, 57 specimens (65.5%) derive from mandibles and 30 (34.4%) from maxillae. Of the mandible teeth, a large part lacks the roots, pointing to breakage of the mandible molar body.



Mandibula		
NISP	97	
MNE	24	
MNI	12	
NISP-gnawed	6	
MNE-gnawed	4	
MNI-gnawed	3	
NISP-cutmarked	33	
MNE-cutmarked	15	
MNI-cutmarked	8	
NISP-impacted	24	
MNE-impacted	10	
MNI-impacted	5	
Element part	NISP	%
Complete mandible	2	2.0
Mandible ramus & corpus	4	4.1
Mandible ramus	29	29.9
Mandible corpus	49	50.5
Mandible fragment	13	13.4
	97	99.9

Table 2.5.2: Horse mandible frequencies summary and counts on recorded element parts.

Among the horse mandible remains, butchering traces caused during dismemberment, filleting / defleshing as well as marrow processing have been observed (Table 2.5.3). Cut marks near the condylar process as well as long cuts on the mandibular ramus (Man—1 & 2) point to dismembering of the mandible from the cranium. Cut-marked mandible molar body parts are proof of filleting, or better, defleshing of the mandible (Figures 2.5.1 and 2). Apart from the tongue, the mandible does not carry much meat (approximately 3 kilogram including the tongue, cf. Outram and Rowley-Conwy 1998). Apparently effort has been put in defleshing the mandible to facilitate mandible marrow processing. Cut marks on the lingual side of the molar body could point to the removal of the tongue (Man—5, Figure 2.5.2). Tongue bone parts however have been frequently encountered (NISP=28 / MNE=10), yielding a NISP% of carnivore gnawed specimens of 21.4% but butchering cut marks are absent. It thus seems that at least a considerable part of the originally number of tongues were deposited in situ and likely still included the tongue bone. Separation of the mandible halves and complete defleshing prior to marrow processing therefore seems a plausible scenario to account for the observed butchering traces, removal of the

Mandibula Butchering traces		
Code	Placement and characteristics	Inferred activity
Man-1	Transversal short cuts below the condylar process, buccal and/or lingual.	Dismembering of the mandible from the cranium.
Man-2	Oblique long cuts on the mandibular ramus body, buccal and/or lingual.	Dismembering idem. (cf. Binford 1981:M-2 & M-6).
Man-3	Transversal short cuts along the caudal edge of the buccal side of the mandibular ramus.	Filleting / Defleshing
Man-4	Oblique and transversal cuts on the buccal side of the molar body.	Filleting / Defleshing
Man-5	Oblique long curvilinear cuts on the lingual side of the molar body.	Filleting / Defleshing (Possibly cutting the <i>mylohoideus</i> muscle facilitating mandible halves separation or/and tongue removal).
Man-6	Series of impact fractures along the lower rim of the molar body.	Marrow processing

Table 2.5.3: Specified butchering traces observed on horse mandibulae.

tongue for consumption cannot be excluded though. Butchery of horse heads was likely directed at reaching the mandible's marrow, mostly leaving behind the skull including the fat brains. Breaking of the mandible's body finally was accomplished by a series of impacts along the lower rim of the mandible (Man—6, Figure 2.5.2).



Figure 2.5.1: Cut marks on the buccal side of a horse mandibular corpus (findnumber 688/25-15). Photos by the author.

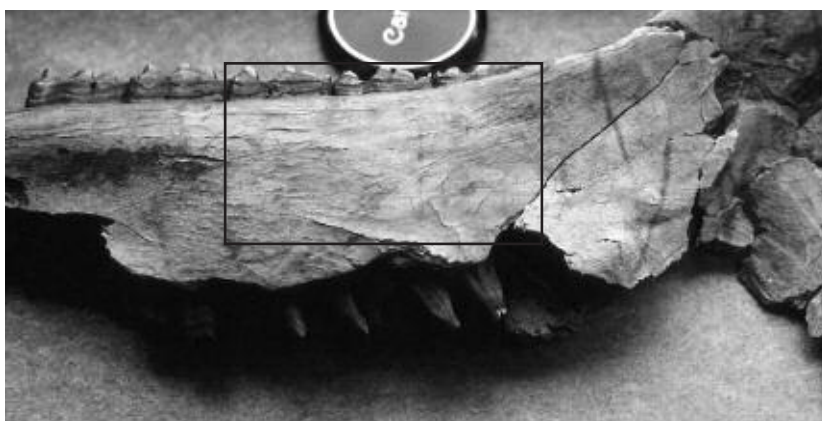
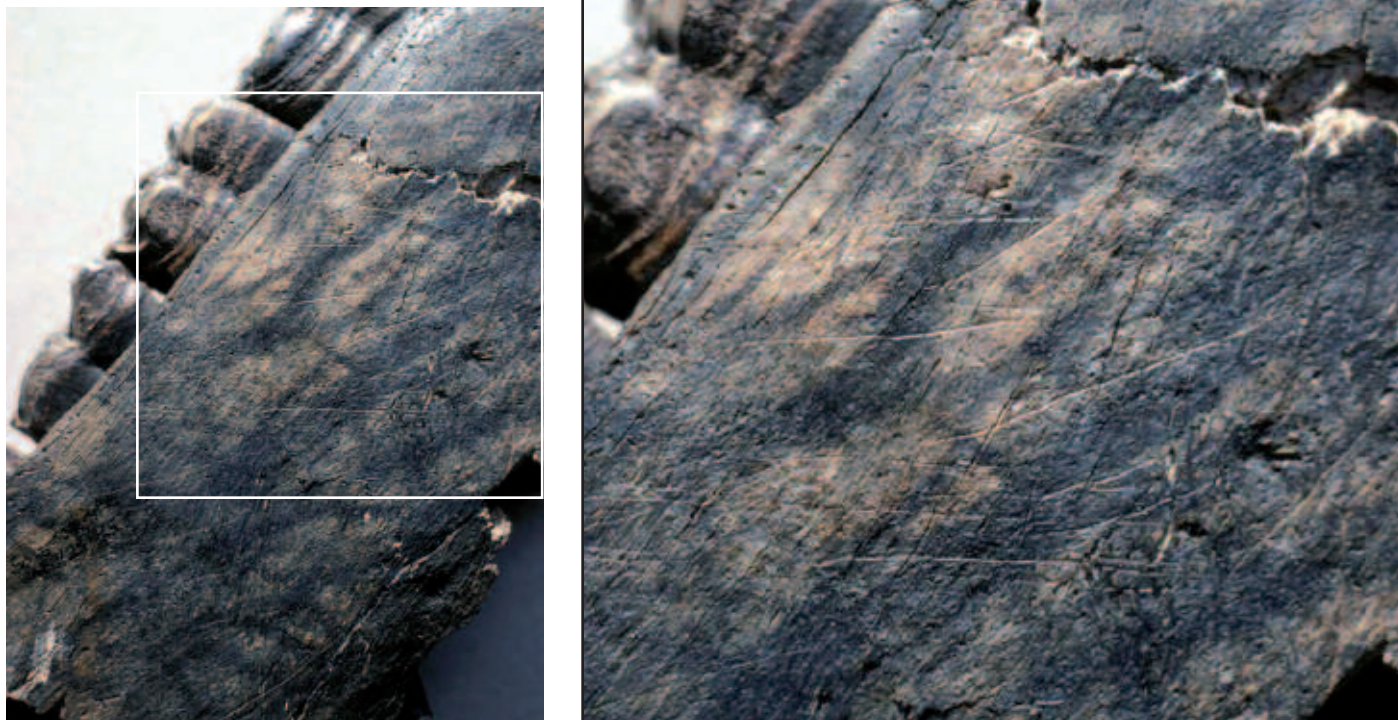


Figure 2.5.2: Long curvilinear scrape-like marks on the lingual side of a horse mandibular corpus, also exhibiting a series of impact notches along the lower corpus rim due to marrow-processing impacts. Photos by the author.



2.5.2.3 Atlas

All encountered horse atlas specimens comprise complete or fairly complete elements. The atlas MNE of 12 thus represents an MNI of 12. One type of butchering cut mark has been observed on the horse atlas (Table 2.5.5). Cuts across the ventral surface are indicative of the dismemberment of the head from the neck (cf. Binford 1981, p. 111, Fig. 4.20). One of the three cut-marked atlases yielded cut marks on the left ventral side only (see also the remarks on cut marks placement among the vertebrae below). Only one atlas specimen yielded some carnivore gnawing traces.

Atlas		
NISP	12	
MNE	12	
MNI	12	
NISP-gnawed	1	
MNE-gnawed	1	
MNI-gnawed	1	
NISP-cutmarked	3	
MNE-cutmarked	3	
MNI-cutmarked	3	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Complete atlas	12	100
	12	100

Table 2.5.4: Horse atlas frequencies and detailed element counts.

Atlas Butchering traces		
Code	Placement and characteristics	Inferred activity
Atl-1	Transversal short cuts across the ventral surface.	Dismembering of the head from the neck (cf. Binford 1981: CV-1 & 2).

Table 2.5.5: Specified butchering traces observed on horse atlas.

2.5.2.4 Axis

In total 13 horse axis specimens have been found of which 6 are complete elements, together representing an MNE of 7 and a corresponding MNI of 7. The atlas has a low representation index of %SURV=36.8% and can be called under-represented. Cut-marked axis specimens have been encountered among the fragments, an MNE of only 1 cut-marked axis could be determined. Cut-mark placement points to dismemberment of the head-neck region (Table 2.5.7). No carnivore gnawing traces on axis specimens have been observed.

Axis		
NISP	13	
MNE	7	
MNI	7	
NISP-gnawed	0	
MNE-gnawed	0	
MNI-gnawed	0	
NISP-cutmarked	1	
MNE-cutmarked	1	
MNI-cutmarked	1	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Complete axis	6	46.1
Axis fragment	7	53.8
	13	99.9

Table 2.5.6: Horse axis frequencies and detailed element counts.

Axis Butchering traces		
Code	Placement and characteristics	Inferred activity
Ax-1	Oblique cuts on the caudal side of the cranial articular process.	Dismembering of the head-neck region.
Ax-2	Longitudinal short cuts on the ventral surface of the cranial part of the axis body.	Dismembering idem. (cf. Binford 1981: CV-3-stiff body).

Table 2.5.7: Specified butchering traces observed on horse axis.



Cervical vertebrae		
NISP	87	
MNE	43	
MNI	8	
NISP-gnawed	3	
MNE-gnawed	2	
MNI-gnawed	1	
NISP-cutmarked	0	
MNE-cutmarked	0	
MNI-cutmarked	0	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Complete cerv.vertbr.	42	48.2
Corpus cerv.vertbr.	2	2.3
Spinous process parts	1	1.1
Cerv.vertbr. fragments	42	48.2
	87	99.8

Table 2.5.8: Horse cervical vertebrae frequencies and detailed element counts.

	MNE	MNE-gnaw	MNE-cut	MNI
Cervical vertebra nr.1	8	1	0	8
Cervical vertebra nr.2	3	0	0	3
Cervical vertebra nr.3	5	0	0	5
Cervical vertebra nr.4	6	0	0	6
Cervical vertebra nr.5	7	0	0	7
Cervical vertebrae nr.1-3	5	0	0	
Cervical vertebrae nr.4-5	1	0	0	

2.5.2.5 Cervical vertebrae

Horse cervical vertebrae are, like the axis, relatively under-represented with a %SURV of 45.2% and an MNI of 8. Detailed counts on cervical vertebrae exhibit especially a low number of cervical vertebra number 2 (Table 2.5.8). Of interest is the complete lack of cut marks and very low incidence of carnivore gnawing on cervical vertebrae. Among the vertebrae five specimens with unfused articular discs have been encountered.

Thoracic vertebrae		
NISP	225	
MNE	170	
MNI	8	
NISP-gnawed	57	
MNE-gnawed	47	
MNI-gnawed	3	
NISP-cutmarked	11	
MNE-cutmarked	10	
MNI-cutmarked	2	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Complete thor.vertbr.	145	64.4
Corpus thor.vertbr.	25	11.1
Spinous process parts	29	12.9
Vertbr.thor. fragments	26	11.5
	225	99.9

Table 2.5.9: Horse thoracic vertebrae frequencies and detailed element counts.

	MNE	MNE-gnaw	MNE-cut	MNI
Thoracic vertebra nr.1	6	2	0	6
Thoracic vertebra nr.2	4	0	0	4
Thoracic vertebra nr.3	5	1	1	5
Thoracic vertebra nr.4	8	1	2	8
Thoracic vertebra nr.5	5	3	0	5
Thoracic vertebra nr.6	3	2	0	3
Thoracic vertebra nr.7	7	3	1	7
Thoracic vertebra nr.8	2	1	0	2
Thoracic vertebra nr.9	1	1	0	1
Thoracic vertebra nr.10	1	0	0	1
Thoracic vertebra nr.11	4	0	0	4
Thoracic vertebra nr.12	5	2	1	5
Thoracic vertebra nr.13	4	2	0	4
Thoracic vertebra nr.14	5	0	0	5
Thoracic vertebra nr.15	5	0	0	5
Thoracic vertebra nr.16	8	1	0	8
Thoracic vertebra nr.17-18	8	1	0	8
Thoracic vertebrae nr.2-6	12	5	1	
Thoracic vertebrae nr.4-9	9	2	2	
Thoracic vertebrae nr.8-13	11	3	1	
Thoracic vertebrae nr.12-18	12	1	0	



2.5.2.6 Thoracic vertebrae

Horse thoracic vertebrae are moderately represented with a %SURV of almost 50%. Most vertebrae specimens are for a large part complete or virtually complete (Table 2.5.9). The highest established MNI for thoracic vertebrae is 8 on the thoracic number 4, 16, 17-18 vertebrae. This MNI accounts for a %MNI of 42.1%.

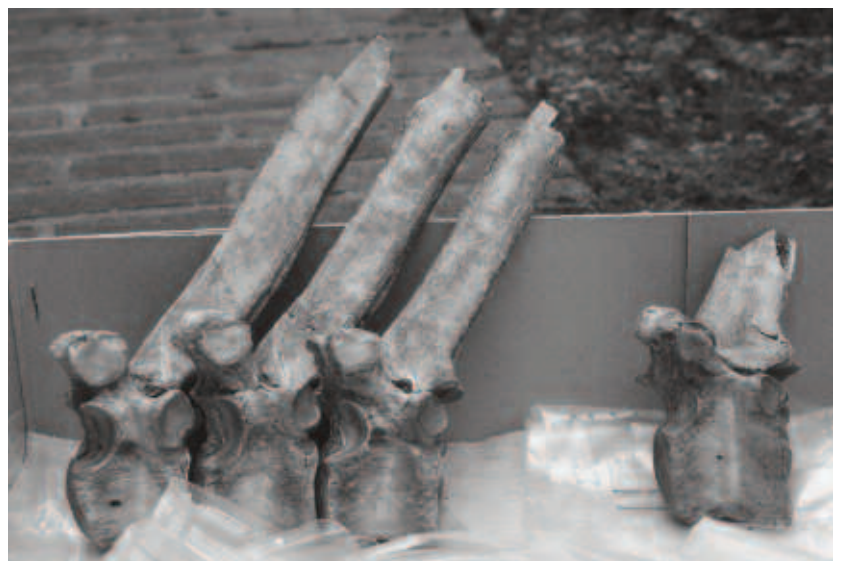
Carnivore gnawing traces are well represented among the vertebrae, constituting a gnawed 27.6% of the MNE. Gnawing traces are concentrated almost entirely on the spinous processes and are mostly present on the most proximal part. The most proximal end of the thoracic vertebrae exists of a cancellous part where muscle and tendon tissues are attached and concentrated. Carnivore activity seems to be mostly directed at these tissue-rich parts. Cut marks inflicted during butchery by hominids have been encountered on in a total of 10 thoracic vertebrae. Of the cut-marked vertebrae of 4 specimens the exact position within the vertebrae column could be established. Seven out of 9 identified cut-marked vertebrae derive from the cranial part of the vertebrae column, constituting thoracic vertebrae numbers 1 to 9 (Table 2.5.9). Only one specimen yielded cut marks present on the vertebra corpus (on the under, ventral, side of the corpus, Table 2.5.10). All other specimens exhibit cut marks concentrated on the spinous process and on the medial to proximal part only. The position of the hominid induced cut marks thus parallels the location on which carnivore gnawing traces are concentrated. Figure 2.3.11 in Section 2.3.5 for example shows the coexistence of cut marks and gnawing traces superimposed on a thoracic vertebra spinous process. By inference a large part of possible previously induced cut marks could have been deleted by ravaging carnivores. The observed number of cut-marked thoracic vertebrae therefore do not necessarily reflect the actual number of cut-marked specimens deposited after butchery (see Chapter III for a discussion on the methodological implications of this co-occurrence of actors).

Another observed feature concerning the location of observed cut marks is the presence on either the left or right side of the spinous process only. Cut marks on the left side of the spinous process have only been recorded in 4 cases, while cuts present on the right side only have been observed on 5 specimens.

Thoracic vertebrae Butchering traces

Code	Placement and characteristics	Inferred activity
Thor-1	Transversal or oblique short cuts on the uppermost part of the spinous process.	Filleting (possibly Dismembering)
Thor-2	Transversal or oblique short cuts along the upper and mid part of the spinous process.	Filleting
Thor-3	Short transversal cuts on the ventral part of the vertebra corpus.	Filleting

Table 2.5.10: Specified butchering traces observed on horse thoracic vertebrae.



Among the thoracic vertebrae are 31 specimens with one or both articular discs unfused. Of these specimens none yielded cut marks. With several thoracic vertebrae anatomical refits could be accomplished. Of a vertebra column the thoracic number 5 to 8 vertebrae could be fitted (see for one anatomical refit example Figure 2.5.3). These vertebrae derive from one and the same individual and the fitted specimens have been found within the same square metre. A number 2 and 4 thoracic vertebra likely belong to the same column and have been found 1.5 metres from the refitted unit. Of all these vertebrae the proximal part of the spinous process has been gnawed by carnivores. Further, a third and fourth thoracic vertebra with caudally unfused articular discs could be refitted, they were found together in one and the same 25 cm square.

Figure 2.5.3: Horse thoracic vertebrae derived from one and the same vertebra column. Note the excellent conservation of the elements (findnumbers 692/22-3 to 6). Photo by the author.



Lumbar vertebrae		
NISP	65	
MNE	59	
MNI	11	
NISP-gnawed	3	
MNE-gnawed	3	
MNI-gnawed	1	
NISP-cutmarked	5	
MNE-cutmarked	5	
MNI-cutmarked	2	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Complete lumbar vertbr.	56	86.1
Corpus lumbar vertbr.	2	3.1
Spinous process parts	2	3.1
Lumbar vertbr. Fragments	5	7.7
	65	100

	MNE	MNE-gnaw	MNE-cut	MNI
Lumbar vertebra nr.1	9	1	1	9
Lumbar vertebra nr.2	1	0	0	1
Lumbar vertebra nr.3	4	1	0	4
Lumbar vertebra nr.4	11	0	2	11
Lumbar vertebra nr.5	8	0	0	8
Lumbar vertebra nr.6	4	0	2	4
Lumbar vertebrae nr.1-4	16	1	0	

Table 2.5.11: Horse lumbar vertebrae frequencies and detailed element counts.

2.5.2.7 Lumbar vertebrae

The highest MNI for horse lumbar vertebrae has been put at 11 for the fourth vertebra (Table 2.5.11). The second, third and sixth lumbar vertebrae only yielded MNIs of 1 to 4, there thus seem to be some discrepancies between the presence of specific lumbar vertebrae. The %SURV for lumbar vertebrae is greater than 50% (51.7%). Carnivore gnawing on lumbar vertebrae is minor. Only three vertebrae yielded gnawing traces. Butchering cut marks have been observed on five lumbar vertebra specimens. As is the case with thoracic vertebrae, also among the lumbar vertebrae there are specimens yielding cut marks on one side only. Of interest are the two cut-marked sixth (MNI-cutmarked=2) lumbar vertebrae yielding cut marks on the left side of the ventral corpus only (Table 2.5.12, Lum-4). These cut marks are most likely associated with dissection of the horse hindquarter and filleting of the hindquarter meat mass. Apparently this activity induced cut marks on the left side of the skeletal elements of at least two horse carcasses. One of the two cut-marked fourth lumbar vertebrae (MNI-cutmarked=2) yielded cuts on the right side of the spinous process and corpus only (Lum-1 and Lum-3). The other fourth lumbar vertebra yielded cut marks on the right transverse process only (Lum-2).

Of the 59 lumbar vertebrae of 15 specimens the articular discs were unfused. Horse lumbar vertebrae yielded a considerable number of anatomical refits. Refits were established on two pairs of a third with a fourth vertebra, one on a fourth with a fifth vertebra, and one on a fifth with a sixth vertebra. All refits were found within one and the same square metre and 25 cm square. In situ deposition while still articulated is very likely for these vertebra column units.

Lumbar vertebrae Butchering traces		
Code	Placement and characteristics	Inferred activity
Lum-1	Short transversal cuts along the spinous process.	Filleting
Lum-2	Short transversal cuts on the dorsal side of the transverse process.	Filleting
Lum-3	Oblique and transversal short cuts on the lateral vertebrae corpus.	Filleting
Lum-4	Oblique and transversal short cuts aside the ventral crest of the corpus.	Filleting

Table 2.5.12: Coded butchering traces observed on horse lumbar vertebrae.



2.5.2.8 Sacrum and Caudal vertebrae

The horse sacrum is well represented with an MNI of 12, derived from 11 complete and virtually complete specimens together with three sacrum parts. Carnivore gnawing traces have been encountered on three specimens and butchering cut marks on only one sacrum part (Figure 2.5.4). The observed cut marks are related to filleting of the hindquarter meat mass and are paralleled by the filleting cuts observed on the ventral lumbar vertebrae corpi (see above). Two anatomical refits on horse sacra could be established. One sacrum could be fitted with two pelvis halves from two adjacent square metres. The other fit is between a sacrum and a sixth lumbar vertebra from one and the same square metre.

Horse caudal vertebrae are remarkably absent from the assemblage. Just one caudal vertebrae has been encountered accounting for a %SURV of only 0.4%. The vertebrae did not yield any traces of modification. Three possible explanations are possible for the absence of caudal vertebrae. Firstly, carnivores could be responsible for either dragging away or consuming the small vertebrae. The gnawed sacra could be an indication of this scenario. Secondly, the small vertebrae were missed during excavation or were winnowed out by water activity. Thirdly, hominids exploited the hides of horse carcasses on which the tails were left attached and thus carried away from the site.

Sacrum		
NISP	14	
MNE	12	
MINI	12	
NISP-gnawed	3	
MNE-gnawed	3	
MINI-gnawed	3	
NISP-cutmarked	1	
MNE-cutmarked	1	
MINI-cutmarked	1	
NISP-impacted	0	
MNE-impacted	0	
MINI-impacted	0	
Element part	NISP	%
Complete sacrum	11	78.5
Sacrum part	3	21.4
	14	99.9

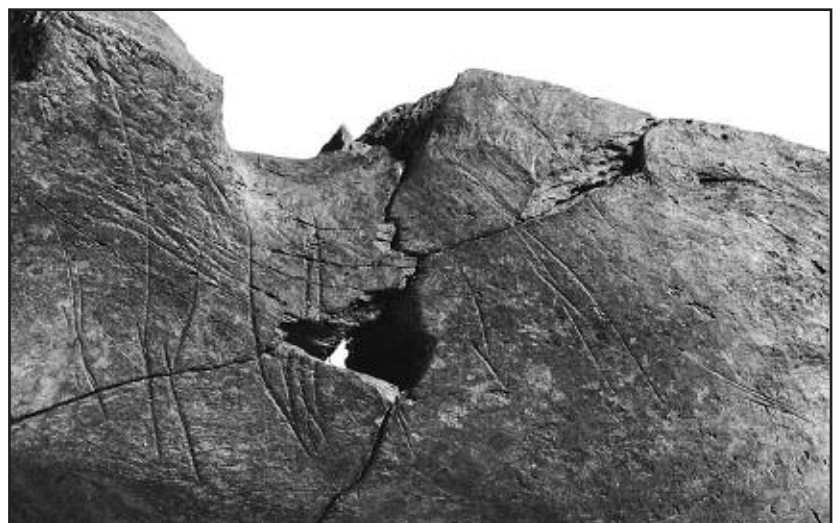
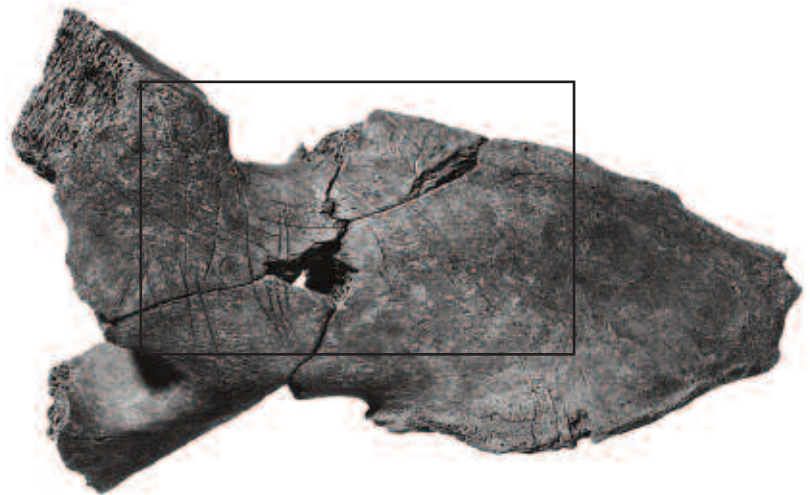
Table 2.5.13: Horse sacrum frequencies and detailed element counts.

Sacrum Butchering traces

Code	Placement and characteristics	Inferred activity
Sac-1	Oblique and transversal short cuts on the ventral side of the sacral wings or alae.	Filleting

Table 2.5.14: Coded butchering traces observed on a horse sacrum

Figure 2.5.4: Deeply incised cut marks on the ventral side of a horse sacrum's left wing or alae (findnumber 705/11-3). Photo by J. Paupit, Leiden.



2.5.2.9 Pelvis

Horse pelvic remains are relatively under represented with a %SURV of 34.2% and an MNI of 7. Complete pelvis halves and large pelvis parts dominate and the observed gnawing damage is limited, mostly being present on the edges of the ilium and ischium blades only. Carnivore gnawed pelvis specimens dominate over cut-marked ones (Table 2.5.15). Some loss of pelvic parts therefore could be related to carnivore activity seeing the high incidence of carnivore gnawing among the remains (MNE-gnawed=10, MNI-gnawed=6). Only four pelvis halves yielded butchery cut marks (MNE-cutmarked=4 and MNI-cutmarked=2). Three of these halves exhibit traces of intensive butchering, indicating both dismembering and filleting of meat (Table 2.5.16). The cut-marked specimens yield dismembering cuts caused during removal of the femur from the pelvis (Pel-1 to 3 codes). Cuts along the arms of the pelvis and on the pelvic blades are proof of filleting of the hindquarter meat mass (Pel-5 to 7 codes). Pelvic halves lacking cut marks possibly have not been subjected to hominid butchering activity. Two cut-marked pelvis halves belonged to one and the same horse individual and were found in the same square metre. Apart from this cut-marked pelvis, two other pairs belonging to one and the same individual could be fitted anatomically and were found near each other. Of one pair the sacrum has been found with it, pointing to

Pelvis		
NISP	24	
MNE	13	
MNI	7	
NISP-gnawed	14	
MNE-gnawed	10	
MNI-gnawed	6	
NISP-cutmarked	4	
MNE-cutmarked	4	
MNI-cutmarked	2	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Complete pelvis halve	10	41.6
Pelvis ilium	3	12.5
Pelvis ischium	1	4.1
Pelvis acetabulum	4	16.6
Pelvis fragments	6	25.0
	24	99.8

Table 2.5.15: Horse pelvis frequencies and detailed element counts.

deposition while still in an articulated state (squares 690/20 and 691/20). Cut-marked and marrow-processed horse femur remains are abundantly present in the studied bone assemblage (MNE-cutmarked=27 and MNI-cutmarked=16). The cut-marked pelvis remains thus account for only 12.5% of the butchered horse hindquarters, as indicated by butchered femur remains (see below).

Pelvis Butchering traces		
Code	Placement and characteristics	Inferred activity
Pel-1	Short and long cuts circling the rim of the acetabulum.	Dismembering of the pelvis-femur joint (cf. Binford 1981: PS-9).
Pel-2	Short and long circling cuts below the acetabulum on the arms of the pelvis.	Dismembering idem. (cf. Binford 1981: PS-10).
Pel-3	Short transversal cuts on the arm of the ilium above the acetabulum.	Dismembering idem. (cf. Binford 1981: PS-7).
Pel-4	Short transversal cuts on the arm of the ischium.	Dismembering idem. (cf. Binford 1981: PS-8).
Pel-5	Oblique short cuts on the medial side of the ilium arm.	Filleting
Pel-6	Oblique short and long cuts on the medial face of the ilium.	Filleting
Pel-7	Transversal short cuts on the medial face of the ischium.	Filleting (like Binford 1981: PS-6, but medial and transversal).

Table 2.5.16: Coded butchering traces observed on horse pelvis remains.



2.5.2.10 Costae

With a %SURV of 45.4% and an MNI of 13, horse ribs are well represented. Large differences do exist however between the presence of specific ribs. While horse first ribs yielded the highest MNI of 13, others yielded MNIs of between 6 to 2 (Table 2.5.17). Carnivore gnawing among the horse ribs is substantial with a %MNE-gnawed of 27.3% and gnawed MNI of 7 (Table 2.5.17). A substantial amount of rib fragments bearing carnivore gnawing traces are indicative of rib destruction by ravaging carnivores, although complete and largely complete ribs mostly bear gnawing traces on their distal ends only (see Figure 2.3.3 for an example of distal gnawing). The fragmentation of ribs made exact determinations on the rib's number from which the fragments derive impossible, which has an influence on the detailed indices. The observed discrepancies between certain ribs therefore can partly be due to dispersal and destruction by carnivores or other fragmentation processes. Otherwise also determination problems have to be taken into account because for some rib case sections individual ribs are morphologically largely identical to each other.

Hominid butchering traces in the form of cut marks have been observed on 105 rib specimens accounting for an MNE of 50 cut-marked horse ribs. These represent a %MNE-cutmarked of 16% and a cutmarked MNI of 4 on rib number 9 and 16. Most cut marks are located on the mid parts of the costae corpus and on the lateral side only (see Figure 2.3.5). Apparently during filleting or skinning of the thorax, mainly the most laterally protruding rib parts have been touched by stone butchering tools. No cut marks have been observed near or on rib articular heads, indicating dismemberment of ribs or rib slabs from the vertebrae. This is in line with the virtual absence of cut marks on vertebrae corpi (see above). Of interest is the difference in the number of cut-marked ribs between the front and rear half of the thorax. The total MNE of 111 for rib numbers 1 to 8 yielded 13 cut-marked specimens (11.7%), while rib numbers 9 to 18 with a comparable MNE of 116 yielded 43 cut-marked specimens (37.1%) (Table 2.5.17). Comparisons on cut-marked ribs deriving from the left and right side of the body did not yield significant differences, 37 cut specimens from the left side against 49 cut specimens from the right side of the body. In total 9 of the ribs derive from juvenile horses of which one yielded cut marks. Apparently at least one juvenile horse individual has been butchered for meat (in line with the one recorded filleted foal scapula, see below).

Costae		
NISP	726	
MNE	311	
MNI	13	
NISP-gnawed	189	
MNE-gnawed	85	
MNI-gnawed	7	
NISP-cutmarked	105	
MNE-cutmarked	50	
MNI-cutmarked	4	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Costa mostly complete	224	30.8
Costa articular head	87	12.0
Costa corpus	34	4.6
Costa corpus fragment	381	52.4
	726	99.8

	MNE	MNE-sin	MNE-dex	MNE-gnaw	MNE-cut	MNI
Costa nr.1	22	13	9	14	2	13
Costa nr.2	16	8	8	4	1	8
Costa nr.3	3	2	1	0	0	2
Costa nr.4	4	3	1	3	2	3
Costa nr.5	10	5	5	2	1	5
Costa nr.6	20	10	10	7	2	10
Costa nr.7	5	2	3	2	0	3
Costa nr.8	8	6	2	3	2	6
Costa nr.9	16	10	6	5	7	10
Costa nr.10	4	2	2	4	3	2
Costa nr.11	7	3	4	1	4	4
Costa nr.12	4	3	1	0	3	3
Costa nr.13	8	4	4	0	3	4
Costa nr.14	6	4	2	1	2	4
Costa nr.15	7	3	4	2	2	4
Costa nr.16	17	7	10	5	4	10
Costa nr.17-18	4	3	1	0	1	3
Costae nr.2-8	23	9	14	8	3	
Costae nr.8-18	43	20	22	17	14	

Table 2.5.17: Horse costae frequencies and detailed element counts.



Costae Butchering traces		
Code	Placement and characteristics	Inferred activity
Cos-1	Transversal short cuts below the neck on the lateral caudal border.	Filleting
Cos-2	Transversal and oblique short cuts along the caudal border of the lateral corpus costa.	Filleting
Cos-3	Oblique short cuts along the cranial border of the lateral corpus costa.	Filleting
Cos-4	Oblique short cuts along the central part of the lateral costa corpus.	Filleting and/or skinning
Cos-5	Oblique short cuts along the distal part of the lateral corpus costa.	Filleting and/or skinning

Table 2.5.18: Coded butchering traces observed on horse costae

Scapula		
NISP	31	
MNE	20	
MNI	10	
NISP-gnawed	8	
MNE-gnawed	7	
MNI-gnawed	4	
NISP-cutmarked	7	
MNE-cutmarked	5	
MNI-cutmarked	3	
NISP-impacted	0	
MNE-impacted	0	
MNI-impacted	0	
Element part	NISP	%
Scapula complete	15	48.4
Scapula neck/articular	5	16.1
Scapula corpus	3	9.6
Scapula fragment	8	25.8
	31	99.9

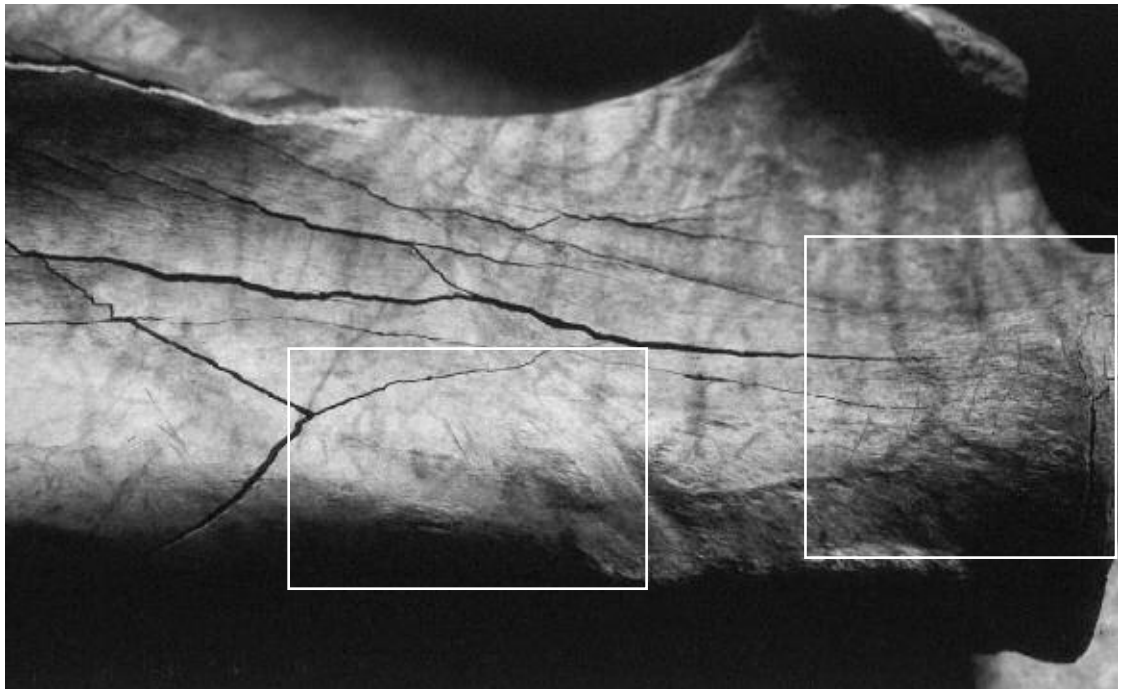
Table 2.5.19: Horse scapulae frequencies and detailed element counts.

2.5.2.11 Scapula

Horse scapulae are represented with a %SURV of 52.6% and a maximum MNI of 10. A total MNE of 20 has been established of which 10 are from the left side and 10 from the right side of the body (Table 2.5.19). This together with the presence of 15 complete scapulae and a relatively small number of fragments seems to indicate reliable representation. Although carnivore gnawing damage has been observed on 7 specimens, like the pelvis remains, carnivore gnawing was mostly limited to the edges of the scapulae blades. Of the total MNI of 10, only 7 individuals of which the scapulae derived were of adult age. Five scapulae of horse foals have been recorded with 2 deriving from the left and 3 from the right side of the body, MNI=3. One pair of these scapulae most probably derived from one and the same individual. Both show unfused *processus coracoideus* and *supraglenoid tubercle* pointing to an age of less than one year (Getty, 1975). The other juvenile scapulae are of approximately the same size or slightly larger. Although the state of fusion could not be established, a comparable or slightly older age for these individuals can be inferred. Together the juvenile scapulae represent one foal younger than one year and two foals probably somewhat older.

The right unfused scapula of a foal exhibits butchering cut marks (number: 698/15-4) (see Section 2.5.4, Figure 2.5.26). The left specimen, lacking cut marks, (number: 693/20-16) which probably forms a pair with the cut-marked right specimen has been found at a distance of approximately 5 metres.





Scapula Butchering traces

Code	Placement and characteristics	Inferred activity
Sca-1	Short transversal cuts circling the border of the glenoid cavity.	Dismembering of the scapula-humerus joint (cf. Binford 1981: S-1).
Sca-2	Transversal short cuts along the medial side of the caudal scapula neck.	Dismembering idem. (cf. Binford 1981: S-2).
Sca-3	Long cuts on the lateral supra-spinous fossa.	Filleting (cf. Binford 1981: S-3).
Sca-4	Oblique short cuts along the medial side of the cranial border.	Filleting
Sca-5	Oblique short cuts along the medial side of the caudal border.	Filleting
Sca-6	Oblique and longitudinal cuts on and across the medial facies serrata and fossa subscapularis.	Filleting (cf. Binford 1981: S-4).

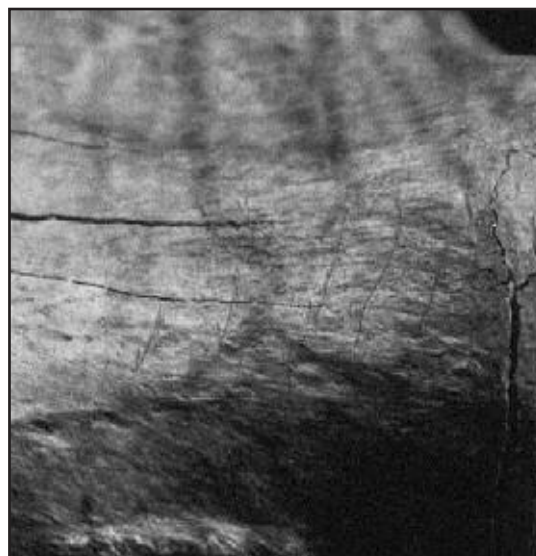
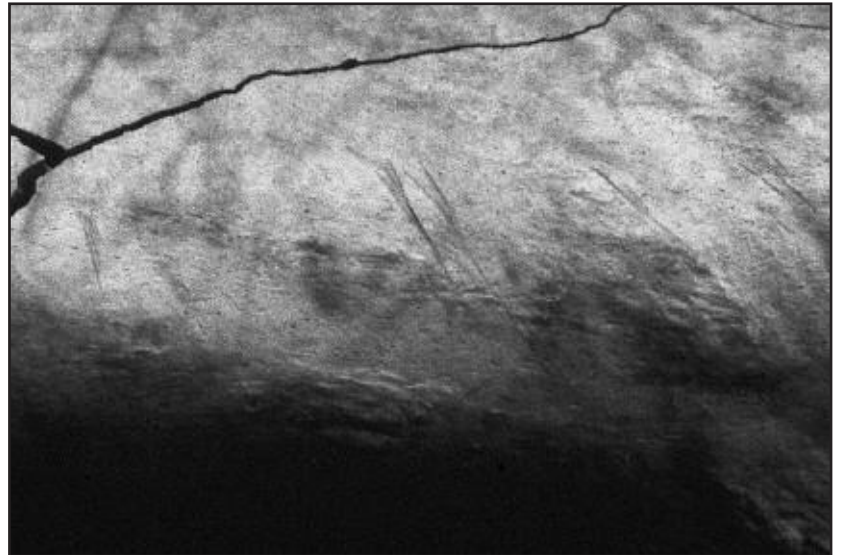


Figure 2.5.5: Horse scapula with cut marks from filleting close-up above and dismemberment close-up at the left (findnumber 691/21-18). Photos by the author.

Table 2.5.20: Coded butchering traces observed on horse scapulae.



Cut marks present on the lateral scapular blade indicate filleting of meat and short cuts on the medial face of the blade indicate filleting or dismembering (Sca—6) of the scapula from the thorax. Likely the recorded cut-marked juvenile rib (see above) can also be associated with this represented horse foal. Four adult scapulae have also been cut-marked, representing an MNI-cutmarked of 2. Both filleting and dismembering cut marks are represented (Table 2.5.20, Figures 2.5.5). This is a relatively low number of cut-marked scapulae seeing the large amount of meat the thorax – frontquarter part of a horse is bearing. Anatomical refits between scapulae and humeri have not been accomplished due to the virtual absence of proximal humeri in the assemblage (see below).

2.5.2.12 Humerus

Horse humeri were severely fragmented as indicated by the NISP/MNE ratio of 130/22 (Table 2.5.21). An MNI of 12 has been established on 20 diagnostic distal shaft fragments including the ridges of the caudal olecranon fossa (Figure 2.5.6a and Figure 2.5.7). An MNE of 22 humerus specimens represent a maximum number of 12 elements from the left side of the body against 10 (including 2 complete humeri) from the right side. These numbers are approximately the same as those for horse scapulae (see above). Pronounced differences in the representation of humerus parts do exist. The proximal humerus is represented by only 3 specimens representing an MNI of 2, while the distal part is represented by 11 elements accounting for an MNI of 8. Shaft fragments dominate the spectrum with 79.2%, accounting for the MNI of 12 and representing 20 elements. The %SURV for horse humeri is put at 57.9%. Carnivore gnawing traces have especially been found on the proximal epiphyseal fragments and some distal parts. The under-representation of especially the cancellous proximal humerus could be due to carnivore ravaging.

Humerus		
NISP	130	
MNE	22	
MNI	12	
NISP-gnawed	23	
MNE-gnawed	8	
MNI-gnawed	5	
NISP-cutmarked	75	
MNE-cutmarked	14	
MNI-cutmarked	7	
NISP-impacted	68	
MNE-impacted	19	
MNI-impacted	10	
Humerus part	NISP	%
Complete humerus	2	1.5
Complete diaphysis only	4	3.1
Proximal part missing	2	1.5
Proximal epiphysis (part)	9	6.9
Proximal diaphysis	20	15.4
Middle diaphysis	51	39.2
Distal diaphysis	32	24.6
Distal epiphysis (part)	10	7.7
	130	99.9

Table 2.5.21: Horse humeri frequencies and detailed element counts.

More than half of the horse humeri derived bone specimens are cut-marked, 57.7% of the total NISP. The highest MNE-cutmarked of 14 is on shaft fragments accounting for an MNI-cutmarked of 7. The two encountered complete humerus specimens do not show any butchering traces. Butchering traces indicate dismemberment (see Figure 2.5.8) of the humerus-scapula joint as well as the humerus-radius joint (Table 2.5.22). The high number of cut-marked shaft fragments point towards intensive filleting/defleshing of the humerus shafts.



Humerus Butchering traces

Code	Placement and characteristics	Inferred activity	Code	Placement and characteristics	Inferred activity
Hum-1	Transversal short cuts circling the caudal neck below the caput humeri.	Dismembering of the humerus-scapula joint.	Hum-10	Oblique short cuts across the lateral face of the lateral epicondyle.	Dismembering idem.
Hum-2	Transversal short cuts on the lateral below the caput	Dismembering idem. neck humeri. (cf. Binford 1981: Hp-3).	Hum-11	Oblique short cuts on the lateral-cranial face of the capitulum.	Dismembering idem. (cf. Binford 1981: Hd-4).
Hum-3	Oblique short cuts on the cranial-lateral face of the tuberositas deltoidea.	Filleting	Hum-12	Oblique and transversal cuts across the medial face of the trochlea.	Dismembering idem. (cf. Binford 1981: Hd-2).
Hum-4	Oblique short cuts along the lateralside of the musculo spiral groove of the diaphysis.	Filleting	Hum-13	Local patches of scraping marks and and long and curvilinear cuts on the diaphysis.	Defleshing, removal of fat tissue prior to marrow processing.
Hum-5	Oblique short cuts along the medial-caudal side of the musculo spiral groove of the distal diaphysis.	Filleting	Hum-14	Impacting of the area near the tuberositas deltoidea on the cranial face of the proximal shaft (H1).	Marrow processing.
Hum-6	Oblique short cuts on the cranial-medial side of the humeral crest of the distal diaphysis.	Filleting	Hum-15	Impacting of the area near the tuberositas deltoidea of the caudal-lateral proximal shaft (H3).	Marrow processing.
Hum-7	Oblique short cuts on the lateral face of the epicondyloid crest.	Filleting (possibly Dismembering)	Hum-16	Impacting of the distal shaft above the lateral epicondyle (H2).	Marrow processing.
Hum-8	Oblique short cuts across the dia-physeal crest just above the olecranon fossa.	Dismembering of the humerus-radius/ulna joint (cf. Binford 1981: Hd-3).	Hum-17	Impacting of the distal shaft above the medial epicondyle (H5).	Marrow processing
Hum-9	Transversal short cuts across the radial fossa.	Dismembering idem. (cf. Binford 1981: Hd-2).			

Table 2.5.22: Coded butchering traces observed on horse humeri.

Two juvenile horse humeri have been documented, one from the left and one from the right side of the body accounting for a juvenile MNI of 1. Both specimens concern complete humerus shafts lacking cut marks as well as traces of marrow processing but of both the epiphysis has been gnawed off by carnivores. One complete adult horse right humerus lacking any traces of modification could be articulated with a complete radius-ulna. Both derive from one and the same square metre (689/19). Apparently here a complete right front leg

has been deposited and stayed articulated in situ. Of a butchered humerus a distal shaft fragment yielding scraping marks could be fitted onto a spirally fractured distal humerus part (see Figure 2.4.1.). Fragmentation of humeri for marrow processing has been intensive. The MNE based on humerus specimens showing impact scars has been put at 19 with an MNI-impacted of 10. These are high numbers of hominid modified element counts when compare to those for the scapulae which belongs to the same anatomical unit (see above).



Figure 2.5.6a: Schematic presentation of separately coded diagnostic humerus fragment areas and their frequencies used to derive the most accurate MNE and MNI counts.

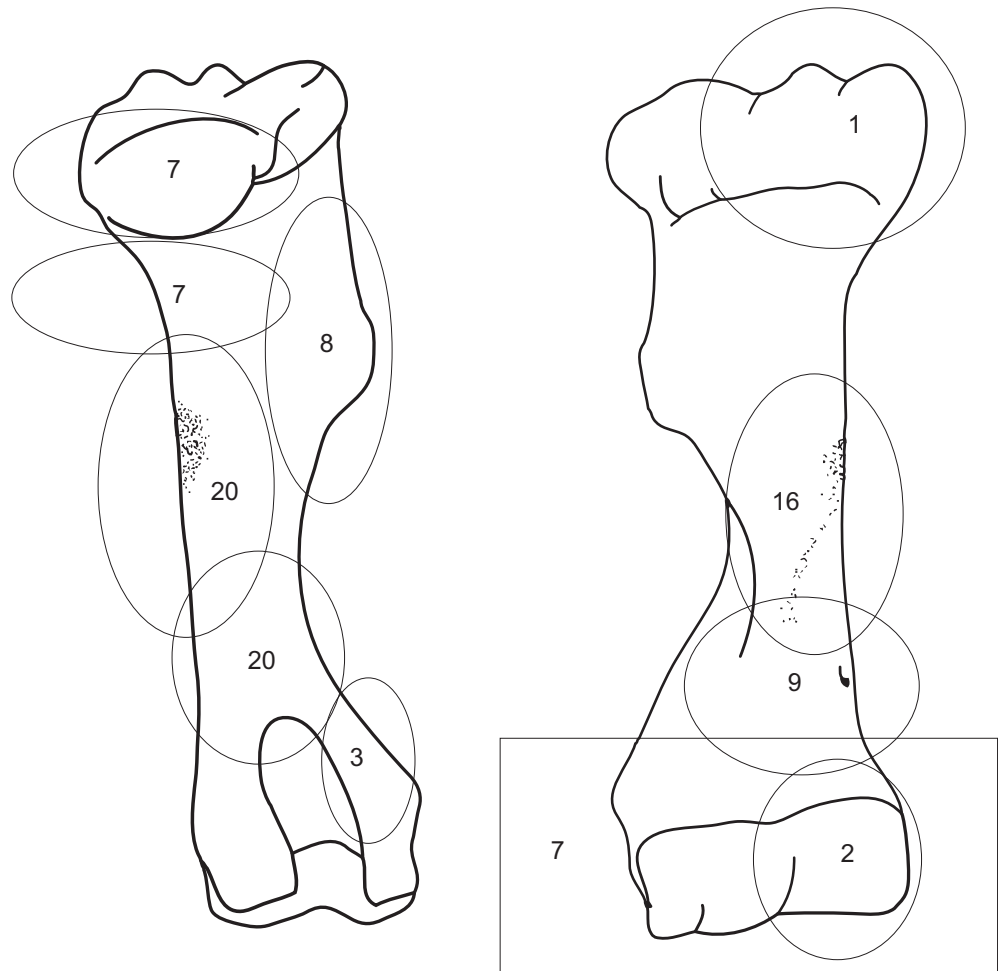


Figure 2.5.6b: Schematic presentation of main marrow processing impact areas on humerus shafts. Bold arrows indicate the most frequently encountered impact areas while small arrows point to less frequent impact locations (see table 2.5.22 for the descriptions).

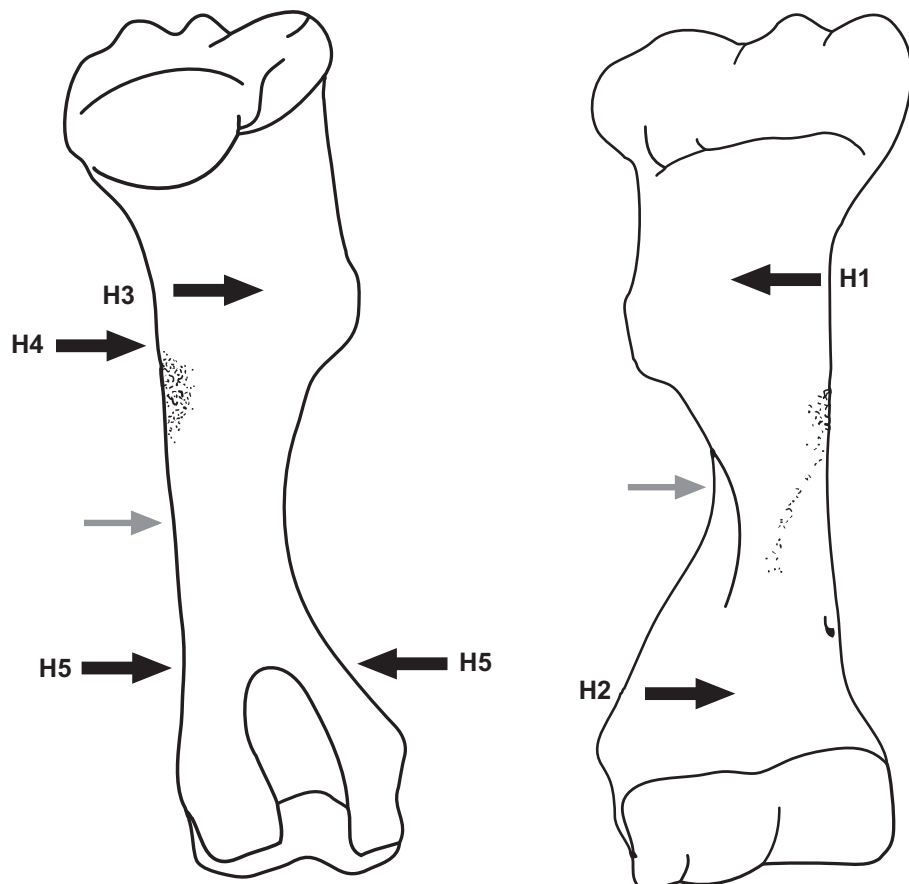




Figure 2.5.7: Example of the occurrence of identical diagnostic horse humerus shaft fragments caused by systematic long bone breakage (H5 impact areas, see Figure 2.5.6b), a left and a right humerus distal shaft fragment. Note the cut marks on the specimen on the left (findnumber 691/30-3), created during dismembering of the humerus – radius/ulna joint. Photo by the author.

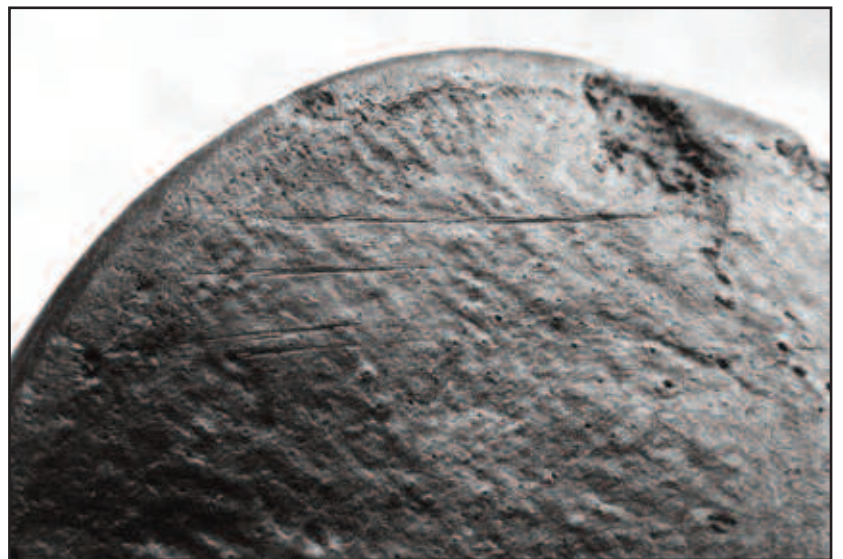


Figure 2.5.8: Dismembering cut marks on the medial side of a horse humerus distal condyle, or trochlea (Hum—12 cut marks). Photos by the author.



2.5.2.13 Radius-Ulna

With the exception of one complete and unmodified ulna-radius all encountered horse ulnae are broken off the radii. In total 15 separate horse ulnae have been counted representing an MNI of 9. The fragmented nature, while being a relatively strong element, of the recorded ulna specimens together with the observation of some impact scars suggest that ulnae were knocked off the radii during marrow procurement. The number of carnivore gnawed ulnae and cut-marked ulnae is about equal (Table 2.5.23). The %SURV for ulnae is relatively low with 39.4% but near the %SURV for radii, being 47.3%. Also among the observed radii the number of carnivore gnawed and cut-marked specimens is about the same (Table 2.5.24). Marrow-processed radii outnumber gnawed and cut-marked specimens with an MNI of 7 against MNIs -gnawed and cut-marked of 4. Some parts of unfused ulnae have been encountered. Also a separate unfused distal radius epiphysis and a complete shaft with missing unfused distal epiphysis have been recorded on which carnivore gnawing was directed at the epiphyseal ends. Of one mostly complete radius broken on DBF the proximal epiphysis, broken in two halves, could be fitted to the shaft, both were found within one and the same square metre (702/18-3-5). A GBF spiral refit was accomplished between two distal shaft fragments yielding scraping marks on both surfaces. The olecranon tuberosity of a cut-marked and impacted ulna could be fitted onto a DBF broken ulna corpus.

Table 2.5.23: Horse ulnae frequencies and detailed element counts.

Ulna		
NISP	33	
MNE	15	
MNI	9	
NISP-gnawed	10	
MNE-gnawed	6	
MNI-gnawed	3	
NISP-cutmarked	10	
MNE-cutmarked	5	
MNI-cutmarked	3	
NISP-impacted	6	
MNE-impacted	3	
MNI-impacted	2	
Ulna part	NISP	%
Complete ulna	1	3.0
Ulna trochlear notch	3	9.1
Ulna olecranon mid part	11	33.3
Ulna olecranon tuberosity	4	12.1
Ulna shaft	10	30.3
Ulna fragments	4	12.1
	33	99.9

Radius		
NISP	147	
MNE	18	
MNI	9	
NISP-gnawed	19	
MNE-gnawed	6	
MNI-gnawed	4	
NISP-cutmarked	84	
MNE-cutmarked	7	
MNI-cutmarked	4	
NISP-impacted	69	
MNE-impacted	10	
MNI-impacted	7	
Radius part	NISP	%
Complete radius	2	1.3
Complete diaphysis only	3	2.0
Distal part missing	1	0.7
Proximal epiphysis (part)	12	8.1
Proximal diaphysis	30	20.4
Middle diaphysis	54	36.7
Distal diaphysis	26	17.6
Distal epiphysis (part)	7	4.7
Radius fragments	12	8.1
	147	99.6

Table 2.5.24: Horse radii frequencies and detailed element counts.

Ulna - Radius Butchering traces		
Code	Placement and characteristics	Inferred activity
Uln-1	Transversal short cuts on the lateral face of the olecranon, caudal of the trochlea.	Dismembering of the humerus-ulna/radius joint (cf. Binford 1981:RCp-2).
Uln-2	Oblique cuts on the medial face of the olecranon between the olecranon tuberosity and the trochlea.	Dismembering, idem (cf. Binford 1981: RCp-3).
Uln-3	Oblique short cuts along the medial side of the ulna diaphysis.	Filleting (cf. Binford 1981: RCp-7).
Rad-1	Transversal short cuts on the cranial face just below the proximal radial tuberosity.	Dismembering of the humerus-radius/ulna joint (cf. Binford 1981: RCp-5).
Rad-12	Longitudinal short cuts on the cranial face across the proximal radial tuberosity.	Dismembering idem. (cf. Binford 1981: RCp-5, but longitudinal).



Code	Placement and characteristics	Inferred activity
Rad-3	Oblique and transversal cuts along the proximal cranial face of the diaphysis.	Filleting (cf. Binford 1981: RCp-6).
Rad-4	Oblique short cuts lateral of the caudal interosseous space.	Filleting
Rad-5	Oblique short cuts along the medial side of the caudal diaphysis.	Filleting
Rad-6	Local clusters of scraping marks and long curvilinear cuts on the diaphysis.	Defleshing / Removal of tissue prior to marrow processing.
Rad-7	Impacting of the cranial face of the diaphyse just below the proximal epiphysis (R1).	Marrow processing
Rad-8	Impacting of the mid-cranial area	Marrow processing
Rad-9	Impacting of the caudal face of the mid area of the diaphyse, just aside of the ulna diaphysis (R4).	Marrow processing
Rad-10	Impacting of the cranial face of the distal diaphyse just above the distal epiphysis (R3).	Marrow processing

Table 2.5.25: Coded butchering traces observed on horse ulna-radii.

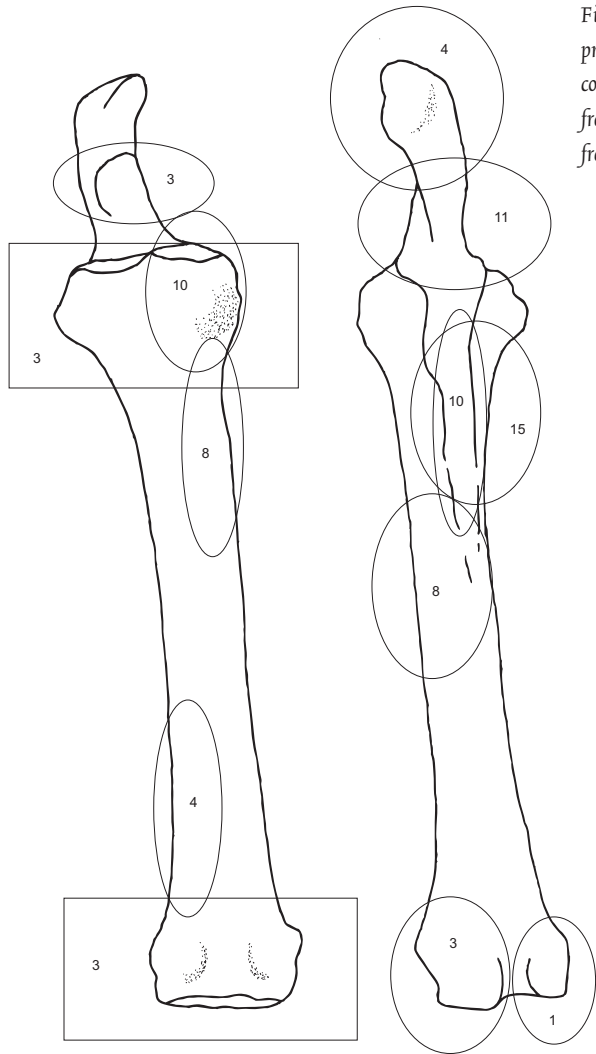


Figure 2.5.9a: Schematic presentation of separately coded diagnostic ulna-radius fragment areas and their frequencies.

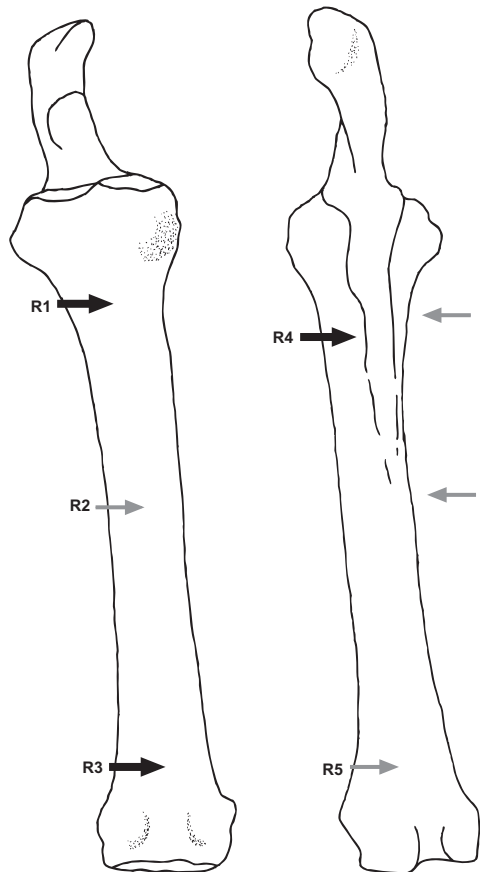


Figure 2.5.9b: Schematic presentation of main marrow processing impact areas on radius shafts. Bold arrows indicate the most frequently encountered impact areas while small arrows point to less frequent impact locations (see table 2.5.25 for the descriptions).



2.5.2.14 Carpals

Horse carpals are under-represented in the assemblage with a %SURV of only 12.8%. The highest derived MNI is 5 on the os carpal tertium. Carnivore gnawing traces have been encountered on 5 carpals representing an MNI-gnawed of 3. Of interest is the complete lack of butchering cut marks on carpals, especially when compared to the tarsals (see below). Apparently dismemberment of the radius to metacarpus region was not directed at the carpal unit. The presence of gnawing marks but complete lack of cut marks could indicate that the low number of these elements is related to carnivore activity. The low values for carpals are further in line with those obtained for the distal radius (see above). The low numbers of both categories seems to be related. One os carpal tertium could be fitted to a metacarpus (see below).



Figure 2.5.10: A proximal horse radius shaft part with knocked off ulna but with still attached ulna base yielding cut marks. Photo by J. Pauptit, Leiden.



Figure 2.5.11: A broken horse proximal ulna yielding cut marks from dismembering. Photos by the author.

Carpals					
NISP	34				
MNE	34				
MNI	5				
NISP-gnawed	5				
MNE-gnawed	5				
MNI-gnawed	3				
NISP-cutmarked	0				
MNE-cutmarked	0				
MNI-cutmarked	0				
NISP-impacted	0				
MNE-impacted	0				
MNI-impacted	0				
Carpal	MNE	MNE-sin	MNE-dex	MNI	
os carpi radiale	3	0	3	3	
os carpi intermedium	5	3	2	3	
os carpi ulnare	4	0	4	4	
os carpi accessory	5	0	4	4	
os carpale secundum	4	1	3	3	
os carpale tertium	8	5	3	5	
os carpale quartum	5	3	2	3	
	34	12	21		

Table 2.5.26: Horse carpal frequencies and detailed elements counts.



2.5.2.15 Metacarpals

Horse metacarpals are represented with an MNI of 6 and %SURV of only 28.9%, values very similar to those obtained for horse carpals and distal radii, these values possibly relate to each other. The highest MNI on the accessory metacarpals is 5 and approaches the counts for the metacarpus (Table 2.5.27). Carnivore gnawing traces have been observed on four metacarpus bone specimens accounting for an MNE of 2 and MNI-gnawed of only 1. The amount of carnivore gnawing on metacarpal specimens is thus very low. Butchering cut marks have been found on two metacarpus specimens accounting for an MNI-cutmarked of 2. An MNI of only 1 has been derived on metacarpus specimens yielding impact scars. Four of a total of 11 metacarpals have survived complete. An MNI of 3 is derived on complete metacarpals only. One unfused and separate distal metacarpus epiphysis has been encountered as well as an unfused distal shaft part, together pointing to a juvenile MNI of 2. Two metacarpal shaft parts and a complete proximal epiphysis were refitted onto DBFs, all parts derived from the same square metre. One complete left side metacarpal lacking any traces of modification could be refitted with a carpal (os carpal tertium).

Metacarpus		
NISP	29	
MNE	11	
MNI	6	
NISP-gnawed	4	
MNE-gnawed	2	
MNI-gnawed	1	
NISP-cutmarked	9	
MNE-cutmarked	2	
MNI-cutmarked	2	
NISP-impacted	7	
MNE-impacted	2	
MNI-impacted	1	
Metacarpus part	MNE	MNI
Acc. Metacarpus II	9	5
Acc. Metacarpus IV	7	4
Complete Metacarpus III	4	3
	NISP	%
Proximal epiphysis (part)	9	36
Diaphysis	12	48
Distal epiphysis (part)	4	16
	25	100

Table 2.5.27: Horse metacarpus frequencies and detailed element counts.

Among the horse metacarpals are specimens exhibiting conspicuous traces, namely battered and flaked epiphyseal condyle edges (see Figure 2.3.14). These traces could indicate use of these parts as a percussion tool or some kind of specific butchery trace. Metacarpals lack meat to be removed during butchering and are low in bone marrow. The presence of defleshing cut- and scraping marks on metapodials (metacarpus and metatarsus) remains could be related to butchering activities like tendon removal or skinning. This will be explored further in Section 2.5.6.

Metacarpus Butchering traces

Code	Placement and characteristics	Inferred activity
Mcp-1	Oblique short cuts next to the proximal metacarpal tuberosity on the lateral-cranial face.	Dismembering of the metacarpus-carpals joint (cf. Binford 1981: MCp-1).
Mcp-2	Oblique short cuts along the cranial face of the diaphysis.	Filleting/Defleshing
Mcp-3	Oblique short cuts next to the distal extremity of the fourth Mcp on the caudal diaphysis.	Filleting/Defleshing
Mcp-4	Transversal short cuts on the centre of the caudal distal diaphysis, just above the distal condyle.	Filleting/Defleshing
Mcp-5	Local clusters of scraping marks and long curvilinear cuts on the diaphysis.	Defleshing/Removal of tissue prior to marrow processing.
Mcp-6	Impacting of the distal diaphysis on the cranial face just above the distal condyle.	Marrow processing.

Table 2.5.28: Coded butchering traces observed on horse metacarpals.



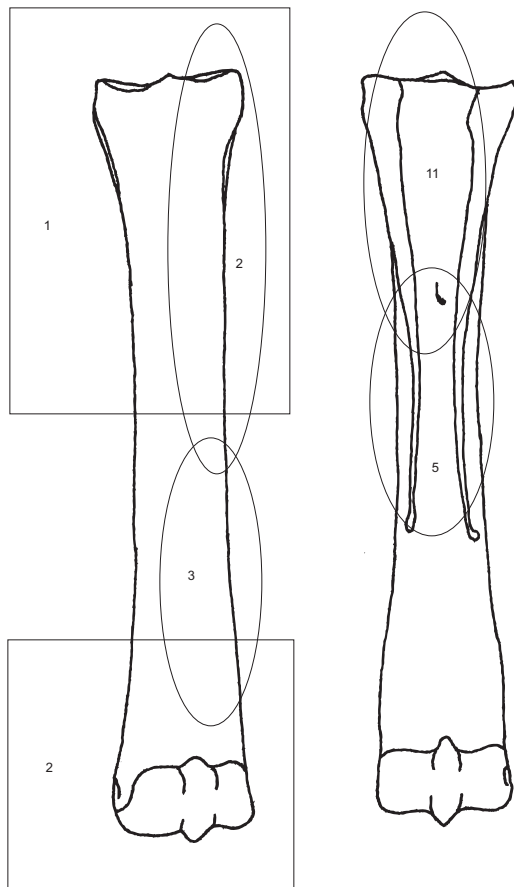


Figure 2.5.12a: Schematic presentation of separately coded diagnostic metacarpus fragment areas and their frequencies.

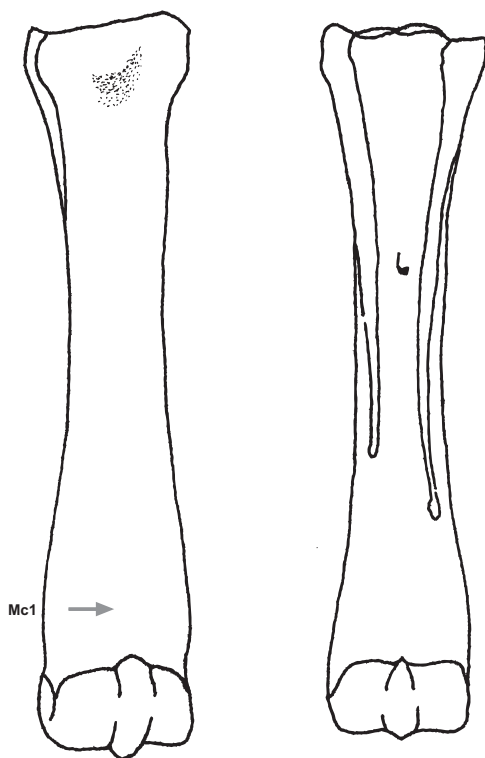


Figure 2.5.12b: Schematic presentation of main marrow processing impact areas on metacarpal shafts (see table 2.3.43 for the descriptions).

Horse femur remains are the most abundantly encountered long-bone specimens, with a recorded NISP of 175 and MNE of 37, together representing an MNI of 19. With these values the femur is the most frequent horse element in the assemblage with the %MNI put at 100% and a %SURV of 97.3%. Three complete untouched horse femora have been recorded, representing an MNI of 2 on the left side femur. The highest MNI of 19 is on the right femur, based on a maximum number of distal shaft fragments containing the complete or part of the *supra condyloid fossa* together with one complete right femur (Figure 2.5.13a). Horse patellae are under-represented compared to the femora, with an MNE of 7 and an MNI of only 4.

Among the femur remains quite some unfused material has been encountered. In total 8 unfused horse femora have been counted of which 7 are proximally unfused and one distally, together accounting for an MNI-unfused of 5. Two of the unfused femora bear butchering traces in the form of cut marks and impact scars. Both specimens are proximally unfused but are of a size comparable to fully adult femora. The proximal horse femur fuses at a relatively late age of up to 3.5 years and both specimens likely are from individuals of sub-adult to adult age, certainly not juvenile. All other unfused femora lack butchering or marrow-processing traces. Possibly the larger unfused specimens have been processed because marrow was available, while the younger specimens will have been poorer in bone marrow. Of one of the unfused femora, a left femoral head could be fitted onto the unfused proximal shaft part.

Of interest is the discrepancy in representation values between the femur and pelvic remains which together form the horse hindquarter. Compared to the femora the pelvis is represented with less than half of the number of counted femora (pelvis MNI=7 against femur MNI=19). If, however, only the proximal femur parts are taken to compare with the values obtained for the pelvis the values are comparable, namely MNI=8 for the proximal femur and 7 for the pelvis. The MNI-cutmarked on proximal femora has been put at 3, less than half of the total proximal MNI. Classic butchering marks located around the femoral head created during dismemberment of the femur from the pelvis (Fem—1 cutmarks) have been encountered in one case only and among the pelvis remains dismemberment cut marks are also scarce. Impacting of the proximal to proximal-mid shaft area below the



proximal epiphyseal end though have often been observed (more than 12 cases, Fem—14 and F3-F6 codes). Also 10 separate femur trochanter major specimens have been encountered which likely have been separated from the proximal femur by impacting the area between the major trochanter and the femoral head. Possibly dismemberment of the femur from the pelvis was facilitated by breaking the femoral proximal end.

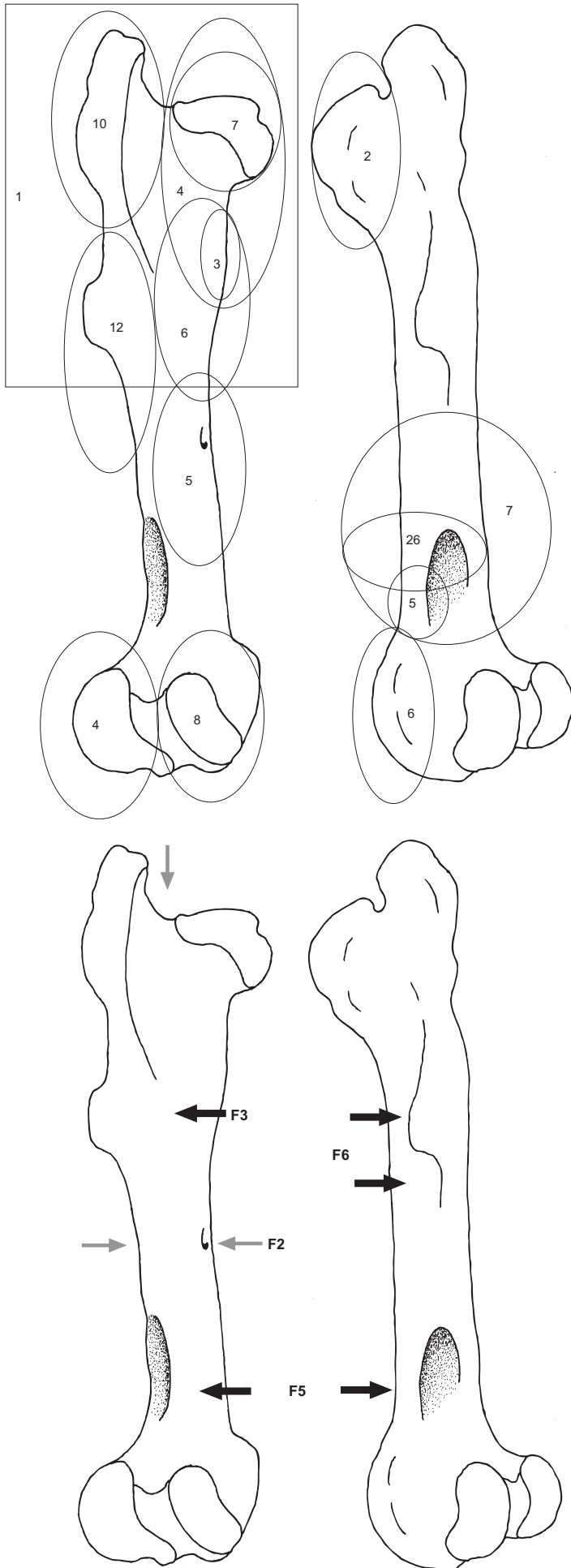
Femur		
NISP	175	
MNE	37	
MNI	19	
NISP-gnawed	25	
MNE-gnawed	7	
MNI-gnawed	4	
NISP-cutmarked	93	
MNE-cutmarked	27	
MNI-cutmarked	16	
NISP-impacted	74	
MNE-impacted	20	
MNI-impacted	13	
Femur part	NISP	%
Complete femur	4	2.3
Shaft only	2	1.1
Distal part missing	6	3.4
Shaft cylinder	2	1.1
Proximal epiphysis (part)	21	12.0
Proximal diaphysis	19	10.8
Middle diaphysis	49	28.0
Distal diaphysis	50	28.5
Distal epiphysis (part)	20	11.4
Femur fragments	2	1.1
	175	99.7

Table 2.5.29: Horse femur frequencies and detailed element counts.

Femur Butchering traces		
Code	Placement and characteristics	Inferred activity
Fem-1	Transversal cuts around the femoral head's neck, medial, cranial as well as lateral.	Dismembering of the femur-pelvis joint (cf. Binford 1981: Fp-3).
Fem-2	Longitudinal long cuts along the caudal side of the lesser trochanter.	Filleting (cf. Binford 1981: Fp-4, but longitudinal).
Fem-3	Oblique long cuts along the cranial side of the lesser trochanter.	Filleting (cf. Binford 1981: Fp-4, but longitudinal).
Fem-4	Longitudinal long cuts along the cranial side of the trochanter tertius.	Filleting
Fem-5	Oblique long cuts on the caudal side of the trochanter tertius area extending into the trochtere fossa.	Filleting
Fem-6	Transversal short cuts below the medial nutrient foramen.	Filleting
Fem-7	Oblique and transversal cuts along the cranial side of the diaphysis.	Filleting
Fem-8	Oblique short cuts along the distal medial part of the diaphysis above the medial condyle.	Filleting
Fem-9	Oblique short cuts along the distal lateral part of the diaphysis above the lateral condyle.	Filleting
Fem-10	Transversal short cuts across the lateral supra condyloid fossa.	Dismembering of the femur-tibia joint (cf. Binford 1981: Fd-1).
Fem-11	Transversal short cuts above the medial distal condyle.	Dismembering idem. (cf. Binford 1981: Fd-1).
Fem-12	Oblique short cuts along the medial supra condyloid tuberosity.	Dismembering idem. (possibly Filleting).
Fem-13	Local patches of scraping marks and long curvilinear cuts on the diaphysis.	Defleshing/ Removal of tissue prior to marrow processing.

Table 2.5.30: Coded butchering traces observed on horse femora.





Code	Placement and characteristics	Inferred activity
Fem-14	Impacting of the area of the proximal diaphysis between the lesser and the third trochanter (F3).	Marrow processing
Fem-15	Impacting of the cranial proximal to mid-diaphysis next to and below the third trochanter (F6).	Marrow processing
Fem-16	Impacting of the distal lateral and medial diaphysis next to the supra condyloid fossa (F5).	Marrow processing

Figure 2.5.13a: Schematic presentation of separately coded diagnostic femur fragment areas and their frequencies.

Figure 2.5.13b: Schematic presentation of main marrow processing impact areas on femur shafts. Bold arrows indicate the most frequently encountered impact areas while small arrows point to less frequent impact locations (see table 2.5.30 for the descriptions).



Figure 2.5.14: Typically encountered broken-off horse distal femur condyles. Photo by the author.



Carnivore gnawing has been encountered on one of the complete femora on which the gnawing damage was limited to scoring and some furrowing. Of a total MNE of 37 femora only 7 yielded traces of carnivore gnawing of which 4 are unfused specimens. Concerning the proximal femur, a role of carnivores possibly deleting part of the proximal ends should be taken into account, as gnawing damage has been detected on 6 of 15 proximal femur bone specimens.

2.5.2.17 Tibia

Horse tibiae are represented by the highest NISP for horse long bones being 185, but are second best represented by their MNE of 28 accounting for an MNI of 15 and %SURV of 73.6% (Table 2.5.31). The high number of identified tibia fragments is partly due to the diagnostic appearance of tibia shaft fragments making determinations easier, therefore values for tibiae in assemblages tend to be higher than for other long bones. Only 3 horse fibulae have been encountered. Being of very small size this element is easily missed during excavation or is deleted by taphonomic processes. Two complete tibiae have been documented, lacking butchering traces, and account for an MNI of 1. Three juvenile tibiae have been documented. All three concern complete shafts on two of which an unfused state could be observed. One left and one right tibia put the MNI-unfused at 1. Based on the proportions, another left side tibia shaft, also derived from a juvenile individual, so the young MNI for horse tibiae actually should be put at 2. As with the other documented juvenile horse long bones, all three juvenile tibiae have been severely gnawed by carnivores. All three specimens display shaft damage and epiphyseal destruction by ravaging carnivores. No hominid-induced traces have been observed on these specimens. Only two fragments of proximal tibia epiphyses have been encountered and thus this part is almost entirely lacking.

If the number of gnawed tibia fragments is taken, 22 out of 185 (11.9% gnawed), the tibia is among the lesser carnivore gnawed elements in the assemblage. Butchering cut marks are abundant though, with 77 cut-marked specimens out of a total of 185 (41.6% cut-marked).

Of a right tibia two middle shaft fragments broken on a spiral GBF could be refitted and have been found within one and the same square metre. One anatomical refit between a right distal tibia showing impact scars and a right astragalus has been made. This refit indicates that although cut marks indicative of dismembering the distal tibia from the astragalus/calcaneus unit have been observed, in

Tibia	
NISP	185
MNE	28
MNI	15
NISP-gnawed	22
MNE-gnawed	5
MNI-gnawed	4
NISP-cutmarked	77
MNE-cutmarked	13
MNI-cutmarked	6
NISP-impacted	99
MNE-impacted	19
MNI-impacted	10

Tibia part	NISP	%
Complete tibia	2	1.1
Shaft only	3	1.6
Proximal part missing	1	0.5
Shaft cylinder	2	1.1
Proximal epiphysis (part)	2	1.1
Proximal diaphysis	48	26.0
Middle diaphysis	88	47.5
Distal diaphysis	14	7.5
Distal epiphysis (part)	21	11.3
Tibia fragments	4	2.1
	185	99.8

Table 2.5.31: Horse tibia overall frequencies and detailed counts.

some cases the tibia apparently was processed for marrow while the astragalus was still attached to the tibia. Two large left tibia shaft parts display a cluster of scraping-like marks and angular pits on their flat sides (see Figure 2.3.12 for an example). Possible explanations for this kind of damage have been postulated in Section 2.3.

Figure 2.5.15: Cut marks just below a horse femur's head caused during dismembering of the femur-pelvis joint (Fem—1). See also Figure 2.3.6 for illustrated horse femur butchery traces (findnumber 690/22-13). Photo by the author.



Table 2.5.32: Coded butchering traces observed on horse tibiae.

Figure 2.5.16a (below on the left): Schematic presentation of separately coded diagnostic tibia fragment areas and their frequencies.

Figure 2.5.16b (below on the right): Schematic presentation of main marrow processing impact on tibia shafts. Bold arrows indicate the most frequently encountered impact areas while small arrows point to less frequent impact locations (see table 2.5.32 for the descriptions).

Tibia Butchering traces					
Code	Placement and characteristics	Inferred activity	Code	Placement and characteristics	Inferred activity
Tib-1	Transversal short cuts on the cranial border of the crista tibia or margo cranialis.	Filleting (cf. approx. Binford 1981: Tp-3).	Tib-7	Transversal short cuts across the lateral malleolus and the groove for the lateral digital extensor tendon.	Dismembering idem. (cf. Binford 1981: Td-1 & Td-3).
Tib-2	Oblique and transversal short cuts across the caudal tubercle on the proximal diaphysis.	Filleting	Tib-8	Local clusters of scraping marks and long curvilinear cuts on the diaphysis.	Defleshing/ Removal of tissue prior to marrow processing.
Tib-3	Oblique long cuts along the medial side of the diaphysis.	Filleting	Tib-9	Impacting of the proximal diaphysis area near to and cranial of the cranial border (T3).	Marrow processing
Tib-4	Oblique and transversal cuts along the lateral side of the diaphysis.	Filleting	Tib-10	Impacting of the proximal diaphysis area near to and caudal of the cranial border (T7).	Marrow processing
Tib-5	Oblique and transversal short cuts across the muscle lines on the caudal side of the diaphysis.	Filleting	Tib-11	Impacting of the distal diaphysis on the flat area above the distal epiphysis on the cranial face (T4).	Marrow processing
Tib-6	Transversal short cuts across the cranial malleolus medialis.	Dismembering of the tibio-tarsals joint (cf. Binford 1981: Td-1 & Td-3).			

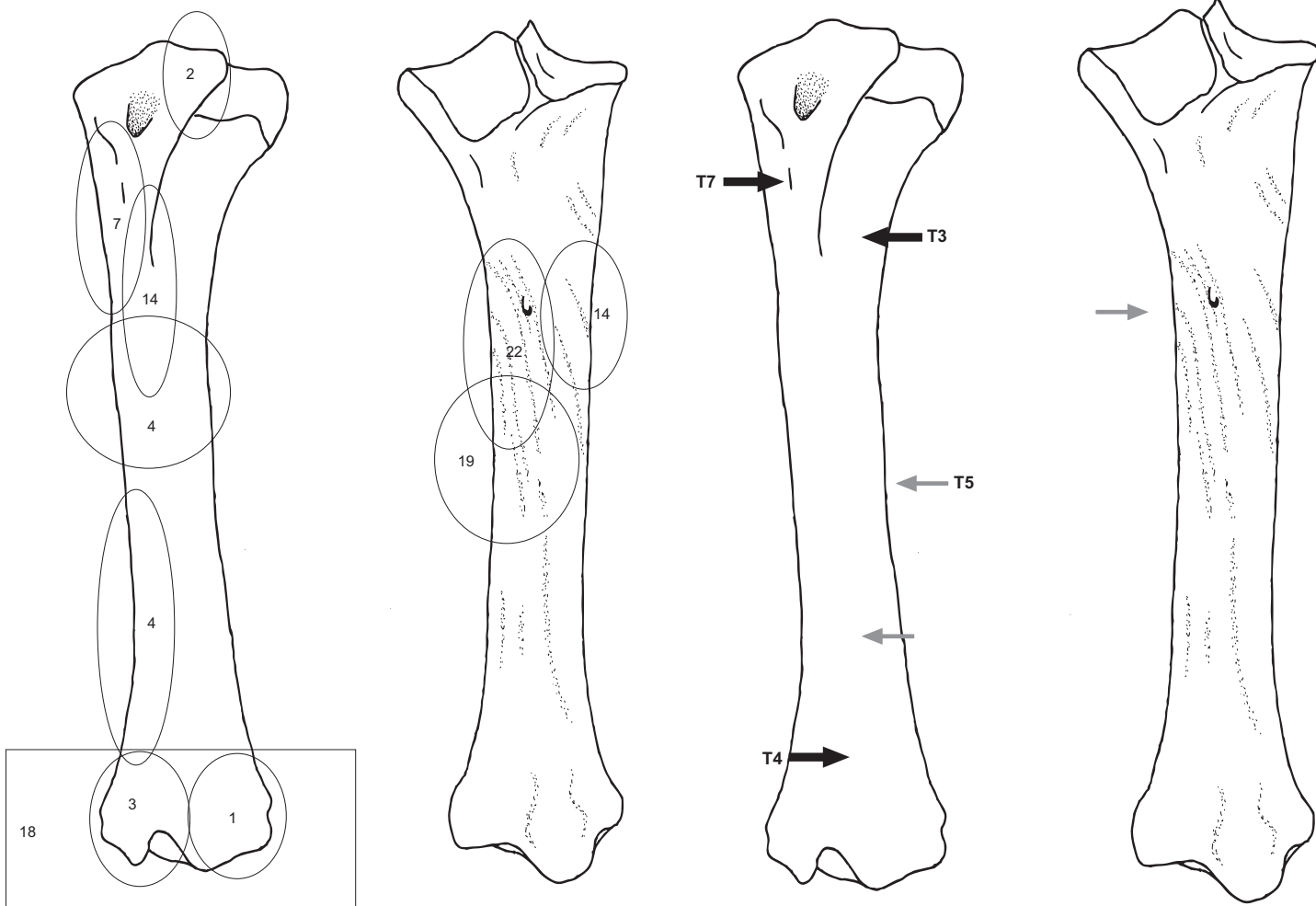




Figure 2.5.17: Typical survival of distal horse tibia epiphyses. Note the impact notches on the upper and lower specimens, caused during tibia bone-marrow processing. Photo by the author.

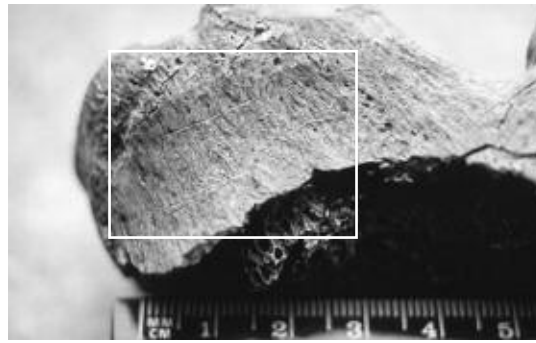
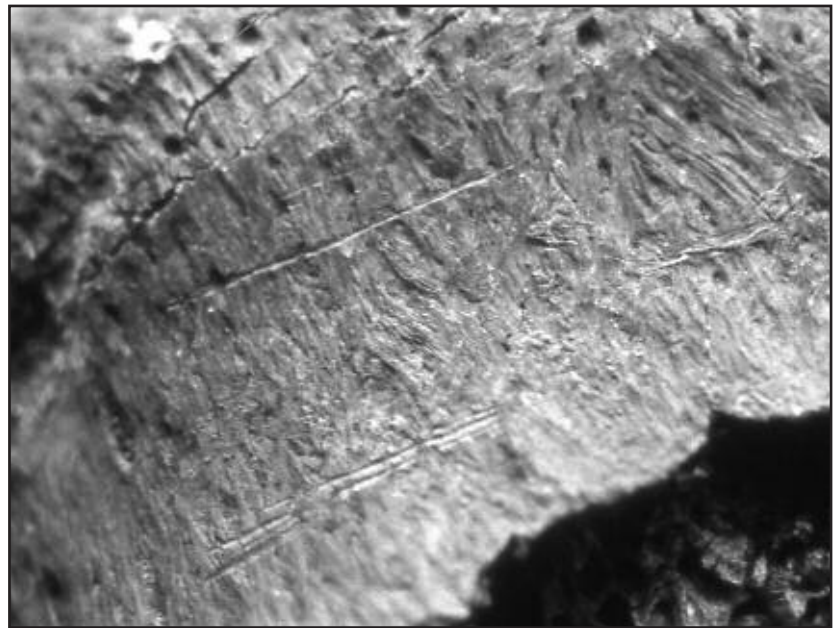


Figure 2.5.18: Dismembering cut marks on a distal horse tibia epiphyses. Photos by the author.



2.5.2.18 Astragalus

When compared to the encountered horse tibiae with which the astragalus articulates, horse astragali are low in number. In total 12 astragali accounting for an MNI of 8 have been recorded, which is 42.8% and 53.3% of the observed tibiae respectively. The MNI of 11 for the distal tibia however is approached by the MNI of 8 for astragali. Eight of the astragali are derived from the left and only four from the right side of the horse body. Carnivore gnawing, in the form of some scoring on the condyle's surface, has been observed on 5 specimens, giving an MNI-gnawed of 3.

All documented astragali survived complete though. Remarkable is the complete absence of butchering cut marks on astragali, although among the distal tibiae dismemberment cuts have been observed (see above). Apart from an astragalus-distal tibia refit, three astragalus-calcaneus units could be refitted, two left units and one right unit. One of these astragali, a right specimen, was fitted onto an

unfused juvenile calcaneus and were found at a distance of approximately one metre from each other. The anatomical refits indicate that astragalus-calcaneus units were deposited while still in an articulated state, which is in agreement with the absence of dismemberment cut marks on these elements.

Astragalus	
NISP	12
MNE	12
MNI	8
NISP-gnawed	5
MNE-gnawed	5
MNI-gnawed	3
NISP-cutmarked	0
MNE-cutmarked	0
MNI-cutmarked	0
NISP-impacted	0
MNE-impacted	0
MNI-impacted	0

Table 2.5.33: Horse astragalus frequencies.



2.5.2.19 Calcaneus

The total MNI of 11 for horse calcani is in agreement with the identical MNI for the distal tibia but slightly higher than the astragali MNI of 8 (see above). Among the calcani, four unfused specimens have been encountered of which two right side specimens, MNI=2, yield an unfused *tuber calcanei* indicating an age younger than 19-36 months (Getty, 1975). One of these specimens could be refitted with an astragalus (see above). Six calcani have been gnawed by carnivores accounting for a MNI-gnawed of 5. Contrary to the astragali, among the calcani there is one cut-marked specimen. The marks have been created during filleting. Cuts created during possible dismemberment of tarsal units are absent (Table 2.5.35).

Table 2.5.34: Horse calcaneus frequencies.

Calcaneus	
NISP	16
MNE	16
MNI	11
NISP-gnawed	6
MNE-gnawed	6
MNI-gnawed	5
NISP-cutmarked	1
MNE-cutmarked	1
MNI-cutmarked	1
NISP-impacted	0
MNE-impacted	0
MNI-impacted	0

Calcaneus Butchering traces

Code	Placement and characteristics	Inferred activity
Cal-1	Oblique cuts on the medial face between the tuber calcanis and the articular surface.	Filleting (cf. Binford 1981: TC-3, hanging carcass).

Table 2.5.35: Coded butchering traces observed on a horse calcaneus.

2.5.2.20 Tarsals

Contrary to horse carpals, examined horse tarsals yielded quite some cut-marked specimens. The tarsals are represented with a %SURV of 17.7%, which is low. Of a tarsal MNE of 27, an MNI of only 6 has been established on the fourth tarsal, *os tarsi quartum* (Table 2.5.36). Of interest is the complete lack of carnivore gnawing traces on tarsals. In total 7 cut-marked tarsals have been counted, representing an MNI-cutmarked of 4. Apart from one cut-marked fourth tarsal, only the third tarsals, *os tarsi tertium*, have been cut-marked (Figure 2.5.19). This pattern echoes consequent systematic butchering of the tarsal unit at one specific location facilitating the dismemberment of the metatarsus on which the third tarsal directly articulates. The cuts observed on the fourth tarsal are likely created during the same butchering activity.

Tarsals	
NISP	27
MNE	27
MNI	6
NISP-gnawed	0
MNE-gnawed	0
MNI-gnawed	0
NISP-cutmarked	7
MNE-cutmarked	7
MNI-cutmarked	4
NISP-impacted	0
MNE-impacted	0
MNI-impacted	0

Tarsal	MNE	MNE-cut	MNE-sin	MNE-dex	MNI
Os tarsale prim./secund.	5	0	2	3	3
Os tarsi centrale	5	0	2	3	3
Os tarsi tertium	9	6	4	5	5
Os tarsi quartum	8	1	2	6	6
	27	7	10	17	

Table 2.5.36: Horse tarsal frequencies and detailed element counts.



Tarsals Butchering traces

Os tarsi tertium

Code	Placement and characteristics	Inferred activity
Ott-1	Oblique short cuts on the dorsal tarsal ridge.	Dismembering of the tarsal-metatarsus joint (cf. Binford 1981: TNC-1 & TE-1).
Ott-2	Transversal short cuts above and below the dorsal tarsal ridge.	Dismembering idem. (cf. Binford 1981: TNC-1 & TE-1).

Os tarsi quartum

Code	Placement and characteristics	Inferred activity
Otq-1	Short transversal cuts on the distal edge of the lateral face.	Dismembering of the tarsal-metatarsus joint.

Table 2.5.37: Coded butchering traces observed on horse tarsals.

2.5.2.21 Metatarsals

Horse metatarsus specimens are better represented than the metacarpals, with an MNE of 19, an MNI of 10 and %SURV of 50%. Among these, 6 complete metatarsals have been documented, three from the left and three from the right side. Accessory metatarsals are less represented with MNIs of 5 to 6 (Table 2.5.38). As with metacarpals, also metatarsal specimens did yield very few carnivore gnawing traces. Only one metatarsus bears clear proof of carnivore gnawing. Butchering marks are however well represented among the metatarsus remains. The main percentage of cut-marked specimens on the NISP comprises 61.5%. Observed conspicuously induced traces are percussion damage traces, identical to those encountered on metacarpals, and possibly the result of using the elements as hammering tools or butchery activities creating percussion damage.

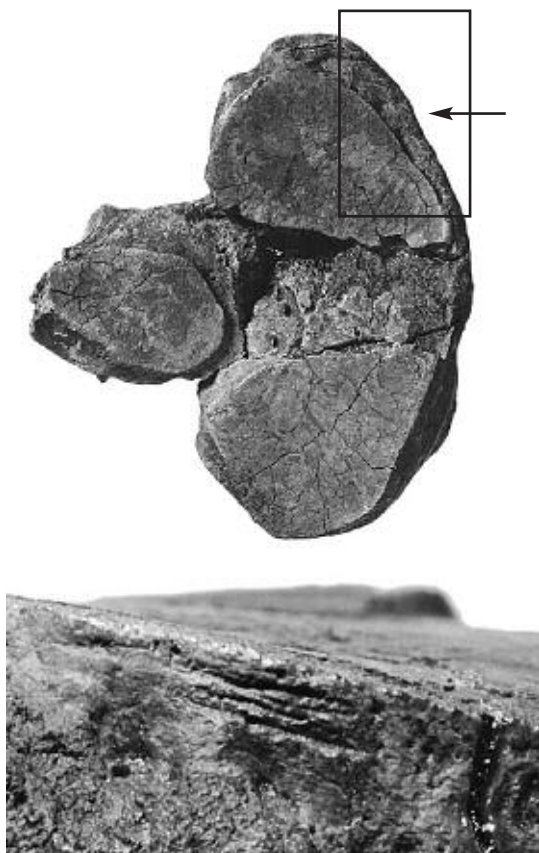


Figure 2.5.19: Dismembering cut marks on the dorsal ridge of a horse third tarsal, *os tarsi tertium* (findnumber 706/22-4). Photos by J. Paupit, Leiden.

Metatarsus		
NISP	52	
MNE	19	
MNI	10	
NISP-gnawed	3	
MNE-gnawed	1	
MNI-gnawed	1	
NISP-cutmarked	32	
MNE-cutmarked	7	
MNI-cutmarked	5	
NISP-impacted	14	
MNE-impacted	4	
MNI-impacted	3	
Metatarsus part	MNE	MNI
Acc. Metatarsus II	7	5
Acc. Metatarsus IV	9	6
Complete metatarsus III	6	3
	NISP	%
Proximal epiphysis (part)	11	23.9
Diaphysis	33	71.7
Distal epiphysis (part)	2	4.3
	46	99.9

Table 2.5.38: Horse metatarsus frequencies and detailed element counts.

Onto one complete, and large, left metatarsus, lacking any traces, the accessory second and fourth metatarsus could be refitted. Of a second complete, and also large, left metatarsus only the fourth accessory metatarsal could be refitted. Onto a proximal fragment of a right metatarsus, the fourth,



and cut-marked, accessory metatarsal could be fitted. A refit on two spiral GBF broken distal shaft fragments of a right metatarsus was also accomplished. Both specimens exhibit scraping-like marks overlapping the refitted fracture, being proof of scraping on the bone's surface prior to the spiral fracture and thus excluding a post-depositional origin of the marks. A proximal shaft fragment could be fitted onto part of a proximal right metatarsus. On the proximal part an impact scar created during breakage of this metatarsus is still present and a large part of the impact flake scar is present on the adhering shaft fragment (Figure 2.4.1).

Table 2.5.39: Coded butchering traces observed on horse metatarsals.

Metatarsus Butchering traces		
Code	Placement and characteristics	Inferred activity
Mtt-1	Transversal short cuts across the rough cranial ridge of the proximal diaphysis for the insertion of the tibialis cranialis.	Dismembering of the metatarsus-tarsal joint.
Mtt-2	Oblique and transversal short cuts along the cranial diaphysis.	Filleting/Defleshing
Mtt-3	Oblique short cuts on the caudal diaphysis above the distal condyle.	Filleting/Defleshing (possibly Dismembering of the tarsus-phalanges).
Mtt-4	Local patches of scraping marks and long curvilinear cuts on the diaphysis.	Defleshing/Removal of tissue prior to marrow processing.
Mtt-5	Impacting of the cranial diaphysis area below the proximal epiphysis (Mt1).	Marrow processing
Mtt-6	Impacting of the caudal diaphysis below the proximal epiphysis between the accessory tarsals (Mt2).	Marrow processing
Mtt-7	Impacting of the cranial diaphysis just above the distal condyle (Mt3).	Marrow processing

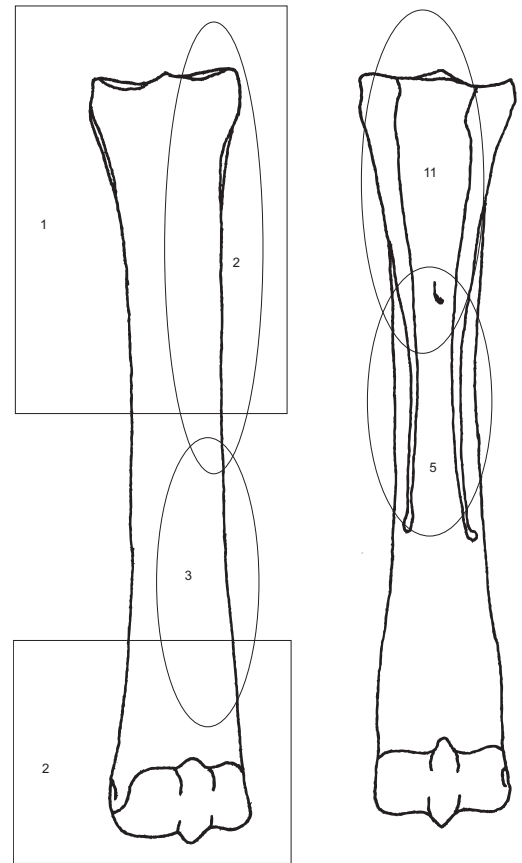


Figure 2.5.20a (above): Schematic presentation of separately coded diagnostic metatarsus fragment areas and their frequencies.

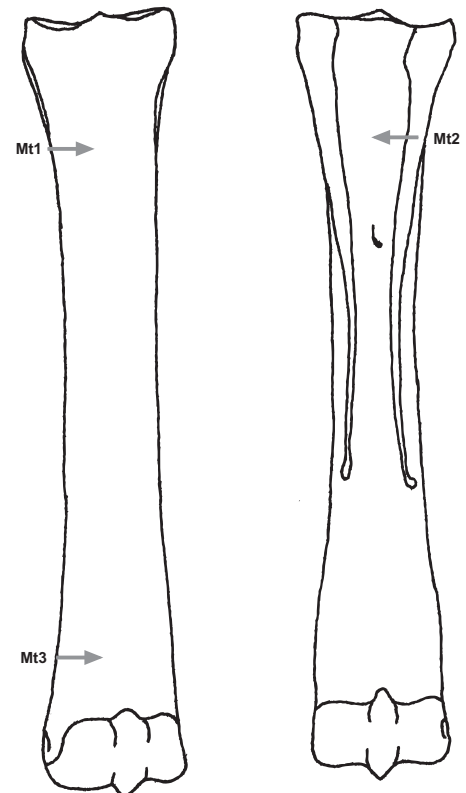


Figure 2.5.20b (below): Schematic presentation of main marrow-processing impact on metatarsus shafts (see Table 2.5.39 for the descriptions).



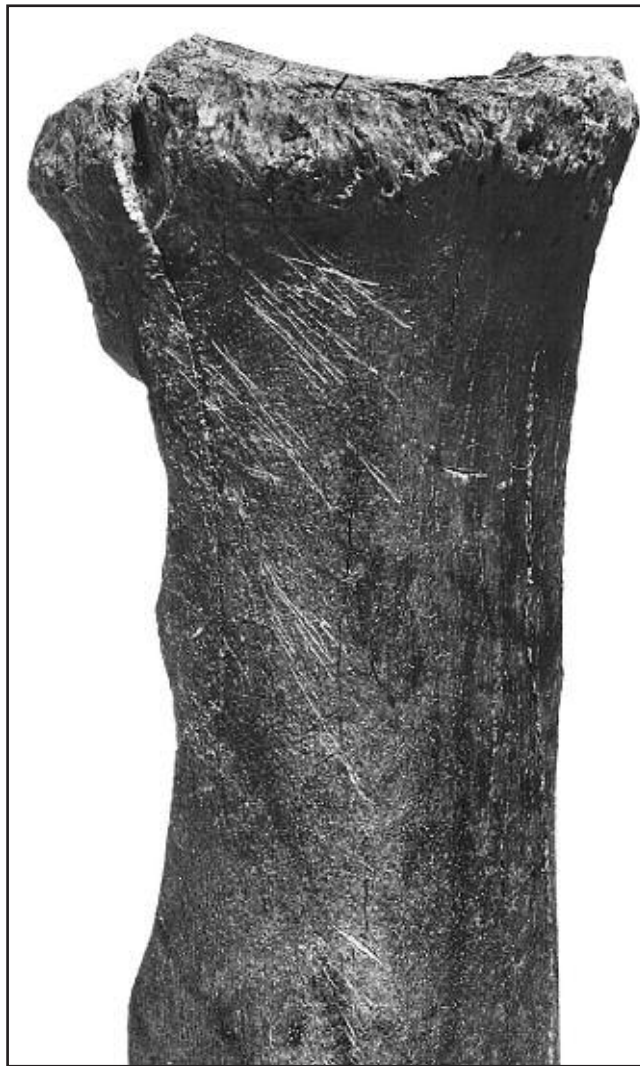


Figure 2.5.21: A horse metatarsus shaft with missing distal part. This specimen exhibits cut marks along the complete shaft from defleshing and paired impact notches on the cranial face just below the proximal epiphysis (Mt1 impacts in Figure 2.5.20b)(findnumber 702/7-10). Photos by J. Pauptit, Leiden.

2.5.2.22 Phalanges & Sesamoids

Horse phalanges as well as sesamoids are under-represented in the studied assemblage sample. The front or rear position and sides of the phalanges have not been determined. %SURV of 8.3% for sesamoids, 18.4% for the first phalange, 15.7% for the second, and 17.1% for the third phalange are proof of their relatively meagre presence. Carnivore gnawing traces are present on up to 6 specimens for the third phalange (Table 2.5.40). Butchering traces like cut marks or impact scars are entirely absent. This together with the low number of horse phalanges in the assemblage requires explanation (see the following sections).

One distal sesamoid bone was found near a third phalange and could be refitted with it. Also, a first and a second phalange found within one and the same square metre could be fitted with each other. These refits indicate that at least part of the deposited leg extremities remained articulated while deposited.

Phalanges & Sesamoids

	Phalange I	Phalange 2	Phalange 3	Sesamoids
NISP	14	12	13	19
MNE	14	12	13	19
NISP-gnawed	5	3	6	0
MNE-gnawed	5	3	6	0
NISP-cutmarked	0	0	0	0
MNE-cutmarked	0	0	0	0
NISP-impacted	0	0	0	0
MNE-impacted	0	0	0	0

Table 2.5.40: Horse phalanges overall frequencies and detailed counts.



Figure 2.5.22: Illustration of the good preservation of horse phalanges and sesamoids found in proximity during the excavations. Photo by the author.



2.5.3 Horse skeletal element representation

The representation frequencies for determined horse skeletal elements from the Schöningen 13II-4 sample can be summarised and analysed for possible discrepancies in the representation of certain body parts. Of interest is the remarkable proximity of the MNE-sinister and MNE-dexter counts for individual horse elements, with even the total counts for elements from the left and right side of the horse body being equal (Table 2.5.41). The highest derived Minimum Number of Individuals (MNI) is on the femur, MNI=19, based on a maximal number of distal shaft fragments containing the complete or part of the *supra condyloid fossa* from the right side femur together with one complete right femur. The highest MNI has been used to calculate the %SURV. To look for representational discrepancies a below <30% and above >50% boundary have been taken as signalling significant differences. The %SURV values for specific horse skeletal elements indicate an under-representation for certain elements (Table 2.5.41 and Figure 2.5.24). Horse elements well above the 50%SURV boundary are the mandible, atlas, sacrum and humerus. The hind leg femur and tibia even score above 70%, while the radius and metatarsus approach 50%. Although the most fragmented within the horse assemblage, the marrow-containing elements thus approach or score above the 50%SURV. Represented with percentages below 30%SURV are the caudal vertebrae, sternum, carpals, accessory metacarpals, patella, fibula, tarsals, accessory metatarsals, sesamoids, and the phalanges, while the metacarpus approaches 30%. The other horse elements can be found with percentages of between 30% and 50% (Figure 2.5.24). The below 30% elements all constitute relatively small skeletal elements. As outlined earlier, winnowing out of elements by flowing water is not very likely and for example the

phalanges are as susceptible to water as the scapula but less susceptible than the atlas. The cause for observed differences therefore has to be sought in the realm of other processes or actors having been of influence on the assemblage and influencing skeletal element abundance.

Discrepancies in skeletal element abundance can be related to processes deleting vulnerable elements, of lesser bone density. Analytical procedures have been developed to check bone assemblages for bone density mediated destruction. Bone density scan site values can be compared to representation indexes for corresponding bone parts to check for possible relationships between bone density and representation within assemblages (Lyman, 1984, 1994). Fortunately for this study, since 1999 bone density values for horse skeletal elements have become available (Lam et al., 1999). Lam et al., 1999, present two series of bone scan site values. A first, labelled Bone Mineral Density 1 (BMD1), represent values for the entire cross-section of scan sites. The second, labelled BMD2, represent scan site values excluding internal cavities in the calculation of the density. The BMD2 scan site values are of interest when measuring long-bone portions because it ignores differences between the long-bone cavities (more or less cancellous bone being present) of different mammalian species (Lam et al., 1999). Table 2.5.42 lists the horse element scan sites and their corresponding bone mineral density values derived by Lam et al. 1999. Locations on horse skeletal elements of the scan sites are presented in the Appendices. To check for possible bone density mediated destruction among the Schöningen 13II-4 horse remains, BMD1 scan site values have been used to make comparisons between all major horse elements including the long bones. To derive one BMD1 value for each Element, the different scan site



Skeletal element	NISP	MNE	MNE-sin	MNE-dex	MNI	%SURV
Cranium	15	1	0	0	1	-
Dental	143	143	0	0	1	-
Mandible	97	24	12	12	12	63.1
Hyoid bone	28	10	0	0	1	52.6
Atlas	12	12	0	0	12	63.1
Axis	13	7	0	0	7	36.8
Cervical vertbr.	87	43	0	0	8	45.2
Thoracal vertbr.	225	170	0	0	8	49.7
Lumbar vertbr.	65	59	0	0	11	51.7
Sacrum	14	12	0	0	12	63.1
Caudal vertbr.	1	1	0	0	1	0.4
Sternum	1	1	0	0	1	5.2
Pelvis	24	13	6	7	7	34.2
Ribs	726	311	144	136	13	45.4
Scapula	31	20	10	10	10	52.6
Humerus	130	22	12	10	12	57.9
Radius	147	18	9	9	9	47.3
Ulna	33	15	6	9	9	39.4
Carpals	34	34	12	21	5	12.8
Metacarpal II	9	9	5	4	5	11.8
Metacarpal IV	7	7	4	3	4	9.2
Metacarpus	29	11	6	5	6	28.9
Femur	175	37	17	19	19	97.3
Patella	7	7	4	2	4	18.4
Tibia	185	28	15	13	15	73.6
Fibula	3	3	0	0	1	7.9
Astragalus	12	12	8	4	8	31.5
Calcaneus	16	16	5	11	11	42.1
Tarsals	27	27	10	17	6	17.7
Metatarsal II	7	7	5	2	5	9.2
Metatarsal IV	9	9	6	3	6	11.8
Metatarsus	52	19	10	9	10	50.0
Sesamoids	19	19	0	0	1	8.3
Phalange I	14	14	0	0	1	18.4
Phalange II	12	12	0	0	1	15.7
Phalange III	13	13	0	0	1	17.1
Total	2422	1166	306	306		

Table 2.5.41: Main representation indexes of the determined horse skeletal elements.

values of each element have been summed and divided by the total number of scan sites to derive a mean BMD1 scan sites value ('Mean BMD1 scansite value', Table 2.5.42). Regression analysis on the %SURV for horse elements against the 'Mean BMD1 scansites values' is shown in Figure 2.5.25. Figure 2.5.25 does not demonstrate any significant correlation between the %SURV for horse elements and their mean bone density values. The coefficient of determination (R^2) of 0.0199 indicates absence of a significant relationship between the two variables. In fact, some skeletal elements with low bone densities are better represented than high bone density elements, and vice versa. Density mediated destruction acting on the overall horse element

assemblage thus appears not to have occurred. This is in agreement with the data on bone weathering and abrasion, which indicate limited pre- and post-burial bone modification or destruction. Also carnivore gnawing traces and patterns point to limited destruction of skeletal elements. This will be explored further below.



Figure 2.5.23: Graphic presentation of main horse element frequencies, MNE / MNI.

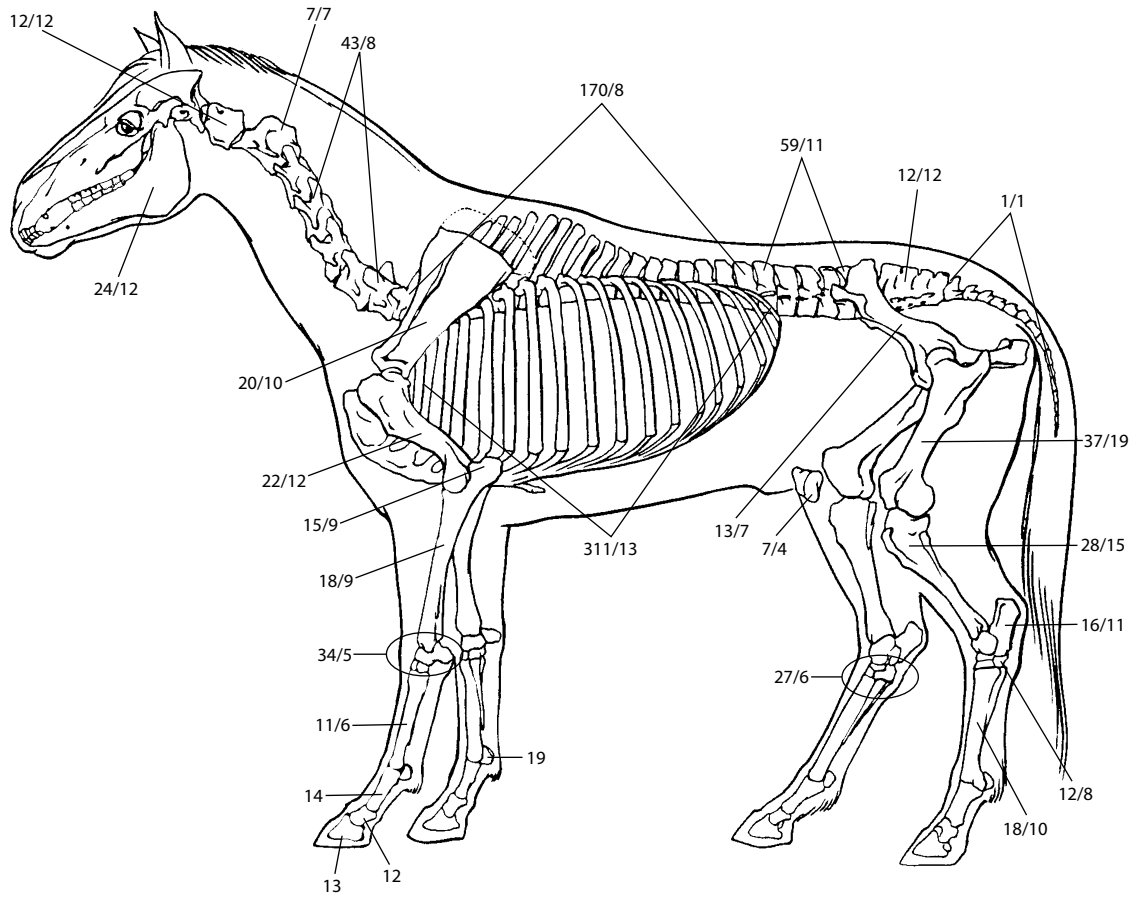
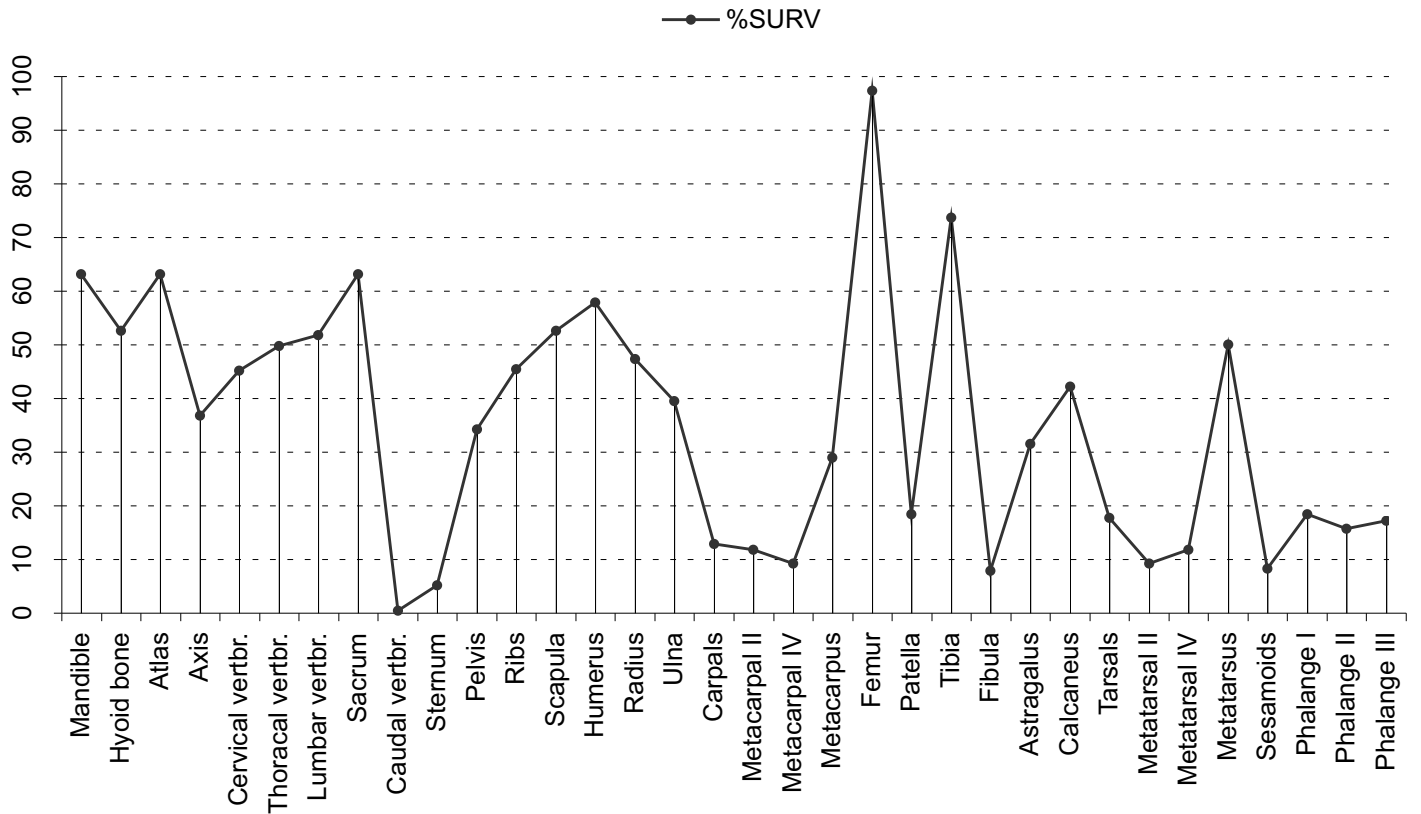


Figure 2.5.24: %SURV for determined horse skeletal elements, data taken from Table 2.5.41.



Skeletal element	Scansite	BMD1 mean value	Mean BMD1 scansites value	BMD2 mean value
Mandibula	DN1	0.66		
	DN2	0.69		0.93
	DN3	0.61		0.98
	DN4	0.60		0.98
	DN5	0.52		0.96
	DN6	0.64		0.94
	DN7	0.83		0.95
	DN8	0.99	0.69	
Atlas	AT1	0.51		
	AT2	0.47		
	AT3	0.54	0.50	
Axis	AX1	0.53		
	AX2	0.37		
	AX3	0.40	0.43	
Cervical vertbr.	CE1	0.50		
	CE2	0.41	0.45	
Thoracal vertbr.	TH1	0.32		
	TH2	0.49	0.40	
Lumbar vertbr.	LU1	0.48		
	LU2	0.42		
	LU3	0.43	0.44	
Sacrum	SC1	0.36		
	SC2	0.37	0.36	
Caudal vertbr.	caudal vert	0.30	0.30	
Pelvis	AC1	0.65		
	IL1	0.29		
	IL2	0.69		0.94
	IS1	0.83		0.98
	IS2	0.30		
	PU1	0.44		
	PU2	0.42	0.51	
	RI1	0.36		
Ribs	RI2	0.39		
	RI3	0.50		0.93
	RI4	0.55		0.94
	RI5	0.51	0.46	
	SP1	0.64		1.03
Scapula	SP2	0.67		1.01
	SP3	0.55		
	SP4	0.66		0.99
	SP5	0.28	0.56	
	Humerus	HU1	0.23	
HU2		0.25		0.33
HU3		0.64		1.10
HU4		0.55		1.05
HU5		0.36	0.40	
Radius	RA1	0.37		
	RA2	0.51		1.04
	RA3	0.84		1.08
	RA4	0.43		1.00
	RA5	0.42	0.51	
Ulna	UL1	0.43		
	UL2	0.65	0.54	0.70

Table 2.5.42: Bone density scan sites and values for horse skeletal elements, after Lam et al., 1999, Table 1, p. 351-353. For locations of scan sites see the Appendices (after Lam et al., 1999, Figure 1, p. 348-349; Lyman, 1994, Figure 7.4, p. 240-241).



Skeletal element	Scansite	BMD1 mean value	Mean BMD1 scansites value	BMD2 mean value
Metacarpus	MC1	0.55		
	MC2	0.66		1.03
	MC3	0.84		1.10
	MC4	0.67		0.71
	MC5	0.56		
	MC6	0.60	0.64	
Femur	FE1	0.35		
	FE2	0.30		
	FE3	0.36		0.99
	FE4	0.59		1.09
	FE5	0.46		0.51
	FE6	0.30		
	FE7	0.24	0.37	
Patella	PA1	0.40	0.40	
Tibia	TI1	0.30		
	TI2	0.44		0.77
	TI3	0.82		1.07
	TI4	0.55		1.05
	TI5	0.45	0.51	
Astragalus	AS1	0.67		
	AS2	0.64	0.65	
Calcaneus	CA1	0.45		
	CA2	0.69		
	CA3	0.55		
	CA4	0.72	0.60	
Metatarsus	MR1	0.59		
	MR2	0.75		1.07
	MR3	0.91		1.10
	MR4	0.71		
	MR5	0.58		
	MR6	0.60	0.69	
Phalange I	P1-1	0.57		
	P1-2	0.67		1.02
	P1-3	0.67	0.63	
Phalange II	P2-1	0.62		
	P2-2	0.59	0.60	
Phalange III	P3-1	0.57	0.57	



Correlation of Mean BMD1 Bone Density values for Equus elements against %SURV.

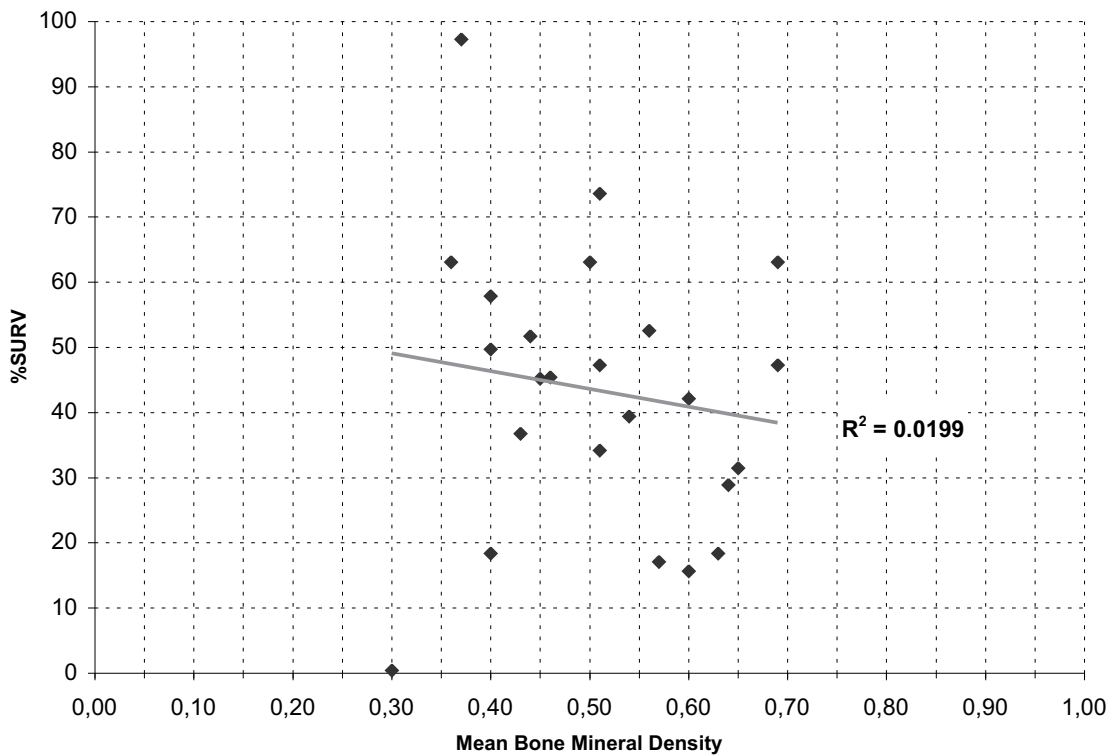


Figure 2.5.25: Scatterplot and regression analysis of horse skeletal elements against 'Mean BMD1 scansites value' on bone density (data from Table 2.5.42).

2.5.4 Horse individuals and age indicators

Although ageing of horse dental elements has not been executed, some indications of represented ages and horse individuals could be derived from unfused, not-fully-grown, skeletal element parts with visible fusing time, and from one largely complete horse foal mandible including the dental elements. Due to the excellent preservation of the bone material young, unfused, material has been preserved. Among all horse skeletal elements some diagnostic young bone specimens are represented. Ageing of this material could be established by the use of documented epiphyseal closure estimates, which are believed to be the most reliable parameters for ageing horse skeletal elements (Getty, 1975). Encountered unfused horse skeletal elements and the inferred age ranges are presented in Table 2.5.43.

Skeletal element	Unfused part	Maximal age range at death	MNE	MNI
Mandible	deciduous pre-molars and molars still present	4 – 6 months	1	1
Scapula	processus coracoideus and supraglenoid tubercle	10 – 12 months	2	1 to 3
Humerus	distal epiphysis	11 – 18 months	1	1
Radius	distal epiphysis	24 – 42 months	1	1
Metacarpus	distal epiphysis	6 – 18 months	3	2
Femur	proximal epiphysis (caput femoris & trochanter major)	36 – 42 months	5	3
Femur	proximal epiphysis (proximal diaphysis)	36 – 42 months	6	4
Femur	distal epiphysis (distal diaphysis)	21 – 42 months	2	2
Femur	proximal and distal epiphyses (complete shaft)	21 – 42 months	2	2
Tibia	proximal epiphysis (proximal diaphysis)	36 – 42 months	2	1
Tibia	distal epiphysis (distal diaphysis)	17 – 24 months	1	1
Calcaneus	tuber calcanei	19 – 36 months	3	3

Table 2.5.43: Epiphyseal unfused horse skeletal elements and their inferred maximal age ranges at death, after Getty, 1975. If an unfused part is in parenthesis, this means that the actual element part is present on which the observed fusion time has been based.



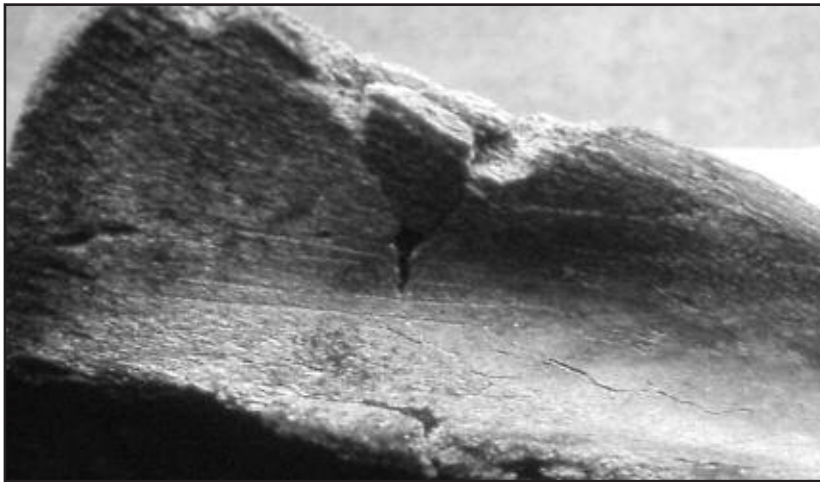
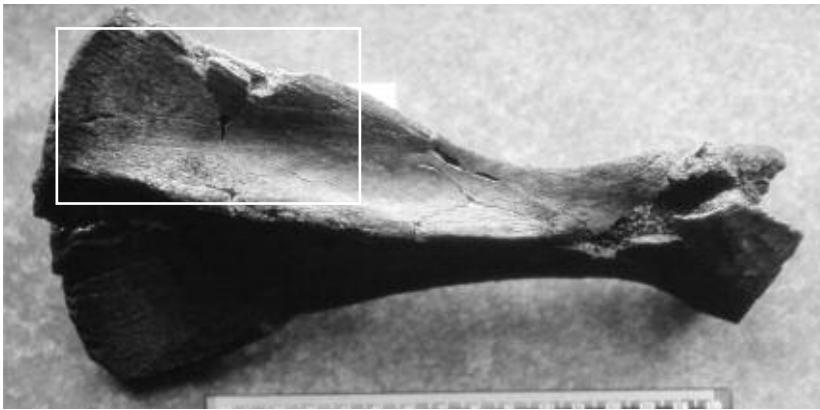


Figure 2.5.26: A horse foal scapula with unfused processus coracoideus and supraglenoid tubercle, photo above the upper right corner of the scapula. The close-up, below, shows encountered long parallel cut marks created during filleting of the scapula by hominids (findnumber 698/15-4). Photos by the author.

Of two encountered juvenile horse scapulae, a left and a right one, the processus coracoideus and supraglenoid tubercle have not yet fused which points to an age younger than one year (Getty, 1975). These specimens can be related to the found horse foal mandible including the deciduous pre-molars and molars indicating an age of 4 to 6 months at a maximum. One of the unfused scapulae specimens yielded cut marks from filleting (Figure 2.5.26). Although the amount of fusing could not clearly be observed on 5 more represented young horse scapulae, the dimensions and morphology of these specimens point to a comparable age. All together these scapulae most probably represent in total 3 foals of which at least one was with certainty younger than one year old, the others being about the same age, possibly slightly older. Other young horse material possibly to be associated with the young scapulae are the unfused metacarpals of 2 individuals pointing to a maximum age of between 6 to 18 months and an unfused distal humerus pointing to a maximum of 18 months of age (Table 2.5.43). Other documented unfused horse bone parts are less precise to be used for ageing, because of a wide age range of possible fusing time. A possible sub-adult horse individual is indicated by the presence of an unfused distal tibia with a maximum age at death of between 17 to 24 months. Three encountered unfused horse

calcani are indicative of three individuals of maximally between 19 and 36 months old (Table 2.5.43). Unfused femur parts are represented by 15 specimens but these are not a reliable indicator of additional presence of young horse individuals because femur parts of adults are included as well, the femur fuses at a maximum age of 3.5 years (Getty, 1975). On the basis of observed horse epiphyseal femur parts it suffices to conclude that at least 4 individuals could be younger than 3.5 years at death. Based on observed sizes of unfused femur shaft parts, horse individuals both from the younger and older end of the femur fusion time age range are represented. Observed completely fused, fully-grown, horse femora among the remains testify to the presence of fully adult horses. Although horse bone marrow-containing skeletal elements mostly have been fragmented, in total 19 complete long bones (see the descriptions on individual horse elements) and 2 complete mandibulae are present in the sample. All these encountered complete long-bone elements are fused and full grown, indicating full adult individuals. One of the complete mandibles is very large and holds large canines, indicative of the presence of an adult male stallion. Based on the identification of an isolated large canine, a second stallion could be determined. Other encountered horse mandible parts include horse adults lacking canines, probably representing mares.

Although insufficient ageing data were been collected to create a mortality profile for the represented horse individuals, some inferences about the composition of the found horse population can be made. It is clear that a considerable age range is represented. At least two to three horse foals have been identified. The presence of sub-adult horse individuals is indicated, and adult horses are with certainty represented, among which at least one adult stallion and some mares. Natural horse population units are the 'family group' and 'bachelor group'. The family group reproductive unit is normally composed of a stallion, his mares and their young up to 2 to 4 years old, while a bachelor group is composed entirely of males from the age of 2 years up to their own group departure at the age of 5 to 6 years (Levine, 1983, 1999). The presence of foals in the Schöningen 13II-4 faunal assemblage sample points to the possible presence of a family group. The presence of horse bone remains pointing to a horse family group could be an indication of a catastrophic event having been responsible for the accumulation of at least part of the remains. This topic will be explored further by making use of encountered data on horse bone modifications (see below). At present however it cannot be excluded that more events were



responsible for the accumulation of horse bone remains included in the assemblage. A future more thorough analysis on ageing of the horse remains spanning the complete excavated horse assemblage should therefore be conducted.

2.5.5 Traces of carnivore activity and carnivore influence on the horse remains

Of the total of 2809 horse, *Equus* sp. bone specimens, 16.2% (NISP = 456) bear traces of carnivore gnawing. Of these, 2422 to specific skeletal element determined horse bone specimens, 17.7% (NISP = 430) bear carnivore gnawing traces (frequencies for gnawed specimens and elements expressed as -gnaw, Table 2.5.44). The number of gnawed bone specimens for specific skeletal elements differ. Percentages for gnawed bone specimens of some skeletal elements are well above 25%, like the thoracic vertebrae, pelvis, costae, scapula, ulna, phalanges and tarsal unit, while for other elements percentages are below 20% or 10% (Table 2.5.44 and Figure 2.5.27). The highest MNI-gnawed calculated from gnawed horse elements is an MNI-gnawed of 7 for the ribs, followed by the pelvis with 6 and the humerus and calcaneus with an MNI-gnawed of 5. Other elements yield MNIs-gnawed of 4 or less.

Gnawing damage types and patterns encountered among the Schöningen horse remains strongly echoes documented gnawing damage inflicted by wolves, as for example documented in Binford's 1981 account and by Haynes, 1983. Lyman (1994) provides a model of gnawing damage intensity on carcasses of ungulates exploited by North American wolves, based on research by Haynes (Lyman, p. 148; Table 5.6). Observed gnawing damage among the Schöningen horse remains on the borders of the scapula and the edges of ilia and ischia of the pelvis are in agreement with that documented for light to moderate wolf utilisation of ungulate carcasses. Gnawing traces encountered on the extremities of horse ribs and vertebrae also point to light to moderate utilisation, leading to fragmentation of a number of these elements but not complete destruction or deletion. Hyenas are exceptionally specialised in bone-shaft breakage to reach bone marrow compared to carnivores like lions and wolves, especially where carcasses of larger ungulates are concerned (Blumenschine, 1986; Domínguez-Rodrigo, 2002). The virtual absence of signs of carnivore long-bone shaft destruction among the horse remains can thus be explained. Frequencies on gnawing type and gnawing patterns point to light to moderate utilisation of carcasses by carnivores (see also Section 2.3.5). Table 2.5.45 lists the encountered frequencies of specific

types of carnivore-inflicted traces and gnawing patterns on horse skeletal elements. Most encountered gnawing damage is located on the distal and proximal extremities of skeletal elements. Carnivore gnawing damage like scores, punctures or notching on fracture edges of long-bone shaft parts or fragments has been recorded in 53 cases. Of these, 33 gnawed long-bone shaft fragments have been interpreted as reflective of intentional carnivore-induced long-bone shaft damage, eg. gnawing of shafts (Table 2.5.45). All other encountered long-bone gnawing damage is concentrated near the epiphyseal (proximal and distal shaft parts) or on the epiphyseal itself (Figure 2.5.28). The percentages of gnawed bone specimens from specific horse long-bone parts decline with an increase of the total NISP for the same long-bone parts. This patterns seems the opposite of what would be expected if carnivores were responsible for the breakage of horse long-bone shafts and support the inference based on gnawing patterns that long-bone shaft destruction by carnivores was very limited. Figure 2.5.28 also shows an increase of carnivore-gnawed bone specimen percentages towards the proximal and distal long-bone ends. Percentage-wise, more gnawing damage occurs on long-bone epiphyseal fragments than on shafts. Horse long-bone epiphyses and epiphyseal fragments are under-represented when compared to long-bone shaft counts (Prox. & Dist. against Med. in Table 2.5.44). If MNE and MNE-gnawed counts on horse long-bone parts are taken, this pattern is less obvious (Figure 2.5.29).

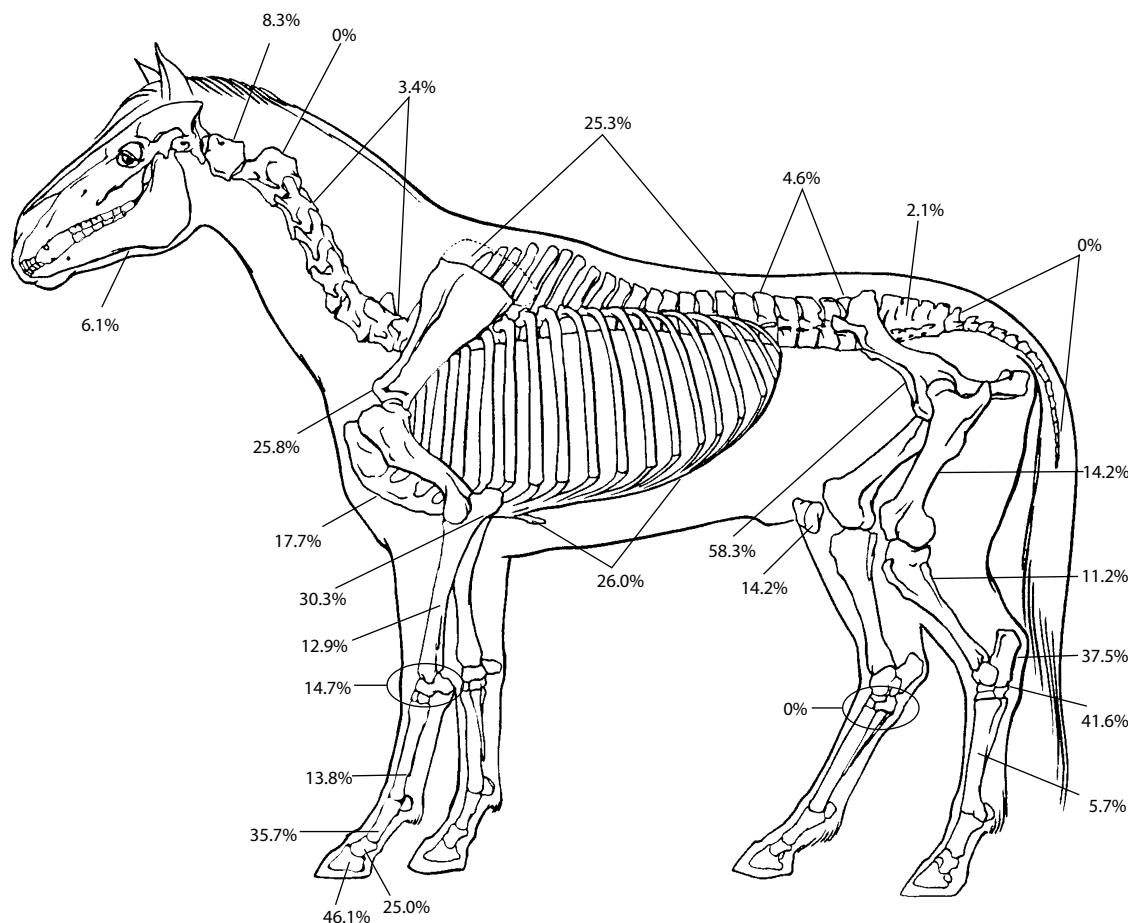
Table 2.5.44 (next page): Frequencies of carnivore gnawing damage (scores, furrows, punctures, etc.) on horse skeletal elements, complete long bones are excluded in the detailed long-bone counts, prox: includes proximal epiphysis and epiphyseal fragments of long bones, dist: includes distal epiphysis and epiphyseal fragments of long bones, med: includes all proximal, medial and distal shaft fragments of long bones.



Skeletal element	NISP	NISP-gnaw	%gnaw	MNE	MNE-gnaw	MNI	%SURV	MNI-gnaw
Cranium	15	0	0	1	0	1		0
Dental	143	1	0.7	143	1	0		1
Mandible	97	6	6.1	24	4	12	63.1	3
Hyoid bone	28	6	21.4	10	1	0	52.6	1
Atlas	12	1	8.3	12	1	12	63.1	1
Axis	13	0	0	7	0	7	36.8	0
Cervical vertbr.	87	3	3.4	43	2	8	45.2	1
Thoracal vertbr.	225	57	25.3	170	47	8	49.7	3
Lumbar vertbr.	65	3	4.6	59	3	11	51.7	1
Sacrum	14	3	21.0	12	3	12	63.1	3
Caudal vertbr.	1	0	0	1	0	1	0.4	0
Sternum	1	0	0	1	0	1	5.2	0
Pelvis	24	14	58.3	13	10	7	34.2	6
Ribs	726	189	26.0	311	85	13	45.4	7
Scapula	31	8	25.8	20	7	10	52.6	4
Humerus	130	23	17.7	22	8	12	57.9	5
prox.Humerus	9	4	44.4	3	1	2	7.9	1
med.Humerus	109	11	10.0	20	2	12	52.6	1
dist.Humerus	12	8	66.6	11	8	8	28.9	5
Radius	147	19	12.9	18	6	9	47.3	4
prox.Radius	13	6	46.1	14	6	8	36.8	4
med.Radius	125	8	6.4	16	1	9	42.1	1
dist.Radius	7	5	71.4	6	5	3	15.8	3
Ulna	33	10	30.3	15	6	9	39.4	3
Carpals	34	5	14.7	34	5	5	12.8	3
Metacarpal II	9	2	22.2	9	2	5	11.8	2
Metacarpal IV	7	0	0	7	0	4	9.2	0
Metacarpus	29	4	13.8	11	2	6	28.9	1
prox.Metacarpus	9	0	0	7	0	4	18.4	0
med.Metacarpus	11	1	9.0	2	1	1	5.2	1
dist.Metacarpus	4	0	0	3	0	2	7.9	0
Femur	175	25	14.2	37	7	19	97.3	4
prox.Femur	27	7	25.9	15	6	8	39.4	2
med.Femur	123	14	11.3	34	5	18	89.4	3
dist.Femur	20	3	15.0	8	3	5	21.0	2
Patella	7	1	14.2	7	1	4	18.4	1
Tibia	185	22	11.2	28	5	15	73.6	4
prox.Tibia	2	0	0	2	0	1	5.2	0
med.Tibia	159	17	10.6	26	5	14	68.4	4
dist.Tibia	22	5	22.7	21	5	11	55.2	3
Fibula	3	0	0	3	0	0	7.9	0
Astragalus	12	5	41.6	12	5	8	31.5	3
Calcaneus	16	6	37.5	16	6	11	42.1	5
Tarsals	27	0	0	27	0	6	17.7	0
Metatarsal II	7	0	0	7	0	5	9.2	0
Metatarsal IV	9	0	0	9	0	6	11.8	0
Metatarsus	52	3	5.7	19	1	10	50.0	1
prox.Metatarsus	11	1	9.0	12	1	7	31.5	1
med.Metatarsus	39	2	5.1	5	1	2	13.1	1
dist.Metatarsus	2	0	0	2	0	2	5.2	0
Sesamoids	19	0	0	19	0	1	8.3	0
Phalange I	14	5	35.7	14	5	1	18.4	1
Phalange II	12	3	25.0	12	3	1	15.7	1
Phalange III	13	6	46.1	13	6	1	17.1	1



Figure 2.5.27: Graphic presentation of carnivore gnawing percentages (% of NISP) on horse skeletal elements, data taken from Table 2.5.44.



Gnawing type	NISP	%
Pitts	78	17.10
Scores	278	60.90
Furrows on weak parts	23	5.00
Punctures on weak parts	26	5.70
Punctures on hard parts (notching on fracture edges)	16	3.50
Multiple traces	35	7.60
	456	99.80
Gnawing pattern		
Epiphyseal damage	30	6.50
Epiphyseal destruction	26	5.70
Diaphyseal damage	33	7.20
Slightly gnawed	328	71.90
Moderately gnawed	34	7.40
Extremely gnawed	5	1.00
	456	99.70

Table 2.5.45: Nature and/or intensity of observed gnawing damage on horse bone specimens, based on the most dominating type of gnawing present on the studied specimen.

Differences between total MNE and MNE-gnawed counts for proximal and distal long-bone parts against those for long-bone shafts appear to be more gradual. We should take into account however that encountered carnivore gnawed, especially proximal, long-bone end fragments constitute for a large part small damaged fragments from which it is very difficult to calculate MNE counts because of a lack of diagnostic features and thus only being recognised as an epiphyseal fragment. From a methodological point of view this illustrates the importance of providing frequencies on both MNE and NISP for bone specimens from assemblages. The lower numbers for horse long-bone epiphyseal ends, both on NISP and MNE, seem to be related to carnivore action. Epiphyseal ends generally are of lesser bone mineral density than shafts and as a consequence more vulnerable to destructive forces. Bone density mediated destruction for the overall horse skeletal elements though has not become obvious through regression analysis (see Section 2.5.3 and Figure 2.5.25).

To check for possible bone density mediated destruction of specific horse long-bone parts, the %SURV has been used to check against bone mineral density for a possible correlation. Figure 2.5.30 shows



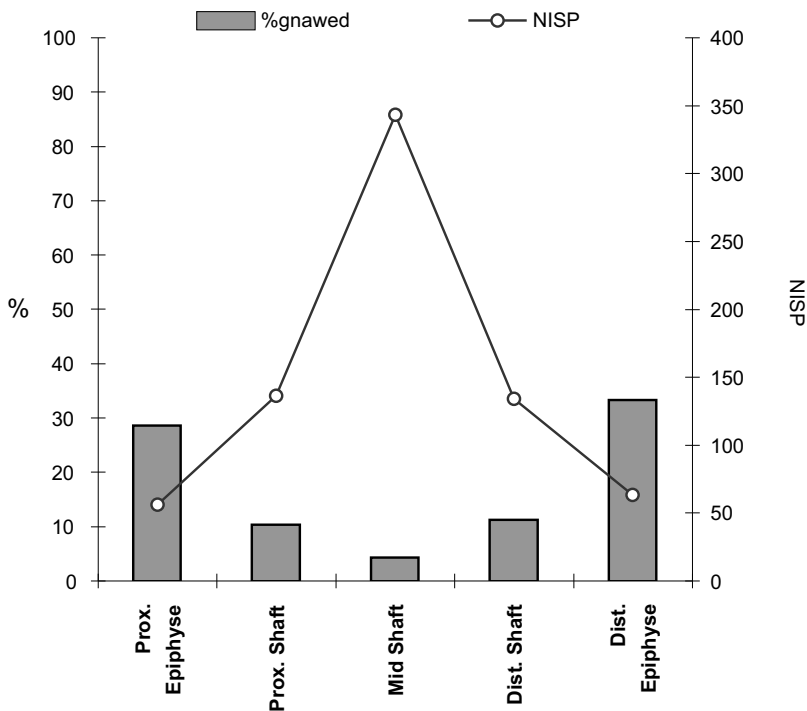


Figure 2.5.28: Frequencies of horse long-bone parts and the recorded percentages for carnivore gnawed specimens (of the NISP), N=732, data taken from Table 2.5.50.

the regression analysis between mean bone mineral density values against the %SURV for long-bone ends versus shafts. With a R^2 of 0.03, any significant relationship between the %SURV and bone mineral density values is statistically absent. This is in line with the R^2 value of about 0.02 for the overall horse skeletal element assemblage against bone mineral density values. Although carnivore-gnawing damage is well represented, present carnivore activity led to damage and destruction of skeletal elements but apparently not to the deletion of elements or element parts to such an extent that it can be detected by bone density related analysis.

The amount of destruction and the distribution of carnivore gnawing damage on skeletal parts and elements in faunal assemblages is believed to be related to the amount of nutritional abundance available to carnivores (Blumenschine, 1986; Blumenschine and Marean, 1993; Domínguez-Rodrigo, 2002; Marean and Spencer, 1991). Carnivore consumption of carcasses can be ranked after carcass parts being first eaten and last eaten as related to their nutritional value (Blumenschine, 1986; Lyman, 1994). Primary access of carnivores to intact carcasses can be indicated by the most nutritional rich carcass parts being under-represented due to carnivore destruction and higher incidence of gnawing damage on higher ranked carcass parts. Figure 2.5.31 shows skeletal elements ranked after the 'general consumption sequence' as developed by Blumenschine, 1986. The elements shown are ranked on the quantity of meat, bone-marrow consumption

by carnivores generally occurs after any available meat has been consumed. For the Schöningen horse remains, the %SURV and the percentage of carnivore gnawed bone specimens (%gnaw) have been supplemented. The first by carnivores-consumed carcass parts which constitute the hindquarters, represented by the pelvis and femur, followed by the forequarter and head flesh. The values on %SURV and %gnaw of the studied horse remains do not exhibit a trend following the general consumption sequence. While horse pelvises yield the lowest %SURV with a relatively high %gnaw which could be associated with carnivores attacking this part first, the second ranked femur yields the highest %SURV of the sample with a low %gnaw. Lower ranked skeletal elements further yield higher %gnaw than high ranked elements and the same can be observed on %SURV for several elements. No consistent pattern following the consumption sequence can be observed. The use of carnivore consumption sequences plays an important role in the hunting versus scavenging debate on early hominid subsistence strategies, because, as stated by Blumenschine:

"Since initial consumers deplete carcasses of edible tissues in a standard anatomical sequence, one can predict the series of parts that are most likely to be available. Resultant bone assemblages accumulated by scavenging should therefore be increasingly represented by skeletal parts that are eaten from by initial consumers in progressively later stages of the consumption sequence. Assemblages accumulated by hunting should show a more complete series of body parts, and particularly one biased toward those higher yielding parts that are typically consumed in the earlier stages of the sequence." (Blumenschine, 1986, p. 656-657)

The use of skeletal part profiles as main tool for zooarchaeological and taphonomical analysis has however been proved to be an ambiguous tool because of the problem of equifinality, the principle of different taphonomic processes leading to the same end products (see Domínguez-Rodrigo, 1999 and 2002 for an in-depth discussion on this topic). All available data on patterns and bone-surface modifications therefore should be included to derive at the most reliable inferences on the roles of carnivores and hominids (see also Section 2.3.5 on PPA-data).



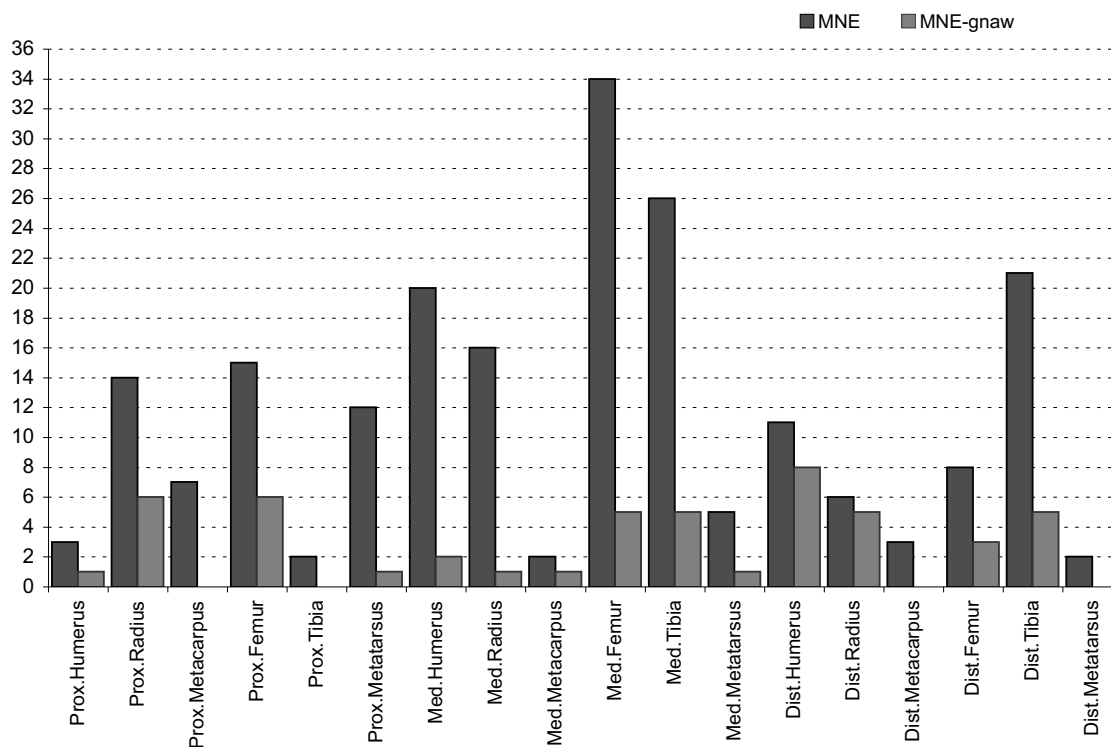


Figure 2.5.29: Comparison of the total MNE and carnivore gnawed MNE for Horse long-bone parts, long-bone proximal ends, shafts and distal ends, data taken from Table 2.5.44.

Data on encountered carnivore activity traces among the Schöningen 13II-4 horse remains can be interpreted and summarised as follows:

- 1 Gnawing traces point to wolves as the most likely main carnivore agent.
- 2 Locations of carnivore gnawing damage on horse skeletal elements indicate light to moderate gnawing damage or carcass ravaging.
- 3 There are very limited signs of marrow-bearing long-bone shaft destruction by carnivores.
- 4 Statistically significant bone density mediated destruction of skeletal elements possibly related to carnivore activity cannot be recognised.
- 5 Differential survival of skeletal elements or body parts possibly related to carnivore consumption sequences cannot be recognised.
- 6 A likely secondary role for the Schöningen carnivores is indicated by several recorded bone specimens with teeth scores overlapping cut marks from hominid butchery (see for one clear example Figure 2.3.11).

A possible secondary role for carnivores should indicate carnivore ravaging of already exploited horse carcasses due to butchery by hominids. In such a case instead of the natural nutritional value of specific carcass parts, as being used for the general consumption sequence, nutritional abundance will have been determined by what was left by the primary carcass exploitants. Some specific research

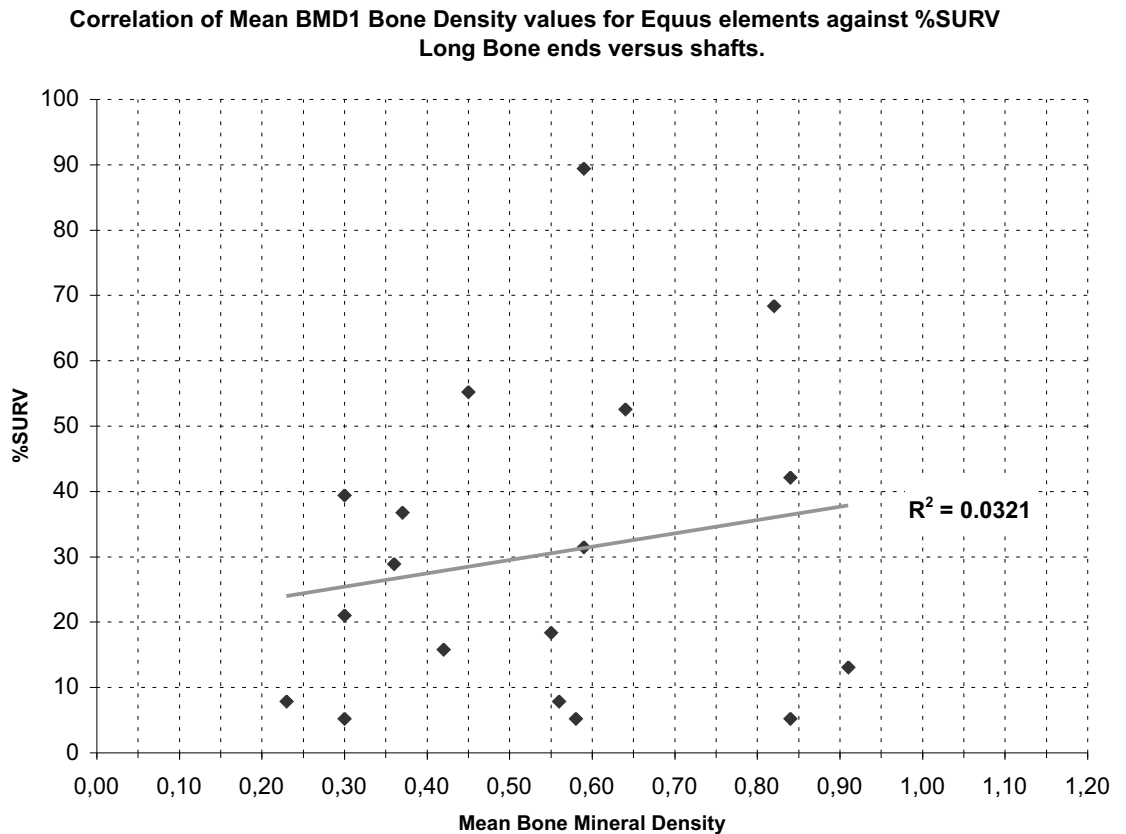
has been done on secondary carnivore access to already butchered carcass remains. For example, captive hyena ravaging experiments proved distributions of gnawing damage on long-bone parts to be related to the presence or absence of inner cavity bone marrow. Primary access by hyenas to marrow-containing bones tends to lead to far higher percentages of gnawed bone specimens than is the case of secondary access to identical bones already marrow depleted. After secondary ravaging, gnawed near epiphyseal and epiphyseal fragments tend to dominate (Blumenschine and Marean, 1993; Marean and Bertino, 1994; Marean and Spencer, 1991). The extreme destructive nature of hyena ravaging in these experiments also led to the virtually complete deletion of axial skeletal elements like ribs, vertebrae, and small bones like the carpals and to a lesser extent the pelvis (Blumenschine and Marean, 1993). This certainly is not the case with regard to the documented Schöningen 13II-4 horse remains, among which these skeletal elements are well represented and hyenas most likely did not play a role. The observed lower frequencies on horse long-bone, epiphyseal, ends as well as relatively high NISPs on gnawed specimens from these parts are however likely related to wolf gnawing and destruction of these parts. This is to be expected because of these parts being more vulnerable. On these parts much tissue remains attached even after butchery, and the cancellous bone remains greasy in content. The same



Table 2.5.46: Mean bone mineral density values, %SURV and %gnawed frequencies (on NISP) for horse long-bone parts used for regression analysis depicted in Figures 2.5.29 and 2.5.30. After Lam et al., 1999, Table 1, p. 351-353. For locations of scan sites see Appendix 1 (after Lam et al., 1999, Figure 1, p. 348-349; Lyman 1994, Figure 7.4, p. 240-241).

Long Bone part	Mean BMD2 bone density value	%SURV-lb-part	Mean BMD1 bone density value	%gnawed (nisp)
P humerus	0.33	7.9	0.23	44.4
M humerus	1.10	52.6	0.64	10.0
D humerus	1.05	28.9	0.36	66.6
P radius	1.04	36.8	0.37	46.1
M radius	1.08	42.1	0.84	6.4
D radius	1.00	15.8	0.42	71.4
P metacarpus	1.03	18.4	0.55	0
M metacarpus	1.10	5.2	0.84	9.0
D metacarpus	0.71	7.9	0.56	0
P femur	0.99	39.4	0.30	25.9
M femur	1.09	89.4	0.59	11.3
D femur	0.51	21.0	0.30	15.0
P tibia	0.77	5.2	0.30	0
M tibia	1.07	68.4	0.82	10.6
D tibia	1.05	55.2	0.45	22.7
P metatarsus	1.07	31.5	0.59	12.0
M metatarsus	1.10	13.1	0.91	5.1
D metatarsus		5.2	0.58	0

Figure 2.5.30: %SURV for horse long-bone ends and shafts against BMD1 bone density values (data taken from Table 2.5.46).



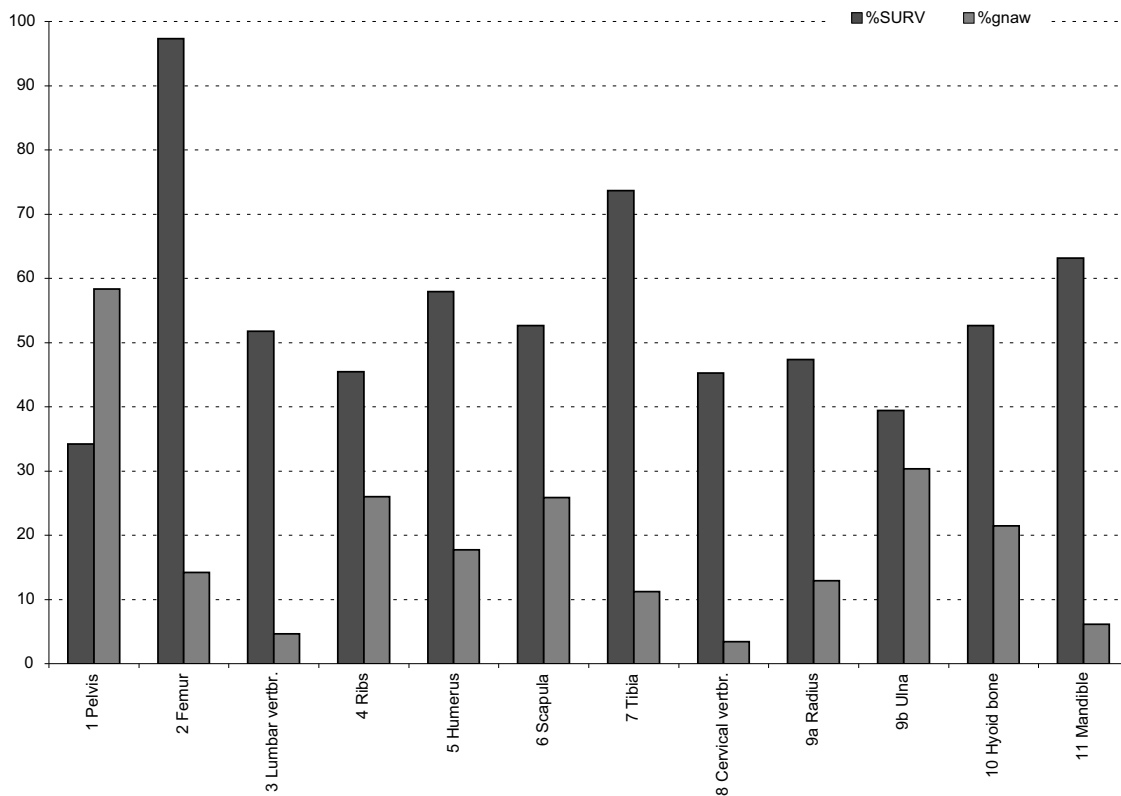


Figure 2.5.31: The Schöningen horse skeletal elements ordered according to the 'ranked general consumption sequence' for carnivore consumption versus the %SURV and %gnaw (derived on the NISP-gnawed from the overall NISP on the skeletal element). Consumption sequence modified after Blumenschine, 1986; Lyman, 1994.

is true for the proximal vertebrae processes, distal rib parts, and edges of scapulae and pelvic blades on which much tissue is attached and will remain nutritionally valued even after butchery. High gnawing incidence on these skeletal element parts, as observed among the horse remains, could therefore be expected. Possibly the identification and reconstruction of hominid-induced horse butchery signatures provide more insight into those horse carcass parts left available and attractive to scavenging wolves. This will therefore be explored in more detail, combined with hominid-induced signatures in the following chapter.

2.5.6 Traces of hominid activity and influence on the horse remains

Among the horse remains the most encountered actor-related bone modification traces are hominid butchering signatures and of these the most conspicuous hominid-induced butchering traces are stone-tool created cut marks on bone surfaces. Of all 2801 horse bone remains, 642 specimens bear cut marks, accounting for 22.9% of the remains. Of the 2422 to specific skeletal element determined horse remains, 23.4% (N=567) bear cut marks (expressed as -cut, Table 2.5.47). Cut-marked horse bone specimens thus outnumber carnivore-gnawed specimens (see the preceding Section). Criteria on the distinction of cut marks caused by stone tools and other traces believed to be created by butchering hominids have been provided in Sections 2.3.4 and 2.3.5. Detailed descriptions of cut marks encountered on specific horse skeletal elements are provided in the sections on horse skeletal element specific analysis. Here data on butchery traces will be summarised and analysed together with PPA data on both butchery and carnivore gnawing traces to derive at inferences on the role of hominids in the formation of the horse assemblage and the possible interaction between hominid and carnivore activity with regard to the modification of horse remains.



Skeletal element	NISP	NISP-cut	%cut	MNE	MNE-cut	MNI	MNI-cut
Cranium	15	1	6.6	1	1	1	1
Dental	143	1	0.7	143	1	0	1
Mandible	97	33	34.0	24	15	12	8
Hyoid bone	28	0	0	10	0	0	0
Atlas	12	3	25.0	12	3	12	3
Axis	13	2	15.3	7	1	7	1
Cervical vertbr.	87	0	0	43	0	8	0
Thoracal vertbr.	225	11	4.9	170	10	8	2
Lumbar vertbr.	65	5	7.7	59	5	11	2
Sacrum	14	1	7.1	12	1	12	1
Caudal vertbr.	1	0	0	1	0	1	0
Sternum	1	0	0	1	0	1	0
Pelvis	24	4	16.6	13	4	7	2
Ribs	726	105	14.4	311	50	13	4
Scapula	31	7	22.5	20	5	10	3
Humerus	130	75	57.7	22	14	12	7
prox.Humerus	9	4	44.4	3	2	2	1
med.Humerus	109	63	57.8	20	14	12	7
dist.Humerus	12	8	66.6	11	8	8	5
Radius	147	84	57.1	18	7	9	4
prox.Radius	13	4	30.7	14	4	8	2
med.Radius	125	80	64.0	16	7	9	4
dist.Radius	7	0	0	6	0	3	0
Ulna	33	10	30.3	15	5	9	3
Carpals	34	0	0	34	0	5	0
Metacarpal II	9	0	0	9	0	5	0
Metacarpal IV	7	1	14.2	7	1	4	1
Metacarpus	29	9	31.0	11	2	6	2
prox.Metacarpus	9	4	44.4	7	2	4	1
med.Metacarpus	11	2	18.1	2	2	1	1
dist.Metacarpus	4	2	50.0	3	2	2	2
Femur	175	93	53.1	37	27	19	16
prox.Femur	27	8	29.6	15	7	8	3
med.Femur	123	75	60.9	34	27	18	16
dist.Femur	20	10	50.0	8	4	5	4
Patella	7	0	0	7	0	4	0
Tibia	185	77	41.6	28	13	15	6
prox.Tibia	2	0	0	2	0	1	0
med.Tibia	159	64	40.2	26	8	14	6
dist.Tibia	22	13	59.0	21	13	11	6
Fibula	3	0	0	3	0	0	0
Astragalus	12	0	0	12	0	8	0
Calcaneus	16	1	6.2	16	1	11	1
Tarsals	27	7	25.9	27	7	6	4
Metatarsal II	7	2	28.5	7	2	5	1
Metatarsal IV	9	3	33.3	9	3	6	2
Metatarsus	52	32	61.5	19	7	10	5
prox.Metatarsus	11	8	72.7	12	7	7	5
med.Metatarsus	39	22	56.4	5	3	2	2
dist.Metatarsus	2	2	100.0	2	2	2	2
Sesamoids	19	0	0	19	0	0	0
Phalange I	14	0	0	14	0	0	0
Phalange II	12	0	0	12	0	0	0
Phalange III	13	0	0	13	0	0	0



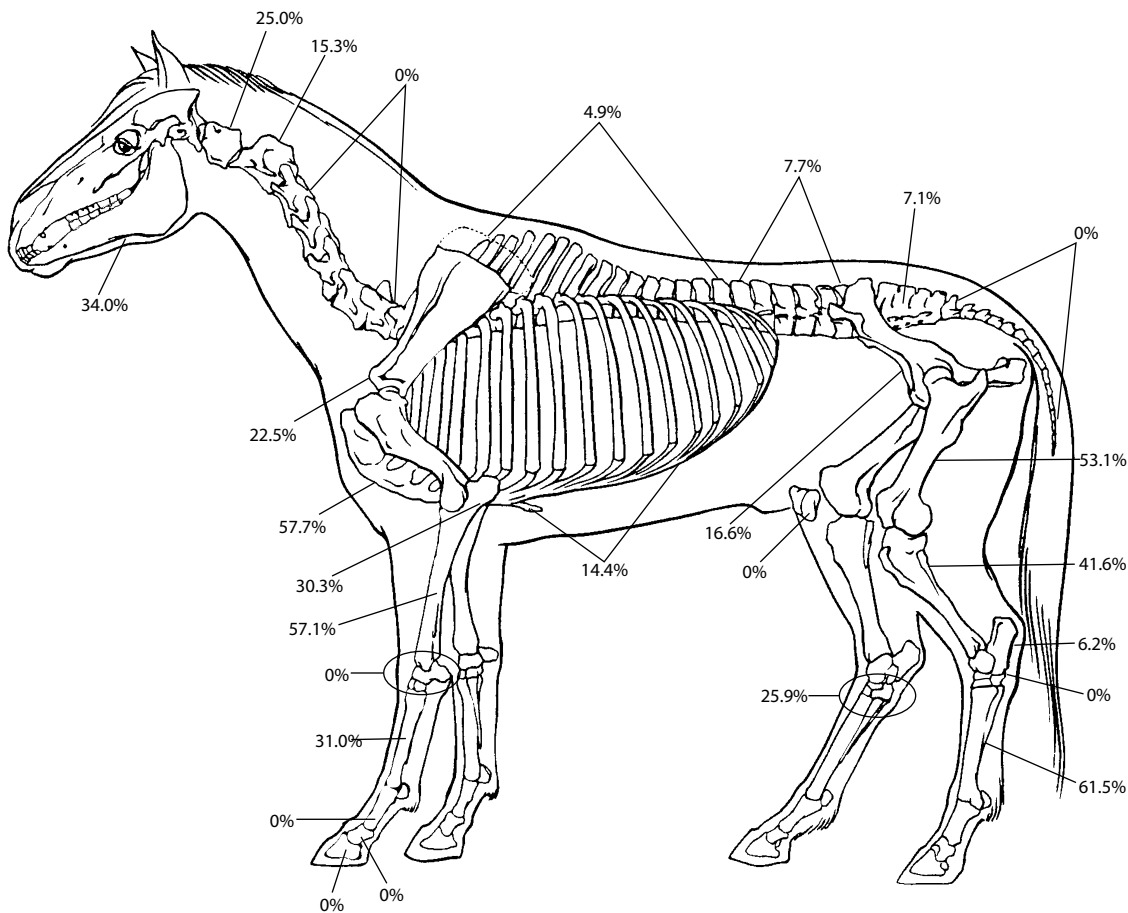


Figure 2.5.32: Graphic presentation of cut-mark percentages (on cut-marked NISP) for horse skeletal elements (data taken from Table 2.5.47).

Horse body parts and butchery trace frequencies

Table 2.5.47 shows the general representation indices obtained for horse remains together with those obtained for cut-marked horse skeletal elements and element parts (also see Figure 2.5.32). Frequencies on cut-marked horse skeletal elements yield some conspicuous proportional differences between skeletal elements and horse body parts. On the NISP-cutmarked and MNE-cutmarked horse skeletal elements, the ribs score highest followed by the femur, mandible, humerus, tibia and thoracic vertebrae (Table 2.5.47 and Figure 2.5.33). The calculation of MNIs-cutmarked yield a different order, with the main leg elements scoring the highest MNIs, followed by the mandible and the ribs (Figure 2.5.34). Comparisons between the values of the MNIs-

cutmarked for different horse elements and body parts show some marked differences. The highest obtained MNI-cutmarked values for horse axial elements are 3 on the atlas and 4 on the 9th and 16th rib. Other axial elements like the pelvis and vertebrae do not exceed MNIs-cutmarked of 1 to 2 (Figure 2.5.34). The upper front leg scapula yielded an MNI-cutmarked of 3, following the values obtained for axial elements. Mandibulae, humeri, tibia and especially the femur though score MNIs-cutmarked of 8, 7, 6 and 16 respectively. Other horse leg elements yield MNIs-cutmarked intermediate to those obtained for the axial and upper leg parts. These discrepancies on MNI-cutmarked values cannot be easily explained by discrepancies in the degree of survival between the different horse skeletal elements. Bone mineral density-related destruction and survival have been proven to have occurred in such a limited amount that it does not become detectable by statistical analysis (see Section 2.5.3). The overall MNI counts and %SURV for horse elements further demonstrate that some elements yielding low MNIs-cutmarked are well represented in the assemblage, such as the atlas, sacrum, ribs and lumbar vertebrae (Figures 2.5.34 and 2.5.35). The highest MNIs-cutmarked are calculated for horse marrow-bearing skeletal elements, the long bones

◀ Table 2.5.47: Frequencies of determined horse skeletal elements and cut-mark frequencies, included are frequencies for detailed counts on long-bone parts, prox: includes proximal epiphysis and epiphyseal fragments of long bones, dist: includes distal epiphysis and epiphyseal fragments of long bones, med: includes all proximal, medial and distal shaft fragments of long bones.



from the legs and the mandibula. Likely the co-occurrence of two favoured products related to these elements, being both meat and bone marrow, led to higher butchery intensity, resulting in the observed discrepancies. This inference will be explored further below.

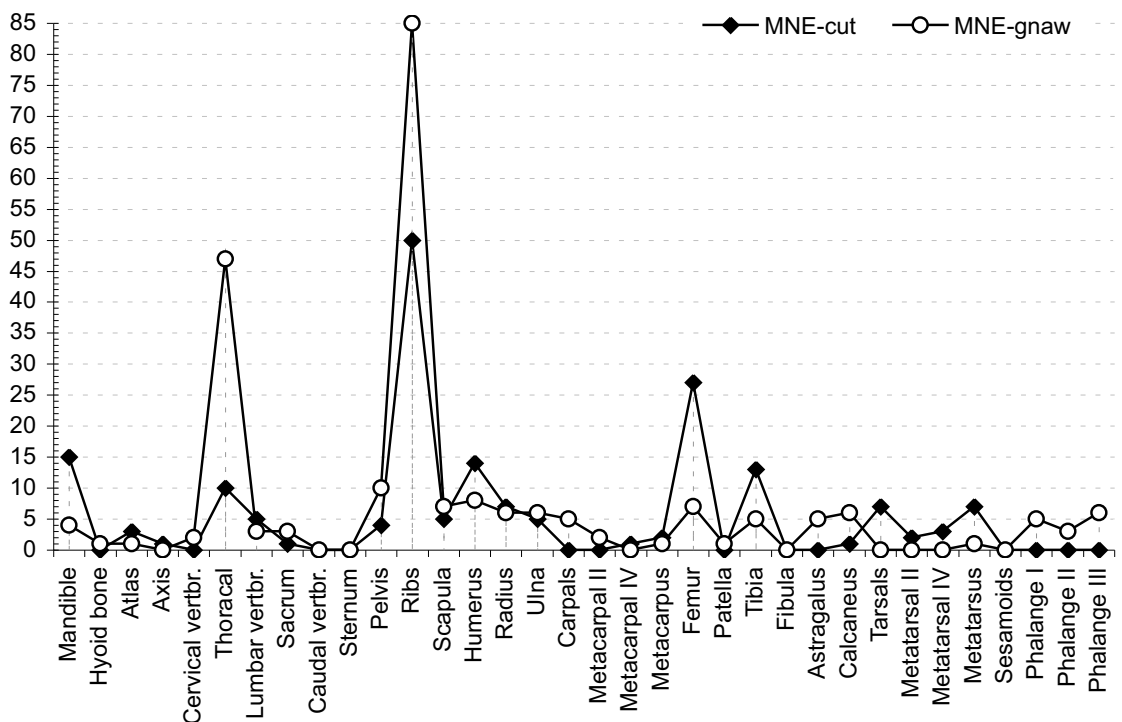
While most of the horse leg elements have been cutmarked extensively, yielding high percentages of cut-marked NISPs, MNEs and MNIs, (Tables 2.5.47 and 2.5.48, and Figures 2.5.32 and 2.5.37), this does not hold for most encountered axial elements. Apart from relatively low cut-marked MNEs and MNIs, cut-mark patterns do not indicate intensive butchery of most axial parts but rather limited or selective butchery. A summarising survey of encountered butchery traces on the neck and axial horse elements yields the following characteristics (counts and percentages are on MNE):

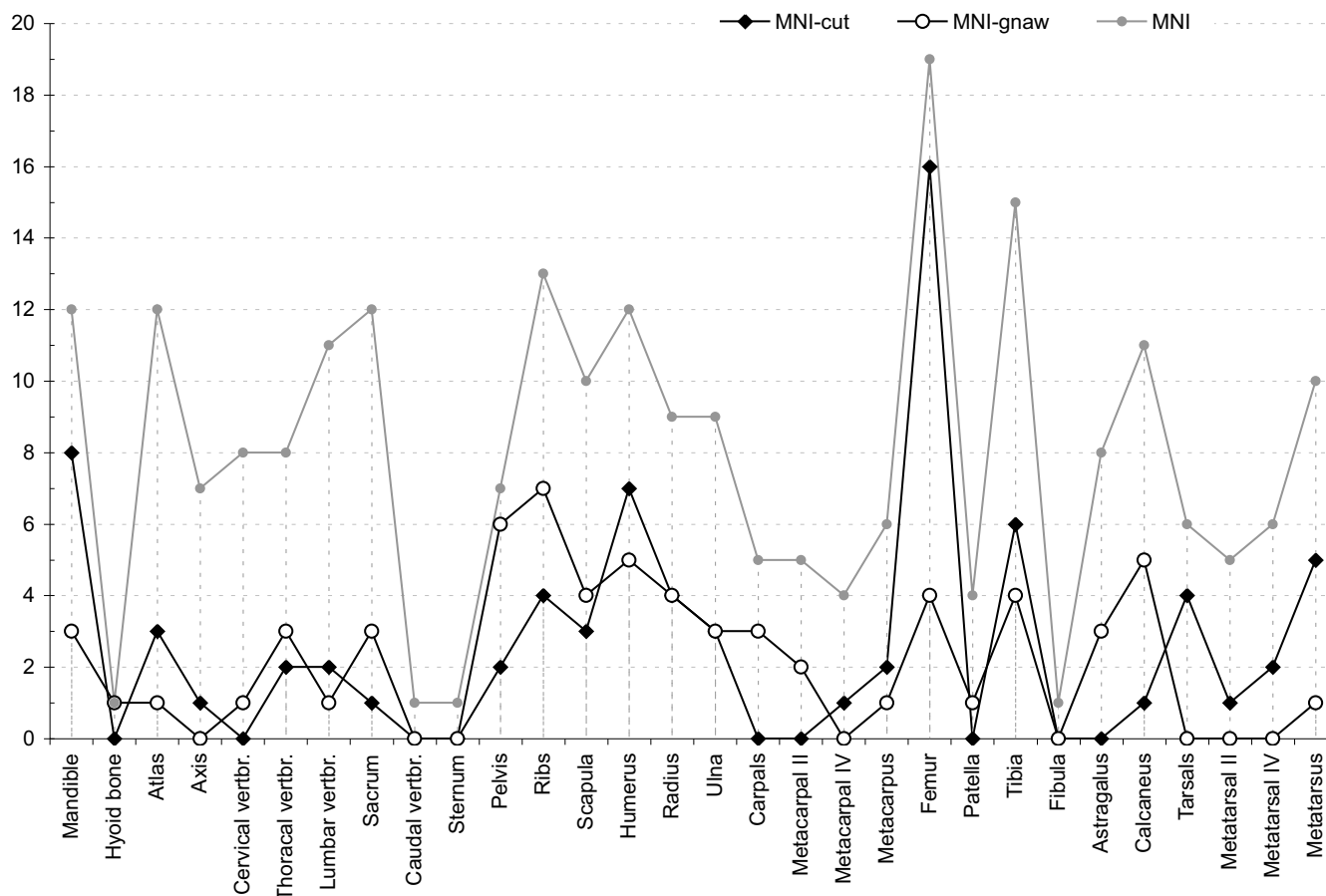
- ▶ For the horse neck region, cut marks have only been observed on the most cranially located vertebrae, the atlas and axis. For both of these elements the observed cut marks should be associated with dismembering of the head-mandible region. The cervical vertebrae did not yield cut-marked specimens though they are well represented among the horse remains.
- ▶ Thoracic vertebrae are well represented but only

5.8% of all counted vertebrae are cutmarked. Most of these are from the cranial part of the vertebrae column. Of only one thoracic vertebrae has the corpus been cutmarked, of all others only the medial to upper spinous processes yielded cut marks and then on one side only.

- ▶ Lumbar vertebrae are well represented but only 8.4% of the specimens exhibit cut marks. Also lumbar vertebrae mostly exhibit cut marks on one side of the element only. Cut marks on both corpi and processes have been encountered. Only one cut-marked horse sacrum has been encountered and appears to have been butchered extensively.
- ▶ Horse pelvises are represented moderately. Of 13 encountered horse pelvic halves 4 specimens, 30%, have been cutmarked and all of these exhibit cut marks from filleting meat.
- ▶ Horse ribs are well represented. Of all determined rib specimens, 16% have been cutmarked. Ribs from both body sides have been cutmarked in equal numbers, but cut-marked specimens from the rear half of the thorax dominate. No cut marks indicating dismemberment of ribs or rib slabs from the vertebrae column have been observed. Cut marks are present on the medial to distal areas on the lateral side only.

Figure 2.5.33: Counted MNs for horse skeletal elements with cut marks (MNE-cut) and carnivore gnawing marks (MNE-gnaw), data taken from Tables 2.5.44 and 2.5.47.





Among axial horse skeletal elements, carnivore-gnawing frequencies are the highest of all horse remains. The pelvis with the sacrum, the thoracic vertebrae and ribs exhibit relatively high frequencies of gnawed bone specimens and %SURV-gnawed (Figures 2.5.33; 35; 36). Among the studied bone remains, 338 small rib fragments have been documented which could not be subscribed to specific mammalian taxa, among these fragments are both cut-marked and carnivore-gnawed specimens. Also 83 taxonomically indeterminable small vertebrae fragments have been documented. Fragmentation of these skeletal elements and relatively high carnivore-gnawing frequencies indicate likely destruction of a number of originally present elements. Of importance is especially the co-occurrence of butchery cut marks and carnivore gnawing on identical areas of these elements. Traces of both agents mostly concentrate on the medial to distal rib parts as well as the spinous processes of vertebrae. The co-occurrence of traces is unambiguously illustrated by the encountered specimens on which gnawing marks overlap cut marks (see Figure 2.3.11). From these observations it can be inferred that the present amount of observed cut marks on horse vertebrae and ribs originally will have been more substantial, but that they are at present partly obscured by carnivore activity. Also weakening of

axial elements due to sediment compaction pressure on water-soaked bone will have facilitated element fragmentation. Although weathering was limited, DBF fractures have been encountered among the bone remains and especially on ribs, vertebrae processes and flat skeletal elements like the pelvis. The encountered horse cervical vertebrae exhibit interesting characteristics. No cut-marked specimens have been encountered and carnivore-gnawed specimens have been encountered only once. Horse caudal vertebrae are noticeably absent. Because of the apparent collection of bone remains even smaller than one centimetre, the chance of missing the small caudal during excavations is expected to have been very small. With regard to horse heads, only some can be discussed because of the complete skulls being unavailable for this study. One cut-marked horse cranial fragment has been documented and together with cut marks indicating disarticulation of the mandibles from the crania as well as crania from the neck, it is to be expected that the found horse skulls will yield cut marks. Horse mandibles have been butchered intensively. About 63% of the documented mandible halves bear cut marks and 42% bear traces of mandible bone marrow processing. Removal of horse tongues is clearly indicated, although no distinction can be made between a dismemberment or consumption purpose for this removal. Carnivore

Figure 2.5.34: Calculated MNIs for horse skeletal elements bearing cut marks (MNI-cut) and carnivore gnawing traces (MNI-gnaw) and the overall MNI, data taken from Tables 2.5.44 and 2.5.47.



Figure 2.5.35: Calculated %SURV indices for horse skeletal elements. The overall %SURV for horse skeletal elements (%SURV), the %SURV for cutmarked elements (%SURV-cut) and %SURV for carnivore gnawed elements (%SURV-gnaw) are calculated from the highest MNI (19 on femur) and the predicted skeletal elements from this MNI.

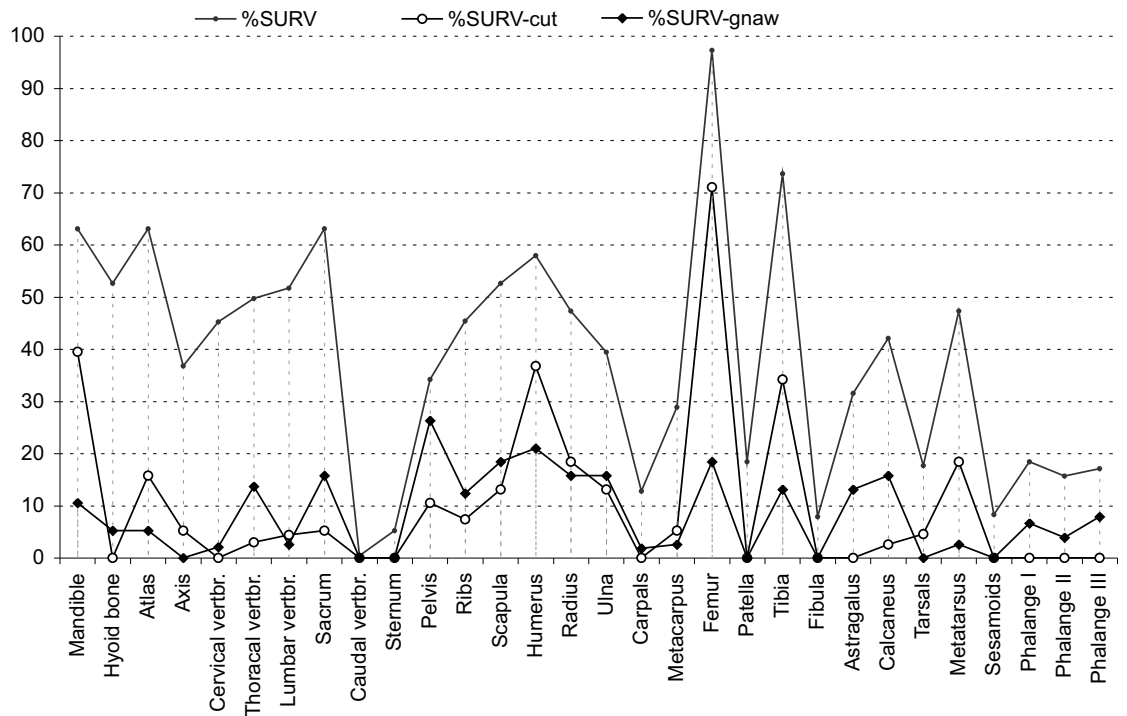
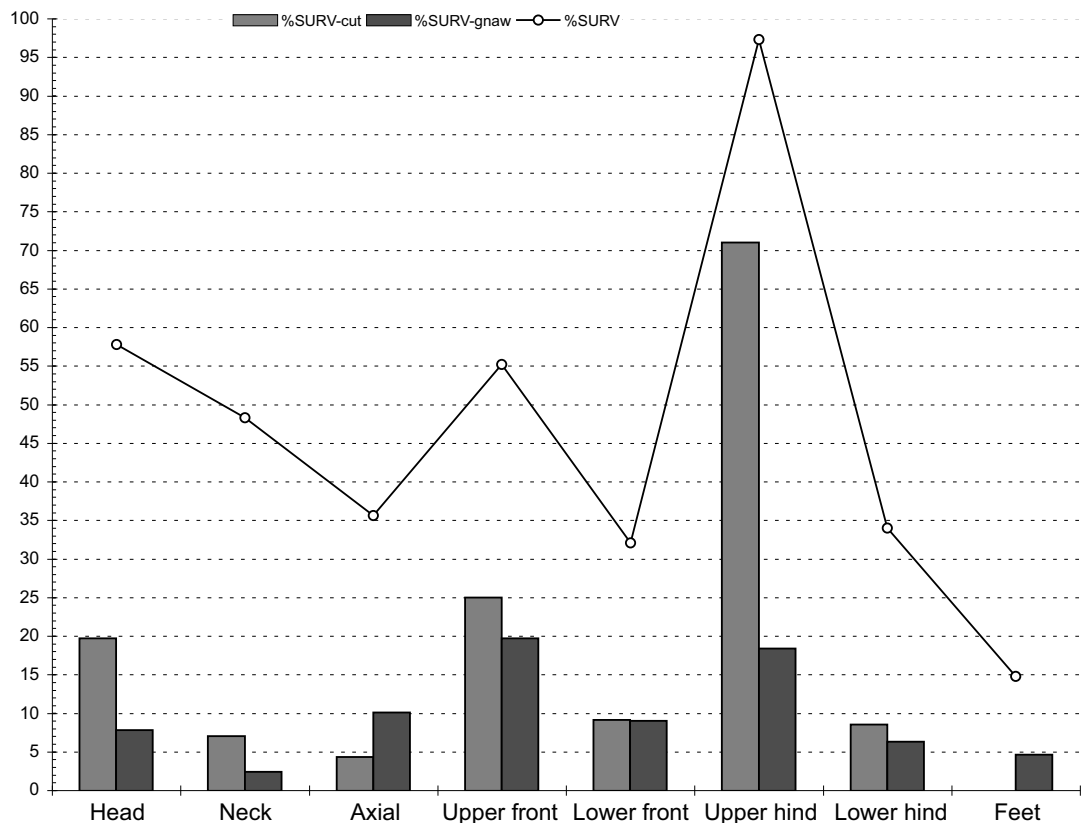


Figure 2.5.36: Modified %SURV for horse body parts, body parts taken after Stiner, 1991. The modified %SURV have been calculated by summing the %SURV values for skeletal elements belonging to a body part and dividing this sum by the number of summed skeletal elements. %SURV = overall %SURV, %SURV-cut = cutmarked %SURV, %SURV-gnaw = carnivore gnawed %SURV.



gnawing on mandibles is limited to 17% of the documented mandible halves. Horse leg elements yielded the highest frequencies of butchery traces. A summarising survey of encountered butchery traces on horse leg elements yields the following characteristics, following the position from upper front to lower hind (counts and percentages are on MNE):

- ▶ Scapulae are well represented. 25% of the counted scapulae exhibit butchery traces, from both

dismembering and filleting. Of the three counted horses on butchered scapulae, one individual is of foal age. Of the total of 10 on scapulae counted horses three are foals.

- ▶ The humerus is well represented. About 64% of the counted humeri have been butchered and 86% exhibit traces of bone-marrow procurement. Observed cut marks point to dismembering and filleting/defleshing.



- ▶ The ulna is moderately represented and 33% of the counted specimens yielded cut marks from both dismembering and filleting, as well as impact traces pointing to the removal of ulnae from the radii by direct impact.
- ▶ Horse radii are moderately to well represented and 39% of the counted specimens have been butchered for meat and exhibit cut marks from dismembering. About 56% of the radii have been marrow processed.
- ▶ The carpals and metacarpals are moderately to relatively low represented. Only carnivore-gnawed carpals have been encountered, cut-marked carpals are lacking. About 18% of all documented horse metacarpals bear cut marks and traces of marrow processing. Only one specimen has been carnivore gnawed. Four metacarpal epiphyseal ends bear traces of percussion damage.
- ▶ Horse femur specimens dominate among the skeletal elements with a calculated MNI of 19, the highest derived for horse remains. 73% of the counted femur specimens have been butchered, bearing cut marks from dismembering and filleting meat. Of all femur specimens 54% have been marrow processed. Only 19% of the counted femora bear traces of carnivore gnawing.
- ▶ Tibiae are second best represented among the horse skeletal elements with an MNI of 15. Of the tibiae specimens 46% have been butchered for meat and exhibits cut marks from dismembering. About 68% of the tibiae have been processed for bone marrow. Carnivore gnawing has been encountered on 18% of the tibiae.
- ▶ Astragali and calcani are moderately to well represented. No astragali have been cutmarked and only one calcaneus exhibit cut marks from filleting. Carnivore gnawing ranges from 37 to 42% of the documented specimens.
- ▶ Horse tarsals are under-represented. 26% of the specimens have been cutmarked from dismembering of the tarsal-metatarsus joint. No gnawing traces have been encountered.
- ▶ The metatarsals are well represented. About 37% of the specimens have been cutmarked and 21% marrow processed. Carnivore gnawing has been encountered on one specimen only. Three metatarsal specimens exhibit percussion traces on their epiphyseal ends like those encountered on metacarpal ends.
- ▶ Horse phalanges and sesamoids are under-represented and the least encountered horse leg elements. No cut-marked or impacted specimens have been encountered. Carnivore gnawing traces though have been documented for 39% of the documented horse phalanges.

Encountered butchery traces on horse leg elements can be divided into four types; cut marks caused during dismembering, during filleting/defleshing, scraping-like marks, and impacts caused during marrow processing of long bones. The marrow-bearing leg long bones often yield a co-occurrence of these butchery marks while for example the tarsals only yield cut marks from dismembering of the tarsal-metatarsus joint. Cut marks caused during dismembering are least represented among the leg long bones. Of all documented horse long-bone specimens (on NISP), 12% exhibit cut marks from dismembering against 64% from filleting (Table 2.5.48). Originally frequencies on cut marks from dismemberment will have been higher for these elements. Dismembering cut marks are located near epiphyseal long-bone ends due to the cutting of joint ligaments. Most of the detected carnivore-gnawing damage among horse leg long bones is present on these parts. Carnivore gnawing of these parts is of influence to the degree of survival of epiphyseal parts and by consequence dismembering marks. This is especially true for the relatively weak proximal epiphyseal ends. Carnivore-gnawed bone specimens from horse proximal long-bone ends dominate over cut-marked specimens, whereas for other long-bone parts cut-marked specimens dominate (see also Section 2.5.5). Binford (1981) has taken carnivore destruction of the proximal humerus as a measure of carnivore influence on skeletal element representation within faunal assemblages. Among the horse leg remains, the proximal humerus is represented by only 9 epiphyseal fragments of which 4 have been carnivore gnawed. This together with the overall higher frequencies of carnivore-gnawed bone specimens from epiphyseal long-bone ends (Table 2.5.50) indicate a certain amount of destruction of these parts by carnivores and therefore likely suppressing dismembering cut mark frequencies. Cut marks from filleting meat mass from horse leg elements are by far the most encountered butchery trace (Table 2.5.48). As outlined before, cut marks caused during filleting can be divided into a long type and short type of cut mark. Table 2.5.51 lists the frequencies for all documented cut-mark types on horse cut-marked skeletal elements. The main characteristics of different cut-mark types already have been outlined in Sections 2.3.4 and 2.3.5. The combined occurrence of short and long filleting cut marks have been encountered on horse leg elements and on mandibles, scapulae and pelvis. Short cuts mostly are transversally oriented to the long-bone axis, while long marks are oriented oblique and parallel to the long-bone axis. Movement of the used stone tool in relation to the morphology of the cut bone surface



Table 2.5.48: Frequencies of identified dismembering, filleting and scraping marks on horse marrow bearing skeletal elements. The category Metapodium includes bone specimens identified as belonging to the metacarpus and metatarsus together with specimens assigned as belonging to either the metacarpus or metatarsus.

Skeletal element	NISP-cut	NISP-dismembering	NISP-filleting	NISP-scraping	%-scraping
Mandible	33	4	27	2	6.0
Humerus	75	18	44	12	16.0
Radius	84	1	53	28	33.3
Femur	93	21	58	12	12.9
Tibia	77	5	68	4	5.2
Metapodium	59	2	22	34	57.6%
Total	421	51	272	92	Av. 21.8

partly determines the characteristics of resulting cut marks. Discussion of observed cut marks and their placement on horse bone remains with a modern, Dutch, professional butcher taught us that to accomplish the removal of a high-quality filleted meat mass from especially the upper legs, a combination of cutting and more piercing-like movements between the meat mass and the bone is used (Morang, 2005 pers. comm.). Cutting of the membrane with which the meat is attached to the bone results in short transversal cuts. Piercing between the membrane and the bone, more parallel and oblique to the bone's axis, makes the removal of a complete meat slab possible by pulling out the complete long bone after loosening of the membrane. This piercing creates long, often parallel and oblique cut marks. Loosening of the bones from the meat mass is further facilitated by cutting on the shafts near the long-bone ends to loosen the concentrated ligaments at the bone ends (Morang, 2005 pers. comm.). Intensive cutting near the long-bone ends, e.g. the proximal and distal shaft areas, during both dismemberment and loosening of these parts during filleting is expected to result in higher cut mark frequencies for these parts. This could be an explanation for why these long-bone parts yield high percentages for cut-marked specimens among the horse remains (Table 2.5.50 and Figure 2.5.37).

Table 2.5.49: Frequencies of marrow-processing traces, impact notches or conchoidal flake scars, on exactly determined horse marrow-bearing skeletal elements.

Skeletal element	NISP	NISP-imp	%impacted	MNE	MNE-imp	MNI	MNI-imp
Mandible	97	24	24.7	24	10	12	5
Humerus	130	68	52.3	22	19	12	10
Radius	147	69	46.9	18	10	9	7
Ulna	33	6	18.1	15	3	9	2
Metacarpus	29	7	24.1	11	2	6	1
Femur	175	74	42.2	37	20	19	13
Tibia	185	99	53.5	28	19	15	10
Metatarsus	52	14	26.9	19	4	10	3
Total	848	361	Av. 41.9	174	87		

Horse bone marrow procurement

Scraping-like traces have been encountered on the cortical surface of marrow-bearing bones only, being the long bones from the legs and the horse mandibulae. On over 30% of the documented horse bone specimens with cortical impact notches the associated bone surface traces are scraping traces (Table 2.5.52). A relationship of scraping traces with possible complete cleaning (including the periosteum) of bones prior to marrow processing can therefore be considered to exist (see also Section 2.3.5), as postulated by other researchers (e.g. Binford, 1981; Díez et al., 1999; Fisher, 1995; White, 1992). However, the scraping traces could also be the result of just boning element parts close to the covering skin. Frequencies on scraped long-bone specimens are highest for specimens derived from the radii and metapodials (metacarpus and metatarsus), followed by humerus, femur, and tibia specimens (Table 2.5.48). Especially the radius and metapodials do not contain much meat and marrow (ranked the last and second last place on the Meat and Marrow Utility Index, see below), and as regards the metapodials, and also the cranial face of the radius, only a limited layer of tissue is present between the skin and bone.



Long bone part	NISP	NISP-gnaw	%gnaw	NISP-cut	%cut	NISP-imp	%imp
prox. Epiphysis	56	16	28.5	14	25.0	8	14.2
prox. Shaft	136	14	10.3	74	54.4	77	56.6
mid Shaft	343	15	4.3	180	52.4	119	34.7
dist. Shaft	134	15	11.2	87	65.0	76	56.7
dist. Epiphysis	63	21	33.3	33	52.3	29	46.0
Total	732	81	11.0	388	53.0	309	42.2

Table 2.5.50: All horse long-bone parts and fragments which could be identified to exact epiphyseal or diaphyseal part against the corresponding trace frequencies.

Some frequencies on long-bone parts and traces shown in this table are lower than given in the other tables on horse long-bone parts and frequencies. This is due to the fact that in certain cases the exact position of long-bone shaft parts overlap. For example a

long-bone shaft part including the proximal shaft and three-quarters of the midshaft could only be determined as a shaft part (like in Tables 2.5.44 and 2.5.47) but not as a proximal or medial shaft fragment.

Comparison of the %gnawed, %cutmarked and %impacted of horse long bone parts/fragments (on NISP).

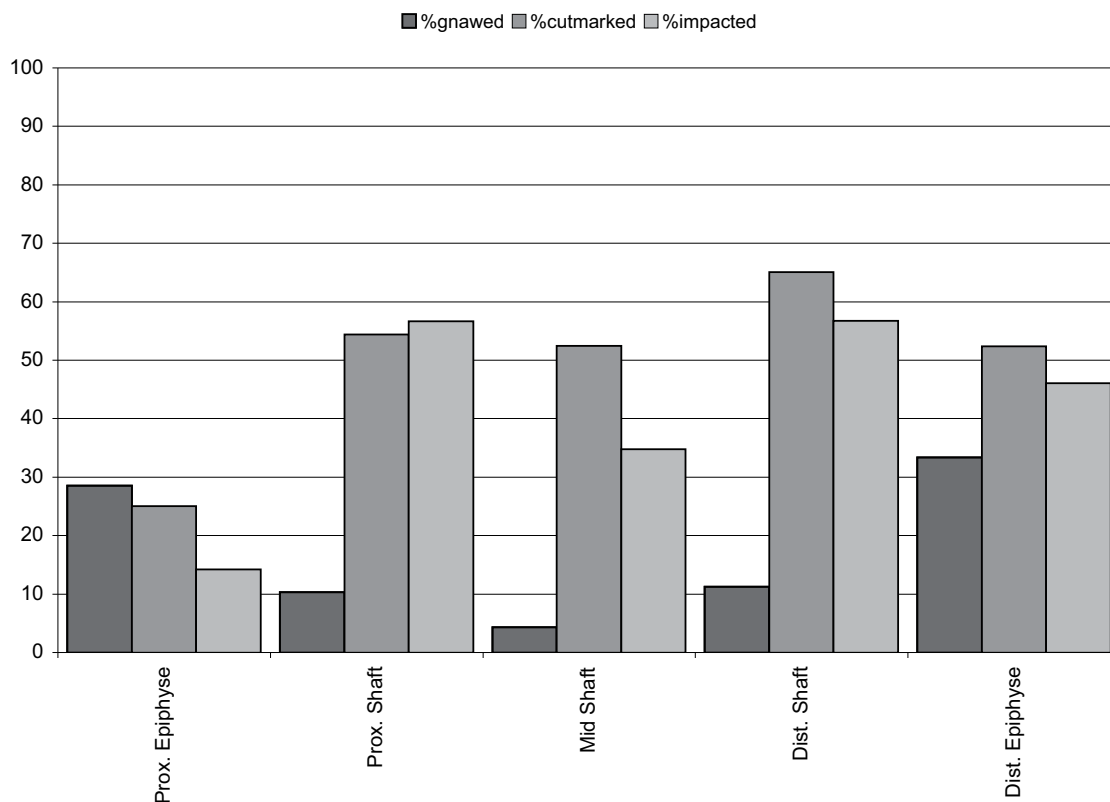


Figure 2.5.37: Graphic presentation of the values taken from Table 2.5.50.

Possibly because of lack of a meat mass, the removal of skin and tissue, among which are tendons, from these parts was accomplished most proficiently by using a scraping or sawing-like movement with a stone tool held obliquely to the bone, its surface resulting in the observed scrape-like marks.

Marrow-bearing horse skeletal elements have been processed intensively with over 40% of the from marrow-bones derived bone specimens (on NISP) yielding signs of dynamic impact breakage, like impact notches and scars (Table 2.5.50 and Figure 2.5.37). Of all counted marrow-bearing horse bone elements (on MNE), 50% bear direct traces of bone-marrow processing in the form of impact notches or (parts of) scars (Table 2.5.49). Of all marrow-bearing

horse bones, over 85% have been fragmented and only 15% survived in a complete state (counted on MNE). The highest counted MNI on complete marrow-bearing elements is 3 on the marrow-poor metapodials, followed by MNIs of only 2 on the marrow-rich femur and humerus. Horse marrow-bone breakage resulted in the recurrent presence of almost identical bone fragments, which facilitated MNE calculations. This is related to the repeated selection of certain areas on marrow bones to be impacted for marrow processing (see the sections on individual horse elements for descriptions of these areas). The chosen areas for impacting strongly echo impacted areas documented for other Palaeolithic and younger butchered faunal assemblages yielding standardised patterns of bone-marrow processing.



Table 2.5.51: Frequencies of recorded main cut-mark types or co-occurrence of cut-mark types on cut-marked horse bone specimens.

Cut mark type	NISP	%
Short isolated	38	6.0
Short clustered (chevron)	329	52.4
Long isolated	14	2.2
Long parallel	66	10.5
Long curvilinear	18	2.8
Scrape clustered	54	8.6
Short isolated & long parallel	1	0.1
Short isolated & scrape clustered	1	0.1
Short clustered & long parallel	52	8.3
Short clustered & scrape clustered	27	4.3
Long isolated & scrape clustered	3	0.4
Long parallel & scrape clustered	13	2.0
Short & long & scrape clustered	11	1.7
	627	99.4

Table 2.5.52: Character and associated cortical bone surface traces of observed impact notches on horse marrow-bone specimens. The number of 414 observations also include long-bone shaft fragments which could not exactly be subscribed to specific skeletal elements but on their dimension and morphology have been ascribed to the Equus taxonomic group.

Impact notch type	NISP	%
Single complete impact notch	95	22.9
Double, paired, notches	41	9.9
Multiple notches, serie	27	6.5
Bipolar impact notches	40	9.6
Double, paired & bipolar	2	0.4
Multiple & bipolar	2	0.4
Part of an impact flake scar only	207	50.0
	414	99.7
Impact notch trace association		
Carnivore gnawing traces	6	8.0
Scraping marks	23	30.6
Scraping marks & gnawing traces	1	1.3
Percussion pits	10	13.3
Percussion pits & scraping marks	6	8.0
Percussion scratches	6	8.0
Percussion scratches & pits	15	20.0
Percussion pits & scratches on opposite side	8	10.6
	75	99.8

This indicates standardised marrow-bone procurement which more is likely to be associated with hominid bone-marrow procurement instead of carnivore-induced marrow-bone breakage. Stone-tool scraping traces associated with cortical impact notches dominate notches associated with carnivore-gnawing traces (Table 2.5.52). Apart from scraping traces, also percussion pits have been encountered frequently (see Figure 2.5.41). These figures suggest butchering hominids are primarily responsible for the creation of bone-marrow processing traces.

Other variables used to distinguish hominid from carnivore-created impact notches and scars are a series of measurements on impact notches and scars (see Figure 2.3.10) as well as the use of impact notch types. Capaldo and Blumenschine (1994), use ratios of impact notch and scar measurements as being reflective of the plan forms of impact notches and the thickness of impact flakes. Their ratio of Notch Breadth / Maximum Notch Depth is used to describe the relative plan form of impact notches as seen from the cortical view. Carnivore tooth notches are believed to be more semicircular to circular in plan form, while dynamic hammerstone impact notches are believed to be more arcuate. Therefore notches resulting from carnivore tooth pressure should approach the ideal circular plan form ratio of 1, while arcuate notches will yield higher plan form ratios.

Figure 2.5.38 shows the frequencies of relative impact notch plan form ratios calculated from complete impact notches discovered on Schöningen horse marrow-bone fragments. Most of the measured impact notches yield relative notch plan form ratios between 4 and 14. The Capaldo and Blumenschine experimental measurements on percussion notches yielded notch plan form ratios of between 5 and 16 for Bovid size classes 1 and 2, and between 5 and 8 for Bovid size class 3. Carnivore tooth notches yielded most plan form ratios ranging from 2 to 6 for Bovid sizes 1 and 2, and from 3 to 8 for Bovid size 3. The Capaldo and Blumenschine Bovid size 3 sample includes bovids with weights ranging from 115 to 340 kg and therefore are most suitable for comparison with the Schöningen 13II-4 horse bone remains. The frequencies of relative impact notch plan forms for the Schöningen horse remains clearly show a more arcuate form spectrum rather than a tendency towards more circular notch plan forms (Figure 2.5.38). The frequencies are however more in agreement with the frequencies derived from the Capaldo and Blumenschine Bovid sizes 1 and 2 percussion sample. Their Bovid size 3 sample was very limited with only 7 measured percussion notches against 53 for their Bovid sizes 1 and 2 percussion sample. It can therefore be questioned whether these values can be compared directly. Future comparisons including statistical analysis of the relatively large (N=135) notch plan form ratio sample from the Schöningen 13II-4 horse bone remains with other large impact notch samples will be necessary.



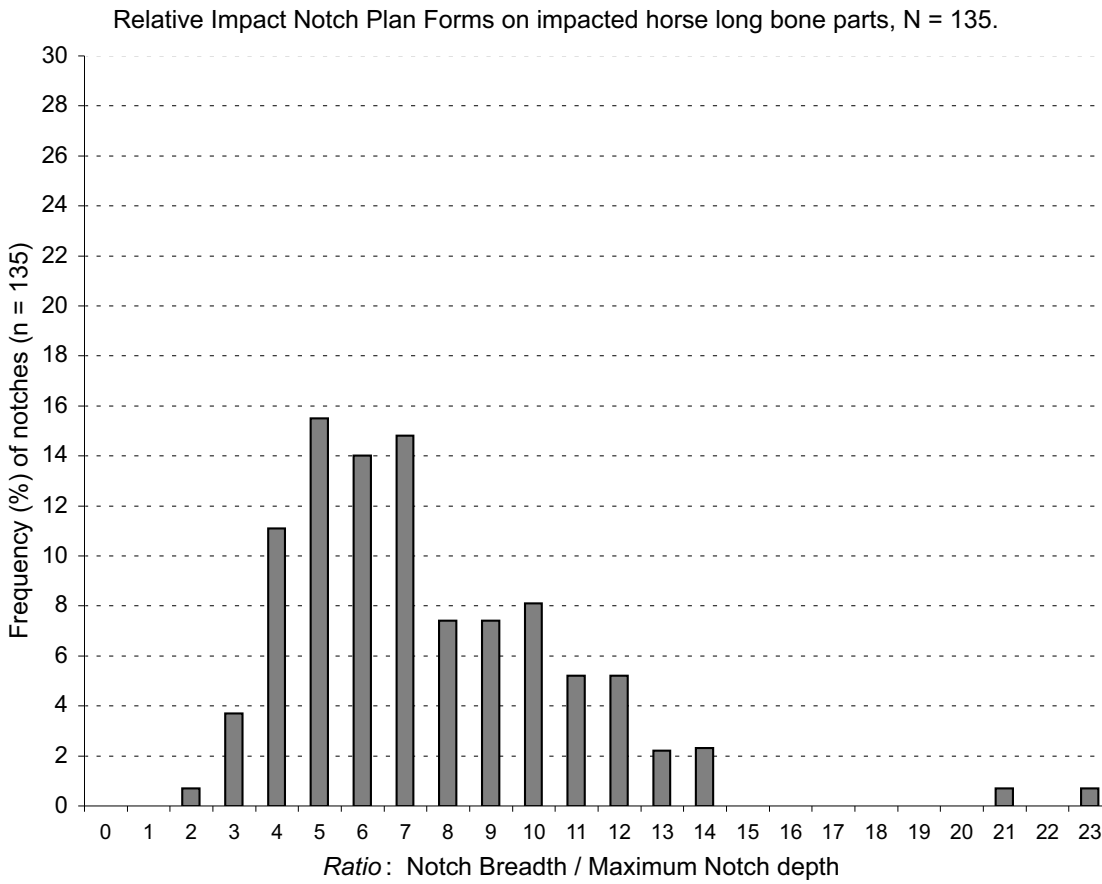


Figure 2.5.38: Frequencies of ratios reflecting the relative notch plan forms of impact notches on Schöningen 13II-4 horse marrow-bone fragments.



Figure 2.5.39: Frequencies of ratios reflecting the relative thickness of the collective bodies of detached flakes from impact notches on Schöningen 13II-4 horse marrow-bone fragments.



Figure 2.5.40: Frequencies of measurements divided over 5 mm size classes on the flake scar breadth of medullar flake scars on horse marrow-bone fragments (N=148) and the flake breadth of encountered bone flakes from Schöningen 13II-4 bone assemblage (N=197). Mean Impact Scar Breadth = 45.6 mm. & Mean Impact Flake Breadth = 38.3 mm.

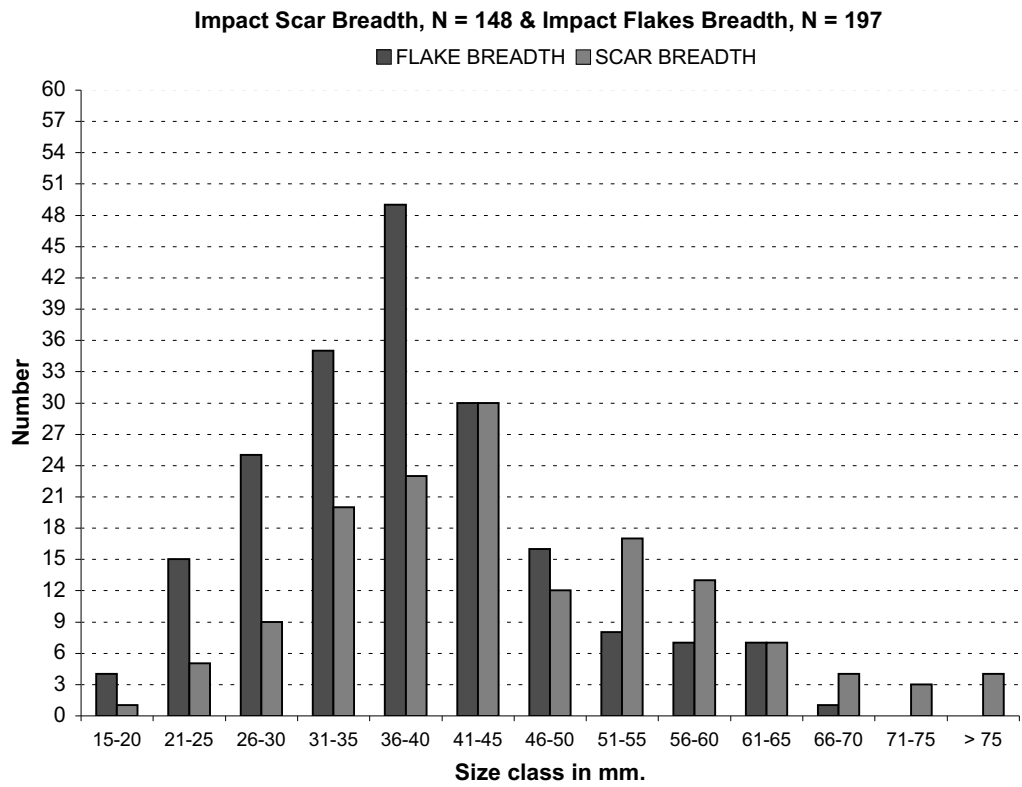
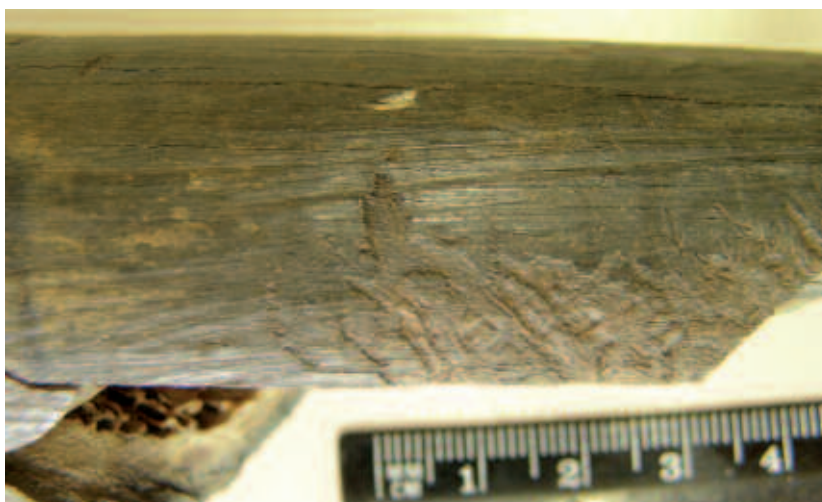


Figure 2.5.41: Impacted areas with clusters of percussion pits encountered on a Schöningen 13II-4 horse metapodial (above, findnumber 689/20-100) and on a horse femur shaft part covered with scraping marks (below, findnumber 691/29-3).



Capaldo and Blumenschine also measured impact flake scars on the medullary surface of impacted bone fragments (see Figure 2.3.10).

Their ratio of Flake Scar Breadth / Maximum Notch Depth reflects the relative thickness of the collective body of detached bone flakes from impact notches. Their Bovid size 3 percussion sample includes only 3 percussion notch / flake scar measurements which is considered to be too marginal to compare with the relatively large Schöningen sample. The ratio frequencies on the relative thickness of the collective body of detached bone flakes from impacted Schöningen 13II-4 horse bone remains is shown in Figure 2.5.39. Individual measurements on impact notches and impact flake scars for comparison with other assemblages are provided in the Appendices.

To check for possible similarities between encountered medullary impact scars on impacted horse marrow-bone fragments and encountered bone flakes in the Schöningen 13II-4 bone assemblage sample, the distribution of flake scar breadth dimensions and the bone flake breadth dimensions have been compared. Figure 2.5.40 shows both distributions of the measurement frequencies over 5 mm size classes. A methodological problem arises with this comparison though. Bone flakes could not be determined to a mammal genus level and therefore also bone flakes from other than horse sized mammals will be included.

Inferences by making use of statistical comparisons therefore will be dangerous. But, as Figure 2.5.40 demonstrates, the size distributions over 5 mm classes for both flake scar breadth and bone flake breadth are comparable.

Capaldo and Blumenschine (1994) classified impact notches by defining impact notch types with which notch assemblages created by different actors can be compared. As with the measurements on impact notches and scars, they provide only a relatively small sample. Very recently though Domínguez-Rodrigo et al. (2007) supplemented the work of Capaldo and Blumenschine with larger samples. Domínguez-Rodrigo et al. found that the relative distribution of notch types differs in impact notch assemblages created by humans and carnivores. The authors use three main defined impact notch types to compare with:

- 1 *Complete impact notches*: having two inflection points on the cortical notch surface and one flake scar on the medullary surface (defined as 'Complete notches' in Capaldo and Blumenschine 1994, and as 'Single complete impact notch' in this study).

- 2 *Overlapping notches*: having medullary overlapping adjacent impact flake scars (defined as 'Incomplete type C notches' in Capaldo and Blumenschine 1994, and as 'Double, paired, notches' in this study).
- 3 *Double opposing notches*: are two complete notches that are present on opposite sides of a fragment and result from two opposing loading points (defined as 'Bipolar impact notches' in this study).

Table 2.5.53 shows frequencies on the three impact notch types derived by Domínguez-Rodrigo et al. during experimental studies involving bone-marrow consuming hyenas (Maasai Mara hyena den) and bone-marrow processing by humans. These studies demonstrated that the overlapping and opposing type of impact notches are far better represented in the hyena sample, while more than half of the notch types in the human butchered samples consisted of single complete notches. Frequencies of the three notch types derived from the Schöningen horse assemblage show values intermediate to those obtained from the Domínguez-Rodrigo et al. hyena and human samples. The Schöningen values on complete and overlapping notches are more in line with those obtained for the experimental human butchered values, while the value for opposing notches is more in line with that of the hyena sample (Table 2.5.53). Hyenas are unique in their capability to crush complete and heavy long-bone shafts to reach marrow. Virtually no recognisable signs of hyena-induced traces have been found among the Schöningen 13II-4 horse remains though, with most damage pointing towards wolves as most likely agent. The use of anvils during bone breakage could be a cause for the presence of opposed notches. This however remains to be investigated. Additional evidence for the use of anvils during bone breakage is lacking.



	Maasai Mara hyena den (N=132)		Human butchered large carcasses (N=77)		Human butchered large and small carcasses (N=146)		Schöningen 13II-4 horse remains (N=207)	
	N	%	N	%	N	%	N	%
Complete notches	45	34.0	59	76.6	101	69.0	95	45.9
Overlapping notches	46	34.8	10	12.9	19	13.0	41	19.8
Opposing notches	21	15.9	7	9.0	11	7.5	40	19.3

Table 2.5.53: Comparisons of frequencies for three impact notch types found by Domínguez-Rodrigo et al. (2007) during experimental studies and during this study on marrow-processed horse bone remains.

From the work of Capaldo and Blumenshine, Domínguez-Rodrigo et al. and comparisons in this study, can be concluded that the use of measurements and types of impact notches and scars is promising but still needs to be refined by making use of many large archaeological and experimental samples from different mammalian species to derive sound models for future research.

Altogether, data on horse marrow-bone breakage and long-bone trace frequencies are in favour of a primarily hominid cause, being horse bone-marrow procurement executed by hominids. The main arguments for this can be listed as follows:

- 1 A scarcity of carnivore gnawing traces, like scores and pits, associated with cortical impact notches.
- 2 A reduced carnivore gnawing incidence from the proximal and distal long-bone parts towards the mid shafts of marrow-bearing horse long bones.
- 3 A spectrum of relative plan forms of impact notches indicative of a dominance of arcuate notch forms.
- 4 Frequencies of impact notch types more in line with those derived from human-butchered bone assemblages than from hyena assemblages.
- 5 The frequent appearance of identical impacted areas of marrow-bearing horse elements to facilitate marrow procurement, being indicative of systematic and standardised marrow processing of horse skeletal elements.
- 6 The presence of stone-tool scraping marks on horse marrow-bearing bones only.
- 7 The presence of percussion pits on horse marrow bone parts and fragments.

Young horse bone remains and butchery indicators

Only a few butchery traces have been encountered among horse bone remains which are believed to originate from foals or juvenile horse individuals. Cut marks observed on a juvenile mandibula part, a foal scapula and a foal rib indicate that at least one of in total three counted horse foals have been butchered by hominids, proof of

involvement of hominids with the encountered juvenile horse individuals. Of the observed long-bone leg elements with characteristics indicating still unfused epiphyseal ends or proportions indicating a juvenile horse origin, none exhibit cut marks or impact scars created during bone-marrow processing (see Figure 2.5.42 for examples of encountered horse foal and juvenile long-bone shafts lacking butchery traces). Three unfused femur specimens yielded cut marks and two unfused femur long-bone specimens yielded impact notches and scars created during marrow procurement. Although still unfused, based on the dimensions of these unfused horse femora, the specimens are derived from sub-adult individuals (see Section 2.5.4 for a discussion on horse age indicators). Table 2.5.54 (lower part, below) lists the frequencies of modification traces encountered on horse bone specimens derived from skeletal elements believed to be of juvenile horse individuals. For comparison modification frequencies have been provided for horse bone specimens from the same skeletal elements but with complete elements and juvenile specimens excluded (Table 2.5.54 upper part, above). The listed frequencies show percentages of carnivore gnawed, cut-marked and impacted juvenile horse element bone specimens which are the opposite of those obtained for sub-adult and adult element bone specimens. Gnawing percentages for juvenile specimens mostly exceed 50% with a mean gnawing percentage for all juvenile element bone specimens of about 49%. No traces of bone-marrow procurement have been encountered among the juvenile long-bone leg specimens which is in strong contrast to the 43% of impacted bone specimens on sub- and adult horse bone specimens. The virtually complete lack of and complete lack of leg elements butchery traces among juvenile horse bone specimens seems to have favoured the existence of high carnivore gnawing activity on these remains. Based on the present data, it seems that juvenile horse individuals have been butchered very selectively. The absence of bone-marrow processing indicators together with an absence of butchery traces on juvenile horse legs could indicate neglecting of immature bone marrow.



Leaving juvenile horse legs untouched will have left relatively large amounts of available nutrients on these parts to scavenging carnivores which could be reflected by the far higher carnivore gnawing frequencies encountered on juvenile horse bone specimens. It should be noted though that the sample of present juvenile horse bone specimens is far smaller when compared to sub-adult to adult specimens and thus should be interpreted with caution. It signals however a trend which should be further examined when the complete faunal remains assemblage from the Schöningen 13II-4 site will be subject of a thorough analysis.

Horse meat and marrow utility indices and inferences on horse butchery systematics

The encountered main characteristics of the Schöningen horse assemblage point to the presence of complete horse carcasses at the find location. All horse body parts, as well as skeletal elements, are represented and most are well represented. Both refits on fragmented bones and on anatomical units have been documented (see the sections on horse individual elements for descriptions on encountered anatomical refits). The encountered refits are proof of in situ deposition of still articulated horse anatomical units from both horse legs and axial parts. Also, frequencies of horse skeletal elements determined to body side of origin yield remarkable corresponding values. The same is true for the estimated number of horse skulls found when compared to the highest derived number of individuals on post-cranial material. Analysis of possible bone density mediated deletion of skeletal elements did not yield significant results pointing to bone density related removal of horse remains. This is in line with the limited proof of bone weathering and signs of diagenetic modification of horse bone remains. The responsibility for conspicuous discrepancies in horse body part representation therefore should rather be sought in the realm of recognised actors acting upon the Schöningen horse remains, being carnivores and hominids.

It is to be expected that, like carnivores, hominids chose the most nutrient carcass parts or products available. Hominid butchery traces and the exploitation of specific carcass parts are therefore expected to be related to available amounts of desirable food quality. To check for such relationships and possible selection on high nutrient body parts, Food Utility Indices (FUI) can be used. Outram and Rowley-Conwy (1998) developed FUI for modern horse carcasses. Their FUI for horses is derived from a General Utility Index (GUI) based on mean meat and mean marrow weight, in kilograms, butchered and



Figure 2.5.42: A horse foal humerus with unfused distal shaft, on the left (findnumber 687/23-16). A horse juvenile tibia with unfused distal shaft, on the right (findnumber 689/24-12). Both specimens lack butchery traces and have been carnivore-gnawed on their proximal shaft ends. The ruler on the left measures 15 cm. Photo by the author.

removed from horse skeletal elements. Both the GUI and FUI can be used to check for selection on body parts, but the mean meat and marrow weight values can be used to compare to individual horse elements as well. Table 2.5.55 lists the horse utility indices together with derived main horse representation indices for the Schöningen assemblage sample.



Table 2.5.54:

Above: Frequencies of carnivore gnawed (-gnaw), cut-marked (-cut) and marrow-processed (-imp) horse marrow-bearing and leg element bone specimens (on NISP), but juvenile and complete element specimens excluded.

Below: Frequencies of carnivore gnawed (-gnaw), cut-marked (-cut) and marrow-processed (-imp) juvenile horse marrow-bearing and leg element bone specimens only (on NISP).

Horse juvenile and complete long bone elements excluded							
Skeletal element	NISP	NISP-gnaw	%gnawed	NISP-cut	%cutmarked	NISP-imp	%imp
Mandible	89	6	6.7	32	35.9	24	26.9
Scapula	24	5	20.0	6	25.0		
Humerus	125	21	16.8	75	60.0	68	54.4
Radius	143	18	12.5	84	58.7	69	48.2
Ulna	31	8	25.8	10	32.2	6	19.3
Metacarpus	25	1	4.0	9	36.0	7	28.0
Femur	157	15	9.5	93	59.2	74	47.1
Tibia	180	19	10.5	77	42.7	99	55.0
Calcaneus	12	5	41.6	1	8.3	0	0
Metatarsus	46	3	6.5	32	69.5	14	30.4
Total	832	101	12.1	419	50.0	361	43.3
Horse juvenile elements only							
Skeletal element	NISP	NISP-gnaw	%gnawed	NISP-cut	%cutmarked	NISP-imp	%imp
Mandibula	6	0	0	1	16.6	0	0
Scapula	7	3	42.8	1	14.2	0	0
Humerus	3	2	66.6	0	0	0	0
Radius	2	1	50.0	0	0	0	0
Ulna	2	2	100.0	0	0	0	0
Metacarpus	4	3	75.0	0	0	0	0
Femur	15	8	53.3	0	0	0	0
Tibia	5	3	60.0	0	0	0	0
Calcaneus	4	2	50.0	0	0	0	0
Totals	48	24	48.7	2	4.1	0	0.0

Regression analysis between horse GUI values and the %SURV for the Schöningen horse elements did not yield statistical relationships between the two variables, with a derived R^2 of 0.026, there is neither a positive nor a negative relationship detectable. Analysis with using the %MNI against the GUI for the horse assemblage yields a lesser relation coefficient of $R^2 = 0.005$. Analysis of a possible relationship between the Meat Utility Index and the %SURV for horse elements also did not yield a significant relationship, $R^2 = 0.025$. Regression analysis between the Marrow Utility Index and the %SURV for marrow-yielding (long bones and the mandibula only) horse elements however did yield a significant correlation of $R^2 = 0.607$ (Figure 2.5.43). How to interpret these outcomes? The recorded high butchery intensity on marrow-bearing horse bone elements together with the systematic and standardised processing of these elements point to a focus on horse marrow-yielding body parts by butchering hominids. Clearly horse bone marrow was a favoured product seeing the high numbers of systematically processed marrow bones. The observed correlation between the amount of representation of marrow-bearing elements and bone-marrow values can be interpreted as the intentional selection and

processing of those horse elements which are most rich in marrow. However another factor related to marrow-yielding horse skeletal elements is relevant. Horse leg long bones are relatively poor in bone marrow when compared to species like Cervids, but they are much larger and weigh much more. Also, with regard to horse leg meat yields, when compared to other species, there is an extreme bias towards the upper legs (Outram and Rowley-Conwy, 1998, and see Table 2.5.55). Outram and Rowley-Conwy (1998) state:

“Of the limb bones, the femur carries by far the most meat, with a massive average of 20.25 kg. We can testify that the roll of meat cut from a horse femur presents quite a transportation challenge on its own” (Outram and Rowley-Conwy, 1998, p. 841).

From the horse upper limbs down to the radius, tibia and metapodials, meat values decrease dramatically. The order of survival frequencies on cut-marked and marrow-processed specimens among the Schöningen horse leg elements could be related to butchery of the meatiest leg parts. Boning the large and heavy leg long bones will have facilitated the production of netto meat yields, while the released bones simultaneously will have been available for



Skeletal element	Utility Index Meat	Utility Index Marrow	GUI	(S)FUI	%SURV	%MNI
Mandible (& tongue)	3.25	0.036	3.29	7.4	63.1	63.1
Atlas & Axis	3.50	0	3.50	7.8	49.9	50.0
Cervical vertbr.	20.25	0	20.30	45.2	45.2	42.1
Thoracal vertbr.	44.75	0	44.80	100.0	49.7	42.1
Lumbar vertbr.	10.00	0	10.00	22.4	51.7	57.9
Scapula	6.75	0	6.75	15.0	52.6	52.6
Humerus	5.75	0.041	5.79	14.5	57.9	63.1
Radius & Ulna	1.50	0.024	1.52	4.5	43.3	47.3
Metacarpus	0	0.011	0.01	1.1	28.9	31.5
Pelvis	23.75	0	23.80	53.0	34.2	36.8
Femur	20.25	0.072	20.30	95.4	97.3	100.0
Tibia	2.25	0.033	2.28	20.2	73.6	78.9
Metatarsus	0	0.009	0.01	43.1	50.0	52.6
Phalanges	0	0.001	0	0.9	17.0	-

Table 2.5.55: Utility indices for modern horse carcasses (meat, marrow and GUI in kg.), together with derived representation indices for the horse remains, taken from Outram and Rowley-Conwy 1998.

marrow processing. The observed positive correlation between marrow values and %SURV of horse marrow-bearing elements therefore can be related to both meat values and marrow yields because with regard to horses anatomically both are interrelated. The counted MNI-cutmarked of 16 on the Schöningen horse femora, being by far the highest counted on butchered horse skeletal elements, can therefore be considered to reflect a hominid-butchery focus on both the high meat and high marrow valued horse upper hind legs (see also Figure 2.5.36). A focus on bone marrow by butchering hominids is further supported by the second best on MNI-cutmarked represented horse skeletal element, the mandible. For horse mandibles a co-occurrence of high meat value and marrow cannot be postulated. Even with the

tongue included, the mandible meat value is among the lowest for horse elements. With regard to bone-marrow value though the mandible ranks third after the femur and humerus, but higher than the horse lower leg elements (Outram and Rowley-Conwy, 1998). Apart from the upper hind leg, other horse body parts associated with high meat yields are the neck and thorax. Outram and Rowley-Conwy (1998) measured the thorax meat with ribs and thoracic vertebrae articulated, as one complete unit. The horse thorax yields the highest amount of meat of all body parts, followed by the upper hind and neck (Table 2.5.55). While the Schöningen horse remains exhibit butchery indices for leg elements following meat and marrow yields, this is not true for the axial elements.

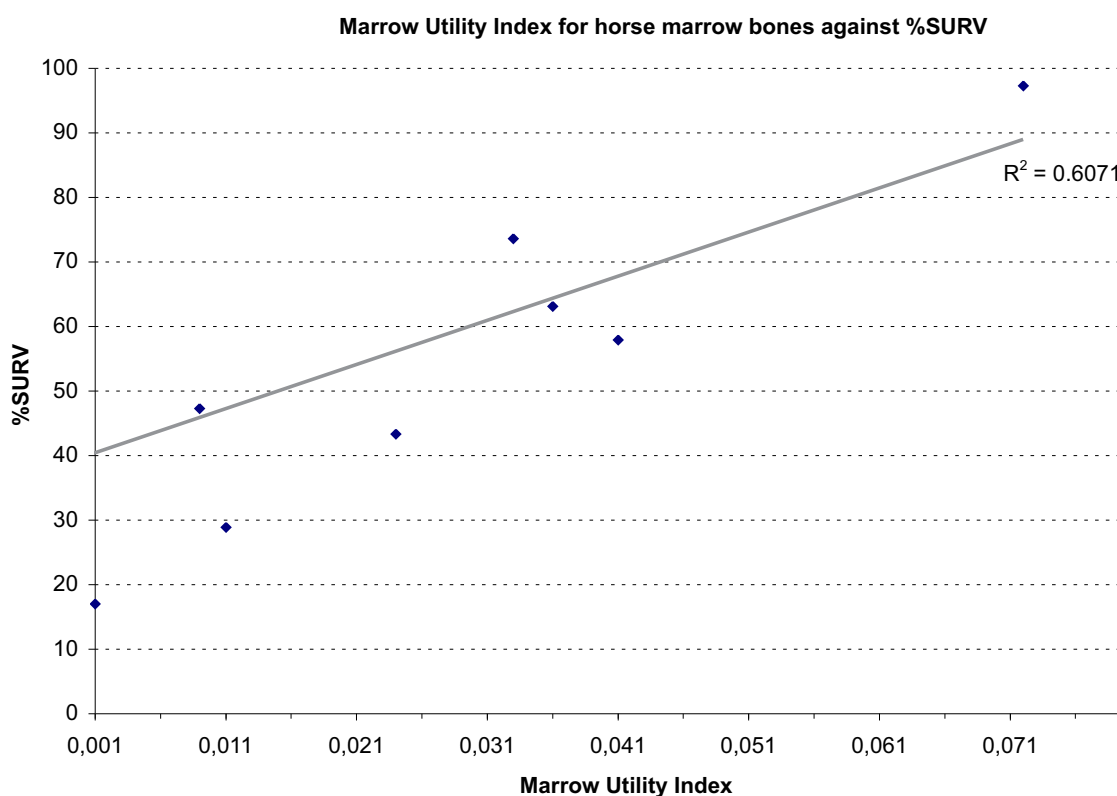
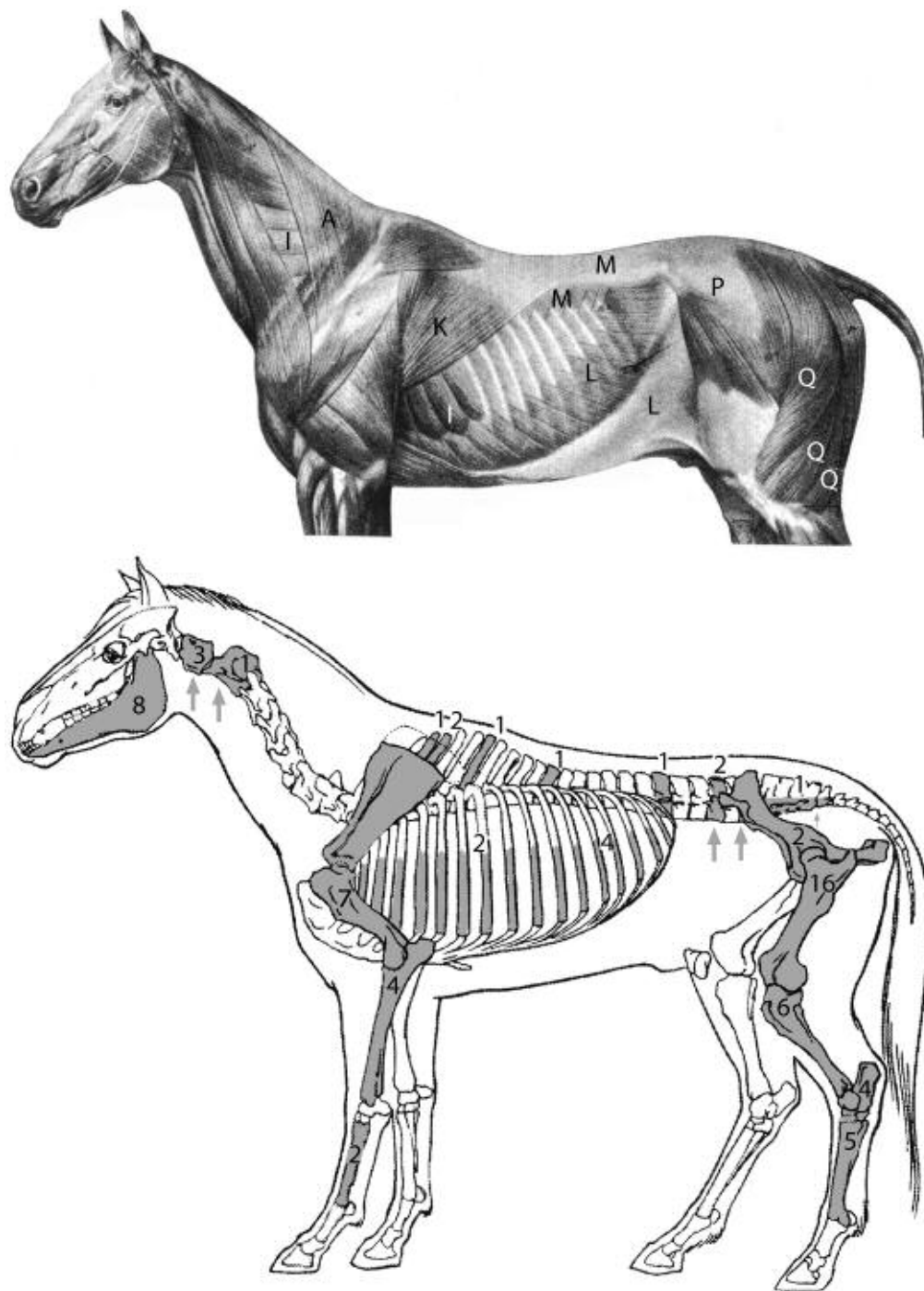


Figure 2.5.43: Marrow Utility Index against the %SURV for horse marrow-bearing elements only, data taken from Table 2.5.55.



Figure 2.5.44:
 Above: Anatomical drawing of
 the superficial muscles of
 horse, taken from Getty, 1975,
 p.394. Below: One sided
 projection of cut-marked
 Schöningen horse skeletal
 elements and their calculated
 cut-marked MNIs.



Related to the upper hind meat mass are both the femur and pelvis, with most meat being concentrated around the pelvis. When compared to the representation of horse femora, the pelvis is moderately represented and exhibits relatively few cut-marked specimens. As outlined earlier, the same is true for cut-marked indices on the sacrum, vertebrae and ribs, while in general they are well represented. The derived butchered MNIs for axial elements are however in proximity, ranging from 1 to maximal 4 for the caudal part of the ribcage (Figure 2.5.44). Conspicuous is the complete lack of cut marks on the horse cervical vertebrae (excluding the atlas and axis), while this body part ranks third on meat yields and is expected to be valued with regard to

meat directed butchery. Discussions on observed butchery traces with a Dutch professional butcher taught us however that this observation does not necessarily mean that horse necks were neglected during butchery. Before actually knowing about the butchery patterns observed among the horse remains, an absence of cut marks on cervical vertebrae was predicted by the butcher. The reason for this prediction is the practice of modern butchers to cut generously around the cervical vertebrae column to remove it as a complete unit without coming even near the vertebrae while filleting (Morang, 2005, pers. comm.). This method is used simply because too many tendons and muscle attachments are concentrated around the horse



cervical column making more thorough filleting of the neck region a very labour-intensive job. Confirmation of the predicted led to a surprise because this could indicate comparable butchery methods separated by an enormous time depth (Morang, 2005, pers. comm.). Methodologically this could be an example of “absence of evidence being not necessarily evidence of absence”. Disarticulation of horse heads from necks is indicated by the documented cut-marked atlas and axis specimens and butchery of the neck can therefore at least be expected to have occurred.

From the feet on to the upper legs, horse elements are better represented. Butchery marks on these elements point to the systematical boning of horse leg long bones after which these have been marrow processed in most cases. Elements from the hind legs are best represented and also yielded the highest cut-marked indices (Figures 2.5.33 and 2.5.44). Cut marks resulting from dismembering leg elements have been encountered on the proximal metatarsus, on the tarsals, the distal tibia, the distal femur and proximal femur. From this pattern can be inferred that the femur and tibia have mostly been completely disarticulated from the legs prior to marrow processing. The virtual absence of proximal tibia parts can partly be explained by a focus on the area near the proximal epiphysis during marrow processing, which possibly led to fragmentation of these vulnerable parts. The horse astragalus-calcaneus units did not yield dismembering marks while being represented quite well. Many distal tibia parts have been removed by impacting the area just above the distal end. This together with dismembering marks encountered on the tarsals likely point to the removal of part of the distal tibia together with the astragalus-calcaneus unit down to the tarsals at the same time. This is supported by the encountered refits between astragali and calcanei pointing to deposition while in an articulated state. Dismembering cut marks on the tarsals and the proximal metatarsus point to dismemberment by cutting. None of the encountered distal metatarsus specimens did yield traces of dismembering by cutting though and neither did the survived horse first phalanges. The distal metatarsus, and metacarpus, to the first phalange joint is a tough, stiff joint which is not easily dismembered by cutting.

On encountered distal metacarpus parts, no cut marks resulting from dismembering the metacarpus to phalange joint have been encountered. Proof of dismembering the proximal metacarpus from the carpal unit does exist but none of the documented

carpals yield cut marks. Distal horse radii are virtually absent. Impacting of the distal, near distal epiphysis, radii shafts have been frequently observed which could indicate destruction of the distal radii during marrow processing, as postulated for proximal tibiae. Cut-marked proximal radii and ulnae specimens point to the dismemberment of these element parts from the distal humerus. This is also reflected by dismembering marks frequently encountered on distal humeri. Dismembering of the proximal humerus from the scapula is indicated by cut marks present on both proximal humerus fragments and the articulating parts of scapulae.

No indications for the disarticulation of horse ribs from the thoracic vertebrae have been encountered, and both elements were cutmarked mostly locally, vertebrae on their spinous processes on one side only, and ribs laterally only and almost all cut-marked specimens are cut from their medial to distal parts. The horse thorax cut-mark distributions seem to indicate occasional local marking of elements and seem not to reflect intensive butchery directed at removing as much tissue as possible from these parts. Possible removal of thorax segments is expected to become visible through representation indices. Of course it cannot be ruled out that some carcass segments have been removed and eventually taken away for secondary butchery. However, both cut-mark distributions and representation indices for horse axial elements do not reveal straightforward indications for the removal of axial sections. This is also supported by the assumption that carnivores destructed part of the axial horse elements influencing to some extent actual representation indices, which likely originally will have been even more pronounced. To gain more insight into the functional meaning behind specific cut-mark locations on horse skeletal elements, studies of modern horse anatomy have been used to compare with (see Figure 2.5.44 for an anatomical drawing of the superficial musculature of horses, and the sections on individual horse elements). From this can be inferred that the distribution of cut marks encountered on horse ribs could be associated with cutting through the *serratus ventralis thoracis* and *obliquus externus abdominis* muscles (see Figure 2.5.44 above: marked with I and L). Modern butchers do not value the meat yield derived from a horse ribcage and believe these cut marks are rather to be associated with cutting loose horse skins together with the underlying muscle tissue (Morang, 2005, pers. comm.). Skinning of horse carcasses could provide an explanation for the virtual absence of horse caudal vertebrae and the pronounced under-representation of phalanges among the remains (see the %SURV for



horse elements in Figure 2.5.35). Of the phalanges present, none yielded cut marks or other signs of modification apart from carnivore gnawing traces. Both caudal vertebrae and phalanges could be under-represented because of being left attached to horse skins after removal of these skins. The cut-marked horse vertebrae mostly are derived from the most cranial and caudal part of the horse vertebrae column, the thoracic vertebrae numbers 1 to 9 and the lumbar vertebrae numbers 4 to 6 (Figure 2.5.44). Cutmarking of these vertebrae could be related to cutting through the heavy, amongst others, *latissimus dorsi* and *trapezius* muscles (a' and k in Figure 2.5.44 above) connecting the upper front leg and neck with the thorax, and the *fascia*, *gluteal* and *biceps femoris* muscles (P, M and Q in Figure 2.5.44 above), connecting the upper hind with the thorax. Cutting of these muscle bundles would have facilitated loosening the upper front and upper hind body parts. Cut marks present only on the spinous processes almost entirely indicates relatively superficial cutting and not intensive filleting of these parts. At the spinous processes the vertebrae are closest to the skin. Skinning could have been combined with the removal of meat from the upper front and upper hind horse body parts. Combined skinning and filleting of meat from the ribcage onwards up to the upper front and upper hind, while cutting bone only at areas closest to the skin, could have provided loosening of the front and hind legs from the axial body part together with skin remaining attached to meat packages derived from these part. Also a large and heavy bone like the pelvis could remain articulated, thus minimising meat package weight. After removal of the horse legs, these could be dismembered and boned separately to facilitate systematic bone-marrow processing of the long bones. Removal of the long bones would have left meat in skin packages minimized in weight. This could be one possible scenario of horse butchery systematics to account for the observed butchery patterns.

The indications for wolves being the carnivore agent responsible for scavenging horse remains predicts that hominid butchery will have determined what was available to these scavengers. By inference, horse carcass parts or skeletal elements being less depleted of food value during butchery by hominids will have been nutritionally most attractive to scavenging wolves. For horse long-bone leg elements after being marrow processed, this will have been the cancellous greasy long-bone epiphyseal ends. Among the horse long-bone remains, these parts yielded most carnivore-gnawed specimens although with regard to wolves, contrary to large carnivores like

hyenas, long-bone gnawing patterns mostly are centred on and near the epiphyseal ends. Figure 2.5.45 shows the percentages of gnawed and cut-marked bone specimens derived from horse skeletal elements on their NISPs, with all element fragments included. Gnawing percentages dominating over cut-marked percentages have been derived for the horse phalanges, astragalus, patella, carpals, cervical vertebrae and hyoid bones. Gnawing percentages almost equalling cut-marked percentages have been documented for the calcaneus, pelvis, sacrum, lumbar vertebrae, thoracic vertebrae and slightly less for the ribs. All axial horse elements exhibit higher gnawing percentages when compared to horse leg elements except the patella, carpals, phalanges and the astragalus-calcaneus units. These elements did not yield any traces of butchery and are believed to be neglected during dismemberment of the horse legs (see above). Only superficial butchery of axial horse body parts could have resulted in abundant meat and tissue remaining on axial elements. For example, superficial filleting of meat from the pelvis will have left a high amount of nutrients available because of the concentrations of muscle and tendon attachment areas on this element. This could be reflected by the high percentages on carnivore gnawing and gnawed MNIs for several axial elements.

It is dangerous to infer contemporaneity of deposition of the counted horse individuals, because of the unknown time depth the overall accumulation of bone remains at Schöningen represents. However some data on the horse remains are in support of a relationship between the remains, possibly reflecting limited time-spaced depositional events. Apart from the stable geological and fast covering sedimentary context indicated by limited weathering, the encountered vertical refits on horse bone material are proof of an originally vertically limited findlayer. Anatomical refits on horse skeletal elements and on modified horse bone remains demonstrate in situ deposition of horse carcass parts and bone remains related to activities modifying skeletal elements. Horse individual age indicators could be indicative of the presence of a horse group structure, because of the presence of foals which would point to a catastrophic event killing part of a horse family group. The documented butchery traces encountered on horse remains are very homogeneous with regard to their characteristics and patterns. Butchery of a single adult horse for meat from the highest meat yielding body parts only (upper hind, neck and thorax) already could produce a net meat weight of between 95 and 109 kilograms, which is a considerable amount (calculated from Outram and Rowley-Conwy, 1998). Selective butchery of horse



Horse bone NISP, %-gnawed versus %-cutmarked (on NISP)

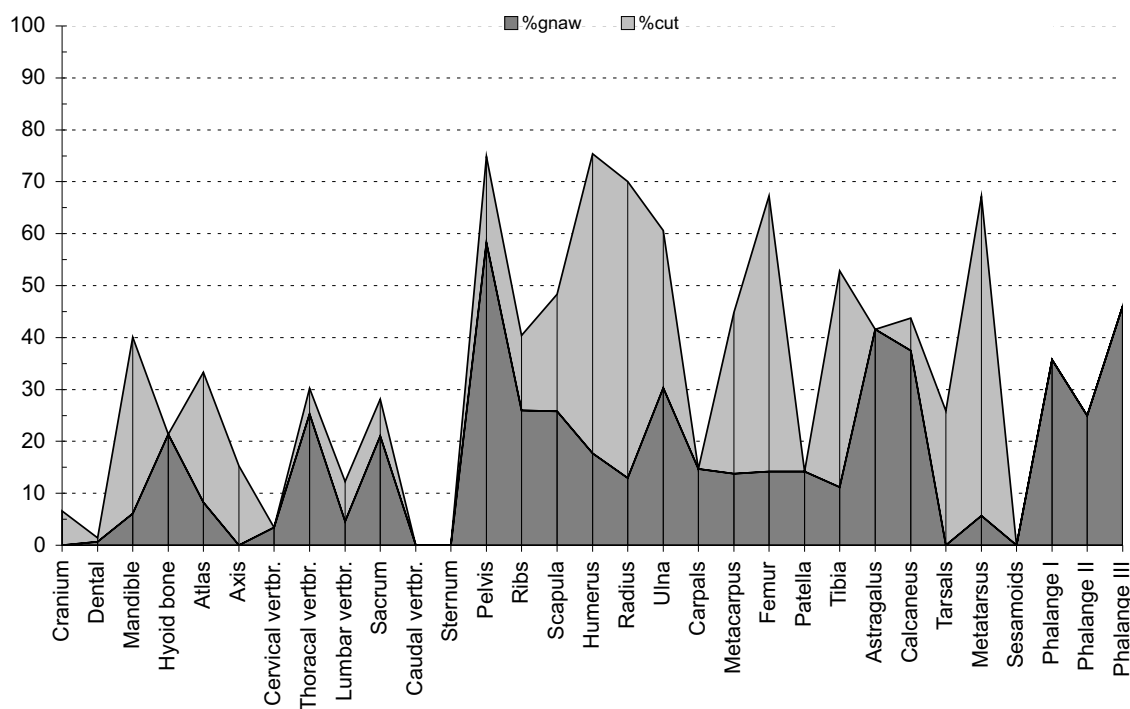


Figure 2.5.45: Comparisons of the % carnivore gnawed and % cut-marked bone specimens derived from horse skeletal elements (on NISP).

carcasses could be explained by an abundance of available meat exceeding intended meat amounts to be consumed or transported by hominids. Vice versa, the indication of selective carcass butchery is in support of a catastrophic depositional event involving several horse individuals to accomplish a more than sufficient meat abundance. The inferred butchery systematics on horse bone remains indicate, apart from meat acquisition, that bone marrow was highly valued and accordingly systematically processed from available horse marrow bones. Apart from these two horse consumable products, also horse hides may have been valued and collected. The documented butchery traces and patterns encountered among the Schöningen 13II-4 horse remains seem to indicate early hominid butchery systematics designed in such a way that they achieve the most effective acquisition of multiple-valued horse products at the same time.

2.5.7 The horse data summarised

The data and conclusions derived from the analysis of the Schöningen 13II-4 horse remains can be summarised as follows:

- 1 Horse bone remains dominate among the taxonomically determined bone remains with 94.8%.
- 2 All horse skeletal elements are represented, although some in larger amounts than others, bone density mediated destruction of elements has not been recognised.
- 3 Data on bone weathering, post-depositional

damage, as well as encountered refits, both on fractures and anatomical, on horse bone specimens indicate in situ deposition and fast covering of horse remains.

- 4 A horse MNI of 19 has been established on the femur. Among these counted horses are three foals, sub-adults and adult horse individuals among which at least one stallion and some mares. A thorough horse aging study to derive a mortality profile has not been undertaken, but the presence of foals could indicate that a horse family group is represented among the remains.
- 5 Horse carcasses have been scavenged by carnivores. Carnivore gnawing traces and gnawing patterns point to wolves as the most likely agent having secondary access to the horse remains. The carnivore gnawed percentage for horse remains is just over 16%. Bone density mediated destruction caused by carnivore ravaging could not be recognised.
- 6 Butchery traces induced by stone tools are abundantly present among the horse remains, with cut marks present on 23% of the remains.
- 7 Butchery traces on horse leg elements indicate the dismemberment, filleting, boning and sometimes complete defleshing of leg marrow bones. Butchery traces encountered on non-leg horse body parts indicate selective meat removal possibly combined with skinning of horse carcasses.
- 8 Bone-marrow processing of horse marrow bones occurred extensively. Impact notches and impact scars created during bone-marrow processing



Table 2.6.1: Determined deer bone specimens and deer skeletal element representation indices.

- have been encountered on 42% of the bone specimens derived from marrow-bearing horse skeletal elements.
- 9 Bone-marrow processing of horse bones appears to have been executed systematically and standardised. There are some indications that juvenile horse marrow bones were neglected during marrow procurement, but one horse foal apparently has been butchered for meat.
 - 10 Some specific horse skeletal elements, especially metapodials, likely have been used for stone tool production and/or curation.

2.6 The deer remains

2.6.1 Preservation and characteristics of the deer remains

The Schöningen 13II-4 faunal sample yielded a total of 60 bone specimens which are believed to originate from deer (Table 2.6.1). Some diagnostic skeletal elements, like a tarsal unit and a cervical vertebra, as well as the morphology of antler parts indicate the presence of red deer, *Cervus elaphus*. Most deer bone specimens could however not exactly be

Skeletal element	NISP	%	MNE	MNE-sin	MNE-dex	MNI
Antler	16	26.6	3	0	0	2
Dental	0	0	0	0	0	0
Mandible	1	1.6	1	0	0	1
Hyoid bone	0	0	0	0	0	0
Atlas	0	0	0	0	0	0
Axis	0	0	0	0	0	0
Cervical vertebrae	1	1.6	1	0	0	1
Thoracal vertebrae	0	0	0	0	0	0
Lumbar vertebrae	0	0	0	0	0	0
Sacrum	0	0	0	0	0	0
Caudal vertebrae	0	0	0	0	0	0
Pelvis	0	0	0	0	0	0
Ribs	7	11.7	3	1	1	1
Scapula	1	1.6	1	0	1	1
Humerus	2	3.3	1	1	0	1
Radius	2	3.3	2	1	1	1
Ulna	1	1.6	1	1	0	1
Carpals	0	0	0	0	0	0
Metacarpus	0	0	0	0	0	0
Femur	1	1.6	1	0	1	1
Patella	0	0	0	0	0	0
Tibia	5	8.3	3	2	1	2
Astragalus	2	3.3	1	1	0	1
Calcaneus	1	1.6	1	1	0	1
Tarsals	0	0	0	0	0	0
Metatarsus	2	3.3	2	1	1	1
Sesamoids	0	0	0	0	0	0
Phalange I	1	1.6	1	0	0	1
Phalange II	2	3.3	2	0	0	1
Phalange III	2	3.3	2	0	0	1
Total	47	77.6	26	9	6	2
Vertebrae fragment	1	1.6	1	0	0	1
Femur or Humerus	1	1.6	0	0	0	0
Metapodium	3	5	0	0	0	0
Carpal or Tarsal	1	1.6	1	0	0	1
Longbone fragm.indet.	7	11.6	0	0	0	0
Total	60	99.0	28			



determined to species level and thus the material is assigned to *Cervus* sp. Among the antler specimens are three naturally shed crowns. These specimens likely represent natural depositions. An MNI of 2 has been established on antler and tibia parts and an equal MNI-cutmarked of 2 on cut-marked deer tibia remains. Carnivore gnawing traces are well represented among the deer remains, but the same is true for butchery cut marks created by stone tools (Table 2.6.2). Of all deer bone specimens, about 20% has been carnivore gnawed and about 16% exhibit cut marks. Cut marks caused during dismembering of

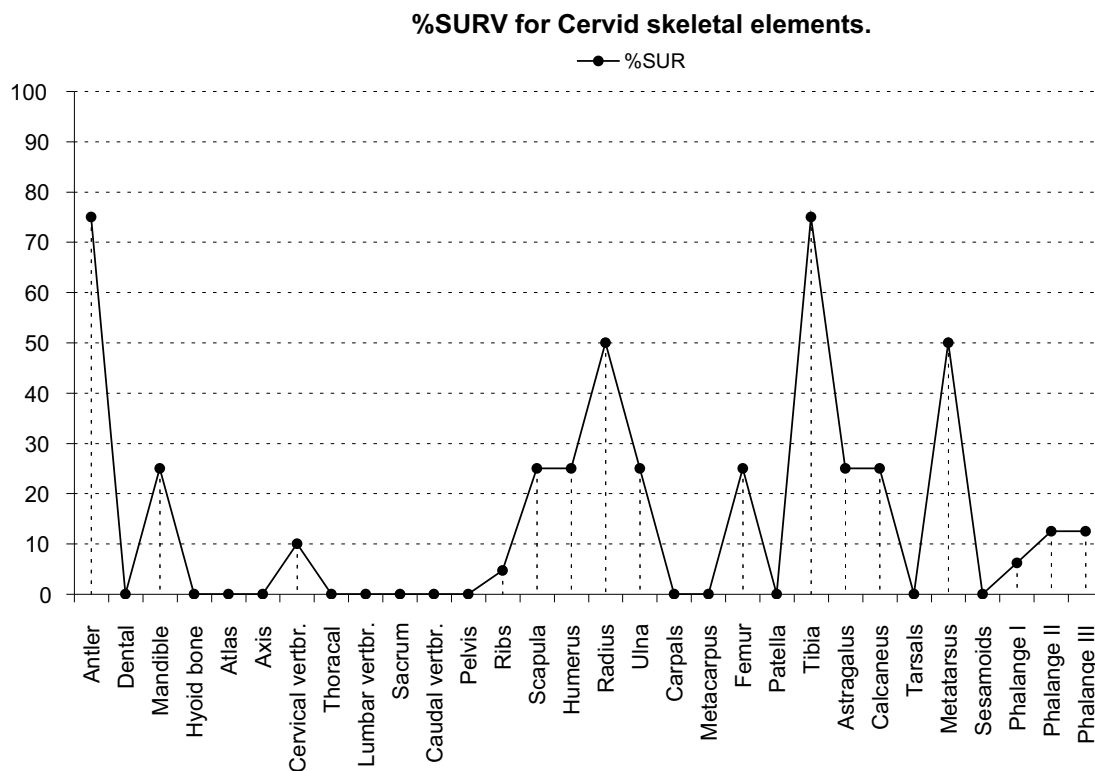
anatomical units and during meat filleting are equally represented. Cut marks from filleting have been observed in 6 cases and from dismembering in 5 cases. When compared to the horse and bovid remains (see Section 2.7), impact notches and impact scars created during long-bone marrow procurement are relatively scarce among the deer long-bone specimens, with only four impact notch observations, accounting for 6%. However, this low number should be considered to be also related to the overall low number of long-bone shaft fragments found among the deer remains. Conspicuous is the fact though that

Table 2.6.2: Frequencies for diagnostic modification traces documented for deer skeletal elements and bone specimens.

Skeletal element	NISP	MNE	MNI	%SURV	NISP-gnaw	%gnaw	NISPcut	%cut	NISP-imp	%imp
Antler	16	3	2	75	1	6.2	0	0	0	0
Dental	0	0	0	0	0	0	0	0	0	0
Mandible	1	1	1	25	0	0	0	0	0	0
Hyoid bone	0	0	0	0	0	0	0	0	0	0
Atlas	0	0	0	0	0	0	0	0	0	0
Axis	0	0	0	0	0	0	0	0	0	0
Cervical vertbr.	1	1	1	10	0	0	0	0	0	0
Thoracal vertbr.	0	0	0	0	0	0	0	0	0	0
Lumbar vertbr.	0	0	0	0	0	0	0	0	0	0
Sacrum	0	0	0	0	0	0	0	0	0	0
Caudal vertbr.	0	0	0	0	0	0	0	0	0	0
Pelvis	0	0	0	0	0	0	0	0	0	0
Ribs	7	3	1	4.7	0	0	3	42.8	0	0
Scapula	1	1	1	25	1	100	0	0	0	0
Humerus	2	1	1	25	0	0	2	100	0	0
Radius	2	2	1	50	0	0	0	0	0	0
Ulna	1	1	1	25	0	0	0	0	0	0
Carpals	0	0	0	0	0	0	0	0	0	0
Metacarpus	0	0	0	0	0	0	0	0	0	0
Femur	1	1	1	25	0	0	1	100	0	0
Patella	0	0	0	0	0	0	0	0	0	0
Tibia	5	3	2	75	2	40	3	60	0	0
Astragalus	2	1	1	25	2	100	1	50	0	0
Calcaneus	1	1	1	25	1	100	0	0	0	0
Tarsals	0	0	0	0	0	0	0	0	0	0
Metatarsus	2	2	1	50	2	100	0	0	1	50
Sesamoids	0	0	0	0	0	0	0	0	0	0
Phalange I	1	1	1	6.2	0	0	0	0	0	0
Phalange II	2	2	1	12.5	0	0	0	0	0	0
Phalange III	2	2	1	12.5	0	0	0	0	0	0
Total	47	26			9		10		1	
Vertebrae fragment	1	1	0	0	1	100	0	0	0	0
Femur or Humerus	1	0	0	0	0	0	0	0	0	0
Metapodium	3	0	0	0	0	0	0	0	1	33.3
Carpal or Tarsal	1	1	0	0	0	0	0	0	0	0
Longbone fragm.indet.	7	0	0	0	2	28.5	0	0	2	28.5
Total	60	28			12	20.0%	10	16.6%	4	6.6%



Figure 2.6.1: Calculated %SURV for deer skeletal elements, data taken from Table 2.6.2.



three of the observed impact notches morphologically could well be the result of carnivore shaft destruction. Unambiguous marrow procurement of deer long bones by hominids cannot be inferred therefore.

Of the deer remains from ascribed layers, 13.5% (NISP=5) derives from the A to A/B layers, 62.1% (NISP=23) from the B layer and 24.3% (NISP=9) from layers B/C to C. Of all deer remains, 83% display none to very slightly weathered surfaces (weathering characteristics Group A) and only 5 bone specimens are more severely weathered (Group B). This is in line with the weathering spectre encountered among the horse remains. One deer bone specimen displays prominent rounding and one has been slightly rounded. Sedimentary striations were encountered on two deer bone specimens.

2.6.2 Deer skeletal element specific analysis

2.6.2.1 Cranium/Antler and mandible

Among the deer remains, 16 antler parts have been documented among which are three naturally shed antler crowns of *Cervus elaphus*. One of these specimens exhibits traces of carnivore gnawing. Because they are shed, the antler crowns likely are not associated with the deer remains yielding traces of butchery.

Only one, fragmented, deer mandible was found.

2.6.2.2 Vertebrae

Only one deer vertebra has been encountered, a cervical vertebra lacking modification traces.

2.6.2.3 Costae

No other axial deer skeletal elements have been found apart from seven deer rib parts. Of these, three specimens have been cutmarked but none have been carnivore gnawed. Cut marks were encountered on a deer rib articular part, a rib corpus and a corpus fragment. Cut marks on the lateral rib corpus indicate filleting or possible skinning of the trunk. Cut marks present on an articular part are indicative of the disarticulation of deer ribs from the vertebra column (Cos—1 & 2 cuts). Although numerous cut-marked horse ribs have been documented, none of these yielded comparable dismemberment marks. Apparently the dismemberment of ribs or rib slabs was thus limited to deer trunks.

One rib corpus part, which could not be ascribed to a specific genus but most likely derived from a deer individual, is not included in the deer rib counts. This specimen yields a conspicuous series of cut marks on the medial face (Figure 2.3.13). These cut marks point to either meticulous filleting of the medial rib side resulting from removing of organs or complete defleshing of the inside of the trunk, or it represents some kind of creative treatment of the rib by a stone-tool using hominid.



2.6.2.4 Scapula

One deer scapula from the right body side has been identified. The specimen lacks butchering traces but has been gnawed by carnivores. Based on the proportions of the scapula, this deer individual is either from a relatively small-sized deer species or from a juvenile individual.

2.6.2.5 Humerus

One complete distal epiphysis of a right-side deer humerus and a distal shaft fragment have been documented. Both specimens yielded cut marks indicative of dismemberment of the humerus from the radius. No carnivore gnawing marks have been observed. The specimens could be refitted with each other on a GBF fracture and derive from one and the same square metre.

2.6.2.6 Radius – Ulna

A complete deer radius shaft with both epiphyses unfused and missing, as well as a distal radius shaft fragment have been encountered. Traces of modification are absent. Also an unfused deer ulna has been found, again lacking any traces of modification. These specimens indicate the presence of at least one juvenile deer individual.

2.6.2.7 Metacarpals and carpals

No remains of deer metacarpals or carpals have been encountered.

2.6.2.8 Femur

Only one deer femur bone specimen has been documented, a distal shaft fragment of a right-side femur. This specimen has been cutmarked during filleting of meat.

2.6.2.9 Tibia

In total five deer tibia fragments have been documented. Three proximal shaft and two mid shaft fragments. Two of the proximal shaft fragments are identical, from the cranial border area and from a left-side tibia. Both specimens also bear butchering cut marks and thus represent an MNI-cutmarked of 2. Both specimens also yield traces of scraping off of tissue and both specimens have been carnivore gnawed. Gnawing traces located on the proximal ends of the fragments indicate carnivore destruction of the proximal tibia epiphysis.

Costae Butchering traces

Code	Placement and characteristics	Inferred activity
Cos-1	Short transversal cuts on the lateral face between the articular facets.	Dismembering of the costae-vertebra joint (cf. Binford 1981: approx. RS-3).
Cos-2	Short transversal cuts on the medial face just below the articular part.	Dismembering idem.
Cos-3	Short cuts along the lateral costa corpus.	Filleting and/or skinning.

Table 2.6.3: Butchering traces encountered on deer costae.

Humerus Butchering traces

Code	Placement and characteristics	Inferred activity
Hum -1	Oblique cuts on the lateral face of the distal condyle.	Dismembering of the humerus-radius joint (cf. Binford 1981: Hd-4).
Hum-2	Oblique cuts on the medial face of the distal condyle.	Dismembering idem. (cf. Binford 1981: Hd-2).

Table 2.6.4: Coded butchering traces observed on deer humerus specimens.

Femur Butchering traces

Code	Placement and characteristics	Inferred activity
Fem-1	Cuts along the distal diaphysis.	Filleting

Table 2.6.5: Description of a cut mark observed on a deer femur fragment.

Tibia Butchering traces

Code	Placement and characteristics	Inferred activity
Tib-1	Cuts around the cranial border of the proximal diaphysis.	Filleting
Tib-2	Cluster of scraping marks on the proximal diaphysis near the cranial border.	Defleshing / Removal of tissue prior to marrow processing.

Table 2.6.6: Coded butchering traces observed on cervid tibia remains.



Table 2.6.7: Butchering cut marks observed on a deer astragalus.

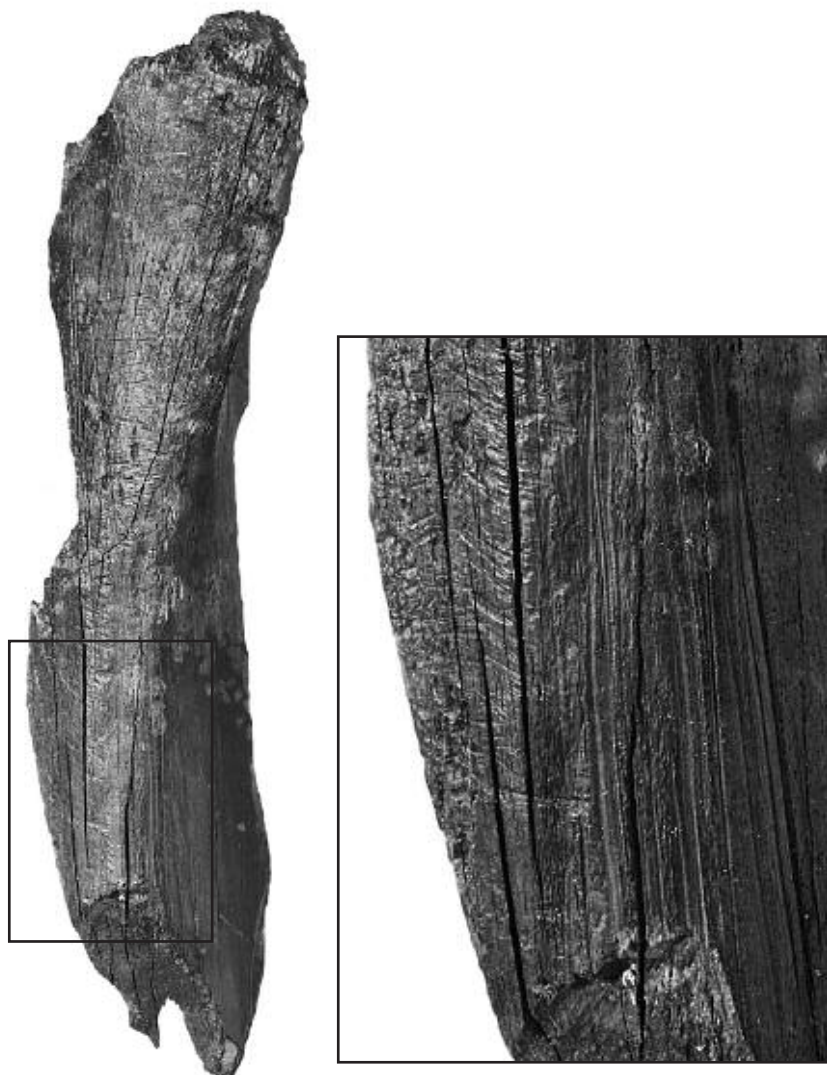
Astragalus Butchering traces		
Code	Placement and characteristics	Inferred activity
Ast-1	Short transversal cuts on the lateral face of the condyle.	Dismembering of the tarsal unit (cf. Binford 1981: TA-2).

2.6.2.10 Astragalus and calcaneus

One deer tarsal unit has been encountered, originating from the left side of the body. Two astragalus halves and an articular part belonging to the calcaneus could be refitted (683/29-15, -16, and -20). The astragalus morphologically corresponds with those from modern red deer, *Cervus elaphus*. The specimen bears classical dismemberment cut marks indicative of the dismemberment of the tarsal unit (Table 2.6.7). The specimens also bear some traces of carnivore gnawing.

Because of the presence of part of the calcaneus the tarsal unit was likely deposited while still in an articulated state after being butchered from the tibia and metatarsus.

Figure 2.6.2: A deer tibia proximal shaft fragment yielding both scraping traces on the shaft (close-up) and carnivore gnawing traces on the proximal end (see also Figure 2.3.4) (findnumber 715/24-2). Photos by J. Paupit, Leiden.



2.6.2.11 Metatarsals

Deer metatarsals are represented by a distal epiphysis and a shaft fragment from different body sides, representing a deer metatarsal MNE of 2. No cut marks have been observed on the specimens but both specimens have been carnivore gnawed. One specimen yields an impact notch but it is not clear whether this impact notch is carnivore or hominid induced in view of its morphology and associated gnawing traces.

2.6.2.12 Phalanges

Five deer phalanges have been counted, one first phalange, two second and two third phalanges. None yielded traces of butchering or carnivore gnawing. A first and a second phalange found together could be refitted (findnumbers 682/26-16 and -17).

2.6.3 Conclusions on the analysis of the deer remains

In several aspects the deer remains of the Schöningen 13II-4 assemblage sample yield different characteristics when compared to the documented horse remains. With only 60 bone specimens, deer remains are scarce compared to horse bones. Also the MNI of 2 is less than 10% of the MNI established on horse skeletal elements. An MNI of 2 was derived on antlers among which are three shed crowns, indicating natural depositions. An MNI of 2 was also derived on proximal tibia shaft parts of a fully grown adult size bearing traces of hominid modification. Among the deer radius remains, there is an unfused young shaft with missing unfused epiphyseal ends. Altogether the presence of two deer individuals represented by adult butchered bones and one by juvenile bones can be inferred, so actually yielding a total MNI of 3.

About 20% of the deer remains bear carnivore gnawing traces. The lack of unambiguous hominid-induced marrow processing traces, but likely carnivore-induced long-bone shaft breakage instead, could indicate a possible naturally deposited deer component on the former lakeshore. Because of the probable mixture of natural deer depositions and butchered deer remains, it is difficult to reconstruct the role of hominid butchery and carnivore behaviour. The observation of gnawing pits obscuring scraping marks on a proximal tibia shaft fragment could indicate secondary access of carnivores to deer butchery remains, as documented for the horse remains. %SURV values on deer skeletal elements have been calculated on the butchered MNI

of 2 (Figure 2.6.1). Representation of deer skeletal elements exhibit a leg dominated profile. Representation values for the leg elements are in close proximity and could be reflective of an original presence of complete deer legs. The only deer axial elements found are rib parts. The presence of unambiguous dismembering marks found on a rib articular part indicates the removal of deer thorax sections. Dismembering marks on horse ribs have not been encountered and thus handling of deer carcasses by hominids apparently differed from horse butchery. Also different from the horse butchery systematics are dismembering cut marks encountered on the deer astragalus. These cut marks indicate complete dismemberment of deer lower hindlegs. Together the deer remains indicate the presence of natural deer deposition, which can be considered to be background fauna, and deer body parts indicating deer butchery by hominids. The butchered deer remains represent a very fragmentary skeletal profile. Carnivore gnawing trace frequencies outnumbering butchery marks could indicate a destructive influence of carnivores on the deer remains, which could also be reflected by likely carnivore-induced deer long-bone breakage. The observed leg element dominance seems to be related to destructive processes operating on weaker skeletal elements like ribs and vertebrae surpassing deer axial element survival, while the stronger compact leg elements and shaft parts survived. Taking these factors into account and considering the low numbers on deer bone specimens, a reliable reconstruction of the taphonomic history or hominid butchery behaviour with regard to the deer remains is very problematic.

2.7 The bovid remains

2.7.1 Preservation and characteristics of the bovid remains

In total 92 encountered bone specimens have been ascribed to bovids, which is 3.1% of the taxonomically determined remains. Two bovid species are likely represented among the remains, *Bos primigenius* and *Bison* sp. The presence of *Bos primigenius* has been established on a complete metacarpus, which has been found together with a *Bison* metacarpus. No detailed study of the taxonomic nature of other elements or parts was conducted. Bone specimens belonging to the bovid category could easily be isolated from those of horses on dimensions and morphology. An MNI of 2 has been established on bovid long bones, while other represented skeletal elements yielded MNIs of less than 2 (Table 2.7.2).

In general the amount of bone weathering encountered on bovid remains is in agreement with that recorded for horse remains (Table 2.7.1). However, the most extremely weathered bone specimen from the total Schöningen assemblage concerns a bovid metacarpus (findnumber 682/18-1). The specimen is extremely weathered and falling apart in situ. It is likely that this specimen is not related to the majority of bone material found at the site. Rounding of fracture edges or on bone surfaces has been encountered on 4 (4.4%) bovid bone specimens, while dissolution of bone surfaces was documented for 9 (9.8%) specimens. The distribution of the bovid remains over the different layers is in agreement with the distribution of the horse remains, with 81.7% (NISP=58) of the 71 to layers ascribed specimens deriving from the B and B/C layers.

Weathering Characteristics Group	NISP	%
Group A	85	95.5
Group B	4	4.4
Total	89	99.9

Table 2.7.1: Distribution of bovid remains over weathering stages.



Skeletal element	NISP	%	MNE	MNE-sin	MNE-dex	MNI
Dental	3	3.3	3	0	0	1
Mandible	3	3.3	1	0	1	1
Hyoid bone	1	1.1	1	0	0	1
Atlas	0	0	0	0	0	0
Axis	0	0	0	0	0	0
Cervical vertebrae	0	0	0	0	0	0
Thoracal vertebrae	2	2.2	1	0	0	1
Lumbar vertebrae	1	1.1	1	0	0	1
Sacrum	0	0	0	0	0	0
Caudal vertebrae	0	0	0	0	0	0
Pelvis	7	7.6	2	1	1	1
Ribs	10	10.9	4	3	1	1
Scapula	0	0	0	0	0	0
Humerus	6	6.6	3	2	1	2
Radius	5	5.5	2	1	1	1
Ulna	1	1.1	1	0	1	1
Carpals	3	3.3	3	0	0	1
Metacarpus	4	4.3	4	0	2	2(4)
Femur	8	8.7	2	1	1	1
Patella	0	0	0	0	0	0
Tibia	8	8.8	3	1	2	2
Astragalus	1	1.1	1	0	1	1
Calcaneus	1	1.1	1	0	1	1
Tarsals	2	2.2	2	0	2	1
Metatarsus	5	5.5	3	1	2	2
Sesamoids	0	0	0	0	0	0
Phalange I	1	1.1	1	0	0	1
Phalange II	0	0	0	0	0	0
Phalange III	0	0	0	0	0	0
Total	72	78.8	39	10	17	
Vertebra fragment	1	1.1	0	0	0	0
Femur or Humerus	1	1.1	0	0	0	0
Tibia or Radius	4	4.3	0	0	0	0
Carpal or Tarsal	1	1.1	0	0	0	0
Longbone fragm.indet.	8	8.7	0	0	0	0
Longbone flake / spall	5	5.4	0	0	0	0
Total	92	100.5				

Table 2.7.2: Skeletal element and element origin of documented bovid remains.



Skeletal element	NISP	MNE	MNI	%SURV	NISP-gnaw	%gnaw	NISP-cut	%cut	NISP-imp	%imp
Dental	3	3	1	0	0	0	0	0	0	0
Mandible	3	1	1	25	0	0	0	0	1	33.3
Hyoid bone	1	1	1	0	0	0	0	0	0	0
Atlas	0	0	0	0	0	0	0	0	0	0
Axis	0	0	0	0	0	0	0	0	0	0
Cervical vertbr.	0	0	0	0	0	0	0	0	0	0
Thoracal vertbr.	2	1	1	3	0	0	1	50	0	0
Lumbar vertbr.	1	1	1	8.3	0	0	0	0	0	0
Sacrum	0	0	0	0	0	0	0	0	0	0
Caudal vertbr.	0	0	0	0	0	0	0	0	0	0
Pelvis	7	2	1	50	0	0	0	0	0	0
Ribs	10	4	1	6.2	2	20	0	0	0	0
Scapula	0	0	0	0	0	0	0	0	0	0
Humerus	6	3	2	75	1	16.6	1	16.6	3	50
Radius	5	2	1	50	0	0	1	20	4	80
Ulna	1	1	1	25	0	0	0	0	0	0
Carpals	3	3	1	0	0	0	0	0	0	0
Metacarpus	4	4	2(4)	50	2	50	0	0	0	0
Femur	8	2	1	50	1	12.5	7	87.5	4	50
Patella	0	0	0	0	0	0	0	0	0	0
Tibia	8	3	2	75	0	0	4	50	6	75
Astragalus	1	1	1	25	0	0	1	100	0	0
Calcaneus	1	1	1	25	0	0	1	100	0	0
Tarsals	2	2	1	0	0	0	1	50	0	0
Metatarsus	5	3	2	75	2	40	4	80	1	20
Sesamoids	0	0	0	0	0	0	0	0	0	0
Phalange I	1	1	1	6.2	0	0	0	0	0	0
Phalange II	0	0	0	0	0	0	0	0	0	0
Phalange III	0	0	0	0	0	0	0	0	0	0
Total	72	39			8	11.1	21	29.1	19	26.3
Vertebra fragment	1	0	0	0	0	0	0	0	0	0
Femur or Humerus	1	0	0	0	0	0	1	100	1	100
Tibia or Radius	4	0	0	0	1	25	2	50	2	50
Carpal or Tarsal	1	0	0	0	0	0	0	0	0	0
Longbone fragm.indet.	8	0	0	0	0	0	6	75	5	62.5
Longbone flake / spall	5	0	0	0	0	0	0	0	5	100
Total	92				9	9.7	30	32.6	32	34.7

Table 2.7.3: Distribution of diagnostic traces on bovid skeletal elements and fragments.



Table 2.7.4: Frequencies of inferred butchering activities related to observed cut marks on bovid bone specimens.

Butchering activity	NISP	%
Dismembering	3	10.0
Filleting / Defleshing	18	60.0
Scraping / Defleshing	6	20.0
Filleting / Scraping-Defleshing	1	3.3
Dismembering / Filleting / Scraping	1	3.3
	29	96.6

The observed types of butchering traces among the bovid remains are almost identical to those observed among the horse remains. The three main butchering cut marks, resulting from dismembering, filleting/defleshing and scraping/defleshing, found among the horse remains have also been found on bovid bone specimens (Table 2.7.4). Carnivore gnawing damage on bovid remains is limited and, apart from two rib parts, only present on the leg long bones, although specimens derived from radii and tibiae did not yield gnawing traces (Table 2.7.3). Butchering cut marks have been found on a more diverse spectrum of skeletal elements (see the descriptions of individual bovid skeletal elements for a detailed description of cut marks).

2.7.2 Bovid skeletal element specific analysis

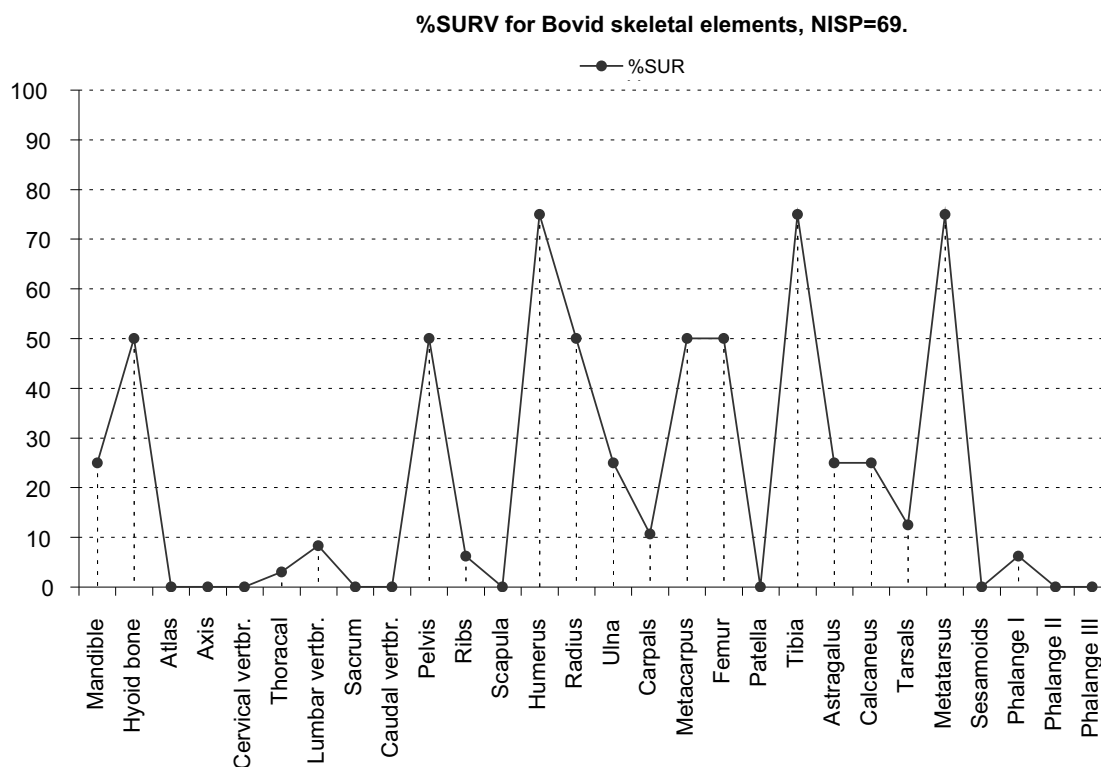
2.7.2.1 Cranium and mandible

No bovid cranial material has been encountered during this study. An MNI of 1 has been established on three bovid mandible fragments. None of these specimens have been gnawed by carnivores but one of the specimens yielded an impact notch indicating mandible marrow processing. Although cut marks have not been observed, this specimen could indicate marrow processing of bovid mandibles by butchering hominids. One part of a bovid hyoid bone has been encountered.

2.7.2.2 Vertebrae

Bovid atlases, axis, cervical and caudal vertebrae are entirely lacking in the studied assemblage sample. Of the thoracic vertebrae, only 2 vertebra parts have been encountered. Both concern separated thoracic vertebra spinous processes, of which one has been cutmarked along the complete process during filleting (Figure 2.7.2). The specimen has been more severely cutmarked than any of the encountered cutmarked horse thoracic vertebrae processes. Of the lumbar vertebrae only one specimen was encountered and it did not yield butchering traces. No gnawing traces have been observed among the vertebrae.

Figure 2.7.1: %SURV frequencies of observed bovid skeletal elements, on an MNI of 2.



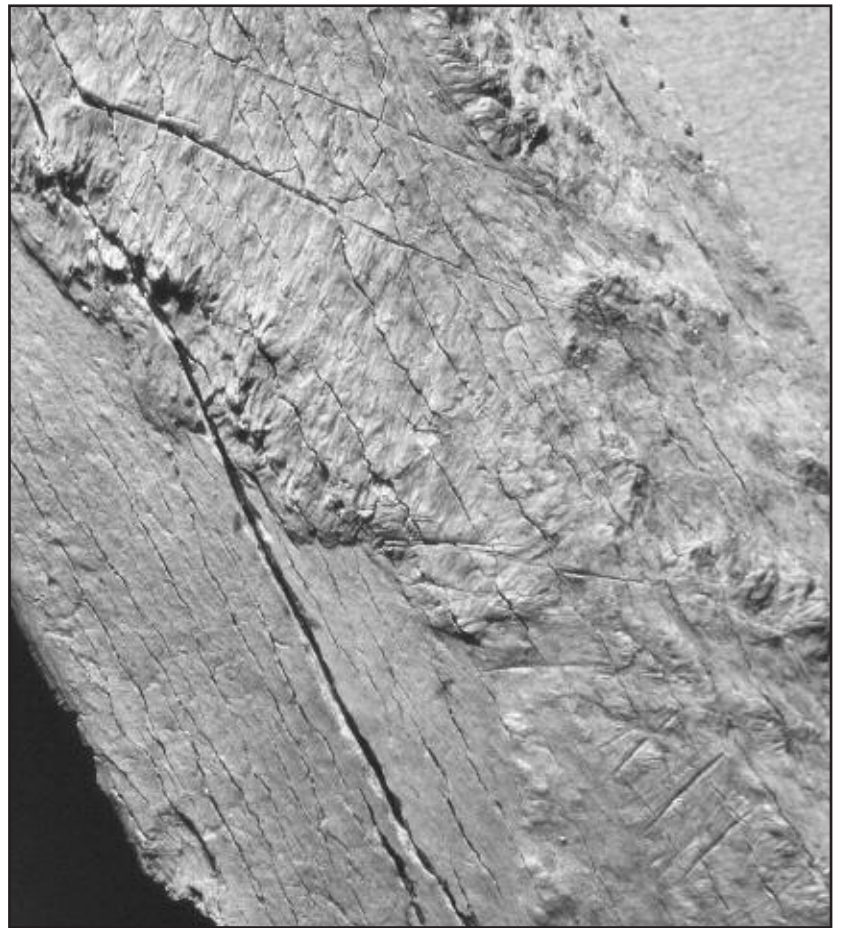
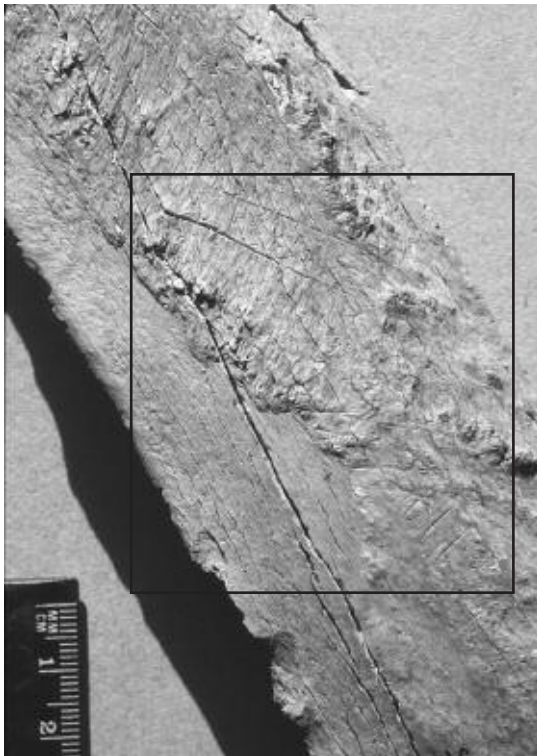


Figure 2.7.2: Spinous process of a bovid thoracic vertebra yielding cut marks from filleting of the thoracic muscle mass (findnumber 687/35-6). Photos by the author.

2.7.2.3 Pelvis

In total seven bovid pelvis parts found together could be fitted to a largely complete pelvis specimen, leading to an MNE and MNI of 1 for bovid pelvises. The specimen shows relatively intense bone weathering (Group B) and surface dissolution features. On this specimen weathering fractures developed on weakened bone parts, likely under sediment pressure. No carnivore gnawing or butchering traces were detectable.

2.7.2.4 Costae

On 10 bovid rib fragments an MNE of 4 could be established, 3 of which are from the left and 1 from the right side of the body. On two specimens some carnivore gnawing traces are present, while butchery traces are lacking.

2.7.2.5 Scapula

No remains of bovid scapulae have been encountered.

2.7.2.6 Humerus

Among the bovid remains, one complete left and unmodified humerus was encountered. On the basis of fragmented humerus specimens, another left specimen and a right specimen could be determined, pointing to an MNI fragmented of 1 and a total MNI for the bovid humerus of 2. All fragments concern shaft fragments, no separate epiphyseal parts have been encountered. Among the humerus remains one specimen yielded carnivore gnawing traces, one cut marks and three specimens yield impact notches likely created during marrow processing by hominids. The cut marks are located along the humerus shaft, pointing to filleting of meat from the upper front leg.

Thoracic vertebrae Butchering traces

Code	Placement and characteristics	Inferred activity
Thor-1	Transversal and short and long cuts along the spinous process.	Filleting

Table 2.7.5: Coded butchering traces observed on bovid thoracic vertebrae.



Table 2.7.6: Butchering traces observed on bovid humerus remains.

Humerus Butchering traces		
Code	Placement and characteristics	Inferred activity
Hum-1	Oblique cuts along the proximal diaphysis.	Filleting
Hum-2	Impacting of the caudal proximal diaphysis (H3).	Marrow processing

2.7.2.7 Radius – Ulna

Only one bovid ulna has been encountered, it concerns the proximal part only, no traces of any kind are present on the specimen. Of bovid radii, four shaft fragments and one proximal epiphyseal fragment have been documented. One shaft fragment yielded scraping marks from defleshing or removal of tissue and four of the five fragments exhibit impact notches from marrow processing.

Table 2.7.7: Butchering traces observed on bovid radius remains.

Radius Butchering traces		
Code	Placement and characteristics	Inferred activity
Rad-1	Local cluster of scraping marks on the diaphysis.	Defleshing/ Removal of tissue prior to marrow processing.
Rad-2	Impacting of the cranial proximal diaphysis below the proximal epiphysis (R1).	Marrow processing
Rad-3	Impacting of the mid-caudal diaphysis just aside the ulna (R4).	Marrow processing

Regarding the location of the impact notches could be observed that the impacted areas are in agreement with those frequently observed among the horse radii (R1 and R4 areas). In total three complete bovid carpals have been found, none yielded gnawing or cut marks.

2.7.2.8 Metacarpals

The metacarpals found among the bovid remains constitute an interesting group. Although all bovid material is grouped under the genus *Bos/Bison* sp., the presence within one and the same square metre of two morphologically distinct complete right metacarpals point to *Bison* sp. as well as to *Bos* sp. (findnumbers 683/30-12 and 683/30-6). Both specimens show conspicuous percussion damage and polish. During this study it could not be established whether these specimens yielded specific butchery traces or have been used as some kind of tool. Other

metacarpals constitute a large, probably adult, but badly weathered shaft of which the epiphyses are missing and which are destroyed by weathering processes, and a distally unfused bovid metacarpal shaft part of a juvenile individual. From the total bovid metacarpus spectrum thus follows an actual MNI of 4. The distal metacarpus in modern bovids fuses around a maximum age of 24 to 30 months (IJzereef, 1981). A bovid individual younger than 2.5 years of age is thus likely represented by the unfused metacarpus.

2.7.2.9 Femur

One proximal epiphyseal bovid femur fragment has been encountered together with seven femur shaft fragments. A distal shaft fragment yields cut marks created during dismemberment of the femur from the tibia. Disarticulation of bovid hindlegs thus did occur. Impacted femur shaft areas, indicated by impact notches, are in accordance with those frequently observed among the horse femur remains (F2 and F5 areas). Only one fragment yielded carnivore gnawing traces, while seven femur fragments are cutmarked through filleting, indicating intensive butchering of the bovid femur. One shaft specimen also yielded scraping marks from the removal of tissue or defleshing of the femur. No bovid patellae have been encountered.

Femur Butchering traces		
Code	Placement and characteristics	Inferred activity
Fem-1	Cuts along the proximal and mid diaphysis.	Filleting
Fem-2	Short transversal cuts on the caudal diaphysis above the distal condyle.	Dismembering of the femur- tibia joint (cf. Binford 1981: Fd-1).
Fem-3	Local cluster of scraping marks on the diaphysis.	Defleshing/ Removal of tissue prior to marrow processing.
Fem-4	Impacting of the caudal mid diaphysis near the foramen (F2).	Marrow processing
Fem-5	Impacting of the lateral distal diaphysis above the distal condyle (F5).	Marrow processing

Table 2.7.8: Butchering traces observed on bovid femur remains.



2.7.2.10 Tibia

Among the bovid tibia specimens, two large proximal tibia epiphyseal parts have been found. No carnivore gnawing marks have been encountered on the tibia remains. Cut marks and impact notches and scars are abundant among bovid tibiae specimens. Four fragments bear cut marks, two of which have been created by filleting, one by scraping off tissue and one shows both activities on the same specimen. Six out of eight tibia fragments bear impact notches from marrow processing.

Tibia Butchering traces		
Code	Placement and characteristics	Inferred activity
Tib-1	Short transversal cuts on the tibia neck just below the proximal epiphysis.	Dismembering of the tibia- femur joint (cf. Binford 1981:Tp-2).
Tib-2	Cuts along the diaphysis.	Filleting
Tib-3	Local clusters of scraping marks on the diaphysis.	Defleshing / Removal of tissue prior to marrow processing.
Tib-4	Impacting of the cranial proximal diaphysis near the cranial border (T3/7).	Marrow processing

Table 2.7.9: Coded butchering traces observed on bovid tibia remains.

2.7.2.11 Astragalus, calcaneus and tarsals

Among the bovid remains, one complete right hind leg tarsal unit was found. All elements were discovered within one and the same square metre and consist of the astragalus, calcaneus, and os tarsales which could be articulated with each other (findnumbers 685/22-3, -5, -13, -14). None of the elements exhibit carnivore gnawing traces, however the astragalus, calcaneus and one os tarsale have been cutmarked during dismemberment of the tarsal unit.

Of interest is the fact that the only bovid tarsal unit yields classic (in the sense of often encountered in documented ethnographically and archaeologically documented butchering systematics, see Binford, 1981), dismembering cuts, while all horse astragalus – calcaneus units lack dismembering traces but were dismembered distally of the unit instead. The butchering systematics which the hominids employed on bovid hind legs thus apparently differed from horse hind leg butchery.

Astragalus Butchering traces

Code	Placement and characteristics	Inferred activity
Ast-1	Short oblique cuts on the medial face of the condyle.	Dismembering of the tarsal unit (cf. Binford 1981: TA-2 medial).

Table 2.7.10: Butchering traces observed on the bovid astragalus.

Calcaneus Butchering traces

Code	Placement and characteristics	Inferred activity
Cal-1	Short oblique cuts on the lateral face of the articular part.	Dismembering of the tarsal unit (cf. Binford 1981: TC-1 lateral).

Table 2.7.11: Butchering traces observed on the bovid calcaneus.

2.7.2.12 Metatarsals

In total five bovid metatarsus parts have been encountered, two shaft fragments, one complete shaft with missing epiphyseal ends, and two proximal specimens. Three specimens yielded cut marks resulting from filleting or defleshing and one specimen had scraping marks. A split proximal metatarsus yielded a series of impact notches (see Figure 2.7.3). This specimen also exhibits heavy scoring by carnivores, which could indicate a possible role for carnivores in breaking the metatarsus. The impact scars yield characteristics of dynamic impacts though with still adhering flakes, pointing to a likely hominid origin. Moreover the specimen also bears cut marks. The only complete proximal bovid metatarsus exhibits percussion traces like other encountered bovid and horse metapodial remains, pointing to the use as a tool.

Metatarsus Butchering traces

Code	Placement and characteristics	Inferred activity
Mtt-1	Long oblique cuts on the cranial face of the mid diaphysis.	Filleting / Defleshing
Mtt-2	Cluster of scraping marks on the diaphysis.	Defleshing / Removal of tissue prior to marrow processing.

Table 2.7.12: Coded butchering traces observed on bovid metatarsus remains.



Figure 2.7.3: A bovid proximal metatarsus shaft yielding a series of dynamic impact scars with still adhering flakes on the lateral side (close up), likely of hominid origin, although carnivore shaft destruction cannot completely be excluded due to a presence of heavy teeth scores on the metatarsus shaft (findnumber 750/5-3). Photos by J. Pauptit, Leiden.



2.7.2.13 Phalanges

Only one complete bovid first phalange has been found. The specimen lacks any traces of modification.

2.7.3 Conclusions on the analysis of the bovid remains

As is the case with the encountered deer remains, also the bovid remains are dominated by leg elements (Figure 2.7.1). Of the axial skeleton only a pelvis, some rib parts, 2 thoracic vertebrae parts and one lumbar vertebra have been documented. The encountered bovid leg elements represent two left front and two right hind legs, together accounting for an MNI of 2. Calculations on the %SURV for bovid remains have been based on the hominid modified bovid MNI of 2 (Table 2.7.1). The documented bovid metacarpals together though bring the total MNI to 4. Two adult metacarpals likely from distinct bovid species, a specimen belonging to a juvenile bovid and a fourth

severely weathered bovid metacarpus. No other juvenile bovid material has been encountered. Both the severely weathered and the juvenile metacarpus could reflect natural depositions of bone remains. Apart from the skeletal element determined bovid elements yielding cut marks from butchering, 9 of the 13 indeterminable long-bone fragments also yielded cut marks. These numbers point to extensive butchering of bovid leg long-bone elements, which dominate the bovid skeletal element spectrum. Carnivore gnawing however is minimal and severe destruction of weak elements by carnivores cannot be recognised, as indicated by the preserved but vulnerable proximal tibiae among the bovid remains. Also impact notches and scars caused during marrow procurement are abundantly present with over 34%. Contrary to those encountered among the deer remains, almost all impact notches and scars on bovid elements bear the characteristics of a hominid cause.



3 CONCLUSIONS: SCHÖNINGEN 13II-4 AND ITS MEANING FOR THE HUNTING VERSUS SCAVENGING DEBATE

3.1 Schöningen 13II-4, hunting versus scavenging, implications for the debate

Apart from horse remains, the Schöningen 13II-4 faunal sample yielded the remains of bovids and deer. From the foregoing sections it has become clear that the three taxa represented differ in various characteristics. The horse component stands out on the number of bone specimens, MNIs and overall skeletal element representation. Deer and bovid remains are represented by far smaller amounts and both yield a butchered MNI of only 2 compared to a butchered MNI of 16 for the documented horses. Butchery evidence encountered on the remains of the three taxa also differs. Deer remains yielded a cut-marked percentage of 16.9% against a carnivore gnawed of 21.6% (Table 3.1.1). Among the deer long bone shaft specimens, 6.6% bear impact notches or scars from long-bone shaft breakage, but clear indications exist that carnivores could be involved with regard to encountered deer bone fractures. Shed antler parts point to natural depositions on the former Schöningen lake shore and could indicate that part of the encountered post-cranial deer remains also originate from natural depositions which could explain more pronounced carnivore involvement and differential survival of deer skeletal elements. Encountered cut marks resulting from hominid butchery of deer point to dismembering of deer body parts, both leg and axial. The observed dismemberment of rib slabs from deer carcasses has not been observed on any of the horse vertebrae or ribs, and the same is true for the dismemberment of the astragalus-calcaneus unit. This indicates different butchery systematics for deer compared to horses. The reason for this difference in butchery systematics

may be related to body size differences between the two species. Differential butchery related to limited carcass availability or facilitating transport of butchered body parts can also be considered to be of relevance though. If found in a Late Upper Palaeolithic cave shelter context, this butchery spectrum could easily be interpreted as to reflect transported deer body parts away from kill-sites into the shelter. However, apart from being a lake shore site, the available Schöningen 13II-4 amount of deer butchery data and ambiguous nature of deer remains deposition makes a distinction between different causes impossible.

Data derived from the bovid remains also yield differences when compared with the horse remains but they are comparable with the deer remains. Cut marks created during butchering by hominids constitute 32.6% for the bovid remains against 22.9% for the horse remains. Also the percentage of impacted bone specimens, the result of marrow processing, is higher for the bovid remains with 34.7% against 12.8% for horse remains. This is however partly caused by the dominance of marrow-bearing bone specimens among the bovid remains pushing up these percentages. Compared to the horse remains, the amount of carnivore-gnawed bone specimens is lower among the bovid remains with 9.7%, against 16.2% for horse remains. Bovid skeletal elements also are dominated by leg element bone specimens. Contrary to the deer remains, among the bovid remains the pelvis and lumbar vertebrae are represented. Hominid butchery of bovid individuals is indicated by cut marks and impact notches and scars from bone-marrow processing.

	NISP	%	NISP-gnaw	% gnaw	NISP-cut	% cut	NISP-imp	% imp
Equus sp.	2809	60.7	456	16.2	642	22.9	423	15.0
Cervus sp.	60	1.3	13	21.6	10	16.9	4	6.6
Bos/Bison sp.	92	2.0	9	8.7	30	32.6	32	34.7
Taxon indet.	1669	36.0	126	7.5	153	9.1	362	21.7
Totals	4630	100.0	604	13.0	835	18.0	821	17.7

Table 3.1.1: Frequencies of counted bone remains with actor-related diagnostic traces encountered in the Schöningen 13II-4 faunal sample. “-gnaw” = carnivore gnawed, “-cut” = cutmarked, “-imp” = yielding impact scars.

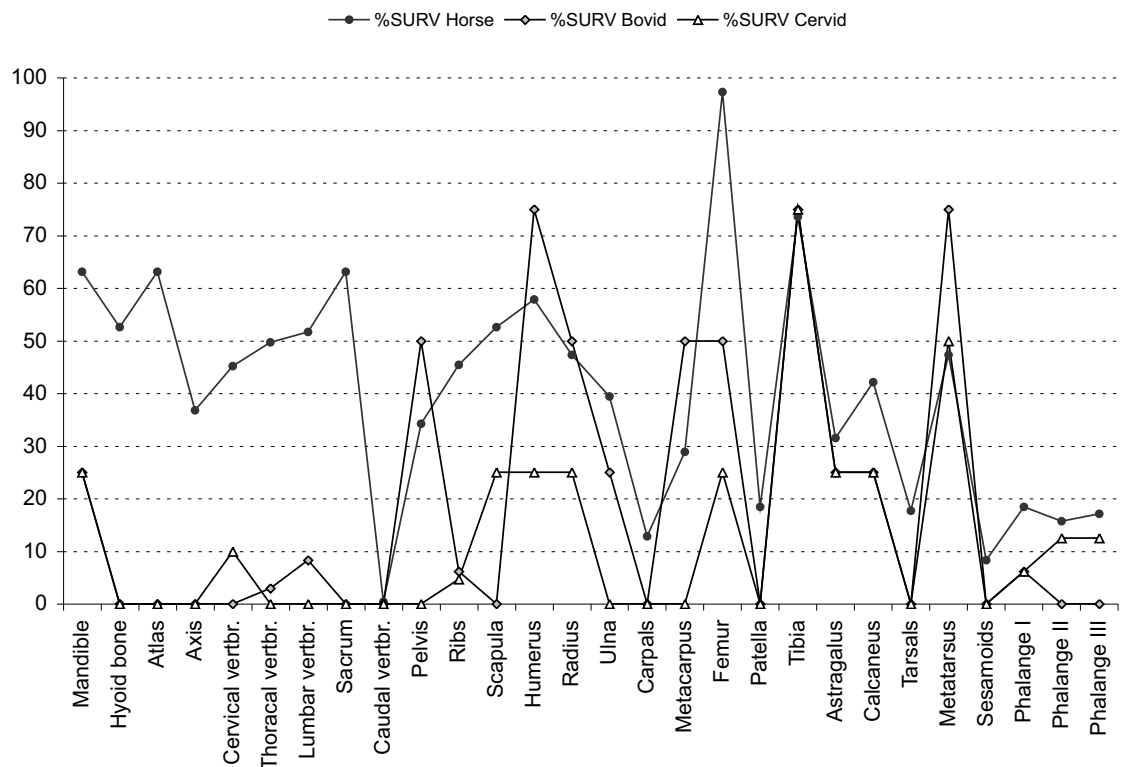


The present cut-marked bovid thoracic spinous process is proof of muscle meat removal. As documented for the deer remains, also during dismemberment of bovid hind legs the astragalus-calcaneus unit has been cutmarked. With regard to bovid remains, like for the deer remains, a presence of natural depositions apart from butchery remains is indicated. The presence of a heavyweight bovid pelvis and remains of the upper hind limb bones could indicate bovid butchery at or near the findspot. The amount of bovid remains though is not sufficient enough to explain observed differential survival of bovid body parts, being a possible result of bone density mediated destruction or subsistence behaviour related causes. The bovid and deer remains are far less represented and represent fragmentary skeletal profiles (Figure 3.1.1). Indications for long-bone shaft destruction by carnivores has been detected for the deer remains and this could point to possible destruction of other more vulnerable skeletal remains by carnivores. Among the bovid and deer remains, axial skeletal elements are scarce, and the remains of both bovid and deer show a head and leg dominated skeletal profile. These head to leg dominated skeletal profiles and the apparent concentration of butchery traces on primarily leg elements could be interpreted as the collection and butchery of carnivore left-behind legs with scraps of meat and bone marrow, following primary carnivore consumption of the meat-rich axial body parts, e.g.

scavenging. The cut-marked deer rib and bovid vertebrae spine found in the Schöningen assemblage are however proof of deer and bovid trunk processing and the placement of cut marks comparable to far more modern butchery debris from butchery sites. This provokes questions on the actual role of hominids with regard to the deer and bovid remains. For the present author the deer and bovid samples are considered too small and too ambiguous though to derive conclusions from.

The more straightforward Schöningen 13II-4 horse component demonstrates the reconstruction potential of well-preserved bone assemblages, but at the same time it demonstrates the vulnerability of butchery traces and patterns to possible destructive processes. For instance, axial horse skeletal elements are very well represented but together yielded the lowest percentages of cut marks created during butchery. Encountered cut-mark locations on the horse axial skeletal elements concentrate on rib parts and the spinous processes of vertebrae. These parts also exhibit the highest amounts of wolf gnawing traces, and of the vertebrae processes often the upper parts have been destroyed by wolf gnawing. It is likely that part of the original amount of cut marks present on the upper parts of vertebrae spinous processes have been gnawed away by ravaging wolves. More destructive ravaging of horse axial elements by wolves or by a more destructive carnivore, like

Figure 3.1.1: Comparison of the %SURV values for the Schöningen 13II-4 horse, deer and bovid skeletal elements.



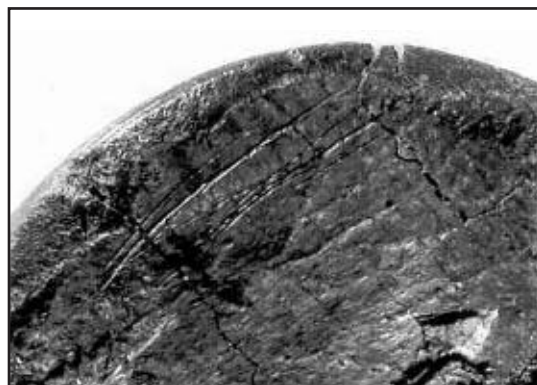
hyenas, would have suppressed axial skeletal element numbers significantly. Moreover, ribs and vertebrae are vulnerable to weathering and fracturing, such as caused by trampling or sedimentary deformation. Significant more influence of these processes, together with carnivore-induced destruction, would have led to far lower amounts of recognisable butchery traces among the axial horse remains, with serious consequences for the interpretations of hominid involvement. With horse marrow-bearing skeletal elements being the most cutmarked in the assemblage, this would have led to a head – leg dominated butchery profile for the horse remains. In such a case the survived butchery mark spectrum could be interpreted as a focus on the defleshing and processing of primarily horse leg and head marrow bones. Such a pattern could be interpreted as being the result of scavenging horse carcasses.

Much of the available Lower Palaeolithic faunal assemblages have been proven to be the result of complex taphonomic histories related to unstable geological contexts and great time depth within assemblages. This resulted in the deletion of especially weaker skeletal elements or bone parts, as well as to diagnostic traces being obscured by biasing processes. Assemblages often yield though at least some indicators of hominid involvement with the encountered faunal remains. Comparison of the site of Schöningen 13II-4 with the site of Schöningen 12b provides an example of the importance of referential archaeological faunal assemblages derived from micro-regional contexts representing different degrees of archaeological resolution. The site of Schöningen 13II-4 constitutes the richest and best-preserved faunal assemblage found within the interglacial former lake shore sedimentary sequences at Schöningen. The abundance of Lower Palaeolithic archaeological remains from the sedimentary sequences indicates that the former lakeshores were visited repeatedly by Lower Palaeolithic hominids during the Middle Pleistocene, as testified by finds of numerous stone artefacts with or without faunal remains. The faunal assemblage from the somewhat older but also Reinsdorf Interglacial site of Schöningen 12b has been proven to be the result of a complex taphonomic history and was found within reworked sediments. Only few bone remains yielding cut marks from butchering are proof of hominid involvement with faunal remains encountered at that site. The complex history and meagre butchery data made it impossible to derive at inferences about possible hominid subsistence behaviour related to the site (Voormolen, 1997). The Schöningen 12b assemblage is dominated by horse remains though they are present among a wide diversity of

mammalian species and with a NISP of only 85. Also at Schöningen 12b, bone remains from bovids were second best represented. Horse dental elements dominate the assemblage, and axial and leg element bone specimens are represented in approximately equal numbers with long-bone shaft specimens slightly dominating. On horse dental elements, a horse MNI of 3 has been established and on the postcranial horse elements an MNI of 2 was derived. Unambiguous cut marks resulting from butchery by hominids have only been encountered on two right-side distal horse humeri which represent a butchered horse MNI of 2. Further possible cut marks were found on one bovid bone specimen and one cave bear bone specimen (Voormolen, 1997). The cut-marked distal horse humeri specimens easily fit in the butchery mark spectrum encountered among the horse remains from Schöningen 13II-4 (compare Figure 2.5.10 with Figure 3.1.2). This together with the dominance of horse remains at the site could indicate that part of the encountered faunal assemblage at Schöningen 12b originally derived from butchery debris accumulations on the former lakeshore, comparable to that encountered at Schöningen 13II-4 but dispersed, reworked, distorted and reaccumulated with other bone depositions. Or, the specimens represent the biased remnants of horse butchery events involving fewer horse individuals. Although it is not possible to provide a solution for this problem, the two Schöningen sites provide an example of different archaeological resolutions determining the possibilities of the reconstruction of Lower Palaeolithic hominid subsistence behaviour found within the same microregional context. The well-preserved Schöningen 13II-4 faunal assemblage is the exception, the Schöningen 12b assemblage though is of a nature generally to be encountered in Lower Palaeolithic contexts.



Figure 3.1.2: One of the cut-marked right horse distal humeri from the Schöningen 12b faunal assemblage resulting from dismemberment of the humerus-radius/ulna joint, taken from Voormolen, 1997, p. 81. Photos by J. Pauptit, Leiden.



3.2 Schöningen 13II-4, a horse kill – butchery site from the Lower Palaeolithic

A comparison of the Schöningen assemblage with two much younger archaeological horse assemblages yields some striking similarities. Especially sites originating from the Upper Palaeolithic Magdalenian archaeological period yielded some faunal assemblages with abundant horse remains. The classic site of Solutré, from the Saône et Loire region in France, provides one of the largest samples of bone remains resulting from hominid horse exploitation known from the European Upper Palaeolithic. The site is interpreted as a hunting and kill site, being the result of the interception of horse groups passing the valley in which the site is situated. Horse remains originating from the Magdalenian levels at Solutré have been examined by several researchers (Berke, 1989; Levine, 1983; Turner, 1996, 1999). High MNI counts on represented horse individuals from only small assemblage samples have been derived, ranging from 6 to 9 horses for Sector L11 and 30 to 45 horses for Sector P16 (Turner, 1996, 1999). Of the P16 horse assemblage only 1.9 % of the bone remains show hominid-induced butchery traces, while of the L11 horse assemblage 5.1 % exhibit butchery traces (Turner, 1999). Butchery systematics, based on observed cut mark placement, mainly focused on primary butchering, like dismemberment, and some butchery-like meat filleting and periosteum removal prior to marrow processing, as indicated by a few impacted shaft specimens (Turner, 1996, 1999). Among the P16 horse remains, cut marks are concentrated near joints (scapula, humerus-radius, radius-carpals-metacarpus, tarsals-metatarsus and phalanges). Meat removal has been observed on the pelvis and radius, tibia, femur and metacarpus shafts. Further, removal of the tongue is indicated by cuts on the lingual side of the mandible as well as by cleaning of the buccal side of the mandible (Turner, 1999). A

pattern indicative of transported anatomical horse units is lacking, although some thoracic segments could have been moved away from the site. There are no clear indications for removal of carcass parts from the site and it seems that meat was removed directly at the kill-site from disarticulated body units, while some body units were left at the site in an articulated condition. Due to the relatively good representation of the phalanges, a focus on (and transport of) hides probably can be ruled out (Berke, 1989). The age ranges of the represented horse individuals from the P16 sector indicate the presence of ‘family groups’ with individuals from the 0 to 4 year age group and female horses in the 6 to 10 year age range. Some dominance of horses in the 8 to 10 year age range can be observed (Turner, 1999). Remains from more than one hunting season are indicated by foetal bone remains of horses in different developmental stages. Cut marks indicative of dismembering have been left on long-bone ends of fused elements of horses older than 3.5 years (all fused), but also on two distally unfused humeri and one unfused proximal ulna which are proof of the exploitation of relatively young (0-3.5 years) animals (Turner, 1996). From the Late Magdalenian period comes the site of Hauterive-Champréveyres, Switzerland (Morel and Müller, 1997). The site has been found on a former lakeshore of Lake Neuchâtel embedded in a thin layer of silt that covered the site soon after deposition of materials. Archaeological and faunal data from this site point to an occupation primarily associated with hunting and butchering of game directly at or very near the kill site. The location on the lakeshore, as well as the inferred presence of a series of comparable sites along the lakeshore, point to strategic locations favoured for game hunting. At the site the remains of 20 different animal species have been identified, among which are 10 mammalian species. Among the mammalian species, horse (*Equus ferus*) remains dominate with an MNI of 21, with reindeer following



with an MNI of 7. Pre- and post-depositional weathering of bone caused the destruction of much of the weakest bone parts and vulnerable skeletal elements of juvenile individuals. Originally the numbers for skeletal elements susceptible to destructive forces are believed to have been higher and the highest MNI values for horses have been derived from horse teeth (Morel and Müller, 1997). However with a NISP of 2610, the discovered horse non-dental skeletal elements provide a useful sample. Cut marks created during butchering of horses have been frequently encountered and are present on 10% of the horse bone specimens. Cut marks present on horse skeletal elements point to dismembering and filleting of meat. Bone breakage facilitating bone-marrow processing has been done systematically and meat removal from marrow-bearing long bones was done thoroughly (Morel and Müller, 1997). Horse leg elements yielded the highest percentages of cut-marked specimens, from 26% for the scapula, 50% for the humerus, 13% for the radius, 22% for the metacarpus to 20% for the femur, 17% for the tibia and 26% for the metatarsus. The marrow-bearing horse mandibles yielded a cut-marked percentage of 27%. Of the 191 encountered bone specimens originating from horse vertebrae, only 7 specimens have been cutmarked (3.6%). Of the 112 bone specimens originating from horse ribs, 22 specimens have been cutmarked (20%) (all frequencies calculated from Morel and Müller, 1997, p. 54, Fig. 70).

Documented cut-mark locations on the Hauterive-Champréveyres horse skeletal elements are for a large part in agreement with those encountered for the Schöningen 13II-4 horses, like the presence of dismembering marks specifically on the third horse tarsals resulting from the disarticulation of the metatarsus. At both sites, Solutré and Hauterive-Champréveyres, horse leg elements yielded the highest cut-mark percentages because leg element have been defleshed thoroughly, as also observed at Schöningen 13II-4. At all three sites dismembering, filleting, defleshing of marrow bones and marrow processing have been observed. The Schöningen 13II-4 horse remains yielded the highest overall cut-mark percentage of 23%, against 2% and 5% for Solutré, and 10% for Hauterive-Champréveyres. At all three sites horse mandibles have been cleaned of meat to facilitate marrow processing, and at Solutré and Schöningen 13II-4 the removal of horse tongues is also indicated. Establishing of exact horse age profiles at Hauterive-Champréveyres was hampered by the loss of juvenile horse skeletal elements due to weathering processes, but horse dental analysis indicated the presence of horse foals up to 1 year of age, sub adults and fully adult horse individuals

(Morel and Müller, 1997). Also at Solutré both horse foals, sub-adults and adults are represented. The Hauterive-Champréveyres horse MNI is almost identical to Schöningen 13II-4, while at Solutré much higher MNI counts have been derived, but at both sites, as at Schöningen 13II-4, it is likely that parts of or complete horse family groups have been killed. At all three sites concrete indications for the removal and transport of horse body parts are lacking.

Do the horse remains from Schöningen 13II-4 provide information concerning hominid-induced signatures indicative of hunting of horses, as inferred from the finds of supposed hunting spears? Taking together horse skeletal element frequencies and the butchery evidence, the site of Schöningen 13II-4 should be considered to represent a horse kill/butchery site exhibiting traces of primary butchery of horse carcasses. Horse butchery was directed at the procurement of meat and the systematic procurement of bone marrow on the spot. There are also indications that horse hides have been exploited. Horse butchery patterns and horse body part representation are proof of an availability of complete horse carcasses at the butchery location. This is strengthened by the identified secondary, scavenging, role for carnivores at the site. The sites of Solutré and Hauterive-Champréveyres are both situated at tactical locations facilitating the interception and killing of horse groups. As at Hauterive-Champréveyres, the Schöningen 13II-4 horse remains have been found within a former lakeshore context. Lakeshores are attractive ecological settings for every carnivore capable of ambushing prey drinking at the waterline. Wild horses regularly return to known predictable water resources (West, 1996). However, horses are strong and fast moving species, not easily intercepted and killed. For example, to capture a wild horse alive, most of the time it is necessary to ride a horse oneself to chase it (Levine, 1999). The most suitable way to capture or kill wild horses is to corral or ambush them, which can lead to the capture of more than a single horse individual (Levine, 1999; West, 1996). Although wooden spears, like those found associated with the Schöningen 13II-4 horse remains, could have been used to wound an animal from a certain distance, a more ambushing and stalking approach of horses would have been necessary to actually kill them. Regarding the possible use of spears during large mammal hunting by Palaeolithic hominids Geist (2000) remarks that:

"...even, if the throwing spear hits a vital organ and does not skewer hunter number two holding onto the prey, the killing power of the thrown spear is much too



low to kill or disable the prey quickly, and allow hunter number two to terminate his dangerous rodeo-ride quickly-....and....-one has to know how to kill a large mammal quickly and safely- a task that requires a bit of study even if you are armed today with a modern rifle of adequate design!”.

If known, a location where horse groups gather to forage or drink should provide the most suitable location to surprise and outsmart them. A horse group drinking at the waterline of a lakeshore could provide such an opportunity. If surprised and rapidly closed in by a group of hominids equipped with spears, it should be possible to drive the animals into the wet soft lakeshore zone to minimize their mobility. This would have enabled the killing of horses with the use of multiple spears by throwing and stabbing at close distance, minimizing the risk for the hominid hunters of horse defence attacks. Ambushing a whole horse group at once could explain the presence of multiple horse individuals and the presence of foals which are normally only to be found within horse family groups. It is likely however that multiple horse kill/butchery events are represented in the Schöningen 13II-4 horse assemblage. Normally horse family groups consist of a stallion and between 2 to 6 mares and their foals, while horse bachelor groups can be as large as 2 to maximally 15 individuals (Levine, 1999). This could mean that several horse killing events are represented by the butchered horse individual counts observed. Parameters on which multiple depositional events can be clearly distinguished are lacking though, and rather a homogeneous spectrum is present. Moreover, refit possibilities and weathering characteristics indicate fast cover and sealing of the deposited remains. This could mean that the actual number of possible events is limited. Formation of the findbearing horizon has been estimated to have lasted little longer than one season, and the autumn (late summer to early winter) has been postulated as the most likely season during which bone remains have been deposited on the former Schöningen lakeshore, because of low precipitation, low water levels and decay of plant materials (Thieme, 2005). Horses form larger herds during the autumn, coming together on migration routes (West, 1996). If known by hominids, these congregations could provide good opportunities for ambushing and killing multiple horse individuals. Also during the autumn, horse hides are in the best condition (Berke, 1989; West, 1996), which is relevant with regard to the suspected exploitation of horse hides at the site.

Summarised, the observed patterns of horse butchery conducted at the site indicate selective butchery, which probably is related to complete horse carcass abundance involving several events of killing multiple horse individuals. The co-occurrence of wooden spears with the butchered horse remains seems no coincidence. The site of Schöningen 13II-4 yields the first known European Lower Palaeolithic archaeological assemblage in which a complete early hominid subsistence toolkit is preserved, tools used to kill and tools used to butcher what has been killed. The present author would like to define hunting as “the exploitation of faunal products facilitated by tactical intentional killing and systematic butchery of animals”. The studied horse remains found at the site of Schöningen 13II-4 fit this definition and in the author’s opinion represent an example of Lower Palaeolithic hunting. One well-preserved faunal assemblage such as from Schöningen 13II-4 does not suffice to resolve the many questions in Lower Palaeolithic subsistence research though. It will however hopefully provide an important contribution to our understanding of Lower Palaeolithic faunal assemblage variability and early hominid faunal exploitation, which in the future will assist the development of more elaborate models for Lower Palaeolithic hominid subsistence strategies. For now it can be concluded that about 350 to 300,000 years ago at least along one European lakeshore there were ancient hunters who butchered in a modern fashion.



REFERENCES

- Aiello, L.C. 1998. The 'expensive tissue hypothesis' and the evolution of the human adaptive niche: a study in comparative anatomy, in: Bayley, J. (ed.), *Science in Archaeology: An agenda for the future*, 25-36, London, English Heritage.
- Aiello, L.C. and P. Wheeler 1995. The Expensive – Tissue Hypothesis, The Brain and the Digestive System in Human and Primate Evolution, *Current Anthropology* 36, 199-222.
- Ardrey, R. 1961. *African Genesis. A Personal Investigation into the Animal Origins and Nature of Man*. New York.
- Ardrey, R. 1976. *The Hunting Hypothesis. A Personal Conclusion concerning the Evolutionary Nature of Man*. New York, Atheneum.
- Asperen van, E. 2003. *De paarden van Schöningen 13II-4*, MA-thesis, University of Leiden, Faculty of Archaeology.
- Auguste, P. 1995. Chasse et charognage au Paléolithique Moyen: L'Apport du gisement de Biache-Saint-Vaast (Pas-De-Calais), *Bulletin de la Société Préhistorique Française* 92 (2), 155-167.
- Behrensmeyer, A.K. 1978. Taphonomic and ecologic information from bone weathering, *Paleobiology* 4, 150-162.
- Behrensmeyer, A.K., D.K. Gordon and G.T. Yanagi 1986. Trampling as a cause of bone surface damage and pseudo-cutmarks, *Nature* 319, 768-771.
- Berke, H. 1989. Solutré-Petersfels-Pekarna-Kniegrotte, Schlachtpuren an Pferdeknochen, *Archäologischen Informationen* 12 (2), 180-194.
- Binford, L.R. 1981. *Bones, Ancient Men and Modern Myths*. New York: Academic Press.
- Binford, L.R. 1983. *In Pursuit of the Past, Decoding the Archaeological Record*, London: Thames & Hudson.
- Binford, L.R. 1984. *Faunal remains from Klasies River Mouth*. Orlando: Academic Press.
- Binford, L.R. 1985. Human Ancestors: Changing Views of Their Behavior. *Journal of Anthropological Archaeology* 4, 292-327.
- Binford, L.R. 1987. Searching for Camps and Missing the Evidence? Another Look at the Lower Palaeolithic, in: Soffer, O. (ed.), *The Pleistocene Old World, Regional Perspectives*, 17-31, New York: Plenum Press.
- Blumenschine, R.J. 1986. Carcass Consumption Sequences and the Archaeological Distinction of Scavenging and Hunting, *Journal of Human Evolution* 15, 639-659.
- Blumenschine, R.J. 1988. An experimental Model of the Timing of Hominid and Carnivore Influence on Archaeological Bone Assemblages, *Journal of Archaeological Science* 15, 483-502.
- Blumenschine, R.J. and C.W. Marean 1993. A Carnivore's View of Archaeological Bone Assemblages, in: Hudson, J. (ed.), *From Bones to Behavior, Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains*, 273-300, Southern Illinois: Centre for Archaeological Investigations, University at Carbondale.
- Blumenschine, R.J. and M.M. Selvaggio 1988. Percussion marks on bone surfaces as a new diagnostic of hominid behaviour, *Nature* 333, 763-765.
- Bocherens, H., D. Billiou, A. Mariotti, M. Patou-Mathis, M. Otte, D. Bonjean and M. Toussaint 1999. Palaeoenvironmental and palaeodietary implications of isotopic biogeochemistry of last interglacial Neanderthal and mammal bones in Scladina Cave (Belgium), *Journal of Archaeological Science* 26, 599-607.
- Boëda, E., J.M. Geneste, C. Griggo, N. Mercier, S. Muhesen, J.L. Reyss, A. Taha and H. Valladas 1999. A Levallois point embedded in the vertebra of a wild ass (*Equus africanus*): hafting, projectiles and Mousterian hunting weapons, *Antiquity* 73, 394-402.
- Brain, C.K. 1981. *The Hunters or the Hunted? An Introduction to African cave Taphonomy*. Chicago: University of Chicago Press.
- Bratlund, B. 1999. Anthropogenic factors in the thanatocoenose of the last interglacial travertines at Taubach, Germany, in: Gaudzinski, S. and E. Turner (eds), *The role of early humans in the accumulation of European Lower and Middle palaeolithic bone assemblages*, 255-262, Bonn: Habelt Verlag.
- Capaldo, D. and R.J. Blumenschine 1994. A Quantitative diagnosis of Notches made by Hammerstone Percussion and Carnivore Gnawing on Bovid Long Bones, *American Antiquity* 59, 724-748.



- Cartmill, M. 1990. Human Uniqueness and Theoretical Content in Palaeoanthropology. *International Journal of Primatology* 11, 173-192.
- Cartmill, M. 1993. *A View to a Death in the Morning: Hunting and Nature Through History*. Cambridge: Harvard University Press.
- Dart, R.M. 1949. The Predatory Implemental technique of *Australopithecus*, *American Journal of Physical Anthropology* 7 (1), 1-39.
- Dart, R.M. 1956. The Myth of the Bone Accumulating Hyena, *American Anthropologist* 58, 40-62.
- David, F. and C. Farizy 1999. Mauran (Haute-Garonne, France), in: Gaudzinski, S. and E. Turner (eds), *The role of early humans in the accumulation of European Lower and Middle Palaeolithic bone assemblages*, 267-277, Bonn: Habelt Verlag.
- Dennell, R. 1997. The world's oldest spears, *Nature* 385, 767-768.
- Díez, J.C., Y. Fernández-Jalvo, J. Rosell and I. Cáceres 1999. Zooarchaeology and taphonomy of Aurora Stratum (Gran Dolina, Sierra de Atapuerca, Spain), *Journal of Human Evolution* 37, 623-652.
- Domínguez-Rodrigo, M. 1999. The study of skeletal profiles: an ambiguous taphonomic tool for zooarchaeological research, *Complutum* 10, 15-24.
- Domínguez-Rodrigo, M. 2002. Hunting and Scavenging by Early Humans: The State of the Debate, *Journal of World Prehistory* 16 (1), 1-54.
- Domínguez-Rodrigo, M., C.P. Egeland and R. Barba 2007. *Deconstructing Olduvai: A Taphonomic Study of the Bed I Sites*, New York, Springer.
- Farizy, C., F. David and J. Jaubert (eds) 1994. *Hommes et Bisons du Paléolithique Moyen à Mauran (Haute-Garonne)*, Paris: CNRS Éditions.
- Fernández-Jalvo, Y., J.C. Díez, I. Cáceres and J. Rosell 1999. Human cannibalism in the Early Pleistocene of Europe (Gran Dolina, Sierra de Atapuerca, Spain), *Journal of Human Evolution* 37, 591-622.
- Fisher, J.W. 1995. Bone Surface Modifications in Zooarchaeology, *Journal of Archaeological Method and Theory* 2, 7-68.
- Gamble, C. 1986. *The Palaeolithic Settlement of Europe*, Cambridge: Cambridge University Press.
- Gamble, C. 1987. Man The Shoveler: Alternative Models for Middle Pleistocene Colonization and Occupation in Northern Latitudes, in: Soffer, O. (ed.), *The Pleistocene Old World, Regional Perspectives*, 81-98, New York: Plenum Press.
- Gamble, C. and W. Roebroeks 1999. *The Middle Palaeolithic Occupation of Europe*, Leiden: Leiden University.
- Gaudzinski, S. 1995a. Wallertheim Revisited: a Re-analysis of the Fauna from the Middle Palaeolithic Site of Wallertheim (Rheinhessen/Germany), *Journal of Archaeological Science* 22, 51-66.
- Gaudzinski, S. 1995b. Kärlich - Seeufer, Untersuchungen zu einer altpaläolithischen Fundstelle im Neuwieder Becken (Rheinland/Deutschland), Neuwied.
- Gaudzinski, S. 1996. On Bovid Assemblages and their Consequences for the Knowledge of Subsistence Patterns in the Middle Palaeolithic, *Proceedings of the Prehistoric Society* 62, 19-39.
- Gaudzinski, S. 1998. Large mammal hunting strategies in the Palaeolithic of Europe: a taphonomic approach, in: Bayley, J. (ed.), *Science in Archaeology: An agenda for the future*, 47-62, London.
- Gaudzinski, S. 1999. The faunal record of the Lower and Middle Palaeolithic of Europe: remarks on human interference, in: Gamble, C. and W. Roebroeks (eds), *The Middle Palaeolithic Occupation of Europe*, 215-233, Leiden: Leiden University.
- Gaudzinski, S. and E. Turner 1996. The role of Early Humans in the accumulation of European Lower and Middle Palaeolithic Bone assemblages, *Current Anthropology* 37, 153-156.
- Gaudzinski, S. and E. Turner 1999. Summarizing the role of early humans in the accumulation of European Lower and Middle Palaeolithic bone assemblages, in: Gaudzinski, S. and E. Turner (eds), *The role of early humans in the accumulation of European Lower and Middle Palaeolithic bone assemblages*, 381-393, Bonn: Habelt Verlag.
- Gaudzinski, S. and W. Roebroeks 2000. Adults only. Reindeer hunting at the Middle Palaeolithic site Salzgitter Lebenstedt, Northern Germany, *Journal of Human Evolution* 38, 497-521.
- Geist, V. 2000. *The Neanderthal Paradigm*, found at: <http://cogweb.english.ucsb.edu/EP/Neanderthal/Paradigm.html>



- Getty, R. 1975. Equine Osteology, in: Getty, R. (ed.), *The Anatomy of the Domestic Animals*, 255-348, Philadelphia-London-Toronto: Saunders.
- Gijssse, K. van 2006. *A continent-wide framework for local and regional stratigraphies: application of genetic and event stratigraphy to the Middle Pleistocene terrestrial sediments of Northwest and Central Europe*, PhD Thesis, Leiden: University of Leiden.
- Grayson, D.K. and F. Delpech 1994. The evidence for Middle Palaeolithic scavenging from couche CIII, Grotte Vaufray (Dordogne, France), *Journal of Archaeological Science* 21, 359-375.
- Hayden, B. 1993. The cultural capacities of Neandertals: a review and re-evaluation, *Journal of Human Evolution* 24, 113-146.
- Haynes, G. 1980. Evidence of carnivore gnawing on Pleistocene and recent mammalian bones, *Paleobiology* 6, 341-351.
- Haynes, G. 1983. A guide for differentiating mammalian carnivore taxa responsible for gnaw damage to herbivore limb bones, *Paleobiology* 9, 164-172.
- IJzereef, G.F. 1981. *Bronze Age animal bones from Bovenkarspel, the excavations at Het Valkje, Amersfoort: Proceedings of the ROB*.
- Isaac, G.L. 1971. The diet of Early Man: aspects of Archaeological Evidence from Lower and Middle Pleistocene sites in Africa, *World Archaeology* 2, 278-299.
- Isaac, G.L. 1978. The food-sharing behavior of proto-human hominids, *Scientific American* 238, 90-108.
- Isaac, G.L. 1983. Bones in contention: competing explanations for the juxtaposition of Early Pleistocene artefacts and faunal remains, in: Clutton-Brock, J. and G. Grigson (eds), *Animals in Archaeology; Hunters and their Prey*, 3-19, Oxford: BAR International Series 163.
- Jaubert, J. 1999. The Middle Palaeolithic of Quercy (Southwest France): palaeo-environment and human settlements, in: Gamble, C. and W. Roebroeks (eds), *The Middle Palaeolithic Occupation of Europe*, 93-106, Leiden: Leiden University.
- King, G.E. 1975. Socioterritorial Units Among Carnivores and Early Hominids, *Journal of Anthropological Research* 31, 69-87.
- Kolen, J. 1999. Hominids without homes: on the nature of Middle Palaeolithic settlement in Europe, in: Gamble, C. and W. Roebroeks (eds), *The Middle Palaeolithic Occupation of Europe*, 139-175, Leiden: Leiden University.
- Kolfschoten, Th. van 1993. Die Vertebraten des Interglazials von Schöningen 12b, *Ethnographisch Archäologische Zeitschrift* 34, 623-628.
- Kolfschoten, Th. van 1995. Faunenreste des altpaläolithischen Fundplatzes Schöningen 12 (Reinsdorf-Interglazial), in: Thieme, H. and R. Maier (eds), *Archäologische Ausgrabungen im Braunkohlentagebau Schöningen*, 85-94, Hannover.
- Kraft, I. 1997. Intentionally fractured bones and horn core counts: some remarks on the early Middle Pleistocene site Isernia la Pineta (in comparison to some other bovid kills), in: Hannus, L.A., L. Rossum and R.P. Winham (eds), *Sioux Falls: Proceedings of the 1993 Bone Modification Conference*, Hot Springs, South Dakota, 122-135.
- Lam, Y.M., X. Chen and O.M. Pearson 1999. Intertaxonomic variability in patterns of bone density and the differential representation of Bovid, Cervid and Equid elements in the archaeological record, *American Antiquity* 64 (2), 343-362.
- Laughlin, W.S. 1968. Hunting: An Integrating Biobehavior System and its Evolutionary Importance, in: Lee, R. and I. DeVore (eds), *Man the Hunter*, 304-320. Chicago: Aldine.
- Lee, R. and I. DeVore (eds) 1968. *Man the Hunter*, Chicago: Aldine.
- Levine, M.A. 1983. Mortality models and the interpretation of horse population structure, in: Bailey, G.N. (ed.), *Hunter-Gatherer Economy in Prehistory*, 23-46, Cambridge: Cambridge University Press.
- Levine, M.A. 1999. Botai and the Origins of Horse Domestication, *Journal of Anthropological Archaeology* 18, 29-78.
- Lietzow, A. and S. Ritzkowski 1996. Braunschweigische Kohlenbergwerke AG, Tagebau Schöningen: Bergbau und die Tertiäre Schichtfolge, *Tagung der Arbeitsgemeinschaft Nordwestdeutscher Geologen, Helmstedt 1996, Kurzfassung der Vorträge und Exkursionsführer*, 30-35.



- Lyman, R.L. 1984. Bone Density and Differential Survivorship of Fossil Classes, *Journal of Anthropological Archaeology* 3, 259-299.
- Lyman, R.L. 1994. *Vertebrate Taphonomy*, Cambridge: Cambridge University Press.
- Mania, D. 1990. *Auf den Spuren des Urmenschen; Die Funde aus der Steinrinne von Bilzingsleben*, Berlin: Deutscher Verlag der Wissenschaften.
- Mania, D. 1993. Die Terrassen-Travertin-Sequenz von Bilzingsleben: Ein Beitrag zur Stratigraphie des Mittel- und Jungpleistozäns im Elbe-Saale-Gebiet, *Ethnographisch Archäologische Zeitschrift* 34, 554-575.
- Mania, D. 1995a. Die geologischen Verhältnisse im Gebiet von Schöningen, in: Thieme, H. and R. Maier (eds), *Archäologische Ausgrabungen im Braunkohlentagebau Schöningen*, 33-43, Hannover: Verlag Hahnsche Buchhandlung.
- Mania, D. 1995b. The earliest occupation of Europe: the Elbe-Saale region (Germany), in: Roebroeks, W. and T. van Kolfschoten (eds), *The earliest occupation of Europe; proceedings of the European Science Foundation workshop at Tautavel (France)*, 1993, 85-102, Leiden: University of Leiden.
- Mania, D. 1996. Ergebnisse der bisherige stratigraphischen Untersuchungen im Tagebau Schöningen / Elm (Nordharzvorland), *Tagung der Arbeitsgemeinschaft Nordwestdeutscher Geologen, Helmstedt 1996, Kurzfassung der Vorträge und Exkursionsführer*, 17-19.
- Marean, C.W. 1998. A critique of the evidence for scavenging by Neandertals and early modern humans: new data from Kobeh Cave (Zagros Mountains, Iran) and Die Kelders Cave 1 Layer 10 (South Africa), *Journal of Human Evolution* 35, 111-136.
- Marean, C.W. and Z. Assefa 1999. Zooarchaeological Evidence for the Faunal Exploitation Behavior of Neandertals and Early Modern Humans, *Evolutionary Anthropology* 8 (1), 22-37.
- Marean, C.W. and L. Bertino 1994. Intrasite spatial analysis of bone: subtracting the effect of secondary carnivore consumers, *American Antiquity* 59 (4), 748-768.
- Marean, C.W. and L.M. Spencer 1991. Impact of carnivore ravaging on zooarchaeological measures of element abundance, *American Antiquity* 56 (4), 645-658.
- Mellars, P. and C. Stringer (eds) 1989. *The Human Revolution, Behavioural and Biological Perspectives in the Origins of Modern Humans*. Edinburgh: Edinburgh University Press.
- Milton, K. 1999. A Hypothesis to Explain the role of Meat-Eating in Human Evolution, *Evolutionary Anthropology* 8 (1), 11-21.
- Moigne, A-M. and D.R. Barsky 1999. Large mammal assemblages from Lower Palaeolithic sites in France: La Caune de L'Arago, Terra Amata, Orgnac 3 and Cagny L'Epinette, in: Gaudzinski, S. and E. Turner (eds), *The role of early humans in the accumulation of European Lower and Middle Palaeolithic bone assemblages*, 219-235, Bonn: Habelt Verlag.
- Morel, P. and W. Müller (eds) 1997. *Un campement magdalénien au bord du lac Neuchâtel, Étude archéozoologique (secteur 1)*, Neuchâtel: Hauterive-Champréveyres 11, Archéologie Neuchâteloise 23.
- Mussi, M. 1999. The Neanderthals in Italy: a tale of many caves, in: Gamble, C. and W. Roebroeks (eds), *The Middle Palaeolithic Occupation of Europe*, 49-80, Leiden: Leiden University.
- Oliver, J.S. 1989. Analogues and Site Context: Bone Damages from Shield Trap Cave (24CB91), Carbon County, Montana, U.S.A, in: Bonnicksen, R. and M. Sorg (eds), *Bone Modification*, Orono: Maine, 73-98.
- Oliver, J.S. 1993. Carcass Processing by the Hadza: Bone Breakage from Butchery to Consumption, in: Hudson, J. (ed.), *From Bones to Behavior, Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains*, 200-227, Southern Illinois: Centre for Archaeological Investigations, University at Carbondale.
- Olsen, S.L. and P. Shipman 1988. Surface modification on Bone: Trampling versus Butchery, *Journal of Archaeological Science* 15, 535-553.
- Outram, A. and P. Rowley-Conwy 1998. Meat and Marrow Utility Indices for Horse (Equus), *Journal of Archaeological Science* 25, 839-849.
- Parfitt, S.A. and M.B. Roberts 1999. Human modification of faunal remains, in: Roberts M.B. and S.A. Parfitt (eds), *Boxgrove, A Middle Pleistocene hominid site at Earthem Quarry, Boxgrove, West Sussex*, 395-415, London: English Heritage.
- Roberts, M. 1999. Sophisticated Primitives. Return of the Hunter; Surprisingly Smart Hominids settled



- Europe 500,000 Years ago, *Discovering Archaeology* May/June 1999, 66-77.
- Roebroeks, W. 2001. Hominid behaviour and the earliest occupation of Europe: an exploration, *Journal of Human Evolution* 41, 437-461.
- Roebroeks, W., J. Kolen and E. Rensink 1988. Planning depth, anticipation and the organization of Middle Palaeolithic technology: the "archaic natives" meet Eve's descendants, *Helinium* 28, 17-34.
- Roebroeks, W., N.J. Conard and T. van Kolfschoten 1992. Dense forests, cold steppes and the Palaeolithic settlement of northern Europe, *Current Anthropology* 33, 551-586.
- Schaller, G.B. and G.R. Lowther 1969. The relevance of carnivore behavior to the study of Early Hominids, *Southwestern Journal of Anthropology* 25 (4), 307-341.
- Shipman, P. and J. Rose 1983. Early Hominid Hunting, Butchering, and Carcass-Processing Behaviors: Approaches to the Fossil Record, *Journal of Anthropological Archaeology* 2, 57-98.
- Soergel, W. 1922. *Die Jagd der Vorzeit*. Jena: Verlag von Gustav Fischer.
- Sorensen, M. and W.R. Leonard 2001. Neandertal energetics and foraging efficiency, *Journal of Human Evolution* 40, 483-495.
- Speth, J. and E. Tchernov 1998. The role of hunting and scavenging on Neandertal procurement strategies, in: Akawaza, T., K. Aoki and O. Bar-Yosef (eds), *Neandertals and Modern Humans in Western Asia*, 223-239, New York.
- Steguweit, L. 1999. Die Recken von Schöningen – 400,000 Jahre mit dem speer, *Mitteilungsblatt der Gesellschaft für Urgeschichte* 8, 5-14.
- Stiner, M.C. 1991. Food Procurement and Transport by Human and Non-human Predators, *Journal of Archaeological Science* 18, 455-482.
- Stopp, M.P. 1993. Taphonomic analysis of the Faunal Assemblage, in: Singer, R., B.C. Gladfelter and J.J. Wymer (eds), *The Lower Palaeolithic Site at Hoxne, England*, 138-149, Chicago-London, University of Chicago Press.
- Stringer, C. and C. Gamble 1993. *In Search of the Neanderthals. Solving the Puzzle of Human Origins*, London: Thames & Hudson.
- Stringer, C. and R. McKie 1996. *African Exodus, the Origins of Modern Humanity*, London: Johnathan Cape.
- Thieme, H. 1997. Lower Palaeolithic hunting spears from Germany, *Nature* 385, 807-810.
- Thieme, H. 1999. Altpaläolithische Holzgeräte aus Schöningen, Lkr. Helmstedt. Bedeutsame Funde zur Kulturentwicklung des frühen Menschen, *Germania* 77, 451-487.
- Thieme, H. 2005. The Lower Palaeolithic art of hunting. The case of Schöningen 13 II-4, Lower Saxony, Germany, in: Gamble, C. and M. Porr (eds), *The Hominid Individual in Context. Archaeological investigations of Lower and Middle Palaeolithic landscapes, locales and artefacts*, 115-132, London & New York: Routledge.
- Thieme, H. and D. Mania 1993. Schöningen 12 – Ein Middle-Pleistozänes Interglazialvorkommen im Nordharzvorland mit paläolithischen Funde, *Ethnographisch Archäologische Zeitschrift* 34, 610-619.
- Thieme, H. and R. Maier (eds) 1995. *Archäologische Ausgrabungen im Braunkohlentagebau Schöningen*, Hannover.
- Thieme, H., B. Urban, D. Mania and T. van Kolfschoten 1992. Sensationelle Neufunde aus dem Mittelpleistozän im Tagebau Schöningen – Die ältesten Fundhorizonte mit artefakten in Niedersachsen, *Archäologie in Deutschland* 4, 49-50.
- Thieme, H., B. Urban, D. Mania and T. van Kolfschoten 1993. Schöningen (Nordharzvorland) Eine Altpaläolithische Fundstelle aus dem Mittleren Eiszeitalter, *Archäologische Korrespondenzblatt* 23, 147-163.
- Trinkaus, E. (ed.) 1989. *The emergence of modern humans: biocultural adaptations in the later Pleistocene*. Cambridge: Cambridge University Press.
- Tuffreau, A., P. Antoine, P.G. Chase, H. Dibble, B.B. Ellwood, T. van Kolfschoten, A. Lamotte, M. Laurent, S.P. McPherron, A-M. Moigne and A.V. Munaut 1995. Le Gisement Acheuléen de Cagny-L'Épinette (Somme), *Bulletin de la Société Préhistorique Française* 92 (2), 169-191.
- Turner, E. 1995. Miesenheim 1, in: Bosinski, G., M. Street and M. Baales (eds), *The Palaeolithic and Mesolithic of the Rhineland, Quarternary field trips in Central Europe* vol. 2, 891-894, München: Verlag Dr. Friedrich Pfeil.



- Turner, E. 1996. An analysis of the horse remains from the Magdalenian level in sector L11 (Q. 69, 79 & 89) at Solutré, in: Pautrat, Y. and A. Thévenin (eds), *Paléolithique supérieur et Epipaléolithique dans le Nord-Est de la France*, Actes de la Table ronde de Dijon, 7 et 8 octobre 1995, 131-140, Dijon.
- Turner, E. 1999. Analyse faunistique du « Kill-Site » Magdalénien de Solutré, *Travaux de l'Institut de Recherche du Val de Saone Maconnais* 4, 51-64.
- Urban, B. 1995a. Palynological evidence of younger Middle Pleistocene Interglacials (Holsteinian, Reinsdorf and Schöningen) in the Schöningen open cast lignite mine (eastern Lower Saxony, Germany), *Mededelingen Rijks Geologische Dienst* 52, 175-186.
- Urban, B. 1995b. Vegetations- und klimaentwicklung des Quartärs im Tagebau Schöningen, in: Thieme, H. and R. Maier (eds), *Archäologische Ausgrabungen im Braunkohlentagebau Schöningen*, 44-56, Hannover.
- Villa, P. 1990. Torralba and Aridos: elephant exploitation in Middle Pleistocene Spain, *Journal of Human Evolution* 19, 299-309.
- Villa, P., A.P. Anzidei and E. Cerilli 1999. Bones and bone modifications at la Polledrara, a Middle Pleistocene site in Italy, in: Gaudzinski, S. and E. Turner (eds), *The role of early humans in the accumulation of European Lower and Middle Palaeolithic bone assemblages*, 197-206, Bonn: Habelt Verlag.
- Villa, P., E. Soto, M. Santonja, A. Pérez-González, R. Mora, J. Parcerisas and C. Sesé 2005. New data from Ambrona: closing the hunting versus scavenging debate, *Quaternary International* 126-128, 223-250.
- Voormolen, B. 1996. Het onderzoek naar de taphonomie van het fauna-complex Schöningen 12B: de vraagstellingen, methoden en enkele voorlopige resultaten, *Cranium* 13 (1), 39-46.
- Voormolen, B. 1997. *The Vertebrate Taphonomy of the Middle Pleistocene site Schöningen 12B, Niedersachsen, Germany*, MA-Thesis, Leiden: Faculty of Archaeology, Leiden University.
- Washburn, S.L. and V. Avis 1958. Evolution and Human Behavior, in: Roe, A. and G. Gaylord Simpson (eds), *Behavior and Evolution*, 421-437. Yale: Yale University Press.
- Washburn, S.L. and I. DeVore 1961. Social Behavior of Baboons and Early Man, in: Washburn, S.L. (ed.), *Social Life of Early Man*, 91-105. Chicago. Routledge.
- Washburn, S.L. and C.S. Lancaster 1968. The Evolution of Hunting, in: Lee, R. and I. DeVore (eds), *Man the Hunter*, 293-303. Chicago: Aldine.
- West, D. 1996. Horse Hunting, Processing, and Transport in the Middle Danube, in: Svoboda, J. (ed.), *Paleolithic in the Middle Danube Region*, 209-245. Brno.
- White, T.D. 1992. *Prehistoric Cannibalism at Mancos 5MTUMR-2346*, Princeton: Princeton University Press.



In 1995 worden op de Duitse vindplaats Schöningen 13II-4 de eerste vondsten gedaan van spectaculair goed geconserveerde houten speren uit het vroeg-paleolithicum (oude-steentijd) en sindsdien zijn er op de locatie in totaal acht van deze speren geborgen. Al snel bleek dat de gevonden speren technologisch het meest overeenkomen met werpsperen, en zelfs vergelijkbaar zijn met speren die tegenwoordig in de atletiek bij het speerwerpen worden gebruikt. Deze vondsten werden aangetroffen in de oeverzone van een voormalig meer. Het meer was in het verleden verland en door veenvorming zijn de archeologische resten vervolgens afgedekt en beschermd tegen verstoringe invloeden. Aan de hand van de lokale geologie, pollenanalyse, en de studie naar faunaresten is bepaald dat de verlanding van het meer en daarmee de depositie van de archeologische resten te plaatsen is in het zogenaamde Reinsdorf Interglaciaal. Een warme klimatologische fase die te dateren is tussen de 300.000 en 350.000 jaar geleden. De vindplaats behoort daarmee tot de oudste vindplaatsen van Noordwest Europa. Het aangetroffen vondstcomplex van Schöningen 13II-4 leverde niet alleen de houten speren op maar tevens honderden stenen werktuigen en, nog belangrijker, vele duizenden exceptioneel goed geconserveerde botresten van grote zoogdieren. Na de eerste publicatie in 1997, in het wetenschappelijk tijdschrift *Nature*, van de in Schöningen gevonden speren laaide het zogenaamde jacht-aaseet debat binnen de vroegpaleolithische archeologie opnieuw op. De conclusie dat de aangetroffen speren technologisch geschikt zouden zijn om mee te werpen gaf voorstanders van het model van de op grote zoogdier jagende vroegpaleolithische mens een belangrijke aanvulling op hun argumentatie. In tegenstelling tot met name continentaal Europese onderzoekers bestaan binnen de Amerikaanse en Engelse vroeg-paleolithicum archeologie sinds de jaren '80 van de vorige eeuw vele voorstanders van het zogenaamde aaseet-model. Het aaseet-model ziet de Europese vroegpaleolithische mens als nog niet ontwikkeld genoeg om op een systematische wijze haar landschap te kunnen exploiteren, zoals met behulp van georganiseerde jacht op wild. In plaats daarvan zocht men volgens de voorstanders van dit model opportunistisch het landschap af naar wat direct voorhanden was, zoals kadavers van natuurlijk gestorven grote zoogdieren. Eerdere vondsten van fragmenten van mogelijke houten speren uit het vroeg-paleolithicum werden in dit kader zelfs beschouwd als sneeuwprikkers waarmee men zocht naar kadavers aanwezig onder de sneeuw. De

Schöningen speren bleken echter te geavanceerd om verklaard te worden als sneeuwprikkers. Maar vooral de associatie van de speren met vele duizenden botresten van grote zoogdieren gaf reden om te denken aan jachtsperen. Vanwege de exceptioneel goede conservering van de botresten leken mogelijke snijsporen van stenen werktuigen ontstaan tijdens de vermoedelijke slacht van de dieren waarvan de botten afkomstig zijn goed afleesbaar. Botresten uit het vroeg-paleolithicum blijven veelal niet bewaard en als deze wel bewaard zijn gebleven dan zijn deze vaak moeilijk afleesbaar. Slachtsperen zijn vaak moeilijk te onderscheiden vanwege verwerking of door verstoring door sporen met een andere dan menselijke oorsprong, zoals vraatsperen van roofdieren. De verwachting was dat de botresten van Schöningen 13II-4 meer inzicht konden verschaffen in een mogelijke relatie tussen de gevonden speren en de botresten maar mogelijk ook gegevens zouden opleveren over de omgang met grote zoogdieren door de vroegpaleolithische mens, werden deze gejaagd of als kadaver verzameld? Dit proefschrift presenteert de gegevens en resultaten van een eerste gedetailleerde studie van botresten uit de vindplaats Schöningen 13II-4. Er werden circa 5000 botresten onderzocht op aanwezige sporen en patronen die met vroeg-menselijk gedrag te maken hebben. De resultaten van het onderzoek blijken van belang te zijn met betrekking tot de mogelijke relatie met de gevonden speren en het jacht-aaseet debat binnen de vroegpaleolithische archeologie.

De onderzochte botresten van Schöningen 13II-4 blijken weinig verschijnselen van verwerking door blootstelling aan de buitenlucht te vertonen. Hoewel enkele botresten redelijk tot zwaar verweerd zijn duidt het overgrote deel van de resten op een snelle afdekking na depositie waardoor verweringsverschijnselen zeer beperkt zijn gebleven. De aanwezigheid van barsten en scheuren in een deel van de botresten lijkt meer te maken te hebben met uitdroging na onttrekking van het grondwater waarin de botresten verbleven dan met verwerking in het verleden na depositie. Een relatief snelle afdekking en bescherming van de botresten na depositie wordt verder bevestigd door de aangetroffen refit-mogelijkheden (het weer aan elkaar kunnen passen van gebroken of anatomisch geassocieerde botten) binnen het bestudeerde vondstcomplex. Op de botresten zijn sporen veroorzaakt door roofdieren duidelijk herkenbaar aanwezig. De meeste van deze sporen concentreren zich op de uiteinden (epiphysen) van de lange



beenderen, de distale delen van ribben en de proximale delen van de doornen van wervels. Ook de randen van bekkens en schouderbladen vertonen soms sporen van vraat. Het totaal aan geobserveerde botresten met vraatsporen van roofdieren komt echter niet boven de 13% uit. Het karakter van de vraatsporen duidt op middelgrote roofdieren, waarschijnlijk wolven. De schade die deze aan de botresten hebben aangericht beperkt zich voornamelijk tot de aanwezigheid van aangevreten zachte botdelen maar niet de totale vernietiging van weke botdelen zoals waar roofdieren als hyena's toe in staat zijn. Het karakter van de vraatsporen in combinatie met een statistische analyse van de aanwezigheid van zwakkere botdelen binnen het vondstcomplex duiden erop dat de verantwoordelijke roofdieren maar een beperkte invloed hebben gehad op de uiteindelijke samenstelling van het vondstcomplex. Een ander belangrijk bewijs voor een beperkte rol voor roofdieren zijn enkele botresten waarop zowel door mensen aangebrachte slachtsporen als sporen van vraat aanwezig zijn. Op deze stukken is namelijk goed waarneembaar dat de vraatsporen zijn ontstaan na de vorming van slachtsporen en deze dan ook ten dele doorsnijden en uitwissen. Dit is een bewijs dat roofdieren de rol van aaseter vervulde en slechts de beschikking hadden over slachtresten achter gelaten door de mens.

Zeer opvallend is de samenstelling van de onderzochte botresten van Schöningen 13II-4 als het gaat om de vertegenwoordigde zoogdiersoorten. Binnen het op soort determineerbare vondstcomplex domineren de botresten van paarden, met bijna 95%, gevolgd door de resten van runderen, oerlund of bison, die met 3% vertegenwoordigd zijn. Een hertensoort, waarschijnlijk het edelhert, is vertegenwoordigd door slechts 2% van de op soort determineerbare botresten. Naast het feit dat botresten afkomstig van paarden het vondstcomplex domineren vertonen deze ook het meest complete skeletelement spectrum. Alle skeletdelen van paarden zijn aanwezig inclusief zwakke botdelen en botresten afkomstig van zeer jonge individuen die normaliter zeer kwetsbaar zijn ten opzichte van verweringsprocessen en roofdiervraat. Dit gaat echter niet op voor de botresten die toegeschreven zijn aan runderen en herten waarvan vooral de sterkere hardere botdelen vertegenwoordigd zijn. Dit lijkt erop te duiden dat het moment van depositie van de paardenresten, runderresten en hertenresten gescheiden zijn in tijd en deze daardoor een andere post-depositionele geschiedenis kennen.

Sporen veroorzaakt door menselijke activiteiten zijn op de bestudeerde botresten veelvuldig aan-

getroffen. Rond de 18% van alle bestudeerde botresten bevat snijsporen veroorzaakt tijdens de slacht van karkassen met behulp van stenen werktuigen of sporen van het kapot slaan van lange beenderen om het voedzame beenmerg te kunnen consumeren. Met betrekking tot de botresten die op zoogdiersoort determineerbaar zijn lopen de percentages voor door mensen aangebrachte slachtsporen op tot boven de 22% voor de paardenresten en boven de 30% voor de runderresten. De ontdekte en beschreven slachtsporen zijn onder te verdelen in een aantal verschillende typen die te relateren zijn aan bepaalde slachtactiviteiten. Clusters van korte scherpe snijsporen duiden op de disarticulatie van gewrichten en lange snijsporen aanwezig op de schachten van lange beenderen en platte botten duiden op het affileren van vlees. Er is tevens sprake van clusters schraapsporen. Deze sporen worden uitsluitend gevonden op botten die beenmerg bevatten. Deze sporen duiden erop dat de mergbeenderen van weefsel werden ontdaan voordat deze gebroken werden om het ingesloten beenmerg te kunnen bereiken. Het breken van de mergbeenderen gebeurde veelal op overeenkomstige wijze. Slaglittekens op botresten veroorzaakt tijdens het kapotslaan van de mergbeenderen worden herhaaldelijk op dezelfde plekken teruggevonden. Omdat het aantal botresten en vertegenwoordigde skeletelementen voor de paarden groot genoeg is kon bekeken worden of er sprake is van over- of ondervertegenwoordiging van bepaalde lichaamsdelen. Gebleken is dat twee lichaamsdelen zwaar ondervertegenwoordigd zijn, namelijk de staart en de onderste delen van de benen, de hoeven met de phalangen. De meest waarschijnlijke verklaring voor deze ondervertegenwoordiging is dat er sprake is van villen en de verwijdering van de paardenhuiden van de slachtlocatie. Bij het villen van dieren blijven de onderste delen van de poten en de staart over het algemeen intact en worden deze weggenomen samen met de huid. Het spectrum van door mensen aangebrachte slachtsporen geeft aan dat in ieder geval paardenkarkassen op systematische wijze geslacht werden. Deze slacht was gericht op het verkrijgen van een veelvoud aan dierlijke producten, namelijk huiden, vlees, mogelijk pezen en ieder geval ook het vette en voedzame beenmerg. De locaties en het karakter van gedocumenteerde slachtsporen komen veelal overeen met slachtspoor typen en patronen bekend van slachtafval uit vele malen jongere archeologische slachtplaatsen van paarden. Naast de sporen die direct te relateren zijn aan slachtactiviteiten zijn op diverse botresten sporen gedocumenteerd die te maken kunnen hebben met het gebruik van botten als werktuig. Clusters van putjes en krassen aanwezig op het oppervlak van bepaalde pijpbeenderen duiden op het herhaaldelijk



slaan op harde materie, zoals steen. Waarschijnlijk werden deze botten gebruikt voor het onderhoud, retoucheren, van stenen werktuigen tijdens de slacht.

Op basis van tellingen van gedetermineerde skeletelementen kon het minimum aantal vertegenwoordigde individuen onder de paarden worden bepaald. Het minimum aantal vertegenwoordigde paarden is op 19 gezet, gebaseerd op het maximale aantal gedetermineerde botten uit het dijbeen van het paard, de *femur*. Onder deze individuen bevinden zich ook een drietal veulens. Deze zijn onder andere geïdentificeerd aan de hand van hun onvolgroeide schouderbladen. De aanwezigheid van veulens geeft aan dat er mogelijk sprake is van een zogenaamde familiegroep. Bij in het wild levende paarden is de familiegroep een belangrijke sociale eenheid, deze bestaat uit merries met hun veulens en staat onder leiding van een volwassen hengst. Met betrekking tot de mate van aanwezigheid van slachtsporen en de verdeling over de verschillende lichaamsdelen valt op dat de benen van paarden schijnbaar consequenter benut en intensiever geslacht zijn dan de rompen. Waarschijnlijk heeft dit te maken met de aanwezigheid van zowel vlees, pezen als beenmerg waardoor meerder producten tegelijkertijd benutbaar waren. Op de rompen van de paarden vinden we slechts lokaal en in relatief beperkte mate slachtsporen terug. Uit deze verhoudingen lijkt een voorkeur voor bepaalde delen naar voren te komen en kan gesproken worden van min of meer selectieve slacht. Een mogelijke verklaring die aan de hand van de slachtspoor locaties kan worden gegeven is het gebruik van een slachtmethode die gericht was op het verwijderen van de huid inclusief de vleesmassa van de heup en bovenbenen. Door de zware pijpbeenderen uit de benen te verwijderen kon het gewicht van de verwijderde vleesmassa worden beperkt en tegelijkertijd het beenmerg worden benut. Vermoedelijk bleven de rompen vervolgens grotendeels ongemoeid achter. Deze vorm van selectieve slacht was wellicht mogelijk vanwege de aanwezigheid van meerdere paarden tegelijkertijd waardoor sprake was van een productsurplus. Bijvoorbeeld in het geval er sprake was van het bejagen en doden van een familiegroep paarden. De landschappelijke setting waarin de vindplaats is aangetroffen, een drassige oever van een meer, is een locatie waar regelmatig groepen dieren komen om te drinken en te waden. Waarschijnlijk was de Schöningen mens ook op de hoogte van dit aanbod van biomassa. Door een aan de waterkant verblijvende familiegroep paarden te verrassen en in te sluiten moet het mogelijk zijn geweest deze met behulp van de houten speren te doden om vervolgens over te gaan op de slacht om de gewenste dierlijke

producten te verwijderen. De associatie van de gevonden houten speren met de vele botresten kan daarom geen toeval zijn. Meer dan 300.000 jaar geleden werden bij Schöningen al paarden gejaagd en volgens een systematische productgerichte methode geslacht. In veel opzichten verschillen de gegevens uit het Schöningen vondstcomplex zelfs nauwelijks van de gegevens die we kennen uit het jong-paleolithicum en nog recentere vindplaatsen waar sprake is van paardenjacht en slacht. Wat betreft de conservering van de botresten en de houten speren is Schöningen 13II-4 een unicum binnen het beschikbare archeologisch bestand uit het vroeg-paleolithicum van West Europa. Het is sterk de vraag of de aanwijzingen voor vroeg menselijke jacht en systematische slacht van grote zoogdieren die uit deze vindplaats naar voren komen uniek zijn voor het vroeg-paleolithicum. Het zou heel goed kunnen dat het beeld van de marginale vroegpaleolitische mens dat door veel onderzoekers wordt geschetst meer samen hangt met de slechte en marginale conservering van tot onze beschikking staande vindplaatsen. Mogelijk is het jacht-aaseet debat binnen de paleolitische archeologie daarom meer een debat gebaseerd op verschillen in archeologische resolutie dan op verschillen van daadwerkelijk vroeg menselijk gedrag.



CURRICULUM VITAE

Boudewijn Voormolen werd op 12 juli 1968 geboren in Rotterdam, is daar opgegroeid en blijven wonen tot 2005. Na zijn MAVO doorliep hij in Rotterdam van 1989 tot 1991 het versnelde VWO aan de Rotterdamse dag- en avondscholengemeenschap. Van 1991 tot 1992 volgde hij de propedeuse Algemene Archeologie aan de Universiteit Leiden. Van 1992 tot 1997 specialiseerde hij zich in de Pre- en Protohistorie van West Europa en in het speciaal het Paleolithicum aan het toenmalige Instituut voor Prehistorie van de Universiteit Leiden. Zijn doctoraal diploma werd in 1997 behaald met een eindschrift over een taphonomisch onderzoek van de botresten uit de vindplaats Schöningen 12b. Vanaf 1997 is hij werkzaam geweest bij verschillende archeologische bedrijven. Onder andere voor Archol Leiden, de toenmalige Rijksdienst voor het Oudheidkundig Bodemonderzoek en later voor het Archeologisch Dienstencentrum op opgravingen in het kader van de aanleg van de Betuweroute. Van 1999 tot 2003 vervulde hij een aanstelling als Assistent In Opleiding aan de Faculteit der Archeologie met als specialisatie het onderzoek naar de taphonomie van vroegpaleolitische faunacomplexen in het kader van het jacht-aaseet debat aan de Universiteit Leiden, met uiteindelijk dit proefschrift als resultaat. Momenteel woont hij in Bennebroek en is hij werkzaam als gemeentelijk archeoloog bij de gemeente Katwijk.



APPENDICES

Skeletal element	NISP	%	NISP-gnawed	%-gnawed
Cranium	57	1.2	1	1.7
Mandibula	155	3.3	9	5.8
Dental	224	4.8	1	0.4
Hyoid	31	0.7	7	22.5
Atlas	12	0.2	1	8.3
Axis	13	0.3	0	0.0
Cervical	94	2.0	3	3.2
Thoracal	237	5.1	59	24.9
Lumbar	68	1.4	3	4.4
Sacrum	14	0.3	3	21.4
Caudal	1	0.0	0	0.0
Sternum	1	0.0	0	0.0
Costae	1103	23.8	269	24.4
Pelvis	35	0.7	14	40.0
Scapula	34	0.7	9	26.4
Humerus	142	3.0	26	18.3
Radius	155	3.3	19	12.2
Ulna	37	0.8	10	27.0
Carpals	37	0.8	5	13.5
Acc.Metacarpals	16	0.3	2	12.5
Metacarpus	33	0.7	6	18.1
Femur	184	3.9	26	14.1
Patella	8	0.1	1	12.5
Tibia	201	4.3	26	12.9
Fibula	3	0.1	0	0.0
Astragalus	15	0.3	7	46.6
Calcaneus	18	0.4	7	38.8
Tarsals	29	0.6	0	0.0
Acc.Metatarsals	24	0.5	1	4.1
Metatarsus	60	1.3	7	11.6
Phalanges	46	1.0	14	30.4
Sesamoids	20	0.4	0	0.0
Vertebrae fragm.	226	4.8	12	5.3
Metapodial	58	1.2	8	13.8
Carpal or Tarsal	4	0.1	0	0.0
Femur or Humerus	24	0.5	1	4.1
Tibia or Radius	23	0.5	1	4.3
Tibia or Metatarsus	1	0.0	0	0.0
Radius or Metapodial	12	0.2	2	16.6
Longbone fragm.indet.	270	5.8	21	7.7
Longbone flakes	448	9.6	3	0.6
Indet.Fragments	457	9.8	20	4.8
Total	4630	100.0	604	13.0

Table 1: Frequencies of all determined Schöningen 13II-4 sample bone specimens and the frequencies of the presence of carnivore gnawing traces.



Skeletal element	NISP	%	NISP-cutmarked	%cutmarked	NISP-impacted	%impacted
Cranium	57	1.2	2	3.5	0	0.0
Mandibula	155	3.3	39	25.1	27	17.4
Dental	224	4.8	1	4.4	0	0.0
Hyoid	31	0.7	0	0.0	0	0.0
Atlas	12	0.2	3	25.0	0	0.0
Axis	13	0.3	2	15.3	0	0.0
Cervical	94	2.0	0	0.0	0	0.0
Thoracal	237	5.1	12	5.0	0	0.0
Lumbar	68	1.4	5	7.3	0	0.0
Sacrum	14	0.3	1	7.1	0	0.0
Caudal	1	0.0	0	0.0	0	0.0
Sternum	1	0.0	0	0.0	0	0.0
Costae	1103	23.8	123	11.1	0	0.0
Pelvis	35	0.7	4	11.4	0	0.0
Scapula	34	0.7	7	20.5	0	0.0
Humerus	142	3.0	78	55.0	72	50.7
Radius	155	3.3	86	55.4	73	47.1
Ulna	37	0.8	11	29.7	6	16.2
Carpals	37	0.8	0	0.0	0	0.0
Acc.Metacarpals	16	0.3	1	6.2	0	0.0
Metacarpus	33	0.7	9	27.2	5	15.1
Femur	184	3.9	101	54.9	78	42.4
Patella	8	0.1	0	0.0	0	0.0
Tibia	201	4.3	86	42.8	106	52.7
Fibula	3	0.1	0	0.0	0	0.0
Astragalus	15	0.3	2	13.3	0	0.0
Calcaneus	18	0.4	2	11.1	2	11.1
Tarsals	29	0.6	8	27.5	0	0.0
Acc.Metatarsals	24	0.5	10	41.6	0	0.0
Metatarsus	60	1.3	37	61.6	16	26.6
Phalanges	46	1.0	0	0.0	0	0.0
Sesamoids	20	0.4	0	0.0	0	0.0
Vertebrae fragm.	226	4.8	0	0.0	0	0.0
Metapodial	58	1.2	21	36.2	13	22.4
Carpal or Tarsal	4	0.1	0	0.0	0	0.0
Femur or Humerus	24	0.5	4	16.6	6	25.0
Tibia or Radius	23	0.5	13	56.5	9	39.1
Tibia or Metatarsus	1	0.0	1	100.0	0	0.0
Radius or Metapodial	12	0.2	6	50.0	4	33.3
Longbone fragm.indet.	270	5.8	65	24.0	68	25.1
Longbone flakes	448	9.6	69	15.4	333	74.3
Indet.Fragments	457	9.8	26	5.6	3	0.6
Total	4630	100	835	18	821	17.7

Table 2: Frequencies of all determined Schöningen 13II-4 sample bone specimens and the frequencies of the presence of hominid-induced butchery traces.



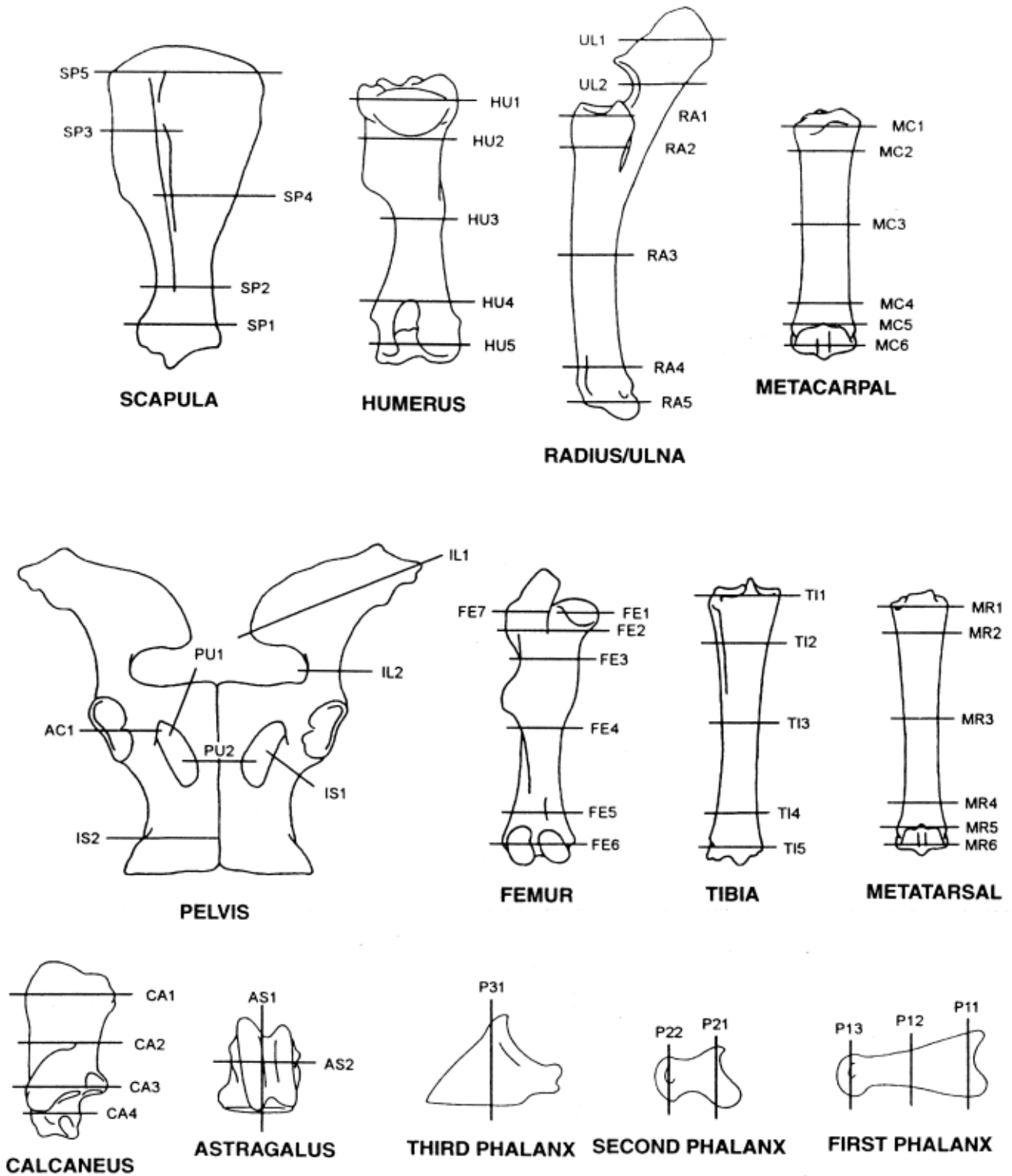


Figure 1: Bone mineral density scan sites on horse skeletal elements, taken from Lam et al., 1999, p. 348-349.



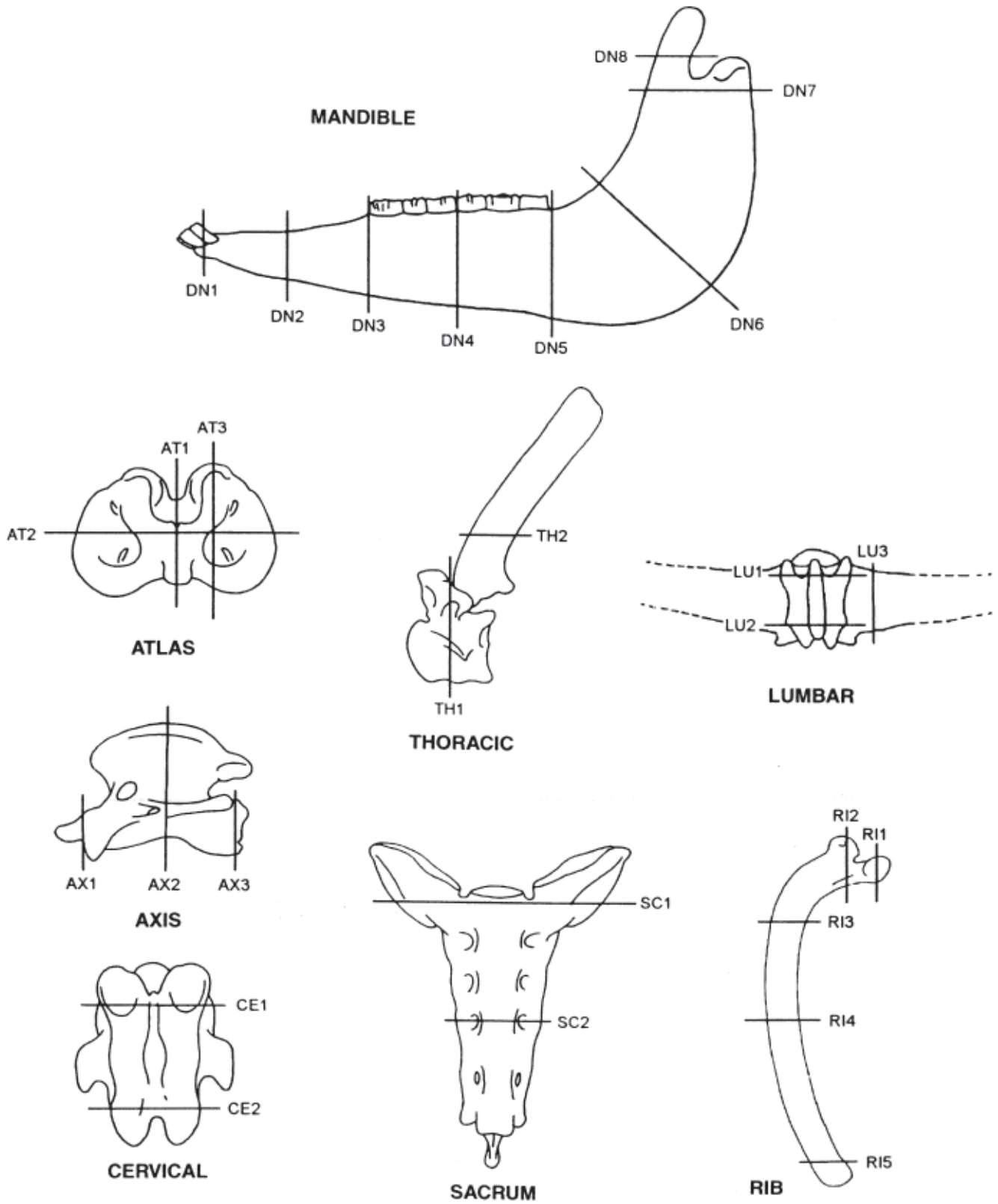


Figure 1: Bone mineral density scan sites on horse skeletal elements, taken from Lam et al., 1999, p. 348-349.



Impact Notches Depth, N = 145

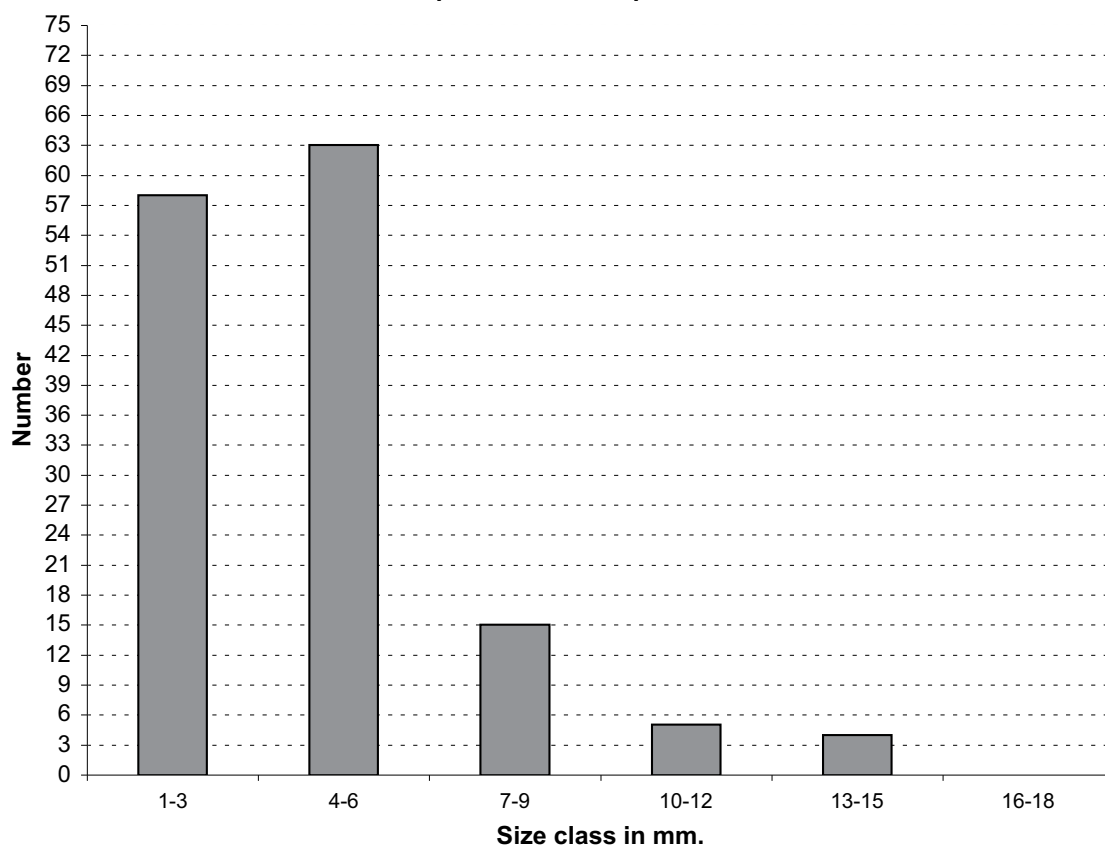


Figure 2: Individual measurements on the maximum impact notch depth on marrow-processed horse marrow-bone fragments (N=145). Mean impact notch depth = 4.8 mm.

Impact Notches Breadth, N = 146

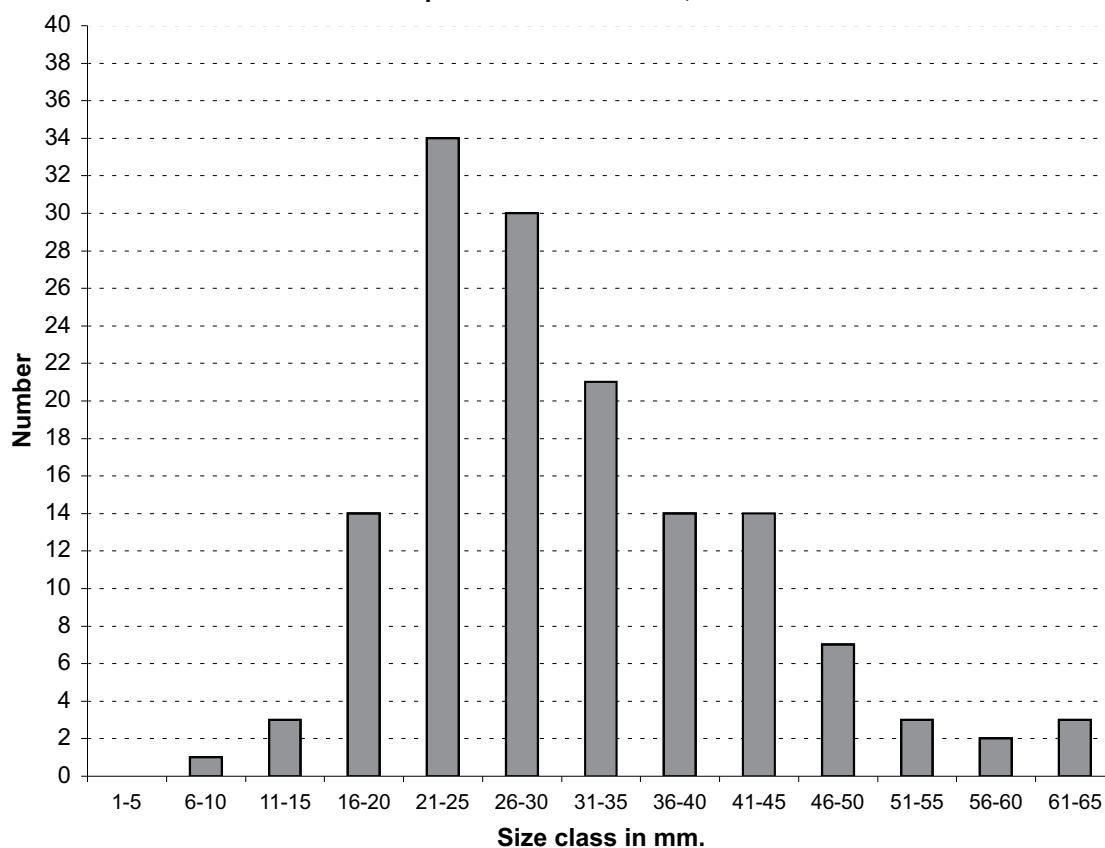


Figure 3: Individual measurements on the maximum impact notch breadth on marrow-processed horse marrow-bone fragments (N=146). Mean impact notch breadth = 31.6 mm.



Figure 4: Individual measurements on the maximum impact scar depth on marrow-processed horse marrow-bone fragments (N=145). Mean impact scar depth = 12.2 mm.

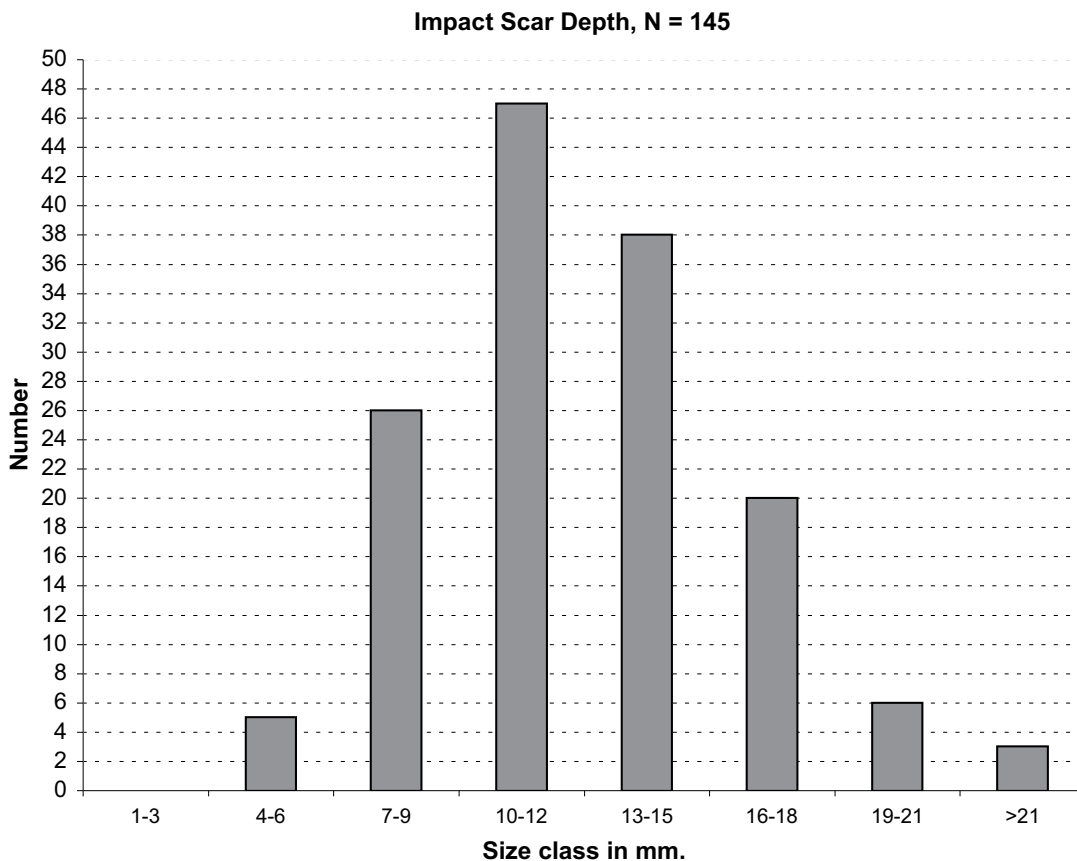


Figure 5: Individual measurements on the maximum impact scar breadth on marrow-processed horse marrow-bone fragments (N=148). Mean impact scar breadth = 45.6 mm.

