Hässleberga – A Late Palaeolithic Kill Site in Scania, Sweden, Confirmed by Analysis of Bone Modifications

BY OLA MAGNELL, RONNIE LILJEGREN & JONAS EKSTRÖM

Abstract

Magnell, Ola, Liljegren, Ronnie & Ekström, Jonas. 1999. Hässleberga – A Late Palaeolithic Kill Site in Scania, Sweden, Confirmed by Analysis of Bone Modifications. Lund Archaeological Review 5 (1999), pp. 5–19.

Late Glacial skeletal remains from mainly reindeer and wild horse, but also other species such as mountain hare, arctic fox and elk, have been collected from kettle holes in Hässleberga, Scania. Bones from reindeer and wild horse have been radiocarbon-dated to the Allerød and Younger Dryas. Analysis of bone modifications has revealed several different actors and factors behind the accumulation of the skeletal remains. Marks caused by gnawing and chewing by rodents, ungulates and carnivores have been observed on skeletal remains from reindeer and wild horse. The frequent occurrence of carnivore tooth marks probably represents both predation by carnivores and scavenging of bone refuse. Modifications interpreted to be cut marks and marrow fracturing caused by humans have been observed on bones from reindeer and wild horse. Man-made modifications on radiocarbon-dated reindeer bones indicate the presence of humans in Hässleberga during the Allerød and Younger Dryas.

Ola Magnell, Institute of Archaeology, Lund University, Sandgatan 1, SE-223 62 Lund, Sweden.
Ronnie Liljegren, Department of Quaternary Geology, Lund University, Tornavägen 13, SE-223 63 Lund, Sweden.
Jonas Ekström, Department of Quaternary Geology, Lund University, Tornavägen 13, SE-223 63 Lund, Sweden.

Introduction

The last decade of Late Palaeolithic research has resulted in excavations of sites and identifications of finds of tanged points from the Hamburg, Bromme and Ahrensburg cultures from different areas of Scania (Larsson 1996; Andersson & Knarrström 1999). In Denmark too, Late Palaeolithic research has been more intense during the last few decades, resulting in excavations and studies of several sites (Fischer & Nielsen 1987; Holm & Rieck 1992; Holm 1993; Vang Petersen & Johansen 1993).

Most of the identified Late Palaeolithic sites in South Scandinavia are found on sandy hills where no organic material has been preserved (Vang Petersen & Johansen 1996, p. 79; Larsson 1996, p. 144). Sites with preserved skeletal remains are of vital importance for the understanding of the subsistence and seasonality of settlements in the Late Palaeolithic cultures. The discovery of Late Glacial osteological assemblages will confirm and develop the proposed models of settlement patterns of Late

Fig. 1. Map of Scania showing the location of Hässleberga.

Palaeolithic hunters (Vang Petersen & Johansen 1993, pp. 26 ff.; Bratlund 1994, pp. 89 f.). Not only are osteological assemblages important for studies of the economy of the Late Palaeolithic cultures, they also form an important source for radiocarbon dating of sites.

Osteological remains in Late Palaeolithic contexts have not previously been found in Scania, apart from a few finds of implements made of reindeer antlers and a few bone fragments from the Segebro site, which may originate from the upper layers of a Mesolithic settlement (Larsson 1996, p. 143; Liljegren & Lagerås 1993, p. 23). Since 1992, the amateur archaeologist Sten-Åke Nilsson has been collecting Late Glacial osteological remains from kettle holes in Hässleberga, Scania. The recovered material is the largest Late Glacial assemblage of reindeer bones and antlers from a single site in Sweden. The first Late Glacial finds of wild horse and arctic fox in South Scandinavia are from Hässleberga. The site is the most important site for studies of the Late Glacial mammalian fauna in Sweden.

Bone modification of the skeletal remains has been studied in order to understand the processes behind the accumulation of the assemblage. The analysis of bone modifications has revealed marks from cuts with stone tools and marrow fracturing caused by humans. These observations make Hässleberga one of the most important sites for discussions of the subsistence and seasonality of Late Palaeolithic cultures in Southern Sweden.

The osteological remains and the analysis of bone modification and its implications for the interpretation of Hässleberga as a Late Palaeolithic site will be presented and discussed here. The Late Glacial fauna and its relationship to Man elucidated by radiocarbon dating and species representation of the skeletal remains from Hässleberga was discussed at the symposium "Behaviour and Landscape Use in the Final Palaeolithic of the European Plain" in Stockholm, 14–17 October 1999.

Site description and material

The site is situated in an area with glaciofluvial deposits and many kettle holes, 6 km from the archaean ridge of Romeleåsen in south-western Scania (Fig. 1).

The kettle holes were formed during the deglaciation when large blocks of ice were isolated from the main ice. The ice blocks were buried in glaciofluvial sediments, and steep-walled kettle holes filled with water were created when the blocks melted. At first clay washed out from the surrounding grounds was deposited. When the surroundings became covered with vegetation and the climate became more favourable in the Allerød interstadial clay gyttja was deposited. In the Younger Dryas, when vegetation became sparse, clay was deposited over the gyttja layer. During the Late Younger Dryas and Preboreal, gyttja was deposited again while the kettle holes were filled up with vegetation. The kettle holes were already overgrown at the end of the Preboreal chronozone. Finally, in the Postglacial, thick layers of peat were formed over the Late Glacial layers.

The studied skeletal remains originate from kettle holes which have been turned into crayfish ponds. The sediments from the kettle holes were excavated and spread on the surrounding ground by the landowner with an excavator. Bones have been collected in heaps of sediments and from the surrounding ground. A total amount of 26 kg skeletal remains has been collected. The osteological assemblage consists of animal remains from both Late Glacial and Postglacial fauna. This study deals with 215 bone and antler fragments weighing 17 kg, which we either know or suspect to have a Late Glacial dating. Skeletal remains have been collected from five kettle holes from an area of about 10 hectares. Of the analysed fragments of antler and bone, 54% have been collected around kettle hole H:1, 33% around H:2 and 8% around H:3, H:4 and from H:7. The remaining 5% of the osteological material has not been connected to a specific kettle hole

Since almost the entire osteological material has been collected from spread-out sediments from the kettle holes, the stratigraphy cannot be used for dating the bone fragments. We have interpreted antlers and bones as Late Glacial if they could be identified as species typical of the fauna of the period, such as reindeer, although we know that the reindeer also occurred in Scania during the Preboreal chronozone (Liljegren & Ekström 1996, p. 137). Further, bones with a colouring and texture of the surface typical of bones from the Late Glacial gyttja layers of the kettle holes have been considered to be Late Glacial. Eighteen bone and antler fragments have a Late Glacial radiocarbon dating. A few of the bone and antler fragments have been collected *in situ* from Late Glacial gyttja layers.

The preservation state of the skeletal remains varies depending on the extent to which the bones have been exposed to post-deposition weathering after the removal of the bones and antlers from the kettle holes. Late Glacial bones from clay gyttja and clay not affected by post-deposition weathering are very well preserved with a hard, shiny surface and a heavy, compact bone structure. The colouring of the bones differs from light brown with pale grey areas to pale grey depending on whether they were deposited in olive-green fine detritus or yellow calcareous gyttja. The condition of the bones affected by post-deposition weathering varies from cracks in the most outer surface on otherwise well preserved bones to specimens with a rugged, dull bone surface. Postglacial bones from the peat are dark brown with a dull surface and are often weathered. Most of the recovered antlers have lost their tines and the breakage is in most cases fresh. The fragmentation of the antlers was probably mainly caused during the excavation of the kettle holes.

The collection of the assemblages from the ground in the spread-out kettle hole sediments has led to a bias of skeletal remains from larger mammals. In spite of this, the assemblages are more representative than most Late Glacial collections of subfossil skeletal remains, which mainly consist of large, conspicuous elements such as antlers and skulls from large mammals (Liljegren 1975, pp. 18 f.). The collecting has been extensive, and bone fragments from rather small species such as hare and pike have been recovered.

Methods

The analysis of the skeletal remains was performed at the osteological collections of the Lund University Zoological Museum. Identification of the osteological remains of arctic fox has been done by Kim Aaris-Sørensen, Zoological Museum, University of Copenhagen.

Bone modification has been studied with stereoscopic light microscope at 8–40 magnifications to make it possible to detect faint marks and identify the causing agents. Very fine tooth scratches of carnivore teeth, trampling marks or other natural processes where stone and gravel cause scratches on the bone can otherwise easily be taken for cut marks caused by stone tools (Andrews & Cook 1985, pp. 683 ff.; Behrensmayer *et al.* 1986; Olsen & Shipman 1988; Fiorillo 1989; Oliver 1989, pp. 89 ff.; Noe-Nygaard 1995, p. 187). By studying the micromorphology of the marks, the orientation of the marks and their anatomical location on the bone, it is possible to identify cut marks caused by humans. The criteria applied for identifying cut marks have been widely discussed (Binford 1981; Shipman & Rose 1983; Noe-Nygaard 1989). The criteria used in this study are taken from a compilation of bone modification criteria published by Blumenschine *et al.* (1996, p. 496). Cut marks caused by humans are diagnosed by a morphology with low breadth:depth ratio, V-shaped cross-section and internal longitudinal microstriations. Cut marks are often identified in subparallel groups. Another criterion for diagnosing man-made cut marks is that their location on the bone must reflect a specific function in the butchering process such as skinning, dismemberment or filleting.

Traces of carnivore gnawing on bones are characterized by punctures of the bone surface and furrows with a high breadth:depth ratio and a U-shaped cross-section (Blumenschine *et al.* 1996, p. 496). Carnivore tooth marks are mainly concentrated in parts of bones with low density such as long bone epiphyses. Unlike butchering marks, carnivore tooth marks usually cover a relatively large area of the bone surface. Carnivore feeding on bones often leads to destruction of the ends of long bones (Binford 1981, p. 51; Haynes 1982, p. 275). Modifications caused by humans may become obscured and impossible to identify by carnivore gnawing on bones (Morey & Klippel 1991, p. 13). Species determination of carnivore tooth marks, particularly between different canids which have similar dentition, is very difficult (Noe-Nygaard 1995, p. 187). Due to this, no species determination of carnivore tooth marks has been achieved.

Trampling modifications are caused when hooves or feet press bones towards stone, sand or gravel. Trampling marks are usually faint and shallow scratches with striations of different widths, which are often shorter than 10 mm (Andrews & Cook 1985, p. 682; Olsen & Shipman 1988, pp. 544 ff.). Cut marks made by stone tools are often deeper and longer. Marks inflicted during trampling are oriented in different directions with a widespread occurrence mainly on curvatures of diaphyses of long bones or on flat surfaces on bones such as pelvis and scapula. Man-made cut marks are located as single marks or in distinct groups (Olsen & Shipman 1988, pp. 550 f.).

Modifications similar to butchering marks can also be caused during excavation and handling of skeletal remains. These post-deposition marks differ from "ancient" modifications by exposure of internal bone with a different colour from the surface of the bones (White 1992, p. 133). Recent shallow scratches on the bone surface, which do not expose underlying bone, leave marks with a bright shiny appearance which differ from "ancient" cut marks. Post-deposition marks also have a more or less random location and orientation just like trampling marks.

Studies of marrow fracturing of bones are also combined with interpretation difficulties since bones are fractured by natural processes such as heavy carnivore chewing, weathering and sediment compression (Marshall 1989, pp. 19 ff.). Marrow fracturing can be diagnosed by identification of impact marks and percussion microstriations. Impact marks are scars/negative "bulbs" on the bone wall caused when the bone is hit by or beaten against a pointed object (Bunn 1989, p. 301; Noe-Nygaard 1995, p. 182). Fracturing of bones by gnawing wolves and bears can however cause damage similar to impact marks (Haynes 1982, p. 269). Percussion microstriations are inflicted when the bone is hit and the hammerstone or anvil scratches the surface of the bone. These marks are commonly found near the fractured edge together with impact marks (White 1992, pp. 150 f.; Blumenschine *et al.* 1996, p. 496).

Bone modifications such as rodent gnawing and chop and sawing marks have distinct morphologies which are relatively easy to identify (Shipman & Rose 1983, pp. 81 ff.; Noe-Nygaard 1995, pp. 181 f.).

Processes during weathering and diagenesis which alter the surface of the bone will, if they are heavy enough, make identification of cut and tooth marks impossible. Because of this, only skeletal remains with a well preserved bone surface have been used in this study. Quantification of the modifications is based on bone fragments identified as reindeer, deer and wild horse.

Animal remains

Fish (*Pisces*)

Bones from pike (*Esox lucius*) have been recovered from kettle holes H:1, H:2, H:3 and H:4. The collected material consists of 33 bones from the skull region, apart from two vertebrae. Most of the pike bones are from H:2, where 23 bones from at least three individuals have been found. From H:1, one dentale from perch (*Perca fluviatilis*) has been identified.

The bones from fish are considered to have a Late Glacial dating since the kettle holes were filled up with vegetation already during the Preboreal. Some of the pike bones have been collected directly from Late Glacial sediments. Pike and perch have previously been recovered from Late Glacial deposits in Denmark and Scania (Liljegren 1975, pp. 121 ff.; Aaris-Sørensen 1988, p. 125). Pike is also present in the bone assemblage from the Bromme settlement (Degerbøl 1946, p. 138).

Birds (*Aves*)

Eight bones from birds have been recovered from H:1 and H:2. One femur has been identified as being from a mallard (*Anas platyrhynchos*). Dating of the bird remains is uncertain, but the colouring and texture of the bone surfaces indicate that they probably were deposited in the same sediments as the pike, wild horse and reindeer bones.

Human (*Homo sapiens*)

A diaphysis fragment of a left tibia from a human has been recovered from H:3. The fragment cannot be radiocarbon-dated since no collagen is preserved. One remarkable character of the tibia fragment is marks from heavy rodent gnawing.

Mountain hare (*Lepus timidus*)

A mandible and tibia from hare have been collected from H:1. During the excavation of H:7, a skull fragment from a mountain hare was recovered from Late Glacial sediments. Only two Late Glacial finds of mountain hare have previously been discovered in Scania (Liljegren 1975, p. 43).

Arctic fox (*Alopex lagopus*)

The first Late Glacial find of arctic fox in Scandinavia is a mandible from H:1. Late Glacial remains from other terrestrial carnivores such as brown bear (*Ursus arctos*), wolverine (*Gulo gulo*) and wolf (*Canis lupus*) have previously been found in Denmark, but not yet in Scania (Aaris-Sørensen 1988, pp. 117 f.; Liljegren & Ekström 1996, p. 136).

Elk (*Alces alces*)

The recovered bone fragments of elk from Hässleberga are a lumbar vertebra from H:1, a femur and a skull fragment from H:2. The skull fragment is from a bull with unshed antlers, radiocarbon dated to the transition between the Allerød and the Younger Dryas (Table I). Few assumed Late Glacial skeletal remains from elk have been dated. The earliest evidence of elk in Sweden is dated to the Bølling (Liljegren & Ekström 1996, p. 137).

Reindeer (*Rangifer tarandus*)

The reindeer, with 94 identified fragments, is the most abundant species in the collections from Hässleberga. More than half of these are fragments of antlers. Most of the reindeer remains are from kettle hole H:1. Antler and bones from reindeer have also been collected in four other kettle holes.

All major anatomical parts of the reindeer skeleton are represented except for vertebrae and ribs (Table II).

Seven bone fragments in the total assem-

Table I. ^{14}C dates in conventional radiocarbon years of skeletal remains from Hässleberga.

Ref. no.	Lab. no.	Species	Skeletal element	Radiocarbon age (BP)
H1:47	Ua-3295	Reindeer	Skull	10 055 ± 80
H1:45	LuA-4495	Reindeer	Pelvis	10 200 ± 130
H1:52	Ua-3294	Reindeer	Skull	10 265 ± 140
H2:25	LuA-4496	Reindeer	Metatarsus	10 450 ± 140
H1:187	LuA-4490	Reindeer	Radius	10 580 ± 140
H1:17	LuA-4494	Reindeer	Humerus	10 640 ± 120
H2:31	LuA-4493	Reindeer	Metacarpus	10 770 ± 150
H1:85	LuA-4491	Reindeer	Calcaneus	10 920 ± 140
H1:134	LuA-4492	Reindeer	Metatarsus	11 300 ± 140
H1:48	Ua-3296	Reindeer	Antler	11 390 ± 90
H1:167	LuA-4489	Reindeer	Humerus	11 410 ± 130
H2:30	LuA-3969	Elk	Skull	11 040 ± 130
H2:16	Ua-4764	Wild horse	Pelvis	10 495 ± 95
H2:81	Ua-4765	Wild horse	Tibia	10 510 ± 95
H2:80	LuA-4497	Wild horse	Radius	10 610 ± 130
H1:75	Ua-4763	Wild horse	Skull	10 725 ± 110
H1:78	Ua-3293	Wild horse	Mandible	11 180 ± 95
H1:72	Ua-3969	Wild horse	Skull	11 190 ± 100

blage have been identified as red deer (*Cervus elaphus*). These fragments have been assumed to be Postglacial, even if it is not impossible that red deer was a part of the Allerød fauna. Because of the great similarities of the skeletal morphology between reindeer and red deer, 29 bone fragments have been determined as deer (*Cervidae*). Mainly fragments of ribs, vertebrae and the diaphyses of limb bones have been identified as deer (Table II). It is most likely that the fragments of ribs and vertebrae identified as deer actually are fragments from reindeer. The colouring and texture of the identified deer and reindeer bone fragments are the same.

The more complete fragments of antler are shed and have a shape of the *arcticus* type, which is described as the dominating antler type of the Late Glacial reindeer in South Scandinavia (Degerbøl & Krog 1959, p. 84; Björck *et al.* 1996, p. 206). Two skull and pelvis fragments from both sexes are present in the material. This contrasts to the recovered antlers, which all are from bulls. Reindeer from different age groups are represented in the assemblage from H:1. One mandible with an erupting first molar is from a calf aged two to four months (Bromée-Skuncke 1952). At least one subadult is represented by a humerus, radius and metacarpal with unfused epiphyses. Most of the bone fragments are from adult individuals with fused epiphyses. Three adult individuals (>28 months) are represented by right metacarpals with fused distal epiphysis (Hufthammer 1995, pp 39 f.).

From H:2, 30 reindeer bones and antlers have been recovered. Eight fragments of bone and antler from reindeer have also been collected from kettle holes H:3, H:4 and H:7.

The reindeer remains from Hässleberga have been radiocarbon-dated to the Middle-Late Allerød and throughout the Younger Dryas (Table I).

Wild horse (*Equus ferus*)

Of the total 64 teeth and bone fragments of horse collected in Hässleberga, probably at least half are from wild horse. Three fragments of horse from H:1 have been radiocarbon-dated. A mandible and a skull fragment have been dated to the Late Allerød and another skull fragment is dated to the Early Younger Dryas. Three

Table II. Number of fragments of reindeer bones and antlers from different kettle holes in Hässleberga. H-90 represents bone fragments not connected to a specific kettle hole. Figures in parentheses are bone fragments determined only as deer.

Rangifer tarandus	H-1	H-2	H-3	H-4	H-7	H-90
Antler	30	15(1)	1	4	1	–
Skull	4	–	–	–	–	–
Mandible	1(1)	–(1)	–	–	–	–
Atlas	1	–	–	–	–	–
Thoracic vertebra	–(1)	–(1)	–	–	–	–(1)
Rib	–(1)	–(1)	–	–	–	–
Lumbar vertebra	–(1)	–	–	–	–	–
Sacrum	–(1)	–	–	–	–	–
Scapula	3(2)	–	–	–	–	–(1)
Humerus	2(1)	1(3)	–(1)	–	–	–
Radius/Ulna	3(2)	2	–	–	–	–
Metacarpal	5	1	–	–	–	–
Pelvis	2(1)	–	–	–	–	–(1)
Femur	2(3)	–	–	–	–	–
Tibia	1(3)	2	1	–	–	–
Calcaneus	1	–	–	–	–	–
Astragalus	–	–	–	1	–	–
Naviculocuboid	1	–	–	–	–	–
Metatarsal	3	2	–	–	–	–
Metacarpal/tarsal	–	–(1)	–	–	–	–
Phalanx1	2	1	–	–	–	–
Phalanx2	1	–	–	–	–	–
Totals	62(17)	24(8)	2(1)	5	1	–(3)

radiocarbon-dated bone fragments from H:2 are all dated to the Middle Younger Dryas (Table I). The wild horse remains from Hässleberga are the first Late Glacial finds of wild horse in South Scandinavia (Liljegren & Ekström 1996, p. 139).

Some of the skeletal remains from Hässleberga are most likely from domestic horse buried in the area during the last centuries. By studying the colour and texture of the bone surface, it may be possible to identify whether a bone is subrecent or subfossil. Analysis of the fluoride content in bones makes it is possible to obtain a measure of the extent to which the fossilization process has changed the chemistry of the bone (Johnsson 1997). Two radii from horse, which have been taken as subrecent, have a low fluoride content, which indicates a young dating.

Bones and teeth from horse, which have the same colour and texture as the dated ones and the reindeer bones, have been interpreted as being from wild horse. The only skeletal remains which with certainty are from wild horse are the radiocarbon-dated ones, but by including the assumed wild horse bones in the discussion it is possible to give a more accurate picture of the assemblages.

Like the reindeer remains, most of the skeletal remains from wild horse have been collected around H:1. Almost all skeletal remains of wild horse from Hässleberga are fragments of the skull, pelvis and lower limb bones (Table III). Both juveniles and adult individuals are represented in H:1 and H:2 by deciduous as well as permanent teeth and limb bones with fused and loose epiphysis.

Table III. Number of fragments of radiocarbon dated wild horse remains from different kettle holes in Hässleberga. Figures in parentheses are teeth and bone fragments assumed to be from wild horse.

Equus ferus	H-1	H-2	H-4	H-7
Skull	2 (4)	-	-	- (1)
Mandible	1	-	-	- (1)
Teeth	- (2)	- (2)	-	-
Cervical vertebra	- (2)	-	-	-
Rib	- (1)	-	-	-
Sacrum	-	- (1)	-	-
Pelvis	- (4)	1 (1)	-	-
Tibia	-	1 (1)	-	-
Metatarsal	- (1)	- (2)	- (1)	-
Radius	- (2)	1 (1)	-	-
Phalanx 1	- (2)	-	-	-
Phalanx 3	- (1)	-	-	-
Totals	3 (19)	3 (8)	- (1)	- (2)

Bone modifications

The bone modifications on the skeletal remains from Hässleberga are hard to interpret due to the frequent occurrence of different kinds of marks caused by various actors and processes. The analysis reveals a complex history of the assemblage from the living reindeer and wild horse to the excavation of their skeletal remains from the kettle holes.

Scrape- and cut-mark-like modifications, which have been interpreted to be recent, have been found on 30% of the fragments. These marks were probably caused during the excavation of the kettle holes and the spreading of the sediments when stone and gravel were pressed into or rubbed on the bone surfaces.

Modifications described in various studies and experiments as trampling have been observed on 11% of the bones from Hässleberga. These marks occur more frequently on bones from wild horse than on bones from reindeer (Table IV). The low frequency and small number of marks per bone of the trampling-like marks on the bones from Hässleberga differ from modifications on bones from trampling experiments. On trampled bone assemblages modifications usually occur on most of the bones, the number of marks is high and the marks cover large areas of the bones (Olsen & Shipman 1988, p. 550). This fact, together with the supposed rapid deposition of the bones based on the well preserved condition of the bone fragments, with no traces of weathering, indicates that the trampling of the assemblage has been very slight or that the trampling-like marks have been caused by other processes.

On almost half of the bones with trampling-like marks, carnivore tooth marks have been observed. Carnivores may have caused these marks by dragging and scratching bones against coarse surfaces while scavenging. Further, it cannot be rule out that these marks were caused by humans, for instance while discarding the bone as waste after butchering or by trampling. However, no modifications specific to humans have been identified on the bone fragments with trampling-like marks, even if the fragmentation of some of the bones may have been caused by humans. A fourth explanation for the trampling-like marks may be tumbling and pressing against stone during transport of the bones by water or ice. If these processes were in action, the trampling-like modification would have occurred more frequently in the assemblage and covered larger areas of the bone fragments. This is not the case, however. Modifications characteristic of water transport, such as polishing and edge rounding, have not been observed on the bones (Marshall 1989, pp. 20 f.).

The trampling-like marks indicate that the skeletal remains were not deposited in the kettle hole immediately after the death of the animals. The trampling-like marks were caused during the accumulation processes of the bones, but several different actors and processes may have inflicted the modifications.

Rodent chewing marks have been identified on the medial diaphysis of a metacarpal from reindeer. The marks cover an area of 3 cm^2. On

Table IV. Frequencies and element occurrence of bone modifications on skeletal remains from Hässleberga.

	Skull	Mandible	Rib	Scapula	Humerus	Radius	Metacarpal	Pelvis	Femur	Tibia	Calcaneus	Metatarsal	Phalanx 1	Totals
"Trampling" (reindeer)	-	-	-	1	-	-	1	1	-	-	-	1	-	4 (10%)
"Trampling" (deer)	-	-	-	1	-	-	-	-	-	-	-	-	-	1 (4%)
"Trampling" (wild horse)	2	1	1	-	-	1	-	-	-	1	-	-	-	6 (19%)
Carnivore tooth marks (reindeer)	-	-	-	2	1	2	1	2	2	2	1	2	1	16 (38%)
Carnivore tooth marks (deer)	-	-	1	1	-	1	-	-	1	-	-	-	-	4 (14%)
Carnivore tooth marks (wild horse)	1	-	1	-	-	1	-	2	-	1	-	-	-	6 (19%)
Cut marks (reindeer)	-	-	-	-	2	-	-	-	-	-	-	2	-	4 (10%)
Cut marks (deer)	-	-	1	-	-	-	-	-	-	1	-	-	-	2 (7%)
Cut marks (wild horse)	-		-	-	-	-	-	1	-	-	-	-	-	1 (3%)
Impact marks (reindeer)	-	-	-	-	-	-	-	-	1	-	-	-	-	1 (3%)
Impact marks (deer)	-	-	-	-	-	-	-	-	-	1	-	-	-	1 (4%)

the metacarpal, trampling-like marks have also been found.

Modifications occur on the brow and bez tines of a shed reindeer antler from H:2 (Fig. 2), which are similar to marks described as artificially cut-off tines on antler axes (Degerbøl & Krog, 1959, pp. 15 f.). The parallel grooved marks are located transverse on the tines and the breakage edge is narrowed. These modifications resemble chewing by ungulates, in this case probably reindeer, more than human working of antlers. Chewing of antlers and bones is a behaviour described in reindeer as well as in other ungulates and is known to result in modifications similar to working caused by humans (Brothwell 1976, p. 179).

Evidence of carnivore gnawing has been identified on 27% of the bone fragments from Hässleberga. The frequency of carnivore tooth marks on bones from reindeer, 40%, is twice the frequency for wild horse (Table IV).

In skeletal remains from Mesolithic sites in Denmark, the frequency of carnivore modifications varies from 7% to 21% (Trolle-Lassen 1990, p. 21; Noe-Nygaard 1995, p. 243). The higher frequency of carnivore tooth marks on the reindeer bones from Hässleberga may to a certain extent be due to differences between the samplings of the materials. The collecting of bones from Hässleberga has probably led to a lower frequency of fragments from diaphyses of long bones compared to the Mesolithic material recovered from archaeological excavations. Carnivore tooth marks are more often found on larger fragments of long bones with epiphyses than on diaphyses fragments from marrow-fractured bones. In a study of canid scavenging on bones from an Archaic period site in Tennessee, USA, the frequency of tooth marks was 10% on diaphyses fragments compared to 35% for proximal and distal ends (Morey & Klippel 1991, p. 16).

Fig. 2. Modification on a bez tine from a reindeer antler from H:2 interpreted as being caused by chewing an ungulate (reindeer). Each scale increment is 1 cm. Photo: Ola Magnell.

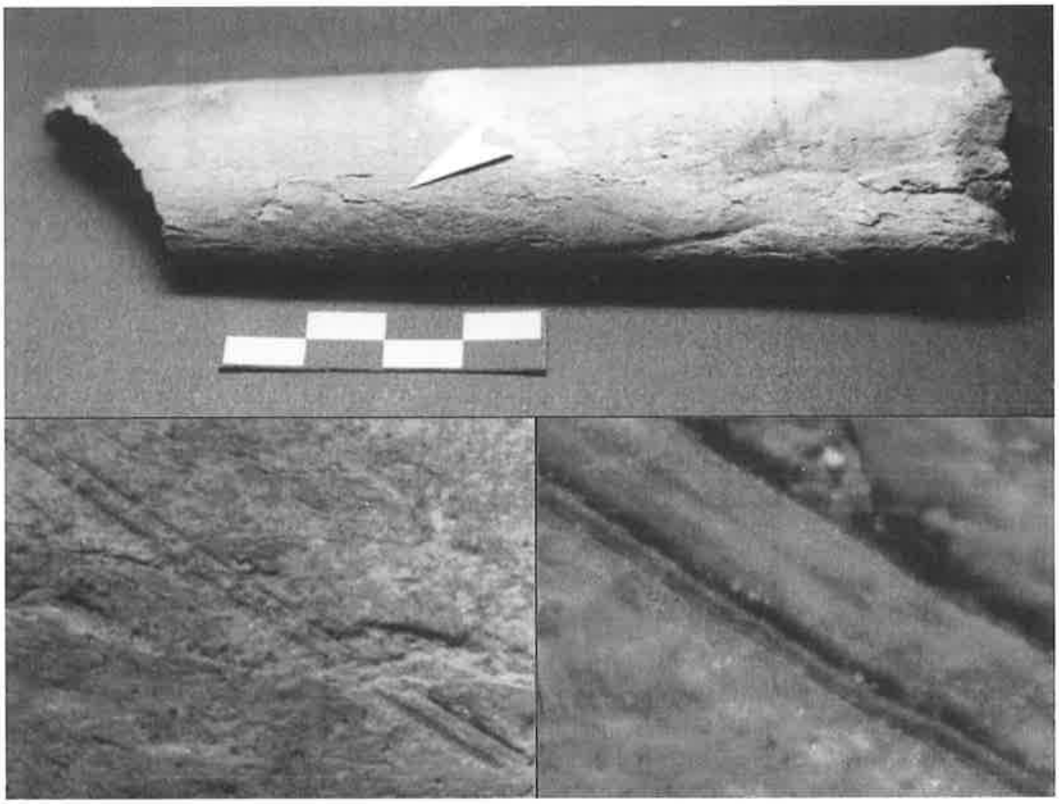

Fig. 3. Modification on a fragment of a metatarsal from reindeer interpreted as being cut marks caused by a stone tool. The arrow on the upper picture indicates the location of the cut marks. Each scale increment is 1 cm on the upper picture. The lower left picture is a close up of the cut marks (6.7x). A detail of the cut marks (40x) is shown on the lower right picture. Photo: Ola Magnell.

The frequency of carnivore tooth marks found on bones fed to captive wolves is nearly 75% (Haynes 1982, p. 269). High frequencies of marks from gnawing reflect what is expected to be found on assemblages from dens and rendezvous sites of wolves. The kettle holes in Hässleberga have probably not been used as dens for wolves or other carnivores. Skeletal remains from wolf kills have a lower frequency of tooth marks, because the meat is primarily consumed at kills (Binford 1981, p. 46; Haynes 1982, p. 268).

Another aspect which makes the interpretation of frequencies of carnivore gnawing on bones more difficult is the fact that less food leads to more intense feeding on bones by dogs and wolves (Noe-Nygaard 1995, p. 242; Haynes 1982, p. 266).

The rather high frequency of carnivore tooth marks on the reindeer bones from Hässleberga can be explained by either a sampling bias of diaphyses fragments, or that the bones represent kills by predators, or that the dogs had less food available than at the compared Mesolithic settlements.

Carnivore tooth marks occur mainly on the ilium of the pelvis and at articulare ends of scapula and the long bones, but also occur rather frequently on the diaphyses of the long bones. Most of the marks are scorings and pits with a great resemblance to modifications caused by dogs or wolves. More intense carnivore gnawing resulting in furrowing and bone destruction occurs on the ends of five fragments from reindeer and two from wild horse. Two complete tibiae and one radius from reindeer and a wild horse radius have only scorings on the diaphyses. The absence of carnivore tooth marks at the ends of these bones and no pits, punctures or furrows together with no breakage or human modifications, distinguish these bones from the other gnawed bones. The different gnawing pattern on these bones may indicate that they represent consumption by carnivores primarily of meat on carcasses from animals killed by predators while visiting the kettle holes.

Four bone fragments with modifications caused by humans show carnivore tooth marks. Three of these fragments have traces of intense carnivore gnawing, which is characteristic of bones fed to dogs. These gnawing marks may equally well have been caused by scavenging by wild carnivores.

Marks characteristic of cuts by stone tools have been identified on bone fragments from reindeer and wild horse (Table IV). Cut marks occurring in groups of parallel grooves with longitudinal striations have been identified on the lateral diaphyses of two metatarsals from reindeer (Fig. 3). These marks were probably inflicted during skinning, since no muscle tissue was found between the hide and the metatarsal in this area. One of these metatarsals is complete and was not skinned to give access to the marrow. A cut mark has been found in the plantar furrow of the metatarsal and was probably inflicted while cutting loose the sinew which runs here. This thick and rather long sinew may have been used for making threads.

On two fragments of humerus from reindeer, cut marks occur proximally to the trochlea. The cuts were probably caused during filleting of meat. One cut mark has been identified on the ischium of a pelvis fragment from wild horse just caudally to the acetabulum. The most likely interpretation of this mark is that it was inflicted during the dismemberment of the hind limb. This bone fragment is interpreted as being from wild horse due to its colouring and texture, but since it has not been radiocarbon dated we cannot be certain.

The study shows that the bones from reindeer have been fractured both by humans and by carnivores. The breakage and occurrence of marks similar to impact marks on a radius gives the expression that the bone has been marrow-fractured, but the fractures were actually caused by the jaws of a carnivore. Gnawing by wolves sometimes causes pressure flaking, and these marks are similar to impact marks (Binford 1981, p. 51). The occurrence of tooth marks along the edge of the bone, connected to the pressure flaking on the medial and lateral part of the distal diaphysis, indicates that the fracturing was caused by a carnivore.

The fragmentation of a femur and tibia was caused by humans during marrow fracturing. Impact marks have been identified on the lateral diaphysis of distal femur, most likely representing hits by a hammer stone (Fig. 4). Even if carnivore tooth marks occur on the distal part of the femur, no gnawing marks have been identified near the breakage, which would be expected if the fractures were caused by a carnivore. The impact marks on the bone, which could be described as flake scars on the bone surface, are similar to marks which are sometimes afflicted during marrow fracturing with a hammer stone. Flake scars are only caused when a bone is hit, and it has never been noticed that carnivore gnawing causes similar modifications (Binford 1981; Haynes 1982). The crude breakage of the proximal diaphysis of a tibia was probably caused by holding the bone at the distal end and hitting it against a pointed object. This marrow fracturing technique does not usually give impact marks, as is the case when a hammer stone is used. We cannot rule out that the fracturing of the tibia was caused by other processes, but since no carnivore tooth marks occur on the bone, the most likely explanation is marrow fracturing.

Modifications caused by humans have also been found on a fragment of reindeer antler. A piece was cut out from the antler fragment for further modifications, leaving an 18 cm long incision with polished edges.

Modifications caused by trampling, carnivore gnawing, cutting with stone tools and marrow fracturing have also been observed on bone fragments identified as deer. These modifications occur less frequently than on the bones identified as reindeer (Table IV). This may be because the bones determined as deer are mainly fragments of diaphyses and vertebrates where modifications are less likely to be found. A cut mark has been identified laterally on a rib and an impact mark occurs medially on a diaphysis fragment of a tibia.

Discussion

The representation of bone elements, age and sex-determined fragments is difficult to use in a discussion about the skeletal remains from Hässleberga because of the rather small material and sample biases. No clear selection – whether natural or caused by humans – has been interpreted from the skeletal remains.

Radiocarbon dating shows that the analysed skeletal remains from Hässleberga were deposited in the kettle holes during a long period from the Middle Allerød to the Late Younger Dryas (Table I). The high occurrence of carnivore tooth marks on the bone fragments indicates that carnivores have played a major part in the formation of the material.

Wolverine, brown bear, arctic fox, wolf and dog are carnivores which probably occurred in Scania during the Allerød and the Late Younger Dryas. Late Glacial finds of wolverine, brown bear and wolf are known from Denmark and a mandible from arctic fox has been found in Hässleberga (Aaris-Sørensen 1988, pp. 117 f.). The earliest evidence of dog in Sweden is dated to the Preboreal, but dogs may already have accompanied the first humans. Remains of dog dated to the Late Glacial have been found in Bonn-Oberkassel, Germany (Benecke 1993, p. 39). Wolverines have probably not caused the tooth marks on the bones from Hässleberga, since wolverines usually remove bones from carcasses to cache and feed on them elsewhere (Haynes 1982, p. 277).

Modifications caused by humans have been found on one reindeer bone dated to the Middle Allerød and two dated to the Middle Younger Dryas. At least during these periods, hunting and butchering of reindeer led to the accumulation of bones in the kettle holes. Bones with modifications caused by humans have been collected from kettle holes H:1 and H:2. Differences between the skeletal remains from the kettle holes will not be discussed because of the rather small material and sample biases.

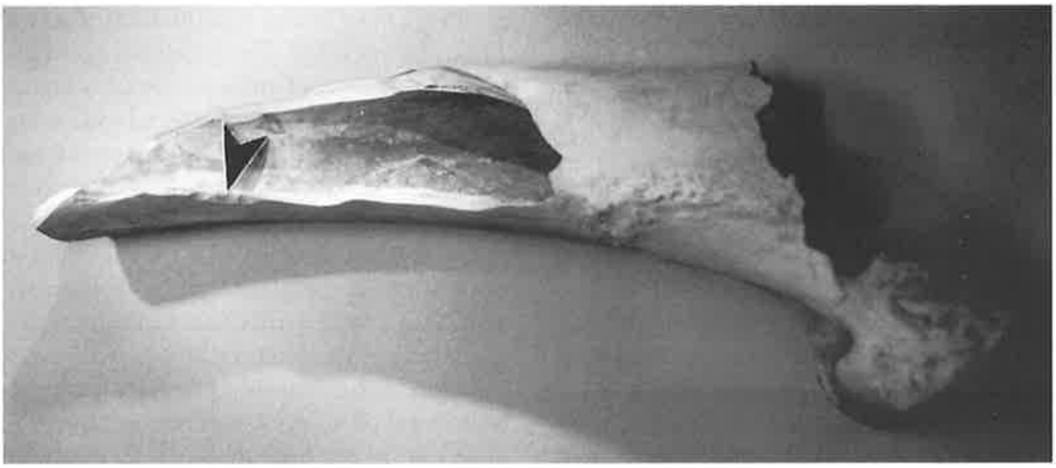

Fig. 4. A marrow-fractured femur of a reindeer. The impact marks (flake scars) are indicated by the arrow. Note the damage at the distal end of the bone caused by gnawing by a carnivore. Photo: Ola Magnell.

The radiocarbon dating to two periods and the occurrence in two kettle holes of reindeer bones with man-made cut marks and fractures indicates a repeated use of the area as a hunting ground during the Late Palaeolithic. The radiocarbon dating for the evidence of human activities at Hässleberga corresponds to the Bromme and Ahrensburg cultures. The repeated use of the same locality by different cultures during the Late Palaeolithic in South Scandinavia is a common feature of many sites (Holm 1991, p. 16; Larsson 1996, p. 148). The explanation for this is that the localization of the sites was dictated by the movement of game animals, mainly reindeer, and suitable places for lookouts or hunting (Holm 1991, p. 16).

The water-filled kettle holes during the Allerød and the Younger Dryas may have served as water holes for animals in the area during dry periods. Horses are dependent on access to fresh water (Karlsson 1983, p. 152). The kettle holes could also have been preferred by reindeer and wild horses as shelters from icy winds during the winter months.

Finds of ten shed male antlers and a male and a female skull with shed and unshed antlers respectively indicate the presence of reindeer in the area during the winter months. Old and adult males shed their antlers during the period December to February while young males shed their antlers in March to April. The antlers of the female reindeer are shed in May-June if the animals are pregnant or in March-April if they are not. The antlers of the females are not fully developed until August-September (Reimers 1989, p. 67). A skull fragment with unshed antlers from elk indicates a season of death from August to March. The antlers of the elk are developed in August and shed by old males in December-January and in March by younger ones (Rulcker & Stålfelt 1986, p. 33 ff.). A mandible from a calf of 2–4 months of age indicates the presence of reindeer in the area also during July-October. Today the reindeer calves in May (Reimers 1989, p. 28).

The kettle holes probably did not only attract reindeer and wild horses, but also predators and Late Palaeolithic hunters. One explanation for the accumulation of the skeletal remains from at least reindeer in the kettle holes would be that they mainly represent animals killed and butchered by humans and then scavenged by dogs and/or other carnivores on the ice in the winter. The bones were then deposited in the gyttja of the kettle holes in the spring season when the ice was melting. Some of the bones most likely also represent remains from wolf kills. Accumulations of bones from caribou and whitetail deer killed by wolves on frozen lakes in bottom sediments have been observed in Saskatchewan, Canada, and Minnesota, USA, respectively (Haynes 1982, p. 279).

Variations of modifications on bones from reindeer and wild horse indicate differences in the accumulation processes between the species. A possible explanation for the more frequent occurrence of man-made modifications and carnivore tooth marks on reindeer bones is that the skeletal remains from reindeer to a greater extent represent animals hunted by humans and scavenged bone refuse.

No modifications have been observed on bones from the other species in the Late Glacial skeletal remains from Hässleberga, except the rodent gnawed tibia from human, the dating of which is uncertain. The remains from fishes, birds, mountain hare and arctic fox most likely represent natural deaths of animals living in or near the kettle holes. Possible actors involved in the accumulation of elk bones still remain unknown. The reindeer antlers were probably deposited by animals shedding their antlers nearby or on the ice of the kettle holes in the winter, except the antler fragment with man-made work traces.

The Late Palaeolithic sites in Southern Scandinavia have mainly been described in terms of base or hunting camps. With Hässleberga we now have what could be described as the first Late Palaeolithic kill site in Scania. The exact terminology of the site may be discussed, since activities such as butchering, marrow fracturing and working of antler took place at the site. However, all activities are consistent with a very short-time occupation of a site in association with the killing of reindeer. A few flint implements with Palaeolithic characters, but no tanged points or other artefacts associated with a specific culture, are all that have been collected from the area around the kettle holes. We have at least for the moment no evidence of settlements in the vicinity of the kettle holes.

Two sites in Denmark, Nørre Lyngby and Køge Bay, display similarities to the Hässleberga assemblage as they have not been collected during archaeological excavations; reindeer is the most common species and all are dated to the Allerød and the Younger Dryas. At Nørre Lyngby on the west coast of Jutland, Late Glacial sediment layers from a freshwater basin have been exposed by erosion of the sea. A reindeer rib with man-made cut marks dated to the Allerød and the finds of a tanged point and a reindeer antler axe associated to the Bromme culture indicate human activities at the site (Aaris-Sørensen 1988, p. 111; 1995, p. 362).

From Køge Bay on the east coast of Zealand, sand-pumping from a submarine bog has unearthed marrow-fractured bones from both reindeer and elk along with worked reindeer antler. The finds are radiocarbon-dated to the Late Bølling, Allerød and Younger Dryas (Vang Petersen & Johansen 1993, pp. 32 f.).

Nine reindeer bones from the collections of the Lund University Zoological Museum, recovered during peat cutting or drainage in the 19th century and at the beginning of the 20th century from different parts of Scania, have also been studied. Four have trampling-like marks and three carnivore tooth marks. A metatarsal found in Hässleberga has cut marks caused during skinning and a mandible from Östra Grevie has impact marks and percussion striations just behind the last molar. The fracture of the mandible may have been caused during the removal of the mandible from the skull. These bone fragments have patterns of modifications similar to those described on the skeletal remains from Hässleberga. They indicate the presence of several sites similar to Hässleberga in Scania.

Acknowledgement

Thanks to Sten-Åke Nilsson for the assiduous recovery of skeletal remains from Hässleberga and for making it possible for us to study them. Nanna Noe-Nygaard kindly provided opinions and useful assistance in the interpretation of bone modifications. We are grateful to Kim Aaris-Sørensen for identification of the arctic fox and Annica Cardell for help in the identification of fish remains. Thanks to Lars Larsson for support with the analysis. Elisabeth Iregren, Per Karsten and Mats Eriksson deserve thanks for comments on the manuscript.

References

Aaris-Sørensen, K. 1988. *Danmarks forhistoriske dyreverden. Fra istid til vikingetid.* Copenhagen.

– 1995. Palaeoecology of a Late Weichselian vertebrate fauna from Nørre Lyngby, Denmark. *Boreas* 24.

Andersson, M. & Knarrström, B. 1999. *Senpaleolitikum i Skåne.* Riksantikvarieämbetet. Skrifter No. 26.

Andrews, P. & Cook, J. 1985. Natural modifications to bones in a temperate setting. *Man* 20.

Behrensmayer, A. K., Gordon, K. D. & Yanagi, G. T. 1986. Trampling as a cause of bone surface damage and pseudo-cutmarks. *Nature* 319.

Benecke, N. 1993. Zur Kenntis der mesolithischen Hunde des südlichen Ostseegebietes. *Zeitschrift für Archäologie* 27.

Binford, L. S. 1981. *Bones, Ancient Men and Modern Myths.* New York.

Björck, S., Ekström, J., Iregren, E., Larsson, L. & Liljegren, R. 1996. Reindeer, and palaeoecological and paleogeographic changes in South Scandinavia during late-glacial and early post-glacial times. *Archæologiske Rapporter fra Esbjerg Museum* 1.

Blumenschine, R. J., Marean, C. W. & Capaldo, D. C. 1996. Blind Tests of Inter-analyst Correspondence and Accuracy in the Identification of Cut Marks, Percussion Marks, and Carnivore Tooth Marks on Bone Surfaces. *Journal of Archaeological Science* 23.

Bratlund, B. 1994. A Survey of the Subsistence and Settlement Pattern of the Hamburgian Culture in Schleswig-Holstein. *Jahrbuch Römisch-Germanische*

Zentralmuseums Mainz.

Bromée-Skuncke, F. 1952. Über Zahnentwicklung und Zahnabnutzen beim Reintier, vergleichen mit denen bei einigen andern Cerviden. *Arkiv för zoologi* 4.

Brothwell, D. 1976. Further Evidence of Bone Chewing by Ungulates: the Sheep of North Ronaldsay, Orkney. *Journal of Archaeological Science* 3.

Bunn, T. B. 1989. Diagnosing Plio-Pleistocene Hominid Activity with Bone Fracture Evidence. In Bonnichsen, R. & Sorg, M. H. (eds.), *Bone Modification.* Orono.

Degerbøl, M. 1946. Dyreknogler. In Mathiassen, T., En senglacial Boplads ved Bromme. *Aarbøger for nordisk oldkyndighed og historie* 1946.

Degerbøl, M. & Krog, H. 1959. *The Reindeer (Rangifer tarandus L.) in Denmark. Zoological and Geological Investigations of the Discoveries in Danish Pleistocene Deposits.* Biologiske Skrifter. Det Kongelige Danske Videnskabernes Selskab 10.

Fiorillo, A. R. 1989. An Experimental Study of Trampling: Implications for the Fossil Record. In Bonnichsen, R. & Sorg, M. H. (eds.), *Bone Modification.* Orono.

Fischer, A. & Nielsen, F. O. S. 1990. Senistidens bopladser ved Bromme – en genbearbejdning af Westerby's og Mathiassens fund. *Aarbøger for nordisk oldkyndighed og historie* 1986.

Haynes, G. 1982. Utilization and Skeletal Disturbances of North American Prey Carcasses. *Arctic* 35.

Holm, J. 1993. Settlements of the Hamburgian and Federmesser Cultures at Slotseng, South Jutland. *Journal of Danish Archaeology* 10, 1991.

Holm, J. & Rieck, F. 1992. *Istidsjægere ved Jelssøerne.* Skrifter fra Museumsrådet for Sønderjyllands Amt 5. Haderslev.

Hufthammer, A. K. 1995. Age Determination of Reindeer (*Rangifer tarandus* L.). *Archæozoologia* 7.

Johnsson, K. 1997. Chemical Dating of Bones Based on Diagenetic Changes in Bone Apatite. *Journal of Archaeological Science* 24.

Karlsson, J. (ed.). 1983. *Djurens underbara värld. Däggdjur* 6. Höganäs.

Larsson, L. 1996. The Colonization of Southern Sweden during the Deglaciation. In Larsson, L. (ed.), *The Earliest Settlement of Scandinavia and its Relationship with Neighbouring Areas.* Acta Archaeologica Lundensia. Series in 8° No. 24.

Liljegren, R. 1975. *Subfossila vertebratfynd från Skåne.* University of Lund. Department of Quarternary Geology. Report 8. Lund.

Liljegren, R. & Lagerås, P. 1993. *Från mammutstäpp till kohage. Djurens historia i Sverige.* Lund.

Liljegren, R. & Ekström, J. 1996. The Terrestrial Late Glacial Fauna in South Sweden. In Larsson, L. (ed.), *The Earliest Settlement of Scandinavia and its Relationship with Neighbouring Areas.* Acta Archaeologica Lundensia. Series In 8° No. 24.

Marshall, L. G. 1989. Bone Modification and "The Laws of Burial". In Bonnichsen, R. & Sorg, M. H. (eds.), *Bone Modification.* Orono.

Morey, D. F. & Klippel, W. E. 1991. Canid scavenging and deer bone survivorship at an Archaic period site in Tennessee. *Archæozoologia* 4.

Noe-Nygaard, N. 1989. Man-made Trace Fossils on Bones. *Human Evolution* 4.

– 1995. *Ecological, Sedimentary and Geochemical Evolution of the Late-glacial to Postglacial Åmose Lacustrine Basin, Denmark.* Fossils and Strata 37. Oslo.

Oliver, J. S. 1989. Analogues and Site Context: Bone Damages from Shield Trap Cave (24CB91), Carbon County, Montana, U.S.A. In Bonnichsen, R. & Sorg, M. H. (eds.), *Bone Modification.* Orono.

Olsen, S. L. & Shipman, P. 1988. Surface Modification on Bone; Trampling Versus Butchery. *Journal of Archaeological Science* 15.

Reimers, E. 1989. *Villreinens verden.* Oslo.

Rulcker, J. & Stålfelt, F. 1986. *Das Elchwild.* Hamburg & Berlin.

Shipman, P. & Rose, J. 1983. Early Hominid Hunting, Butchering and Carcass-Processing Behaviours: Approaches to the Fossil Record. *Journal of Anthropological Archaeology* 2.

Vang Petersen, P. & Johansen, L. 1993. Sølbjerg I – An Ahrensburgian Site on a Reindeer Migration Route through Eastern Denmark. *Journal of Danish Archaeology* 10, 1991.

– 1996. Tracking Late Glacial reindeer hunters in eastern Denmark. In Larsson, L. (ed.), *The Earliest Settlement of Scandinavia and its Relationship with Neighbouring Areas.* Acta Archaeologica Lundensia. Series in 8° No. 24.

White, T. D. 1992. *Prehistoric Cannibalism at Mancos 5MTUMR–2346.* Princeton.

English revised by Alan Crozier