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Summary

About 35 kilograms of bones, mostly deriving from butchery and food waste, were recovered from the mid-late Iron Age levels at Market Deeping. These were predominantly found in the fills of a palaeochannel. The animal economy of the site was primarily based on the exploitation of domestic animals, although wild game was also occasionally hunted. Water resources, such as beavers, swans, geese, ducks, were sometimes used, but represented only as an occasional addition to the diet. The scarcity - or absence - of fish is particularly noticeable. Sheep was the most common animal, but cattle provided the largest quantity of meat. Cattle were probably mainly reared for traction and sheep for meat. The presence of neonatal bones suggests that breeding was carried out on site and that the site was occupied in spring. But the analysis of the sheep tooth wear stages points to the fact that the site was also occupied in summer and autumn, when most of the lamb culling was probably carried out.

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The Iron Age animal bones excavated in 1991 from Outgang road - Market Deeping (MAD 91), Lincolnshire

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Introduction

The Iron Age and Roman settlement of Outgang Road is located in the Market Deeping parish (TF15871154), on the interface between the lower Welland Valley and the Fen edge (Fig.1). The site was first discovered in 1986 and then excavated, as part of the *Fenland Management Project* (FMP), in 1991 by Heritage Lincolnshire under the direction of Tom Lane.

The excavated area of 22m by 3m revealed the presence of Iron Age and Roman occupation. The most remarkable feature uncovered was a large infilled palaeochannel, which provided the longest stratigraphic sequence from this site. The fills at the bottom of the palaeochannel were organic and waterlogged and included a deposit of wood, bone and cobbles. Iron Age gullies and pits, a series of Roman ditches and enclosures, a series of clay-filled holes (possibly representing a structure) and a briquetage-rich deposit are also worth mentioning. In particular the abundant briquetage may indicate salt production, but this is at odds with the apparent lack of brackish water suggested by the analysis of the foraminifers (Lane undated).

The Roman levels at Market Deeping were severely affected by problems of residuality (Lane undated, Luff undated), as suggested by the high percentages of Iron Age pottery in some Roman contexts. Consequently the study of the animal bones has been limited to the material deriving from Iron Age contexts which were undisturbed and mostly free of contaminant or residual elements.

The ***mid-late Iron Age*** levels of the site have produced a small, but interesting, assemblage of animal bones. A total **35.5 Kg** of bones derived from these levels. They were distributed in the four phases, all of the mid-late Iron Age occupation, as follows:

Phase 1: 15.9 Kg
Phase 2: 12.7 Kg ↓time
Phase 3: 1.9 Kg
Phase 4: 5.0 Kg.

These figures only include hand-collected material. The four phases are defined stratigraphically and cannot be attributed to any specific chronological periods within the mid-late Iron Age (Dale Trimble pers.comm.).

Methods

Animal bones were hand-collected from all contexts. In addition a few samples were taken for flotation and sieving. These can be divided in two groups:
a) samples of 3 to 45 litres - but mainly 15 litres or 20 litres - taken for *flotation and 0.5mm wet sieving*
b) samples of 10 to 75 litres - but mainly or 20 litres or 30 litres - taken for *5mm wet sieving.*

All these samples were "whole earth", i.e. no finds were removed prior to flotation and/or sieving. Flotation and 0.5mm sieving of the flotation residues only produced a few fragments of unidentifiable bones, whereas a fair amount of identifiable bones were collected on the 5mm sieve (Table 1).

The mammal bones were recorded following a modified version of the method described in Davis (1992) and Albarella & Davis (1994). In brief, all teeth (lower and upper) and a restricted suite of parts of the postcranial skeleton were recorded and used in counts. These are: skull (zygomaticus), scapula (glenoid articulation), distal humerus, distal radius, proximal ulna, carpal 2-3, distal metacarpal, pelvis (ischial part of acetabulum), distal femur, distal tibia, calcaneus (sustentaculum), lateral astragalus, naviculo-cuboid, distal metatarsal, proximal phalanges (1st, 2nd and 3rd). At least 50% of a given part had to be present for it to be counted.

For birds the following were always recorded: scapula (articular end), proximal coracoid, distal humerus, proximal ulna, proximal carpometacarpus, distal femur, distal tibiotarsus, distal tarsometatarsus.

Horncores with a complete transverse section and "non-countable" elements of particular interest were recorded, but not included in the counts.

Wear stages were recorded for all P_4s and dP_4s as well as for the lower molars of cattle, caprines and pig, both isolated and in mandibles. Tooth wear stages follow Grant (1982) for cattle and pig and Payne (1973, 1987) for caprines.

Measurements are listed in Appendix 2. These in general follow von den Driesch (1976). All pig measurements follow Payne & Bull (1988). Humerus HTC and BT and tibia Bd measurements were taken for all species as suggested by Payne & Bull (1988) for pigs. Measurements taken on equid teeth follow Davis (1987). The width of caprine teeth represents the "maximum" width.

The bones from this site will be stored in the Lincoln City and County Museum.

Provenance and preservation

The preservation of the bone was generally fairly good, but bones tended to be very fragmented, as is the case for most assemblages derived from butchery and food refuse. A quick scan of the Roman material has not revealed any obvious difference in the preservation pattern between this and the Iron Age assemblage.

The large majority of the Iron Age bones were found in the channel fills. The rest of the assemblage derives from a variety of contexts, including ditch and pit fills and occupation layers.

No bones were found in articulation, which suggests that, potentially, they might all be redeposited. About 10% of the animal bones bore gnawing marks, but these were almost exclusively on cattle and equid bones (Table 6). Since these are the largest and most robust bones it is likely that dogs gnawed caprine and pig bones to complete destruction or when the "countable" diagnostic area had disappeared. Unfused bones were probably particularly affected by this problem. The relatively large amount of gnawing is also an indication that most bones were not rapidly buried and are therefore probably found in secondary deposits.

Occurrence and frequency of species

The list of taxa found at Market Deeping is shown in Table 1. As in most contemporary assemblages the main domesticates, such as cattle, sheep and pig, dominate the assemblage. However, a few wild mammals and birds are also found, whereas fish bones are totally absent. Though this may be partly due to a recovery bias, the absence of fish bones in the floated and fine sieved samples suggests that fishing did not play an important role in the economy of the site. This seems to be the case for other Iron Age sites in Britain too (Serjeantson *et al.* 1994)

Cattle and sheep/goat, followed by pig and equid, are the best represented taxa. Though cattle is numerically slightly more common than sheep/goat (table 2) it is most likely that this is due to a recovery and preservation bias. Caprine bones are smaller and therefore more easily overlooked on site and, since more fragile, less commonly preserved (see above). When the minimum number of individuals (MNI) - a method which is less affected by preservation and recovery biases - is considered, caprines become twice as common as cattle (Table 3). The much higher number of sheep/goat bones in the material from sieving (Table 1) confirms the probable under-representation of this taxon in the hand-collected assemblage.

Caprines were thus the most common taxon, as is the case for most Iron Age sites (see for instance Wilson *et al.* 1978, Grant 1984 and 1991, Levitan 1990, Wilson 1993 and Davis 1995). However, cattle, due to its much larger size, probably provided the largest amount of meat.

Slight differences in the frequency of the main taxa in different phases are noticeable but are of no statistical significance (Table 2), and might thus be merely due to chance. However, this does not necessarily mean that no changes occurred between the four phases of occupation. It is possible that our assemblage is not large enough to highlight any differences.

Many of the caprine bones and teeth could definitely be identified as "sheep" (Table 1). Goat was only represented by a very slender horncore found in a context from phase 1 (Table 1), indicating that, although rare, goats were indeed used. The scarcity of goats is typical of British sites, whether they are Iron Age or later.

Only one equid specimen - an almost complete skull - could definitely be assigned to the horse (*Equus caballus*) from the morphology of its cheek teeth

(Davis 1980). However, due to the rarity of the donkey (*Equus asinus*) from British sites of any period, it is most likely that all equid bones belong to the horse. Unlike many other contemporary sites, horse is more common than pig at Market Deeping, but this is probably due to a preservation and recovery bias.

Dog is the only other domestic mammal found in the assemblage. As concerns wild mammals, red deer is only represented by three antler fragments from phase 1. One of these is still attached to the skull, suggesting that, at least occasionally, deer were hunted, and that we are not dealing only with shed antlers collected in the woods. Due to the full development of the antler this killing probably occurred in summer or autumn. One pig tusk from phase 1 is remarkably large and probably belongs to a wild boar, which was thus also occasionally hunted.

Beaver (Plate 1) is the best represented of the wild species, with a few bone and tooth fragments - some of them "non countable" - all from phase 1. The beaver became extinct in the British Isles by late Saxon times, but one or two bones are found in most prehistoric bone assemblages, and it is especially common in the East Anglian Fens (Corbet and Harris 1991). This suggests a specific interest of the Iron Age inhabitants of the Fenlands in the exploitation of this aquatic resource, possibly for meat but more likely for fur. Beaver bones are remarkably frequent at the Iron Age Fenland site of Upper Delphs, Haddenham (Evans and Serjeantson 1988).

Birds are represented by a few bones of swan, goose and duck (Table 1). Together with the beaver they are the only evidence of the use of water resources. These birds were probably caught for eating although the swan could also have been valued for its large feathers. The Iron Age site of Upper Delphs has also provided large numbers of swan bones (Evans and Serjeantson 1988). There is no evidence of the domestication of geese and ducks in Europe in pre-Roman times (Crawford 1984; Clayton 1984). Until new evidence is found it is therefore reasonable to assume that the Market Deeping ducks and geese are wild.

Body parts

Most parts of the cattle and sheep skeleton are present in this assemblage (Table 3). This suggests that the animals were probably killed on site and that no selection of body parts occurred. The differences in the distribution of different anatomical elements can be entirely explained by a recovery bias - e.g. the absence of sheep phalanges - or a preservation bias - the under-representation of bones compared to teeth. The higher number of mandibular teeth can also be explained in terms of preservation as the mandible is more robust than the maxilla.

Age

Although fusion of the bones has been recorded, due to the low number of post-cranial bones in this assemblage, the study of kill-off patterns has been limited to the analysis of tooth eruption and wear. Wear stages of individual teeth of cattle and sheep/goat can be found in Table 4, while the list of mandibles which could be assigned to mandibular wear stages is in Appendix 1. The study is limited to the two most common species on site - cattle and sheep.

A few neonatal bones and/or teeth of cattle, sheep and pig have been found. This suggests that all these species were reared on site, and it is consistent with what is suggested by the distribution of the body parts (see above). The presence of these neonatal specimens is probably due to natural mortality, although the possibility that some of the calves and lambs were slaughtered to allow the exploitation of milk for human purposes cannot be ruled out. However, the large proportion of young calf bones which had been noted at the other Fenland Iron Age site of Cowbit Wash (Albarella and Mulville in press), in the Iron Age phase at Brean Down (Levitan 1990) and at the well known Bronze Age site of Grimes Graves (Legge 1981 and 1992) has not been found at Market Deeping.

Unfortunately only a small number of cattle mandibles could be attributed to age stages. These belong to either young or fully adult animals, with a remarkable absence of "subadults" (Table 5). This trend is also confirmed by the analysis of the wear of individual teeth - note for instance the absence of dP_4s in late wear. Although caution is necessary because of the small number, it can be tentatively suggested that at Market Deeping beef was only a by-product of the cattle breeding, and that the main emphasis was placed on milk production and use of power for transport. An economy geared mainly to meat production would be aimed at the slaughtering of animals when immature or subadult, whereas if the main emphasis was milk or transport a relatively large number of adult animals would be expected. An economy aimed at milk production would also be consistent with the killing of large numbers of juveniles, although there is not full agreement on this theory (see for instance Clutton-Brock 1981, Entwhistle and Grant 1989 and McCormick 1992). An approximately similar kill-off pattern has been found in the later phases of the Iron Age occupation at Danebury (Grant 1991) - where the sample is much larger and therefore more reliable.

The study of the sheep mortality pattern has provided some interesting results. Both the wear stages of individual teeth (Table 4) and mandibles (Table 5) point to the presence of a high number of young animals. Although some of the older animals might have been reared on site and subsequently sold or exchanged, the overall pattern suggests that the sheep breeding was mainly aimed at the production of meat. In an intensive milk-oriented husbandry we would expect a higher number of very juvenile animals (stage "A") whereas if the main product was wool there would have probably been a majority of adult sheep (Payne 1973). It is interesting in this respect to compare the mortality curve at Market Deeping with that from the other Iron Age sites of Barrington (Davis 1995) and Ashville (Hamilton 1978) (Fig.2). Despite some differences, the overall pattern is the same with many animals killed when immature, possibly in the second half of their first year (peak at stage "C"). A similar kill-off pattern was found at Danebury (Grant 1991) suggesting that meat may have been the main product of the sheep husbandry during the English Iron Age. A striking difference can be noted between the kill-off pattern of sheep at the Iron Age sites and at the medieval site of West Cotton, where this has been interpreted as evidence for an emphasis on wool production (Albarella and Davis 1994). A much higher number of adult animals (peak at stage "F") is found in the West Cotton assemblage (Fig.2).

A similar comparison between late prehistoric and medieval kill-off patterns has been carried out by Wilson (1994 and pers.comm.) in his study of animal bone assemblages from archaeological sites in the Oxford area. The mortality profile of the medieval sheep indicates emphasis in wool production, possibly associated with some marketing of meat, while meat and perhaps milk seem to have been the main products of the Iron Age economy.

I must stress here that what is discussed is the *emphasis* on one product, rather than a truly specialized economy. It is most likely that from Bronze Age to early modern times meat, milk, wool and manure were all valuable products of the sheep husbandry, though in some cultures some of these assumed a particular importance. Modern "specialized" husbandry is normally characterised by a much higher concentration of killings in a specific age stage (see Grant 1991 and Albarella in press).

Seasonality

A traditional theory suggests that the Fenland sites were seasonal settlements related to a lowland transhumant cycle. Although this theory has been challenged by some authors (Clarke 1972, Evans 1988), the debate is still open. In spite of the location of Market Deeping on the Fenland edge, the possibility that the site was seasonally occupied cannot be ruled out.

A seasonal occupation would result in evidence for the killing of the animals only at a specific time of the year. If we assume that these animals were all born approximately in the same period - which seems a reasonable hypothesis - this should result in distinct peaks in the distribution of age stages. Thus, if, for instance, the animals were born in March and the site was occupied in winter, we would expect killing peaks at about 8-10 months, 20-22 months etc. This selective killing should result in peaks in the distribution of wear stages. However, wear stages do not all have the same duration, therefore wear stages that last longer are likely to be the most commonly recorded in an assemblage. But fortunately, thanks to the work carried out by Deniz and Payne (1982) on modern Turkish Angora goats, we know the approximate average duration of wear stages in caprines. Unfortunately, there is no direct evidence that the length of wear stages is the same in sheep and goat, but, due to the similar morphology of the teeth of these two species, this could be the case. Deniz and Payne's data have therefore been applied to our assemblage.

The distribution of wear stages of sheep dP_4 and M_1 has thus been compared to a theoretical distribution based on the duration of wear stages (Fig.3). If sheep were regularly killed throughout the year we would expect that the main factor which affects the distribution of wear stages is their duration and thus there should be no major differences between the Market Deeping and the theoretical distributions. In fact dP_4 wear stages at Market Deeping differ significantly from the theoretical distribution - <1% that the difference is due to chance according to a two tailed Kolmogorov-Smirnov test (Siegel 1956). In particular there is a much higher number of teeth in early wear than expected.

This may indicate that the sheep slaughtering was not continuously distributed across the year, but it was concentrated at a specific time. The most common wear stage at Market Deeping is "14"; in female goats this can occur as early as at 2 months and as late as at 13 month, but it is on average found in animals of 4-6 months[1] (Deniz and Payne 1982, Fig.20). In males this may occur somewhat earlier (Deniz and Payne 1982). If we assume that lambing would most commonly occur in early spring[2] - as is generally the case - this would lead to the hypothesis that there was a killing peak in late summer/early autumn. This may have occurred later (late autumn/early winter) if preliminary data from modern sheep collected by Gillian Jones (pers. comm.) are considered. However, the presence of neonatal animals (see above) indicates the presence of sheep on site also during the spring.

Another possible explanation is that the duration of stages is different in sheep and goat. In this case the contrast in the distribution of the dP_4 wear stages between Market Deeping and the modern Turkish goats (Fig.3) would only testify the difference between the two species. There is a strong need for data from modern sheep to verify these hypotheses.

An unusual number of dP4s in wear stages "13" and "14" was also found at Barrington. Seasonal dumping in pits was considered as one of the possible explanations for the high number of juveniles on that site (Davis 1995).

When M_1 wear stages are taken into account it is possible to note that in this case too there is a higher than expected occurrence of teeth in early wear (Fig.3). Nevertheless, the overall distributions do not differ significantly (> 5% that the difference is due to chance) and this is probably due to the very long duration of stage "9" which may obscure possible seasonal peaks in the distribution. It is also possible that the seasonal slaughtering would only concern animals in their first year.

Size and shape

Unfortunately this assemblage has produced only a few metric data (see Appendix 2), which are not sufficient to undertake any detailed analysis of the size of the animals at Market Deeping. In general it seems that both cattle and sheep were of a size comparable to the rather small animals from Owlesbury (Maltby 1987), Danebury (Grant 1991), Barrington (Davis 1995) and other Iron Age sites in

[1] Preliminary data on a study in progress (Gillian Jones pers. comm.) suggest that this stage may last longer in sheep than in goats and in sheep is found at a slightly older age

[2] Births are concentrated in mid April in several flocks of unimproved sheep breeds in Britain (Gillian Jones pers. comm.)

England.

Only a few cattle horncores have been found, but these suggest that the Market Deeping cattle were very short-horned (Appendix 2) and in one case the horncore is also extremely curved (Plate 2).

Butchery and craft

Butchery marks were fairly common on the Market Deeping bones, but these are almost entirely represented by cut marks. Only one definite chop mark was recorded (Table 6).

Maltby (1989) has noted a prevalence of cut marks in cattle bones deriving from Roman rural sites, whereas a prevalence of chop marks could be noted in assemblages from Roman towns. He associates this discrepancy with the different ways in which cattle carcasses were processed. The activity of professional butchers and the intensive extraction of marrow from the animals used to supply the towns would produce a different butchery pattern in urban sites. In smaller settlements this procedure may not have been cost-effective.

It is difficult to say whether, on the basis of Maltby's hypothesis, we can correlate Market Deeping to these Roman rural settlements. Certainly at the Iron Age site of Cowbit Wash, where many bones were in primary deposit and in an excellent state of preservation, chopping marks were fairly common (Albarella and Mulville in press). The possibility that a rather crude technique and poor quality cleavers may not have left noticeable chopping marks on the Market Deeping bones must be considered as another possible explanation for this phenomenon.

The number of cut marks on cattle and equid bones was similar (Table 6) as was the level of fragmentation of the bones. It does not seem that horse carcasses were disposed of in a different way from the main meat animals, and it is thus probable that horse meat was also consumed. However, the horse was probably mainly bred for riding and transportation purposes.

A sheep scapula from phase 2 presents a hole in the blade (plate 3), similar to those generated by hook damage, which are more commonly found in Roman cattle. Similar marks on sheep scapulae were found in postmedieval contexts from Lincoln (Dobney *et al.* 1996). In cattle these marks are generally interpreted as generated by a hook when joints are hung for salting or brining (Dobney *et al.* 1996), but it is uncertain whether a similar interpretation can be applied to sheep. A cattle scapula with one of these typical "hook marks" was noted in the Roman assemblage.

Cut marks were noted on two of the swan bones. But these are located on a distal ulna and distal radius (Plate 4) and could therefore be associated with the removal of feathers rather than meat.

Only cattle, and no sheep, horncores were found. Some of these had not been detached from the skull and only one bore cut marks. This indicates that horn was probably only occasionally used as working material. A deep cut mark was also noted on the largest of the red deer antler fragments.

Conclusions and summary

The animal bones from the middle-late Iron Age site of Market Deeping mostly derive from butchery and food waste. The animal economy was mainly based on the exploitation of domestic animals, although wild game was also occasionally hunted. Water resources, such as beavers, swans, geese, ducks, were sometimes used but, unlike the other Fenland site of Upper Delphs (Evans and Serjeantson 1988), represented only an occasional addition to the diet. The scarcity - or absence - of fish is particularly noticeable.

Although sheep was the most common animal, cattle provided the largest quantity of meat. However, the scanty age data that we have for cattle suggest that this animal was mainly bred for traction and possibly for milk. Meat production seems to have been the main concern of the sheep husbandry. This is consistent with what has been found in many other Iron Age sites in England. Pork, venison and horse meat were also eaten.

No significant differences in the use of the animals were noted between different phases, but this might merely be due to the insufficient size of our assemblage.

Both the presence of neonatal bones and of anatomical elements from the whole skeleton suggest that cattle, sheep and pig were all bred, slaughtered and butchered on site. The evidence of newborn animals also indicates that the site was occupied during the spring, the most likely birth season for these animals. The study of sheep wear stages tentatively suggests an intensive killing of this species probably carried out during the late summer/early autumn. This might lead to the suggestion that Market Deeping was only occupied from spring to autumn and that during the winter the inhabitants would leave the Fenland in search of drier land. But a note of caution is necessary: a seasonal activity does not necessarily imply a seasonal occupation of the site. The lambs might have been more commonly killed during the autumn, just to prevent natural deaths which would occur during the colder season, when a scarcity of pasture in the Fenland may also be expected.

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	Phase 1		Phase 2		Phase 3		Phase 4		TOTAL	
	HC	SIE	HC	SIE	HC	SIE	HC	SIE	HC	SIE
Cattle (*Bos taurus*)	47	*1*	46	*6*	13	-	25	-	131	*7*
Sheep/Goat (*Ovis/Capra*)	49	*3*	54	*30*	6	*1*	8	-	117	*34*
Sheep (*Ovis aries*)	(24)	*(-)*	(17)	*(4)*	(3)	*(-)*	(-)	*(-)*	(44)	*(4)*
Goat (*Capra hircus*)	(+)	*(-)*	(-)	*(-)*	(-)	*(-)*	(-)	*(-)*	(+)	*(-)*
Pig (*Sus scrofa*)	16	-	4	-	-	-	2	-	22	-
Equid (*Equus sp.*)	20	*1*	14	-	3	-	5	-	42	*1*
Dog (*Canis familiaris*)	3	-	2	-	-	-	-	-	5	-
Red deer (*Cervus elaphus*)	+	-	-	-	-	-	-	-	+	-
Beaver (*Castor fiber*)	2	*1*	-	-	-	-	-	-	2	*1*
Large rodent	-	-	-	*1*	-	-	-	-	-	*1*
Small rodent	-	-	1	-	-	-	-	-	1	-
Duck (*Anas* sp.)	-	-	-	*1*	-	-	+	-	+	*1*
Goose (*Anserinae*)	-	-	-	+	-	-	-	-	-	+
Swan (*Cygnus* sp.)	-	-	+	-	-	-	-	-	+	-
Amphibian	-	-	-	*1*	-	-	-	-	-	*1*
TOTAL	137	*6*	121	*39*	22	*1*	40	-	320	*46*

Table 1.

Market Deeping (MAD 91): **Numbers of animal bones and teeth (NISP)** in the Iron Age phases. Sheep/Goat also includes the specimens identified to species. Cases where only "non-countable" bones were present are denoted by a "+".
HC = collected by hand SIE = collected on a 5mm sieve (wet, "whole earth" samples)

	Phase 1		Phase 2		Phase 3	Phase 4	TOTAL	
	n	%	n	%	n	n	n	%
Cattle (*Bos taurus*)	47	*36*	46	*39*	13	25	131	*42*
Sheep/Goat (*Ovis/Capra*)	49	*37*	54	*46*	6	8	117	*38*
Pig (*Sus scrofa*)	16	*12*	4	*3*	-	2	22	7
Equid (*Equus sp.*)	20	*15*	14	*12*	3	5	42	*13*
TOTAL	132		118		22	40	312	

Table 2.

Market Deeping (MAD 91): **Numbers (NISP) and percentages of the main species** in the Iron Age phases (hand-collected only). Percentages are only calculated when the total number was greater than 100.
A chi square test (Spiegel 1961) has been carried out to test the significance of the difference between phases 1 and 2. The difference is *not* statistically significant (χ^2=7.47 df=3 i.e. the probability that the difference between the two phases is due to chance is >5%).

	Cattle		Sheep/Goat		Pig	Equid
	NISP	MNI	NISP	MNI	NISP	NISP
Maxillary teeth	22(+1)	3	13(+6)	3	12	13.5(+0.5)
Mandibular teeth	37(+1)	8	65(+22)	19	4	4.5(+0.5)
Cranium	4(+1)	2	-	-	2	1
Atlas + Axis	-	-	1	1	-	1
Scapula	3	2	2	1	-	1
Humerus d	7	4	4	2	1	2
Radius d + Ulna p	9	3	9(+1)	3	-	3
Carpal	-	-	-(+1)	-	-	-
Metacarpal d	4	3	2	1	-	1
Pelvis a	3	2	1(+1)	1	-	3
Femur d	1	1	-	-	1	-
Tibia d	8	4	12	6	2	4
Astragalus	6(+1)	3	4	2	-	-
Calcaneus	7	4	1	1	-	-
Tarsal	3(+2)	2	-	-	-	1
Metatarsal d	3(+1)	2	4	2	0.5	1
Phalanges p	9	2	-	-	-	6

Table 3.

Market Deeping (MAD 91): **Frequency of the body parts** of the main species. Unfused epiphyses are not counted. Material from sieving is in parentheses. Only hand-collected specimens have been used for the calculation of MNI. Due to the small number of pig and equid bones, MNI has only been calculated for cattle and sheep/goat.
p = proximal, d = distal, a = acetabulum.

CATTLE

	C	V	E	H	a	b	c	d	e	f	g	h	j	k	l	m	n	o	p
dP4					1			1		1	1	1	2	1					
P4			1	2		1				2	1	2							
M1			1	2				1		1			4	1	2	1			
M2		1									3		2	2					
M1/2		1								1	2	1	1	2	1				
M3							4		1	1	1		2	1					

SHEEP/GOAT

	C	V	E	H	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
dP4					1							1				2		7	13		6	1
P4		2	1	1									5	7		1	2					
M1					1		3		4		5	1		20	2	1				1		
M2	3								2	1	3	1	4	10	1							
M1/2			1		1				5		1	1	1	1								
M3	1		2				2			3			5	2	2	5						

Table 4.

Market Deeping (MAD91): **Cattle and sheep/goat wear stages of individual teeth** (following Grant 1982 for cattle and Payne 1973 and 1987 for sheep/goat). Both teeth in mandibles and isolated teeth are included.
Grant's stage "U" is considered equivalent to stage "a". Unworn isolated teeth which could have been in one of the eruption stages (C, V, E, H) are coded as "a" for cattle and "0" for sheep/goat.

CATTLE

Mandibular wear stage										
Juvenile		Immature		Subadult		Adult		Elderly		Total
n	%	n	%	n	%	n	%	n	%	n
4	27	2	13	-	0	5.5	37	3.5	23	15

SHEEP/GOAT

Mandibular wear stage																		
A		B		C		D		E		F		G		H		I		Total
n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n
1	3	-	0	13.5	36	6	16	7	19	8.5	23	1	3	-	0	-	0	37

Table 5.

Market Deeping (MAD 91): **Cattle and sheep/goat mandibular wear stages.** These follow O'Connor (1988) for cattle and Payne (1973) for sheep/goat. See appendix 1 for complete list of individual mandibles. Only mandibles with two or more teeth (with recordable wear stage) in the dP_4/P_4 - M_1 are considered.

	Chopping		Cuts		Total Butchery		Gnawing	
	n	%	n	%	n	%	n	%
Cattle	1	1	18	23	19	25	13	17
Sheep/Goat	-	0	12	28	12	28	1	2
Pig	-	0	1	14	1	14	-	0
Equid	-	0	5	21	5	21	4	20
Total	1	1	36	24	37	25	18	12

Table 6

Market Deeping (MAD 91): Percentages of **butchered and gnawed postcranial bones.** Total butchery includes chop and cut marks. The percentage is calculated from the total number of postcranial bones for each taxon.

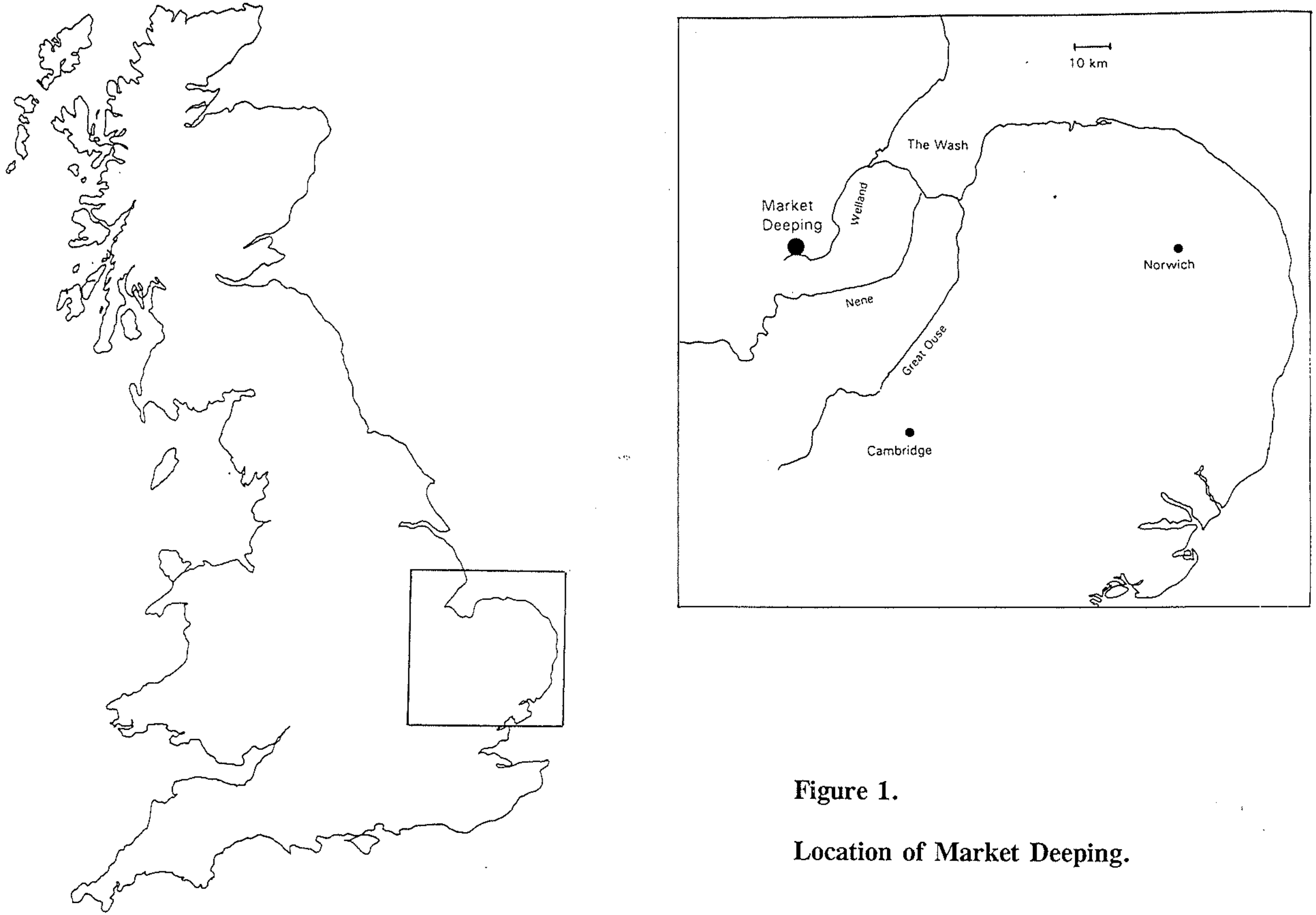
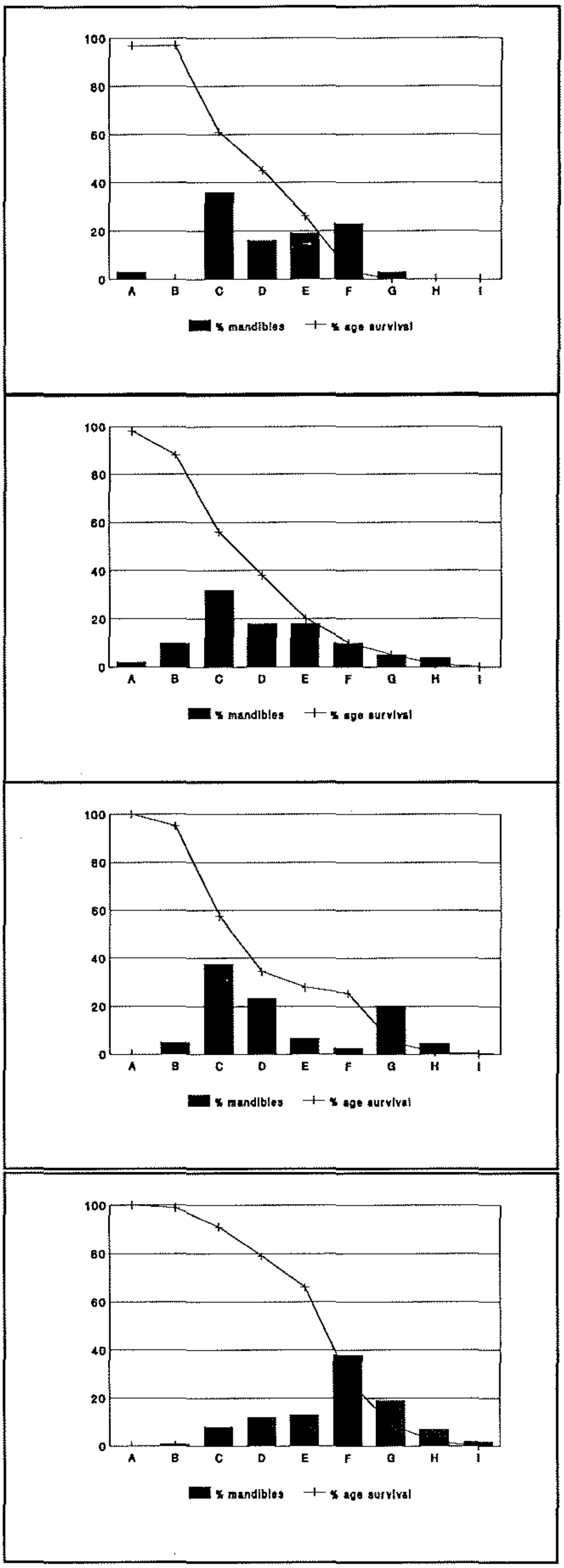


Figure 1.

Location of Market Deeping.



MARKET DEEPING
(Iron Age)
n = 37

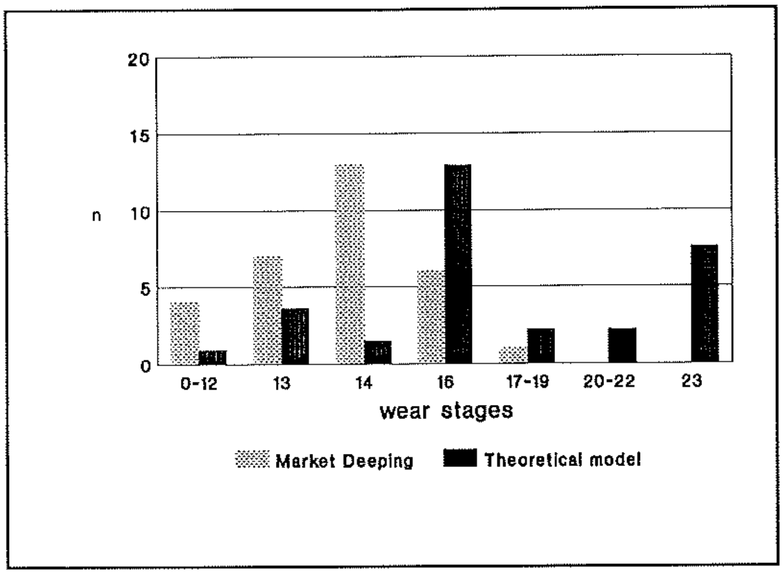
BARRINGTON
(Iron Age)
n = 48

ASHVILLE
(Iron Age)
n = 170

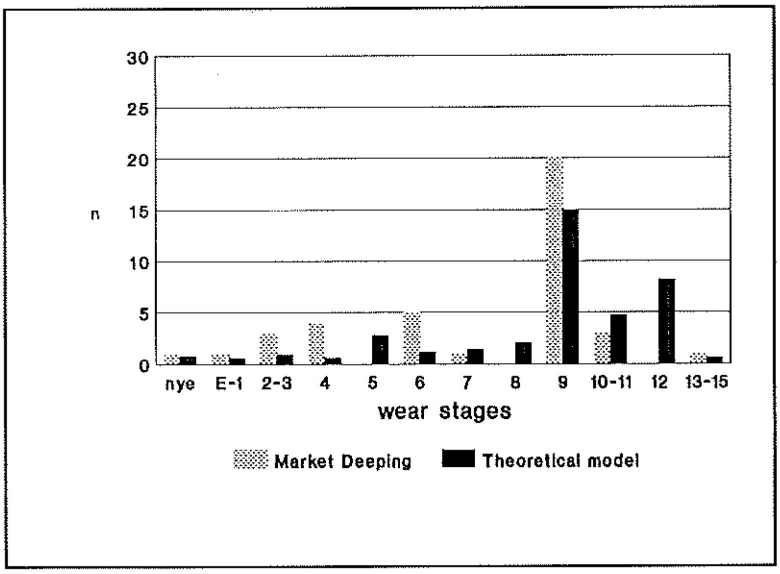
WEST COTTON
(Mid-Late Medieval)
n = 99

Figure 2.

Relative percentages of **sheep/goat mandibles by age stage** at the Iron Age sites of Market Deeping, Barrington (Davis 1995) and Ashville (Hamilton 1978). To emphasize the contrast the kill off-pattern at the medieval site of West Cotton (Albarella and Davis 1994) is also shown.



dP$_4$ wear



M$_1$ wear

Figure 3.

Wear stages for sheep/goat dP$_4$ and M$_1$ at Market Deeping compared with a theoretical distribution based on the average duration of wear stages as calculated by Deniz and Payne (1982) from Turkish modern goats (only females). These "theoretical diagrams" display what would be the most probable distribution of wear stages for a sample of the same size as Market Deeping, if there was no selection of any particular age group.
Wear stages follow Payne (1973 and 1987); nye = not yet erupted.

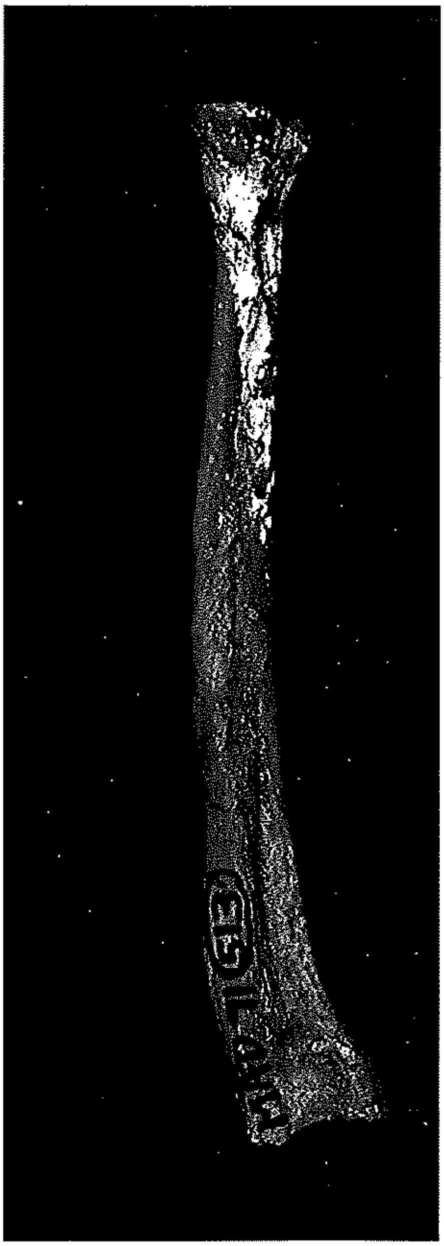


Plate 1.

Market Deeping (MAD 91): A beaver (*Castor fiber*) radius (phase 1).

Plate 2.

Market Deeping (MAD 91): A very curved and short cattle (*Bos taurus*) horncore (phase 1).

Plate 3.

Market Deeping (MAD 91): A sheep (*Ovis aries*) scapula with a hole in the blade (phase 2).

Plate 4.

Market Deeping (MAD 91): A swan (*Cygnus sp.*) distal radius with cut marks (phase 2).

APPENDIX 1

Market Deeping (MAD 91). **Mandibular wear stages** for cattle and sheep/goat.

Tooth wear stages for cattle follow Grant (1982) and for sheep/goat follow Payne (1973 and 1987). Mandibular wear stages for cattle follow O'Connor (1988) and for sheep/goat follow Payne (1973). Only mandibles with two or more teeth (with recordable wear stage) in the dP_4/P_4 - M_1 row are given.

TAX = TAXON   B = Cattle   O = sheep/goat   OVA = sheep

CATTLE:

J = juvenile
I = immature
SA = subadult
A = adult
E = elderly

SHEEP/GOAT:

A = c.0-2 months
B = c.2-6 months
C = c.6-12 months
D = c.1-2 years
E = c.2-3 years
F = c.3-4 years
G = c.4-6 years
H = c.6-8 years
I = c.8-10 years

TAX	P4	dP4	M1	M2	M3	Mandibular stage
B		a				J
B		d	E			J
B		f	H			J
B		g	H			J
B		h	d	V		I
B		j	f			I
B				g	e	A
B				j	f	A
B	b		j			A
B	E		j	g	c	A
B	H		j	g	c	A
B	g		k			A/E
B	f		j	j	j	E
B	h		l			E
B	h		l	k	j	E

TAX	P4	dP4	M1	M2	M3	Mandibular stage
O		0				A
O		14L	6A			C
OVA			2A	C		C
OVA		13L	0	C		C
OVA		13L	2A	C		C
OVA		13L	4A			C
OVA		13L	7A			C
OVA		14L	2A			C
OVA		14L	4A			C
OVA		14L	4A			C
OVA		14L	6A			C
OVA		14L	6A			C
OVA		14L	6A			C
OVA		16L	4A			C
OVA		16L	6A	4A	C	C/D
OVA		16L	9A	4A		D
OVA		16L	9A	6A	E	D
OVA		17L	9A	5A		D
O	V		9A	6A		D
O	V		9A	6A	E	D
O			9A	7A		D/E
O	8B		9A			E
O	8B		9A			E
O			9A	8A	2A	E
O			9A	8A	2A	E
O	9A		9A	8A	5A	E
O	E		9A	8A	5A	E
O	9A		9A	9A		E/F
O	12S		10A	9A	10G	F
O	9A		10A	9A	10G	F
O	11S		11A	9A	11G	F
O	12S		15A	10A	11G	F
O			9A	9A	8G	F
O	9A		9A	9A	8G	F
O	9A		9A	9A	9G	F
O	9A		9A	9A	9G	F
O	8B		9A	9A	11G	G

APPENDIX 2.

Market Deeping (MAD 91). **Measurements** of animal bones and teeth. All measurements are in tenths of a millimetre. See text for an explanation of how measurements are taken. Measurements are given in the following order: horncores, teeth, postcranial bones.

Key:

Phase:

P1 = phase 1
P2 = phase 2
P3 = phase 3
P4 = phase 4

Parts of skeleton (ELEM) are coded as follows:

HC horncore (antler in deer)
HU humerus
RA radius
MC metacarpal
PE pelvis
FE femur
TI tibia
AS astragalus
CA calcaneus
MT metatarsal
P1 1st phalanx

Taxa (TAX) are coded as follows:

B *Bos* (cattle)
OVA *Ovis* (sheep)
O *Ovis/Capra*(sheep/goat)
S *Sus* (pig)
EQ *Equidae* (equid)
CAF *Canis familiaris* (dog)
CEE *Cervus elaphus* (red deer)
ANA *Anas* (duck)

Epiphysial fusion/age (FUS) is coded as follows:

F fused
H fused/fusing
G fusing
UM unfused diaphysis
UE unfused epiphysis

Approximate measurements are designated:

c - within 0.2
e - within 0.5 mm

HORNCORES AND ANTLERS

Context	Phase	ELEM	TAX	L	W_{max}	W_{min}
111	P4	HC	B		477	380
139	P3	HC	B	1270	508	383
43	P2	HC	B		383	272
486	P1	HC	B	978	542	345
513	P1	HC	B		496	348
518	P1	HC	CEE		651	534

TEETH

Context	Phase	TAX	dP4W	M1W	M2W	M3W
301	P2	B				146
43	P2	B				145
43	P2	B				142
113	P4	B				156
177	P4	B				161
76	P4	B				160
153	P1	O		70		
321	P1	OVA	57			
321	P1	OVA	61			
339	P1	OVA	58	66		
350	P1	OVA		58	c69	
352	P1	OVA	69			
353	P1	OVA	68			
353	P1	OVA	61			
354	P1	O				78
354	P1	OVA	58			
355	P1	O				74
356	P1	OVA	62			
373	P1	O		66	72	
386	P1	OVA	59			
448	P1	O		71	78	
463	P1	O				81
513	P1	O		66	73	79
518	P1	OVA	62			
518	P1	O		67	74	76
518	P1	O		65	68	
518	P1	OVA	54			
519	P1	OVA	55			
130	P2	OVA	56			
295	P2	O		63		
298	P2	O		68		
298	P2	OVA	62			
298	P2	O				79
301	P2	O				88
301	P2	O		70		
301	P2	OVA	57			
301	P2	O		62	70	75
43	P2	OVA	57			
43	P2	OVA	59			
43	P2	O		69		
43	P2	OVA	60	75		
43	P2	O		69	78	
43	P2	O		70		
43	P2	O		70		
43	P2	O			78	
43	P2	O				75
43	P2	O		65		
52	P2	OVA	59			
52	P2	OVA	61			
52	P2	O		59		
57	P2	O		73		
81	P2	OVA	55			
89	P2	O				78
98	P2	OVA	61			
98	P2	OVA	57			
177	P4	O	65			

Context	Phase	TAX	dP4L	dP4W	M1WA	M1WP	M3WA
354	P1	S	186	80	96	97	
518	P1	S					141

Context	Phase	TAX	$M3W_a$	$M3W_d$
153	P1	EQ	115	32

POST-CRANIAL BONES

Context	Phase	ELEM	TAX	FUS	GL[1]	Bd	Dd[2]	BT	HTC	LAR	SD	BatF	a	b	1	4
355	P1	HU	B	H				626	275							
513	P1	HU	B	F				652	303							
140	P2	HU	B	F				645	285							
301	P2	HU	B	F				697	311							
43	P2	HU	B	F				630	278							
139	P3	HU	B	H				626	275							
159	P3	HU	B	H					274							
276	P2	HU	OVA	G				220	117							
43	P2	HU	OVA	G				224	120							
43	P2	HU	OVA	G					136							
518	P1	HU	EQ	F	2660			668	321		295					
276	P2	HU	EQ	F				631	336							
129	P2	HU	LRO	F		58										
43	P2	HU	ANA			153										
513	P1	RA	B	F	2450						354					
43	P2	RA	O	UM	520[3]											
513	P1	RA	EQ	F	3240						332					
301	P2	RA	CAF	F	1464											
513	P1	MC	B	F	1760	515	258				271	461	251	237		
519	P1	MC	B	F	1890	538	259				304	497	254	255		
535	P1	MC	B	F	1880	530	244				283	485	247	255		
159	P3	MC	B	F	c1900									230		
453	P1	MC	OVA	F	1150	215	119				107		103	102	93	88
489	P1	MC	EQ	F	2080	470	329				301					
321	P1	PE	O	F						e256						
295	P2	PE	O	F						245						
153	P1	PE	EQ	F						595						
153	P1	PE	EQ	F						610						
135	P4	PE	EQ	F						565						
518	P1	FE	CAF	F	1730						125					
452	P1	TI	B	F		556										
140	P2	TI	B	F		544										
140	P2	TI	B	F		e525										
43	P2	TI	B	F		527										
43	P2	TI	B	G		517										
76	P4	TI	B	F		541										
153	P1	TI	OVA	F		221										
518	P1	TI	OVA	F		243										
535	P1	TI	OVA	F		240										
535	P1	TI	OVA	G		217										
298	P2	TI	OVA	F		212										
43	P2	TI	OVA	F		230										
139	P3	TI	OVA	F		215										
518	P1	TI	S	F		272										
140	P2	TI	EQ	F		596										
57	P2	TI	EQ	F		634										
159	P3	TI	EQ	F		e560										

POST-CRANIAL BONES (cont.)

Context	Phase	ELEM	TAX	FUS	GL[1]	Bd	Dd[2]	BT	HTC	LAR	SD	BatF	a	b	1	4
140	P2	AS	B		586		327									
295	P2	AS	B		581	372	327									
43	P2	AS	B		616	405	349									
43	P2	AS	B		598	377	337									
43	P2	AS	B		635	381	344									
52	P2	AS	B		550	370	310									
92	P4	AS	B		589	372	328									
321	P1	AS	OVA		254	164	140									
271	P2	AS	OVA		253	153	141									
43	P2	AS	OVA		251	166	139									
89	P2	AS	O		244	151	138									
518	P1	CA	B	F	1136											
463	P1	CA	OVA	F	482											
295	P2	MT	B	F		496	270				239	461	241	230		
76	P4	MT	B	F	c2240	c533	277				247	496	c260	241		
516	P1	MT	OVA	F	1248	202	112				97					
139	P3	MT	OVA	F	c1236	211	117				98					
159	P3	MT	OVA	F	1202	196	114				85					
519	P1	MT	EQ	F	2510	456	354				266					
513	P1	P1	EQ	F	750	393	242				296					
301	P2	P1	EQ	F	744	389	224				305					

[1] "GL1" in astragalus [2] "2" in metapodials and "D1" in astragalus [3] this measurement does not include the epiphyses