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Ancient Monuments Laboratory
Report 104/97

ANIMAL BONES FROM CAS SITES 452 AND 482, THORNBROUGH FARM, CATTERICK, NORTH YORKSHIRE

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Summary

The animal bones from Roman Thornbrough Farm, Catterick, are typical of the Romano-British period of northern England. Both hand-recovered and sieved collections are dominated by cattle, sheep and pigs. The predominance of cattle bones in the hand-recovered material is an over-emphasis caused by recovery bias, but beef clearly contributed the greatest quantity of meat, although the age distributions suggest that the cattle consumed were kept for other purposes whilst sheep and pigs were raised primarily for meat. Prime beef cattle may have been exported. The incidence of splaying of cattle metapodials may be related to a similar incidence of small lesions in cattle foot bones, which could be traumatic rather than congenital in origin. The frequencies of congenital dental abnormalities in cattle are typical for northern Romano-British collections. The sizes and conformation of the cattle bones are very variable, perhaps in part due to the presence of a mixture of cows, castrates and entire males, but it is possible that more than one type of livestock is represented. The average measurements of the bones tend to be slightly higher than most Romano-British stock, and the ranges are also rather large. The health of the animals, even the elderly cattle, appears to have been very good, suggesting careful husbandry. Other species were utilised to very little extent, although domestic fowl contributed a small proportion of the food supply. Despite the extensive sieving programme, extremely few fish bones were recovered, and these appear to derive from imported (and processed) sea fish rather than local species from the River Swale. None of the material indicates utilisation by military personnel.

Author's address :-

Dr S Stallibrass
UNIVERSITY OF DURHAM
South Road
Durham
DURHAM
DH1 3LE

The animal bones from excavations at Thornbrough Farm, Catterick, North Yorkshire, within the locality of the Roman (Antonine) fort and small town: CAS sites 452 (1990) and 482 (1993).

Introduction

The Roman site of Catterick/Cataractonium

Settlement at Catterick during the period of the Roman occupation was complex, and consisted of various forts and civilian settlements around the crossing of the River Swale by the main road (Dere Street) which linked the legionary base at York, via Aldborough, to the forts at Corbridge and Chesters on the northern frontier of the empire.

During the Roman period, the river was probably navigable by shallow draught barges almost as far as the Roman and present road bridges, and the forts and civilian settlements may have been used as redistribution centres for local and/or imported commodities.

Wacher discovered a fort ditch dating to the later 2nd Century and postulated that there may have been an earlier fort on the same site, associated with the known bath-house constructed during the Flavian period (later 1st Century). Civilian settlement is also known from the 1st and 2nd centuries.

The civilian settlement at Catterick is particularly important for studies of Roman Britain since it developed, after the demise of the 2nd Century fort in about AD 200, into one of the northernmost small towns in the province. The only other known small towns north of the Humber-Mersey line are Corbridge and Carlisle (Burnham & Wacher 1990) and Kirby Thore (Frere 1975). The civilian settlement at Catterick was walled in the early 4th Century and was occupied at least into the early 5th century. Metalwork, of types thought to be associated with cavalry units, may indicate a further period of military occupation during the late 4th Century.

The Roman settlement(s) were superseded by, encroached upon, or integrated with, 5th and 6th Century Anglo-Saxon and Anglian occupation and burial sites.

Previous excavations at Catterick

The Roman sites at Catterick have been investigated in several known major excavations since at least 1938, mainly under the direction of Hildeyard & Wade, Wacher, and Wilson. The results of these investigations are currently being written up for publication by Wilson (in prep.). Animal bones were not fully recovered or recorded for many of the earlier excavations, but AML reports are available for some of the material recovered by Wacher in 1972 at Site 434 (Payne 1990), and for material recovered from Catterick Bridge (Meddens 1990a) and from Bainesse (Meddens 1990b). All of this material was hand-recovered.

A synthesis of these AML reports together with the data contained here on Thornbrough Farm has been prepared for publication in Wilson (in prep.) by Stallibrass (1997). This report, therefore, contains little discussion of how the collections compare.

The sites at Thornbrough Farm

Thornbrough Farm is situated on a bluff overlooking the River Swale, to the immediate south of the river itself, and west of the Roman road. Previous work, mainly by Wacher, had revealed that this area should lie within a fort dated to the later part of the 2nd Century (and possibly within an earlier fort on the same site), and within the later walled town.

The grid reference for the excavated sites is SE 224992.

The excavations

The excavations at Thornborough Farm were directed by Peter Wilson for the Central Archaeological Service. They investigated an area to the south of the River Swale and to the west of Dere Street, close to a large area investigated in 1959 by rescue excavation directed by Prof. John Wacher in advance of major roadworks for the A1 Catterick bypass (see Figure 1: but please note that some of the line drawn for the town wall is unsubstantiated). Site 452 was located within the conjectured northern line of the town wall, which was probably constructed in the early 4th Century (Burnham & Wacher 1990), whilst the smaller trench at Site 482 (20 metres to the west) lay immediately outside (ie to the north, and towards the river) of this conjectured northern wall. Site 452 straddled a ditch from a later 2nd Century fort that was also located by Wacher in his 1959 excavations (see Wilson, in prep.). Thus, both civilian and military occupation was expected (and discovered) in these trenches.

The depths of the excavation trenches were restricted by the requirements of the new constructions proposed on the site. The earliest features recorded in 1990 (Site 452) relate to the eastern ditch and rampart of the 2nd Century (Antonine) fort. No evidence was found for the postulated late 1st century (Flavian) fort. Defensive features included a ditch, which included some waterlogged levels at the base of the excavations, a berm, a clay-based rampart and a gravelled road. The ditch was subsequently infilled, partly with the slighted clay-base of the rampart. The slightly hollow surface of the infilled ditch was used for industrial activities including small metal-working hearths, a corn drier and a probable water-tank. The industrial features were sealed by a gravel road associated with timber buildings of the mid - later 3rd Century, and these were followed by stone buildings of the 4th Century, some of which overlay the gravelled road.(Part of at least one stone wall survived in use into the late 20th Century). No floor levels were found in any of these timber or stone buildings. The majority of the animal bones derives from fills and layers from the 3rd and 4th Centuries. A small quantity of animal bone derives from contexts dated 'up to modern' that may include Roman material, either *in situ* or redeposited. There are no medieval or post-medieval layers separating Roman stratigraphy from modern features.

The 1993 excavations (Site 482) consisted of a smaller trench that contained, mainly, remains of the Antonine (later 2nd Century) fort rampart and wall. Most of the animal bones derived from Phases 3 -5 (late 2nd/3rd Centuries), in deposits relating to the robbing of the wall, some pits, and some general accumulations of sediments including a dump of clay. Roman deposits had been truncated in the late 2nd/early 3rd Century and, again, in the later post-medieval period. Almost no post-Roman occupation material was found.

Research aims based on the animal bones

Particular topics of interest that should be addressed through the study of the animal bones from these and other excavations at Catterick include, amongst others:

i) the identification of traits that characterise civilian as distinct from military patterns of animal exploitation, by differences in patterns of preparation, consumption and discard of their carcases, and any differences in the role of local, wild resources, locally raised domestic livestock and imported supplies,

ii) changes through time in the nature of the livestock themselves, their patterns of husbandry, and the relative importance of different species (particularly the three main domestic food species: cattle, sheep and pigs),

iii) any industrial uses of animals such as the production of tanned hides, horn processing etc.

Whilst these are all, in the first place, of intrinsic interest to a study of the development of Catterick itself, they are also all of interest in a regional and national study of the developments and relationships of Roman military and civilian settlements and lifestyles.

The topic of cattle hide tanning is particularly important at Catterick, since there is some circumstantial evidence and speculation that Catterick was a centre for hide production. The evidence gathered prior to the excavations at Thornbrough Farm consisted of the presence of some very large, deep pits of unexplained origin and use, dated to the mid-2nd Century, and a large deposit of organic-rich waste including large quantities of cattle bones. These pits and bones were noted by Wacher during his 1959 excavations along the A1 route but, unfortunately, the animal bones themselves are not available for study due to the forcibly rushed nature of the excavations. There is also a writing tablet from Vindolanda, dating to the late 2nd century, that refers to the delivery of hides from Catterick. Although it might be logical to infer that the hides were processed at Catterick, it is also possible that Catterick simply acted as a depot for dispersal of supplies to the military, given its location on a major roadway, just south of a major junction with a trans-Pennine route (the modern A66) that gives access to the western end of Hadrian's Wall at Carlisle and Stanwix. The River Swale was probably navigable by Roman boats until just below the river crossing by Dere Street, giving an alternative route for transport of supplies and personnel, via the River Ouse to York and thence to the Humber estuary.

The material

Methods of recovery

A variety of methods of excavation and recovery appear to have been used at Thornbrough Farm. Some of the slightly brittle bones from Site 452 appear to have been smashed during excavation, presumably due to the use of heavy tools such as mattocks or pick axes. However, it is clear that major efforts were made to recover all of the resulting fragments. Otherwise, the standard of recovery for the hand-recovered material was quite high, particularly for the partial skeletons (even the smallest bones such as sesamoids and loose incisors were picked up). Inevitably, small bones and teeth will be under-represented in the hand-recovered collection, especially from non-burials.

A major programme of flotation and wet sieving of a sample of bulk sediment (what the CAS refer to as a 'whole earth sample') from every sievable deposit was undertaken, and many of the resulting residues have been sorted by project workers. Animal bone fragments have been picked out of 4 mm and 2 mm mesh sieves from these residues.

Quantities

Site 452 (the 1990 excavation) provided the bulk of the animal bone material: 18 long bone boxes of hand-recovered animal bones, weighing a total of 63 kg, plus two further long bone boxes of material picked out of sieved bulk samples, weighing a total of 7630g. In addition, there were some burials of partial or relatively complete skeletons of cattle, and one dog skeleton. Human infant remains were found from a neonate, but these are reported upon by Mays (in Wilson in prep.)

Site 482 (the 1993 excavation) produced one further long bone box of hand-recovered animal bones, weighing 2.5 kg, plus 14 bags of material sorted out from sieved bulk samples, weighing 215g.

The vast majority of the hand-recovered material from the two sites (97% by weight, and 97% by numbers of fragments) derives from well stratified Roman contexts.

Appendix 1 presents quantities (by weight and fragment numbers) of hand-recovered material by period for each site. These exclude the animal burials. The total weight recovered is 65 kg, and the total number of fragments is 4460. Of these, 1803 (40%) were catalogued, using the methodology described below. Again, 97% of the catalogued bones come from well stratified Roman deposits. The remaining 3% are split between 1% possibly pre-Roman/early Roman and 2% 'up to modern'.

States of bone preservation

Most of the animal bones have good preservation. That is, their surfaces are clean and uneroded, and surface alterations such as fine knife cuts, carnivore gnawing marks and pathological lesions are clearly visible. A minority of the bones from site 452 are slightly brittle and have recent breaks. The bones from one context (Site 452, context 500) are excellently preserved and appear to derive from a waterlogged deposit. Generally, the material from Site 482 is even better than the material from Site 452.

The site archive

The animal bones from both sites (including the sieved material) are currently stored at the Biological Laboratory of the Department of Archaeology in the University of Durham, South Road, Durham, DH1 3LE. They will be returned to the main site archive which is with the CAS at Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth, Hampshire, PO4 9LD.

Methods of recording

The bones have been catalogued using a system whereby only bones or fragments retaining at least 50% of a pre-defined unique anatomical zone are recorded. Appendix 2 lists the zones utilised for each skeletal element. This method is chosen to avoid over-recording of more fragmented bones, such as those of larger animals (such as cattle, in comparison with sheep and pigs), and to facilitate counts of skeletal elements and estimates of Minimum Numbers of Individuals (MNIs). Any fragments with fresh breaks were refitted wherever possible prior to recording (but have not been fixed in any way).

The distributions of recorded bones are given in Tables 1 and 2 for Sites 452 and 482 respectively.

Bones and fragments were identified using reference material held by the Environmental Laboratory of the Department of Archaeology, University of Durham, and by the author. Fowl-type bones were checked against domestic chicken, grouse, guinea fowl and pheasant bones whenever appropriate, and attention was paid to distinguishing between the bones (and the lower deciduous fourth premolars) of sheep and those of goat whenever possible.

Ribs and vertebrae were recorded as deriving from the relevant category of: cattle-size, sheep-size or pig-size. In all cases of cattle-size vertebrae, there is no reason to doubt their origin as cattle. No horse or red deer vertebrae, nor any horse ribs could be identified. None of the ribs appear to be from red deer. Similarly, none of the sheep-size vertebrae are from pigs or dogs, and there is no reason to suspect that any of them derive from roe deer. Pig vertebrae are highly distinctive and have probably all been assigned appropriately to 'pig-size'. The only case where a size and corresponding species category may not tally exactly concerns the ribs of pigs and sheep, although pig ribs are probably sufficiently distinctive to have been assigned to the relevant category, regardless of their actual physical size (since many of them derive from immature animals).

Ageing by epiphysial fusion and tooth eruption has been undertaken using data provided by Silver (1969) for modern animals, and comparative ageing by tooth wear stages has followed the method of Grant (1982). Anatomical measurements have been taken where appropriate, using those defined by Driesch (1976) unless otherwise stated. For cattle metapodials, Howard's (1962) ratios have been utilised in an attempt to assess the sex of individuals, and Zalkin's (1960) formulae have been used to assess withers (shoulder) heights.

Phases and dates of contexts

The two excavations were phased independently, but can be grouped together for studies of broad changes through time within the Roman period. Tables 1 and 2 present the distributions of catalogued (hand-recovered) fragments by grouped phases for Sites 452 and 482, respectively.

None of the material from 'up to modern' (Site 452) or '?18th/19th C' (Site 482) contexts is particularly noteworthy. The 'up to modern' material is indistinguishable in terms of preservation condition, species ratios, sizes of bones and ages of cattle teeth from the well-dated Roman material and is probably, itself, Roman in origin. These minor quantities of bone are not discussed further in this report.

Table 1: The distribution of catalogued (hand-recovered) animal bones from Site 452

Phases	1 & 1-4	2 to 4	5 to14	14a	1 to 14a	15	
Date	Up to cAD 160/3rd C	Late 2nd - 3rd C	3rd-4th C	Late 4th C	Total stratified Roman	Up to modern	Grand Totals
Species							
Cattle	3	31	560	181	775	27	802
Pig	1	9	132	43	185	2	187
Sheep/Goat	1	22	292	55	370	10	380
(Sheep)	(1)	(7)	(98)	(8)	(114)	(2)	(116)
(Goat)			(6)		(6)		(6)
Horse	2	1	9	3	15	1	16
Dog		1	20	4	25		25
Cat			1		1		1
Hare			1	1	2	1	3
Watervole			1		1		1
cattle size	1	9	107	15	132	2	134
pig size		4	28	7	39	1	40
sheep size		13	58	5	76	2	78
dog size			1		1		1
large mammal				1	1		1
Goose sp.			1		1		1
domestic Fowl			19	2	21	1	22
Grouse sp.?				1	1		1
Raven			1		1		1
Crow/Rook			1		1		1
fowl size			4	3	7		7
bird sp.			1	1	2		2
Totals	**8**	**90**	**1243**	**322**	**1663**	**47**	**1710**

Table 2: The distribution of catalogued (hand-recovered) animal bones from Site 482

Phase(s)	2 to 4	5	6	
Date	late 2nd - early 3rd C	3rd C --	?18/19th C	Grand Totals
Species				
Cattle	17	7	3	27
Pig	10	3	1	14
Sheep/Goat	14	4		18
(sheep)	(4)	(2)		(6)
Horse	1			1
Dog	1			1
Cat	1			1
cattle size	5	1		6
pig size	9	2		11
sheep size	10	2		12
domestic Fowl	2			2
Totals	70	19	4	93

The hand-recovered material

The species represented

The lists of identified species in Tables 1 and 2 are typical for Romano-British sites, of both military and civilian types, except for the slightly surprising absence of any deer (red deer and, to a lesser extent, roe deer, are usually represented by small numbers of bones on Romano-British sites, at least in the north of England). Typically for Roman military sites anywhere in Britain, and civilian Romano-British sites in northern England, the collections are dominated by bones of the three major domesticated mammals: cattle, sheep/goat and pig, with cattle bones predominant. Of the 404 sheep/goat bones, 128 (32%) could be identified to species level, of which sheep contributed by far the greater number (in a proportion of 20:1 sheep:goat). Small numbers of bones of other domestic animals, such as horse, dog and domestic fowl, are also well distributed throughout the site, with one occurrence of cat in Site 482. Only one goose bone was found (it is not possible to tell if it derives from a domestic or a wild individual). Although goose bones are generally less common than those of domestic fowl on Romano-British sites, its almost complete absence is unusual, particularly given the fact that the site lies beside the River Swale. Other, probably wild, bird species represented include some corvids (one raven bone and one crow or rook bone) and, possibly, grouse (one bone). Wild species, such as hare, deer, wild boar and wild birds, contribute negligible quantities in terms of either numbers of individuals or potential meat supply. No fish bones were recovered by hand. Although the recovery methods would have biased against the recovery of small bones such as those from the majority of freshwater fish, the total absence of larger fish bones (such as those of the gadid (cod) family) does suggest that few, if any, bones of these species were discarded in the excavated areas. The sieved material is described separately (see below). Again, the total absence of bones from small birds such as larks and thrushes, suggests that these were not present in the excavated deposits. Remains of invertebrates including shellfish, are not considered in this report.

The relative frequencies of remains from the three major domestic animals: cattle, sheep and pigs

The relative proportions of bones from the three main domestic mammals show an interesting time trend during the phases of Roman occupation at the sites. Table 3 presents the data for the three phase groups that produced more than 100 relevant fragments (combining the material from the two sites). It should be appreciated that the three phase groups may not be mutually exclusive. The earliest group (late 2nd/early 3rd Centuries) may overlap with the beginning of the largest group (3rd/4th Centuries) which may, in turn, include some late 4th Century material. Given this potential overlap, any apparent trends are likely to be real, and understated. There is a trend for cattle bones to become more dominant between the late 2nd and the late 4th Centuries, and for relative numbers of sheep/goat bones to decline correspondingly. The relative proportion of pig bones remains roughly constant, fluctuating around 15% of the total for the three species. Although the earliest group is only a very small collection (N=103) and the latest group is not large (N=279), the changes are considered to be significant for the reasons presented above. The changeover from military to civilian usage of the site does not appear to affect this general trend.

Minimum Numbers of Individuals (MNIs) have been calculated by taking the greatest number of unique anatomical zones for each element and dividing this by the number expected in a complete skeleton. No account has been taken of whether a zone derives from a bone from the left or the right side of the body, since it is difficult to assess from fragmentary material whether or not two fragments might derive from a pair from a single individual. Since the degree of loss incurred through various taphonomic factors is likely to have been high (see below), it is quite probable that very few, if any, of the catalogued fragments derive from paired elements and this manner of calculating MNIs is, therefore, extremely conservative. Actual numbers of individuals responsible for the material recovered is, perhaps, more likely to approach (or surpass) the number of fragments catalogued, but these numbers are not currently being sought. The reason for calculating estimated MNIs for this collection is to compare, in a crude manner, the relative frequencies of the major domesticates. For this purpose, the simplest standardised method is likely to be the most appropriate.

Table 4 presents the estimated MNIs for the three major species, although these should be viewed with caution due to the small sample sizes. As usual, the remains of smaller and/or scarcer species obtain greater emphasis through estimates of MNIs than they receive in considerations of numbers of identified specimens. In particular, sheep/goat appear to have been more common than cattle in the earlier two periods, although cattle still dominate the late 4th Century collection.

Table 5 presents the data in a third manner, utilising the Minimum Numbers of Elements (MNEs). These have been calculated using the most frequent zone for any one element for each species within a broad period. The actual counts for each of these are presented in Table 6, which is the basis for considerations of body part representations (see below). A few elements, such as minor tarsals and lateral metapodials are not included in these counts, due to differences between pigs compared to cattle and sheep, but cattle-sized, sheep-sized and pig-sized ribs and vertebrae are included with their comparable species. These 'sized' elements are extremely unlikely to include any bones from other species due to the almost complete lack of bones identified to species of comparable size (there are no identified bones of red deer, very few of horse, and none of roe deer) and the fact that most ribs and vertebrae of pigs are easily identifiable even when the animal is young and hence similar in size to a sheep. The two main advantages of using MNEs compared to the two methods discussed above are that the sample size is increased considerably compared to that available using MNIs (but, in contrast, it is susceptible to the bias against the recovery of small bones) and that it avoids the possibility of double counting butchered elements from large species (but, by doing this, it reduces the

Table 3: Distribution of catalogued fragments from the three major domestic species (cattle, sheep/goat and pig), by broad period

occupation	military		civilian		?civilian	
Period	late 2nd/3rd C		3rd/4th C		late 4th C	
Site:Phase	452: 2 to 4 482: 2 to 4		452: 5 to 14 482: 5		452: 14a	
Species	N	%	N	%	N	%
Cattle	48	47%	567	56%	181	65%
Sheep/goat	36	35%	302	30%	55	20%
Pig	19	18%	135	13%	43	15%
Totals	103		1004		279	

Table 4: Minimum Numbers of individuals (MNIs) of the three major domestic species: cattle, sheep/goat and pig, by broad period

occupation	military		civilian		?civilian	
Period	late 2nd/3rd C		3rd/4th C		late 4th C	
Site:Phase	452: 2 to 4 482: 2 to 4		452: 5 to 14 482: 5		452: 14a	
Species	MNI	%	MNI	%	MNI	%
Cattle	2		15	36%	6	
Sheep/goat	3		19	45%	3	
Pig	2		8	19%	3	
Totals	7		42		12	

Table 5: Minimum Numbers of Elements (MNEs) of the three major domestic species: cattle, sheep/goat and pig, by broad period

(as used for calculating relative frequencies of skeletal parts: includes ribs and vertebrae)

occupation	military		civilian		?civilian	
Period	late 2nd/3rd C		3rd/4th C		late 4th C	
Site:Phase	452: 2 to 4 482: 2 to 4		452: 5 to 14 482: 5		452: 14a	
Species	MNE	%	MNE	%	MNE	%
Cattle	44	38%	400	48%	107	63%
Sheep/goat	45	38%	303	36%	36	21%
Pig	28	24%	128	15%	28	16%
Totals	117		831		171	

sample sizes from those available when all identified fragments are considered). Thus, it tends to form a compromise calculation, and Table 5 demonstrates this very well. Again, the data indicate that cattle increase and sheep/goat correspondingly decrease in relative importance through time, whilst pigs remain roughly stable.

All three methods of calculating the relative frequencies of the remains of the three major domesticates, cattle sheep/goat and pigs, therefore, indicate this trend through time. The differences between the methods concern the relative role of sheep/goats and cattle. The biggest sample sizes derive from the 3rd/4th Centuries. Fragment counts indicate that cattle provided just over half of the total remains from these three species, with sheep/goat being considerably less important and pigs contributing a significant minority of the remains. In contrast, the MNIs suggest that sheep/goats were more important, in terms of numbers of individuals, than cattle, although they made up slightly less than half of the total, whilst cattle were more important than pigs. The MNEs suggest that cattle contributed nearly half of the remains, with sheep/goat twice as important as pigs.

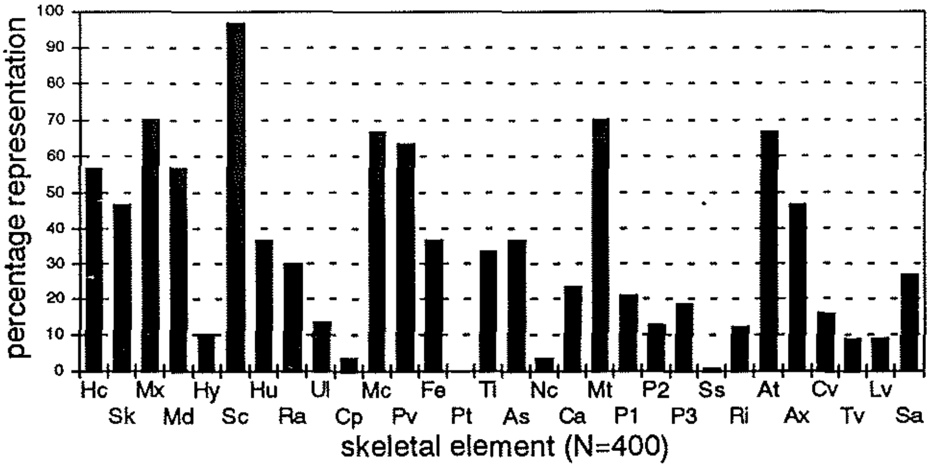
Relative proportions of body parts

The relative frequencies of different parts of the skeleton can provide information regarding the completeness of carcase remains disposed in excavated deposits. Complete carcases should be represented if animals are slaughtered and butchered *in situ*, or if whole carcases are brought to the site and butchered *in situ*. The presence of a complete animal carcase on a site does not necessarily indicate that that animal was born and raised there: people incur less work if a traded animal transports itself to a slaughter location whilst it is still alive, than if they have to transport a heavy carcase themselves. Because of biases against the preservation of less robust elements due to butchery itself, and the depredations of carnivores (particularly dogs), and the problems of recovering small bones by hand during excavation, whole skeletons would not be expected to be represented in their entirety in archaeological collections, but all of the robust parts should be represented in approximately equal proportions. .

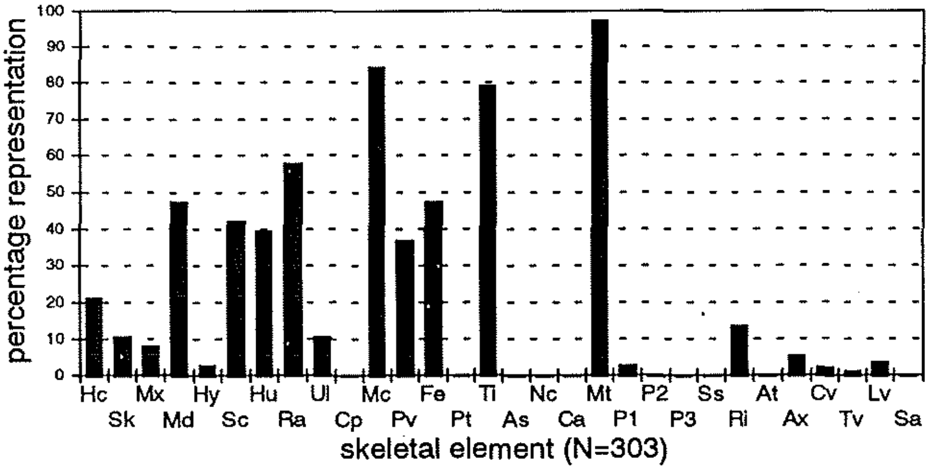
Table 6 and Figure 2 present the body part representation for cattle, sheep and pig bones from the 3rd/4th Centuries (Site 452: phases 5 - 14 *(excluding 14a)*; Site 482: phase 5). Because the nature of the occupation at the site may have changed during the 4th Century, between Phase 14 and Phase 14a, (there are some hints of renewed military activity at the site), the material that can be dated specifically to the later part of the 4th Century has been kept separate. Sample sizes for the other main periods are too small to present here (ie: only cattle from late 4th Century deposits *(Site 452, phase 14a)* have a an MNE greater than N=100). For each species, each element has been quantified by its most frequently catalogued anatomical zone (eg: for cattle: the neck of the scapula, the supracondylar fossa of the femur, and the midshaft of the metacarpal, etc; for sheep: the apex of the y-shaped olecranon fossa for the humerus, the ilial section of the acetabulum of the pelvis,, etc etc.). Vertebrae and ribs from comparative sized animals have been dealt with in a similar manner and are included with the appropriate species (see 'Methods of recording' above). The relative frequency of each element has been normalised in the manner of Stallibrass (1986) following Brain (1981). That is, for each of the paired major limb and girdle bones, the greatest number of a unique anatomical zone has been divided by two, whilst the numbers of atlas and axis vertebrae have been left unaltered, and carpals, sesamoids, metapodials and phalanges have been adjusted according to how many occur in the fore and hind extremities for each species. In Table 6 and Figure 2 the observed Minimum Number of Elements (ie the greatest number of occurrences for any unique anatomical zone) is expressed as a percentage of the expected number of elements (calculated by multiplying the MNI by the number of times a specified element occurs in a single complete skeleton).

Figure 2: percentage representations of skeletal elements for 3rd/4th Centuries

Cattle: skeletal representation



Sheep/goat: skeletal representation



Pig: skeletal representation

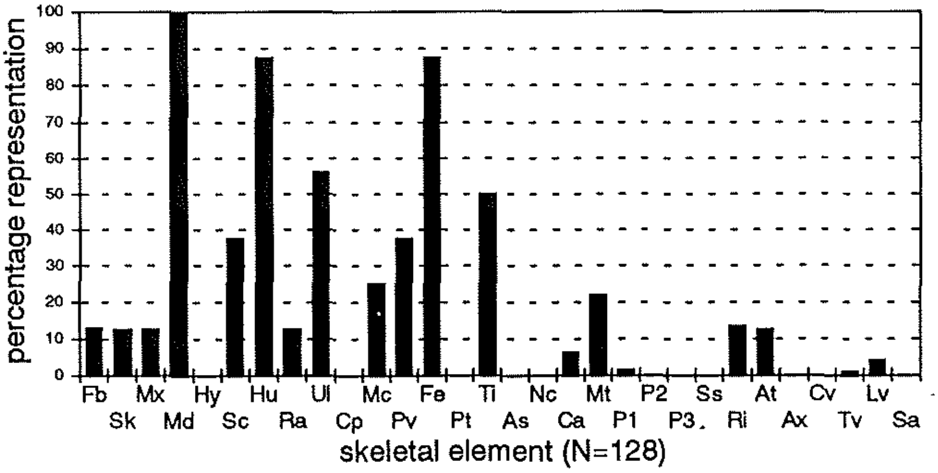


Table 6: percentage representation of 30 skeletal elements of cattle, sheep/goat and pig from 3rd/4th century deposits (Site 452: Phases 5-14; Site 482: Phase 5) (compare with Table 16 for sieved data)

		Cattle			Sheep/ goat			Pig		
		MNE	MNE	%	MNE	MNE	%	MNE	MNE	%
ELEMENT	CODE	observed	expected	represent.	observed	expected	represent.	observed	expected	represent.
	Fig 2	(o)	(e)	(o*100/e)	(o)	(e)	(o*100/e)	(o)	(e)	(o*100/e)
*horncore	Hc	17	30	57	8	38	21		na	
skull	Sk	14	30	47	4	38	11	2	16	13
maxilla	Mx	21	30	70	3	38	8	2	16	13
mandible	Md	17	30	57	18	38	47	16	16	100
hyoid	Hy	3	30	10	1	38	3	0	16	0
scapula	Sc	29	30	97	16	38	42	6	16	38
humerus	Hu	11	30	37	15	38	39	14	16	88
radius	Ra	9	30	30	22	38	58	2	16	13
ulna	Ul	4	30	13	4	38	11	9	16	56
carpals	Cp	6	180	3	0	228	0	0	96	0
metacarpal	Mc	20	30	67	32	38	84	8	32	25
pelvis	Pv	19	30	63	14	38	37	6	16	38
femur	Fe	11	30	37	18	38	47	14	16	88
patella	Pt	0	30	0	0	38	0	0	16	0
tibia	Ti	10	30	33	30	38	79	8	16	50
fibula	Fb		na			na		2	16	13
astragalus	As	11	30	37	0	38	0	0	16	0
naviculo-cuboid	Nc	1	30	3	0	38	0	0	16	0
calcaneum	Ca	7	30	23	0	38	0	1	16	6
metatarsal	Mt	21	30	70	37	38	97	7	32	22
1st phalange	P1	25	120	21	4	152	3	1	64	2
2nd phalange	P2	15	120	13	0	152	0	0	64	0
3rd phalange	P3	22	120	18	0	152	0	0	64	0
sesamoids	Ss	2	360	1	0	456	0	0	192	0
ribs	Ri	47	390	12	67	494	14	28	208	13
atlas	At	10	15	67	0	19	0	1	8	13
axis	Ax	7	15	47	1	19	5	0	8	0
cerv. vertebrae	Cv	12	75	16	2	95	2	0	40	0
thor. vertebrae	Tv	17	195	9	3	247	1	1	104	1
lumb. vertebrae	Lv	8	90	9	4	114	4	2	48	4
sacrum	Sa	4	15	27	0	19	0	0	8	0
simplest MNI=		15			19			8		
MNE		400			303			128		

*horncore: N.B. In Figure 2, for pig, the fibula is substituted for the horncore

N.B. for pigs, only metapodials II and III are included

A visual inspection of the data in Table 6 and Figure 2 indicates that the distribution of elements of cattle (N=400) is affected mainly by preservation and recovery biases rather than by butchery or preferential import/export of body parts to or from the site. Most of the poorly represented elements are small and/or cancellous (eg the carpals (Cp), the patella (Pt) and the sesamoids (Ss)). These are particularly susceptible to being overlooked during recovery by hand and to destruction through taphonomic processes such as scavenging by canids. The distribution of the more robust elements, such as the major limb bones and girdles, suggests that all parts of the skeleton are relatively evenly represented. The scapula is the most frequent element, but is not excessively over-represented as it is at some Roman military sites in Britain (such as Carlisle: Stallibrass 1991: Fig 9) and continental Europe.

The slightly smaller sample of sheep/goat elements (N=303) shows a much greater bias against the recovery and/or survival of small bones, which is logical given the generally smaller size of sheep bones than those of cattle. Again, the major limb and girdle bones are represented in roughly even proportions, save that the most robust elements (ie: those of the lower limbs: the tibia, the metacarpal and the metatarsal) are noticeably better represented than the others. Although this could represent an emphasis on butchery debris, this is unlikely since it is not matched by a similar frequency of mandibles. Also, it is unlikely to indicate specialist craft waste, since this would not be expected to include tibiae in equal proportions to metapodials. Overall, it would appear that the sheep/goat bones represent the *in situ* remains of utilised whole carcases, biased by the effects of comparatively poor survival and/or recovery of small and less robust elements. Since the metapodials are often recovered relatively, if not entirely, intact, whereas bones that bear greater amounts of meat (such as the pelvis, femur and humerus) are often butchered at some point, a bias against the recovery of smaller bones may even act against some of the major limb and girdle bones, where these exist as fragments rather than as whole bones.

Only six fragments were identified specifically as deriving from goat rather than sheep or sheep/goat. The four elements represented by the goat fragments are: horncore, radius, tibia and metatarsal. This distribution is very similar to that of the elements identified specifically as deriving from sheep. Although the sample size is tiny, the distribution does not suggest that the goat bones are the remains of specialist craft working of horns or skins.

The sample size for pigs is considerably smaller (N=128), and shows a greater degree of variation between the relative frequencies of different elements. The bias against the recovery of smaller and less robust bones is even more marked than in the sheep/goat sample. This may be due to the smaller sample size as well as to the fact that many of the pig bones derived from juveniles (see below), thus rendering them even more susceptible to taphonomic biases such as destruction through cooking and scavenging (although this is equally true of the sheep/goat bones), compounded by the fact that young pigs tend to have particularly open textured bone. The best represented elements are, once again, those that are largest and most robust ie: the mandible and the major limb bones. The metapodials are less well represented than those of either sheep/goat or cattle, but this is easily explicable by the fact that pig metapodials are much smaller in comparison to the limb bones than those of the other two species. Perhaps, surprisingly, the radius is not as well represented as the other major limb bones. Whether this is archaeologically significant or simply an artefact of a small sample size is unknown. At some sites, pig mandibles are very heavily predominant over any post-cranial elements (personal observation) but, although they are the most frequent element in this group, they are only marginally more frequent than the humerus and femur, suggesting that, once again, the collected remains represent the surviving elements from utilised whole carcases.

There is no evidence for any of the major species being brought in or sold off as joints of meat or partial carcases in this major period (3rd/4th Centuries AD). The only other sample size of N>100 is for cattle elements from Site 452, Phase 14a (late 4th Century). This shows a very similar pattern of element representation, with all elements represented to some extent, and those that are largest and most robust being the most frequent.

There is no evidence from the element distributions for any industrial use of cattle bones, hides or horn. Similarly, there are no deposits with any concentrations of horncores of either sheep or goats, and the frequency of sheep/goat metapodials probably reflects their enhanced potential for survival and recovery rather than workshop debris. The fibrous young pig bones would not have been suitable for craft work and, similarly, there is no evidence for the preparation of sheepskins or pig skins. The element distributions suggest that the recovered remains are waste from food preparation and consumption (including some primary butchery waste as well as kitchen and table waste).

Whether the animals were raised at the site or brought in (either as whole carcases or on the hoof, to be slaughtered on site) cannot be investigated through the use of element representation, and requires an analysis of the age structure of the population represented by the recovered remains.

Age at death

I: Tooth eruption and wear stages.

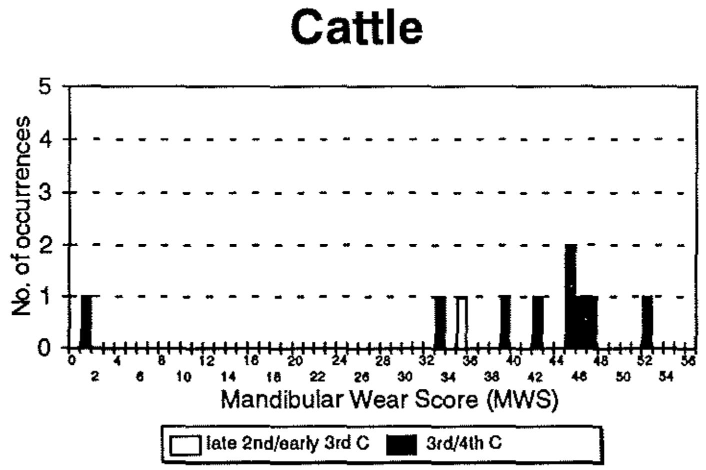
Appendix 3 presents selected mandibular dental data for the three main domestic species (cattle, sheep/goat and pig), separated into the main periods of occupation represented by this collection. The data include Mandibular Wear Scores (MWSs), length measurements and wear stages for individual M_3s (whether still *in situ* in the mandible or loose), and the ratio of deciduous to permanent last premolars ($dp_4 : P_4$). In addition, there are relevant notes regarding individual teeth and, for pig, an assessment of the ratios of female to male canines.

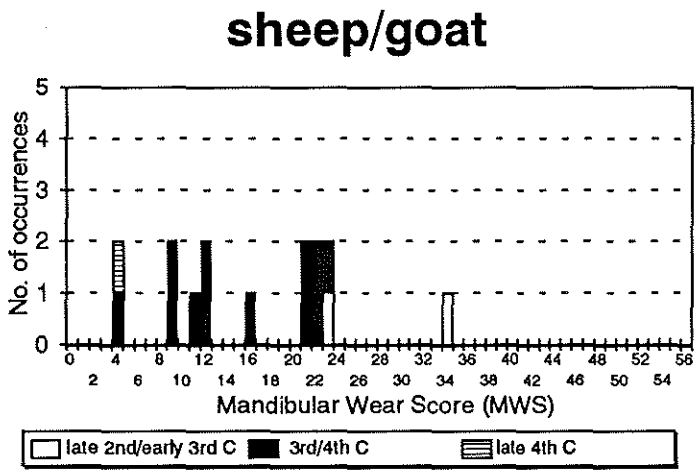
The numbers of mandibles for which MWSs could be assessed are very small, even when estimated scores are included (scores have been estimated where one molar is missing, or where its wear stage has been obscured by breakage or burning). The consideration of dp4:P4 ratios makes use of a larger sample size, but is limited to an assessment of proportions of teeth from individuals younger or older than the age at which P4 erupts. The majority of the data derive from contexts dating to the 3rd/4th Centuries, with only a few ascribable to the late 2nd/early 3rd or late 4th Centuries. This precludes comparisons for a single species through time. However, despite the small sample sizes, the data do show striking differences between the species within the overall time span of the late 2nd - late 4th Centuries, and these are illustrated, using the MWSs, in Figure 3. Data for contexts dated to 'up to modern' (from Site 452, Phase 15) are included in Appendix 3, and do not look out of place compared to the securely dated Romano-British material.

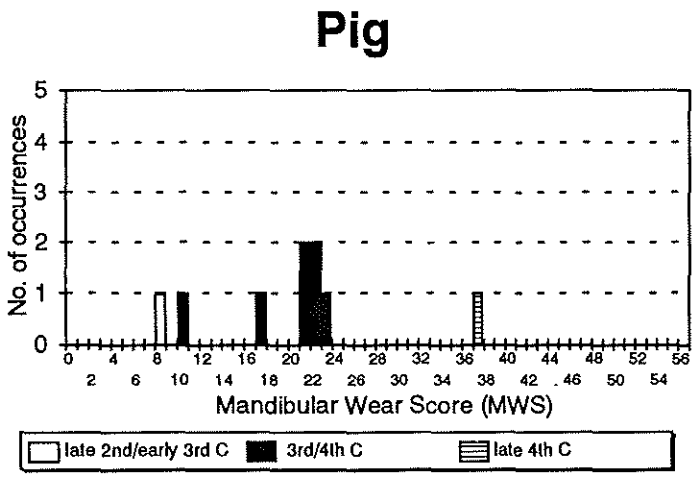
Cattle

An M1 still in its crypt indicates the presence of a very young, possibly neonatal, calf (the M1 erupts at 5 - 6 months), and also suggests that burial conditions were not unconducive to the preservation of very young teeth (although their small size may have led to an under-representation due to recovery biases). There is then a complete gap in the MWS distribution until an estimated MWS of 33, for a mandible in which the M3 is at a very early stage of wear (b/d), suggesting that the animal died shortly after the tooth erupted at about 24-30 months. All of the loose M3s have moderate to heavy wear, with wear stages falling between 'g' and 'l'. This last tooth was very well worn and is in a mandible with a MWS of 52. All the teeth in this jaw are very well worn: down to, or almost down to the gumline, and the animal may have been well into its second decade of life by the time it died. The eleven Romano-British jaws emphasise the role of mature cattle represented in this collection: apart from a calf so young that it may have died as a neonate, no cattle are represented that died before the age of 2 - 2.5 years, and the majority appear to have been much more mature than this. Older cattle can be utilised for breeding and milking, as well as providing traction and manure. It is quite probable that younger cattle were sold on or sent elsewhere for fattening up for slaughter, and that the last thing that the mature and elderly animals represented in this collection were kept for was meat provision.

Figure 3. Mandibular Wear Scores (MWS) for cattle, sheep and pig from the three Romano-British main periods







Appendix 3 includes other dental records that support the data supplied by MWSs. Loose M3s have wear stages of 'd' or greater, and the overall Romano-British ratio of dp4 : P4 is 4 : 17, indicating that the majority of animals (c 80%) were older than 2.5 - 3 years old at death. Since most of the P4s have wear stages of 'g' or 'h', these animals were probably considerably beyond this age.

Sheep/goat

The age distribution indicated by MWSs for the sheep/goat mandibles contrasts very strongly with that described above for the cattle. Far from indicating a group of mature and elderly animals, the sheep jaws suggest that only one of the 15 Romano-British jaws comes from an animal that survived beyond the age at which the M3 completes its eruption through the jaw (at about 18-24 months). Two jaws come from lambs that died when the M1 was only half erupted, indicating early, possibly neonatal deaths of less than 3 months of age. There is a little cluster of five jaws with MWS = 9-12, which all have M2 visible or just starting to erupt, and a fifth jaw with an M2 half erupted. All of these are specifically identifiable as lambs rather than kids. Since the M2 of sheep completes its eruption at about 9-12 months, these data indicate that nearly half of the 15 jaws come from animals that died between the ages of 3 and 9-12 months. If they were born in the spring, these ages might coincide with an autumn cropping of first year lambs. The carcases would still have been rather small, but the meat should have been very tender. A further small cluster of six jaws has MWS = 21 - 23 (none of these could be identified positively as deriving from pairs, and so are assumed to indicate six different individuals). These scores coincide with M3 forming in the crypt or just becoming visible through the bone. Since M3 erupts at 18-24 months, these animals probably died (or were killed) during this approximate age span. Again assuming a spring date of birth, they could indicate a cull of larger (second year) lambs, that would have provided greater quantities of meat, still of a tender texture. An alternative interpretation might be that any or all of these 14 young animals (aged from <3 months to < 2 years at death) represent unfortunate losses in winter weather. Although this might be a reasonable interpretation for some of the individuals, it is unlikely to apply to them all since, if all of the animals were lost through such unfortunate circumstances, there would be no breeding stock left to keep the flock viable. Even the jaw with a MWS=34 comes from an animal that had light wear on its M3 (stage 'd').

Again, the supplementary data provided in Appendix 3 emphasise the young ages at death for the sheep, although there are two loose M3s with wear stages of 'f' and 'g', indicating moderately mature ages at death. The ratio of dp4 : P4 shows a very high proportion of young animals. Not only is the ratio 23 dp4 : 6 P4 (suggesting that only 21% survived beyond 21 - 24 months), but of the 6 P4s, three are still in their crypts and one is only half up, indicating that most of the 'older' animals actually died <u>at</u> 21-24 months, not beyond this age. A more accurate assessment might be, therefore, that only 2/29 jaws (7%) represent animals that survived beyond 2 years of age.

This high juvenile mortality pattern might indicate that the animals were imported for food rather than raised by people living at Catterick, but this hypothesis may be countered by the presence of the very young sheep (with MWS=4). Killing an animal so young makes the meat extremely expensive in terms of capital investment in breeding stock compared to quantities of meat gained, and slaughter at very young ages is usually restricted to specialised production of skins (for astrakhan or parchment, in which case the lambs are usually slaughtered before they gain any tooth wear at all) or milk (in which case high numbers of neonates in a death assemblage are usually complemented by high numbers of elderly females, not immature animals). One further possibility is that one member of each pair of twins was slaughtered in order to strengthen the chances of survival of the other (Simon Davis, pers. comm.). Although the very young lambs at Thornbrough Farm might have been highly desirable items acquired for eating on special occasions, it is equally feasible that they were unfortunate losses of newborn livestock. The sheep that died towards the end of their second year could have been bred for one season and would have provided one clip of wool before they died. This might have been sufficient for the flock to be self-maintaining, but it is clear that the prime product from the sheep represented in this collection was meat not stock, milk or wool. In contrast to the cattle, it may have been the older stock that were disposed of elsewhere.

Pigs

Unlike cattle and sheep, pigs are almost always kept primarily for the provision of meat, since they have little to commend them regarding the supply of traction, milk or wool, although they can be useful in agricultural situations requiring the turning over and manuring of soil, and have the benefit that they can be kept in sties or back yards and fed on scraps from households and various organic-based industries (such as brewing and dairying). Typically, therefore, pig remains show a high proportion of juveniles, and this is the case at Catterick. There are only nine MWSs, one of which is estimated, and eight of them fall in the range of 8-23. The two youngest of these (MWS=8 & 10) have M1 just in wear (stage 'a' and 'c') and the M2 visible and these probably derive from animals of about 7-13 months old. The jaw with MWS=17 has M2 at wear stage 'a' and M3 in the crypt, and probably derives from an animal about 14 - 20 months old. There is a small cluster of five jaws with MWS = 21-23, which all have M3 visible or just starting to erupt, and these probably derive from animals of about 17-22 months. Eight of the nine jaws, therefore, derive from animals that died in their first or second year, although there is no evidence for neonatal deaths. The only 'mature' jaw comes from an animal with an MWS=37, but even this jaw has an M3 with a very light degree of wear (stage 'b) and is unlikely to derive from an animal much (if anything) over two years of age. Again, like the sheep, the pigs that died in their second year should have provided some offspring to continue the breeding stock, but their prime function was to provide meat.

The supplementary data provided in Appendix 3 again support the MWS evidence. The loose M3s are all from immature animals, being unerupted or having very light wear stages ('a' to 'c'). Although the ratio of dp4 : P4 might appear to indicate a much higher proportion of older animals at first glance (the ratio is 3 dp4 : 12 P4), it should be remembered that P4 erupts quite early in pigs (at 12 - 16 months). This ratio appears to reflect a considerable majority (80%) surviving beyond 12-16 months. However, at least 11 of the 12 P4s are at stages between 'up but unworn' and 'b', and none of them are likely to derive from an animal much beyond 16 months of age. Again, this emphasises the high mortality in the second year of life indicated by the MWSs (ie: 7/9 surviving beyond their first year but only 1/9 reaching 2 years of age).

Sexing ratios of pig canines

The pig mandibular permanent canines were assessed for sex, to give an indication of the ratios of males and females dying after c. 8 - 12 months (see Appendix 3.iii). The sample size is small, but there are approximately equal numbers of males and females in each broad time period (in a total of 5:5). Once again, the majority of the teeth derive from animals that survived their first year (the ratio of permanent to deciduous canines is 10:4). Since pigs breed profligately, young females can be culled in equal numbers to young males (in other species, females are preferentially kept on as breeding stock), and an age at death of over one year would certainly allow for the females to provide at least one litter of piglets before they themselves were killed for meat.

ii: Epiphysial fusion

To check against, and to enhance, the ageing data provided by the tooth eruption and wear data presented in the section above, the epiphysial fusion data for cattle, sheep and pigs from the

3rd/4th Century deposits are summarised in Table 7 (data for the other species and periods are very scanty). This check has been made for two main reasons:. Firstly, the recording of Mandibular Wear Scores (MWSs) depends upon mandibles being recovered with the molar toothrows relatively intact, and samples that have suffered considerable fragmentation can be biased or seriously reduced in size. In contrast, the breakage of a bone need not destroy the epiphysial fusion data. Secondly, cranial and post-cranial material need not derive from the same populations of animals. Primary butchery waste including head bones can be disposed of in different contexts or site locations to those utilised for waste from food consumption. Post-cranial meat-bearing bones deriving from carcases consumed on site may relate to one age group, whilst head and foot bones from animals culled on site but exported as carcases to be consumed elsewhere might relate to a different age group. A comparison of the two sets of ageing data can, therefore, be used to investigate whether or not some animals arrived at, or departed from, a site as butchered carcases rather than as live animals. Table 7, however, tends to confirm the evidence provided by the tooth eruption and wear data.

Cattle

For cattle (N=254), the majority of the epiphyses that fuse prior to about 4 years of age are fully fused although, in the small group relating to the ages of 3.5 - 4 years, there is a significant minority of epiphyses that are not yet fully fused. These latter examples may relate to the MWSs of 33-39, where the M3s are in light to moderate stages of wear indicating ages at death not greatly beyond the eruption age of 2 - 2.5 years. The large proportion of unfused vertebrae may indicate a cull of young, rather than mature, adult animals (<c. 4.5 - 5 years, possibly later for castrates). This is not in such good accord with the dental data (which indicate the presence of some mature, or even senile, animals), but may indicate a high proportion of bones from castrates. Given the small sample sizes of both dental and epiphysial fusion data, however, the overall age distributions appear to be in good general agreement, and there is no reason to suppose that different populations are presented by cranial and post-cranial elements.

Both methods of age assessment, however, can suffer from a bias against the recovery of data pertaining to juvenile animals. In the case of the dental assessments, loose deciduous teeth are small and less likely to be recovered than are the larger, more robust molars (particularly M3), and young mandibles are more susceptible than older ones to fragmentation and, hence, tooth loss from alveoli. In the case of epiphysial fusion, a fusion state can only be recorded if the epiphysis (or unfused metaphysis) is recovered, and it has been demonstrated that young bones preferentially have these parts removed by scavengers (Stallibrass 1986), besides being more susceptible to breakage and destruction through other taphonomic factors such as trampling and butchery. This is definitely the case for the Thornbrough Farm collection, where several bones were noted in the database as having a young surface texture (immature bone has a 'woven' texture, with irregularly-orientated collagen filaments. This is easily distinguishable from mature bone, which has the filaments realigned through remodelling into a more parallel arrangement). Many of these bones do not appear in Table 7 since they do not retain an epiphysis or unfused metaphysis. Of note, however, are those that were subjectively assessed at being neonatal to a few weeks old (four examples of cattle bones) or a few weeks/months old (three examples of cattle bones). The presence of these bones from very young calves indicates that the cattle were home produced (unless the inhabitants had access to extremely expensive supplies of meat).

Sheep/goat

The sheep/goat epiphysial fusion data (N=119) support the age distribution suggested by the MWS and tooth eruption data very closely, with an emphasis on immature animals throughout all of the age categories from the end of the second year onwards. Again, many bones were recorded as coming from young animals, and many of these do not appear in Table 7. Apart from one bone from a neonate/weeks old animal and four more from animals only a few weeks or months old that do appear within Table 7 (although not necessarily until a later stage *eg* an unfused distal radius that comes from a week/months old animal but appears in the <3 - 3.5 years category), there are a further nine bones from animals only weeks or months old when they died. Since heavily scavenged or trampled young bones can be destroyed beyond the point of hand - recovery or element zone recording, it is likely that even these young bones are an under-representation of the original proportion of young bones in the material deposited at the site. The consistent emphasis on young sheep (mostly less than two years of age) in the recovered and catalogued collection is, therefore, likely to be an under statement and is definitely not an artefact of methodological biases in recovery or recording.

Pig

The pig data (N=40) form a very small data set but similarly confirm the MWS and tooth eruption data, with an overall emphasis on juveniles, particularly on animals dying between the ends of the first and second years of life. Once again, many bones were recorded as having young surface texture, and two bones not included in Table 7 are likely to come from animals less than a few weeks or months of age, with a third probably deriving from a neonatal piglet. Although suckling pig is a delicacy, and might be imported for a special occasion, the general distribution of young bones and teeth of varying ages probably indicates that the pigs were home-reared.

Table 7. Epiphysial fusion data for cattle, sheep/goat and pig from 3rd/4th Century deposits

7.i: Cattle (N=254)

fusion age	Fused	Fusion line visible	Partially fused	UnFused
7 - 10 months	35	-	-	-
12 - 18 months	48	4	-	3
2 - 2.5/3 years	35	3	1	4
3 - 3.5 years	10	2	-	3
3.5 - 4 years	6	3	2	4
4.5 - 5 years	15	1	8	67

7.ii: Sheep/goat (N=119)

fusion age	Fused	Fusion line visible	Partially fused	UnFused
6 - 10 months	20	-	1	1
10 - 16 months	16	-	2	3
1.5 - 2/2.5 years	25	4	-	13
2.5 - 3 years	1	-	-	2
3 - 3.5 years	2	1	2	10
4 - 5 years	3	-	-	13

7.iii: Pigs (N=40)

fusion age	Fused	Fusion line visible	Partially fused	UnFused
by 12 months	11	-	-	2
2 - 2.5 years	-	1	-	18
by 3.5 years	-	-	-	4
4 - 7 years	-	-	-	4

Table 7 (cont.): key to epiphyses in each age group: (p: proximal; d: distal)

7.i: Cattle

fusion age	epiphyses included in age group
7 - 10 months	scapula (bicipital tuberosity); acetabulum
12 - 18 months	d. humerus; p. radius; p. 1st & 2nd phalanges
2 - 2.5/3 years	d. tibia; d. metapodials
3 - 3.5 years	calcaneum (tuber calcis); p. femur
3.5 - 4 years	p. humerus & tibia; d. radius & femur, p. & d. ulna
4.5 - 5 years	pelvis (pubis & sciatic tuberosity); p. & d. vertebrae

7.ii: Sheep/goat

fusion age	epiphyses included in age group
6 - 10 months	scapula (bicipital tuberosity); acetabulum
10 - 16 months	d. humerus; p. radius; p. 1st & 2nd phalanges
1.5 - 2/2.5 years	d. tibia; d. metapodials
2.5 - 3 years	p. & d. ulna; calcaneum (tuber calcis); p. femur
3 - 3.5 years	p. humerus & tibia; d. radius & femur, pelvis (pubis & sciatic tuberosity)
4 - 5 years	p. & d. vertebrae

7.iii: Pigs

fusion age	epiphyses included in age group
by 12 months	scapula (bicipital tuberosity); acetabulum d. humerus; p. radius; p. 2nd phalange
2 - 2.5 years	d. tibia, fibula & metapodials; calcaneum (tuber calcis); p. 1st phalange
by 3.5 years	p. humerus, tibia & fibula; p. & d. ulna & femur
4 - 7 years	pelvis (tubercoxae, pubis & sciatic tuberosity) p. & d. vertebrae

Size, shape and sex

The sample sizes of measured bones are small, and most examples derive from contexts dating to the 3rd/4th centuries, precluding any investigations of possible time trends. Appendices 4, 5 and 6 list the measurements for elements of cattle, sheep/goat and pigs, respectively, where more than five bones could have some measurements taken. Appendix 7 lists all measurements available for other species (mainly dog, horse and domestic fowl). Most of these measurements can only be made use of in conjunction with those from other sites or with material from any future excavations at Catterick.

A few elements are considered in more detail, despite the small sample sizes, because the distributions appear to indicate trends that should be investigated further if suitable material can be obtained from the site.

Cattle

Cattle metacarpal measurements are provided in Appendix 4 and are illustrated in Figures 4, 5 and 6. Of the 14 distal breadth measurements (Bd, taken across the distal condyles) taken from fully fused or, in one case, partially fused bones, 11 derive from 3rd/4th Century contexts. These show a wide range in size (from 49.4 - 70.5mm) with an average breadth of 57.6mm and a standard deviation of 7.05. This average breadth is quite large for Romano-British material (see Luff, 1982) but the bar graph in Figure 4 demonstrates that the distribution is not a normal one. There is a cluster at 50 - 54mm, which is typical of indigenous 'Celtic shorthorn' cattle of the British Iron Age and Romano-British periods, and then a long 'tail' of larger measurements. One of the larger 3rd/4th Century bones (with Bd = 57.5mm) has a slightly splayed distal end, which may have biased the distribution a little, but the only other distally splayed bone (which is from a late 4th Century deposit and is also affected only to a slight degree) has a Bd = 50.9 mm, which is one of the smallest measures in the sample. The distributions of Bd measurements, therefore, are unlikely to have been biased to any significant extent by pathological or traumatic alterations.

Only two of the metacarpals are complete as well as distally fused, and these have been assessed using Howard's (1962) shape indices. The bone with the smallest measurement (Bd = 49.4mm) is both small and slender (?a female), and the bone with the largest Bd (= 70.5mm) is both large and robust (?an entire male). Although the tight clustering of smaller Bd measurements may indicate the presence of a group of females of Celtic shorthorn type, the larger measurements could derive from male animals (both castrated and entire) of the same genetic stock, or could derive from 'improved' types of cattle (or any combination of the two. A scattergram (see Figure 5) of the distal breadths across the condyles (Bd) compared to those at the fusion line of the metaphysis (BFd) emphasises the tight cluster and the long 'tail'.

Figures 4, 5 and 6: Cattle metacarpal measurements

Figure 4: Bar graph of cattle metacarpal distal breadths

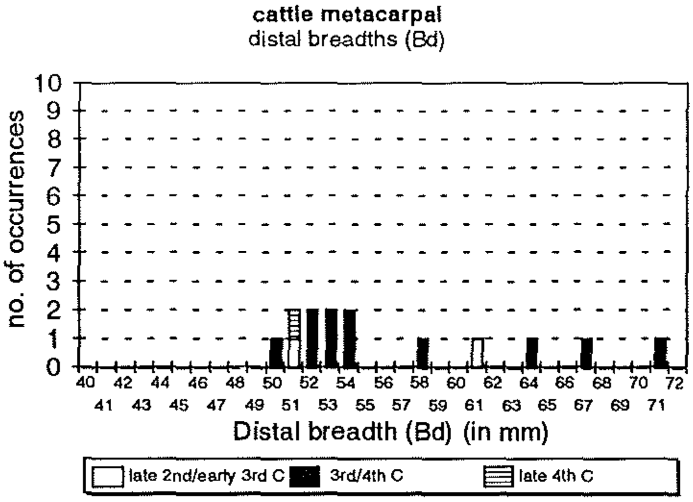


Figure 4: Scattergram of cattle metacarpal distal breadths

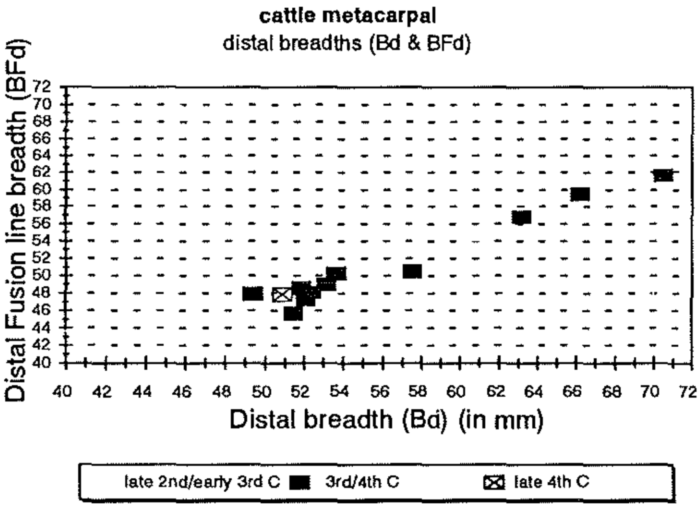
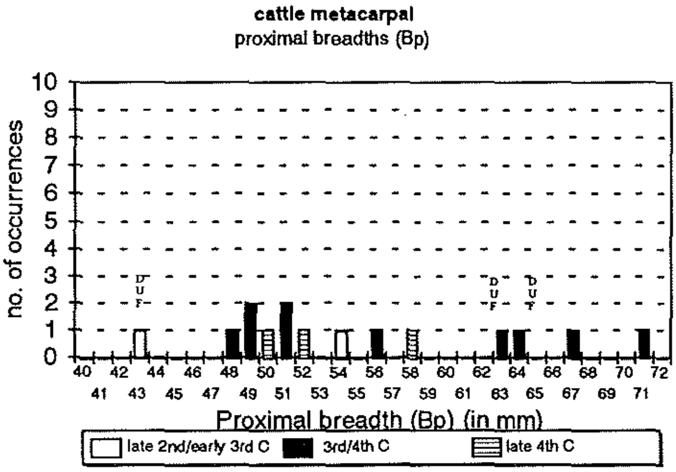


Figure 6: Bar graph of cattle metacarpal proximal breadths



A bar graph of the proximal breadths (Bp) (see Figure 6) shows a similarly wide range of measurements, although the cluster at the lower end of the range is rather looser. Part of this observed variation may derive from the presence of bones at differing stages of maturity. Three of the measurable examples are from bones known to be distally unfused (DUF) and, hence, immature (most of the others do not have their distal portions remaining and cannot be assigned to mature or immature categories). One of the DUF examples provides the smallest measurement (Bp = 42.3mm) but the other two are two of the largest examples (Bp = 62.4 and 63.3 mm) and may well derive from immature males, perhaps castrates. The two complete and distally fused bones provide the second smallest and the second largest Bp measurements (Bp = 48.3 and 66.7 mm). These are the same bones that provided the smallest and the largest Bd measurements (a ?female and an ?entire male, respectively). Again, a scattergram of the proximal breadth (Bp) and depth (Dp) measurements (not illustrated) shows the same wide distribution and does not suggest any bimodality. Apart from the complete bones, the fragments providing proximal measurements are different from those providing distal measurements, and they probably derive from different individuals (this statement is based on the states of relative completeness of the fragments, combined with their contextual distribution). The information provided by them, therefore, confirms rather than duplicates that already provided by the distal measurements.

The metatarsals provide a similar sample size, with 12 of the 13 Bd measurements deriving from bones dated to the 3rd/4th Century. The distribution of these is similar to that of the metacarpals, with a main cluster of smaller measurements, plus a few larger ones, but the 'tail' of larger measures is much less spread out (average Bd = 52.2mm, N = 12, SD = 4.21). It is possible that this is due to the fact that the bones of the hind limbs tend to show less sexual di/tri-morphism than those of the fore limbs. Only two of the bones are splayed, to a very slight degree. One of these has a Bd falling within the main cluster of smaller measurements, whilst the other has the largest distal breadth in the sample. Compared to data listed in Luff (1982), the Thornbrough cattle metatarsal measurements fall in a normal range for Romano-British material, although the upper end of the Thornbrough range and, possibly, the average measurement are slightly higher than normal for sites other than villas (which tend to have the largest cattle in Roman Britain).

Six metatarsals retain their complete (fully fused) lengths. Two of the three longest bones are extremely slender, both at their midshafts and across the distal epiphyses. These may derive from castrates.

Withers heights have been calculated for all complete cattle longbones (see Table 8). There are three metacarpals, six metatarsals, and one radius, all dating to the 3rd/4th Centuries. Zalkin's (1960) factors have been used for the metapodials whilst Matolcsi's factor (cited in Driesch & Boessneck 1974) has been used for the radius. The withers height calculated from the radius is higher than any of those calculated from the metatarsals, but is not greatly beyond their range, and is less than that calculated for a particularly large metacarpal. Bartociewicz's (1985) study of the relative contributions of different elements to the theoretical extremity length (TEL), which is directly related to withers height, suggests that metapodials contribute a relatively greater proportion of the TEL in younger than in older animals. Given the ageing evidence for predominantly mature cattle bones recovered from Thornbrough Farm, this factor is unlikely to have seriously biased the results based on the fully fused bones. Guilbert and Gregory's (1952) study of Hereford cattle found that the metacarpal had already reached an average of 87% of its full size at an age of only 19 days (whereas its withers height at that age would only be approximately 56% of it adult size). The two immature metacarpals are likely to derive from animals less than, or approximately, 2 - 2.5 years of age. Their withers heights may be slight overestimates of their actual sizes, and closer to their full adult sizes, but they are notably smaller than the others calculated.

Howard (1962) attempted to separate bones from females, castrates and bulls on the basis of her shape indices, but the groupings may have been affected by small sample sizes and by circular arguments. In Table 8, allocations based on Howard's indices are presented for comparison with the withers heights and notes made during recording. However, these allocations are considered too unreliable to warrant the use of Zalkin's (1960) separate factors calculated for use with material from animals of known sex: the factors used are those provided by Zalkin for bones from animals of unknown sexual identity.

Table 8: Withers height calculations for all complete cattle longbones

Taxon	Date	Element	Fusion	GL (in mm)	factor* (Zalkin 1960)	Withers height (in metres)	Howard Index		Notes recorded in catalogue
							SD :GL	Bd :GL	
cattle	3rd/4th C	metacarpal	PF DFsg	168	6.12	1.028			short, stocky & immature
cattle	3rd/4th C	metacarpal	PF DUF	170	6.12	1.040			short, stocky, young, skinned, scorched (GL includes UF epiphysis)
cattle	3rd/4th C	metacarpal	PF DF	199	6.12	1.218	M/C	M	extremely large
cattle	3rd/4th C	metatarsal	PF DF	196	5.47	1.072	C/F	C	pathology, skinning marks
cattle	3rd/4th C	metatarsal	PF DF	200	5.47	1.094	C	C	
cattle	3rd/4th C	metatarsal	PF DF	205	5.47	1.121	C/M		
cattle	3rd/4th C	metatarsal	PF DF	210	5.47	1.149	F	F	unusually long & slender
cattle	3rd/4th C	metatarsal	PF DF	210	5.47	1.149	M	C	
cattle	3rd/4th C	metatarsal	PF DF	213	5.47	1.165	F	F	creases in proximal articular facets
cattle	3rd/4th C	radius	PF DFsg	274	4.30**	1.178			

KEY

factor*	Zalkin's factors are for animals of unknown sex
4.30**	factor from Matolcsi, cited in Driesch & Boessneck 1974
PF DF	proximal fused, distal fused
DFsg	distal epiphysis still in process of fusing
DUF	distal unfused
F	Female
C	Castrate
M	Male (entire)

fully fused	**bones only**
	3rd/4th C
N	7
average	1.138
minimum	1.072
maximum	1.218
Std. Dev.	0.0446

The seven complete and fully fused cattle bones (one metacarpal and six metatarsals) give an average withers height of 1.138m, with a range from 1.072m - 1.218m (SD = 0.045). These figures fall within the overall ranges of data given for other Romano-British sites in Luff (1982); above those from native or weakly romanised sites, but below those of heavily romanised sites such as southern towns and villas.

Apart from the general size differences expected from bones of animals of different sexes, the most useful skeletal elements for assessing the sex of an individual are the skull and the pelvis. No complete or semi-complete skulls were found at Thornbrough Farm, but several pelvic fragments were recovered that could be assessed for sexual di/tri-morphism using the morphology of the acetabular rim and the cranial branch of the pubis. Only one acetabular rim height could be measured (see Grigson 1982: Figure 1). This is from a young individual of about 7 - 10 months of age (the three segments of the acetabulum were still in the process of fusing when the animal died). The morphology of the bone appears male, and the rim height is 16.70mm, which is so large that it also suggests that the bone derives from a male.

Overall, 11 pelvic fragments could be assessed morphologically. Five appear to be from females, and one of these has an eburnated and pitted acetabulum, indicative of osteoarthritis (which is often age related). Four more (including the juvenile) derive from males, with a further two that are very probably from males, but probably from castrates rather than entire animals. For the 3rd/4th Century material, the sex ratio is four females (one with osteoarthritis) to four males (one less than 7-10 months, and one probably a castrate). For the late 4th Century, the ratio is one female to two males (one possibly a castrate).

The wide ranges of the cattle metapodial breadth measurements in such a small sample are interesting, but could be due to the mixture of males, females and castrates within the collection, as indicated by the metapodials themselves and by the pelves. But the variability might reflect a mixture of native type stock of small sizes (the so-called 'Celtic shorthorns' or *Bos longifrons*) plus improved, larger stock. These are thought to have been introduced or developed during the later Romano-British period, either by Roman military personnel in the region, or by indigenous people in response to the army's presence and need for large supplies of meat. Because of the problems inherent in distinguishing between size related to sex identification (female, castrate and entire male) or to genetic affinity (native or introduced stock, or new strains deliberately chosen for breeding) or methods of husbandry (supplementary nourishment, winter housing *etc etc*) absolute size alone cannot be used to distinguish between native, introduced and nurtured types of stock. However, when it is considered in conjunction with morphology and conformation, it may be likely to reflect genetic differences rather than husbandry practices (although sex differences must still be taken into account).

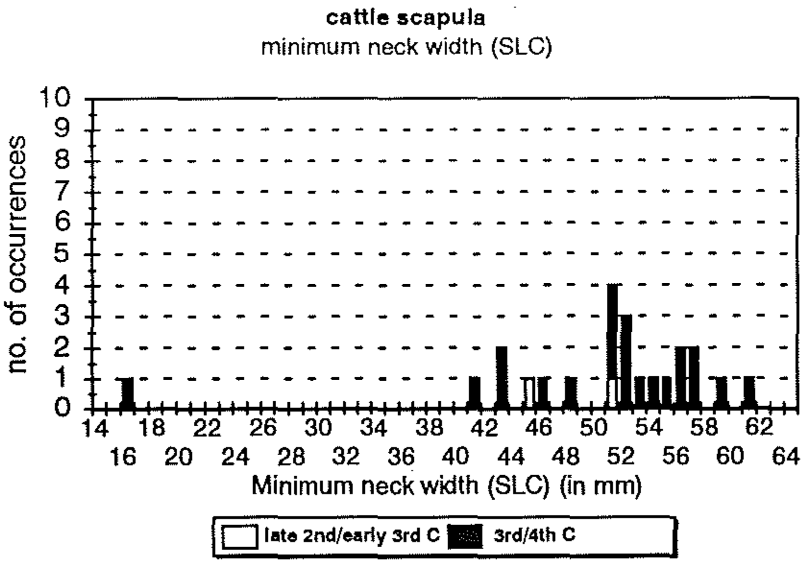
An analysis of horncore size and morphology, whilst sometimes relating to sex (see Armitage & Clutton-Brock 1976, although their methodology has been found by this author to be unsuited to Romano-British cattle) can sometimes show two types of horncore in association with differently sized cattle, and this has been attributed to the presence of two types of cattle gene pools (eg York, Tanner Row: O'Connor 1988; Carlisle, The Lanes: Stallibrass 1993). The sample size for Thornbrough Farm is extremely small. There are only eight complete horncores: one from the later 2nd/3rd Century, the other seven from the 3rd/4th Centuries. One of these is far longer than the others, with an outer curvature of 206mm, compared to the range of 84 - 133mm for the other seven cores. A scattergram of the basal shape index (maximum/minimum basal diameter) against the length of the outer curvature (not illustrated) again demonstrates a surprisingly large range for so small a sample (see Appendix 4 for the raw data). One possible interpretation of these data is that the material contains a wide range of sizes of horncore deriving from a combination of male, female and castrate 'Celtic shorthorns' plus one, much larger, horncore (possibly from an animal of different genetic stock).

Of the MNE of 17 horncores, 14 retain sufficient surface area for their overall texture to be assessed. Six of the 14 have an open texture indicative of immaturity. Three of these, together with a further five more mature horncores, are deeply grooved longitudinally. This grooving may be correlated with castration (Luff 1994), although it can also occur in entire males. One of the smallest horncores is complete and fully mature, and may derive from an entire male. Some of the open textured and/or deeply grooved horncores have the greatest basal diameters, and the exceptionally large (in this sample) horncore is deeply grooved.

No examples of polled skull fragments were recovered.

Given the small sample sizes and the problems associated with attempts to separate the effects of sex differences, individual variation, and the effects of husbandry and genetics upon size and conformation of animals and their bones, all that can be suggested is that the Thornbrough Farm animals would have appeared very variable in size and shape, that there were roughly equal numbers of females and males (including some castrates and, possibly, some entire males), and that there may also have been a few individuals of new or improved stock.

Figure 7. Minimum neck widths (SLC) of cattle scapulae



A bar graph of the minimum neck width of the scapula (SLC) (see Figure 7) has a sample size of 22 (20 from the 3rd/4th Centuries) and indicates the size distribution of cattle, regardless of their age at death. Apart from one neonatal example, there are no small examples that might come from juveniles, but a large cluster (possibly compounding two groups) of larger bones that probably derive mainly from mature animals. The distribution pattern is remarkably similar to that of the Mandibular Wear Scores (MWS, N=10) (see Figure 3), which is almost entirely age-related, but which may have under-represented young animals due to biases relating to fragmentation of delicate juvenile bones and the requirement of the methodology for relatively complete mandibles. The scapula data suggest that the apparent gap in the MWS distribution is real, and not an artefact of taphonomic or methodological biases.

Occasional bones of cattle are noticeably larger than the general ranges observed within the collection, but not all of these retain portions conventionally used for anatomical measurements. In particular, a 3rd/4th Century cattle femur is half as big again as a femur from a modern Chillingham bull. Its distal epiphysis is not fully fused onto the diaphysis (the fusion line is still clearly visible), and it appears to be a poor fit. In contrast, no bones are particularly small compared to the rest of the collection.

Sheep/goat

The ageing data show that most of the sheep/goat bones are immature, restricting the numbers of fused epiphyses available for measurements.

Figure 8 is a scattergram comparing proximal breadths (Bp) and depths (Dp) of 15 metacarpals (13 of which are from 3rd/4th Century deposits). The sample includes a mixture of bones with fused and unfused distal epiphyses, together with bones of unknown distal fusion states. When the fusion data are taken into consideration (see Appendix 5), it is clear that unfused and fused bones are completely intermixed in size, probably indicating the presence of both males and females younger and older than the age at which the distal epiphysis fuses (c. 18 - 24 months). The largest measurements come from a bone of unknown distal fusion status, but it has an immature texture that suggests that it derives from a young animal (presumably a large adolescent male).

Distal tibiae provide an identical number of measurements (see Figure 9) but, in this case, all of the examples derive from animals over the age at which the distal epiphysis fuses (which is, again, 18-24 months). Two of the bones have fusion lines not yet fully erased by bone remodelling. The measurements of one of these falls in the middle of the range, but those of the other bone provide the largest example, and the bone may derive from a large male very close to two years of age.

Of the 13 3rd/4th Century examples, eight are identified specifically as sheep bones, one as a goat bone and four as sheep/goat bones. The goat bone has measurements in the middle of the range (Bd=24.4mm, Dd=18.2mm) that are not distinguishable from those of sheep or sheep/goat bones (although its SD is much higher than any of the others (N=29)). If the goat tibia measurements are excluded from Figure 9, there is a slight suggestion of bimodality, with a main cluster of eight smaller bones and five larger examples, plus one particularly small specimen (that is fully fused distally and which is identified specifically as deriving from a sheep). This may simply be due to a small sample size (N=14), particularly since it is not mirrored by the proximal metacarpal measurements in Figure 8.

Horncore measurements are included in Appendix 5 although there are less than five measurable examples, due to the general interest in horncore morphology. Three are identified as deriving from sheep and one from a goat. One of the sheep horncores has a young texture and is small with a slight depression of the 'thumbprint' type described by Hatting (1975) who suggests that the trait is associated with castration (although this aetiology has not yet been confirmed elsewhere). Albarella (1995) disputed Hatting's interpretation, but the shape and location of the 'thumbprint' depressions that she discussed differ in character from those of the indentations at the base of the horncore that he described, and which he considered to relate (at least partially) to breeding stress in elderly ewes. There are no examples of polled skulls of sheep or goats, nor any examples of four-horned sheep.

Figure 8. Scattergram of proximal measurements of sheep/goat metacarpals

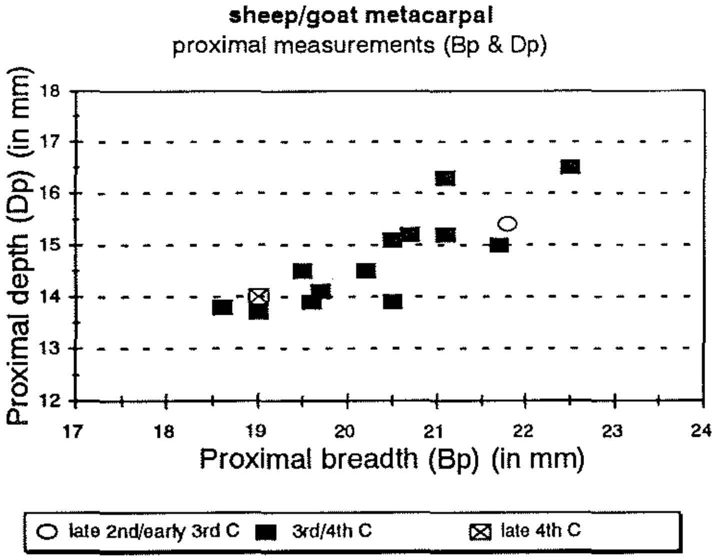
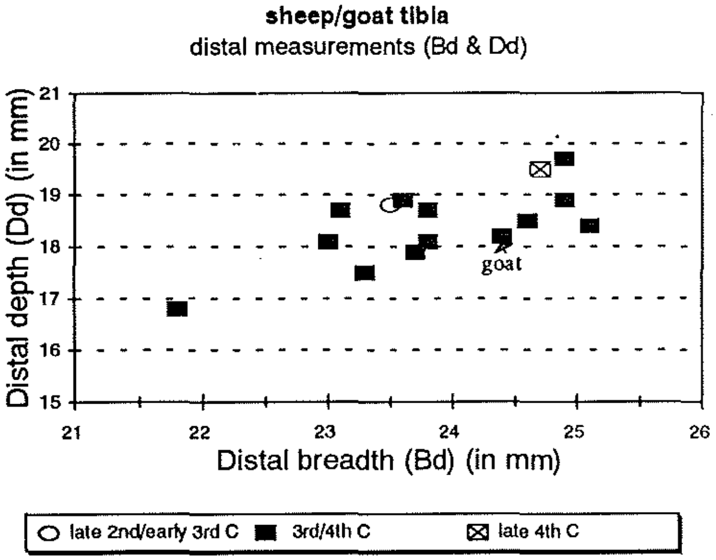


Figure 9. Scattergram of distal measurements of sheep/goat tibiae



Overall, the sheep/goat measurements fall within the normal ranges observed for Romano-British remains.

Estimated withers heights are given in Table 9. All are for bones identified specifically as deriving from sheep: five metacarpals, seven metatarsals and one radius from 3rd/4th Century deposits, plus one metatarsal from a late 4th Century context. Teichert's factors for prehistoric and early historic sheep (cited in Driesch & Boessneck 1974) are used for all of the elements, but the withers height calculated from the single specimen of a radius is way beyond the range of those calculated from the 3rd/4th Century metapodials (647mm *cf.* 586 - 604mm, N=12). The bone has not been mis-measured but is genuinely a rather large bone (see Appendix 5). Whether the animal that it derives from was truly a much larger animal than any of those represented by metapodials is impossible to ascertain. It is possible that Teichert's factors are suited to sheep of a slightly different conformation, where the metapodials were relatively longer in relation to the radius than those of the sheep represented at Thornbrough Farm. However, the application of the same factors to samples of 1st/2nd Century (N=16) and 2nd/3rd Century (N=22) sheep metapodials and radii from a civilian settlement in Carlisle (Stallibrass 1993: Table 18) shows no discrepancies, with the estimates based on radii, metacarpals and metatarsal being completely intermingled. A similar intermingled pattern is demonstrated by the sheep withers heights calculated for 1st and 2nd Century sheep bones from military deposits at Ribchester Roman fort (Stallibrass in press). The radius from Thornbrough Farm, therefore, may genuinely indicate the presence of a particularly large individual. Its distal epiphysis was still in the process of fusing when the animal died (at about 3 years of age), and the animal may have been a young adult male (possibly a castrate) rather than an animal of 'improved' stock, although this is also a possibility.

Table 9. Withers height calculations for all complete sheep/goat longbones (in mm)

Taxon	Date	Element	Fusion	GL (mm)	factor*	Withers height	Notes recorded in catalogue
sheep	3rd/4th C	metacarpal	PF DF	116	4.89	567	
sheep	3rd/4th C	metacarpal	PF DF	120	4.89	587	
sheep	3rd/4th C	metacarpal	PF DF	122	4.89	597	
sheep	3rd/4th C	metacarpal	PF DFvis	123	4.89	601	
sheep	3rd/4th C	metacarpal	PF DF	123	4.89	601	
sheep	3rd/4th C	metatarsal	PF DF	124	4.54	563	
sheep	3rd/4th C	metatarsal	PF DF	126	4.54	572	DF just visible, dorsal side
sheep	3rd/4th C	metatarsal	PF DF	126	4.54	572	
sheep	3rd/4th C	metatarsal	PF DF	128	4.54	581	
sheep	3rd/4th C	metatarsal	PF DF	129	4.54	586	
sheep	3rd/4th C	metatarsal	PF DF	133	4.54	604	fine skinning cuts, proximal shaft
sheep	3rd/4th C	metatarsal	PF DF	133	4.54	604	
sheep	3rd/4th C	radius	PF DFsg	161	4.02	647	artics. w. humerus, & pair w. radius
sheep	late 4th C	metatarsal	PF DF	125	4.54	568	

KEY

PF DF	proximal fused, distal fused
DFvis	line of distal fusion still visible
DFsg	distal epiphysis still in process of fusing

***Teichert's factors for prehistoric & early historic sheep cited in Driesch & Boessneck (1974)**

summary statistics for metapodials only

	3rd/4th C
N	12
average	586
minimum	563
maximum	604
Std. Dev.	14.50

Pigs

Almost all of the pig bones are immature and/or have lost their epiphyses due to taphonomic factors including butchery, consumption, and trampling by humans, and scavenging by canids. The few measurements that could be taken are usually for minimum midshaft widths (SD) only. These are presented in Appendix 6, and give an indication of the sizes of the animals, regardless of age.

Most of the pig bones and teeth are typical of the small domestic pigs commonly found on Romano-British sites. One very large but distally unfused ulna from the late 4th Century is the same size as that of a modern mature sow of reconstructed 'Iron Age' type. It could derive from an immature domestic male or from a young wild boar or pig.

The canines indicate an equal balance of males and females (see the section on ageing, above).

Other species

All measurements taken for bones of other species are listed in Appendix 7 (dog, horse, hare, domestic fowl, fowl-sized bird, ?grouse sp. and raven).

Many of the dog bones were noted as being rather small, and some of the limb bones are noticeably bandy. A few bones that probably derive from one small and bandy legged individual were recovered from context 786 (Phase 9, 3rd/4th Century). The tibia gives an estimated shoulder height of 258mm (following Harcourt, 1974). No other partial/complete dog skeletons were found, nor any skulls, precluding any further studies of skeletal conformation.

Only five horse bones could be measured. All fall within the usual ranges for Romano-British equids, which tend to be of a size comparable to modern British ponies (such as Exmoor and Dales ponies). Withers heights were calculated for three complete longbones, each from a different period, and provide estimates of 1.26 - 1.47 metres (12.4 - 14.5 hands). In addition, two cheek teeth (also from differing periods) are quite small, and a calcaneum is smaller than that of a modern Dales pony mare.

The hare bones (fragments of a pelvis, a metacarpal and a radius, each from a different period) cannot be identified to species level and could be from brown hare(s) (*Lepus europaeus* Pallas) and/or mountain hare(s) (*Lepus timidus* L.). The pelvis is rather large and robust.

The late 2nd/early 3rd Century cat mandible from site 482 is similar in size to those from two modern skeletons of domestic females, and the cheek tooth row is slightly crowded in the region of M_1 and M_2. The mandible probably derives from a domestic animal rather than a wild cat (*Felis silvestris* Schreber).

The sizes of the domestic fowl (and fowl-sized) bones all fall within the usual ranges for Romano-British fowl. None of the broken bones contain medullary bone (medullary bone indicates that a female bird is in an egg-laying condition). Two tarsometatarsi were recovered. One has a scar for a spur that has detached since death, and the other retains a short stocky spur. Both of these bones probably derive from male birds (although a few females also carry spurs).

One broken femur probably derives from a black grouse (*Tetrao tetrix* L.) and contains no medullary bone.

Pathological, pseudopathological and congenital traits

Congenital traits

Some of the cattle mandibles and loose teeth demonstrate congenital traits that may be hereditary, and which are more commonly found in material dating to the Roman rather than the medieval period in Britain. The data are presented in Table 10.

Out of a total of 14 mandibles (12 of them from 3rd/4th Century deposits) that retain the area where P_2 should be located, two bones have no trace of an alveolus. This incidence of 14% is common for Romano-British cattle. Out of 12 M_3 teeth, 11 have three full columns whilst one (8%) has only two. In addition to the teeth themselves, there are two alveoli that demonstrate that a further two M_3 teeth (not recovered during the excavations) also bore three full columns. This incidence of 7% of M_3 teeth with only two columns is also within the normal range for Romano-British cattle jaws. There are no examples of M_3s with a reduced third column,

Table 10: cattle mandibles: incidence of congenital traits

Period	P_2 alveolus		P_2 no alveolus		Totals
late 2nd/early 3rd C	1		0		1
3rd /4th C	10		1		11
late 4th C	1		1		2
Total Roman	*12*	*86%*	*2*	*14%*	*14*
up to modern	1		0		1

Period	M_3 3 columns		M_3 2 columns		Totals
late 2nd/early 3rd C	2		0		2
3rd /4th C	10		0		10
late 4th C	1		1		2
Total Roman	*13*	*93%*	*1*	*7%*	*14*
up to modern	3		0		3

Period	M_3 pillars		M_3 no pillars		Totals
late 2nd/early 3rd C	2		0		2
3rd /4th C	8		0		8
late 4th C	1		1		2
Total Roman	*11*	*92%*	*1*	*8%*	*12*
up to modern	2		1		3

although this is also seen in a significant minority of cattle jaws at some Romano-British sites. Occurring independently of the number of columns on an M_3, is the occasional absence of the inter-columnar pillars on the labial aspect of the tooth. The incidence of this trait in the Roman material is 8%, and one further example was found in the sample of three teeth recovered from deposits that have been dated as 'up to modern', but which probably contain mostly, if not exclusively, redeposited Roman animal bones. Again, similar incidences have been noted at other Romano-British sites, both civilian and military (see Stallibrass 1993 & 1995).

One 3rd/4th Century sheep mandible congenitally has no P_2.

Congenital/traumatic lesions

Crease- and pit-like lesions have been noted in a significant minority of articular surfaces of cattle lower limb bones at a number of Romano-British sites (see Stallibrass 1993 & 1995), but their aetiology is unclear. They may be congenital, or may be the result of trauma (such as that incurred through heavy work, or through walking on hard surfaces such as cobbled roads, yards and trackways. It has also been suggested (Noddle, pers. comm.) that rapid weight increase such as that seen in modern fast-growing animals can over-burden and damage immature joint surfaces). Baker & Brothwell (1980: 109-111) describe three types of linear depressions that commonly occur on cattle phalanges found at a variety of sites from the Neolithic to the medieval period. They are, however, not restricted to phalanges, and are also common on cattle metapodials, as well as occurring less frequently on some other elements. It is possible that the aetiologies of the three types are different. In particular, some of the deep linear 'creases' may be due to incomplete remodelling of adjoining areas of bone deriving from separate ossification centres (this may apply, in particular, to the Type 3 lesions seen in terminal phalanges, and the Type 2 lesions seen in the distal articular surfaces of the first and second phalanges). The shallow, irregular depressions of Type 1, and the small pit-like lesions (not described by Baker & Brothwell) may be more likely to be due to post-partum trauma. Table 11 presents the incidences of affected cattle elements. Detailed descriptions of the nature and location of the lesions are provided in the database and accompanying notes that are stored with the site archive.

Table 11. Incidences of lesions occurring in articular surfaces of cattle elements

Element	2nd/3rd C			3rd/4th C			late 4th C			totals		
	LP	N	%	LP	N	%	LP	N	%	LP	N	%
mandible: condyle				2	10	20%	0	4		2	14	14%
atlas: caudal artic.				1	8					1	8	
lumbar vert: cranial ep.				0	2		1	3		1	5	
scapula: glenoid	0	2		9	26	35%				9	28	32%
humerus: dist. condyle	0	2		0	6		1	4		1	12	8%
radius: dist. artic.				1	4		0	2		1	6	
metacarpal: prox. artic.	0	2		2	13	15%	0	3		2	18	11%
metacarpal: dist. artic.	1	2		4	13	31%	0	2		5	17	29%
metatarsal: prox. artic.	0	1		5	16	31%	0	3		5	20	25%
metatarsal: dist. artic.				3	20	15%	0	4		3	24	13%
nav.-cuboid: cranial				1	1					1	1	
tarsals				1	1		1	1		2	2	
ant. phalange 1: prox.				2	18	11%	1	9		3	28	11%
ant. phalange 1: dist.				4	16	25%	1	8		6	25	24%
post. phalange 1: prox.				1	7		0	4		1	11	9%
post. phalange 1: dist.				0	7		0	4		0	11	0%
phalange 2: prox.				4	17	24%	0	7		4	24	17%
phalange 3	0	1		6	21	29%	0	5		6	27	22%

LP Lesion(s) Present; N minimum number of relevant part of element;
artic. articular surface(s); ep. epiphysis (articular surfaces of);
prox. proximal; dist. distal; ant. anterior; post. posterior

It is very clear from Table 11 that the most frequently affected elements are the foot bones (metapodials, tarsals and phalanges) and the glenoid cavity of the scapula.

All of the affected scapulae have fused tuberosities (fusion age = 7- 10 months). The lesions tend to be very irregular in shape, sometimes including pits as well as linear depressions. The periosteum tends to appear to be unaffected and these forms of 'lesions', with the surface of the bone involuted but still intact, may be developmental rather than traumatic. The relatively high incidence in the scapulae is unusual and cannot be explained in terms of immaturity, since all of the ageing evidence suggests that the cattle bones derive overwhelmingly from adult animals. The forms of these depressions in the glenoid cavities are reminiscent of the Type 2 lesions seen in two of the five affected distal anterior first phalanges, and the Type 3 lesions seen in four of the six affected third phalanges, in that the surface is 'creased' rather than 'punctured'.

In contrast, most of the lesions seen on the metapodials and first phalanges (particularly the anterior first phalanges) consist of depressions in the articular surfaces that have very clearly defined edges, as though the top layer of the bone has been excised (although the edges of the depressions are, without exception, rounded and smooth). These Type 1 lesions may have more traumatic origins. The tarsals are particularly severely affected.

Tiny pits (often only 1mm in diameter) are also seen in some of the articular surfaces. Their aetiology is completely unknown, but it may be significant that there is one instance of an articulating joint (a distal metacarpal and a proximal first phalange) in which a pit is located in the corresponding articular surface of each side of the joint. There is a tendency for pits to be located at the distal extremity of a metapodial's condyle, in a central position anterio-posteriorly.

The presence of lesions (of any type) does not appear to correlate with other traits such as splaying or osteochondritis dessicans, nor with evidence for osteoarthritic alterations (such as eburnation and grooving of articular surfaces).

The presence of lesions (of any type) is not confined to cattle bones, but it is more prevalent than it is on the bones of any of the other species represented. It is possible that this is due to the fact that the cattle bones tend to be from adults, whereas those of other species tend to be predominantly from juveniles or adolescents (and, therefore, the cattle bones would have had more time to accrue post-partum alterations). It is also possible that cattle were more susceptible to traumatic joint damage than animals such as sheep and pigs, which are unlikely to have been used for traction or transport. None of the horse articular surfaces have any lesions, but the sample size is extremely small. If the lesions are congenital, of course, then the ages at death are irrelevant. Table 12 lists the examples noted for non-cattle bones.

The pig radius, the sheep proximal metatarsal and the sheep/goat distal tibia articular surfaces have small pit lesions, whilst the sheep distal metatarsal and the sheep distal humerus articular surfaces have Baker & Brothwell's (1980) Type 1 lesions (shallow linear depressions).

Table 12. Incidences of lesions occurring in articular surfaces of non-cattle elements

Element	2nd/3rd C			3rd/4th C			late 4th C			totals		
	LP	N	%	LP	N	%	LP	N	%	LP	N	%
Sheep humerus: dist.	0	3		1	12	9%	0	1		1	16	6%
Pig radius: dist. artic.				1	2					1	2	
S/G tibia: dist. artic.	0	1		1	13	8%	0	1		1	15	7%
Sheep metatarsal: prox.				1	8		0	1		1	9	11%
Sheep metatarsal: dist.				1	22	5%	0	2		1	24	4%

LP Lesion(s) Present; N minimum number of relevant part of element;
S/G Sheep/goat;
artic. articular surface(s);
prox. proximal; dist. distal;

Alterations possibly related to working conditions

Bone, being a living tissue, responds to stresses and strains imposed upon it during life. There is some evidence to suggest that hard work by cattle (such as that incurred during use as traction animals) can result in the splaying of the distal ends of metapodials (Bartosiewicz *et al* 1993), and the splaying of the proximal ends of phalanges is probably a similar response. Splaying may also be related simply to old age. The incidences of splayed epiphyses are presented in Table 13. None of the splaying is particularly severe, and both condyles tend to be affected to approximately the same degree.

Table 13. Incidences of splayed epiphyses of cattle foot bones

Element	2nd/3rd C			3rd/4th C			late 4th C			totals		
	Sp	N	%	Sp	N	%	Sp	N	%	Sp	N	%
metacarpal: dist. artic.	0	2		1	13	8%	1	2		2	17	12%
metatarsal: dist. artic.				4	20	25%	0	4		4	24	17%
ant. phalange 1: prox.				1	18	11%	2	9		3	27	11%
post. phalange 1: prox.				0	7		0	4		0	11	0%
phalange 2: prox.				1	17	6%	0	7		1	24	4%

Sp Splayed; N minimum number of relevant part of element;
artic. articular surface(s);
prox. proximal; ant. anterior; post. posterior

It is notable that all four of the affected distal metatarsals also have evidence of joint surface alteration due to osteoarthritis, in the form of eburnated and/or grooved articular surfaces.

One of these is particularly large and robust, and has an asymmetric shaft that may be associated with the distal splaying. The medial half (MTIII)of the shaft is much deeper anterio-posteriorly than the lateral half (MTIV), and the medial distal condyle is more splayed than the lateral one. There is also some extra bony growth around the distal portion of the shaft, possibly due to infection or to irritation from muscle strain (or a combination of the two). Due to chewing at the distal end and modern breakage of the proximal end, the only conventional anatomical measurement that can be taken is the minimum midshaft diameter (SD=29.7mm). The distal breadth at the fusion line (BFd) is estimated to be approximately 56.4mm (not including the extra bone growth), which is slightly larger than the largest measurable metatarsal (see Appendix 4).

Pitted depressions in the articular surfaces of cattle wrist bones that are probably due to osteochondritis dessicans occur in 22% of the proximal metacarpals (1/2 2nd/3rd C; 2/13 3rd/4th C & 1/3 late 4th C) and 13% of the carpals (1/5 3rd/4th C & 0/3 late 4th C). These are probably caused by impact trauma suffered at the joint.

Occasional cattle bones are noticeably rugose, with exacerbated muscle attachments. Usually, these bones are also rather large in comparison to the others. They include examples of humerus, femur and tibia.

Other post-cranial pathologies

Despite the predominance of mature animals, there are few instances of osteoarthritic alterations to cattle bones. Besides the four affected distal metatarsals, there are two pelvic acetabula (at least one of which is morphologically female) with eburnation and resorption of the articular surfaces. These are both from 3rd/4th Century deposits (incidences = 2/17 3rd/4th C: 12%; 0/11 late 4th C; total = 2/28: 7%).

In addition, a cattle ulna has exostoses around the surface that articulates with the humerus at the elbow. The surface itself is pitted and possibly necrotic.

There are no instances of osteoarthritic pathologies on any bones of any other species.

A cattle-sized thoracic vertebra (almost certainly cattle, rather than horse or red deer) has some slipped articular facets, as though it was displaced slightly during life and became slightly misaligned with its posteriorly adjacent thoracic vertebra. In addition, the caput of a rib is conjoined to its new 'articulation' point on the vertebra by extra bony growth, which also occurs around the edges of the facets that articulated with the anteriorly adjacent thoracic vertebra. Clearly, the spine still retained some flexibility at this point, but it is difficult to assess how painful the dislocation would have been, since the lack of the relevant articulating vertebrae precludes any investigation of whether or not the intervertebral disc or the spinal cord were affected.

One 3rd/4th Century cattle terminal phalange has a rather pitted, open texture on its plantar and dorsal surfaces, but it is unclear whether this is due to immaturity (it is a particularly large bone) or to some slight infection in the foot. A similarly equivocal area of pitted, open textured bone occurs on the distal articulation of a large tibia, whose fusion line is still visible.

Two immature sheep/goat bones (a 3rd/4th Century sheep radius and a late 2nd/early 3rd Century sheep/goat tibia, both distally unfused) have a layer of woven bone overlying the original surfaces of their shafts, indicative of periosteal infection.

A distally fused domestic fowl tibiotarsus, of a size similar to a modern game bantam cockerel, has proliferative bony growth around the distal end of the shaft, although the articulation itself is not affected. The bony growth is very irregular and bridges a major tendon placement. It may be a response to an infection brought on by a slight trauma.

The only example of a fractured bone is a 3rd/4th Century sheep metatarsal that appears (macroscopically and by radiography) to have been broken close to the proximal epiphysis. The fracture is well healed, with only a slight misalignment to the axis of the shaft.

Oral health

Cattle

Periodontal infections are common on the cattle jawbones, but few of them are particularly severe, and the general level of dental health appears to have been good. Two areas are notably affected: the alveoli for the mandibular incisors and the palate of the maxilla. The incisors themselves often show a high degree of wear. Four of the 22 incisors (all permanent teeth) have a transverse groove across the base of the enamel on one of the lateral sides, at its junction with the root. Grooves such as these are sometimes recorded as 'wedge shaped' abrasion and may be due to the drawing of tough vegetable fibres (such as coarse grasses) through between the teeth (Michel 1904, cited in Miles & Grigson 1990). A fifth tooth is worn right down to the base of the enamel. Five of the 12 3rd/4th Century mandibular symphyses show periodontal alteration around the alveoli of the permanent incisors, emphasising the susceptibility of this part of the jaw to problems possibly involving extreme wear, impaction of food and gum disease.

In the upper jaw, two of the nine premaxillae have periosteal alterations, possibly corresponding to infections in the lower jaws (no articulating upper and lower jaws were found). In the maxillae, there is a very high incidence of periodontal alterations to the edges of the palate, along the borders of the cheek tooth alveoli. Fifteen of the 24 3rd/4th Century maxillae (63%) show signs of infection, although it is normally slight rather than extreme.

Despite these high incidences of periodontal infections, possibly associated with high rates of tooth wear, there are very few occurrences of unevenly worn or misaligned teeth. There are no cases of teeth lost during life, nor of abcesses nor of caries.

Taken together with the tooth wear data, the oral pathology suggests that the cattle were basically very healthy, but may have had a somewhat coarse or gritty diet at times, and may have suffered a high incidence of gum disease. Some of the dental alterations may have accumulated over several years in the older animals. None of the animals are likely to have died (or to have required culling) due to poor feeding caused by any dental problems: even the one or two individuals whose teeth had worn right down to the gum level still had perfect teeth.

Sheep/goat

Perhaps relating to the young ages at death of the sheep/goats, there is only one case of oral pathology in a sheep/goat jaw. This concerns the presence of three small areas of raised plaques of woven bone on the horizontal ramus of a young sheep/goat mandible (the P4 was still erupting when the animal died). The plaque bone occurs in patches, two on the buccal and one on the lingual side of the ramus, alongside but not adjacent to the alveoli for the premolars (which were unaffected). The infection appears to have centered on the jawbone itself, rather than on the tooth sockets.

Pig

Many of the pig jaws have tightly packed or overcrowded teeth, sometimes with rotated or impacted fourth premolars. These are traits that are common in Romano-British pig jaws, and they probably relate to the greater reduction in size of the bones compared to that of the dental elements incurred during the process of domestication. Despite the high incidences of jaws affected in this way (3/20 3rd/4th Century mandibles and 2/3 3rd/4th Century maxillae), the teeth themselves and their alveoli appear unharmed and uninfected (although the young ages at death may have helped the animals to avoid any longterm problems).

Horse

One small and well worn lower third molar of a horse has enamel hypoplasia. Unusually, this has only affected the lingual side of the tooth, and may have been caused by localised trauma rather than by malnutrition or disease.

The sieved material

A comprehensive sieving programme recovered animal bones from a large number of contexts, using bulk sediment ('whole earth') samples and 4mm and 2mm mesh. Occasionally, when the amount of animal bone material was comparatively large, pre-screening with 8mm mesh was carried out. Quantities of material recovered are provided in Appendix 8. The same recording system was used for the sieved material as that utilised for the hand-recovered material. Numbers of recorded fragments are presented in Table 14 for Site 452, and Table 15 for Site 482.

The collection overwhelmingly comprises comminuted fragments of bone from sheep-, pig- and cattle-sized animals. Many of the fragments in the smaller fraction (ie that recovered in the 2mm sieves) are highly burned, with mottled grey and calcined white appearance. Much of the smaller fraction is likely to have become incorporated into the sediment as clasts within the matrix, and the degree of contemporaneity of this material with the date assigned to a context's infilling is dubious. However, extremely few of the identifiable fragments appear to be residual. Only one identified bone appears to be intrusive. This is a rat bone from context 118 (Phase 14a, late 4th Century). Although the bone (and another, unidentified fragment from a rat-sized mammal) were stratified within the context, their surface colouration and texture are very different from all of the other material from that context (and, indeed, from the rest of the entire collection). It is extremely unlikely that they derive from a rat that lived in the late Roman period, although a few finds of *Rattus rattus* have been made at other Roman sites in Britain (Armitage 1994).

Perhaps ironically, the most important results obtained from the sieving programme, with respect to the animal bone studies, are all negative ones. Almost no fish bones were recovered (N=14 catalogued fragments), comparatively few bird and small mammal bones, and extremely few acid etched fragments indicative of faecal material.

The few fragments that do appear to have passed through a carnivore's gut tend to derive from toe bones of sheep/goat and pig. They probably derive from dog faeces rather than human faeces (judging by the sizes and appearances of the remains). None of the samples produced more than one or two faecal fragments, and most produced none at all. This suggests that these parts of Catterick (close to the town wall in the later period, and near to the edge of the settlement throughout its occupation) were kept quite clean. Human excrement may have been concentrated in designated latrine features sited elsewhere (or disposed of into the river).

Most of the bones of birds and small mammals that were recovered in the sieved sediment (apart from those of domestic fowl) probably derive from animals that were killed by non-human agencies. Most of the bird bones are highly fragmentary, although none of them appear to be faecal. None of them could be identified to species level, but they probably include at least one small thrush (such as song thrush or redwing) and a small passerine of finch size. It is, of course, quite possible that they were eaten by people, but the numbers involved indicate that, if this were the case, such items formed a very minor and occasional part of the human diet.

Table 14. Distribution of catalogued (sieved) animal bones from CAS Site 452

Phases	0, 1 & 1-4		2 to 4		5 to 14			14a		1 to 14a	15	
Date	Up to cAD 160/ 3rd C		Late 2nd - 3rd C		3rd -4th C			Late 4th C		Total stratified Roman	up to modern	
Species	>4mm	>2mm	>8mm	>4mm	>8mm	>4mm	>2mm	>4mm	>2mm		>4mm	>2mm
Cattle	3			3	8	45		14		73	2	
Pig	2		2	4	1	109		7		125	8	
Sheep/Goat	3		1	2	1	77		16	1	101	11	
(Sheep)	(2)					(3)				(5)	(1)	
Dog						1		1		2		
Rat sp.*								1		1		
Watervole	20	2				3		2	2	29		
Field vole	19	2				2	4		1	28		
Wood mouse		1				2	2			5		
cattle size	1		1		2	12		1		17	1	
pig size			1		1	1		2		5	1	
sheep size				2		17		1		20		
pig/sheep size						7	1		2	10		
watervole size	10	2				2	2	1	1	18		
mouse/vole size	37	10				5	18		3	73		1
domestic Fowl			2	1		11		1		15	3	
Jackdaw								2		2		
fowl size(1)				3		27		2		32	2	
cf. thrush sp.	1							1		2		
cf. finch sp.										0		1
large bird (2)						2		1		3		
small bird (3)						6	3	5		14	2	
Frog							2			2		
Toad						1				1		
Frog/Toad				1		1	5			7		
small vertebrate							4			4		
Catfish	2									2		
cf. Red mullet				1			1			2		
cf. Mullet						1				1		
Herring							1			1		
cf. Wrasse							1			1		
fish sp.		2					1		3	6		
Totals	98	19	7	17	13	332	45	58	13	602	31	2

Notes

	stratified, but preservation condition suggests intrusive
pig/sheep size	foetal bones not identified to species
mouse/vole size	post-cranial bones not identified to species
fowl size(1)	probably fowl, but cannot be identified specifically, due to immaturity and/or incompleteness
large bird (2)	goose size
small bird (3)	up to and including size of fowl

Watervole	*Arvicola terrestris*
Field vole	*Microtus agrestis*
Wood mouse	*Apodemus cf. sylvaticus*
Jackdaw	*Corvus monedula*
cf. thrush sp.	*cf. Turdus sp.*
cf. finch sp.	cf Fringillidae
Frog	*Rana temporaria*
Toad	*Bufo bufo*
Catfish	*Anarhichas lupus*
cf. Red mullet	*cf. Mullus surmuletus*
cf. Mullet	Mugilidae
Herring	*Clupea harengus*
cf. Wrasse	cf. Labridae

Table 15. Distribution of catalogued (sieved) animal bones from CAS Site 482

Phases	2 to 4		5		2 to 5
Date	Late 2nd - 3rd C		3rd C --		Total stratified Roman
Species	>4mm	>2mm	>4mm	>2mm	
Cattle			1		1
Pig	1		2		3
Sheep/Goat	1		1		2
Watervole	1				1
mouse/vole size	1			3	4
fowl size(1)			1		1
salmonid sp.			1		1
Totals	4		6	3	13

The sieved material confirms the paucity of goose bones noted for the hand-recovered collection. The only large bird bones are a few vertebrae, which might derive from small geese. In contrast, bones of domestic fowl were found in the sieved collection, together with bones from birds of similar size, which may well have been domestic fowl (but the remains are too fragmentary and/or immature to be identified specifically).

The only corvid bones recovered from sieved samples are two bones, probably from a single individual, of jackdaw. No raven bones nor bones of any raptor were found.

Many of the small mammal bones were found in clusters, and most of them (if not all) probably derive from owl pellets. The only small mammal species identified are watervole, field vole and woodmouse. These three species are commonly found in pellets from a variety of owl species, and indicate the presence of grassland in the vicinity of the site. Although the site is close to the river, watervoles are not obligatory riverside dwellers, and they used to inhabit most of Britain in habitats similar to those it still occupies in continental Europe.

Despite the proximity of the site to the river, very few bones were found of frogs or toads. This may relate to the nature of the contexts sampled: frogs and toads tend to accumulate in negative features that act as pitfall traps, from which they cannot escape before death. However, even basal ditch deposits contained few frog/toad remains, and the live animals may have avoided the site if there was too much human activity.

The fish bones are extremely scarce (N=14), but rather interesting. All of the identified fragments consist of vertebral centra, with a few unidentified fin rays and other small fragments. There are no bones from the head. This suggests that the fish were brought to the site in a processed form, possibly filleted, and probably preserved in some way such as smoked, dried or salted. The species identified (by Alison Locker) include a surprising variety: mullet (probably red mullet), which is uncommon off the North Yorkshire coast, and which may have been imported from the Mediterranean, catfish, which is in the south of its range off British shores, a Labrid (probably wrasse) and herring. These all came from Site 452. From Site 482, a salmonid bone is the only indication of any exploitation of local fish that could have been caught in the River Swale. None of the fish vertebrae appear distorted by consumption (ie they do not appear to be faecal material).

Of the fragments identified as deriving from sheep/goat and pig, a great number are from juveniles. This confirms the ageing data obtained from the hand-recovered collection. The pig bones include some from very young piglets (some of them foetal rather than neonatal) which supports the suggestion that pigs were raised on site. Some of the young bones are too immature to assign to species and could derive from sheep/goats or pigs. There are also a few neonatal cattle bones but no juveniles, again supporting the age distributions seen in the hand-recovered collection.

The presence of immature bones of pig and sheep/goat leads to an emphasis on these species in the numbers of recorded fragments (see Tables 14 & 15): high numbers of unfused epiphyses exaggerate the relative frequencies of these species. Pig bones are particularly susceptible to this bias in comparison with those of sheep/goats and cattle, due to the greater number of digits on each foot. In one context, 50 fragments of pig bone were recorded, although most of these could have derived from two feet (from two different individuals).

Because of this bias towards young bones and teeth, the relative proportions (based on fragments counts) of cattle:sheep/goat:pig are probably as inaccurate as those obtained from the hand-recovered collection, although in the opposite direction. Table 16 presents the Minimum Numbers of Elements (MNEs) for 3rd/4th Century cattle, sheep/goat and pig bones, in a form exactly comparable to that used in Table 6 for the hand-recovered material. Sample sizes are extremely small, but do suggest that the relative numbers of all three species were quite similar (MNI=2 for each species).

Table 17 then groups these data, together with the MNEs for loose teeth and minor tarsals, into 13 skeletal body zones (loose lower teeth, vertebrae, long bones, phalanges etc). The equivalent hand-recovered data are included for comparison. Elements that are anatomically more frequent in pigs (such as those relating to the feet) have been standardised to be directly comparable to those for cattle and sheep/goat. The data are displayed visually in Figure 10.

The sample sizes are all very small (all are less than MNE=100, even when loose teeth are included) but there are some clear trends. In the sieved collection, all three species have quite high numbers of loose teeth (predominantly lower teeth) and small foot bones. For sheep/goat and pig, phalanges and carpals/tarsals were recovered in far greater numbers in the sieved collection, despite its smaller overall size (N=217.2 *cf* N=957.5). Since the numbers of pig foot elements have been adjusted to take anatomical differences into account, the figures are all directly comparable (ie the ratio of 7:18:28 cattle:sheep/goat:pig phalanges represents the actual number of feet or individuals, not the number of digits, represented).

In contrast, long bones and metapodials are less well represented in the sieved collection (in terms of both relative and absolute numbers). This trend emphasises the bias against the recovery by hand of smaller items, noted by Payne (1975).

The paucity of skull and maxilla fragments from sheep/goats and pigs in both the hand-recovered and the sieved collections suggests differences in butchery patterns (or locations) for cattle compared to the smaller species.

Table 18 presents the relative proportions of catalogued fragments of cattle, sheep/goat and pigs, together with those of domestic fowl, from the hand-recovered and sieved collections from Sites 452 and 482. In order to obtain the maximum sample size for the sieved material, all of the stratified Roman material has been pooled together (Site 452: Phases 0 - 14a; Site 482: Phases 2 - 5).

The differences in the ratios of the three major species are very great, but can be explained by the biases of the methodologies already noted (ie recovery bias against smaller bones, versus the over-representation of juvenile bones and teeth and the over-representation of pig foot bones). In the sieved collection (N=320), the ratios suggest that pigs were the most common of the three species, followed by sheep/goats, with cattle contributing one quarter of the identified fragments. This is in marked contrast with the hand-recovered material, which indicates that cattle contributed well over one half of the catalogued fragments, with sheep/goat considerably more important than pigs.

Table 16: percentage representations of 30 skeletal elements of cattle, sheep/goat and pig based on Minimum Numbers of Elements (MNEs) in the sieved collection from 3rd/4th Century deposits (Site 452: Phases 5-14; Site 482 Phase 5) (compare with Table 6 for hand-recovered data)

		Cattle			Sheep/ goat			Pig		
		MNE	MNE	%	MNE	MNE	%	MNE	MNE	%
ELEMENT	CODE	observed	expected	represent.	observed	expected	represent.	observed	expected	represent.
	Fig 2	(o)	(e)	(o*100/e)	(o)	(e)	(o*100/e)	(o)	(e)	(o*100/e)
horncore*	Hc	-	4	-	-	4	-	-	na	-
skull	Sk	2	4	50	2	4	50	-	4	-
maxilla	Mx	2	4	50	-	4	-	-	4	-
mandible	Md	1	4	25	1	4	25	-	4	-
hyoid	Hy	-	4	-	2	4	50	-	4	-
scapula	Sc	-	4	-	-	4	-	-	4	-
humerus	Hu	-	4	-	-	4	-	1	4	25
radius	Ra	-	4	-	-	4	-	-	4	-
ulna	Ul	1	4	25	1	4	25	1	4	25
carpals	Cp	4	24	17	6	24	25	9	24	38
metacarpal	Mc	-	4	-	2	4	50	2	8	25
pelvis	Pv	1	4	25	1	4	25	-	4	-
femur	Fe	2	4	50	3	4	75	-	4	-
fibula	Fb		na			na		2	4	50
patella	Pt	-	4	-	-	4	-	-	4	-
tibia	Ti	1	4	25	-	4	-	2	4	50
astragalus	As	-	4	-	-	4	-	2	4	50
centro/quartal	Nc	-	4	-	1	4	25	3	8	38
calcaneum	Ca	-	4	-	1	4	25	2	4	50
metatarsal	Mt	1	4	25	1	4	25	-	8	-
1st phalange	P1	3	16	19	13	16	81	11	16	69
2nd phalange	P2	2	16	13	2	16	13	7	16	44
3rd phalange	P3	2	16	13	3	16	19	10	16	63
sesamoids	Ss	4	48	8	3	48	6	1.2	52	2
ribs	Ri	1	52	2	8	52	15	1	52	2
atlas	At	2	2	100	1	2	50	-	2	-
axis	Ax	1	2	50	-	2	-	-	2	-
cerv. vertebrae	Cv	4	10	40	2	10	20	1	10	10
thor. vertebrae	Tv	3	26	12	1	26	4	-	26	-
lumb. vertebrae	Lv	-	12	-	5	12	42	1	12	8
sacrum	Sa	1	2	50	1	2	50	-	2	-
simplest MNI=		2			2			2		
MNE		38			60			54		

horncore* for pig, the fibula is substituted for the horncore

N.B. for pigs, lateral metapodials and their associated phalanges are not included. The 'observed' number of sesamoids has been adjusted accordingly (by a factor of 0.62)

Table 17: A comparison of Minimum Numbers of Elements (MNEs) in the sieved and hand-recovered collections for cattle, sheep/goat and pig dating to the 3rd/4th Centuries, grouped into 13 skeletal body zones (see Figure 10)

		Hand-recovered				Sieved		
body part	**code for Fig 10**	**cattle** MNE	**sheep/ goat** MNE	**pig*** MNE		**cattle** MNE	**sheep/ goat** MNE	**pig*** MNE
skull	sk	14	4	2		2	-	-
maxilla	mx	21	3	2		2	2	-
mandible	md	17	18	16		1	1	-
loose teeth (upper)	up	63	18	0		9	5	5
loose teeth (lower)	lw	27	17	12		11	13	16
vertebrae (inc. sacrum)	vt	58	10	4		11	10	2
ribs	rb	47	67	28		1	8	1
scapula/innominate	sp	48	30	12		1	1	-
long bones	lb	45	89	47		4	4	4
carpals/tarsals	ct	26	0	1		4	8	16*
metapodials	mp	41	69	7.5*		1	3	1*
phalanges	ph	87	4	1		7	18	28
sesamoids	ss	2	0	0		4	3	1.2*
Totals		496	329	132.5		58	85	74.2

Notes relating to which elements are included in the groups, and to the methods for making pig skeletal element counts compatible with those for cattle and sheep/goat:

- skull: horncores are not included.
- loose teeth: pig upper incisors and canines are not included in these counts. (Three deciduous and four permanent pig upper incisors were recovered.)
- vertebrae: atlas, axis, cervical, thoracic and lumbar vertebrae are included, together with the sacrum. Caudal vertebrae are not included.
- long bones: humerus, radius, ulna, femur and tibia. Pig fibula is not included.
- *carpals/tarsals: numbers of pig tarsals (other than astragalus and calcaneum) have been adjusted by a factor of x 0.62.
- *metapodials: for pigs, only metapodials II and III were included. The total was then divided by 2 to make it comparable to those for cattle and sheep/goats.
- phalanges: for pigs, only phalanges associated with metapodials II and III were included.
- *sesamoids: observed numbers have been adjusted to take into account the fact that only digits II and III are considered here.
- the hyoid, sternebrae, patella and lateral malleolus are not considered in this table.

The other domestic species likely to have contributed to the diet of people living at Cataractonium is the domestic fowl, which would have provided eggs as well as chicken meat. Table 18 demonstrates how the bias against small bones affected its representation in the hand-recovered collection. When considered together with the three major domesticates, fowl provided 5% of the identified bones. Although this is still a very small proportion of the total, it is notably greater than its 2% representation in the hand-recovered material. If the bones of sheep/goat and fowl are compared, the ratio changes from 17:1 in the hand-recovered collection to 7:1 in the sieved material, indicating a severe under-representation of fowl in the hand-recovered collection (the ratio of cattle:fowl bones changes from 35:1 to 5:1, whilst the ratio of pig:fowl bones remains stable at 9:1 in both collections)

Figure 10. Bar graphs of Minimum Numbers of Elements (MNEs) in the sieved and hand-recovered collections for cattle, sheep/goat and pig dating to the 3rd/4th Centuries, grouped into 13 skeletal body zones (see Table 17 for key)

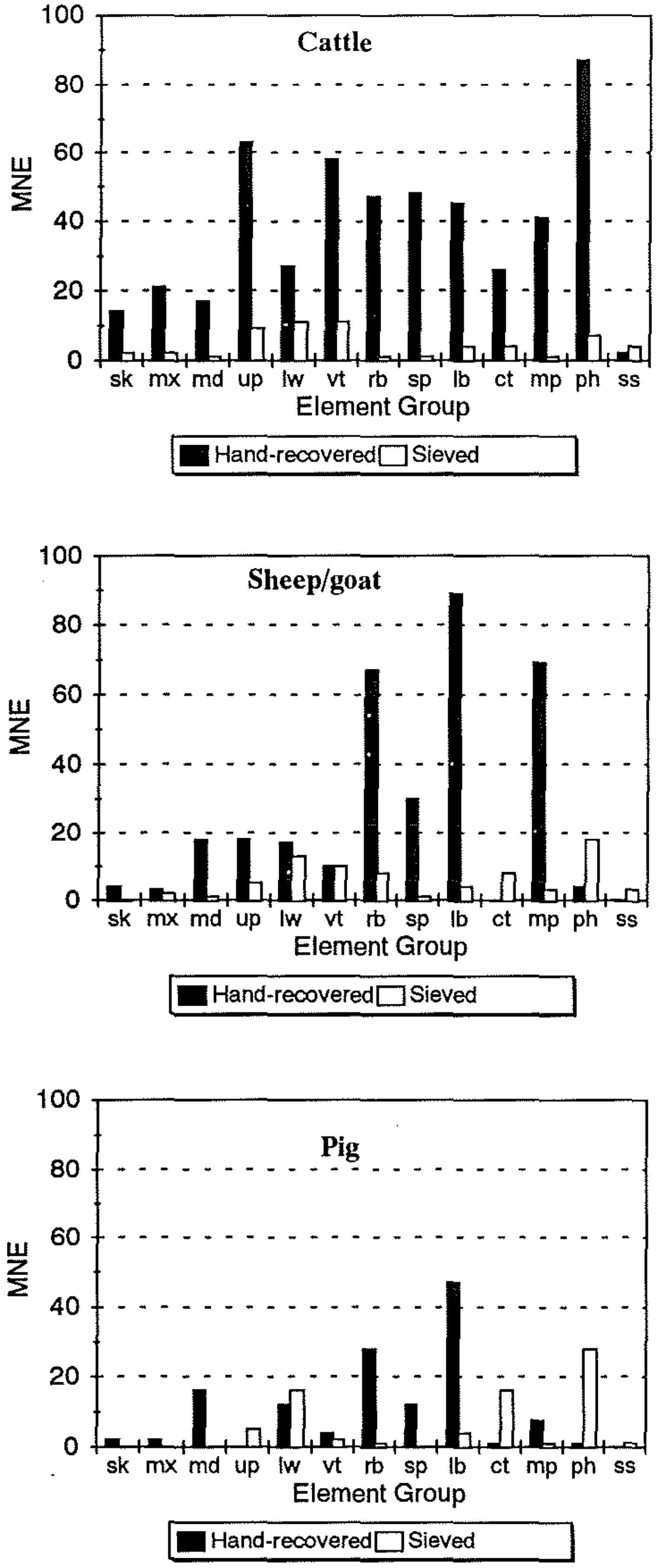


Table 18. Percentage frequencies of domestic food species (cattle, sheep/goat, pig and domestic fowl) in the total hand-recovered and sieved collections for stratified Roman deposits at Site 452 (Phases 0 - 14a) and Site 482 (Phases 2 - 5)

	Hand-recovered				Sieved		
	N	%	%		N	%	%
Cattle (C)	802	57%	57%		74	24%	23%
Sheep/goat (S/G)	394	28%	28%		103	34%	32%
Pig	199	14%	14%		128	42%	40%
C + S/G + Pig	**1395**				**305**		
domestic Fowl	23		2%		15		5%
Grand Totals	**1418**				**320**		

Partial skeletons and other unusual deposits

Three deposits of partial or substantially complete animal skeletons were recovered from Site 452, and the bones from these have been kept separate from the preceding discussions and counts of bones deriving from butchery and consumption refuse. Details of these remains are given in Appendices 9, 10 and 11.

A complete dog skeleton (Skeleton No. 6651) was found in a context dated to Phase 14a (late 4th Century) but the excavator noted that it might have been intrusive, given the disturbed nature of the layer immediately overlying it. The preservation of this skeleton is excellent, and very unlike that of the bones from any other context (apart from the waterlogged material from context 500, which has a very different colour). The evidence is inconclusive, but tends to suggest that this may be a relatively recent burial. The recovery of small bones (such as sesamoids) from this burial was meticulous, and the absence of a baculum (penis bone) in the recovered collection is probably genuine, indicating that this dog was female. The teeth are all fully erupted but there is only light wear on the tips of the carnassials, suggesting that the animal was still relatively young. All of the long bone epiphyses are fused, including those of the fibula (which fuses by about 18 months). All of the vertebral epiphyses are also fused, but only about 40% of the pubic symphysis is closed and, although the sciatic tuberosities of the ischia are fully fused, the tuber coxae of each ilium is only fused for half-way along its length. The animal may, therefore, have been only a couple of years old when it died, supporting the dental evidence for a young adult. Measurements have been taken following Driesch (1976) and Harcourt (1974) whose formulae have been used for calculating skull shape indices and shoulder height (see Appendix 9). Even if the skeleton cannot be dated with absolute certainty to the late 4th Century, the measurements form a useful set of reference data for a complete dog skeleton. The dog was quite large with long slender legs, and had a long narrow skull with a long narrow muzzle (possibly resembling a modern collie-type sheepdog). The calculated withers heights range considerably, from 523 - 544 mm, which emphasises the problems of applying a single set of formulae to animals that vary so greatly in size and conformation. Compared to the reference skeletons from which Harcourt obtained his formulae, the Thornbrough Farm dog has rather short upper limb bones compared to those from the lower limbs, and rather longer hind legs in relation to the forelegs. There are no indications of any cutmarks on any of the bones, and the only indication of any pathology is a slightly collapsed proximal epiphysis on the second lumbar vertebra. The premolar teeth are very well spaced apart, although the molar teeth do touch each other without impacting at all. The cause of death is unknown, but could have been due to some rapidly terminal disease such as distemper.

Alternatively, the dog may have been destroyed because of unacceptable behaviour, such as sheep worrying.

Context 765 (Site 452, Phase 14a, late 4th Century) contained a well preserved and complete juvenile cattle skeleton (see Appendix 10). The epiphysial fusion and tooth eruption and wear data suggest that the calf was between five and ten months old when it died. The relative degree of fusion of the epiphyses of the elbow (distal humerus and proximal radius) appears to be slightly in advance of that expected, given the totally unfused nature of all other epiphyses (see Appendix 10). The lack of any skinning or butchery marks on this skeleton, plus its complete state, suggest that the animal died of a noxious disease and was buried for reasons of hygiene. The morphology of the pelvis suggests that the calf was male. A few measurements were taken, although it should be remembered that the calf bones are very unlikely to have attained full size in any of their dimensions. Despite the immaturity of the bones, the measurements taken (for the distal condyle of the humerus, the astragalus and the metapodials) all indicate that the calf, although still very young, was quite large compared to the adults whose bones have been measured (see Appendix 4). Howard's shape indices are inappropriate for immature bones, since the metapodials continue to broaden after they have attained their full length, but the total lengths of the metapodials (including the unfused epiphyses) indicate that the calf was comparatively large, even if it had not actually attained the estimated withers height of >1.25 metres (see page 25 regarding the relative contribution of metapodials to overall height). The skull has two very small scurs in place of horncores, but it is not clear whether the calf was naturally hornless or had been dehorned after birth. The general conformation of the bones appears 'normal' for Romano-British livestock and, despite the unusually good preservation of these bones and their rather large size (considering their stage of development), there is no zoological reason to doubt their Roman provenance.

The articular surfaces of the calf bones were searched for signs of lesions. Several surfaces contain small pit-type lesions, Type 2 or Type 3 lesions, or creases along the lines of fusion of separate ossification centres. Given the young age at death of this calf, and the extreme improbability that it was put to use for traction or other heavy work, these traits are considered to be congenital or developmental in origin. The total absence of Type 3 lesions (the shallow depressions forming irregularly-shaped linear 'creases' in articular surfaces) that have sometimes been noted (either in isolation or in association with osteoarthritic alterations to joint surfaces) on more mature cattle bones in this collection may be an indication that Type 3 lesions have a different aetiology, possibly being related to physiological stress. This is, however, a speculation based on the observation of frequencies of occurrence, and research on modern animals of known genetic stock and lifestyle is required in order to test the hypothesis.

Context 249, dating to Phase 9 at Site 452 (3rd Century) contained head remains from two adult cattle plus six butchered cattle scapulae (see Appendix 11). The two skulls are very similar in size, conformation and maturity, and both probably derive from large castrates (based on size and conformation of the skulls and of the horncores). The tooth wear indicates that they were mature adults, but their dentition was good (apart from some periosteal infection along the palatal borders) and the teeth were not yet worn down to the gumline. A pair of mandibles probably belongs with the skull of 'Cow 2', and gives Mandibular Wear Scores of 43 and 44. Although both skulls have been broken across their frontals, at the level of the orbits, and both skulls have had their horncores broken off, they are both more or less complete, and neither has any definite cutmarks on them. How they came to be deposited is unknown. The occipital condyles are all intact and show no signs of decapitation. Although this can be achieved by butchery through the atlas, no atlas vertebrae were recovered with the skulls. The skulls both appear to have been broken deliberately, possibly with some force. This makes a motive associated with ritual less likely (foundation deposits are usually placed in a cut feature in an intact state).

The six more or less complete cattle scapulae found in the same context are likely to be butchery waste. All of the bones have been butchered with heavy metal tools around the glenoid, neck and spine, although there are no signs of subsequent meat removal (which can be achieved easily once the meat has been cooked, without leaving any knife marks on the bones). The pattern of butchery is systematic, but is not one that is typical of military sites, and there are no hook holes in the blades of the bones. None of the scapulae form pairs, and they probably do not relate to the skulls except for the fact that they were finally deposited into the same feature.

What were the animals used for?

Food supplies

The frequencies of butchery marks on bones of certain species indicate that the carcases of cattle, sheep/goat, pig and domestic fowl were prepared for consumption (see Appendix 12). In contrast, there are no cut marks on any of the bones identified as horse or dog, which probably suggests that they were not utilised for meat.

The most frequently butchered bones are those of cattle, plus cattle-sized ribs and vertebrae. These are also more commonly chopped with a cleaver-type tool rather than cut with a knife. In contrast, fewer bones of sheep/goats or pigs (and similar sized ribs and vertebrae) bear butchery marks, and these tend to be knife cuts rather than chopmarks. These differences probably reflect functional requirements: an adult cattle carcase is several times larger than that of an adult sheep or pig (let alone an immature one) and requires a greater degree of butchery in order to reduce it to comparable portions for sale or food preparation. Fowl bones are more likely to have received knife cuts during consumption or whilst being prepared for cooking, since these birds are unlikely to have been butchered into portions smaller than an entire carcase for sale or distribution.

Other species, represented by occasional bones (eg hare, wild birds, fish and small mammals) may have been exploited by people for food, but are unlikely to have contributed significantly to the diet.

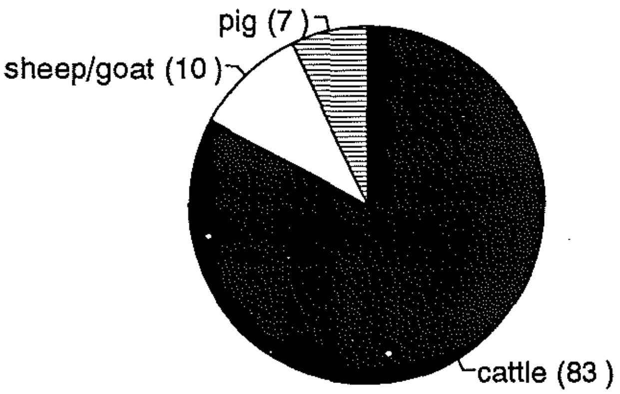
The relative contribution of fish to people's diet is difficult to estimate. The paucity of fish bones, even in the sieved collection, suggests that fish were rarely consumed, but it is possible that filleted fish were imported (these, of course, would have left no trace in the bone record at this site).

Similarly, the contribution of domestic fowl is difficult to assess. Eggs may have been more important than meat from adults. The presence of a few bones of immature birds, very probably domestic fowl, in the sieved collection suggests that fowl were raised at the site, rather than brought in as carcases or birds ready to slaughter for cooking. The sieved evidence suggests that fowl bones are under-represented in the hand-recovered collection, but that they still formed only a small minority of domestic food species. In terms of food supply, hens' eggs and chicken meat probably comprised a very minor part of people's diets. However, these food items may have been highly prized, both for their own nutritional qualities and tastes, and as a relief from the more frequently available meat of the domestic animals.

Given these methodological and taphonomic problems, together with the small size of an individual fowl carcase in terms of meat provision, fowl have not been included in Figure 11. This presents the relative proportions of meatweights provided by cattle, sheep/goat and pigs represented in the 3rd/4th Century hand-recovered collection. This exercise is considered valid since the elemental representation of all three species indicates that whole carcases are represented at the site, not just joints of meat. It is based in the Minimum Numbers of Individuals (see Table 4) multiplied by meatweights obtained by the author from modern animals of comparable types (Dexter cattle, Soay and Manx Loghtan sheep, and Tamworth pigs and wild boars).

Figure 11 indicates that cattle overwhelmingly provided the bulk of the meat supply (83%), with sheep/goat and pig contributing relatively little (10% and 7% respectively). Since the ageing data indicate that almost all of the cattle carcases came from mature individuals, whilst many of the sheep and pigs would not have attained their full adult size, this emphasis on the contribution from cattle is, in fact, likely to be an under-representation of the importance of beef in the diet.

Figure 11: estimated meatweights (in percentages) for cattle, sheep/goat and pig from 3rd/4th Century deposits



The relative proportions of cattle, sheep/goat and pig bones in the hand-recovered collection are extremely similar to those seen at various other Roman sites in northern England, whether military or civilian in nature (see Stallibrass 1991 & 1993 for examples). Although species ratios cannot be utilised to distinguish military from civilian occupation deposits in this region, military refuse is sometimes characterised by specialist butchery patterns of cattle bones. The collection from Thornbrough Farm relating to the Antonine fort is small and does not contain any obvious military bone debris (N=48 cattle bones). The 3rd/4th Century collection (N=567 cattle bones) is sufficiently large that military style butchery patterns would be expected to be present, if the military had been in control. Such patterns include multiple trimming blows with a cleaver around the glenoid cavity of the scapula, long thin rectangular holes through cattle scapula blades (thought to indicate piercing for hooks to hang shoulder blades covered with meat whilst it becomes preserved through drying or smoking) and the longitudinal splitting of cattle longbones (thought to relate to the extraction of marrow). None of these traits is present in the Thornbrough Farm material. In addition, military material often contains a superabundance of cattle scapulae. This is also not the case at Thornbrough Farm. One context (context 16, Phase 13) did contain several cattle scapulae, together with several cattle maxillae from mature and elderly animals. This probably represents specialist butchery waste, but it does not indicate any military influence. The late 4th Century material is quite a small collection (N=181 cattle bones) and is similarly devoid of any indications of military processing debris.

Ironically, although cattle would have provided most of the available meat represented at the site, their age and sex ratios suggest that they were raised primarily for other purposes. It is also quite possible, if not probable, that young animals of prime beef age were exported for consumption elsewhere (probably at military installations).

In contrast, the sheep/goats and pigs were raised almost exclusively as meat providers.

Other products

The cattle represented at the site include approximately equal numbers of females and males (including some castrates and some entire males) and were predominantly fully mature, if not very mature, when they died. The females were probably utilised as breeding stock, providing calves to replace the herd or to fatten up for trade elsewhere as beef stock. Both females and males could have been used as traction animals, and the presence of some splayed distal metapodials indicate that some individuals were used in this way, although none of the alterations are particularly severe, and the low incidence of pathology indicates that animals were generally well looked after.

Skinning marks are very common on the metapodials and some other cattle foot bones. Given the high demand for leather from cattle skins by the Roman military (besides any civilian needs), it is very likely that hides were valued and removed for processing. However, there are no indications in this collection of any specialised deposits of tanning waste (ie cattle toe bones), and so the processing must have been undertaken elsewhere (possibly, but not necessarily, at Catterick itself). A possible location at Catterick lies on the other (north) bank of the river. This is much lower lying, facilitating the use of water directly from and back to the river, and is also located close to the road where it crossed the river. Tanning produces very noxious waste, and tanneries are traditionally located at the edges of settlements, close to water supplies.

Approximately half of the cattle horncore fragments have been chopped through or into at their base, indicating that horns were removed for processing, but no deposits of specialist waste are present in the excavated material. Again, any such processing must have been undertaken elsewhere.

Although the sheep/goats and pigs were kept predominantly to provide meat, they would also have supplied valuable dung for fertilising the arable fields that were presumably associated with the settlement, and the sheep could have provided a clip of wool each before they were killed. Skinning marks on metapodials indicate that sheepskins were used.

The sheep and cattle were probably kept outside the settlement, at least during the daytime, but the pigs may have been kept in sties or yards (or left to roam the streets), and they could have provided a useful street cleaning and refuse disposal service.

The horses and dogs were almost certainly kept as working animals (although some of the dogs might have been pets as well). The horses could have worked as pack animals or draught ponies. The dogs are most likely to have been used for herding or guarding livestock and other property. None of the dog remains are from large, slender animals that might have been used as hunters.

Many of the other species represented in the collections may have been commensals (eg the jackdaw) or incidental residents of local habitats, not relating directly to the human occupation of the site.

Summary and conclusions

The animal bones recovered from excavations of Roman period deposits at Thornbrough Farm, Catterick, are, in many ways, typical of Romano-British material from the north of England.

The hand-recovered and sieved collections are both dominated by the bones of cattle, sheep and pigs. Cattle bones dominate the hand-recovered material. The sieved collection indicates that cattle are over-represented, but beef clearly contributed by far the greatest quantity of meat to the diet.

The age distributions suggest that beef cattle may have been exported from the site, leaving mainly mature adults to be consumed, whilst sheep/goat and pigs were slaughtered overwhelmingly as immature individuals and appear to have been raised almost exclusively for home consumption as meat animals.

The health of the animals, even the elderly cattle, appears to have been very good, suggesting careful husbandry.

The sizes and conformation of the cattle bones are very variable. At least some of this must be due to the presence of a mixture of cows, castrates and entire male animals. The castrates, in particular, may have appeared very different in size and robusticity, but it is also possible that more than one type of livestock is represented. The average measurements of the bones tend to be slightly higher than normal for Romano-British stock, and the ranges are also rather large. There may be a mixture of indigenous 'Celtic shorthorn' cattle and larger, 'improved' cattle (either bred up through selection and good husbandry from indigenous stock, or imported to this part of Britain from elsewhere in the Roman Empire).

There are significant incidences of congenital dental abnormalities of cattle jaws and teeth, and of small lesions in the articular surfaces of cattle foot bones. The latter may be congenital or may be traumatic, in which case they may relate to the incidence of splayed metapodials thought to be caused by the use of cattle as traction animals.

Other species were utilised to very little extent. Despite the extensive sieving programme, almost no fish bones were recovered. Those that are present are probably the remains of preserved sea fish imported to the site, despite the location of the settlement on the bank of the River Swale.

Almost no birds were exploited, except domestic fowl which contributed a very small, but probably significant, proportion of the food supply.

None of the material indicates utilisation by military personnel.

The paucity of faecal material from any of the contexts suggests that standards of cleanliness were high, and that disposal of such waste was well organised.

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Sue Stallibrass

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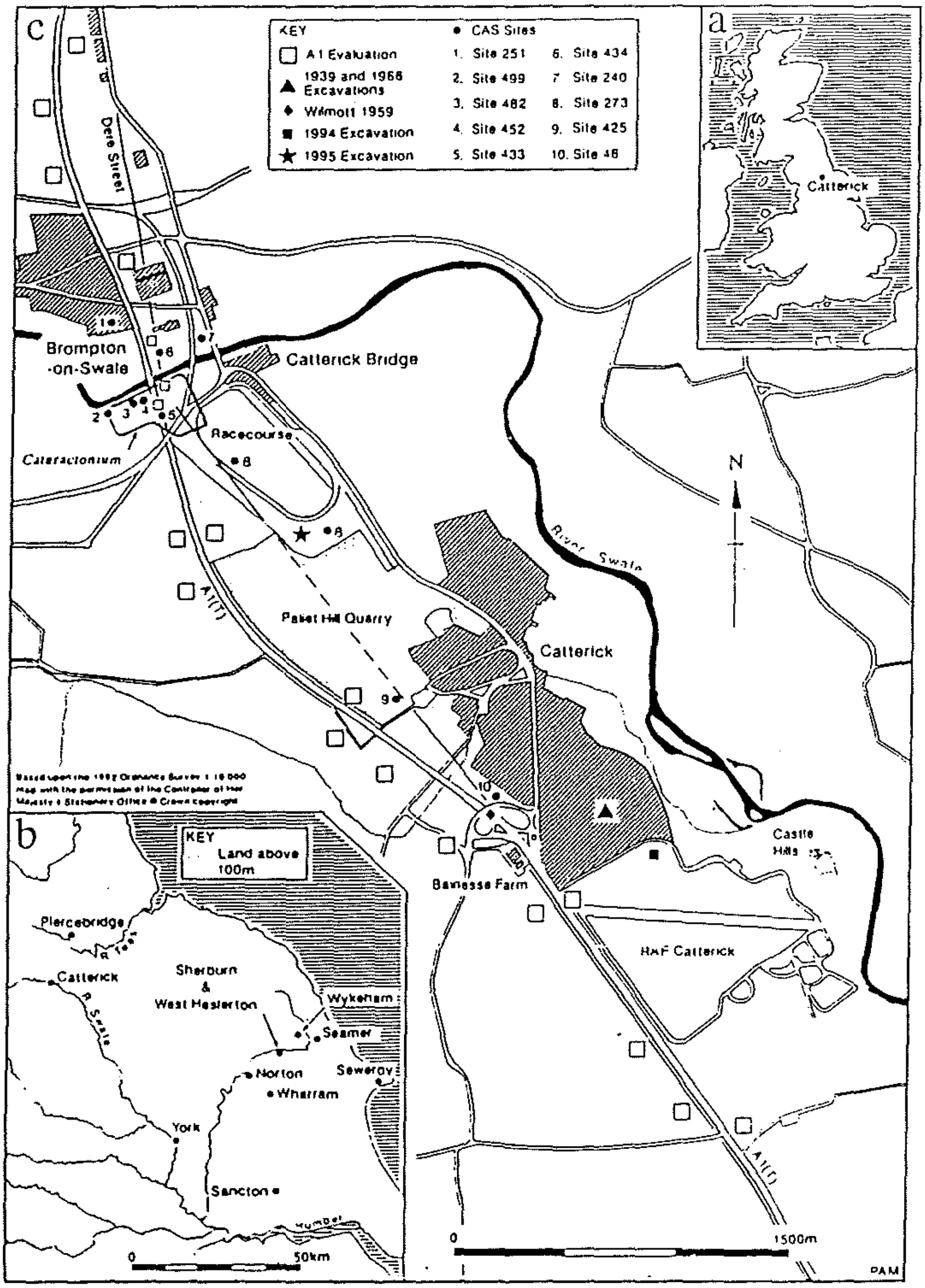
Figure 1: Location maps for Thornbrough Farm, Catterick, West Yorkshire. CAS Sites 452 & 482



APPENDIX 1: quantities of hand-recovered animal bones from Sites 452 and 482

Site 452

Phase	Date	No. of Contexts		Weight (g)	% weight		No. of Fragments	% fragments
0	natural/buried soil	1		354	1%		1	0%
1 & 1-4	up to c AD 160/3rd C	7		546	1%		51	1%
2 to 4	late 2nd - 3rd C	13		3391	5%		155	4%
5 to 14	3rd - 4th C	112		48175	77%		2916	68%
14a	late 4th C	17		8707	14%		1004	24%
(Total	**stratified Roman)**	**(149)**		**(60819)**	**(97%)**		**(4126)**	**(97%)**
15	up to modern	10		1416	2%		138	3%
Grand	**Totals**	**160**		**62589**			**4265**	

Site 482

Phase	Date	No. of Contexts		Weight (g)	% weight		No. of Fragments	% fragments
2	cAD 160-200	5		217	9%		20	10%
3	late 2nd C +	2		470	19%		38	19%
4	late 2nd/early 3rd C	4		784	31%		71	36%
5	3rd C --	6		759	30%		58	30%
6	18th/19th C?	1		280	11%		8	4%
	TOTALS	**18**		**2510**			**195**	

APPENDIX 2: the anatomical zones recorded for this collection

In each case, the zone is recorded if more than 50% of it is present.

Each fragment is only counted once in the tables of identifications, regardless of how many zones are present. The zone information has been used to calculate minimum numbers for each element, in order to compare the relative frequencies of the skeletal elements.

A loose epiphysis counts as a zone, and a note is made in the database if it refits an unfused metaphysis. In that case, the two fragments (epiphysis and metaphysis) contribute a single occurrence of a zone in counts of Minimum Numbers of Elements.

any fragment not retaining any of the zones listed below has not been included in any of the bone counts. The only record of these fragments is in the bone weights.

1. For all long bones (including metapodials), each proximal or distal end is recorded (either as a fused epiphysis or as an unfused metaphysis), and the midshaft is also recorded if present.
2. Vertebrae are recorded in the same way.
3. The proximal articulation of each rib is recorded.
4. Any fragments of carpals, tarsals, the patella, sesamoids and phalanges are recorded once, regardless of whether or not they are complete. In practice, they are always either complete or substantially so (ie: >50% is present).
5. Each Loose tooth is recorded if more than 50% is present (loose pieces of enamel are not recorded). First and second molars of cattle and sheep/goat are not differentiated (other than into upper $M^{1/2}$ and lower $M_{1/2}$) and cannot, therefore, be used for estimates of Minimum Numbers of Elements.
6. For the humerus, the presence of the deltoid muscle attachment is recorded (since proximal epiphyses survive so rarely), as is the apex of the olecranon fossa (since distal humeri of cattle are so frequently damaged by butchery in Roman military assemblages).
7. Similarly, for the femur, the supracondylar fossa is recorded, since the distal epiphysis has poor survival.
8. For the scapula, the glenoid and the neck are recorded as two separate zones. In effect, the neck is recorded if the muscle attachment is more than 50% present.
9. For the pelvis, the acetabulum is recorded if the ilial segment is present; the ilium is recorded if the midpoint of the shaft is present, and the ischium and pubis are recorded in the same way.
10. For the mandible, the coronoid, forms one zone, the condyle forms another, the angle a third, the tooth row a fourth (if it retains the alveolus for dp_4/P_4 and/or M_1), the diastema a fifth, and the symphysis a sixth. Individual teeth *in situ* are not counted as individual zones.
11. For the skull, the basioccipital, orbit, zygomatic arch and maxilla (retaining the alveolus for dp^4/P^4 and/or M^1) each forms a separate zone (isolated maxillae are recorded in the same way)
12. For a horncore, the base, midpoint and tip are each recorded. Judging the midpoint is slightly subjective, but has been found to be effective in separating out those horncores that have been chopped through near the base from those that are substantially complete but which have had their tips broken off.

APPENDIX 2 (continued)

List of abbreviations used in figures for anatomical elements.

Hc	Horncore
Sk	Skull
Mx	Maxilla
Md	Mandible
Hy	Hyoid
Sc	Scapula
Hu	Humerus
Ra	Radius
Ul	Ulna
Cp	Carpals
Mc	Metacarpal
Pv	Pelvis (innominate)
Fe	Femur
Pt	Patella
Ti	Tibia
As	Astragalus
Nc	Naviculo-cuboid
Ca	Calcaneum
Mt	Metatarsal
P1	1st Phalange
P2	2nd Phalange
P3	3rd Phalange
Ss	Sesamoids
Ri	Ribs
At	Atlas vertebra
Ax	Axis vertebra
Cv	Cervical vertebrae
Tv	Thoracic vertebrae
Lv	Lumbar vertebrae
Sa	Sacrum

Appendix 3. Mandibular tooth wear stages and selected tooth eruption traits for cattle, sheep/goat and pig

MWS: Mandibular Wear Score (estimated scores suffixed by an '?')

3.i: Cattle teeth

cAD 160 - early 3rd Century

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
	33.8	g	0	2
35	30.7	d	*P_4 erupts*	*at 28-36 mths*

3rd/4th Centuries

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
1			4	13
33?	35.2	b/d		
39?	35.5	g		
	35.6	g		
42	39.1	h		
45	38.9	k		
45	40.1	k		
46?				
47	36.4	k[1]		
		k		
52		l		

k[1] this tooth, which is definitely cattle not red deer, has interlobar pillars between the cusps on the labial side

late 4th Century

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
		g/h[1]	0	4[1]
		h[1]		
	35.1	k		

g/h[1] this M_3 only has two columns;
h[1] this M_3 has no interlobar pillars and the wear stage may be an underestimate
4[1] one P_4 is still in the process of erupting

3.i: Cattle teeth (continued)

up to modern

MWS	M_3 length	M_3 wear stage
	33.2	b
	32.9	f
	37.0	g^1

no. of dp_4s	no. of P_4s
0	2

g^1 this M_3 has no interlobal pillars and the wear stage is probably an underestimate. The degree of wear suggests that a stage of 'k' or 'l' might be more appropriate

3.ii Sheep/goat teeth

cAD 160 - early 3rd Century

MWS	M_3 length	M_3 wear stage
23		erupting
		visible
34	18.6	d

no. of dp_4s	no. of P_4s
3	3[1]
P_4 erupts	*at 21-24 mths*

3[1] one P_4 is still in the crypt, and one is only ½ up

3rd/4th Centuries

MWS	M_3 length	M_3 wear stage
4		
9		
9		
11		
12		
12		
16		
21		visible
21		visible
22		visible
22		crypt/visible
23		crypt
		a/b
	20.8	f
	21.1	g

no. of dp_4s	no. of P_4s
17	3[1]

3[1] two P_4s are still in their crypts

late 4th Century

MWS	M_3 length	M_3 wear stage
4		

no. of dp_4s	no. of P_4s
3	0

up to modern

MWS	M_3 length	M_3 wear stage
24		erupting

no. of dp_4s	no. of P_4s
1	1

3.iii: Pig teeth

N.B. the lower canine sex ratio includes counts of teeth *in situ*, empty alveoli and loose teeth that do not fit an empty alveolus from the same context
(no attempt has been made to fit loose teeth with alveoli from different contexts);
the permanent lower canine erupts at *c.* 8 - 12 months

cAD 160 - early 3rd Century

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
8			1	2[1]
		c	*P_4 erupts*	*at 12 - 16 mths*

2[1] one P_4 is at wear stage 'a', the other is broken.

lower canines: 1MALE

3rd/4th Centuries

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
10		not formed	2	10[1]
17		crypt		
21		erupting		
21?				
22		visible		
22		visible		
	31.3	visible		
	34.3	visible		
23		erupting		
	25.3	a		

10[1] all ten P_4s are at wear stages between 'unworn' and 'b'

lower canines: 4 FEMALE : 4 MALE

late 4th Century

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
		crypt	0	0
		a		
37		b		

lower canines: 1 FEMALE

up to modern

MWS	M_3 length	M_3 wear stage	no. of dp_4s	no. of P_4s
			0	1

Appendix 4. Measurements of cattle bones

Element	Zones	TF	GLP	LG	BG	SLC	PHASE	DATE	Notes
scapula	PN	TF	63.3	54.0		45.0	3	cAD160-early 3rd C	
scapula	PN	TF				50.9	4	cAD160-early 3rd C	
scapula	N					15.6	14	3rd-4th C	NEONATAL CALF SCAP DAYS/WEEKS
scapula	PN					40.9	5	3rd-4th C	
scapula	PN	TF				42.7		unphased (3rd/4th)	
scapula	PN	TF	63.2			47.3	7	3rd-4th C	LINEAR CREASE IN GLENOID
scapula	GN	TF				50.8	13	3rd-4th C	
scapula	GN	TF				51.0	13	3rd-4th C	
scapula	GN					51.0	13	3rd-4th C	
scapula	GN	TF				51.8	13	3rd-4th C	
scapula	PN	TF			49.2	51.8	5	3rd-4th C	LESIONS IN GLENOID
scapula	PN				52.3	54.9	13	3rd-4th C	LARGE
scapula	PN	TF	80.1		52.7	55.9	7	3rd-4th C	LINEAR CREASES IN GLENOID
scapula	GN	TF				58.4	13	3rd-4th C	
scapula	PN	TF		52.0	41.5	45.3	13	3rd-4th C	
scapula	PN	TF	57.8	53.0	42.9	42.4	12	3rd-4th C	
scapula	PN	TF		54.8		51.6	7	3rd-4th C	CREASES IN GLENOID
scapula	PN	TF		58.1			14	3rd-4th C	
scapula	PN	TF		58.4		52.2	8	3rd-4th C	LESIONS, CENTRE OF GLENOID
scapula	PN	TF	70.5	59.8	46.9	53.2	8	3rd-4th C	LINEAR LESION IN GLENOID
scapula	GN	TF		63.2		56.5	13	3rd-4th C	
scapula	PN	TF	76.1	63.5	50.4	56.9	7	3rd-4th C	MINOR LESION GLENOID
scapula	PN	TF	73.5	63.9	54.3	55.7	11	3rd-4th C	
scapula	PN	TF		66.5			7	3rd-4th C	
scapula	PN	TF	80.8	67.5	58.6	60.6	5	3rd-4th C	LINEAR LESION ACROSS GLENOID

TF Fusion of the supraglenoid Tuberosity

3rd/4th C
(excluding neonatal example of 15.6mm)

N	20
average	51.5
minimum	40.9
maximum	60.6
Std. Dev.	5.32

Element	Zones	Greatest basal diameter	Least basal diameter	Basal circumf.	Length of outer curvature	PHASE	DATE
horncore	BMT	49.3	38.2	140	115	4	cAD160-early 3rd C
horncore	BMT	40.6	25.8	109	84	11	3rd-4th C
horncore	BMT	46.7	34.8	135	133	7	3rd-4th C
horncore	BMT	49.5	33.6	134	121	7	3rd-4th C
horncore	BMT	56.8	38.9	156	122	13	3rd-4th C
horncore	BMT	56.8	40.8	156		13	3rd-4th C
horncore	BMT	58.3	34.3	148	100	7	3rd-4th C
horncore	BMT	62.0	47.4	170	132	13	3rd-4th C
horncore	BM	62.0				7	3rd-4th C
horncore	BMT	63.7	47.7	181	206	9	3rd-4th C
horncore	BM	76.7				7	3rd-4th C
horncore	BM	78.1	55.6	220		7	3rd-4th C

Appendix 4. Measurements of cattle bones

Element	Zones	DF	SD	BT	HTg	HTl	PHASE	DATE	Notes
humerus	TFMYD	DF	25.8	64.4	45.8	31.2	4	cAD160-early 3rd C	
humerus	YD	DF			47.4	33.4	13	3rd-4th C	
humerus	MYD	DF				35.0	8	3rd-4th C	
humerus	YD	DF		79.0	49.0	36.2	14	3rd-4th C	OLD BREAK FITS BELOW
humerus	D	DF		64.7		26.3	14 a	late 4th C	LESION IN D ARTIC
humerus	YD	DF			38.6		14 a	late 4th C	
humerus	MFY		18.8				14 a	late 4th C	VERY YOUNG ?WEEKS/MONTHS

HTg greatest height of distal trochlea (Legge & Rowley-Conwy's 1988 HT)
HTl least height of distal trochlea (Legge & Rowley-Conwy's 1988 HTC)

Element	Zones	Fusion	Bp	BFp	Dp	SD	Bd	BFd	Dd	GL	PHASE	DATE	Notes
radius	PFMD	PF DUF				28.8					8	3rd-4th C	?RICKETS, YOUNG CATTLE RADIUS
radius	PFM	PF	68.3	65.1		33.4					8	3rd-4th C	
radius	P	PF	68.4	63.0							7	3rd-4th C	
radius/ulna	PFMD	PF DFsg			40.4	40.2	73.6	69.2	45.2	274	8	3rd-4th C	MEASURES = RADIUS
radius	P	PF	67.6	66.0	39.8						15	up to modern	

Appendix 4. Measurements of cattle bones

Element	Zones	DF	Bp	Dp	SD	Bd	BFd	Dd	GL	PHASE	DATE	Notes
metacarpal	PMD	DUF	42.3	24.0	19.4		39.9			1	up to c AD 160	YOUNG TEXTURE
metacarpal	PM		53.8	33.0	27.5					4	cAD160-early 3rd C	?OSTEOCHONDRITIS DESSICANS
metacarpal	MD	DF			29.2	50.2	47.2	27.8		4	cAD160-early 3rd C	TINY SHALLOW LESION DISTAL CON
metacarpal	MD	DF			32.8	60.5	54.8			4	cAD160-early 3rd C	
metacarpal	M				23.9					13	3rd-4th C	BOTH ENDS CHEWED OFF, PROB YNG
metacarpal	PM				28.3					12	3rd-4th C	
metacarpal	D	DF				51.5	45.7	28.3		8	3rd-4th C	IRREGULAR LESIONS DIST CONDYLE
metacarpal	D	DF				51.9	48.6	29.7		13	3rd-4th C	
metacarpal	D	DF				52.1	47.3	29.0		9	3rd-4th C	PIT IN DISTAL CONDYLE,?FIT PHA
metacarpal	MD	DF				52.4	48.1	29.1		9	3rd-4th C	EXCELLENT SKINNING MARKS
metacarpal	D	DF				53.2	49.0			13	3rd-4th C	
metacarpal	D	DF				53.7	50.2	28.8		12	3rd-4th C	TINY LINEAR CREASE ALONG D CON
metacarpal	D	DF				57.5	50.5	30.2		9	3rd-4th C	SLIGHT SPLAY, SMALL PIT
metacarpal	D	DF				63.2	56.8			5	3rd-4th C	Bd MAY BE SLIGHTLY UNDERESTIMA
metacarpal	MD	DF				66.2	59.4	36.3		8	3rd-4th C	
metacarpal	PM		47.4	29.3	25.6					6	3rd-4th C	?OSTEOCHONDRITIS DESSICANS? ?s
metacarpal	PMD	DFsg	48.3	28.6	27.0	49.4	47.9	27.3	168	9	3rd-4th C	SHORT, STOCKY & IMMATURE
metacarpal	PM		49.0	32.1	25.1					7	3rd-4th C	?DUF, D CHEWED OFF
metacarpal	PM		50.2	31.0	26.7					13	3rd-4th C	
metacarpal	P		50.5	31.2						10	3rd-4th C	COLOUR VERY LIGHT cf REST
metacarpal	PMD	DF	55.9	34.4	33.1					13	3rd-4th C	PROX LESION MED FACET
metacarpal	PM		62.4	37.6						5	3rd-4th C	TINY PIT LESION NEXT TO ?OSTEO
metacarpal	PMD	DUF	63.3	30.4	29.1		50.7		170	9	3rd-4th C	SHORT, STOCKY, YG, SKIND, SCORCH
metacarpal	PMD	DF	66.7	41.9	39.7	70.5	61.7	36.5	199	7	3rd-4th C	AN ABSOLUTE STONKER
metacarpal	P		70.7	44.4						13	3rd-4th C	MASSIVE C MC
metacarpal	MD				24.6					14 a	late 4th C	
metacarpal	MD	DF			28.3	50.9	47.9	27.1		14 a	late 4th C	SPLAYED, BUT MEAS OK FIT ABOVE
metacarpal	P		51.3	31.7						14 a	late 4th C	?OSTEOCHONDRITIS DESSICANS?
metacarpal	P		57.1	35.5						14 a	late 4th C	A BIT BATTERED
metacarpal	P		49.2	33.0						14 a	late 4th C	C MC SCORCHED ON PROX MED SHAF

Bd	Breadth of distal condyles
BFd	Breadth at distal fusion line (of metaphysis)
Dd	Depth of medial distal condyle (see Legge & Rowley-Conwy 1988)

3rd/4th C

	Bp	Bd
N	10	11
average	56.4	57.6
minimum	47.4	49.4
maximum	70.7	70.5
Std. Dev.	8.02	7.05

Appendix 4. Measurements of cattle bones

Element	**Zones**	**Fusion**		**SD**	**Bd**	**Dd**	**PHASE**	**DATE**	**Notes**
tibia	MD		DUF	33.4			4	cAD160-early 3rd C	
tibia	MD		DFvis	30.5	52.3	36.6	5	3rd-4th C	fusion line just visible in places
tibia	FM			32.9			12	3rd-4th C	
tibia	MD		DF	37.2	59.2	45.8	12	3rd-4th C	slightly off distal fusion
tibia	PFM	PFvis		38.2			11	3rd-4th C	
tibia	MD		DF	38.7	65.4	46.3	7	3rd-4th C	
tibia	FM			21.1			14 a	late 4th C	young
tibia	MD		DF	37.9	65.5	48.1	14 a	late 4th C	exacerbated muscle attachments, distal

Element	**Bd**	**GLm**	**GLl**	**PHASE**	**DATE**	**Notes**
astragalus	35.8	56.4	60.1	9	3rd-4th C	
astragalus	39.5	55.9	61.6	13	3rd-4th C	
astragalus	40.7			11	3rd-4th C	
astragalus	41.0	64.2	68.9	12	3rd-4th C	
astragalus	42.2	61.2	66.3	12	3rd-4th C	
astragalus	47.5		71.0	13	3rd-4th C	
astragalus	48.6		71.1	12	3rd-4th C	
astragalus			57.1	14 a	late 4th C	TEXTURE SLIGHTLY YOUNG
astragalus	34.1	49.8		14 a	late 4th C	

Appendix 4. Measurements of cattle bones

Element	**Zones**	**DF**	**Bp**	**Dp**	**SD**	**Bd**	**BFd**	**Dd**	**GL**	**PHASE**	**DATE**	**Notes**
metatarsal	MD	DUF			19.7		45.0			4	cAD160-early 3rd C	young texture. Proximal chewed off
metatarsal	P			51.4						13	3rd-4th C	very large, but modern break
metatarsal	D	DF						33.2		14	3rd-4th C	
metatarsal	D	DF						27.7		14	3rd-4th C	
metatarsal	MD	DF			27.7					8	3rd-4th C	
metatarsal	MD	DUF			24.9					5	3rd-4th C	
metatarsal	P		41.0	39.9						13	3rd-4th C	deep lesions around medial facet
metatarsal	P		42.9	42.7						12	3rd-4th C	prox. articulation: lesions & resorption
metatarsal	P		43.9	43.1						13	3rd-4th C	permineralised. deep lesions prox. articltn.
metatarsal	P		44.6	43.1						9	3rd-4th C	
metatarsal	PM		44.6	42.2	22.7					13	3rd-4th C	
metatarsal	PMD	DF	48.2	46.0	27.8				205	13	3rd-4th C	
metatarsal	MD	DFvis				46.0	44.8	28.0		9	3rd-4th C	very slender
metatarsal	PMD	DF	43.0	41.5	23.3	48.5	44.6	29.2	213	7	3rd-4th C	proximal creases
metatarsal	D	DF				48.8	46.3	28.6		13	3rd-4th C	small linear lesion medial condyle
metatarsal	PMD	DF	43.5		24.4	48.9	46.4	28.9	210	9	3rd-4th C	unusually long & slender
metatarsal	D	DF				49.4	44.4	28.8		5	3rd-4th C	
metatarsal	D	DF				50.3	45.8	27.3		13	3rd-4th C	very slight splaying & grooving
metatarsal	PMD	DF	45.9	46.2	26.2	52.6	49.8	29.3	200	11	3rd-4th C	
metatarsal	D	DF				53.1	49.8	31.9		8	3rd-4th C	odd pits in distal condyle
metatarsal	PMD	DF	44.7	41.6	25.0	53.4	48.8	29.8	196	12	3rd-4th C	pathological. skinning marks
metatarsal	PMD	DF	50.0		29.3	57.3	54.8	31.7	210	5	3rd-4th C	
metatarsal	MD	DF				58.9	55.1			8	3rd-4th C	lesions, eburnation & splaying
metatarsal	D	DF				59.5	53.3	33.9		13	3rd-4th C	very slight splaying & grooving
metatarsal	MD	DF			29.7					14 a	late 4th C	extremely large, distal pathological
metatarsal	D	DF				59.6	54.3			14 a	late 4th C	
metatarsal	P		49.1	46.6						14 a	late 4th C	

Bd	Breadth of distal condyles
BFd	Breadth at distal fusion line (of metaphysis)
Dd	Depth of medial distal condyle (see Legge & Rowley-Conwy 1988)

	3rd/4th C	
	Bp	Bd
N	11	12
average	44.8	52.2
minimum	41.0	46.0
maximum	50.0	59.5
Std. Dev.	2.41	4.21

Appendix 4. Measurements of cattle bones

Element	PF	Bp	GL	PHASE	SUB	DATE	Notes
(anterior)							
1st phalange	PF		49.5	9		3rd-4th C	
1st phalange	PF		48.5	9		3rd-4th C	LESIONS, ?FITS MC ABOVE
1st phalange	PF	25.7	50.6	12		3rd-4th C	
1st phalange	PF	26.4	50.2	9		3rd-4th C	DEEP PITS/CREASES DISTAL ARTIC
1st phalange	PF	26.7	56.1	13		3rd-4th C	
1st phalange	PF	26.7	55.1	13		3rd-4th C	
1st phalange	PF	26.7	55.2	12		3rd-4th C	
1st phalange	PF	27.6	51.8	10		3rd-4th C	LINEAR DISTAL LESION
1st phalange	PF	28.1	50.8	8		3rd-4th C	SOME SPLAYING & LESIONS
1st phalange	PF	29.1	52.0	8		3rd-4th C	
1st phalange	PFvis	30.3	56.2	7		3rd-4th C	FUS LINE VIS MEDIAL SIDE ONLY
1st phalange	PF	30.9	56.5	5		3rd-4th C	SLIGHT BUM CRACK LESION, D END
1st phalange	PF	32.8	55.0	8		3rd-4th C	MASSIVE
1st phalange	PF	34.3	59.7	8		3rd-4th C	
1st phalange	PF	25.9	50.2	14	a	late 4th C	?FITS MC, PAIR WITH ABOVE
1st phalange	PF	26.1		14	a	late 4th C	SLIGHT PIT LESION, PROX ARTIC
1st phalange	PF	28.3	55.0	14	a	late 4th C	FINE SKINNING MARKS ON PLANTAR
1st phalange	PF	31.0	62.5	14	a	late 4th C	BUTTOCK LESION, D. ARTIC, BIG
1st phalange	PF	33.0		14	a	late 4th C	MODERN BREAK, MEAS=MIN
(posterior)							
1st phalange	PF	23.2	52.2	9		3rd-4th C	
1st phalange	PFvis	24.4		8		3rd-4th C	TINY PIT, PROX ARTIC GROOVE
1st phalange	PF	24.9	55.3	8		3rd-4th C	PROB ARTICS WITH MT ABOVE
1st phalange	PFvis	25.0	54.1	5		3rd-4th C	
1st phalange	PF	26.0	56.6	7		3rd-4th C	
1st phalange	PF	26.9	59.8	12		3rd-4th C	
1st phalange	PF	25.6	60.8	14	a	late 4th C	
2nd phalange	PF	23.4		14	a	late 4th C	
2nd phalange	PF	27.9		14	a	late 4th C	
2nd phalange	PF	28.0		14	a	late 4th C	
2nd phalange	PF	28.6		14	a	late 4th C	
3rd Phalange			42.6	9		3rd-4th C	V YG, HORIZ CREASE PROX
3rd Phalange			54.6	12		3rd-4th C	YOUNG TEXTURE
3rd Phalange			55.6	13		3rd-4th C	
3rd Phalange			58.1	7		3rd-4th C	MINOR CREASE AROUND ARTIC EDGE
3rd Phalange			59.1	9		3rd-4th C	
3rd Phalange			60.7	5		3rd-4th C	TYPE 3 LESION ACROSS CENTRE PR
3rd Phalange			65.2	7		3rd-4th C	SMALL ?TYPE 3 LESION
3rd Phalange			68.0	8		3rd-4th C	
3rd Phalange			69.9	12		3rd-4th C	
3rd Phalange			70.8	14		3rd-4th C	?INFECTED BENEATH TOE
3rd Phalange			72.0	8		3rd-4th C	
3rd Phalange			76.2	10		3rd-4th C	
3rd Phalange			76.9	13		3rd-4th C	
3rd Phalange			77.7	12		3rd-4th C	
3rd Phalange			84.9	13		3rd-4th C	
3rd Phalange			76.0	14	a	late 4th C	
3rd Phalange			79.0	14	a	late 4th C	

PF	Proximal Fused
PFvis	Proximal Fusion line still visible

Appendix 5. Measurements of sheep/goat bones

Taxon	Element	Zones	PF	DF	SD	Bd	BT	HTg	HTI	PHASE	DATE	Notes
Sheep	humerus	TMFYD		DF	12.2		25.0		12.2	4	cAD160-early 3rd C	
Sheep	humerus	YD		DF				15.9		14	3rd-4th C	FINE SKINNING KNIFE ACROSS MED
Sheep/Goat	humerus	TMFY			13.6					6	3rd-4th C	YOUNG TEXTURE
Sheep/Goat	humerus	MFY			13.3					12	3rd-4th C	
Sheep	humerus	FMYD		DF	11.7	26.4	24.0	15.8	12.2	13	3rd-4th C	
Sheep	humerus	TFMYD		DF	12.5		24.3	15.5	12.7	14	3rd-4th C	
Sheep	humerus	MYD		DF		27.3	25.1	16.8	12.5	7	3rd-4th C	UNUSUAL COLOUR ?INTRUSIVE
Sheep	humerus	YD		DF		28.1	25.3	16.9	12.4	8	3rd-4th C	
Sheep	humerus	FMYD		DF	13.3	28.7	26.1	16.7	12.3	13	3rd-4th C	
Sheep	humerus	YD		DF		27.4	26.3	18.2	13.1	13	3rd-4th C	
Sheep	humerus	MYD	DF		14.9	28.4	27.0	16.8	13.2	9	3rd-4th C	
Sheep	humerus	FMYD		DF	13.4	28.4	27.2	17.1	12.9	13	3rd-4th C	
Sheep	humerus	PFMYD	PUF	DF	14.5	30.3	27.8	16.5	13.3	8	3rd-4th C	ARTICS W RADIUS
Sheep/Goat	humerus	MFYD		DF	14.8	30.0	27.8	17.8	13.3		unphased (3rd/4th)	
Sheep	humerus	FMYD		DF	13.0	27.3	26.2	16.1	12.8	14 a	late 4th C	

	3rd/4th C		
	Bd	**BT**	**HTg**
N	9	10	10
average	28.3	26.1	16.7
minimum	26.4	24.0	15.5
maximum	30.3	27.8	18.2
Std.Dev.	1.18	1.31	0.77

Taxon	Element	Zones	PF	Bp	BFp	Dp	SLC	PHASE	DATE	Notes
Sheep/Goat	scapula	PN	PF				14.8	12	3rd-4th C	
Sheep/Goat	scapula	N					17.7	6	3rd-4th C	
Sheep/Goat	scapula	PN					18.7	12	3rd-4th C	
Sheep/Goat	scapula	PN	PF				20.7	5	3rd-4th C	
Sheep/Goat	scapula	PN	PF	28.3	16.4		14.8	7	3rd-4th C	
Sheep/Goat	scapula	PN	PF	29.0	18.1		17.5	6	3rd-4th C	
Sheep/Goat	scapula	PN	PF	29.2	19.0		20.1	11	3rd-4th C	
Sheep/Goat	scapula	PN	PF	29.3		19.0	15.7	14	3rd-4th C	
Sheep/Goat	scapula	PN	PF	31.3		19.4	16.5	8	3rd-4th C	
Sheep/Goat	scapula	PG	PF	28.1	20.0		16.3	14 a	late 4th C	

Taxon	Element	Horncore Zones	Bp	BFp	Dp	GL	PHASE	DATE	Notes
Sheep	frontal+horncore	BMT	25.0	64.0	14.9	52	10	3rd-4th C	SMALL, YOUNG, SLIGHT THUMBPRIN
Sheep	frontal+horncore	BM	25.4	70.0	16.0		10	3rd-4th C	
Sheep	horncore	BMTIP	28.7		17.0	113	9	3rd-4th C	VERY SMOOTH & MATURE, INTACT
Goat	horncore	BM	26.8		19.0		9	3rd-4th C	

Appendix 5. Measurements of sheep/goat bones

Taxon	Element	Zones	PF	DF	Bp	BFp	Dp	SD	Bd	BFd	Dd	GL	PHASE	DATE	Notes
Sheep	radius	FM						8.3					1 b	up to c AD 160	V YOUNG ?WEEKS?
Sheep	radius	FM						14.4					4	cAD160-early 3rd C	
Sheep	radius	MD		DUF				15.5					3	cAD160-early 3rd C	
Sheep	radius	PFM	PF		28.1	28.0	14.4	16.2					3	cAD160-early 3rd C	
Sheep	radius	PFMD	PUF	DUF	18.0			8.8		18.7		73.4	8	3rd-4th C	LAMB, ?WEEKS/2 MONTHS OLD
Sheep/Goat	radius	PFMD	PUF	DUF				9.2					5	3rd-4th C	V YOUNG TEXTURE
Sheep/Goat	radius	MD		DUF				10.9					9	3rd-4th C	VERY YOUNG, FLARES OUT DISTAL
Sheep	radius	FM						12.2					8	3rd-4th C	YOUNG TEXTURE ?MONTHS
Sheep	radius	FMD		DUF				12.6					14	3rd-4th C	PERIOSTEAL PLAUE BONE ON SHAFT
Sheep	radius	FM						14.2					13	3rd-4th C	
Sheep/Goat	radius	M						15.1					14	3rd-4th C	
Sheep	radius	FM						15.2					6	3rd-4th C	
Sheep	radius	M						15.5					12	3rd-4th C	
Sheep	radius	FM						15.8					10	3rd-4th C	CLASSIC TUNING FORK CHEWING PR
Sheep	radius	M						16.0					7	3rd-4th C	
Sheep	radius	FMD		DUF				17.4					9	3rd-4th C	
Goat	radius	FM						19.5					5	3rd-4th C	GOAT
Sheep	radius	PFM	PF		25.1		13.4	12.7					10	3rd-4th C	ARTICS WITH U LNA BELOW
Sheep/Goat	radius	PF	PF		28.5	26.7	14.8	17.2					13	3rd-4th C	AMBIGUOUS S/G RAD
Sheep	radius	MD		DF				14.4	24.1	21.4	15.6		13	3rd-4th C	
Sheep	radius	FMD		DFvls				15.4	24.6				11	3rd-4th C	
Sheep	radius	FMD		DF				14.3	25.4		17.5		6	3rd-4th C	
Sheep	radius	D		DFsg					26.7	21.4			13	3rd-4th C	
Sheep	radius	PFMD	PF	DFsg	30.9	28.3		15.8	28.4		17.8	161	8	3rd-4th C	ARTICS W HUM & PAIR W RAD
Sheep/Goat	radius	M						15.0					14 a	late 4th C	
Sheep/Goat	radius	M						18.0					14 a	late 4th C	
Sheep	radius	M						18.6					14 a	late 4th C	
Sheep	radius	P	PF		28.6	28.1	15.2						15	up to modern	

Appendix 5. Measurements of sheep/goat bones

Taxon	Element	Zones	DF	Bp	Dp	SD	Bd	BFd	Dd	GL	PHASE	DATE	Notes
Sheep/Goat	metacarpal	PM		21.8	15.4	13.3					4	cAD160-early 3rd C	
Sheep/Goat	metacarpal	M				10.6					14	3rd-4th C	V YOUNG TEXTURE ?MONTHS
Sheep	metacarpal	PM				10.7					7	3rd-4th C	
Sheep	metacarpal	PM				11.7					8	3rd-4th C	
Sheep/Goat	metacarpal	M				11.9					8	3rd-4th C	
Sheep	metacarpal	PM				12.1					7	3rd-4th C	
Sheep/Goat	metacarpal	M				12.1					10	3rd-4th C	TAN COLOUR
Sheep/Goat	metacarpal	M				13.0					6	3rd-4th C	
Sheep/Goat	metacarpal	PM				13.2					10	3rd-4th C	FINE KNIFE SKINNING MARKS
Sheep/Goat	metacarpal	MD	DUF			13.6					13	3rd-4th C	
Sheep/Goat	metacarpal	PM				13.7					6	3rd-4th C	
Sheep/Goat	metacarpal	M				15.2					12	3rd-4th C	
Sheep/Goat	metacarpal	PM				15.3					8	3rd-4th C	VERY PROBABLY MALE SHEEP
Sheep/Goat	metacarpal	PM		18.9		10.8					9	3rd-4th C	V YG TEXTURE
Sheep	metacarpal	PM		19.0	13.7	10.5					13	3rd-4th C	YOUNG TEXTURE, PROB DUF
Sheep	metacarpal	PMD	DUF	19.5	14.5	12.4					7	3rd-4th C	
Sheep	metacarpal	PMD	DUF	19.6	13.9	10.5					10	3rd-4th C	
Sheep	metacarpal	PMD	DUF	20.2	14.5	13.9					13	3rd-4th C	BROAD, BUT SHEEP, ?YOUNG MALE
Sheep	metacarpal	PMD	DUF	20.5	15.1	12.4		23.4			7	3rd-4th C	
Sheep	metacarpal	PM		21.1	15.2	13.6					13	3rd-4th C	
Sheep	metacarpal	PM		21.7	15.0	12.3					7	3rd-4th C	SKINNING MARKS
Sheep	metacarpal	PM		22.5	16.5	12.3					13	3rd-4th C	YOUNG TEXTURE, PROB DUF
Sheep	metacarpal	PMD	DF	18.6	13.8	11.6	21.6	21.4		119.8	5	3rd-4th C	
Sheep	metacarpal	PMD	DF	20.5	13.9	11.0	21.7	21.6	14.8	121.8	7	3rd-4th C	
Sheep	metacarpal	PMD	DF	19.7	14.1	11.0	21.9	22.3	13.6	116.0	11	3rd-4th C	
Sheep	metacarpal	PMD	DFvis	20.7	15.2	11.8	23.6	22.1	15.1	123.3	5	3rd-4th C	
Sheep	metacarpal	D	DF				23.9		15.1		13	3rd-4th C	V PROB A RAM, SLIGHTLY GOAT-LI
Sheep	metacarpal	PMD	DF	21.1	16.3	13.4	24.0	25.9	15.0	122.5	12	3rd-4th C	
Sheep	metacarpal	P		19.0	14.0	11.3					14 a	late 4th C	
Sheep/Goat	metacarpal	M				12.0					14 a	late 4th C	
Sheep	metacarpal	MD	DF			13.1	22.1		14.7		14 a	late 4th C	
Sheep/Goat	metacarpal	PM		21.8	17.2	13.7					15	up to modern	

	3rd/4th C	
	Bp	Dp
N	14	13
average	20.3	14.7
minimum	18.6	13.7
maximum	22.5	16.5
Std. Dev.	1.08	0.88

Appendix 5. Measurements of sheep/goat bones

Taxon	Element	Zones	PF	SD	PHASE	DATE	Notes
Sheep/Goat	femur	M		9.4	13	3rd-4th C	VERY YOUNG TEXTURE
Sheep/Goat	femur	FMF		11.1	8	3rd-4th C	YOUNG TEXTURE
Sheep/Goat	femur	M		11.2	13	3rd-4th C	YOUNG TEXTURE ALL OVER
Sheep/Goat	femur	FMF		11.3	10	3rd-4th C	
Sheep/Goat	femur	M		11.4	12	3rd-4th C	BUFF-COLOURED & PWDERY ?RESIDU
Sheep/Goat	femur	FM		11.9	5	3rd-4th C	YOUNG TEXTURE
Sheep/Goat	femur	MFOS		12.3	9	3rd-4th C	
Sheep/Goat	femur	M		12.7	9	3rd-4th C	
Sheep/Goat	femur	MF		13.5	7	3rd-4th C	
Sheep/Goat	femur	PFMF	PUF	8.4	14 a	late 4th C	V YOUG ?WEEKS/MONTHS
Sheep/Goat	femur	FMF		12.1	14 a	late 4th C	
Sheep/Goat	femur	MFF		13.3	14 a	late 4th C	YOUNG TEXTURE

Taxon	Element	Zones	PF	DF	SD	Bd	BFd	Dd	PHASE	DATE	Notes
Sheep/Goat	tibia	FM			13.0				4	cAD160-early 3rd C	
Sheep	tibia	MD		DF	12.0	23.5		18.8	4	cAD160-early 3rd C	
Sheep/Goat	tibia	FMD		DUF	8.3				7	3rd-4th C	VERY YOUNG TEXTURE
Sheep/Goat	tibia	FM			10.4				9	3rd-4th C	YOUNG TEXTURE
Sheep/Goat	tibia	MD		DUF	10.4				13	3rd-4th C	
Sheep/Goat	tibia	M			11.3				12	3rd-4th C	
Sheep/Goat	tibia	FM			11.9				5	3rd-4th C	
Sheep/Goat	tibia	M			12.0				14	3rd-4th C	
Sheep/Goat	tibia	FMD		DUF	12.5		22.1		14	3rd-4th C	
Sheep/Goat	tibia	PFM	PUF		12.6				13	3rd-4th C	
Sheep/Goat	tibia	FM			12.8				10	3rd-4th C	
Sheep/Goat	tibia	PFM	PUF		13.6				13	3rd-4th C	
Sheep/Goat	tibia	FM			14.0				6	3rd-4th C	
Sheep	tibia	MD		DF	12.1	21.8		16.8	8	3rd-4th C	
Sheep/Goat	tibia	MD		DF	12.3	23.0		18.1	9	3rd-4th C	SMALL DEEP PIT IN DISTAL ARTIC
Sheep	tibia	MD		DF	13.5	23.1		18.7	13	3rd-4th C	
Sheep	tibia	D		DF	12.4	23.3		17.5	13	3rd-4th C	
Sheep/Goat	tibia	MD		DFvis		23.6		18.9	14	3rd-4th C	
Sheep/Goat	tibia	FMD		DF	12.5	23.7		17.9	8	3rd-4th C	
Sheep/Goat	tibia	D		DF	13.0	23.8		18.7	12	3rd-4th C	
Sheep	tibia	MD		DF	13.3	23.8		18.1	6	3rd-4th C	
Goat	tibia	D		DF	15.7	24.4		18.2	13	3rd-4th C	
Sheep	tibia	MD		DF	13.9	24.6		18.5	13	3rd-4th C	
Sheep	tibia	FMD		DF	12.9	24.9		19.7	14	3rd-4th C	
Sheep	tibia	FMD		DF	13.9	24.9		18.9	8	3rd-4th C	
Sheep	tibia	D		DFvis		25.1		18.4	7	3rd-4th C	
Sheep/Goat	tibia	M			10.8				14 a	late 4th C	
Sheep/Goat	tibia	FM			11.9				14 a	late 4th C	
Sheep/Goat	tibia	FM			13.7				14 a	late 4th C	
Sheep/Goat	tibia	MD		DF	14.0	24.7		19.5	14 a	late 4th C	
Sheep/Goat	tibia	FM			12.6				15	up to modern	

	3rd/4th C	
	Bd	Dd
N	13	13
average	23.8	18.3
minimum	21.8	16.8
maximum	25.1	19.7
Std.Dev.	0.90	0.69

Appendix 5. Measurements of sheep/goat bones

Taxon	Element	Zones	DF	Bp	Dp	SD	Bd	BFd	Dd	GL	PHASE	DATE	Notes
Sheep/Goat	metatarsal	PM				9.7					8	3rd-4th C	
Sheep	metatarsal	PM				9.9					10	3rd-4th C	
Sheep/Goat	metatarsal	M				10.1					13	3rd-4th C	
Sheep	metatarsal	PM				10.4					8	3rd-4th C	SGS MT NASTY PATH AT PROX END
Sheep/Goat	metatarsal	M				11.0					11	3rd-4th C	
Sheep/Goat	metatarsal	M				11.1					11	3rd-4th C	
Sheep/Goat	metatarsal	PM				11.2					11	3rd-4th C	
Sheep	metatarsal	PMD	DUF			11.2					11	3rd-4th C	
Sheep/Goat	metatarsal	M				11.4					7	3rd-4th C	YOUNG TEXTURE
Sheep/Goat	metatarsal	M				11.6					12	3rd-4th C	
Sheep/Goat	metatarsal	M				11.8					10	3rd-4th C	
Sheep	metatarsal	MD	DUF			12.1					9	3rd-4th C	TOP BROKEN OFF BY DIGGERS
Sheep/Goat	metatarsal	M				13.9					14	3rd-4th C	
Sheep	metatarsal	PM		16.7	16.8	9.0					13	3rd-4th C	DINKY LITTLE SHEEP MT
Sheep	metatarsal	PM		16.9	17.5	9.2					9	3rd-4th C	SKINNING KNIFE CUTS
Sheep	metatarsal	PMD	DUF	17.2	18.2	9.3					10	3rd-4th C	
Sheep	metatarsal	PM		17.4	18.0	10.1					6	3rd-4th C	PIT LESION IN MED ARTIC FACET
Sheep	metatarsal	PM		18.0	18.5	11.1					12	3rd-4th C	
Sheep	metatarsal	PMD	DUF	18.3	16.8	8.3					12	3rd-4th C	YOUNG FIBROUS TEXTURE (duf)
Sheep	metatarsal	PMD	DF	18.4	17.5	10.5				126.2	8	3rd-4th C	
Goat	metatarsal	PMD	DUF	19.4	17.7	12.2					5	3rd-4th C	SKINNING MARKS AT P EPIPH, GOA
Sheep	metatarsal	PMD	DUF	19.7	19.3	11.5		23.4			14	3rd-4th C	SKINNING KNIFE CUTS, CREASES P
Sheep	metatarsal	PMD	DF	17.2	18.4	9.4	20.7	20.1	14.2	128.0	6	3rd-4th C	
Sheep	metatarsal	PMD	DF	17.9	17.8	10.3	21.0	20.4	14.8	124.0	11	3rd-4th C	
Sheep	metatarsal	PMD	DF	17.8	17.6	10.8	21.3	20.5		133.4	8	3rd-4th C	FINE SKINNING CUTS, PROX SHAFT
Sheep	metatarsal	PMD	DF	18.4	18.1	10.6	21.7	21.0	13.7	129.0	9	3rd-4th C	
Sheep	metatarsal	PMD	DF	18.5	18.3	10.2	21.8	20.9	15.1	125.7	14	3rd-4th C	DF JUST VISIBLE, DORSAL SIDE
Sheep	metatarsal	PMD	DF	18.2	18.7	10.5	22.4	21.7	15.0	132.7	7	3rd-4th C	
Sheep	metatarsal	MD	DF			12.9	23.1	23.2	15.6		11	3rd-4th C	LINEAR CREASE ON MED EPICONDYL
Sheep	metatarsal	PMD	DF	17.0	17.3	10.0	21.0		14.2	125.0	14 a	late 4th C	
Sheep	metatarsal	PM		17.7		10.3					14 a	late 4th C	

	3rd/4th C	
	Bp	**Dp**
N	15	15
average	18.0	17.9
minimum	16.7	16.8
maximum	19.7	19.3
Std. Dev.	0.82	0.65

Appendix 6. Measurements of pig bones

Taxon	Element	Zones	PF	DF	Bp	Dp	SD	Bd	BT	PHASE	DATE	Notes
Pig	scapula	N					13.8			9	3rd-4th C	V YG, IN 3 (OLD) FRAGS
Pig	scapula	PN					17.9			7	3rd-4th C	YOUNG TEXTURE
Pig	scapula	PN	PF		32.0	22.2	20.3			11	3rd-4th C	
Pig	scapula	PN	PF		33.4	24.1	21.7			7	3rd-4th C	
Pig	scapula	PG	PF		30.8					14 a	late 4th C	
Pig	humerus	FMY					12.1			13	3rd-4th C	
Pig	humerus	FMYD		DTFvi			12.8	33.8	28.1	13	3rd-4th C	DISTAL TUBEROSITY Fvis DF
Pig	humerus	MFY					13.1			6	3rd-4th C	YOUNG TEXTURE
Pig	humerus	MFYD		DF			13.3			11	3rd-4th C	
Pig	humerus	MFYD		DF			13.6			9	3rd-4th C	
Pig	humerus	FMY					14.0			14	3rd-4th C	
Pig	humerus	MFY					15.5			6	3rd-4th C	
Pig	humerus	MFY					15.7			11	3rd-4th C	
Pig	humerus	TMY					16.0			12	3rd-4th C	
Pig	humerus	MFY					16.2			9	3rd-4th C	
Pig	humerus	FMY					12.2			14 a	late 4th C	
Pig	humerus	FMY					12.5			14 a	late 4th C	
Pig	humerus	MY					12.8			14 a	late 4th C	
Pig	humerus	TM					13.4			14 a	late 4th C	
Pig	humerus	MY					14.7			14 a	late 4th C	
Pig	femur	FMF					14.7			4	cAD160-early 3rd C	
Pig	femur	MD					11.7			6	3rd-4th C	
Pig	femur	MFOS					12.9			9	3rd-4th C	
Pig	femur	FMFO					13.8			13	3rd-4th C	
Pig	femur	PM	PUF				14.7			11	3rd-4th C	
Pig	femur	MF					14.9			13	3rd-4th C	
Pig	femur	MFO					15.6			13	3rd-4th C	
Pig	femur	FMF					15.7			6	3rd-4th C	
Pig	femur	MF					16.1			7	3rd-4th C	
Pig	femur	TFMFO					17.4			13	3rd-4th C	
Pig	femur	MF					17.5			7	3rd-4th C	

Appendix 7. Measurements of bones of other species

Dog

Element	Zones	Fusion	Bp	BFp	SD	Bd	BFd	BT	HTg	HTl	GL	PHASE	DATE	Notes
mandible	CCATD					length M1 = 19.3						9	3rd-4th C	SMALL, CLOSELY SET TEETH
humerus	MYD	DF			12.3	31.3		21.4	14.5	11.4		8	3rd-4th C	WELL CHEWED DOG HUM
radius	PM	PF	11.6		9.1							6	3rd-4th C	GL cc 64mm? BANDY ?RESIDUAL
pelvis*	AILIS	AF ISF				acetabular rim height = 14.4						9	3rd-4th C	SMALL DOG FITS FEM
femur*	PM	PF	23.6	11.1	9.9							9	3rd-4th C	SLIGHTLY ERODED BANDY DOG
femur	MF				12.6							7	3rd-4th C	
tibia	D	DUF			7.5		14.6					13	3rd-4th C	
tibia*	PFMD	PF DF	23.6		9.0	15.7			11.9		84.9	9	3rd-4th C	VERY SMALL & BANDY DOG
metatarsal	W	DF			5.4						60	11	3rd-4th C	

pelvis* and femur* articulate; tibia* probably also from same (small and bandy legged) individual
shoulder height calculated from tibia* GL (Harcourt 1974) = 258 mm

Horse

Element	Zones	Fusion	Bp	BFp	Dp	SD	Bd	BFd	BT	HTg	HTl	GL	GLl	PHASE	DATE	Notes
tibia	PMD	PF DF				32.8	62.9			40.7		314	290	0	natural	
radius	PFMD	PF DF	71.4	66.9		30.0	65.6		57.5	39.0		316	304	4	cAD160-early 3rd C	
scapula	PND	PF	85.6	52.7	41.1	60.6								8	3rd-4th C	?SLIGHTLY CHEWED, DISTAL END??
metatarsal	PMD	PF DF	52.1		45.6	33.0	51.5	50.8	40.2			281	276	14	3rd-4th C	

withers heights calculated from GLl measurements (Kiesewalter 1888, cited in Driesch & Boessneck 1974):

Phase 0 ('natural')	tibia..	1264 mm = 12.4 hands
late 2nd/early 3rd C	radius..	1319 mm = 13.0 hands
3rd/4th C	metatarsal..	1471 mm = 14.5 hands

Hare

Element	Zones	Fusion	Bp	Dp	PHASE	DATE	Notes
radius	PFM	PF	9.7	6.4	15	up to modern	

Cat

Site 482

mandible CCATDS cheek tooth row (Driesch mandible measurement 5) = 19.1 4 late 2nd C+
length of carnassial alveolus (Driesch mandible measurement 7) = 7.9
length of whole mandible (Driesch mandible measurement 1) = 60.7
depth of ramus in front of P3 (Driesch mandible measurement 10) = 9.7
depth of ramus behind M1 (Driesch mandible measurement 9) = 10.5

Appendix 7. Measurements of bones of other species

Taxon	**Element**	**Zones**	**PF**	**DF**	**Bp**	**Dp**	**SD**	**Bd**	**GL**	**Sex**	**PHASE**	**DATE**	**Notes**
domestic Fowl	coracoid	W							51.7		12	3rd-4th C	
domestic Fowl	humerus	PM					6.6				14	3rd-4th C	
domestic Fowl	humerus	MD		DF				15.3			7	3rd-4th C	
domestic Fowl	humerus	MD		DF			6.8	15.8			6	3rd-4th C	
domestic Fowl	humerus	PMD	PF	DF			7.8				14	3rd-4th C	
domestic Fowl	radius	PMD	PF	DF	4.5	4.9	3.0	6.5	54.5		12	3rd-4th C	
domestic Fowl	radius	PMD	PF	DF			3.4	7.4	71.5		14	3rd-4th C	
domestic Fowl	radius	MD		DF			3.4	7.5			13	3rd-4th C	
domestic Fowl	ulna	PAMD	PF	DF			4.9	11.0	79.3		13	3rd-4th C	
domestic Fowl	femur	PM	PF				7.3				13	3rd-4th C	CHEWING VERY SHARP ?CAT/MUSTELIC
domestic Fowl	femur	PMD	PF	DF	16.8		7.6	16.4	81.8		9	3rd-4th C	
domestic Fowl	tibiotarsus	MD		DF			6.1	10.3			13	3rd-4th C	
domestic Fowl	tibiotarsus	FMD		DF			7.2	12.1			14	3rd-4th C	PROLIFERATIVE BONE GROWTH DIST
domestic Fowl	tibiotarsus	FM					7.2				13	3rd-4th C	
domestic Fowl	tarsometatarsus	MD		DF			5.3	11.5		M?	13	3rd-4th C	TMT SCAR FOR SPUR
domestic Fowl	humerus	MD		DF			7.2	14.4			15	up to modern	
fowl size	tibiotarsus	D		DF			5.7				7	3rd-4th C	
fowl size	tibiotarsus	M					5.8				6	3rd-4th C	
fowl size	tibiotarsus	M					6.4				7	3rd-4th C	
Grouse sp.?	femur	MD		DF			6.4				14 a	late 4th C	NO MEDULLARY BONE, ?GROUSE
Raven	ulna	PMD	PF	DF			6.7				8	3rd-4th C	

Appendix 8. Quantities of sieved animal bones from Sites 452 & 482 by weight (in g)

Site 452

DATE	**up to c AD 160 / 3rd C**	**late 2nd - 3rd C**	**3rd/4th C**	**late 4th C**	**Total Roman**	**up to modern**
PHASES(S)	**0, 1 and 1-4**	**2 - 4**	**5 - 14**	**14a**	**0-14**	**15**
>2mm	19	11	240	67	**336**	34
>4 mm	231	173	4341	865	**5610**	494
>8mm		108	1048		**1156**	
Totals	**250**	**291**	**5629**	**932**	**7102**	**528**

Site 482

DATE	**late 2nd - 3rd C**	**3rd C --**	**Total Roman**
PHASES(S)	**2 - 4**	**5**	**2 - 4**
Totals	**100**	**115**	**215**

Appendix 9: the dog skeleton, Skeleton No. 6651

N.B. This was recovered from a context assigned to Phase 14a at Site 452 (late 4th Century) but there is a possibility that the dog is intrusive.

Body parts present
(all fully fused and completely intact unless otherwise stated):

skull

L & R mandibles

(for skull and both mandibles: all adult teeth are fully erupted and present in the bone. The premolars are well spaced apart, but the molars touch each other without impacting or overlapping)

atlas, axis, five cervical, 13 thoracic and seven lumbar vertebrae
(the proximal epiphysis of the 2nd lumbar vertebrae is slightly collapsed)

sacrum and 12 caudal vertebrae

13L & 13 R ribs, plus nine fragments of costal cartilages

L & R scapula, humerus, radius & ulna

L & R metacarpals I, II, III, IV & V

pelvis
(sciatic tuberosities of ischia both fully fused, tuber coxae of both ilia fused half-way along length, pubic symphysis fused along 40% of length)

L & R femur, tibia & fibula

L & R astragalus & calcaneum

L & R metatarsals II, III, IV & V

15 assorted carpals & tarsals

16 first phalanges

16 second phalanges

8 third phalanges

15 sesamoids

Bone fragments recovered from sediment surrounding the skeleton:

a few fragments with very mixed preservation conditions suggesting admixture/residuality of material: these consist of a fowl femur and a fowl coracoid, a neonatal piglet longbone, a large sheep-sized rib (probably recent) a highly polished and eroded pig lower deciduous incisor and three rodent bones of mouse/vole size.

Appendix 9: the dog skeleton, Skeleton No. 6651 (cont.)

Measurements of the dog bones from Skeleton 6651

Skull

Harcourt 1974 (skull & mandibles)	Driesch 1976 (meas. no.)	measurement in mm
I	(~1)	193.5
II	-	107.7
III	8	96.1
IV	30	105.5
IX	13	97.2
X	34	62.5
XI	15	66.8
XII	36	36.7

		Left	Right
	Mandible		
XV	8	76.7	76.8
greatest length	1	145.5	146.5
	length M_1	20.4	20.7
height vert. ramus	18	(eroded)	52.2
	Scapula		
	GLP	29.4	29.4
	SLC	24.8	25.0
	HS	(eroded)	135.5
	Humerus		
	Dp	42.6	42.1
	SD	12.5	12.9
	Bd	33.4	33.1
	HTl*	13.5	13.7
	GL	160.2	159.8
	GLC	152.0	155.0

HTl* least height of distal condyle (see Legge & Rowley-Conwy's HTC for definition)

Appendix 9: the dog skeleton, Skeleton No. 6651 (cont.)

Measurements of the dog bones from Skeleton 6651 (cont.)

	Left	Right
Radius		
Bp	18.1	18.2
Dp	12.2	12.4
SD	13.0	12.9
Bd	24.3	23.9
Dd	13.3	13.4
GL	162.1	161.8
Ulna		
SDO	22.0	22.6
GL	191.1	191.1
Femur		
Bp	38.0	38.8
SD	12.3	12.3
Bd	33.0	32.2
GL	172.0	172.1
Tibia		
Bp	36.4	35.9
SD	12.3	12.3
Bd	23.3	22.9
Dd	17.0	17.3
GL	183.2	185.0
Fibula		
GL	175.1	(warped)

Appendix 9: the dog skeleton, Skeleton No. 6651 (cont.)

Measurements of the dog bones from Skeleton 6651 (cont.)

		Left	Right
	Astragalus		
	GL	26.8	27.0
	Calcaneum		
	GL	45.9	44.6
	Pelvis		
	LAR	21.7	21.5
	SH	18.9	19.3
	GL	16.0	15.9
acetabular	rim height	16.0	15.9
43.1	LS		
	Atlas		
81.1	GB		
36.3	GL		
15.7	LAD		
31.6	BFcr		
38.3	BFcd		
	Axis		
30.0	BFcr		
35.8	H		
47.4	LCDe		
50.6	LAPa		
	Sacrum		
28.3	BFcr		
47.2	GB		

Appendix 9: the dog skeleton, Skeleton No. 6651 (cont.)

Harcourt's (1974) skull indices

Harcourt's Index	formula	Index	cf. Harcourt's 1974 Romano-British data (Table 10)
Cephalic Index (skull width *cf.* skull length)	(IV*100)/I	54.5	low end of range (ie narrow)
Snout Index (snout length *cf.* skull length	(III*100)/I	49.7	high end of range (ie long)
Snout Width Index (muzzle width *cf.* nose length)	(XII*100)/III	38.2	low end of range (ie narrow)

Estimated shoulder heights calculated using Harcourt's (1974) formulae

(using Greatest Lengths of Left limb bones)

Element(s)	Estimated shoulder height (in mm)
Humerus	523
Radius	535
Ulna	537
Humerus + Radius	527
Femur	527
Tibia	544
Femur + Tibia	537

Appendix 10: the calf skeleton, Skeleton No. 6654

Context 765, Phase 14a at Site 452 (late 4th Century).

Body parts present (all intact and unfused unless otherwise stated):

skull: L + R frontals/parietals/temporals (frontals not fused along sagittal suture)
L & R maxillae
(maxillary dentition: dp^2, dp^3 dp^4 M^1 all erupted and in wear, M^2 visible in crypt)
L & R nasals
L premaxilla
occipital condyle
basilar part of occipital bone

L & R mandibles
mandibular dentition: dp_2, dp_3 dp_4 M_1 all erupted and in wear, M_2 visible in crypt
(age = > 5 - 6 months; <15 - 18 months)

4L & 4 R deciduous incisors, all in moderate wear

atlas (wings and body all unfused: age = < 6 months)

axis (DUF. Proximally, fusion lines of ossification centres still visible)

five cervical, 13 thoracic and seven lumbar vertebrae
(plus 38 unfused epiphysial plates)

sacrum (PUF. Apart from segments 2 & 3, which are fusing together, all segments are completely unfused)

4 caudal vertebrae

13L & 13 R ribs

7 sternebrae

L & R scapula (tuberosity fusing, age c 7 - 10 months)

L & R humerus (PUF, distal condyle fusing: age = c 12 - 18 months, but distal tuberosities unfused)

L & R radius (Proximal fusing: age = c 12 - 18 months, DUF)

L & R ulna

L & R metacarpals (III & IV fused, DUF)

pelvis (acetabulum unfused, age = < 7 - 10 months; pubis, ilium and ischium all unfused)

L & R femur & tibia

L lateral malleolus

L & R astragalus, naviculo-cuboid & calcaneum

L & R metatarsals (III & IV fused, DUF)

12 carpals

4 tarsals

7 first phalanges, 7 second phalanges & 5 third phalanges

5 sesamoids

Appendix 10: the calf skeleton, Skeleton No. 6654 (cont.)

Notes on the calf bones

Ageing: the mandibular dentition suggests that the calf was >5 - 6 months, but the atlas suggests that it was < 6months. The scapula suggests that it was about 7 - 10 months but the pelvis suggests that it was < 7 - 10 months. Overall, these indications might suggests that the calf was 6 - 7 months old when it died, but the elbow joint (distal humerus and proximal radius) suggests that it was approaching 12 - 18 months.

Skull: the horncores are tiny scurs

Pelvis: the shaft of the ilium is short and curved, the rim of the acetabulum is high (18.2mm and 18.6 mm) and the pubis is very short and stocky. These morphological traits all suggest that the calf was male.

The R metacarpal has a large sinuous area of pock-marked bone in the medial facet of the proximal articulation: a cross between a Type 1 lesion and osteochondritis dessicans in appearance.

Carpals: two have one deep pit-type lesion each in one of their articular surfaces.

Second phalanges: One has two tiny pit-type lesions in the central groove of the distal articulation, one has a deep Type 2 crack-type lesion in the central groove of the distal articulation

Third phalanges: one has a slight Type 3 lesion transversely across the middle of the proximal articulation

Metatarsals: the L m/t has a pit-type lesion alongside the verticillus on the medial distal condyle, and a crease alongside the verticillus on the lateral distal condyle,
the R m/t has a series of pit-type lesions alongside the verticillus on the lateral distal condyle.

Naviculo-cuboids: both bones have deep creases corresponding to the developmental fusion line (in both proximal and distal facets)

There are no examples of Type 1 lesions (shallow crease-like depressions) in any of the bones.

There are no cutmarks on any of the bones.

There has been very little breakage to any of the bones (either pre-or post-burial).

In almost every case, unfused epiphyses and tuberosities have been recovered together with the unfused metaphyses.

Bone fragments recovered from sediment surrounding the skeleton:

A few other fragments of animal bone were recovered in association with the calf burial. All appear to be contemporaneous or residual. They include broken or butchered fragments of a cattle scapula, a cattle humerus (SD = 27.7mm), a cattle metatarsal shaft fragment (split longitudinally), an eroded shaft fragment of a cattle femur (also split longitudinally), a cattle-sized long bone shaft fragment, a pig scapula and a pig lower canine (male).

Appendix 10: the calf skeleton, Skeleton No. 6654 (cont.)

Measurements of selected bones of the calf skeleton

Because of the immature nature of the bones, only a few elements were selected for measuring. The elements that were chosen mature relatively early in the sequence of an animal's development, but are unlikely to have attained full size when this calf died. They do, however, provide a comparison with the other measurements from the site (see Appendix 4), and give an indication of the size of the animal. Despite the immaturity of the bones, their measurements indicate that the calf was already quite large, and was probably male.

Right humerus, distal condyle:
breadth of distal condyle (BT) = 75.6mm
greatest height of condyle (HTg) = 44.9mm
least height of condyle (HTl) = 34.5mm

	Metacarpal		Metatarsal	
	Left	Right	Left	Right
proximal breadth (Bp)	59.3	58.7	52.0	52.6
proximal depth (Dp)	36.6	36.4	48.7	48.1
midshaft diameter (SD)	24.0	23.9	22.4	22.6
distal breadth across condyles (Bd)	53.8	52.8	52.4	53.0
distal breadth across metaphysis (BFd)	54.0	54.6	53.2	53.2
greatest length (includg. unfused epiph.)	203.5	204.0	232.5	233.6

Astragalus:
greatest length (GL) = 75.7mm (L & R)
greatest breadth (Bd) = 46.1mm (L) & 46.5 mm (R)

Appendix 11. Cattle heads and scapulae from Context 249

Remains from Context 249, Phase 9 at Site 452. (3rd Century)

'Cow 1'

Almost complete skull, broken into two major parts in antiquity. Slight warpage prevents exact refitting.

Rear part of skull: frontals, parietals, temporals etc, from nuchal eminence to orbits.
All sutures fused.

The intercornual protuberance is very slight, with a slight dishing in the centre.

Both horncores have been broken off halfway along their lengths (given the robust nature of them both, this may have required some deliberate effort). Two fragments from the right horncore refit.

The horncores have an oval cross-section and leave the skull horizontally, with almost no curvature or twist. The refitted horncore has a blunt tip. The horncores both bear deep grooves along their lengths, particularly on the upper surfaces. This trait has been linked by Luff (1994) to castration.

There are no perforations through the occiput.

The skull is large, broad and robust.

The fore part of the skull reaches from the zygomatics to the premaxillae.

There are no cutmarks anywhere on the skull apart from a group of parallel striations across the end of a maxilla above M^3, but these do not appear to have been made by a metal or stone blade. They may be scratch marks from a stone in the matrix of the deposit or, possibly, tooth marks.

Most of the teeth are missing from their sockets, but it is clear that all of the adult teeth were fully erupted, and the two teeth present (an M^2 and an M^3) are in full wear, although they have not been reduced to the gumline. The molars are at a stage equivalent to Grant's stages 'l' and 'k' for mandibular molars.

The palatal borders of the teeth, from P^2 to M^2 on both sides, have been altered by periosteal infection. On the right maxilla, two perforations partially penetrate through the periosteally altered palatal border alongside M^1. They do not appear to have been caused by an abscess and do not reach the roots of M^1. They may be root alveoli for a supernumerary tooth.

Appendix 11. Cattle heads and scapulae from Context 249 (cont.)

The measurements taken on the skull of 'Cow 1' (which was probably a male, probably a castrate) are:

Driesch: cattle skull measurement		(in mm)	Left	Right
1	total length from Prosthion - Akrokranion	~ 502		
26	greatest breadth of occipital condyles	104.3		
28	greatest breadth of foramen magnum	38.1		
30	least occipital breadth	153.8		
32	least frontal breadth	173.3		
33	greatest frontal breadth across orbits	~>215		
44	horncore: basal circumference		189	195
45	horncore: greatest basal diameter		67.2	67.7
46	horncore: least basal diameter		52.7	46.5
47	horncore: outer curvature			193

Appendix 11. Cattle heads and scapulae from Context 249 (cont.)

'Cow 2'

The skull from 'Cow 2' is very similar in size, conformation and maturity to that from 'Cow 1', apart from being a little shorter in overall length.

The rear portion of the skull consists of the frontals, parietals and temporals etc and the skull has been broken across at the orbits.

The intercornual protuberance is very similar in shape to that of 'Cow 1', with a slight rise and a slight dish at the midpoint.

Both horncores have been broken off part-way along their lengths. Both leave the skull almost horizontally, with little or no curvature or twist. Their cross-sections are oval and they have deep grooves, particularly along their upper surfaces.

The occiput has one small perforation through it, c 4mm broad by 2 mm wide, on the centre (sagittal) line below the nuchal crest.

Both maxillae refit but are separate from each other. The facial tuberosities are extremely marked, forming projecting flanges of bone.

The palatal borders of the upper tooth rows have been affected by periosteal infection from the P^2 to the M^2.

Most of the teeth are missing from their alveoli (post-mortem). The left M^3 and the right M^2 are present, both at Grant's stage 'k' but not worn right down to the gumline.

The premaxillae are still fused on to the maxillae, but are damaged (?chewed) at their anterior tips.

A pair of mandibles is present. Due to breakage, they cannot be refitted onto the skull, but their conformation and degree of maturity are consistent with those of the skull. The left mandible has a green metallic stain on the horizontal ramus behind M_3.

One very worn right permanent incisor is present (loose).

Complete adult tooth rows remain *in situ* in the mandibles, from P_2 to M_3:

Left mandible: P_2 P_3 P_{4g} M_{1k} M_{2k} M_{3h} MWS = 43

Right mandible: P_2 P_3 P_{4g} M_{1k} M_{2k} M_{3j} MWS = 44

Appendix 11. Cattle heads and scapulae from Context 249 (cont.)

The measurements taken on the skull and mandible of 'Cow 2' (which was probably a male, probably a castrate) are:

Driesch: cattle skull/mandible measurement		(in mm)	Left	Right
1	total length from Prosthion - Akrokranion	~~460		
26	greatest breadth of occipital condyles	106.2		
28	greatest breadth of foramen magnum	43.4		
30	least occipital breadth	135.7		
32	least frontal breadth	179.7		
33	greatest frontal breadth across orbits	~222.8		
44	horncore: basal circumference		195	190
45	horncore: greatest basal diameter		70.6	71.3
46	horncore: least basal diameter		46.3	48.3
	length M_1		36.0	35.9
7	cheek tooth row length		127.7	126.6
15b	height of mandible at M_1		44.8	44.5

Cattle scapulae found associated with the skulls of Cows 1 and 2

Apart from various small fragments of thin broken bone deriving from internal parts of cattle skulls, Context 249 also produced a group of six cattle scapulae. These are unusual in that they are all virtually intact. They have all been butchered around the glenoid and neck with heavy metal tools such as cleavers, and the spines have been trimmed off with similar heavy butchery blows. There are, however, no knife marks anywhere on the bones (ie they have not been filleted raw) and there are no holes through the blades that might have been made by a metal hook. One of the scapulae has a green metallic stain in the centre of the ventral side of the blade. There are two right scapulae and four left scapulae. None of them form any obvious pairs. Five of them are quite large. The largest, which is also the most complete, has a greatest length of >350mm. At least four of them had their tuberosities fully fused (the others have been trimmed through this region, which is missing). Neck widths (SLC) for bones that have not been trimmed through this area are: 45.1, 51.0, 52.6, 56.2 and 56.4mm. The sixth bone is of a size equivalent to those with measurements between 53 - 56 mm.

Appendix 12: Distributions of butchery marks by species

		Total No. Butchered		Chopped		Knifecut	
Species	Total stratified Roman	No.	%	No.	%	No.	%
Cattle	799	235	29%	161	20%	95	12%
Pig	198	31	16%	15	8%	18	9%
Sheep/Goat	394	58	15%	21	5%	39	10%
(Sheep)	(120)	(27)	(23%)	(7)	(6%)	(21)	(18%)
(Goat)	(6)	(2)	(33%)	(2)	(33%)	(0)	(0%)
Horse	16						
Dog	26						
Cat	2						
Hare	2						
Watervole	1						
cattle size	138	63	46%	51	37%	19	14%
pig size	50	10	20%	2	4%	9	18%
sheep size	88	20	23%	8	9%	13	15%
dog size	1						
large mammal	1						
Goose sp.	1						
domestic Fowl	23	4	17%	0	0%	4	17%
Grouse sp.?	1						
Raven	1						
Crow/Rook	1						
fowl size	7						
bird sp.	2						
Totals	1752	421	24%	258	15%	197	11%

N.B. A bone can bear cutmarks and also be chopped. The combined counts of these two columns often exceed the total number of butchered fragments.