Ancient Monuments Laboratory
Report 96/93

ANIMAL BONES FROM EXCAVATIONS IN THE SOUTHERN AREA OF THE LANES, CARLISLE, CUMBRIA, 1981-1982

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Summary

This is the first of three major archive reports concerning the 1981-1982 urban excavations of The Lanes, Carlisle, Cumbria. It covers deposits from five sites in the southern half of the investigated area. Most of the material dates to the early Roman period (late 1st-early 3rd century AD). There is also some medieval (12th/13th C) material and a little from 3rd-12th century contexts that cannot be dated more closely. All of the contexts appear to represent domestic civilian occupation. The collection is dominated by the bones of cattle, sheep and pigs. Although sheep sometimes rival cattle in terms of numbers of individuals, cattle would have provided the majority of the meat in people's diet in both the Roman and medieval periods. Birds, fish and wild species of mammals (although still of minor importance) provided a greater, more varied, proportion of the diet during the medieval period. Waterlogging of the earlier (late 1st/2nd C) deposits has led to excellent preservation conditions, and the assemblage forms an interesting comparison to the equally well-preserved contemporaneous deposits in the military part of the town. Aspects of animal husbandry and livestock morphology are discussed in detail, and particular attention is paid to a comparison between the civilian and military Roman assemblages. The two subsequent studies will concentrate on the Roman and medieval deposits, respectively, from the northern half of the area.

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Animal bones from excavations in the southern area of The Lanes, Carlisle, 1981 - 1982

INTRODUCTION

Background to the project

The Lanes area consisted of a grid of narrow medieval lanes fronted by medieval and post-medieval buildings in the centre of the modern city of Carlisle. The whole area was demolished in the early 1980s and replaced by an under-cover shopping complex.

The excavations of trenches on Old Grapes Lane (OGL-A & 0GL-B), Lewthwaites Lane (LEL-A), Crown & Anchor Lane (CAL-A) and Old Bush Lane (OBL-B) formed part of a major archaeological programme of excavation, building recording and documentary research for 2.4 hectares of The Lanes. The project was undertaken by the Carlisle Archaeological Unit under the direction of Mike McCarthy, and 25 trenches were excavated between 1978 and 1982. A further twenty trenches had watching briefs, mainly at the southern end of the Lanes, and a small amount of material was excavated prior to the main project by Clack and Gosling in 1975 (McCarthy 1991).

Figure 1 shows the position of The Lanes with respect to the medieval city walls (N.B. all maps are taken from McCarthy 1991). It also shows how the city of Carlisle is situated on a tongue of land between the confluences of the Rivers Caldew and Petteril into the River Eden.

Figure 2 shows the distribution of the excavations undertaken in the southern half of the excavated area of The Lanes between 1978-1982. These trenches are being studied as a group and will be reported on together in Volume 1 of the post-excavation monograph on The Lanes (McCarthy *in prep.*). Figure 2 shows how these excavations relate spatially to each other and to the street frontages. In effect, the five sites considered in this report form a north-south transect through the central portion of the demolished area (*ie* the southern half of the area in which excavations took place).

Figure 3 presents the locations of known Roman remains discovered in Carlisle, particularly at sites that have produced major assemblages of animal bones, such as the fort at Annetwell Street (Stallibrass, 1991a & 1991b), the fort annexe at Castle Street (Rackham *et al*, 1991), and another area of civilian settlement at Blackfriars Street (Rackham 1990).

This report is the third of a series that will form the archive reports for the whole of The Lanes project. It is a synthesis of the archive reports for Old Grapes Lane trenches A & B

Castle Street (Rackham *et al*, 1991), and another area of civilian settlement at Blackfriars Street (Rackham 1990).

This report is the third of a series that will form the archive reports for the whole of The Lanes project. It is a synthesis of the archive reports for Old Grapes Lane trenches A & B (Stallibrass, 1993) and for Lewthwaites, Crown & Anchor and Old Bush Lanes (Stallibrass, 1992), and will form a basis for the publication monograph Volume 1. This report covers some aspects that were not covered in the site specific reports due to small sample sizes. In particular, this report discusses relative frequencies of skeletal elements for cattle, sheep and pigs, and discusses the bones of scarcer species such as dogs, horses and birds.

Volume 2 will cover Roman remains from the northern half of the area, and Volume 3 will cover Medieval remains from the northern area. There may be a fourth volume synthesising the information from Volumes 1 - 3.

DATING AND PHASING

The Phases stretch from the prehistoric period (almost no animal bone), through the earlier Roman period until the turn of the 2nd/3rd Centuries AD. There is comparatively little evidence for activity between *c* AD 210/220 and the late 12th/ early 13th Centuries. These intervening phases have proved impossible to date more closely. Coins are very rare, and pottery is scarce consisting mainly of Roman pottery that appears to be residual (the post-Roman period in this region was aceramic). The extreme scarcity or lack of medieval pottery in these layers may be significant, and may indicate that they date to the late Roman and/or the post-Roman /Anglian periods. The medieval material dates to the 12th/13th Centuries, and there is a small amount of post-medieval material from LEL-A.

Table 1 (below) shows how the phases at the five sites relate to one another, and also shows how the phases have been grouped by the author into five major periods, for all of the reports relating to the southern half of the Lanes excavations. It is hoped that these major periods may also be applied to Volumes 2 and 3, covering the northern half of the excavated area.

Table 1: Concordance of sites and phases for the southern Lanes

DATE	OGL-A	OGL-B	CAL-A	LEL-A	OBL-B	PERIOD
OGS	1C	1B	1	1		
Roundhouse	2					
late 1st	3-5	2A-3		2-5	2	late 1st/early 2nd C
AD 93-94	6	4A	2A-C	6		late 1st/early 2nd C
AD 96-117	6	4B-D	3A-4	7		late 1st/early 2nd C
AD 121-160	6			8	6	late 1st/early 2nd C
late 2nd C	7A-8C	4E-5C		9		late 2nd/early 3rd C
late 2nd C	9A	5D		10		late 2nd/early 3rd C
2nd-3rd C	9B	6A		11-16		late 2nd/early 3rd C
2nd-3rd C	9C	6B		11-16		late 2nd/early 3rd C
2nd-3rd C	9D	6C		11-16		late 2nd/early 3rd C
2nd-3rd C	9E	6D		11-16		late 2nd/early 3rd C
2nd-3rd C	9F-H	6E		11-16		late 2nd/early 3rd C
2nd-3rd C	10A-D	6F		11-16		late 2nd/early 3rd C
2nd-3rd C	10E	7A		11-16		late 2nd/early 3rd C
2nd-3rd C	10F	7B		11-16		late 2nd/early 3rd C
3rd-12th C	11	8A-B		17		3rd-12th C
3rd-12th C	12A	8A-B		17		3rd-12th C
3rd-12th C	12B	8A-B		17		3rd-12th C
3rd-12th C				18		3rd-12th C
12th/13th C	13	9		19B-21		12th/13th C
post-medieval				22-23		post-medieval

N.B. OGS = Old Ground Surface

Some of these phases have approximate equivalents at the other recent excavations in Carlisle.

Overall, the area appears to have been on the edge of the main Roman settlement, beside one of the major road routes. It had a low density of occupation, with timber buildings in plots of land defined by fences, hedges *etc.* The first major structure to be built on the site dates to the medieval period.

OGL-A: Phase 1 **Old Ground Surface**
OGL-B: Phase 1

A very small amount of animal bone was recovered from the Old Ground Surface in both of the Old Grapes Lane trenches. The identifiable fragments were from cattle, and the collection is not considered further in this report.

OGL-A: Phase 2 **round house**

A round house was located beneath the Phase 3 deposits at Old Grapes Lane trench A. The round house could not be dated directly, although it predates a dendrochronology date of AD 93-4. The excavator considers that the house may well date to the Roman period rather than to the pre-Roman Iron Age. No animal bones were found associated with the round house, and so a comparison cannot be made between any putative 'Iron Age' material and the earliest Roman material on this site.

OGL-A: Phases 3 - 6 **late 1st/early 2nd C. AD**
OGL-B: Phases 2 - 4D
LEL-A: Phases 2 - 8
CAL-A: Phases 2 and 3
OBL-B: Phases 2 and 6
are roughly contemporaneous with Phases 2-7 at Castle Street (AD early 70s - 140s/160), Phases 2-5 at Blackfriar's Street (*c.* AD 79 - 150/180s), and Phases 3-5 at Annetwell Street (AD 73/4 - 140).
At Old Grapes Lane A (phases 3-6) and OGL-B (phases 2-4D), there were gulleys, pits, soil deposits and surfaces, that were later overlain by two properties with boundaries (gulleys, ditched, fences and hedges) each enclosing a single timber building. At LEL-A, phases 1 - 4 comprise a sequence of relatively wet silts and patchy surfaces of clay and gravel. These are cut by some slots and gulleys. By phase 5, a gulley split the site and appears to have been a boundary. In phase 6, a central gulley flanked by fences running east-west split the site. There were a number of gravel surfaces and silt accumulations. At the same time at OBL-B (phases 2-7) there was a rectangular timber building with a north-south fence line to the east of it. This fence line is on exactly the same alignment and position as one in LEL-A, although

the two are separated by the unexcavated area underneath the road. At CAL-A (phase 2), there was another property enclosing timber buildings, and it is possible that the east-west boundary of LEL-A forms its northern boundary.

OGL-A: Phases 7 - 10 **late 2nd C / early 3rd C**
OGL-B: Phases 4E-7
LEL-A: Phases 9-16

corresponds approximately to Phases 8 & 9 at Castle Street (mid-late 2nd C -late 2nd/mid 3rd C) and to Phases 6-8 (AD 150s/180s) and 9a-n (late 2nd/early 3rd C) at Blackfriar's Street. There was little activity at Annetwell Street at this time.

At Old Grapes Lane A (Phases 7-10) there is a possible abandonment phase with some demolition material followed by a metalled road. This itself was superseded by soil deposits, a building and various surfaces. At the same time at Old Grapes Lane B (Phases 4E-7B) there were soil spreads and a building represented by slots, gulleys, postholes etc. At LEL-A in phases 7-9, and simultaneously at CAL-A in phase 3, these property boundaries and timber buildings were obliterated by overlying surfaces and soil deposits, with miscellaneous pits and gullies at LEL-A (but not at CAL-A). The surfaces were probably external as no indications of any walls were found. In phase 10 at LEL-A, a major post-built timber structure was built on substantial clay and cobble foundations. The building appears to have been a courtyarded structure, and no floors were recovered, although various external features were recorded. This building extended into OBL-B, and similar, probably related features were found in CAL-A, but no animal bones have been studied for these (or any later) phases from either CAL-A or OBL-B, since they were not prioritised by the excavator. The building may have been a large private house at the junction of the roads through CAL-B and Scotch Street. At LEL-A during phases 11-12, further changes were made to the layout and building plan. In phase 12B several walls and at least two rooms were present, including clay and earthern floors.

Material dating to the later Roman period (*ie*: 3rd/4th/5th C) was recovered from Castle Street, Blackfriar's Street and Annetwell Street, but has not been identified from any of the southern Lanes excavations.

OGL-A: Phases 11, 12 **3rd-12th C**

OGL-B: Phase 8

LEL-A: Phases 17 & 18

the material from these phases was difficult to date. Similar problems were encountered at Old Grapes Lane in Phases 11-12 (at OGL-A) and Phase 8 (at OGL-B). In LEL-A phase 13-20 there was a succession of poorly dated features including fragments of buildings plus numerous surfaces.

OGL-A: Phase 13 **12th/13th C**

OGL-B: Phase 9

LEL-A: Phases 19-21

At Old Grapes Lane in this period, the main features were a well (OGL-A Phase 13) and a series of pits (OGL-B Phase 9). The period of activity at OGL and LEL-A may overlap with some of the earlier material from Phases 13 onwards at Castle Street (Medieval). In phase 21 at LEL-A a large medieval post-built hall was erected, with its gable onto the Scotch Street frontage. There was little evidence for any floors from this building, which fits into the position of No. 65, Scotch Street, and was probably the 12th/13th Century precursor of the late 17th Century building that was demolished as part of the Lanes rebuilding programme in the 1980s.

LEL-A: Phase 22 **post-medieval**

no post-medieval material was recovered from Old Grapes Lane. At Lewthwaites Lane, minute quantities of recordable animal bones were recovered (46 fragments weighing a total of 1.6 kg). Nearly all of these derive from the three main domestic mammals, and more than half of them are from cattle. The only bone of particularly interest is a complete humerus of a woodcock. This species was not represented in any of the earlier deposits, although it does occur in Roman and Medieval material elsewhere. The post-medieval material is not considered further in this report, although it may be possible to include it in the discussion of the Volume 3 report (on medieval and post-medieval remains from the northern half of the Lanes).

The phases have been grouped into major periods in order to consider the material from all five sites as samples of a single population. Previous analyses (Stallibrass 1992) have shown that the material from all five sites is very uniform. Although most sites have phases that can be split between the turn of the first Century (AD 96-117, eg LEL-A phase 7) and the early-mid 2nd Century (AD 121-160, eg LEL-A phase 8), phase 6 at OGL-A transgresses this boundary, lasting from AD 93-160. Since phase 6 provided a major amount of material, it was thought prudent to combine the phases so that all five sites could be pooled. It is intended that the same periods will be applied to the analyses of the Roman material from the northern half of the Lanes excavations (Volume 2) if they prove to be appropriate to the sites' stratigraphy.

Methods of recovery

Most of the animal bones were recovered by hand during excavation of a large (but unmeasured) quantity of stratified deposits, but a significant minority were recovered from the residues from bulk samples processed through a flotation machine using 0.5 mm mesh. The term 'bulk sample' is used here in its standard definition of a volume of soil or sediment that has nothing removed from it prior to processing. Whenever possible, a minimum of 30 litres of sediment was processed, and most of the bulk samples contained 75 or 150 litres. The residues were picked through by members of the excavation team and, in effect, all bone fragments over 25mm long were recovered together with many that were between 10 and 25mm in maximum length. These are listed as 'sieved' fragments. The remaining residues (referred to in the rest of this report as the 'fine fraction') were sorted in the Durham University Department of Archaeology Biological Laboratory by Mr. Shaun Doran in 1991. Due to insufficient financial resources for this work, not all of the fine fraction residues could be sorted. This accounts for the lack of fine fraction material from LEL-A phases 2 and 6, and OBL-B phases 2 and 6.

The quantities of material

The material from the southern Lanes sites was assessed by the site director, and a total of 80 long bone boxes of animal bones was awarded Priority 1 (*ie*: 26 boxes from OGL-A, 25 from OGL-B, 24 boxes from LEL-A, 3 boxes from CAL-A and 2 boxes from OBL-B) on the grounds of secure stratigraphy and dating information.

All of the Priority 1 material was sent for analysis and has been catalogued and analysed for this report.

Table 2, below, shows how the quantities of bone considered in this report relate to the mode of retrieval. Table 3 gives the distributions of bone weights by period and recovery method for the three sites.

Table 2: weights of animal bones from the southern Lanes in g

	OGL-A	OGL-B	LEL-A	CAL-A	OBL-B	TOTALS
hand-recovered	55,513	94,103	96,451	10,724	7,722	**264,513**
sieved	11,783	980	4,163	2276	954	**20,156**
'fine fraction'	690	54	143	53		**940**
TOTALS	**67,986**	**95,137**	**100,757**	**13,053**	**8,676**	**285,609**

There is very little material from prehistoric deposits (357 g), and four cattle bones were the only pieces identified to species level.

The total quantity of material weighs nearly 300kg, and most of this dates to the 1st/2nd C or the 2nd/3rd C (more than 100 kg each). Nearly 20kg derives from ?late or post-Roman/Anglian deposits. These cannot be dated more closely than the 3rd-12th centuries AD, possibly due to the facts that the region was aceramic for several centuries and coinage was sometimes scarce. Material from these deposits has been included in the analyses in attempts to investigate whether the material resembles well-dated Roman or medieval material. Since the usual dating methods are not applicable (*ie* ceramic and coinage sequencies), the bones themselves have been used to try to date the deposits. Approximately 40 kg of material dates to the medieval period (12th/13th C).

Material from the major periods is not evenly spread between the sites. All of the priority one material from CAL-A and OBL-B (20kg) dates to the 1st/2nd C. LEL-A contributes almost half of the 1st/2nd C material, whereas OGL-B contributes two-thirds of the 2nd/3rd C material, half of the 3rd-12th C material, and all of the post-medieval material (1.6kg).

Sieved samples were analysed from all five sites for 1st/2nd C material, from OGL-A and -B for 2nd/3rd C material and from OGL-A only for medieval material (12th/13th C). The material from sieved samples weights approximately 7% of the total material recovered (10% of the contexts were sampled).

The archive

The site archive, including the animal bones, will be stored in the Tullie House Museum, Carlisle.

RESEARCH PRIORITIES

The research priorities for the work relating to the Lanes project as a whole, and Volume 1 in particular, are given in detail in the archive report for Old Grapes Lane (Stallibrass, 1993). A general summary is repeated below.

General priorities and aims for animal bone specialist work for the whole of the Lanes project.

1: To compare Roman material from The Lanes (a civilian settlement) with that from Annetwell Street (the fort), Castle Street (the fort annexe) and Blackfriars Street (a separate civilian area), in order to investigate potential differences in site function during the Roman occupation.

2: To compare the early (1st/2nd Centuries AD) and later (3rd/4th Centuries AD) Roman material within the Lanes (civilian area), and to compare the later Roman material from the Lanes with that from Castle Street, in order to study potential changes in civilian site function and status as the fort went through different phases of importance.

3: To compare material from different periods *ie*: the prehistoric (where present), Roman, Anglo/Scandinavian (where present), medieval and post-medieval periods, in order to investigate the development of Carlisle through time.

4: To investigate any changes in livestock types and husbandry patterns through time, in order to compare with other parts of Britain.

In addition there are other, more specific, research aims that relate to:

5: particular contexts or groups of deposit, in order to answer questions regarding aspects of stratigraphy or site function, and

6: particular bones of interest.

disclaimer

Due to the imposition of an arbitrary deadline for the specialist work, the estimated time available for study of the animal bones was cut by fifty percent. Because of this, some aspects that should have been studied have had to be left out. In particular, this includes all of the archaeological and taphonomic studies that are needed in order to compare the collection with those from other sites. It is hoped that work on Volumes 2 and 3 of the material from The Lanes will rectify this situation. Even simple quantifications such as the relative frequencies of identified fragments are not strictly comparable, since the Lanes material had to be recorded in a simplified manner.

PRESERVATION

When the animal bones were assessed (Stallibrass, unpublished, 1991), it was noted that their states of preservation ranged from one extreme to the other. Four states were identified: Excellent, Good, Brittle and Shot. These are defined as follows:

EXCELLENT: the bones are dense and robust, and their surfaces are as smooth as they are in life. All of their surface details such as muscle attachments, minor lesions, periosteal alterations etc. together with any post-mortem alterations such as fine knife cuts, carnivore toothmarks etc. are clearly visible.

GOOD: these bones are quite robust but they have lost the 'satin-like' smoothness of their surface texture and surface details may occasionally have been lost.

BRITTLE: these bones are very light in weight, and the bones are very brittle and easily broken (both in the past and during excavation and handling). In addition, the surfaces are often flaky or eroded. This surface destruction has often removed any anatomical or post-mortem details that might have been present. In addition to surface erosion, many of the bones are encrusted with soil minerals, obscuring the shape and surface of the bones.

SHOT: these bones are almost completely 'shot to pieces' ie: minerals have infiltrated between the lamellae and have led to severe exfoliation. The outer surfaces are often missing completely. The bones are highly fragmented and are generally completely unidentifiable by eye.

For the assessment, each bag of bone was classified as belonging primarily to one of these four categories. Some contexts produced several bags, each of which was recorded individually. Weights of calcined bones were negligible and were not recorded separately.

Table 4 presents the weights of bones by period and preservation type for the five sites. Sixty-one percent of the total is excellently preserved. For the 1st/2nd C material, 95% is excellently preserved and for the 2nd/3rd C this is reduced to 56%. At all three sites with material from both periods analysed (OGL-A, OGL-B and LEL-A), there is an abrupt change in the preservation conditions during the second period, between the mid- and late-2nd Century. For the earlier phases almost all of the bones are classified as Excellent. In the later second Century (post *c.* AD 160) the emphasis shifts, first to a mixture of Good and Brittle, and then (by the late 2nd/3rd C) to almost totally Brittle. All of the 3rd-12th C material is poorly preserved. Most of the medieval material is Brittle, too, although small quantities are better preserved in some of the deeper contexts. The change in preservation conditions may be related to a change in building materials. In phase 10 at LEL-A the building was constructed on clay and cobble foundations which would have altered the drainage pattern at the site, but it is interesting to note that exactly the same change in preservation type was noticed at Old Grapes lane at exactly the same time period, whilst at that site there was no concommitant change in building materials. A sychronous change in preservation condition was also seen at the military site at Annetwell Street. Again, this may relate to a change in building materials from timber to more clay and stone, or it may relate to a more widespread phenomenon affecting water tables and drainage systems, since the Lanes and Annetwell Street lie at the same height above sea level (about 21m OD).

THE SPECIES

Notes on identifications and recording.

1: Where possible, bones were identified specifically as sheep or goat. Out of a total of 726 sheep/goat bones, three (0.4%) were identified as goat whilst 212 bones (29%) were identified as sheep. The remaining 511 bones could not be identified to species level. For the purposes of this report, it is assumed that the majority of the 511 'sheep/goat' bones derive from sheep, and the term 'sheep' will be used on the understanding that a very few (if any) goat bones are subsumed within the term.

2: Only bones or fragments retaining diagnostic anatomical zones were recorded (see Appendix 1). Vertebrae and ribs were recorded if they retained the defined zones, but could not always be identified to species level. Due to the extremely low frequency of other elements identified as horse or red deer, it is highly probable that (almost) all of the cattle-size vertebrae and ribs derive from cattle. Similarly, due to the extremely low frequency of identified roe deer bones, it is highly probable that (almost) all of the sheep-size vertebrae and ribs derive from sheep. Most of the pig vertebrae were identified specifically, but the ribs were recorded as pig-size. The pig-size ribs have been ascribed to taxon on morphological grounds as well as by size, since the size ranges of sheep-size and pig-size ribs overlap (particularly when juveniles of both species are present).

3: Fusion evidence has been recorded as one of four stages:

F: Fused

Fsg: Fusing *ie* the central portion of the epiphysis has begund to fuse with the diaphysis, but there is a gap between them around the outer edge of the bone

Fvis: Fusion line visible *ie* the epiphysis is fully joined onto the diaphysis, but the line of fusion is still visible (although no longer forming a gap)

UF: Unfused *ie* the epiphysis is completely separate from the diaphysis, even if it can be refitted.

For the tables of epiphyseal fusion, unfused counts include unfused diaphyses only (whether or not refittable epiphyses are present). The figure in brackets following the main number is the number of any 'extra' unfused epiphyses that cannot be accounted for by unfused diaphyses.

4: Bird bones listed as 'fowl' are domestic (*ie*: chickens). Those listed as 'fowl?' are almost certainly fowl and those listed as 'fowl-size' are very probably fowl. Identified bones of black grouse are extremely scarce and there is no indication of any pheasant bones nor of any guinea-fowl bones. Again, further identification has been undertaken by Dr. Allison and should be available for the publication report. Her study includes all of the bird bones, whether or not they retain the diagnostic anatomical zones used in this analysis.

5: The bones of domestic geese (which are thought to have been domesticated from wild greylag geese) cannot always be distinguished from bones of wild greylags. Some of the bones recorded in these tables as 'greylag' may, therefore, derive from domestic rather than wild geese. Only those bones that are clearly much larger than those of wild greylag have been recorded as 'domestic'. Further identification of the bird bones is being undertaken by Dr. Enid Allison and will form the basis of a separate Ancient Monuments Laboratory report.

6: The fish bones have been studied by Dr. Rebecca Nicholson and will form the basis of a separate AML report. Her conclusions are summarised below, and her identifications from the deposits that were studied for this report are included in the relevant table (Table 7).

7: The specialist reports will be integrated for the publication volume.

8: All measurements have been taken in accordance with von den Driesch (1976) unless otherwise stated.

The relative numbers of identified specimens

Tables 5, 6 & 7 present the distributions of fragments recorded for the presence of anatomical zones. The recording methodology follows that used for Old Grapes lane (Stallibrass, 1993). Fragments retaining zones form a small fraction of the total numbers of fragments, and the species ratios are not strictly comparable with other types of recording, which would have taken too long for the time available. Thus, comparisons with Annetwell Street, for instance, are not strictly valid. For Volume 2 of The Lanes analysis, methods will be utilised that can link the two systems, to make comparisons feasible. Table 5 lists the fragments recovered by hand from each site (Total N=3703), Table 6 lists the fragments recovered by the excavators in Carlisle from the sieved samples from each site (Total N=431) and Table 7 lists the fragments recovered from the fine fractions from OGL-A & -B, LEL-A and CAL-A (Total N=755).

The hand-recovered collections are all heavily dominated by the bones of the three major domestic mammals: cattle, sheep and pigs. If the vertebrae and ribs are included as being from cattle, sheep and pigs, then these three species account for 95% of the total hand-recovered collection; without them, they still comprise 78%.

Table 8 (below) groups the hand-recovered fragments from all five sites by major period. It is very clear that, within each period, the relative frequencies of cattle:sheep:pigs are almost identical regardless of whether or not the ribs and vertebrae are included. Since statistical analyses tend to be more reliable when samples are larger, the ribs and vertebrae have been included with the specifically identified elemental fragments for the rest of this report.

Table 8: Identified specimens of cattle, sheep and pigs in the hand-recovered collections from the southern Lanes

	late 1st/2nd C		late 2nd/3rd C		12th/13th C	
	N	%	N	%	N	%
Cattle	674	54%	632	63%	337	73%
Sheep	343	28%	180	18%	66	14%
Pigs	224	18%	195	19%	60	13%
Totals	1241		1007		463	
	N	%	N	%	N	%
Cattle+Csize	846	55%	752	63%	397	72%
Sheep+Ssize	420	27%	213	18%	80	15%
Pigs+Psize	264	17%	231	19%	72	13%
Totals	1530		1196		549	

For the rest of this report, it is assumed that the cattle-size vertebrae and ribs derive from cattle, that the sheep-size vertebrae and ribs derive from sheep, and that the pig-size vertebrae and ribs derive from pigs. The following ratios, therefore, include counts of vertebrae and ribs.

The effects of recovery method

The effects of recovery bias can be seen by comparing the hand-recovered collection (Table 5) with the material recovered from the sieved samples (Table 6). Although the proportion of the collections composed of bones from the three major domesticates are extremely similar (97% and 98% for the hand- recovered and sieved collections, respectively), the relative proportions of the three species themselves are significantly different. Figures can only be compared for the late 1st/early 2nd Centuries, since this is the only period for which both collections exist. In the hand-recovered collection, the ratio is 56:27:17% Cattle:Sheep:Pigs (N=1521), whereas in the sieved sample, the ratio is 39:38:23% (N=269). It is very clear that the hand-recovered collection is biased towards the larger bones of cattle in preference to smaller bones of both sheep and pigs (even though the ratio in the sieved collection may itself be slightly inaccurate due to the small sample size).

The numbers of identifed bones recovered in the fine fraction are even smaller (N=110) and cannot be used for species ratios because so much had been selectively removed berfore they were sorted. The material does, however, suggest that small bird bones and all of the fish bones may have been overlooked in both the hand-recovered and sieved collections. Most of the identified mammal bones are loose teeth (mainly incisors, mainly deciduous) and small foot bones (such as juvenile pig sesamoids).

The effects of methods of analysis

Within the hand-recovered collection, two methods of analysis have been utilised to calculate the relative frequencies of the three major domestic species. The simplest method is to count the numbers of fragments recorded for the presence of diagnostic zones (see Table 5 above). This method is probably more accurate than counts of identifiable fragments (regardless of whether or not they retain diagnostic zones) since it is not so subject to bias in favour of larger bones. It is not, however, entirely proof against 'double counting' of bones, since a broken cattle tibia could result in two fragments, one retaining the foramen and one retaining the distal epiphysis. Both of these fragments would be counted. In the case of a sheep tibia, the bone is less likely to be broken (it forms a neater butchery unit than the larger bone of cattle) and so might be counted only as a single fragment, albeit one that retains both the foramen, and the midshaft and the distal epiphysis.

In this report (unlike the previous two reports on Old Grapes Lane: Stallibrass 1993; and Lewthwaites Lane *etc.*: Stallibrass 1992), skeletal elements of each of the three major species are analysed. By counting the frequencies of anatomical zones, minimum numbers of elements can be counted. From these, Minimum Numbers of Individuals (MNIs) have been calculated, using the simplest method of dividing the number of each element by the number of times that that element occurs in a single individual. If the minimum number of elements is an odd number for an element that occurs twice in a skeleton, then the number has been rounded up to an even number (*ie* all MNIs are whole numbers). Comparing the MNIs for the major domestic species in the hand-recovered collections tends to give a very different ratio to that given from the same material by fragment counts (see Table 9, below, and compare it with Table 8, above). Interestingly, the ratio based on the MNIs is often much closer to that based on the sieved sample, whenever a sieved sample is available for that period at that site (see Table 10, below).

Table 9: Ratios of cattle:sheep:pigs
based on Minimum Numbers of Individuals (MNIs)
calculated from element frequencies in the hand-recovered collections from the southern Lanes

	late 1st/2nd C		late 2nd/3rd C		12th/13th C	
	N	%	N	%	N	%
cattle	25	38%	37	49%	14	58%
sheep	28	43%	24	32%	6	25%
pigs	12	18%	15	20%	4	17%
Totals	65		76		24	

The hand-recovered collections are the only ones for which a time sequence can be studied for the group as a whole, since bulk samples (for sieving) from later periods were only taken from Old Grapes Lane. Although the actual percentages are very different to those calculated from the numbers of identified fragments, the same steady trend can be observed through time, indicating an increasing importance of cattle bones (see Table 9 above, for the same time trend shown by the hand-recovered fragments numbers in Table 5). For the MNIs, the percentage of cattle bones increase from 38% in the late 1st/early 2nd C, through 49% in the late 2nd/early 3rd C to 58% in the 12th/13th C. The corresponding percentages using the hand-recovered fragment numbers are 56% through 63% to 73%.

The main effect of using MNIs compared to raw fragment counts is to reduce the emphasis on cattle bones compared to bones of sheep and pigs.

Table 10: a comparison of the ratios of the three major domestic species for the southern Lanes according to different methodologies

late 1st/2nd C.

	Nos. of frags. hand-recovered		Nos. of frags. sieved samples		Minimum Numbers of Individuals	
cattle	674	54%	104	39%	25	38%
sheep	343	28%	102	38%	28	43%
pigs	224	18%	61	23%	12	18%
Totals	1241		267		65	

A study was made of the effect on the observed time trend of recovery method, using the collections from Old Grapes Lane trench A (the only site for which hand-recovered and sieved collections are available from each major period. Unfortunately, sample sizes are often small. No period has >100 fragments from both the hand-recovered and sieved collections, and neither type of recovery produced >100 fragments from every period. The results, using the four different types of analysis (counts of hand-recovered fragments, counts of sieved fragments, MNIs for hand-recovered fragments and MNIs from sieved fragments) are ambiguous and show no consistent pattern, either through time or by method. This is probably due to the problem of small sample sizes. The results are not presented here.

Cattle

Measurements

The measurements for bones from individual sites have already been presented in the archive reports. Since statistical analysis shows that the samples of bone measurements from Old Grapes Lane and from Lewthwaites Lane *et al* are not significantly different, the data from all five sites have been pooled in the analyses presented below.

Calculations of withers heights, measurements of distal metacarpals and measurements of horncore basal diameters are presented here. Linear regression statistics are given for some of the analyses and will be used to compare material from different sites in Carlisle when the material from the northern half of the Lanes has been recorded.

Withers heights

Withers heights have been calculated for all complete long bones using factors given in von den Driesch & Boessneck (1974). The data are presented in Table 11 and Figure 4. There are 45 bones from Roman deposits, 24 of them from the 1st/2nd Century and 21 from the 2nd/3rd C. The mean withers height for the Roman samples are: 1.042 m. (range = 0.933 - 1.174 m; Standard Deviation [SD] = 0.056) for the 1st/2nd C, and 1.101m (range = 0.982 - 1.307 m; SD=0.097) for the 2nd/3rd C. These are not statistically significantly different from each other ($t=0.4340$; $df=43$; $p>0.50$), indicating that there is no appreciable change through time between the early and middle Roman periods at The Lanes, Carlisle. The combined Roman sample (for the late 1st - early 3rd C) of 45 specimens has a mean calculated withers height of 1.070 m (range = 0.933 - 1.307 m; SD = 0.083).

There are only seven measurements from the medieval period (12th/13th C), and their mean is slightly higher: 1.123 m, with a range of calculated measurements that starts higher: 1.037 - 1.232 m; SD=0.065. However, a Student's t-test shows that this is statistically indistinguishable from the Roman sample ($t=0.2500$; $df=50$; $p>0.50$), again indicating that there is no appreciable change in withers height of cattle through time. It is possible that the size of cattle in this region remained stable until the deliberate changes in breeding and husbandry practices of the later Middle Ages.

Horncores

The measurements that are used here are: minimum basal diameter (= von den Driesch's oro-aboral diameter, 45), maximum basal diameter (= von den Driesch's dorso-basal diameter, 46) and outer curvature (= von den Driesch's 47). Figure 5 plots a scattergram of the minimum against the maximum basal diameter. The data sets for the

1st/2nd C and the 2nd/3rd C (N=19 & N=20, respectively) are statistically indistinguishable. The Roman measurements fall on a straight line with a high correlation coefficient: r=0.932 with 37 degrees of freedom. The regression slope of minimum on maximum basal diameter is 0.694 (SE=0.044) and the intercept is 0.868 (SE=1.988). The line has been plotted onto Figure 5.

All of the measurements fall within the usual range for the indigenous Iron Age 'Celtic shorthorn' cattle. There is no separate group of larger horncores as there was in Roman deposits in York (O'Connor, 1988).

The two 3rd-12th Century pairs of measurements both lie along the same line within the same range. At least one if not both of the horncores are almost certainly Roman (or post-Roman) rather than Medieval judging by their measurements. They were both found in Lewthwaites Lane context 84, a deposit in Phase 18.

The eleven pairs of 12th/13th C measurements, however, show a slightly different distribution. The two largest pairs lie considerably beyond the range observed for the Roman horncores. Also, although they all lie along a similar line of slope, the intercept is higher on the minimum diameter scale. In other words, the ratio of minimum to maximum diameter is closer to unity, indicating a rounder cross-section compared to the more ovoid cross-section typical of the Roman material.

The sample size for the medieval period is too small for statistical tests to be useful, but the pattern appears to be quite clear, and will be investigated when the data for the northern half of the Lanes has been recorded (which will be in two parts: the Roman material in Volume 2 and the Medieval material in Volume 3).

Table 12: Summary statistics for cattle horncore basal measurements from the southern Lanes.

	Roman N=39		Medieval N=11	
mean of minimum basal diameter	31.5 mm	(SE=0.80)	35.0 mm	(SE=2.73)
mean of maximum basal diameter	44.2 mm	(SE=1.08)	45.1 mm	(SE=3.45)

Figure 6 plots the basal diameter index (maximum divided by minimum) against the length of the outer curvature for the complete horncores (N=9 1st/2nd C; N=16 2nd/3rd C; N=1 3rd-12th C & N=7 12th/13th C). For the combined Roman sample, the basal diameter index ranges between 1.3 and 1.6 and seems to be independent of length of outer curvature, which ranges from approximately 80 - 170 mm. The figure again emphasises the difference in basal cross-section between the more ovoid Roman horncores and the more rounded Medieval horncores (whose basal diameter indices tend to lie between 1.2 and 1.35).

Metacarpals

For the southern group of sites from The Lanes, the post-cranial element that had the most numerous measureable examples for cattle is the distal metacarpal (1st/2nd C N=24; 2nd/3rd C N=23; 3rd-12th C N=5; Medieval N=11). Figure 7 plots the distal breadth measurements across the condyles (Bd). It shows two main points: (1) the distribution is skewed towards the smaller measurements, and (2) the range of medieval measurements is very similar to that of the Roman bones, with the addition of one very small and one very large outlier. There is almost no difference between the means and ranges of the 1st/2nd and 2nd/3rd C samples (t=0.2024; df=45, p>0.50). The combined Roman sample has a mean Bd of 52.0 mm (N=47; range=46.5 - 64.4 mm; SD=4.24).

Figure 8a is a scattergram plotting the distal breadth at the fusion point on the diaphysis (BFd) against the distal breadth of the epiphysis (Bd). The data are presented in Table 13. The samples from the 1st/2nd C and the 2nd/3rd C are statistically indistinguishable. The pooled Roman measurements have a high correlation coefficient: r=0.9188, with 44 degrees of freedom. This may suggest that a single population is represented, with no influx of any new sized animals in the later period. The regression coefficient of BFd on Bd has a slope of 0.765 (SE=0.050) and an intercept of 7.557 (SE=2.578).

The two largest of the ten medieval bones have measurements that lie beyond the range of the Roman measurements, but otherwise all of the points (including those for the 3rd-12th C) lie along the same regression line. The majority of the measurements fall within a tight cluster towards the lower end of the range. Using sex identifications (see below), the lower end of the cluster tends to include bones thought to be from females, and the higher end of the cluster tends to include bones thought to derive from castrates as well as a few females. There is no clear cut-off point between the measurements of females and castrates. The fewer larger measurements tend to derive from animals thought to be either castrates or entire males. Again, there is no clear cut-off point between the ranges of the putative castrate and entire male bones. Figure 8b plots the sex identifications for all complete cattle metacarpals. It is clear that Howard's indices (used for sex identifications) give ambiguous results for the bones with middle range measurements.

Sex ratio

The complete metacarpals were analysed using Howard's (1962) shape indices. Table 13 presents the relevant data. Both of Howard's indices have been given (using the ratio of the midshaft diameter (SD) to the greatest length, and the ratio of the distal breadth (Bd) to the greatest length). This gives two sex 'identifications' which are not always identical. In the table and on Figure 8b the identification from the distal breadth ratio has always been given first. Compared to her figures for *Bos longifrons* ('Celtic shorthorns'), of the seventeen complete Roman metacarpals from the southern Lanes, eight are from females (FF), six are from females/castrates (FC or CF), two from castrates/entire males (CM) and one from an entire male (MM), giving an overall ratio of 8:3 females:males, with six 'don't knows'. One of the problems with Howard's method is the paucity of data, particularly for the castrates and entire males. Far more work is required with modern material to ascertain the degree of overlap between the measurements and measurement ratios of bones from females, castrates and entire males, and to ascertain relevant ranges of measurements for past livestock. It is not clear from her published work how Howard defined *Bos longifrons*. Her data for modern *Bos taurus* show much larger measurements that may not be directly applicable to all archaeological data, particularly material predating the stock improvements in the later Middle Ages.

Table 14 presents the information regarding measurements and visual assessments of cattle pelves. Only twelve pelves from Roman deposits could be measured at their acetabular rims. Of these, eight are judged to be from females and four from males. Visual assessment of pelvic fragments that could not have their rim heights measured suggest that there are a further two female, one query female, three male and two query male pelves in the collection. If these are added to the measured examples, the overall sex ratio for the Roman collections is ten (plus 1?) females to seven (plus 2?) males. This ratio is less biased towards the females than the ratio suggested by the complete metacarpals using Howard's (1962) indices. The discrepancy may be due to the small sample sizes involved, or may reflect a tendency for larger (probably male) metacarpals to be selectively removed for use in artefact manufacturing. There is, however, no evidence for the latter at this site.

Dental data.

Figure 9a shows the distributions for Mandibular Wear Scores (MWSs) (Grant, 1982) for cattle.

Forty-five Roman cattle mandibles have complete MWSs (16 from the 1st/2nd C and 29 from the 2nd/3rd C). Five mandibles from the 3rd-12th Centuries and three more from the 12th/13th Centuries also have MWSs. There are no obvious pairs of jaws. Figure 9 shows a clear bias towards high scores, with 35 of the Roman scores (78%) lying between 38 (when all three molars are in full wear) and 54 (at which stage all three molars are worn down to gum level). There are no MWSs from very young calves, and only five from juveniles (MWS=16-26). The jaw at score 16 has the lower second molar (M_2) half up. Silver (1969) puts the eruption age of this tooth at 15-18 months. Then there is a small cluster of mandibles with scores at 21-26. For the jaws at 21-23, the lower third molar (M_3) is in the crypt or visible, and for those at 22-26 the M3 is erupting or half up. Silver puts the eruption age of M3 at 24 months. The next small cluster of MWSs is at 33-38 and all of these jaws have M3 in the early stages of wear (Grant's stages b-f). Every jaw at 41 or more has all three cusps of the M3 in full wear (Grant's stage g or beyond), with all permanent teeth (including P4) fully erupted. Ages cannot be ascribed to these jaws, although it is clear that all of them had been in use for some time since the fourth lower premolar erupted (at *circa* 3 years), and the jaw with a MWS of 54 clearly belonged to an aged animal that would not have been able to chew food for very much longer due to the particularly worn state of its teeth.

This sample shows that the majority of the cattle (in all periods) were kept well into maturity. This suggests either that there was no problem in overwintering livestock, or that juveniles were sent elsewhere for slaughter/fattening. If juveniles had been slaughtered *in situ*, it is likely that primary butchery would also have taken place, leading to the local deposition of their jaws. Whilst the six jaws with MWS of 21-26 may well represent animals slaughtered at the prime age for meat, it is clear that the majority of animals represented by jaws had been kept primarily for other purposes such as breeding, milking or traction before being killed (or suffering natural deaths).

The large sample and the remarkably consistent patterns of wear on the molar teeth permits estimations of MWSs to be made for jaws from which one molar cannot be recorded (due to loss or breakage). Figure 9b presents the MWSs from Roman deposits, including estimated scores. Because of the consistent patterns of wear observed on the complete jaws, most of the estimated scores are probably accurate to within 1 point. The sample sizes for both periods are increased considerably (from 16 to 27 for the 1st/2nd C and from 29 to 48 for the 2nd/3rd C). The ratio of numbers of jaws available from the two periods are almost identical (1:1.8 and 1:1.7 from the 1st/2nd C: 2nd/3rd C for observed and estimated jaws respectively). The distributions of scores either side of MWS=36 (when the P_4 erupts) are very similar in the observed and estimated collections (1:4.6 and 1:4.8 resepectively), suggesting that there has been no preferential breakage of juvenile jaws, nor any noticeable difference in rates of fragmentation between the two periods. The increased sample size used in Figure 9b, together with the exclusion of the few medieval scores (four observed, plus two estimated) serves to highlight the predominance of jaws with mature adult dentition.

The necessity for jaws to be more or less complete in order for MWSs to be recorded tends to favour the more robust adult jaws in preference to immature mandibles. Using all of the teeth (whether *in situ* or loose) the ratio of deciduous:permanent last lower premolars for the Roman period is 15 dp_4s: 80 P_4s (~~19%~~ juveniles), which confirms the predominance of 16%
fully adult jaws. In fact, this ratio is almost identical to the ratio of juveniles in the Roman
very similar

collection of jaws used for MWSs (18%), suggesting that the predominance of mature jaws indicated by the MWSs is genuine, rather than a reflection of any preservation and recovery biases. However, an analysis of the wear stages of the dp_4s shows that the youngest individuals represented at the Lanes by dental data are not included in the Mandibular Wear Scores. One of the dp_4s is only half erupted and must come from a neonatal animal. Two other teeth are only just coming into wear (Grant stages a and b) and must derive from calves that died within a month or two of their births. A fourth dp_4 has a wear stage of only d. This is also likely to come from a young calf. The least worn dp_4 to be represented by a MWS has Grant's wear stage of h and a MWS of 16 (see Figure 9). This jaw was estimated to come from a calf that was 15-18 months old, since the M_2 is half erupted. The first four dp_4s, therefore, are all from animals much younger than this. Three of them, if not all four of them, deriving from calves that were probably neonatal or, at most, less than about six months old.

For the other periods, there are five P_4s and no dp_4s in the sample dating to the 3rd-12th C, and there are four P_4s and 2 dp_4s from medieval deposits.

The preservation conditions at the Lanes is generally excellent for the Roman period (particularly for the 1st/2nd Century) and there are few loose teeth.

Congenital dental abnormalities

Sixty-eight Roman cattle mandibles retain the portion that should contain the second lower premolar (P_2) (24 in the 1st/2nd C and 44 in the 2nd/3rd C). Table 15 below presents the raw data.

Table 15: Distributions of congenital dental traits for cattle from the southern Lanes.

Period	P2 alveolus		P2 no alveolus		Totals
1st/2nd C	20	83%	4	17%	24
2nd/3rd C	39	89%	5	11%	44
Roman	59	87%	9	13%	68
3rd-12th C	3		1		4
12th/13th C	3		0		3

Period	M3 no pillar		M3 two columns		M3 third column reduced		Totals
1st/2nd C	2	8%	2	8%			26
2nd/3rd C	7	17%	1	2%	4	10%	42
Roman	9	13%	3	4%	4	6%	68
3rd-12th C	1						7
12th/13th C	2				1		11

Combining the Roman samples, nine of the mandibles have no alveolus present (nor any indication that it has infilled) suggesting that approximately 13% of the individuals congenitally lacked P_2.

Three of the 68 Roman lower third molars (M_3s) lack their third column, whilst a further four teeth each has a reduced third column, together forming 10% of the total. In addition, nine of the 68 Roman third molars lack the buccal pillar (13%), as do two of the eleven Medieval teeth (18%).

An incidental effect of the lack of this pillar is the inability of the tooth wear score for affected M_3s to extend beyond Grant's (1982) stage 'g'. It is probable, therefore, that the high MWSs for cattle jaws are, in fact, *under*estimates of the relative wear stages of some of the jaws. This emphasises even more the importance of elderly animals in this collection.

Fusion data.

Table 16 presents the epiphyseal fusion data for the cattle bones from the five sites, grouping the data into 1st/2nd C, 2nd/3rd C and 12th/13th C deposits. The numbers of diaphyseal fusion surfaces (metaphyses) used in each data set are N=570, N=568 and N=268 respectively (loose unfused epiphyses have not been included in these counts). The three data sets all show very similar patterns of fusion stages, with extremely few unfused examples of early-fusing and middle-fusing metaphyses. Only in the final group of late-fusing epiphyses (mainly represented by vertebrae) are there significant percentages of unfused examples. However, even by this stage, the unfused epiphyses are in the minority. In the three data sets only 23%, 25% and 19% respectively of the epiphyseal fusion surfaces come from animals less than about four and a half to five years old at death. The fusion evidence thus confirms the dental evidence suggesting that the great majority of the cattle were killed when fully adult.

Figure 10 presents percentage survival curves for cattle, sheep and pigs based on their epiphyseal fusion data, again separated into the three main periods. It shows that at least 77%, 75% and 81% of the cattle bones derive from animals that survived beyond the time at which epiphysøal fusion is complete (*circa* 5 years of age). The shape of the curve suggests that the main period for slaughter prior to *circa* five years of age occurred between the ages of 40 - 60 months.

These estimations are very similar to the proportions derived from the Mandibular Wear Scores and from the ratio of dp_4 : P_4 calculated for the combined Roman collection (see above). This close agreement beteen the methods suggests that the mandibular and post-cranial material may derive from the same animals. This is not always the case, since primary butchery can lead to the deposition of jaws of slaughtered animals whose post-cranial carcases are exported and deposited elsewhere. Analyses of relative frequencies of skeletal parts are presented below.

As with the Mandibular Wear Scores, there are some bones that cannot be included in the assessments of epiphsyøal fusion (due to the loss/destruction of the relevant portions of the diaphyses), which clearly derive from very young individuals. Some of these are from neonatal anaimals. From 1st/2nd C deposits, these are: neonatal: one each of: skull (frontal), femur, metacarpal, metatarsal; very young (?weeks/1-2 months): one metatarsal; young calves (a few months, probably less than six months): one each of: radius, metacarpal, metatarsal. None of these bones is thought to derive from the same individual as any of the others, due to differences in stratigraphy and stage of development. From the 2nd/3rd Centuries, there are: one neonatal metatarsal, two extremely young (weeks?) radii and one metatarsal, and one metatarsal (?a few months old). From the 12th/13th C deposits, only one extremely young (?weeks) metacarpal was found that could not be included in the fusion table. These few bones support the dental evidence that a few neonatal and very young calves are represented in the collection, although they fail to be represented either by the Mandibular Wear Scores or by the fusion data due to taphonomic factors. They do not alter the overall interpretation of the collection *ie*: that the vast majority of the cattle in all three periods were fully adult when they died, but they do add credence to the notion that some of the animals were 'home produced' rather than imported.

Cattle skeletal element representation

A note on methodology.

A bone or bone fragment was only recorded if it retained at least one of the diagnostic anatomical zones listed in Appendix 1. For most elements, several zones could be recorded. The Minimum Number of an Element has been taken to be the same as the most frequently recorded zone for that element within each data set (again, material has been separated into the three main periods: 1st/2nd C, 2nd/3rd C and 12th/13th C. Material from deposits dating *to anywhere between the 3rd and 12th Centuries has not been included.). To calculate the Minimum Number of Individuals, the number of each element observed (ie recorded) has been divided by the number expected in an entire skeleton, and the number rounded up to a whole number. The greatest of these whole numbers has been taken as the Minimum Number of Individuals. The Minimum Number of each element is then expressed as a percentage of the number expected for that element in the Minimum Number of whole Individuals.*

Table 17 presents the data for observed and expected frequencies of elements of cattle for each of the three main periods and also lists the abbreviations used in Figure 11 where the same data are expressed graphically in bar charts. These data pertain only to the hand-recovered material. The sieved sample is too small to be used in comparison. The results for the 1st/2nd C show an unequal distribution of percentage representation ranging from 98% for the most frequent element (the metatarsal) to 0% for the least frequent (sesamoids). Closer inspection of the graph suggests that most of the poorly represented elements are either very small (such as the sesamoids and carpals) or are particularly likely to have suffered physical and chemical damage due to their high content of marrow-containing trabecular bone (such as the ribs and vertebrae). The distribution in Figure 11, therefore, can be interpreted as a collection remaining from entire carcases that is biased due to two factors: (1) poor recovery of smaller bones, and (2) the preferential destruction of trabecular bone. All of the major bones of the body (longbones of both the forelimb and the hindlimb, together with the mandible, scapula and pelvis) are well represented, suggesting that there has been little selective deposition/ redeposition of body parts. The pattern of element representation is generally similar for the 2nd/3rd C excepting that the most frequent element is the scapula rather than the metatarsal. The pattern for the 12th/13th C is, again, broadly similar although there tends to be a greater spread of percentage reprentations. For all three periods, therefore, the interpretation is put forward that the element representations suggest that the collections consist of the remains of whole cattle carcases.

Discussion of the cattle bones

Types:

The Romano-British cattle bones all appear to derive from typical 'Celtic shorthorns': small cattle with small horncores. The horncore and metacarpal measurements are extremely similar at all five sites.

The few Medieval examples of metacarpals and horncores show greater ranges in size, and the horncores may be of a subtly different shape (*ie*: more rounded in basal cross-section).

Ages:

The dental and epiphyseal fusion data support each other with regard to the age structure of the dead cattle represented. Both sets of data emphasise the predominance of fully adult animals in all three of the main periods (1st/2nd, 2nd/3rd and 12th/13th C). Approximately three-quarters of the bones derive from mature adults. The main methods used show no evidence for any young calves, and very little evidence for juveniles, but a closer investigation of the material reveals the presence of some very young animals (neonatal or a few weeks old to a few months old) whose remains have suffered taphonomic destruction.

Carcase completeness:

The Minimum Numbers of Elements suggest that whole carcases are represented in the collections from all three periods. The main causes of variation in percentage representation of skeletal elements are thought to be recovery bias against the collection of small bones and preservation bias against trabecular bone.

Comparison with the military sites in Carlisle:

This emphasis on mature cattle contrasts slightly with the evidence from the military sites. The collection at Annetwell Street was also dominated by bones from fully mature animals, but there was also a significant minority of juvenile or sub-adult animals represented. These animals were probably raised primarily for meat. The presence of bones from very young calves at The Lanes suggests that the collection is refuse from a producer society rather than a consumer society. Whilst the bones of young animals can be interpreted as the remains of high class feasting of succulent young meat, the paucity of other potentially high status remains suggests that these bones derive from accidental deaths of young livestock raised locally.

The sizes of the animals at the military and civilian sites appear to be very similar. The metrical similarities of the cattle bones will be tested statistically when the whole of The Lanes material is catalogued, to investigate whether or not the bones might have derived from a single population.

The incidences of congenital abnormalities of cattle teeth are very similar to those seen in the military material at Annetwell Street.

At Annetwell Street in Period 3, there was a superabundance of cattle scapulae compared to any other skeletal element. The rest of the bones from these 'extra' animals represented only by scapulae must have been deposited elsewhere. However, there is no complementary evidence for a paucity of scapulae at The Lanes. The shoulder joints represented at the fort must either have come from some other site(s) or from elsewhere within the fort/civilian areas.

Sheep

Measurements

N.B. Regression coefficients are given here for future comparisons with other material.

Withers heights

Table 18 and Figure 12 present the evidence for withers heights of sheep, using all fully fused complete long bones and factors given in von den Driesch & Boessneck (1974). For the Roman examples (N=38) the calculated withers heights range from 0.527 - 0.658 m with an average of 0.579 m (SD=0.031). There was only one suitable bone from Medieval deposits, and two from contexts dating from the 3rd-12th Centuries. The ranges and means of the collections from the 1st/2nd C and the 2nd/3rd C are extremely similar and statistically are not significantly different ($t=0.277$, 36 df, $p>0.50$). All of these bones were identified specifically as deriving from sheep rather than goats.

Metacarpals

The most frequent available pair of measurements for sheep metacarpals at the Lanes is the proximal breadth (Bp) and the proximal depth (Dp). These are plotted as a scattergram in Figure 13a (the original measurements are listed in Stallibrass 1992 & 1993). There are 35 Roman examples (18 of which date to the 1st/2nd C) and 7 Medieval examples. The medieval measurements all lie in the upper half of the range of Roman measurements. The regressions for the 1st/2nd C and 2nd/3rd C are extremely similar and are not statistically significantly different. The correlation coefficient for the grouped Roman sheep measurements is $r=0.834$ with 33 degrees of freedom. The regression coefficient of Dp on Bp has a slope of 0.644 (SE=0.074) and an intercept of 1.520 (SE=1.499). Most of the bones were identified specifically as sheep. None were identified as goat.

Some of the metacarpals are complete enough to retain fusion evidence for the distal epiphysis. Figure 13b plots the distribution of the proximal measurements (as above) coded for the distal fusion data. There are eleven fused bones, seven unfused bones, and one bone where the distal epiphysis is fused, but the fusion line is still visible, suggesting that the fusion had only recently been completed when the animal died. All nineteen examples are from the Roman deposits (there are no medieval examples retaining fusion evidence). The young bones that are distally unfused probably derive from animals that died before they reached 1.5 - 2 years. It is immediately clear that their proximal measurements cover the same range as those of the fully fused bones. In fact, six of the seven unfused bones have measurements in the upper half of the range of measurements from fully fused bones. This may suggest that some, at least, of the unfused bones derive from young males, which might be expected to reach larger adult sizes than most of the females.

Tibiae

Table 19 and Figure 14a present the comparable data for the distal tibia measurements (distal breadth:Bd and depth:Dd). There are 41 Roman pairs of measurements (17 of them from the 1st/2nd C), one from the 3rd-12th C, three from the 12th/13th C and one post-medieval pair. Two of the three medieval pairs, together with the 3rd-12th C and post-medieval examples, fall just beyond the range of the Roman measurements, at the higher end. The regression coefficients for the 1st/2nd and 2nd/3rd C are extremely similar and are not statistically significantly different. The correlation coefficient for the grouped Roman sheep measurements is r=0.863 with 39 degrees of freedom. The regression coefficient of Dd on Bd has a slope of 0.749 (SE=0.073) and an intercept of 0.968 (SE=1.595).

Silver (1969) gives the age of fusion of the distal tibia as 1.5 - 2 years *ie.* the same as the distal metacarpal. All of the examples given in Table 19 and Figure 14 are fused or in the process of fusing. They should, therefore, complement the distribution of metacarpals with unfused distal epiphyses (see section above and Figure 13). Figure 14b presents the same measurements as those in the upper graph, coded by fusion status rather than by period. Thirty-seven of the bones are fully fused distally, one of the medieval examples is in the process of fusing, and six of the Roman bones have the fusion line still visible, suggesting that the animals died relatively soon after the epiphysis became fully fused on to the diaphysis. There is no evidence for the proximal fusion status of any of the bones that retain their distal epiphysis. As in Figure 13 for the metacarpals, it is clear that most, if not all of the younger bones (those with the fusion line still visible, plus the one example still fusing) derive from bones that fall within the upper half of the range of measurements. Again, it is tempting to suggest that these may derive from young male animals, slaughtered at about, or soon after, 1.5 - 2 years of age. A bar graph of the distal breadth (Bd) on its own (not included in this report) does not show any indication of bimodality in its distribution of measurements. All it shows is a broadly normal distribution of Bd measurements for the Roman collections, with the measurements for bones from the later periods (3rd-12th, 12th/13th and post-medieval deposits) all falling near or beyond the upper limit of the Roman range.

Sex ratio

Table 20 presents the measurements of the midshaft diameter of the ilium (SD) and of the acetabular rim height, together with visual assessments of the sex of the sheep pelves. Thirteen Roman sheep pelves could be measured for rim heights (ten from the 1st/2nd C), plus four more from the 12th/13th C, and the measurements give a good correlation with the visual assessments. There appear to be approximately equal numbers of males and females represented by pelves in all three of the major periods. Most of the male pelves are thought to derive from castrates rather than entire males due to the degree of definition of the ilio-pectineal ridge. Visual assessments were also made on some fragments that could not have their rim heights measured (these are also given in the table). All of these are thought to derive from males or possibly from males, due to the length of the ilial shaft together with its degree of curvature (Boesssneck 1969). Less reliance is made on these assessments, however, than on those made from the shape and height of the acetabula. The midshaft diameter of the ilial shaft does not appear to corelate with the results of the acetabular method. Studies of modern bones from sheep of known sexes are required to investigate whether or not the midshaft diameter of the ilium has any relationship with the sex of an individual.

Very few fragments of sheep horncore and/or skull were recovered, so nothing can be said concerning ratios of polled to horned individuals (which might or might not relate to sex ratios).

Dental data

Figure 15a shows the Mandibular Wear Scores for sheep jaws (Grant, 1982). Sixty-seven Roman mandibles could be scored, 28 of them dating to the 1st/2nd Centuries. A further nine mandibles were used from 12th/13th C deposits. The Roman sheep scores are more widely distributed than those for the cattle jaws, ranging from 2 to 48. All of the dp_4s are from sheep not goats, indicating that all of the young animals are sheep. The older mandibles have not been assessed for species identification.

Using the tooth eruption data for these jaws in conjunction with Silver's (1969) modern data, the mandibles with MWS= 2-4 derive from lambs that died before M_1 had fully erupted (*ie*: <3 months). The MWSs at 7-13 derive from animals that died as M_2 was in the process of forming in the crypt and erupting. This puts the age at death at less than or up to approximately 9-12 months. A large group of mandibles have MWSs=17-27. At MWS=17-25, the M_3 is concealed or visible in the crypt (N=17). At MWS=17-19 this coincides with the M_2 just coming into wear (probably at approximately 12 months of age, or slightly later). A few mandibles have M_3 beginning to erupt, at MWS=26 -27. Silver puts the eruption age of M_3 at 18-24 months. There is then a very tight group of Mandibular Wear Scores of 30-32. These all have the M_3 erupted, but only just in wear (Grant's 1982 stages b and c). These probably derive from animals that died at or just beyond two years of age.

The M_3 is fully in wear (with all three cusps showing some dentine on their occlusal surfaces) at Grant's stage e. This coincides with MWS 34. All of the mandibles with MWS of 34 or more are, therefore, from dentally mature animals over two years old at death. However, it is noticeable that even within this group, there is a bias towards lower scores (34-42) with only one mandible scoring more than 42. For the 67 Roman mandibles, there are equal proportions of jaws with scores and dental eruption data suggesting age at death of below and above the age of two years. Overall, there are 34 < 2 years and 33 > 2 years. This even distribution is the same in both the 1st/2nd C (16:12) and the 2nd/3rd C (18:21) collections. Only in the small medieval collection is the ratio imbalanced, with two jaws <2 years and seven jaws >2 years.

Grant's (1982) method of recording tooth wear stages does not calibrate the lengths of time that a tooth may remain at one stage, and it is thought that some stages are comparatively short-lived. The absence of teeth at certain wear stages, therefore, should not be over-interpreted (for instance, there are no M_3s with the wear stage d, although there are seven at b, four at c, and six at e). Evidence for seasonal slaughter would require a pattern of clear peaks of closely-aged jaws separated by gaps in which no/very few jaws occur. The data given above do not rule out the possibility that sheep tended to be slaughtered during a restricted part of the year, although they are not definitive, partly because of the problem inherent in Grant's method (mentioned above). However, the large numbers of jaws that contain either M_2 or M_3 in the process of forming in the crypt or erupting do suggest that at least a notable proportion of the young animals were dying towards the end of either their first or second year. Because we do not have modern data to indicate how long the teeth take to form in the crypt prior to eruption, it is not possible to narrow down the season(s) of death. Those jaws with a tooth actually in the process of erupting probably derive from animals that died in the winter, but those that have the tooth still in the crypt might have died during the autumn or early winter (given a spring season for birth). It is not economical, usually, to slaughter animals at the end of the winter, since they have usually lost a lot of condition by then. Males killed towards the end of their second year need not have been castrated, but would have had to have been kept away from the ewes at tupping time if they were not wanted for breeding purposes.

It is not possible to say whether these were accidental or deliberate deaths, or a mixture of the two. Far more animals died towards the end of their second rather than their first year of life. For male animals, slaughter at the later age is an economical use of animals that have attained a reasonable size for sale for meat carcases, and have provided one wool clip, but are not required for future breeding purposes. For females, a death at just under two years might relate to problems during their first pregnancy (either problems relating to the pregnancy/birth itself, or to deficiencies in nutrition) causing natural deaths, or to the culling of ewes that had failed to become pregnant. As with the males, they would, at least, have provided one wool clip during their lives. Deaths towards the end of the first year of life are more likely to relate to deliberate culling of unwanted/poor quality livestock, to selective slaughter of specific animals deemed suitable for eating at some special occasion, and to unintential deaths caused by accidents, illhealth or malnutrition.

The large sample size and the consistent patterns of wear on the molars permit estimates to be made of MWSs for jaws for which one of the molars cannot be recorded directly. Figure 15b plots the Roman wear scores including the estimated scores. Because of the consistent patterns of wear, nearly all of the estimated scores are likely to be accurate to within 1 point, and the few remaining scores are probably within 2 points. The sample sizes are increased from 39 to 49 for the 1st/2nd C and from 28 to 32 for the 2nd/3rd C. As with the cattle jaws, the inclusion of estimated wear scores does not alter the ratio of jaws above and below the age at which P_4 erupts, but serves to highlight the pattern already demonstrated by the directly observed jaws. Again, this suggests that preservation conditions were good, even for young jawbones.

In the Roman collection as a whole (including all teeth, whether or not *in situ*, whether or not a MWS can be counted) there are almost equal numbers of deciduous: permanent last lower premolars (ie: 51 dp_4s: 50 P_4s), reinforcing the evidence from the Mandibular Wear Scores for equal numbers of juveniles and adults (the P_4 erupts at about 2 years). Just as with the MWSs, the even distribution is the same in both Roman periods (29:33 and 22:17 in the 1st/2nd and 2nd/3rd C respectively). The excellent preservation of the sheep jaws is illustrated by the fact that only three loose teeth are included in these counts: two dp_4s and one P_4. Of these, one dp_4 and the one P_4 were found in sieved samples.

In the medieval collection, the ratio favours the older jaws (2 dp_4s: 10 P_4s). This is similar to the ratio of jaws with MWSs and dental eruption stages indicating age at death of below and above two years.

Fusion data

Table 20 gives the epiphyseal fusion data for sheep from the three main periods at all five sites, and the data are plotted as percentage survival curves in Figure 10. The sample numbers are considerably smaller than those for the cattle (N=271, N=159 and N=55 for the 1st/2nd, 2nd/3rd and 12th/13th C respectively).

In the Roman deposits, there are almost no unfused examples of metaphyses that fuse before 10-16 months (using Silver's modern comparisons, Silver, 1969). But almost one third (31%) of the epiphyses in the next group (expected to be fused by 1.5 - 2/2.3 years) are unfused. There are extremely few examples of epiphyseal fusion locations (whether fused or unfused) in the group expected to be fused by 3 - 3.5 years (N=14, 64% unfused). Of the vertebral epiphyses, expected to fuse between 4 -5 years, 75% are unfused. These figures of unfused metaphyses are clearly much higher than those encountered for the cattle bones.

The shape of the survival curve in Figure 10 demonstrates a slight loss of sheep in their second year, followed by a major loss in their third and fourth years. The patterns for the

1st/2nd and 2nd/3rd C are extremely similar, and even the small sample from the medieval period shows the same distribution. This pattern is broadly similar to that seen in the dental data, except that (1) there are no very young animals represented by fusion data equivalent to the MWS=2-4, (2) the numbers of sheep dying in their first year are very small, and (3) the relative proportions of sheep dying before and after reaching two years of age are very different.

Some of the youngest post-cranial bones could not be included in the fusion table, since their relevant metaphyses had not survived. However, some of these bones are clearly from very young animals. From the 1st/2nd C, there are: neonatal: one radius and one metatarsal; extremely young (probably weeks old): one cervical vertebra and two ribs; very young (probably weeks/ a few months old, almost certainly < 6 months): one humerus, one metacarpal and one tibia. From the 2nd/3rd C, there are: one neonatal metatarsal, one radius, one femur and one metatarsal, all from extremely young lambs (?weeks old). There are no very young bones from medieval deposits, but this could be due to the small sample size.

These examples of bones from neonatal and very young lambs and/or kids suggest that the lack of very young bones in the fusion tables is an artefact of preservation and the methods used, rather than a genuine reflection of a lack of post-cranial material to go with the youngest Mandibular Wear Scores *(eg* MWS=2-4). Similarly, the lack of post-cranial evidence for animals dying towards the end of their first year may be due to preferential destruction of unfused epiphyses *eg* by scavenging canids or by other mechanical or chemical taphonomic agents.

The fusion evidence suggests that only 10% of the metaphyses come from animals that died at less than two years (whereas the dental data suggested that the proportion was 50:50%). This discrepancy might be due to problems relating the two methods, or might be a genuine reflection of the dental and post-cranial elements deriving from different, or overlapping, populations of carcases. One indication of this might be differential representation of the relevant skeletal elements (see below).

Sheep skeletal element representation

Table 22 and Figure 16 present the data for sheep skeletal element representation in the hand-recovered collections for each of the three main periods, pooling the information from all five sites. The numbers of elements involved are N=395 (MNI=28), N=287 (MNI=24) and N=76 (MNI=6) for the 1st/2ndC, 2nd/3rd C and 12th/13th C respectively. The sieved collections produced too few bones to be used in this type of analysis. The methodology follows that used for the cattle bones (see above). As with the cattle bones, smaller elements, or bones that contain a high proportion of cancellous tissue are particularly poorly represented. This pattern is even more important for the sheep than for the cattle, since the bones are considerably smaller than their counterparts in the bovine skeleton, rendering them even more susceptible to recovery bias and to destruction by physical and chemical agents.

Apart from the poor representation of susceptible elements, two trends are apparent in Figure 16, (1): In all three periods, the major limb bones from all parts of the skeleton are represented approximately equally (there is more variation in the medieval collection than in either of the two Roman collections, but this may be due to the much smaller numbers of elements involved). (2): In both of the Roman collections, the tibia is exceptionally well represented. This is frequently noted in sheep bone collections from archaeological sites (*eg* Gidney, 1991) and is probably due to the robust nature of the element together with its relatively large size. It is not interpreted here as having any particular cultural significance. Besides these two trends, there is one element that stands out in the 1st/2nd C collection, and that is the mandible, which is extremely well represented compared to all other elements apart from the tibia. Whether this is due to chance is difficult to assess. The mandible is, like the tibia, a relatively large and robust element, but its relative frequency in the 1st/2nd C collection is not matched in the collections from the other two periods. Primary butchery waste of carcases usually results in the deposition of unwanted heads and feet. In the case of the foot bones, these would not be expected to have been recovered in large numbers due to their small size, but the comparative paucity of sheep skulls in this collection does not support the suggestion of primary butchery waste. Whilst an over-representation of mandibles, might, therefore, support the suggestion made from the ageing data that some young sheep are represented only by dental material that does not have any corresponding post-cranial material in these collections, the skeletal element evidence is ambiguous. Whilst there is an over-representation of mandibles in the 1st/2nd C collection, this is not the case in the 2nd/3rd C collection, and in neither group is there supporting evidence of large numbers of skulls. Whilst it is possible, of course, that skulls were disposed of elsewhere, this requires special pleading to support an hypothesis that is otherwise plausible, but unsubstantiated.

Overall, it would appear that whole carcases are represented in all three periods, the main causes of skeletal imbalances being: recovery bias against small bones, preservation bias against trabecular bone and the commonly-observed but not fully understood good preservation and recovery of sheep tibiae.

Discussion of the sheep bones

Types:

Very little can be said about the type(s) of sheep represented, except that at least some of the animals were horned. The sizes of the sheep show no change between the 1st/2nd C and the 2nd/3rd C, but the few examples of medieval sheep bones do appear to represent larger stock. Whether this relates to different conformation or to different sex ratios cannot be assessed. The sex ratios in all three periods appear to be roughly equal, but the sample size for the medieval period is extremely small (N=4).

Ages:

The dental evidence for the sheep suggest that there was an equal number of deaths incurred by animals of less than and more than two years of age. Some of the young animals were killed in the second half of their first year, whilst a considerably larger group were killed in the second half of their second year. This may indicate some form of seasonal slaughter, but the inaccuracies of current knowledge about the time taken for teeth to erupt makes this suggestion tentative rather than positive. A programme of tooth sectioning for incremental growth lines might be able to test the hypothesis. This pattern is the same for both of the Roman periods. It suggests that meat was an important product from the dead sheep. The small sample from the medieval period shows a strong bias towards the killing of adult sheep. The sample is too small to interpret on its own, but is suggestive of a sheep economy that was more dependent on wool than on meat. This hypothesis will be tested when the medieval material from the northern half of the Lanes excavations is analysed for Volume 3 of the project.

The fusion evidence for the Roman periods emphasises the same young ages for slaughter of some of the animals, but suggests that far more of the animals died at over 2 years. Some of them appear to have died in their third and fourth years. One possible explanation for the discrepancy between the dental and fusion data is the possibility that some young animals are only represented by primary butchery waste (heads and feet) and that their post-cranial elements were deposited elsewhere.

Carcase completeness:

Apart from the paucity of small or susceptible elements, thought to have been biased against by recovery and preservational factors, most of the skeletal elements of sheep demonstrate approximately equal relative frequencies. The tibia is sometimes particularly well represented, and this has been noted in other collections. It may be due to its large and robust nature. In the 1st/2nd C collection, the mandible appears to be over-represented. This might also be due to its good preservational properties and its high visibility to excavators, or may be a genuine 'super-abundance'. It might explain the discrepancy between the dental and fusion data regarding ageing, but this evidence is ambiguous (see the longer discussion above).

Comparison with the military sites in Carlisle:

The age distribution for sheep, as demonstrated by dental evidence, is broadly similar to that seen during Period 3 of the fort at Annetwell Street. Figure 17 presents bar graphs of the Mandibular Wear Scores for the 1st/2nd C collection from The Lanes and for the 1st/2nd C collection from the fort's Period 3. Both collections have a majority of wear scores between

23 and 41 and, also, have coinciding gaps in the distributions of the scores. However, there is a greater number of very young animals at the fort. The first aspect suggests that the animals may all have been part of one general management practice (whether or not they were from the same flocks) and the second suggests that the military personnel had access to prime young lamb meat. The neonatal deaths only appear at the Lanes, and are probably accidental and an indication of a producer site.

The over-representation of mandibles seen in the 1st/2nd C collection at the Lanes is far more obvious at Annetwell Street during Period 3. Many of the Annetwell Street sheep jaws had toothrows that were tightly packed. In 11 of the 74 measured mandibles (15%), this overcrowding had led to impaction or overlapping of teeth, usually to a minor degree. These animals may have been culled deliberately for meat for the military because of the potential problems they might have encountered in feeding. Alternatively, since overcrowding was not noted for the material from the Lanes, it is possible that sheep from different flocks, or from farms with different husbandry practices, may have been deposited preferentially at the two sites.

In addition to the relatively large numbers of mandibles at Annetwell Street, there were high numbers of metapodials, distal tibiae and distal radii, suggesting the presence of some butchery waste in addition to the remains of whole carcases. This evidence is much stronger than that seen at the Lanes.

At both site, skull bones are poorly represented. At Annetwell Street it was noted that the few skulls or horncores that were recovered appeared to have been butchered to remove the brains, and to have had the horncores chopped off. It is possible that the paucity of skulls at both sites relates to an industrial process utilising horns, that may have caused skull fragments to be generally disposed of in a particular location, away from the general refuse and butchery waste.

At both sites, the sex ratio appears to be approximately equal, although numbers of pelves are small in each case.

Pigs

Measurements

None of the bones was fully fused, and so no withers heights have been calculated. Although no data on post-cranial measurements are presented here, it was clear during the cataloguing of the material that all of the bones appear to derive from small domestic pigs.

Similarly, only fifteen lower second molars (M_2s) and eight lower third molars (M_3s) are measureable from the combined collections for all periods from all five sites. These sample sizes are considered too small for statistical analysis, although it was noted that none of the teeth are particularly large, again suggesting that no wild animals are represented.

Dental data

Figure 18a presents a bar graph of the Mandibular Wear Scores for pigs. There is a range of scores from very young piglet (MWS=1) to young adult (MWS=40). There are no scores from mature adults. This emphasises the juvenile ages of the pigs compared to the cattle and sheep.

'Calibrating' the MWSs with Silver's (1969) modern data on tooth eruption, the mandibles with MWS=1-5 have the first molar (M_1) either not yet erupted or just completing its eruption. This puts the animals at less than, or approximately equal to, 4-6 months of age at death. A further group of jaws has scores of 8-12. In all of these the M_1 is just coming into wear (Grant's stage a or b), and/or M_2 is visible in its crypt. Silver gives the age of eruption of M_2 as 7-13 months, so these jaws derive from animals that were probably in the second half of their first year when they died. There is a group of mandibles with MWS=19-20/22. These all have M_2 just coming into wear (Grant's stages a and b) plus M_3 visible in its crypt. Silver gives an eruption age for M_3 of 17-22 months. This puts the group at >7-13 but <17 months old. A small group of mandibles have MWS at 25-27, and these all have the M_3 half up or up-but-unworn, suggesting an age of less than or equal to 17-22 months. The mandibles with WMS=32 & 33 have the M_3 up, with the anterior cusps just in wear (stages a and b), suggesting that the pigs were about two years old when they died.

The most worn toothrow has a MWS=40. Even this jaw comes from a relatively young adult, since the M3 was still only in light wear (Grant's stage c), suggesting that the pig was only about two years old when it died. Pigs are sexually mature at six months, and so it is possible that some of the animals may have been used to produce one or two litters before they died, but there is a notable absence of any mature breeding stock. Seasonality of death cannot be estimated, since pigs do not have a very restricted season of birth.

Using the observed Mandibular Wear Scores for complete jaws, scores have been estimated for jaws in which one of the molars cannot be observed. The estimates are not as accurate as those for the cattle and sheep due to two factors: (i) the sample size is smaller, which means that there are gaps in the observed scores, and (ii) the rates of wear are not so consistent. In particular, the earlier-erupting molars (M_1 and M_2) show greater degrees and ranges of wear prior to the eruption of the later teeth (M_2 and M_3) than in the cattle and sheep. For instance, the pig mandible with a MWS=40 has M_3 at Grant's stage 'c', whereas the sheep jaws at MWS=40 have M_3 at stage 'g' and the cattle jaws have M_3 at 'g' or 'h'. Figure 18b presents the Mandibular Wear Scores for Roman pig jaws including the estimated scores, but it should be remembered that these estimates are probably only accurate to within 2 points rather than 1. It increases the Roman sample size from 21 to 26 and alters the ratio of Wear Scores either side of 19 (when P_4 erupts at about 12 months). All of the estimated scores fall within the range of observed scores and lie between 20 and 38 inclusive (corresponding to ages at death of approximately one to two years). The apparent greater fragmentation of the 'older' jaws may relate simply to their greater size compared to the very young jaws, or may be an artefact of sample size. A comparison of deciduous and permanent last premolars (below) supports the ratio given by the observed Mandibular Wear Scores rather than the combined group of observed and estimated scores.

The ratio of deciduous: permanent lower last premolars is not suitable for comparing juvenile with adult pigs, since P_4 erupts before M_3 (at 12-16 months). The P_4 is already erupted at MWS=19 in this collection. The ratio of 18 dp_4s: 22 P_4s (45:55%), therefore, is comparing animals on either side of one year, rather than juveniles to adults. It correlates exactly with the ratio shown by the observed Mandibular Wear Scores (11 <13: 14 >18 [44:56%]). For the Roman collections, the same pattern can be observed *ie*: 16:19 (46:54%) dp_4s:P_4s, and 9 <13: 12 >18 (43:57%) for the MWSs.

The medieval collection is extremely small and only contains two deciduous and two permanent fourth premolars.

Sex ratio

Lower permanent canine teeth have been used to assess the sex ratio of the pigs in the Roman levels. There are eight female and 16 male teeth *in situ*, plus a further four female and three male mandibles in which the teeth have fallen out of their alveoli (*post mortem*), giving an overall ratio of 12:19 females:males (a ratio of 39:61%).

In the medieval layers, there are four mandibles retaining adult male canines.

In the combined Roman collections, using the canines to allocate sexual identification to the jaws, more of the mandibles with dp_4 present derive from females than from males (8:4 females:males). Since P_4 erupts at approximately 12-16 months, this suggests that approximately twice as many females of less than or about one year of age were killed than males. They may have been surplus stock, killed for meat, or may have been culled because of failure to get in pig. In the older age group, with P_4 present (*ie* >12-16 months), the corresponding ratio is 3:8 females:males, possibly suggesting that females kept beyond one year tended to be kept alive, whilst the larger males were slaughtered for meat. Where the bones of the older females were eventually deposited is unknown. Given a sex ratio at birth of approximately 50:50, and the need to keep sows on for breeding in order to maintain the livestock, some older sows must have been kept, but there is no evidence for their final disposal in this excavated area of the Lanes.

Fusion data

Table 23 presents the epiphyseal fusion data for pigs by major period. The patterns of fused and unfused epiphyses contrasts strongly with those for cattle and sheep. The medieval collection is extremely small (N=55). For the two Roman collections (N=147 and N=142), 29% and 18% of the metaphyses in the youngest age group (<12 months) are unfused. This trend of early deaths continues in the next age groups: <2-2.5 years: 76% and 62% unfused; by the <3.5 years and 4-7 years groups, all collections are 100% unfused. In both the 1st/2nd and 2nd/3rd C collections, there is one example of a vertebral epiphysis in the process of fusing (at 4-7 years). These are the only post-cranial indications of the presence of any adults in the entire collection.

Figure 10 presents the percentage survival curves for pigs, compared with those for cattle and sheep. The pig curves show that animals died throughout the period from birth to skeletal maturity. The percentages that appear to have survived beyond *circa* 5 years are maximum possible percentages. It is possible that the fused examples of early-fusing epiphyses derive from animals that failed to reach this age, but that cannot be ascertained one way or the other.

This pattern of persistent slaughter of young pigs fits that shown by the Mandibular Wear Scores. In contrast to the cattle (77% and 75% surviving) and sheep (59% and 66% surviving), maximums of only 33% and 40% of the pig bones derive from animals that might have survived beyond the age at which their vertebral epiphyses fuse (*circa* 5 years). Since none of the recorded vertebrae are fused, the actual percentage surviving beyond five years may well be zero, but the fused examples of early-fusing epiphyses cannot be aged precisely.

In addition to the bones retaining metaphyses that could be used in the fusion tables, some other bones of very young piglets were also found. From 1st/2nd C contexts, these are: neonatal: one scapula, one radius and one metacarpals; weeks old: one femur. From the 2nd/3rd C deposits, the bones recovered include one neonatal humerus, one weeks old humerus and one weeks old tibia. None of the bones appears to be from a complete or partial carcase. In addition to these bones in the hand-recovered collections, several bones from foetal or neonatal piglets were recovered from some of the sorted fine fractions from wet-sieved samples. These were all from Old Grapes Lane, but this is probably because most of the processed samples were taken from this site. The original distribution of foetal and neonatal piglet bones, therefore, is unknown.

Pig skeletal element representation.

Table 24 and Figure 19 present the data for pig skeletal element representation in the hand-recovered collections from each of the three main periods. The sample size for the medieval collection is very small (N=62). For the 1st/2nd and 2nd/3rd C collections, the smaple sizes are: N=227 and N=241 respectively. As with the sheep elements, small and/or trabecular bones are particularly scarce, probably due to biases of recovery and preservation. Although the actual percentages vary quite a lot, there is no obvious pattern of preferential recovery of any of the major elements. Bones from both fore-and hind-limbs, upper-and lower limbs are well represented, together with the girdle bones (the scapula and pelvis) and the mandible. This suggests that the elements recovered represent the remains of whole carcases.

Discussion of pig bones

Types:

Due to the small sample sizes of measureable bones or teeth, and to the lack of complete skulls, nothing can be said concerning the types of pigs represented, except that there are no obviously large bones that might appear to derive from wild animals.

Ages:

The pig bones and teeth overwhelmingly suggest the presence of juveniles and sub-adults, with a notable lack of mature breeding stock. At least some of the slaughtered juveniles were females.

Carcase completeness:

The skeletal element representation suggets that the material is the remains of whole carcases.

Comparison with the military sites in Carlisle:

At Annetwell Street, there was some suggestion of the presence of primary butchery waste in addition to general carcase waste. This was not the case at the Lanes. The ages of the pigs are very similar, except that foetal pig bones were not recovered at the fort. Neither site had any evidence for the presence of any large (?wild) animals. The most significant difference between the two Roman collections may lie in the sex ratios estimated from lower canine teeth. At the Lanes, the sex ratio appeared to be 1.6:1 (19:12) males:females, whereas at Annetwell Street male mandibles outnumbered those of females by 3:1 (12:4).

THE SIEVED MATERIAL

Species proportions (cattle, sheep and pigs)

Although samples were taken from approximately ten percent of all contexts from all five sites, the selected contexts are predominantly from the 1st/2nd C. Contexts from the 2nd/3rd C were only sampled at Old Grapes Lane A and B, and only Old Grapes Lane A had any 12th/13th C material sampled (mainly from the well, context 1237). This means that it is not possible to look for any trends through time at the combined sites. It is only potentially possible at Old Grapes Lane A, and this is not suitable because of the small numbers of bones involved.

The main use of the sieved samples for checking for recovery bias in the hand-recovered collections, therefore, lies with the 1st/2nd C material. Table 25 below gives the relative proportions for cattle, sheep and pigs from sieved and hand-recovered collections dating to the 1st/2nd C, using both Minimum Numbers of Individuals and raw fragment counts.

Table 25: relative proportions of cattle:sheep:pigs (C:S:P)
in the 1st/2nd C deposits, comparing the sieved and hand-recovered collections

	sieved				hand-recovered			
	C:	S:	P	Total	C:	S:	P	Total
MNI	3	4	3	10	25	28	12	65
MNI	30%	40%	30%		38%	43%	18%	
Frags.	39%	38%	23%		55%	27%	18%	
Frags.	106	102	61	269	673	337	222	1232

Key: MNI= Minimum Number of Individuals
Frags.= number of identified fragments

In the sieved collection of material from the 1st/2nd C, the numbers of fragments are small, but indicate that roughly equal proportions of cattle and sheep bones are present, with pig bones far less numerous. The Minimum Numbers of Individuals are all very small and, therefore, subject to the bias inherent in the method that over-emphasises the rarer species.

This factor probably explains the raising of pig to joint second place, and the apparent lead of sheep over cattle. Overall, however, the ratios are not radically different between the two methods.

Comparing the sieved and hand-recovered collections, using fragment counts it seems clear that cattle are over-represented in the hand-recovered collection, as expected (Payne, 1975). But the ratios given by the Minimum Numbers of Individuals in the hand-recovered collection is very similar to that given by the fragment counts in the sieved collection. Again, it emphasises the equal importance of sheep and cattle (in terms of numbers of bones/individuals) and the third place of pigs. The MNIs are useful in this analysis because it has already been shown that whole carcases are represented rather than selective joints of meat or butchery waste. Given that the carcase of a cow contains several times more meat than that of a sheep, the contribution of beef to the diet was potentially several times that of mutton, but in terms of numbers of animals, the cattle and sheep were probably approximately equal.

Element representation

Due to small sample sizes, only the 1st/2nd C material can be used at all to investigate the relative numbers of different elements in the sieved collection. Even within the 1st/2nd C deposits, only cattle and sheep reach 100 fragments (these include zoned ribs and vertebrae of cattle-sized and sheep-sized animals).

The sieved samples were picked through by the excavators and most bones down to approximately 10mm in maximum length were recovered.

The sample size for cattle is small (N=106, see Figure 20) and a minimum of only three individuals is represented. The better recovery of smaller elements probably accounts for the presence of some carpals, phalanges etc. although the very smallest bones (sesamoids) are still almost absent. The small sample size means that the presence of a single extra bone can double a percentage representation, and so the precise percentages should not be relied upon, due to the possibility of chance factors influencing the data, but the overall pattern appears to confirm that seen in the hand-recovered collection (N=632, see Figure 11). All parts of the body are present in roughly equal numbers, suggesting that whole carcases are represented. Some aspects may be worthy of future investigation with larger samples ie: the metapodials are some of the least frequent longbones, and no scapulae are represented at all. These three elements were all well represented in the hand-recovered collection. Although fragment completeness could not be recorded for these sites due to a lack of time, it was noticed that all three elements often survive in large fragments. Is their comparative scarcity in the sieved samples due to a genuine scarcity, or does it reflect a bias in favour of their collection in the hand-recovered collection, due to their large and, therefore, conspicuous fragments?

The sieved collection of sheep bones is of a similar small size to that of cattle bones (N=102, see Figure 21). The main difference between the proportional representation of elements in the sieved and hand-recovered collections concerns the numbers of smaller bones recovered, which is much greater in the sieved collection, confirming that small bones were biased against in the main collection. Otherwise, the pattern in Figure 21 shows a very similar pattern to that seen in Figure 16 for the hand-recovered elements. That is, whole carcases are represented, save for some of the small and susceptible elements.

Rarer species

Although the sieved samples have retrieved a greater proportion of smaller elements than the hand-recovered collections, the species represented are extremely similar. Bones of cattle, sheep and pigs (plus their '-sized' vertebrae and ribs) comprise 96% of the number of identified fragments in the overall hand-recovered collection, and 97% in the overall sieved collection. The sieved collection has not produced a relative increase in bird bones. The hand-recovered collection contains 1.3% bird bones, the sieved collection 0.95% bird bones. Some of the rarer species represented in the hand-recovered collection (N=3703), such as horse, roe deer, hare, bear and badger, together with most of the specifically identified birds, are absent from the smaller sieved collection (N=431). Only one species is represented in the sieved collection that was not identified in the hand-recovered collection. This is cat, one bone of which was recovered from a sieved sample from the medieval well (context 1237) in Old Grapes Lane A. No fish bones were recovered initially from the sieved samples. All of them were sorted later from the fine fractions (see note on recovery methods at the start of this report).

THE FINE FRACTIONS

Only some of the residues were sorted for bones, due to a lack of time and funding allowances. The results, therefore, cannot be directly compared to those from the sieved samples in order to assess the degree of recovery bias against smaller bones. Table 7 presents the identified fragments from the residues that were sorted. It is immediately apparent that several new species are represented in this collection. Cattle, sheep and pigs (and their '-sized' vertebrae and ribs) comprise only 17% of the total collection (N=747). The dominant group of identified bones in the fine fractions derive from species of fish (65% of the total), none of which were present in either the hand-recovered or the sieved collections. Birds form 11% of the collection, and bones of smaller birds are present in equal numbers to those of larger birds such as chicken (fowl) and geese. Small mammals and amphibians are represented for the first time, too: occasional bones of house mouse, woodmouse, pygmy shrew, a vole species and toad (and possibly frog) are present. Further details of the fish bones are given in Nicholson's (nd) specialist report, and all of the bird bones from the site will be reported on by Allison.

Food and faecal remains.

Many of the fragments in the fine fraction show signs of having been digested by carnivores/omnivores. This evidence takes two forms. Some of the fragments appear to have been etched by acids: sometimes the internal trabecular bone has been exposed and sometimes the outermost remaining layer of bone is shiny. Since only some of the fragments in a sample show this acid etching, which is often quite severe, whilst the rest of the material appears to be well-preserved, it seems unlikely that the etching is due to soil acids and more likely that it relates to digestive juices. Some of the fragments (usually those also displaying acid etching), also have patches of black glazing on their surfaces. Huntley (pers. comm.) has noticed that these black deposits are associated with the presence of bran in the botanical material from the same samples. These acid etched and/or black glazed fragments, therefore, all of which are less than 10mm in maximum dimension, are interpreted as being the remains of material that has passed through a carnivore's gut. Some of the fragments are also crushed or bear tooth marks. This type of material includes bones of mammals, birds and fish (see Nicholson's report). It cannot be estimated from the bone material whether it was digested by humans, dogs or pigs (or any combination of the three species). Huntley feels that the presence of bran implies that associated digested bones were passed by humans, and Nicholson feels that the crushed eel and small flatfish vertebrae may also have been eaten by people, whereas some of the larger salmonid vertebrae may have been eaten by dogs or pigs due to their size. Particularly large numbers of this type of fragment were recovered from certain contexts in Old Grapes Lane trench A. Most of these contexts (numbers 737, 750 and 803) are related to a boundary hedge and gulley behind the building in Phase 6. Pit 1126 in Phase 3 also had several faecal bones associated with bran, grape pips, fig pips etc..These are all likely to have contained human ordure.

In addition to the bones that appear to have been digested, several of the bones appear to have been chewed. This is particularly true of the smaller bird bones (especially the passerines) and the fish.

Foetal bones

Many of the bones of two of the three major domestic species found in the fine fractions, especially those of pigs but also some of sheep/goats, are from foetal or neonatal animals. No young bones of calves were found. Several of the foetal and neonatal bones also show signs of having been chewed and/or digested. All parts of the body of these very young animals are represented. The presence of the foetal bones suggests that these animals died unintentionally (abortions, still births etc.) which would support the suggestion that this site was a producer site. Although neonatal bones can indicate a high status site, where newborn animals could be bought in for special occasions, the combination of foetal and neonatal bones, together with the almost total absence of any artefactual evidence of high status, suggest that this was not the case at The Lanes.

NOTES ON MINOR SPECIES

Horse

Occasional horse bones (N=34) occurred throughout the deposits, almost equally dispersed between Roman and Medieval deposits. All parts of the body are represented, although metapodials and phalanges are particularly frequent. These may relate to the deposition of remains removed during tanning, but other elements (such as the scapula and the pelvis) cannot be interpreted in this way. At least one bone (a metacarpal from a Medieval deposit at OGL-B) shows signs of having been worked.

A group of horse bones was found in pit 108 at OBL-B (late 1st/2nd C), and these probably derive from a single individual, although none of them articulate. The elements present are: the right mandible, the right scapula, one thoracic and one lumbar vertebra, two ribs, the right innominate (half pelvis), the left tibia and the right metatarsal. The teeth in the mandible show that the animal was definitely a horse rather a mule or donkey.

Some of the bones have cut marks on them. The mandible has been chopped through from the inside and bears knife scraping marks on the horizontal ramus, indicating the removal of the cheek meat. The scapula has a possible knife mark running along the length of the spine on the dorsal border. The tibia and metatarsal both have fine knife cuts and /or scrape marks on their proximal shafts. The marks on both bones are more likely to be associated with meat removal than skinning due to their location and orientation. Horseflesh was not usually eaten by people in Roman Britain (Hyland, 1990), but this deposit indicates that at least some horse meat was consumed (possibly, but not necessarily by dogs as well as/instead of, by humans).

The metatarsal has slight osteoarthritic creasing and polishing of the proximal articulation. The fusion states of the epiphyses indicate that the horse was between 4.5 and 5 years old when it died. This is young for an adult horse to die, and the animal may have been an accidental death. Alternatively, it may have had to be slaughtered due to a lack of food (either for the horse or for the people who possibly ate it). If it were a ritual killing, the skeleton might have been expected to have been buried complete, whereas the pit appears to have only contained selected parts of the carcase.

The sizes of the horse bones from the Lanes vary slightly, but none are particularly large or small. Five longbones retain their full lengths: the cut, arthritic metatarsal from OBL-B has a lateral length = 254mm, the scraped tibia from the same context has a lateral length =311mm, a metatarsal from CAL-A (also late 1st/2nd C) has a lateral length=224mm, a radius from a 1st/2nd C deposit at OGL-B has a GL=311mm and the trimmed medieval metacarpal from OGL-B has a lateral length = 200mm. Using Kiesewalter's factors given in Driesch & Boessneck (1974), these convert to withers heights of 1.35m, 1.36m (possibly the one individual, from OBL-B context 108), 1.19m, 1.35m and 1.28m respectively. These would all be called ponies rather than horses, today, with withers heights between 12 and 13 - 14 hands.

All epiphyses are fused. Besides the late 1st/2nd C metatarsal from OBL-B there is a late 2nd/3rd C metatarsal from OGL-B that shows slight indications of arthritic lesions around its proximal articulation. This could be a sign of old age rather than of any overstraining due to hard physical work, although in the case of the partial skeleton the animal was still quite young when it died.

Overall, the horse bones give us little information concerning the uses of live horses, but indicate that some horses were used, that their flesh was sometimes eaten, and that occasional bones were deposited at the site, some of them in connection with the work of artisans.

Dog

Dog bones were similarly widely distributed (N=36) although nearly all of them come from Roman rather than Medieval deposits. All parts of the body are represented. Although no complete or partial skeletons were found, there is a pair of scapulae from context 1019 (Phase 6, late 1st/2nd C) at OGL-A, and two metacarpals from context 75 (Phase 3B, late 1st/2nd C) at CAL-A articulate.

A mixture of ages is present. At LEL-A, all seven of the bones with metaphyses are fully fused, as are the three at CAL-A, but at OGL-A & B, nearly half of the metaphyses are unfused, and three more are only just fused (total N=20). Only two longbones are complete enough for shoulder height calculations: a radius (GL=89mm) from context 750 (late 1st/2nd C) at OGL-A and an ulna (GL=183) from context 184 (late 2nd/3rd C) at OGL-B. Using Harcourt's (1974) factors, these give shoulder heights of 302mm and 515mm respectively. In addition, a damaged femur from context 599 (late 1st/2nd C) at LEL-A could be measured approximately, and has a GL of *circa* 127mm, which would give a shoulder height of approximately 386mm. The sizes of Romano-British dogs vary greatly (see Harcourt 1974), and these shoulder heights are unremarkable. Some sites have bones of dogs the size of Jack Russell Terriers or smaller, which are thought to have been lap dogs of wealthy people, but no particularly small bones were found at The Lanes. Only one dog skull was complete enough for Harcourt's measurements. This came from context 71 at CAL-A (late 1st/2nd C). The Cephalic Index is 57.4, the Snout Index=48.7 and the Snout Width Index=42.7. These index values are all middle of the range for Romano-British dogs. In addition, a partial skull from context 197 (late 2nd/3rd C) at OGL-B has a broad snout and notably well worn teeth.

Red Deer

Twenty-two fragments of red deer bone (not including antler) were found distributed amongst the sites, with almost equal numbers of fragments from the Roman and medieval periods. Eighteen of the pieces came from one site: LEL-A. Most of the elements represented are limb bones, and most of these are lower limb bones, especially of the hindlimb (this is particularly true for the medieval material). One bone has heavy defleshing knife slice marks on it (a tibia). Although some of the bones may indicate that venison was eaten, the predominance of metatarsals and tibiae may suggest that some of the bones were collected for craft working rather than as joints of meat.

Fragments of antler were found throughout the sites, all of them showing signs of having been worked (see Tim Padley's finds report in the Volume 1 monograph (McCarthy, in prep)).

A few of the red deer bone fragments were complete enough to be measured. The Greatest Lengths are: tibia (OGL-A context 765, phase 6, late 1st/2nd C) GL=311mm (N.B. this is the bone that has defleshing slice marks cut out of it); astragalus (LEL-A context 85, phase 19B, 12th/13th C) GLl=52mm; metatarsal (LEL-A context 428, phase 10B, late 2nd/3rd C) GL=164mm.

Roe deer

Fourteen bones of roe deer were recovered, almost all of them from Roman contexts. Nearly all of them are foot bones or bones of the hindlimb. This may indicate that many of the bones were brought to the site in association with skin or bone working, although the pelvis and femur and, possibly the radius and tibia may have been used as meat sources. One of the metatarsals, from Phase 6 (late 1st/2nd C) at OGL-A has fine knife marks just below the proximal articulation, which probably relate to skinning.

A tibia from OGL-B phase 51 (late 2nd/3rd C) has a slight pathological alteration on the shaft, possibly due to infection or bruising.

The greatest lengths of the complete bones are: metacarpal: GL=163mm; metatarsals: GLs=191mm, 198mm and 199mm.

No roe deer antler fragments were found.

Hare

Two hare bones (a radius and a tibia) were found, both in Roman contexts at OGL-A. Hare bones are usually present in low numbers on Romano-British sites.

Badger

One badger bone, a complete, fully fused tibia, was found in context 550 (Phase 7A, late 1st/2nd C) at LEL-A. Badgers can be used for meat and skins, although they are not commonly found on archaeological sites. No cut marks were observed on this bone. The preservation condition of this bone is similar to that of the rest of the material from this context, and the bone does not appear to be intrusive.

Bear

The single occurrence of a bear bone is a complete mandible from a post-trench (context 28) in Phase 21A at LEL-A. The length and width of the P_4, M_1, M_2 and M_3 are 12.1 x 6.1; 21.4 x 10.8; 21.8 x 13.2 and 18.6 x 13.5 mm respectively. The length of the tooth row from P_4 - M_3 is 76.0 mm (von den Driesch measurement 8) and the jaw length (von den Driesch measurement 6) is 190 mm. The jaw is from an adult animal, with quite worn M_1 and M_2 but very little wear on the P_4 and M_3. Since the jaw is an isolated find, it is possible that this mandible was a curiousity that had been kept for some time before being deposited amongst otherwise ordinary bone refuse. The date of the deposit is 12th/13th Century. At this time, wild bears were extremely scarce in Britain, and the jaw may have been saved from a captive 'show' bear. There are no signs of any cut marks anywhere on the bone.

Small mammals and amphibians

Remains of small mammals etc. were only recovered from the fine fractions (see Table 7 and compare with Tables 5 and 6). Identified species include the commensal house mouse, plus woodmouse (which can be either commensal or wild, or alter seasonally between the two) and wild pygmy shrew. Other bones could only be referred to mouse sp. and vole sp.. Amongst the amphibian bones only toad could be specifically identified.

Perhaps the most interesting aspect of the small mammal etc. collection is its paucity, in terms of both numbers of bones and numbers of species present. If the area was relatively open ground, with hedges, banks and ditches, a small rodent and shrew population would be expected to flourish, but few of their bodies have been trapped in the sampled deposits. None of the small vertebrate bones look like the remains of owl pellets. The concentrations are too low and lack the distinctive damage to skulls indicative of owl predation. The lack of bones of rats may be significant and may indicate a lack of grain storage on the site but, given the extremely low numbers of any rodent bones, their absence may simply be due to sample size. Black rats like warm dry conditions, and the buildings at the southern lanes may not have provided suitable habitats for them.

Bird bones

All of the bird bones in the hand-recovered collection are relatively large species that are consistently used as sources of food: domestic fowl and goose, plus possibly wild species of goose and swan, together with black grouse and woodcock (the latter found only in the post-medieval period). These are all species commonly recovered from Romano-British deposits. Some of these bird bones have butchery marks on them, and all parts of the skeleton are represented, indicating that they were utilised for food rather than for craft working (when wing bones in particular would be expected to dominate the assemblage).

In the sieved samples, the numbers of bird bone are very small, and consist only of bones of the larger and commoner species *ie* fowl and species of goose.

In the fine fractions, these larger species are added to by a few bones from smaller birds including a thrush species, and small passerines (perching birds) of thrush and sparrow sizes. Although these small birds could be natural deaths (either dropping dead out of trees on cold nights, or caught and only partially eaten by cats or foxes etc.) they may equally well be the remains of food items eaten by people. Although the amounts of meat available from small birds are considerably smaller than those available from domestic fowl or geese, these birds are 'free' with no costs apart from capture, and small birds are still a common part of people's diet in many parts of the world, including Europe (and, especially, Italy).

A full account of the bird bones from the southern Lanes will be provided by Dr. Enid Allison. This will form a separate AML archive report and its findings will be incorporated in the site publication.

Fish bones

The fish bones have been reported upon by Dr. Becky Nicholson, and her identifications have been included in Table 7, although her report will be presented separately in the published volume.

Her main comments concerning the fish bones from the southern Lanes can be sumarised as: (1) there are remarkably few fish bones on the site; (2) this is common for Roman-British sites, which appear to have made little use of the potential sources of food in British rivers and seas; (3) the Roman species are almost all riverine or anadromous (such as salmonids and eels) and (4) the medieval deposits contain a greater range of species, especially of sea fish (this is also a common pattern for British sites).

In addition, she draws attention to the fact that occasional bones of large marine species such as haddock and cod were present in Roman deposits. Considering the scarcity of other bones, she feels that their presence is significant and might relate to some special food preparation.

Nicholson also highlights the presence of many chewed bones of fish, some of which may have been deposited in human faeces, whilst others are more likely (due to their larger size) to have been deposited in dog faeces.

Considering the size of the site and the potential contribution of fish to the meat part of people's diet, the numbers of fish bones recovered are very small (see the section on meatweights, below). In the 1st/2nd C samples, there were 14 fish bones per sample. In the 2nd/3rd C, this level of frequency dropped to 1.4 fish bones per sample and in the 12th/13th C the frequency was 1.75 fish bones per sample. The medieval samples were nearly all from the well and may not be directly comparable to the early Roman samples, which included material from latrines and pits. The numbers given above include only those bones identified to species, genus or family (*ie*: those included in Table 7). If all of the fish bones recovered are included in the analysis, then the frequencies increase to 38, 9 and 5 fish bones per sample, for the three periods respectively.

Because precise records were not kept of the sizes of bulk samples taken for processing, it is only possible to give estimated densities of fish bones from the sites. If a sample is assumed to have consisted of 150 litres, these densities convert approximately to : 0.25, 0.06 and 0.03 fish bones per litres of sediment wet sieved over 0.5 mm mesh. Even if a conservative estimate of the average bulk sample size is taken (using 75 litres as the mean), these densities only rise to 0.51, 0.12 and 0.06 fish bones per litre of sediment.

Locker (1992) commented on the sparse distribution of fish bones in the Roman levels at Culver Street, Colchester. Colchester is also situated on a river close to its estuary, and the presence at that site of large numbers of shells of molluscs (such as oysters) demonstrates that the people living there were exploiting other types of estuarine if not riverine and coastal resources. Even at Colchester, however, the densities of fish bones in the Roman levels were only 1.8 per litre (more than three times the conservative estimate for the Lanes, Carlisle).

ESTIMATES OF MEATWEIGHTS

Calculations of meatweights from archaeological animal bones are fraught with inaccuracies, assumptions and compounded estimations. Some very crude estimates are provided here, to highlight the relative importance of beef in the meat part of the diet of people living in the southern half of the Lanes, and the minimal reliance on wild species.

Estimates of 'meatweights' have been based on estimates of Minimum Numbers of Individuals (MNIs) and average carcase weights for modern animals with comparable-sized skeletons. For minor species for which carcase weights were not available, a dressing out percentage of 60% has been used. This is the difference between live weight and carcase weight. Average weights have had to be taken for males and females. Appendix 2 lists the MNIs for all of the species considered in this study. For all species, MNIs have been calculated from estimates of frequencies of skeletal elements, using anatomical zones (see the note on methodology under the section on cattle skeletal element representation, above). Actual meat (*ie* flesh) weights have not been used as these data are not easily available. For the major species, the proportion of bone weight to carcase weight is broadly similar (Gerrard, 1945).

Two major problems with the method are relevant to this study. The use of MNIs and average carcase weights relies on the assumption that whole carcases are represented. The analyses of skeletal elements for cattle, sheep and pig bones from the southern half of the Lanes excavations showed that this assumption is probably a fair one. For the more scarcely-represented species, however, such as horse, red deer, roe deer *etc*, this assumption cannot be tested and may be false. These species, therefore, may be over-represented in the calculated meatweights if the bones represent partial skeletons, skins or individual joints of meat rather than whole carcases. The second major problem concerns the decision regarding which species were eaten by people.

For these analyses it has been assumed that the meat from dogs and cats (and the bear mandible) was not consumed by people, since there is no evidence at the site for any butchery of the bones of these species. Whether or not horse-flesh was eaten by people is more controversial (see the section on horse bones, above). Due to the large size of a horse, the inclusion of carcase weights does affect the overall analyses, especially with respect to the role of mutton and pork in the diet. Since the role of horseflesh at the Lanes is debatable and the numbers of bones are so small that whole carcases are unlikely to be represented, horseflesh has been left out of the analyses presented here, although estimates of the Minimum Numbers have been included in Appendix 2.

Figure 22 is a series of pie charts showing the relative contribution of meat (*ie* carcase) weights to the total for each of the three main periods at the Lanes. Because of the small quantities concerned, all of the bird, fish and wild mammal data have had to be combined in order for them to be visible on the charts. There are two very obvious aspects highlighted by these charts.

Firstly, cattle contributed by far the greatest proportion of meat to the diet in all three periods. There is no evidence for any change of emphasis to mutton in the medieval period.

Secondly, although they were still of minor importance, species other than the three main domesticates contributed a greater proportion of the diet in the medieval period than they did in either of the Roman periods. This evidence concurs with that from the fish bones (Nicholson, n.d., and see the summary above), which indicates that a greater range of fish taxa were taken from a greater range of habitats during the medieval period.

The data for the 1st/2nd Century can be compared with those for the military site at Annetwell Street during Period 3 (Stallibrass, 1991a). Minimum Numbers of Individuals are a slight problem for cattle from Annetwell Street, since the number calculated from the scapulae was twice that calculated from the next most frequent element (the mandible). Minimum Numbers of Individuals were not calculated for the minor species and so this comparison restricts itself to a consideration of the three major domesticates. In the civilian area excavated in the southern half of the Lanes the relative proportions of meat weight contributed by cattle, sheep and pigs were approximately: 85%, 7% and 7% respectively. At Annetwell Street (using the lower MNI from the mandibles) the equivalent contributions were:

87%, 6% and 6%. These ratios are extremely similar. It would be invalid to use the extra scapulae to represent whole carcase weights, but they did, presumably, represent some addition to the quantities represented by the rest of the skeletal material. If they had been whole carcases, then the ratios would change to 93%, 3% and 4%. The 'real' ratios probably lie somewhere in the vicinity of these two sets of figures.

It is interesting that, although there may have been a slightly greater emphasis on beef at the military site, the dependance on beef at the civilian site was so great that the differences are minimal. Whether or not this was due to the proximity of the military settlement cannot be judged until material is available from local 'native' sites for comparison.

An emphasis on beef in the Romano-British diet was not restricted to the north of England. At the town of Baldock in Hertfordshire, a large collection of animal bones from Phase 2 (AD 43-150) represented several hundred individuals. Chaplin and McCormick (1986) calculated that cattle, sheep and pigs contributed a ratio of 84%, 11% and 5% respectively to the total meatweight provided by the three major species. Chaplin and McCormick's average meatweights are slightly different to those used in this report, but the results would be very similar if they were used (*ie*: 83%, 12% and 5%). Although the relative contributions made by sheep and pigs are slightly different, the overall dominance of beef in the diet is extremely similar.

NOTES ON INTERESTING CONTEXTS AND TREATMENTS OF BONES

The presence of faecal material in certain contexts at Old Grapes Lane have already been referred to above.

Also at Old Grapes Lane, the distributions of animal bones appear to have varied in relation to the quantities of pottery whilst different buildings were in use. A full discussion of these distributions can be found in the archive report for those sites (Stallibrass 1993).

Although most of the bones recovered from Lewthwaites lane, Crown & Anchor Lane and Old Bush Lane appear to be ordinary domestic waste and refuse deposits, there are occasional deposits that appear to be more specialised. At LEL-A in phase 19B (12th/13th Century) pit 85 contained several foot bones (metapodials, astragali etc.) of red deer, roe deer and cattle mixed in with more 'ordinary' refuse. In the same phase, surface 87 also contained a horse metapodial plus three cattle astragali mixed in with ordinary refuse. These small concentrations of foot bones from four large species may represent waste from a tanners workshop. There were no offcuts of worked bones associated with the collections, and so it is less likely that the bones derive from a bone workshop.

Other unusual deposits have already been noted in the site archive reports, such as the pit (108) at OBL-B that contained large numbers of cattle scapulae and sheep mandibles. Some of these cattle scapulae have been trimmed around the glenoid and/or perforated in the centre of the blade. Both of these patterns of alteration were noted at the military site at Annetwell Street (Stallibrass, 1991a:Plate 1, & 1991b) and are thought to relate to processing of meat on scapulae, possibly by smoking. At Annetwell Street, cattle scapulae were far more numerous than any other cattle skeletal element, and are though to have been imported to the site for processing/ready processed. The date of pit 108 (OBL-B phase 6, AD 121-160) is similar to that of the second timber fort at Annetwell Street (AD 105-140).

It has been noticeable at the Lanes generally that pits are more likely to have 'non-ordinary' collections of bones in them, perhaps suggesting that particularly noxious waste or artisan's waste tended to be disposed of in a different manner to ordinary domestic waste.

A partially complete cattle skull from posthole 639 at LEL-A (phase 4: late 2st C) shows very clear signs of having been poleaxed, indicating not only that it was deliberately slaughtered, but also the method of slaughter.

BONES OF PARTICULAR INTEREST

Several cattle bones show signs of charring. The location of the charring tends to follow a pattern noticed on Roman cattle bones at Annetwell Street *ie*: the charring is located midshaft on a longbone, usually a metapodial. The Annetwell Street examples date to the fort's Period 3 (AD74-105) and examples are illustrated in Stallibrass (1991a: Plate 2). The degree of charring varies considerably,. In all cases, the surface of the bone is dry and cracked, with the cracks tending to run parallel to the main axis of the long bone. The cracks are very fine and close together, and small flakes of surface bone may be fully or partially detached from the body of the bone. In severe cases of charring, the surface of the bone is discoloured to very dark brown or black (whereas the usual colour for the bones is rufous brown), but in cases of slight charring the surface colour may hardly have been altered.

All of the examples at the southern Lanes date to the Roman period. There are no examples in the deposits dated to the 3rd-12th C nor to the medieval period. For the metapodials, the location of the charring coincides with one of the anatomical zones recorded for identification and quantification purposes. In the 1st/2nd C deposits, 6 of the 36 midshaft metacarpals (17%) and 3 of the 49 midshaft metatarsals (6.1%) are charred to varying degrees. Other charred cattle bones include one mandible (charred on the diastema) and one tibia (charred just above the unfused distal metaphysis). In the 2nd/3rd C deposits, 4 of the 36 metacarpals (11%) and 3 of the 47 metatarsals (6.4%) are charred at their midshafts. In addition, one mandible is charred at its symphysis and two tibiae are charred or scorched on their distal shafts. Also dating to the 2nd/3rd C are some fore-limb bones showing charring along their midshafts, although the charring is less localised on these bones: 4 of the 44 radii (9%) and 2 of the 42 (4.8%) humeri. Apart from these bones, all of them charred on their midshafts, there are only three other cattle bones showing signs of burning: one charred first phalange, one charred and calcined first phalange, and one calcined second phalange. These seem to be incidental occurrences.

The charring of several cattle bones at their midshafts appears to have ben deliberate. Many of the bones are broken at the charred location, although it cannot be judged whether or not this was a desired or accidental effect of the process. Occasionally, chop marks also occur in the same location. Significantly, there are no bones of sheep or goat showing the same pattern of charring. Although occasional bones of both species are burnt, all of them are either charred at an end, or calcined. These would all appear to be accidental burnings or the result of being thrown onto a fire as fuel or refuse.

The purpose of charring these long bones is unknown, but the relative frequency with which it occurs, together with the fact that the same behavioural pattern was observed at the military site at Annetwell Street, does suggest that the practice was deliberate, and part of the Roman culture in Carlisle.

The presence of cattle scapulae with holes in their blades that may relate to hanging by a hook to smoke or cure the meat, together with the practice of trimming around the glenoid cavity has been referred to, above, in the section on interesting contexts.

PATHOLOGICAL AND PSEUDO-PATHOLOGICAL ALTERATIONS

As at Annetwell Street, several cattle bones have minor lesions in their articular surfaces (see Baker and Brothwell, 1980: 109-114). Comparable examples from Annetwell Street are illustrated in Stallibrass (1991a) Plates 3, 4 and 5. Most of the affected bones are metapodials, with a few phalanges and very few other elements. In all but one case (a first phalange), the lesions are Baker & Brothwell's Type 1.

In the 1st/2nd C material, these occur in 5 of the 36 proximal metacarpals (14%) and 1 of the 28 distal metacarpals (3.6%). They are also present in 10 of the 46 proximal metatarsals (22%), although none of the 31 distal ends of metatarsals are affected. There are also Type 1 lesions in one proximal and three distal articulations of first phalanges (all of them from anterior rather than posterior toes). In addition, one naviculo-cuboid is affected and one distal femur, where the lesion occurs in the medial ridge of the trochlea.

In the 2nd/3rd C material, lesions occur in 2 of the 33 proximal metacarpal (6.1%) and 1 of the 31 distal metacarpals (3.2%), and in 7 of the 39 proximal metatarsals (18%) and 1 of the 30 distal metatarsals (3.3%). There are also a Type 1 lesion in one anterior first phalange (proximal articulation) and a Type 2 lesion in the distal articulation of another anterior first phalange. There is also a possible Type 1 lesion in the proximal articulation of a radius.

It is clear that the most frequently affected articulations are the proximal metacarpal and the proximal metatarsal.

These lesions are not restricted to the Roman material. In the 3rd-12th C material, one proximal metacarpal, and two proximal and one distal metatarsal articulations are affected (these may or may not date to the Roman period), and three proximal metatarsal articulations dating to the 12th/13th C (20%)are also affected.

The aetiology of these minor lesions is unknown. Various suggestions have been proposed ranging from damage to the articular cartilages caused by stressful work or injuries, to congenital traits of no consequence. By recording the incidences of such lesions in a variety of archaeological assemblages, it may be possible to highlight periods or regions in which they are particularly common. Even if they are congenital, it is uncertain as to whether or not they are hereditary.

No lesions were observed in any articular surfaces of sheep or pigs. The only non-bovine example is the proximal articulation of a horse metatarsal.

For the five sites as a whole, there are remarkably few examples of any pathological alterations to bones, and the few examples that do exist are nearly all very minor. There are 29 affected cattle bones. The main type of pathology relates to osteoarthritis, which is not surprising considering the large proportion of very mature animals represented. Mostly, the effects consist of slight exostoses around the proximal articulations of some of the metacarpals, metatarsals and first phalanges. Only one case was severe enough to cause grooving of the bone surfaces, and there is only one case of spavin, where the naviculo-cuboid has become fused onto the proximal metatarsal by excessive bony growth (Lewthwaites Lane 1st/2nd C). Several of the bones may show the effects of strenuous use, such as that related to employment as traction animals, rather than of osteoarthritis. These bones are splayed at their distal ends (metapodials) or at their proximal ends (first phalanges). Examples of both types of alteration (splaying and exostoses) are spread throughout the deposits, although they appear to be concentrated to some extent in 2nd/3rd C deposits at Old Grapes Lane B. The only non-foot bone to be affected is a pelvis with exostoses on the acetabular rim from a 1st/2nd C deposit at Old Grapes Lane A.

Otherwise, the only pathology of any of the cattle bones is occasonal periodontal infection of the palate, usually beside the upper molars, but extending alongside the premolars in one case. There is one example of a lost tooth: an upper third premolar that has been lost and its alveolus infilled with new bone (Crown & Anchor Lane, 1st/2nd C).

There is only one example of a pathological sheep bone. This is a radius from a 1st/2nd C deposit at Old Grapes Lane A, which has a bony exostosis on the lateral edge of the proximal articulation. This is often described as 'penning elbow' and is thought to relate to knocking of the joint against a hard surface (as might happen in a confined space), but the aetiology is not really proven.

There are five examples of pathological pig bones. Two of them are damaged lateral metapodials: one a healed midshaft fracture, the other a periosteal infection of the midshaft, possibly relating to bruising. There are also two cases of radii with unsual shapes. Both are unfused distally and one is also unfused proximally. This latter bone is particularly short and stocky and may derive from a runt. Its slightly splayed distal end might be related to rickets, in which case it may indicate the custom of keeping some pigs indoors in sties rather than allowing them to roam freely through the streets. The other radius is particularly slender waisted, although the length and proximal and distal widths appear normal. These two bones are illustrated alongside a 'normal' bone from the excavations for comparison (Figure 23). The fifth affected bone is a maxilla with a minor rotation of the upper third premolar.

There are three pathological horse bones: two of them being Roman metatarsals showing minor osteoarthritic exostoses. There is also a medieval metatarsal with a damaged periosteum, possibly related to bruising or a slight infection.

One dog metapodial from a 2nd/3rd C deposit at Old Grapes Lane B has a healed midshaft fracture. Healed fractures of dog bones are common on Romano-British sites (personal observation), where dogs appear to have suffered blows from people, stones, or other animals. Dogs used for herding cattle are particularly susceptible to being hurt by kicks from the cattle's hind legs.

Four fowl bones show alterations. Two tibiotarsi from Roman deposits at Old Grapes Lane show evidence of avian osteopetrosis. One bone is in an advanced stage and closely resembles the bone illustrated by Baker and Brothwell (1980: Figure 9).

The other bones are both tarsometatarsi, and they may be related to the practice of cock-fighting. The 1st/2nd C example from Lewthwaites Lane has had the spur removed and the bone has healed over. In contrast, the medieval bone from Old Grapes Lane B, which is a particularly large bone, has a healed split through the spur. This may have been made to take a metal spur extension, to be used in fighting.

SUMMARY AND DISCUSSION

The main body of data discussed in this report concerns the earlier Roman period (late 1st - early 3rd Century AD). The deposits dating to the late 1st - mid 2nd C tend to be waterlogged and their animal bones are excellently preserved. Later material has suffered slightly from desiccation. However, although this may have led to greater fragmentation due to their more brittle texture, the presence of identifiable very young bones does suggest that most of the bones deposited in the ground have survived until the time of excavation.

The quantities of animal bone studied from the five sites total just under 300 kg. Because of restricted specialist time available, only fragments retaining diagnostic anatomical zones have been recorded. Whilst this has proved a valuable methodology for studying the relative numbers of different species, age and sex ratios and percentage representation of different parts of the body, it has precluded the analysis of taphonomic variables relating to site formation processes such as fragmentation and weathering. Similarly, it has not been possible to investigate patterns of butchery or damage by scavengers.

Stratigraphic and artefactual studies suggest that this part of Carlisle was an area of peripheral civilian occupation during the Roman period, and the animal bones support this interpretation. All of the deposits contain domestic refuse, with very little evidence for craft or specialist butchery waste. The few medieval deposits show a greater degree of craft waste (especially of red deer antler) but are still dominated by domestic rubbish. Little further can be investigated with the medieval material, until a greater amount is studied from the northern half of the Lanes.

The collections from the five sites are all remarkably similar in content and have been pooled for most analyses. They are dominated by bones of the three major species - cattle, sheep and pigs. Bones of goats, horses, dogs, hares, roe deer and red deer are all very sparsely distributed. The other species that are consistently present in low numbers are large species of birds, mostly domestic such as fowl (chicken) and goose. Some of the latter may have been wild and obtained from the Solway estuary.

Fish bones, as at most Romano-British sites, are very rare and are dominated by a few freshwater and anadromous types. Most of the fish represented were small, and would have contributed very minor quantities of meat to the diet. Many of the bones appear to have been eaten and excreted, either by people or by dogs. For the medieval period, fish bones represent more varied taxa and habitat types than in the Roman periods, and include more marine examples.

Ten percent of the contexts had bulk samples taken from them for flotation over 0.5 mm mesh, but the numbers of bones recovered are not sufficient for confident comparisons of species ratios to be made for any but the earliest deposits. Bones of fish, small mammals and amphibians and small birds were only recovered from the fine fractions from these samples, not from the hand-picked sieved collections (which selected nearly all bones over 10mm long from the residues). The numbers of bones and species represented in these fine fractions are surprisingly small, and consist only of very common British species.

By weight, volume, and numbers of fragments the bones of cattle dominate the hand-recovered collection, but an analysis of Minimum Numbers of Individuals based on diagnostic zones of elements shows that sheep are represented approximately equally in terms of numbers of individuals. In terms of meatweights, cattle were far more important than all of the other species put together in all three of the major periods, contributing more than three-quarters of the calculated meatweights. For the medieval period, wild species of mammal, birds and fish are notably more important than in either of the Roman periods, but still contributed less than 10% of the calculated meatweights.

Cattle, sheep and pigs are all represented by all parts of the skeleton throughout the deposits. This, together with the presence of foetal and neonatal bones (particularly of sheep and pigs), may suggest that the animals were raised locally by the inhabitants of the Lanes, rather than bought in as joints of meat. There is a slight possibility that some of the younger Roman sheep were butchered at the site and their carcasses exported, but the evidence is ambiguous.

The age distributions of the three species are extremely different from one another. The patterns shown by dental analyses (Mandibular Wear Scores) and by post-cranial fusion analyses correlate closely for each species. The cattle bones and jaws are dominated by the remains of mature animals, some of which may have been approaching death through old age. The degree of pathology is minimal and is restricted to minor osteoarthritic conditions (possibly related to age) and occasional periodontal infections. The level of husbandry care, therefore, appears to have been very good. The age distribution contrasts slightly with that seen at the fort excavated at Annetwell Street, which also had a majority of elderly animals but also a significant minority of juveniles killed at the prime time for meat production. Morphologically and metrically the cattle are indistinguishable between the civilian and military areas, and all resemble the small indigenous 'Celtic shorthorn'. There is no indication of any increase in size during the Roman period, neither by the addition of larger animals nor by any general increase in average size. The medieval collection, however, does indicate that some new type(s) of cattle had been introduced or developed by the 12th/13th C. These tended to have a slightly different shape of horncore and some of them are considerably larger than the more numerous Roman examples.

There are some morphological alterations to articular surfaces of many of the cattle bones, especially the foot bones, and it is unclear as to whether these are congenital or a result of minor trauma. Splaying of some of the foot bones may be related to use for traction, causing strain on the associated muscles. The cattle jaw bones also have high incidences of dental traits that are though to be congenital, specifically the absence of the second lower premolar and the absence or reduction of the third column on the lower third molar. High incidences were also noted at the fort at Annetwell Street and are not uncommon in collections of Romano-British cattle remains.

The sheep ageing analyses indicate a much more even balance between young or juvenile animals and adults. Many of the young bones may derive from juvenile males rather than females. These may have been raised for meat rather than for wool, milk or breeding. There is a slight imbalance between the numbers of jaws and the numbers of other parts of the body, and it is possible that the 'excessive' jaws derive from young males butchered at the site for export. The contemporaneous asemblage at Annetwell Street does not show a corresponding lack of jaws, however.

The sizes and morphology of the sheep bones are 'normal' for Romano-British sheep, and there is no obvious increase or change in the medieval period.

There is only a single example of a pathologically altered sheep bone. This is a case of 'penning elbow' which might relate to a knock to the joint incurred during crowded conditions.

The age distribution of the pig bones and teeth consists almost entirely of young ones ranging from foetal and neonatal up to approximately two years of age. There is only one jaw from a mature adult pig. Pathological alterations are scarce and mainly concern minor physical damage to foot bones.

There is no indication of the presence of any wild pigs. The sex ratio includes several females but rather more males, all of them killed at a young age when they could not have been used for breeding for more than a few months. The age structure does not represent a viable self-regenerating population, and the skeletal remains of the mature adult females that would have been essential for breeding must have been deposited elsewhere.

Overall, the collection gives us useful insights into the nature of Romano-British husbandry in this region in the earlier Roman period, and allows us to show that the animals utilised by the civilians and military personnel at Carlisle were probably parts of the same pools of livestock.

The presence of foetal and neonatal sheep and pigs may indicate that these animals were being raised in the vicinity. The location of the excavated area, on the outskirts of the civilian settlement beside a major road, would have been well placed for farming or small holding concerns, since people would have had easy access to pasture and to the markets (both civilian and military). The lack of foetal calf bones and the dominance of mature cattle may suggest that cattle were not actually kept *in situ*, but brought in for slaughter and marketing. The area could have acted as a holding area for animals brought in for sale, barter or tax purposes.

The next stage of these analyses needs to investigate the possible changes in husbandry and livestock types during the later Roman period (*ie* the 3rd and 4th Centuries). This should be possible with material from the northern half of the Lanes, which have longer stratigraphic sequencies for the Roman deposits. This is particularly important as it is becoming apparent that there are major differencies between the north and south of what is now England during the Romano-British period, and it may also be the case that there were differences between the eastern and western sides of the country. Carlisle was on the 'North-West Frontier' of the Roman empire, and may not have followed the trend developed in the more romanised south of the country.

Following that, it is planned that a major study will be undertaken of the medieval and later material from the northern Lanes, to investigate the development of Carlisle and northern husbandry practices during the medieval period (when it was a city centred around an early cathedral) and the post-medieval period (when it formed a crucial point in the droving routes from Scotland into England).

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Bibliography

Baker, J. & Brothwell, D. 1980. Animal diseases in archaeology. London: Academic Press.

Boessneck, J. 1969. Osteological differences between sheep (*Ovis aries* Linné) and goat (*Capra hircus* Linné). In Science in Archaeology London: Thames & Hudson. Pages 331-358

Chaplin, R.E. & McCormick, F. 1986. The animal bones. In I.M. Stead & V. Rigby. Baldock. The excavation of a Roman and pre-Roman settlement, 1968-72. London: Society for the Promotion of Roman Studies. Britannia Monograph Series No. 7: 396-415

von den Driesch, A. 1976. A guide to the measurement of animal bones from archaeological sites. Harvard: Peabody Museum of Archaeology and Ethnology, Harvard University. Peabody Museum Bulletin 1.

von den Driesch, A. & Boessneck, J. 1974. Kritische Anmerkungen zur Widderisthöhenberechnung aus Längenmassen vor-und frügeschichtlicher Tierknochen. Säugetierkundliche Mitteilungen 22: 325-348

Gerrard, F. 1945. Meat technology. 1st edn. London: Hill

Gidney, L.J. 1991. Leicester, The Shires 1988 excavations. The animal bones from the Roman deposits at Little Lane. Ancient Monuments Laboratory Report 56/91.

Grant, A. 1982. The use of tooth wear as a guide to the age of domestic ungulates. In B. Wilson, C. Grigson & S. Payne (eds.) Ageing and sexing animal bones from archaeological sites. Oxford: British Archaeological Reports, British Series. 109: 91-108

Harcourt, R.A. 1974. The dog in prehistoric and early historic Britain. Journal of Archaeological Science 1: 151 - 175.

Howard, M.M. 1962. The early domestication of cattle and the determination of their remains. Zeitschrift für Tierzüchtung und Züchtungsbiologie 76:252-264

Hyland, A. 1990. Equus: The horse in the Roman world. London: Batsford

King, A.C. 1978. A comparative survey of bone assemblages from Roman sites in Britain. Bull. Inst. Archaeol. London 15:207-232

Locker, A. 1992. The fish bones. In P. Crummy. Excavations at Culver Street, the Gilberd School, and other sites in Colchester 1971-85. Colchester: Colchester Archaeological Trust. Colchester Archaeological Report 6: 278-280 & fiche tables 8.12 - 8.13.

Luff, R-M. 1982. A zooarchaeological study of the Roman north-western provinces. Oxford: British Archaeological Reports, International Series No. 137.

McCarthy, M.R. 1991 FACTPACK. The Lanes Project, Carlisle: background and guidance for specialists. unpublished monograph, Carlisle Archaeological Unit.

McCarthy, M.R. *in prep.* Roman Carlisle, The Lanes Volume 1: excavations at Old Grapes, Crown and Anchor and Lewthwaites Lanes 1981-2.

O'Connor, T.P. 1988. The bones from the General Accident Site, Tanner Row. London: Council For British Archaeology. The Archaeology of York: The animal bones. Volume 15 Fascicule 2.

Nicholson, R. A. n.d. Fish remains from excavations at "The Lanes", Carlisle, 1981-1982. archive report on file with the site archive at Carlisle.

Payne, S. 1975. Partial recovery and sample bias. In A.T. Clason (ed) Archaeozoological Studies. Amsterdam: North Holland. pp 7 - 17

Rackham, D.J. 1990. The vertebrate remains and mollusc shells (1983). In M.R. McCarthy. A Roman, Anglian and Medieval site at Blackfriars Street. pp 320-329 & fiche 3/9 - 3/14.

Rackham, D.J., Stallibrass, S.M. & Allison, E.P. 1991. The animal and bird bones. In M.R. McCarthy. The structural sequence and environmental remains from Castle Street, Carlisle: excavations 1981-2. Fascicule 1. pp73-88. Kendal: Cumberland & Westmorland Antiquarian and Archaeological Society Research Series No. 5.

Silver, I.A. 1969 The ageing of domestic animals. In D. Brothwell & E. Higgs (Eds.) Science in Archaeology London: Thames & Hudson. Pages 283-302

Stallibrass, S.M. 1991a. Animal bones from excavations at Annetwell Street, Carlisle, 1982-4. Period 3: the earlier Roman timber fort. Ancient Monuments Laboratory Report Series. No. 132/91

Stallibrass, S.M. 1991b. A comparison of the measurements of Romano-British animal bones from Periods 3 and 5, recovered from excavations at Annetwell Street, Carlisle. Ancient Monuments Laboratory Report Series. No. 133/91

Stallibrass, S.M. 1992. Animal bones from excavations at Lewthwaites Lane, Crown and Anchor Lane and Old Bush Lane, The Lanes, Carlisle, 1981-1982. Ancient Monuments Laboratory Report Series. No. 82/92

Stallibrass, S.M. 1993. Animal bones from excavations at Old Grapes Lane trenches A & B, The Lanes, Carlisle, 1981-1982. Ancient Monuments Laboratory Report Series. No. 93/93

Table 3: Weights of animal bone, by period and recovery method for all five sites in the southern Lanes

all weights are in g

DATE and SITE	PHASE	HAND recovered	SIEVED	FINE FRACTION	TOTALS
?prehistoric					
OGL-A	1	37	4	3.2	44
OGL-B	1	313			313
Totals		350	4	3.2	357
late 1st C/2nd C					
OGL-A	3 - 6	24567	3627	519.3	28713
OGL-B	2 - 4D	10734	193	20	10947
LEL-A	2 - 8	43072	4163	64.7	47300
CAL-A	2,3	10724	2276	53.2	13053
OBL-B	3,6	7722	954	-	8676
Totals		96819	11213	657.2	108689
late 2nd C/3rd C					
OGL-A	7 - 10	23369	337	75.6	23782
OGL-B	4E - 7	72958	787	34	73779
LEL-A	9 - 16	19372	-	-	19372
Totals		115699	1124	109.6	116933
3rd-12th C					
OGL-A	11,12	3452	-	-	3452
OGL-B	8	3565	-	-	3565
LEL-A	17,18	10020	-	-	10020
Totals		17037	-	-	17037
12th/13th C					
OGL-A	13	4088	7815	92.1	11995
OGL-B	9	6367	-	-	6367
LEL-A	19 - 21	22344	-		22344
Totals		32799	7815	92.1	40706
post-medieval					
LEL-A	22	1643	-	-	1643
GRAND TOTALS		264347	20156	862.1	284582

Table 4: Weights of animal bones by period and preservation type for all five sites from the southern Lanes

DATE, SITE & PHASE		EXCELLENT g	GOOD g	BRITTLE g	SHOT g	TOTALS g
late 1st/2nd C						
OGL-A	2 - 6	27952	101	141	-	28194
OGL-B	2 - 4D	12590	-	-	20	12610
LEL-A	2 - 8	41888	3481	1730	201	47300
CAL-A	2.3	12844				12844
OBL-B	3.6	8676				8676
	Totals	**103950**	**3582**	**1871**	**221**	**109624**
late 2nd/3rd C						
OGL-A	7 - 10	10045	1749	9770	371	21935
OGL-B	4E - 7	52077	6470	15088	110	73745
LEL-A	9 - 16	2331	8448	8465	128	19372
	Totals	**64453**	**16667**	**33323**	**609**	**115052**
3rd-12th C						
OGL-A	11.12	-	-	3112	340	3452
OGL-B	8	-	117	3325	123	3565
LEL-A	17.18	-	88	9932	-	10020
	Totals	**-**	**205**	**16369**	**463**	**17037**
12th/13th C						
OGL-A	13	580	1573	9103	647	11903
OGL-B	9	4090	445	1819	13	6367
LEL-A	19 - 21	-	130	20675	1617	22422
	Totals	**4670**	**2148**	**31597**	**2277**	**40692**
post-medieval						
LEL-A	**22**	**-**	**-**	**1443**	**200**	**1643**
GRAND TOTALS		**173073**	**22602**	**84603**	**3770**	**284048**

Table 5: Distribution of recorded fragments recovered by hand from the southern Lanes

DATE	late 1st/ early 2nd	late 2nd /3rd	3rd-12th	12th/13th	post-med	
PHASE						
OGL-A	3 - 6	7 - 10	11,12	13		
OGL-B	2 - 4D	4E - 7	8	9		
LEL-A	2 - 8	9 - 15	17,18	19,20,21	22	
CAL-A	3,6					
OBL-B	2,6					**TOTALS**
SPECIES						
CATTLE	674	632	123	337	28	**1794**
SHEEP/GOAT	241	117	19	52	7	**436**
SHEEP	102	62	8	14	1	**187**
GOAT		1				**1**
PIG	224	195	33	60	3	**515**
CATTLE-SIZED	172	120	31	60		**383**
SHEEP-SIZED	77	33	7	14	1	**132**
PIG-SIZED	40	36	6	12	1	**95**
HORSE	10	7	2	12	3	**34**
DOG	19	14		3		**36**
RED DEER	6	5	2	9		**22**
ROE DEER	7	6		1		**14**
HARE	1	1				**2**
BEAR				1		**1**
BADGER	1					**1**
FOWL	9	3	1	17		**30**
FOWL-SIZED	1	1			1	**3**
BLACK GROUSE	1	1				**2**
GOOSE, *cf* Anser			1	5		**6**
GOOSE, *cf* Branta	1	1				**2**
GOOSE, DOMESTIC				1		**1**
GOOSE, SMALL	2					**2**
SWAN sp.				1		**1**
SWAN-SIZED				1	1	**2**
WOODCOCK					1	**1**
TOTALS	**1588**	**1235**	**233**	**600**	**46**	**3702**

Table 6: Distribution of recorded fragments recovered from sieved samples from the southern Lanes

DATE (AD):	late 1st C/ early 2nd	late 2nd /3rd	3rd-12th	12th/13th	post-medieval	
PHASE:						
OGL-A	3 - 6	7 - 10		13		
OGL-B	2 - 4D	4E - 7				
LEL-A	2 - 8					
CAL-A	3,6					
OBL-B	2,6					
						Totals
SPECIES						
CATTLE	81	13		57		**151**
SHEEP/GOAT	64	8		17		**89**
SHEEP	10	1		1		**12**
GOAT				1		**1**
PIG	58	12		17		**87**
CATTLE-SIZED	25	5		8		**38**
SHEEP-SIZED	28	5		5		**38**
PIG-SIZED	3	1				**4**
DOG	3	2				**5**
CAT				1		**1**
RED DEER				1		**1**
FOWL	3					**3**
GOOSE sp.	1					**1**
Totals	**276**	**47**	**-**	**108**	**-**	**431**

Table 7: Distribution of recorded fragments recovered from fine fractions from the southern Lanes

DATE:	late 1st/ 2nd C	late 2nd/ 3rd C	12th/ 13th C	Totals
PHASE:				
OGL-A	3 - 6	7 - 10	13	
OGL-B	2 - 4D	4E - 7		
LEL-A	2 - 8			
CAL-A	3			
SPECIES:				
CATTLE	4			4
SHEEP/GOAT	25	8	3	36
PIG	37	4		41
CATTLE-SIZED	9		1	10
SHEEP-SIZED	33	3	1	37
PIG-SIZED	2	1		3
DOG	5			5
Unidentified large mammal	1			1
MOUSE, house (*Mus musculus*)	3			3
MOUSE, wood (*Apodemus* sp)	2			2
MOUSE, sp.	1			1
VOLE, sp.	1	1		2
SHREW, pygmy (*Sorex minutus*)	1			1
Small Mammal	8	3	1	12
TOAD (*Bufo* sp.)	1			1
FROG/TOAD	4			4
Small Vertebrate	12	2		14
FOWL	4		1	5
FOWL?	1			1
FOWL-SIZED	2	2	1	5
DUCK *cf.* mallard (*Anas platyrhynchos*)	1			1
GOOSE, greylag (*Anser*)*			6	6
GOOSE-SIZED			4	4
THRUSH, sp. (*Turdus*)	3			3
Passerine, thrush-sized	6			6
Small Passerine, Sparrow-sized	9			9
Unidentified bird	34	6	5	45
ELASMOBRANCH			1	1
SHAD (*Alosa* sp.)	1			1
HERRING (*Clupea harengus*)			2	2
SALMON (*Salmo salar*)	20	3		23
TROUT (*Salmo trutta*)	1			1
SALMONID	56			56
SALMONID?	4			4
PIKE (*Esox lucius*)			1	1
PIKE?	10	1		11
EEL (*Anguilla anguilla*)	348			348
EEL?		1		1
COD (*Gadus morhua*)	1		2	3
COD/SAITHE (*Gm/Pollachius virens*)			1	1
HADDOCK (*Melanogrammus aeglefinus*)	2			2
COD sp. (*Gadidae*)	1			1
Gadid?	1			1
BASS (*Dicentrarchus labrax*)			1	1
MACKEREL (*Scomber scombrus*)	1			1
PLAICE (*Pleuronectes platessa*)	1			1
PLAICE/FLOUNDER (*Pp/Platichthys flesus*)	2			2
Right-sided FLATFISH	12	1	5	18
PLEURONECTID?	1		1	2
FLATFISH sp.	2	1		3
Totals	673	37	37	747

* could be wild or domestic

Table 11: Cattle withers heights from the southern Lanes

measurements are as defined by von den Driesch (1976)

SITE	PHASE		DATE (Century AD)	ELEMENT	FUSION		GL (in mm)	factor	WITHERS HEIGHT (in m)
LEL-A	2	C	1/2	Metacarpal	PF	DF	153	6.1	0.933
OGL-B	4	A	1/2	Metacarpal	PF	DF	160	6.1	0.976
LEL-A	8	E	1/2	Metatarsal	PF	DFvis	184	5.4	0.993
OGL-A	6		1/2	Metacarpal	PF	DF	163	6.1	0.994
LEL-A	5		1/2	Metatarsal	PF	DF	186	5.4	1.004
CAL-A	3	A	1/2	Metacarpal	PF	DF	165	6.1	1.006
OGL-A	6		1/2	Tibia	PFsg	DF	293	3.45	1.011
OBL-B	6		1/2	Radius	PF	DF	236	4.3	1.014
OGL-B	3		1/2	Radius	PF	DF	236	4.3	1.015
OGL-A	4		1/2	Radius	PF	DF	237	4.3	1.019
OGL-A	4		1/2	Metatarsal	PF	DF	189	5.4	1.021
OGL-B	3		1/2	Metacarpal	PF	DF	168	6.1	1.025
LEL-A	4		1/2	Metacarpal	PF	DF	168	6.1	1.024
LEL-A	6	A-E	1/2	Metatarsal	PF	DF	191	5.4	1.031
OGL-A	4		1/2	Radius	PF	DF	240	4.3	1.032
LEL-A	6	A-E	1/2	Metatarsal	PF	DF	192	5.4	1.036
LEL-A	6	A-E	1/2	Metatarsal	PF	DF	198	5.4	1.069
OGL-A	6		1/2	Humerus	PF	DF	(GLC)225	4.77	1.073
OGL-A	6		1/2	Metacarpal	PF	DF	176	6.1	1.074
OGL-A	6		1/2	Metacarpal	PF	DF	182	6.1	1.110
LEL-A	6	A-E	1/2	Tibia	PF	DF	322	3.45	1.110
CAL-A	3	A	1/2	Metacarpal	PF	DF	184	6.1	1.122
LEL-A	8	E-F	1/2	Humerus	PF	DF	(GLC)240	4.77	1.144
OGL-A	4		1/2	Radius	PF	DFsg	273	4.3	1.174
LEL-A	10	B	2/3	Metacarpal	PF	DF	161	6.1	0.982
OGL-B	5		2/3	Radius	PF	DF	231	4.3	0.993
OGL-B	7		2/3	Metacarpal	PF	DF	165	6.1	1.006
OGL-B	7		2/3	Metacarpal	PF	DF	166	6.1	1.013
OGL-A	9		2/3	Metatarsal	PF	DF	189	5.4	1.021
OGL-B	5		2/3	Radius	PF	DF	240	4.3	1.032
OGL-B	5		2/3	Metatarsal	PF	DF	196	5.4	1.058
OGL-A	8		2/3	Radius	PF	DF	247	4.3	1.062
OGL-B	5		2/3	Radius	PF	DF	248	4.3	1.066
OGL-B	5		2/3	Metacarpal	PF	DF	175	6.1	1.068
OGL-B	5		2/3	Metacarpal	PF	DF	176	6.1	1.074
OGL-B	6		2/3	Metacarpal	PF	DF	177	6.1	1.080
OGL-B	7		2/3	Metatarsal	PF	DF	201	5.4	1.085
OGL-A	8		2/3	Metacarpal	PF	DF	178	6.1	1.086
OGL-B	7		2/3	Metacarpal	PF	DF	182	6.1	1.110
OGL-B	5		2/3	Metatarsal	PF	DF	206	5.4	1.112
OGL-B	7		2/3	Metacarpal	PF	DF	189	6.1	1.153

Table 11: Cattle withers heights from the southern Lanes

measurements are as defined by von den Driesch (1976) (continued)

SITE	PHASE		DATE (Century AD)	ELEMENT	FUSION		GL (in mm)	factor	WITHERS HEIGHT (in mm)
LEL-A	12	B	2/3	Radius	PF	DFsg	281	4.3	1.208
OGL-A	9		2/3	Radius	PF	DF	302	4.3	1.299
OGL-B	6		2/3	Radius	PF	DF	303	4.3	1.303
OGL-A	8		2/3	Radius	PF	DF	304	4.3	1.307
OGL-B	8		3-12	Radius	PF	DF	246	4.3	1.058
LEL-A	18		3-12	Metacarpal	PF	DF	191	6.1	1.165
LEL-A	18		3-12	Metatarsal	PF	DF	219	5.4	1.182
LEL-A	19	B	12/13	Metacarpal	PF	DF	170	6.1	1.037
OGL-A	13		12/13	Metacarpal	PF	DF	173	6.1	1.055
LEL-A	21	B	12/13	Metatarsal	PF	DF	203	5.4	1.096
LEL-A	19	B	12/13	Metacarpal	PF	DF	182	6.1	1.110
LEL-A	21	B	12/13	Metatarsal	PF	DF	212	5.4	1.144
OGL-B	9		12/13	Metatarsal	PF	DF	220	5.4	1.188
LEL-A	21	B	12/13	Metacarpal	PF	DF	202	6.1	1.232

	all Roman	1st/2nd C	2nd/3rd C
N	45	24	21
average	1.070	1.042	1.101
minimum	0.933	0.933	0.982
maximum	1.307	1.174	1.307
Standard Deviation	0.083	0.056	0.097

TABLE 13: Cattle metacarpal measurements from the southern Lanes.

SITE	PHASE	DATE (Cent AD)	DISTAL FUSION	SD	Bd	BFd	Dd	GL	BD/GL IND 1	SD/GL IND 2	GLx6.1 WITHERS HEIGHT
OGLA	6	1.2			46.6	42.1					
OBLB	6	1.2			50.6	46.9					
CALA	3	1.2			49.4	45.2					
OGLA	6	1.2			62.9	53.9					
OGLA	6	1.2			53.3	49.4					
OGLA	6	1.2			50.6	46.4					
LELA	5	1.2	DF		50.7	45.7					
LELA	7 A	1.2	DF		52.9	47.3	27.9				
LELA	7 A	1.2	DF		49.5	46.4	28.4				
LELA	7 A	1.2	DF		46.7	44.1	27.5				
OGLB	3	1.2		17.2		29.1					
OGLB	4	1.2		24.4	46.5	43.1		160	29.1	15.3	976
LELA	4	1.2	DF	25.1	50.3	44.1	26.9	168	29.9	14.9	1025
OBLB	6	1.2		25.4							
OGLA	6	1.2		25.5		45.6					
LELA	7 A	1.2		25.6							
OGLB	4	1.2		25.7							
OBLB	6	1.2		26.0							
LELA	7 A	1.2	DF	26.1	51.4	46.3	26.0				
OGLA	6	1.2		26.1	47.4	43.6		163	29.1	16.0	994
LELA	8 D	1.2	DF	26.2	48.6	42.4					
CALA	3	1.2		26.5	47.3	43.8		165	28.7	16.1	1006
OGLA	6	1.2		26.5							
OGLB	3	1.2		26.7	52.9	47.6		168	31.5	15.9	1025
OGLA	6	1.2		26.9	49.6	45.8		176	28.2	15.3	1074
CALA	3	1.2		27.0							
LELA	8 D	1.2		27.1							
LELA	8 E-F	1.2	DF	27.3		42.9					
OGLA	6	1.2		27.5	49.5	45.0					
OGLB	0	1.2		27.7	52.0	49.8		177	29.4	15.6	1080
LELA	8 E-F	1.2		29.2							
OGLA	6	1.2		30.0	59.7	53.4		182	32.8	16.5	1110
LELA	7 A	1.2	DF	30.6	58.0	56.9					
LELA	8 E-F	1.2		30.7							
LELA	7 A	1.2		31.1							
CALA	3	1.2		31.3	53.4	50.0		184	29.0	17.0	1122
LELA	2 C	1.2	DF	31.4	53.7	48.5	25.9	153	35.1	20.5	933
LELA	7 B	1.2		31.5							
OGLB	6	2.3			49.6	45.6					
OGLB	5	2.3			49.0	45.4					
OGLB	7	2.3			50.9	44.6					
OGLB	7	2.3			64.4	55.9					
OGLB	7	2.3			49.3	46.1					
OGLB	5	2.3			50.3	46.6					
OGLB	6	2.3			48.8	43.2					
OGLB	5	2.3			64.1	55.5					
OGLB	5	2.3			49.4	46.8					
LELA	12 A	2.3	DF		54.3	49.1					
LELA	11	2.3	DF		49.3	45.0					
OGLB	5	2.3		18.6		39.2					
LELA	11	2.3	DUF	18.9		35.4					
OGLA	10	2.3		19.8							

TABLE 13: Cattle metacarpal measurements from the southern Lanes (continued).

SITE	PHASE	DATE (Cent AD)	DISTAL FUSION	SD	Bd	BFd	Dd	GL	BD/GL IND 1	SD/GL IND 2	GLx6.1 WITHERS HEIGHT
OGLA	8	2.3		25.0	49.4	43.8		178	27.8	14.0	1086
OGLB	5	2.3		26.0		49.7					
OGLB	5	2.3		26.3	49.7	44.5		176	28.2	14.9	1074
OGLB	5	2.3		26.5							
OGLB	7	2.3		26.9	47.5	44.2		166	28.6	16.2	1013
OGLB	6	2.3		27.0	51.6	51.0					
OGLB	5	2.3		27.0	54.2	49.5		175	31.0	15.4	1068
OGLA	7	2.3		27.2	50.8	46.1					
OGLB	5	2.3		27.2							
OGLB	5	2.3		27.8							
OGLA	7	2.3		28.2		55.8					
OGLA	8	2.3		28.9		55.9					
OGLB	5	2.3		29.0							
OGLB	7	2.3		29.3	52.8	46.3		182	29.0	16.1	1110
OGLB	7	2.3		29.6	56.6	50.7		165	34.3	17.9	1006
LELA	10 B	2.3	DF	29.7	55.3	48.1	29.3	161	34.3	18.4	982
LELA	10 A	2.3	DF	30.3	54.4	49.6	29.9				
OGLB	7	2.3		30.6	52.2	47.8					
LELA	12 A	2.3		33.9							
OGLB	7	2.3		35.3	55.6						
LELA	18	3.12	DFvis		50.0	47.4					
OGLB	8	3.12			51.4	47.3					
OGLB	8	3.12				62.2					
LELA	18	3.12	DF		61.1	52.5					
LELA	18	3.12	DF		49.8	46.6					
LELA	18	3.12		31.3							
LELA	18	3.12	DF	37.2	64.2	56.6	28.0	191	33.6	19.5	1165
LELA	19 B	12.13	DF		46.9	42.5					
OGLA	13	12.13			52.8	48.8					
OGLA	13	12.13		30.0							
OGLB	9	12.13			68.5	61.1					
LELA	19 B	12.13	DF		57.2	50.5					
OGLA	13	12.13			50.0	44.5					
LELA	19 B	12.13	DUF			51.6					
LELA	19 B	12.13	DF	24.6	49.1	44.8	24.8	170	28.9	14.5	1037
OGLA	13	12.13		28.3	53.5	50.3		173	30.9	16.4	1055
LELA	19 B	12.13		29.1							
LELA	19 B	12.13	DF	31.2	58.2	51.7	27.9				
LELA	19 B	12.13	DF	32.7	55.2	51.9		182	30.3	18.0	1110
LELA	21 B	12.13		33.9							
LELA	21 B	12.13	DF	36.2	64.6	61.2	31.8	202	32.0	17.9	1232
LELA	21 B	12.13		39.2							

Table 14: Measurements and visual assessments of sex for cattle pelves from the southern Lanes

SITE	PHASE	DATE (Century)	fusion of acetabulum	SD (in mm)	RIM HEIGHT (in mm)	visual identification of sex
LEL-A	8 C	1st/2nd		37.1		
LEL-A	8 C	1st/2nd	AF	38.0		
LEL-A	8 D	1st/2nd	AF	36.1		
LEL-A	8 E	1st/2nd	AF	44.4		
OGL-B	5	2nd/3rd	AF	30.8		MALE
LEL-A	10 A	2nd/3rd	AF	31.2		
LEL-A	10 A	2nd/3rd	AF	32.9		
OGL-B	5	2nd/3rd		35.5		
OGL-B	4 F	2nd/3rd		35.8		
LEL-A	12 A	2nd/3rd		31.7		
LEL-A	10 B	2nd/3rd	AF	38.3		
LEL-A	10 B	2nd/3rd		40.8		
LEL-A	20	12th/13th		28.5		
LEL-A	20	12th/13th	AF	37.3		
OGL-B	9	12th/13th		39.0		
OBL-B	6	1st/2nd	AUF	29.7		MALE?
LEL-A	8 C	1st/2nd	AF	36.2	5.2	FEMALE
LEL-A	8 D	1st/2nd	AF		6.1	FEMALE
LEL-A	7 A	1st/2nd	AF		8.5	FEMALE
OGL-B	4 A	1st/2nd	AF		9.8	FEMALE
LEL-A	8 D	1st/2nd	AF		12.4	FEMALE
LEL-A	7 A	1st/2nd	AF		12.8	FEMALE
OGL-A	6	1st/2nd	AF		*16.0	FEMALE
LEL-A	6 A	1st/2nd	AF		22.0	MALE
CAL-A	3 B	1st/2nd	AF		27.7	MALE
OGL-B	6	2nd/3rd	AF		6.4	FEMALE
OGL-A	9	2nd/3rd	AF		26.8	MALE
OGL-A	13	12th/13th	AF		6.7	FEMALE
OGL-B	9	12th/13th	AF		6.9	FEMALE

Key

AF ACETABULUM FUSED
AUF ACETABULUM UNFUSED
SD MIDSHAFT DIAMETER OF ILIUM

* this measurement includes extra bone laid down during osteoarthritic alteration.

TABLE 16: CATTLE EPIPHYSEAL FUSION DATA BY MAJOR PERIOD FOR THE SOUTHERN LANES

	1st/2nd C					2nd/3rd C				
	F	Fsg	Fvis	UF	(ep)	F	Fsg	Fvis	UF	(ep)
7 - 10 mths										
scapula tub.	30	-	-	-	-	60	-	-	-	-
acetabulum	34	-	-	2	-	32	-	-	-	-
TOTALS	64			2	-	92				
12 - 18 mths										
humerus d.	26	-	-	-		35	2	-	3	(1)
radius p.	35	-	-	-		42	-	-	3	
1st phalange p.	39	2	1	1		26	-	-	1	
2nd phalange p.	12	-	-	-		8	-	-	-	
TOTALS	112	2	1	1		111	2		7	(1)
2 - 2.5 /3 yrs										
tibia d.	18	2	2	3		31	1	1	7	
metacarpal d.	26	-	-	1	(1)	26	-	1	5	
metatarsal d.	23	1	-	4	(3)	27	-	-	3	
TOTALS	67	3	2	8	(4)	84	1	2	15	
3 - 3.5 yrs										
calcaneum	4		-	2		5	-	1	-	
femur p.	19	1	1	-	(1)	8	5	-	1	(3)
TOTALS	23	1	1	2	(1)	13	5	1	1	(3)
3.5 - 4 yrs										
humerus p.	9	1	1	2	(1)	5	-	1	7	(1)
radius d.	14	4	-	2		25	2	1	8	(1)
ulna p.	3	-	-	2	(1)	5	-	-	1	
ulna d.	2	-	-	5		8	-	1	-	
femur d	9	2	-	5	(4)	6	4	2	7	(1)
tibia p.	16	1	2	3		10	-	-	4	(1)
TOTALS	53	8	3	19	(6)	59	6	5	27	(4)
4.5 - 5 yrs										
pelvis: pubis	1	-	1	3		-	-	-	1	
pelvis: ischium	1	-	-	-		-	-	-	-	
vertebrae (p/d)	91	13	13	75	(6)	44	10	11	73	(6)
TOTALS	93	13	14	78	(6)	44	10	11	74	(6)

TABLE 16: CATTLE EPIPHYSEAL FUSION DATA BY MAJOR PERIOD FOR THE SOUTHERN LANES (continued)

MEDIEVAL (12th/13th C)

	F	Fsg	Fvis	UF	(ep)
7 - 10 mths					
scapula tub.	20	-	-	-	
acetabulum	23	-	-	-	
TOTALS	43				
12 - 18 mths					
humerus d.	16	-	-	-	
radius p.	19	-	-	-	
1st phalange p.	24	-	-	-	
2nd phalange p.	10	-	-	-	
TOTALS	69				
2 - 2.5 /3 yrs					
tibia d.	7	-	-	-	
metacarpal d.	12	-	-	2	
metatarsal d.	24	-	1	-	
TOTALS	43		1	2	
3 - 3.5 yrs					
calcaneum	5	-	1	2	
femur p.	13	-	1	-	
TOTALS	18		2	2	
3.5 - 4 yrs					
humerus p.	-	-	-	2	
radius d.	7	-	-	2	
ulna p.	-	-	-	1	
ulna d.	1	-	-	-	
femur d	2	-	-	1	(2)
tibia p.	4	1	-	1	(1)
TOTALS	14	1		7	(3)
4.5 - 5 yrs					
pelvis: pubis	-	-	-	-	
pelvis: ischium	1	-	-	-	
vertebrae (p/d)	27	-	6	32	
TOTALS	28		6	32	

TABLE 17: Observed and expected frequencies of cattle skeletal elements by major period for the southern Lanes.

		late 1st/early 2nd C			late 2nd/early 3rd C			medieval (12th/13th C)		
ELEMENT	CODE	observed	expected	(o*100/e)	observed	expected	(o*100/e)	observed	expected	(o*100/e)
horncore	Hc	21	50	42	18	74	24	10	28	36
skull	Sk	19	50	38	21	74	28	9	28	32
mandible	Md	47	50	94	70	74	95	10	28	36
hyoid	Hy	1	50	2	2	74	3	0	28	0
scapula	Sc	40	50	80	74	74	100	25	28	89
humerus	Hu	27	50	54	52	74	70	18	28	64
radius	Ra	35	50	70	47	74	64	15	28	54
ulna	Ul	20	50	40	36	74	49	8	28	29
carpals	Cp	3	300	1	1	444	0	0	84	0
metacarpal	Mc	36	50	72	36	74	49	13	28	46
pelvis	Pv	26	50	52	32	74	43	17	28	61
femur	Fe	26	50	52	31	74	42	12	28	43
patella	Pt	1	50	2	0	74	0	2	28	7
tibia	Ti	28	50	56	38	74	51	8	28	29
astragalus	As	7	50	14	12	74	16	8	28	29
naviculo-cuboid	Nc	2	50	4	7	74	9	0	28	0
calcaneum	Ca	5	50	10	13	74	18	8	28	29
metatarsal	Mt	49	50	98	47	74	64	27	28	96
1st phalange	P1	39	200	20	28	296	9	23	112	21
2nd phalange	P2	6	200	3	6	296	2	8	112	7
3rd phalange	P3	5	200	3	7	296	2	8	112	7
sesamoids	Ss	0	600	0	0	888	0	0	336	0
ribs	Ri	69	650	11	74	962	8	38	364	10
atlas	At	12	25	48	8	37	22	3	14	21
axis	Ax	11	25	44	6	37	16	2	14	14
cerv. vertebrae	Cv	24	125	19	17	185	9	5	70	7
thor. vertebrae	Tv	40	325	12	30	481	6	7	182	4
lumb. vertebrae	Lv	27	150	18	18	222	8	3	84	4
sacrum	Sa	6	25	24	4	37	11	1	14	7
simplest MNI=		25			37			14		
N=		632			735			288		

TABLE 18: BAR GRAPH OF SHEEP WITHERS HEIGHTS FROM THE SOUTHERN LANES

all measurements are in mm

SITE	PHASE	DATE	ELEMENT	FUSION		GL	FACTOR x GL	WITHERS HEIGHT
OGLA	6	1st/2nd C	RADIUS	PF	DF	132	4.02	531
OGLB	3	1st/2nd C	METACARPAL	PF	DF	111	4.89	543
OGLB	3	1st/2nd C	METATARSAL	PF	DF	120	4.54	545
OGLA	6	1st/2nd C	METATARSAL	PF	DF	120	4.54	545
LELA	5	1st/2nd C	METACARPAL	PF	DF	116	4.89	567
LELA	7	1st/2nd C	METACARPAL	PF	DF	116	4.89	567
OGLA	6	1st/2nd C	RADIUS	PF	DF	144	4.02	579
OGLA	5	1st/2nd C	RADIUS	PF	DF	144	4.02	579
CALA	3	1st/2nd C	METATARSAL	PF	DF	129	4.54	586
OGLB	3	1st/2nd C	METATARSAL	PF	DF	131	4.54	595
OGLB	2	1st/2nd C	METATARSAL	PF	DF	133	4.54	604
LELA	6	1st/2nd C	METACARPAL	PF	DF	126	4.89	616
LELA	6	1st/2nd C	METACARPAL	PF	DF	126	4.89	616
OGLA	6	1st/2nd C	METATARSAL	PF	DF	137	4.54	622
LELA	7	1st/2nd C	METACARPAL	PF	DF	128	4.89	626
LELA	8	1st/2nd C	METATARSAL	PF	DF	145	4.54	658
OGLB	7	2nd/3rd C	RADIUS	PF	DF	131	4.02	527
OGLA	7	2nd/3rd C	METACARPAL	PF	DF	110	4.89	538
LELA	10	2nd/3rd C	METATARSAL	PF	DF	121	4.54	549
OGLB	5	2nd/3rd C	METATARSAL	PF	DF	121	4.54	549
LELA	10	2nd/3rd C	METACARPAL	PF	DF	114	4.89	557
OGLA	8	2nd/3rd C	METACARPAL	PF	DFvis	114	4.89	557
OGLB	5	2nd/3rd C	RADIUS	PF	DFvis	139	4.02	559
OGLA	9	2nd/3rd C	METACARPAL	PF	DF	115	4.89	562
OGLB	5	2nd/3rd C	METATARSAL	PF	DF	124	4.54	563
OGLA	9	2nd/3rd C	METATARSAL	PF	DF	124	4.54	563
OGLB	5	2nd/3rd C	METATARSAL	PF	DF	126	4.54	572
OGLB	5	2nd/3rd C	METACARPAL	PF	DF	117	4.89	572
OGLB	5	2nd/3rd C	METATARSAL	PF	DF	127	4.54	577
LELA	10	2nd/3rd C	METATARSAL	PF	DF	127	4.54	577
OGLB	7	2nd/3rd C	RADIUS	PF	DF	144	4.02	579
OGLB	5	2nd/3rd C	METATARSAL	PF	DF	128	4.54	581
OGLB	5	2nd/3rd C	METACARPAL	PF	DF	119	4.89	582
OGLB	5	2nd/3rd C	METACARPAL	PF	DF	122	4.89	597
OGLB	6	2nd/3rd C	METACARPAL	PF	DF	122	4.89	597
OGLB	5	2nd/3rd C	METATARSAL	PF	DFvis	132	4.54	599
OGLB	5	2nd/3rd C	METATARSAL	PF	DF	137	4.54	622
OGLA	7	2nd/3rd C	METACARPAL	PF	DF	133	4.89	650
OGLB	8	3rd-12th C	METACARPAL	PF	DF	115	4.89	562
LELA	18	3rd-12th C	METATARSAL	PF	DF	136	4.54	617
OGLA	13	12th/13th C	METATARSAL	PF	DF	129	4.54	586

	1st/2nd C	2nd/3rd C	Roman
N	16	22	38
AVERAGE	0.586	0.574	0.579
MINIMUM	0.531	0.527	0.527
MAXIMUM	0.658	0.650	0.658
STANDARD DEV.	0.035	0.027	0.031

TABLE 19: Sheep tibia distal breadth (Bd) and depth (Dd) measurements from the southern Lanes.

ALL ARE SHEEP OR SHEEP/GOAT (NO GOATS)
NO PROXIMAL MEASUREMENTS AVAILABLE

SITE	PHASE		DATE		FUSION	SD	Bd	Dd
LELA	7	A	1.2		DF	12.2	20.9	16.8
OGLB	3		1.2		DF	11.7	21.1	16.0
LELA	5		1.2		DF	11.2	21.2	17.0
OGLB	4	C	1.2		DF	12.6	21.6	17.0
OGLB	3		1.2		DFvis	11.9	21.6	18.0
OBLB	6		1.2		DF	11.4	21.9	17.0
OGLA	4		1.2		DF	11.8	22.4	18.1
LELA	6	A-E	1.2		DF	12.1	22.5	17.2
OGLA	6		1.2		DF		22.7	17.6
OGLB	3		1.2		DFvis	13.1	22.8	18.6
OBLB	6		1.2		DF	12.4	23.2	17.9
LELA	7	A	1.2		DF	13.4	23.2	18.6
OBLB	6		1.2		DFvis	13.6	23.3	17.8
OGLA	6		1.2		DUFep		23.5	18.9
LELA	8	E-F	1.2		DF	13.4	23.7	18.6
LELA	8	E	1.2		DF	14.0	24.6	20.1
CALA	3	A	1.2		DF	14.6	24.6	20.1
OBLB	6		1.2		DF		24.7	18.6
OGLB	5	B	2.3		DF	11.7	20.0	15.8
OGLA	10	F-11	2.3		DF	11.5	20.7	16.9
OGLA	8	C	2.3		DF	11.3	21.0	16.4
OGLA	10	E	2.3		DF	12.7	21.1	17.2
LELA	9		2.3		DF	12.3	21.3	16.9
OGLA	8	A	2.3		DF	13.4	21.3	18.3
OGLB	5	B	2.3		DF	12.3	21.4	17.1
OGLA	9	H	2.3		DF	11.8	21.6	16.8
OGLB	5	A	2.3		DF	12.6	22.1	16.4
OGLA	8	A	2.3	PUF	DF	11.7	22.3	16.8
OGLA	7	A	2.3		DF	12.0	22.6	17.5
OGLB	5	A	2.3		DF	13.5	22.8	18.5
OGLB	5	A	2.3		DF	13.4	22.8	17.8
OGLA	9	D	2.3		DFvis	13.0	23.1	18.6
OGLB	7	B	2.3		DF	13.2	23.2	18.6
OGLB	5	A	2.3		DF	14.8	23.2	19.0
OGLB	5	A	2.3		DF	13.4	23.2	19.2
LELA	9		2.3		DFvis	13.1	23.4	18.1
OGLB	6	E	2.3		DF	12.6	23.9	18.3
OGLA	7	A-8C	2.3		DF	13.1	24.2	19.0
OGLB	7	B	2.3		DF	13.4	24.3	19.2
OGLA	8	B	2.3		DF	14.0	24.3	19.7
OGLA	9	A-D	2.3		DFvis		24.3	19.6
OGLB	5	A	2.3		DF	14.6	24.5	18.8
OGLA	12	A-B	3.12		DF	15.1	26.3	19.4
OGLA	13		12.13		DF	12.7	23.1	17.4
OGLA	13		12.13		DFsg		25.0	20.2
OGLA	13		12.13		DF	14.3	25.7	20.0
LELA	22		16		DF	13.2	25.3	19.6

1st/2nd C		2nd/3rd C		all Roman	
Dd	Bd	Dd	Bd	Dd	Bd
17	17	24	24	41	41
17.9	22.7	17.9	22.6	17.9	22.6
16.0	20.9	15.8	20.0	15.8	20.0
20.1	24.7	19.7	24.5	20.1	24.7
1.071	1.196	1.100	1.290	1.088	1.253

Table 20: Sheep pelvis measurements and visual assessments of sex from the southern Lanes.

SITE	PHASE	DATE (Century)	fusion of acetabulum	SD (in mm)	RIM HEIGHT (in mm)	visual identification of sex
LEL-A	7 A	1st/2nd	AF	10.9		
LEL-A	7 A	1st/2nd	AF	12.1		
OGL-B	3	1st/2nd	AF	12.2		MALE?
LEL-A	7 A	1st/2nd	AF	13.1		
OGL-B	4 C	1st/2nd	AF	13.4		
CAL-A	3 A	1st/2nd		14.5		MALE?
OGL-B	3	1st/2nd	AF	15.0		MALE
OGL-B	5 B	2nd/3rd		12.4		
OGL-B	5 A	2nd/3rd		12.6		MALE?
LEL-A	11	2nd/3rd		13.2		
OGL-B	5 A	2nd/3rd		14.0		MALE?
OGL-B	5 C	2nd/3rd	AF			MALE
LEL-A	18	3rd-12th		15.8		
LEL-A	21 B	12th/13th	AF	17.6		
LEL-A	7 A	1st/2nd	AF	13.5	2.1	FEMALE
OGL-A	6	1st/2nd	AF		2.2	FEMALE
LEL-A	6C-7A	1st/2nd	AF	13.2	2.2	FEMALE
OGL-A	6	1st/2nd	AF		2.5	FEMALE
OGL-A	3	1st/2nd	AF PUF		2.6	FEMALE/CASTRATE
LEL-A	7 B	1st/2nd	AF	13.2	3.1	FEMALE
LEL-A	2 C	1st/2nd	AF		3.2	FEMALE
LEL-A	5	1st/2nd	AF	12.8	5.0	CASTRATE?
LEL-A	7 A	1st/2nd	AF	14.0	5.4	CASTRATE?
LEL-A	7 A	1st/2nd	AF	12.6	5.5	CASTRATE?
OGL-B	3	1st/2nd	AF PUF	15.0	5.8	CASTRATE
LEL-A	5	1st/2nd	AF	14.2	6.1	CASTRATE?
OGL-B	7 B	2nd/3rd	AF	14.9	5.1	CASTRATE?
OGL-B	5 A	2nd/3rd	AF	11.9	8.0	MALE
OGL-B	5 B	2nd/3rd	AF PUF	13.1	0.6	FEMALE
LEL-A	19 B	12th/13th	AF	12.9	3.2	FEMALE
OGL-B	9	12th/13th	AF	18.8	5.7	FEMALE
OGL-A	13	12th/13th	AF PFsg		6.1	MALE
OGL-A	13	12th/13th	AF ISUF		7.4	MALE

Key

SD	MIDSHAFT DIAMETER OF ILIUM
AF	ACETABULUM FUSED
PF	PUBIS FUSED
PFsg	PUBIS FUSING
ISUF	ISCHIUM UNFUSED

TABLE 21: SHEEP EPIPHYSEAL FUSION DATA BY ~~MAJOR~~ PERIOD FOR THE SOUTHERN LANES

	1st/2nd C					2nd/3rd C				
	F	Fsg	Fvis	UF	(ep)	F	Fsg	Fvis	UF	(ep)
<u>6 - 10 mths</u>										
scapula tub.	17	-	-	-		8	-	-	-	
acetabulum	33	1	1	-		5	-	-	-	
TOTALS	50	1	1			13				
<u>10 - 16 mths</u>										
humerus d.	12	1	-	1		13	1	-	-	
radius p.	22	-	-	-		15	-	-	-	
1st phalange p.	4	2	-	3		1	-	-	-	
2nd phalange p.	-	-	-	-		-	-	-	-	
TOTALS	38	3		4		29	1			
<u>1.5 - 2/2.5 yrs</u>										
tibia d.	20	4	-	9	(2)	22	3	-	7	
metacarpal d.	9	-	-	8		7	3	-	5	
metatarsal d.	9	-	-	8		10	1	-	3	
TOTALS	38	4		25	(2)	39	7		15	
<u>2.5 - 3 yrs</u>										
ulna p.	1	-	1	1		-	-	-	1	
ulna d.	-	-	-	-		-	-	-	-	(1)
calcaneum	3	-	-	1		-	-	-	-	
femur p.	1	-	1	3	(1)	-	-	-	1	
TOTALS	5	-	2	5	(1)				2	(1)
<u>3 - 3.5 yrs</u>										
humerus p.	-	-	-	1		1	-	-	4	
radius d.	4	-	-	14		3	1	-	12	(1)
pelvis: pubis	-	-	1	3		-	-	-	1	
pelvis: ischium	1	-	-	-		1	-	-	-	
femur d	1	1	1	1		1	-	-	1	
tibia p.	1	-	-	4		-	-	-	3	
TOTALS	7	1	2	23		6	1		21	(4)
<u>4 - 5 yrs</u>										
vertebrae (p/d)	12	1	2	47	(8)	9	-	1	15	
TOTALS	12	1	2	47	(8)	9		1	15	

TABLE 21: SHEEP EPIPHYSEAL FUSION DATA BY MAJOR PERIOD FOR THE SOUTHERN LANES (continued)

MEDIEVAL (12th/13th C)

	F	Fsg	Fvis	UF	(ep)
6-10 mths					
scapula tub.	3	-	-	-	
acetabulum	8	-	-	-	
TOTALS	11				
10-16mths					
humerus d.	7	-	1	1	
radius p.	-	-	-	-	
1st phalange p.	1	-	-	-	
2nd phalange p.	-	-	-	-	
TOTALS	8		1	1	
1.5 - 2/2.3 yrs					
tibia d.	2	-	1	2	
metacarpal d.	1	-	-	1	
metatarsal d.	1	-	-	-	
TOTALS	4		1	3	
2.5 - 3 yrs					
ulna p.	1	-	-	-	
ulna d.	-	-	-	-	
calcaneum	-	-	-	-	
femur p.	-	-	-	-	(2)
TOTALS	1				(2)
3 - 3.5 yrs					
humerus p.	-	-	-	1	
radius d.	1	-	-	1	
pelvis: pubis	-	-	1	-	
pelvis: ischium	-	-	-	1	
femur d	1	-	-	-	
tibia p.	1	-	-	-	
TOTALS	3		1	3	
4 - 5 yrs					
vertebrae (p/d)	5	2	1	10	
TOTALS	5	2	1	10	

TABLE 22: Observed and expected frequencies of sheep skeletal elements by major period from the southern Lanes.

		late 1st/early 2nd C			late 2nd/early 3rd C			medieval (12th/13th C)		
ELEMENT	CODE	observed	expected	(o*100/e)	observed	expected	(o*100/e)	observed	expected	(o*100/e)
horncore	Hc	7	56	13	5	48	10	1	12	8
skull	Sk	5	56	9	5	48	10	1	12	8
mandible	Md	56	56	100	29	48	60	10	12	83
hyoid	Hy	1	56	2	0	48	0	0	12	0
scapula	Sc	29	56	52	12	48	25	3	12	25
humerus	Hu	19	56	34	22	48	46	8	12	67
radius	Ra	34	56	61	30	48	63	3	12	25
ulna	Ul	3	56	5	3	48	6	0	12	0
carpals	Cp	0	336	0	0	288	0	0	72	0
metacarpal	Mc	30	56	54	29	48	60	11	12	92
pelvis	Pv	27	56	48	10	48	21	6	12	50
femur	Fe	13	56	23	8	48	17	1	12	8
patella	Pt	0	56	0	0	48	0	0	12	0
tibia	Ti	52	56	93	48	48	100	7	12	58
astragalus	As	0	56	0	1	48	2	0	12	0
naviculo-cuboid	Nc	0	56	0	0	48	0	0	12	0
calcaneum	Ca	2	56	4	0	48	0	0	12	0
metatarsal	Mt	31	56	55	32	48	67	8	12	67
1st phalange	P1	3	224	1	1	192	1	0	48	0
2nd phalange	P2	0	224	0	0	192	0	0	48	0
3rd phalange	P3	1	224	0	0	192	0	0	48	0
sesamoids	Ss	0	672	0	0	576	0	0	144	0
ribs	Ri	58	728	8	36	624	6	11	156	7
atlas	At	3	28	11	1	24	4	0	6	0
axis	Ax	2	28	7	1	24	4	1	6	17
cerv. vertebrae	Cv	2	140	1	2	120	2	0	30	0
thor. vertebrae	Tv	7	364	2	4	312	1	2	78	3
lumb. vertebrae	Lv	8	168	5	5	144	3	3	36	8
sacrum	Sa	2	28	7	3	24	13	0	6	0
simplest MNI=		28			24			6		
N=		395			287			76		

TABLE 23: PIG EPIPHYSEAL FUSION DATA BY MAJOR PERIOD FOR THE SOUTHERN LANES

	1st/2nd C					2nd/3rd C				
	F	Fsg	Fvis	UF	(ep)	F	Fsg	Fvis	UF	(ep)
<u>by 12 mths</u>										
scapula tub.	10	-	2	3		5	-	-	-	
humerus d.	6	1	-	3	(1)	10	-	1	3	
radius p.	5	-	-	3	(1)	7	-	-	1	
acetabulum	14	-	-	4		15	-	-	3	
2nd phalange p.	4	-	1	-		-	-	-	-	
TOTALS	39	1	3	13	(2)	37		1	7	
<u>2 - 2.5 years</u>										
metacarpal d.	3	-	-	12		2	3	-	8	
metatarsal d.	1	1	-	6		5	1	1	12	
tibia d.	1	2	-	5	(1)	5	1	2	5	
fibula d.	-	-	-	-	(1)	-	-	-	2	
calcaneum	-	-	-	3	(1)	1	-	-	2	
1st phalange p.	1	-	-	2	(1)	1	1	-	-	
TOTALS	6	3		28	(4)	14	6	3	29	
<u>by 3.5 yrs</u>										
humerus p.	-	-	-	1		-	-	-	7	
radius d.	-	-	-	2		-	-	-	2	(1)
ulna p.	-	-	-	8		-	-	-	8	
ulna d.	-	-	-	3		-	-	-	1	
femur p.	-	-	-	5		-	-	-	2	(2)
femur d	-	-	-	5	(4)	-	-	-	2	
tibia p.	-	-	-	-		-	-	-	8	
fibula p.	-	-	-	-		-	-	-	2	
TOTALS				24	(4)				32	(3)
<u>4 - 7 yrs</u>										
pelvis: pubis	-	-	-	-		-	-	-	2	
pelvis: il/ischium	-	-	-	3		-	-	-	1	
vertebrae (p/d)	-	-	1	26		-	-	1	9	
TOTALS			1	29				1	12	

TABLE 23: PIG EPIPHYSEAL FUSION DATA BY MAJOR PERIOD FOR THE SOUTHERN LANES (continued)

Medieval (12th/13th C)

	F	Fsg	Fvis	UF	(ep)
by 12 mths					
scapula tub.	-	-	-	-	
humerus d.	1	-	-	2	
radius p.	2	-	-	3	(1)
acetabulum	2	-	-	-	
2nd phalange p.	1	-	-	-	
TOTALS	6			5	(1)
2 - 2.5 years					
metacarpal d.	1	-	-	3	
metatarsal d.	-	-	-	2	
tibia d.	1	-	-	4	
fibula d.	-	-	-	-	
calcaneum	-	-	-	2	
1st phalange p.	-	-	-	1	
TOTALS	2			12	
by 3.5 yrs					
humerus p.	-	-	-	-	
radius d.	-	-	-	3	
ulna p.	-	-	-	2	
ulna d.	-	-	-	-	
femur p.	-	-	-	4	
femur d	-	-	-	3	(2)
tibia p.	-	-	-	2	
fibula p.	-	-	-	-	
TOTALS				14	(2)
4 - 7 yrs					
pelvis: pubis	-	-	-	-	
pelvis: il/ischium	-	-	-	-	
vertebrae (p/d)	-	-	-	4	
TOTALS				4	

TABLE 24: Observed and expected frequencies of pig skeletal elements by major period from the southern Lanes.

		late 1st/early 2nd C			late 2nd/early 3rd C			medieval (12th/13th C)		
ELEMENT	CODE	observed	expected	(o*100/e)	observed	expected	(o*100/e)	observed	expected	(o*100/e)
horncore										
skull	Sk	16	24	67	8	30	27	2	8	25
mandible	Md	23	24	96	30	30	100	6	8	75
hyoid	Hy	0	24	0	0	30	0	0	8	0
scapula	Sc	21	24	88	9	30	30	0	8	0
humerus	Hu	9	24	38	19	30	63	3	8	38
radius	Ra	8	24	33	11	30	37	7	8	88
ulna	Ul	12	24	50	11	30	37	4	8	50
carpals	Cp	0	144	0	0	180	0	0	48	0
metacarpal	Mc	17	48	35	15	60	25	4	16	25
pelvis	Pv	15	24	63	20	30	67	3	8	38
femur	Fe	14	24	58	12	30	40	6	8	75
patella	Pt	0	24	0	0	30	0	0	8	0
tibia	Ti	18	24	75	25	30	83	7	8	88
fibula	Fb	1	24	4	4	30	13	1	8	13
astragalus	As	0	24	0	1	30	3	1	8	13
calcaneum	Ca	3	24	13	3	30	10	2	8	25
metatarsal	Mt	11	48	23	21	60	35	3	16	19
1st phalange	P1	0	96	0	2	120	2	0	32	0
2nd phalange	P2	0	96	0	0	120	0	0	32	0
3rd phalange	P3	0	96	0	0	120	0	0	32	0
sesamoids	Ss	0	288	0	0	120	0	0	96	0
ribs	Ri	46	336	14	42	420	10	12	112	11
atlas	At	1	12	8	3	15	20	1	4	25
axis	Ax	0	12	0	0	15	0	0	4	0
cerv. vertebrae	Cv	3	60	5	1	75	1	0	20	0
thor. vertebrae	Tv	6	168	4	1	210	0	0	56	0
lumb. vertebrae	Lv	2	72	3	3	90	3	0	24	0
sacrum	Sa	1	12	8	0	15	0	0	4	0
simplest MNI=		12			15			4		
N=		227			241			62		

N.B. lateral metapodials have not been included in these counts

FIGURE 1: The situation of The Lanes in Carlisle.

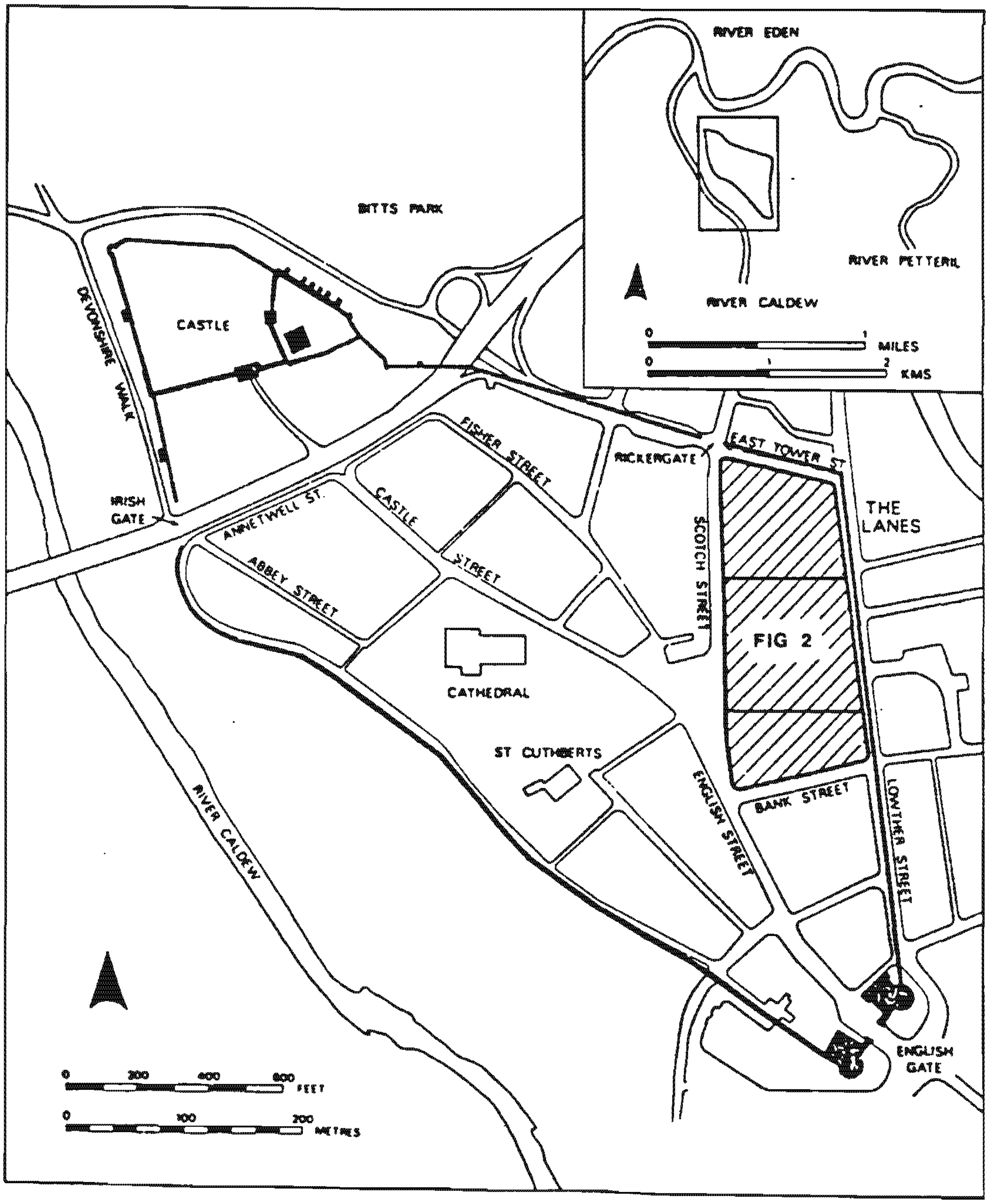


FIGURE 2: The southern group of excavation trenches in The Lanes.

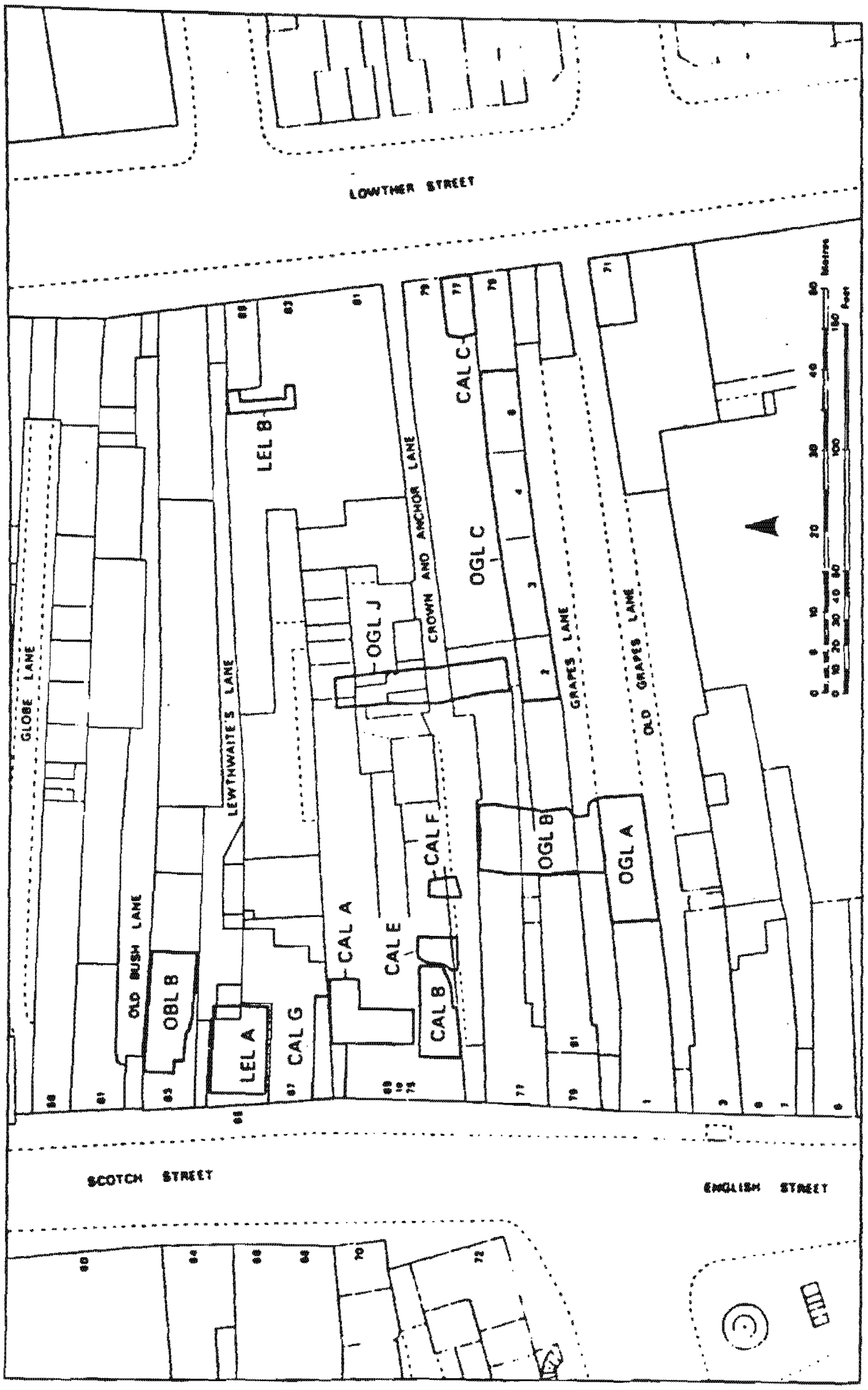


FIGURE 3: Roman remains recovered from Carlisle.

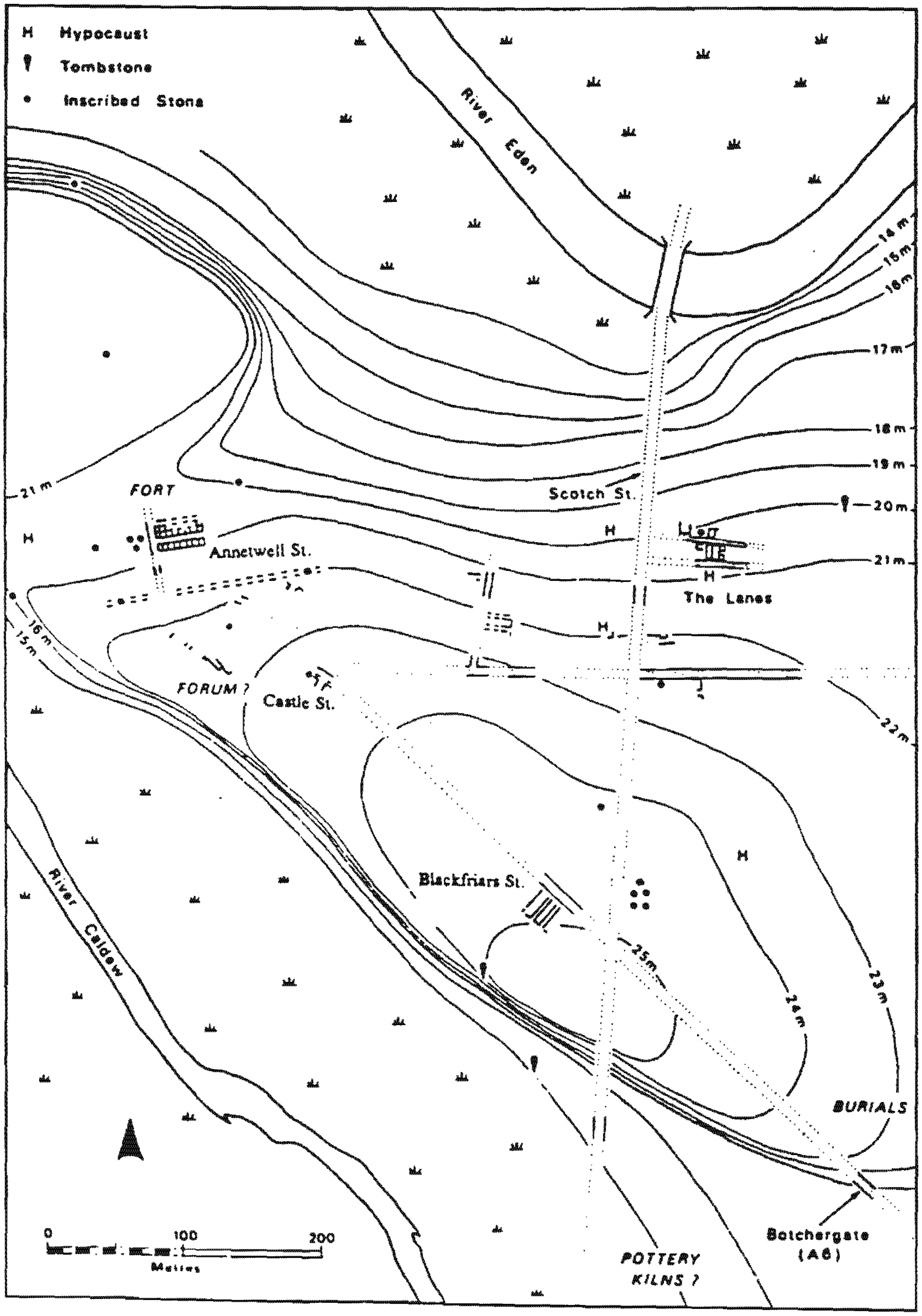


FIGURE 4: Bar graphs of cattle withers heights from the southern Lanes.

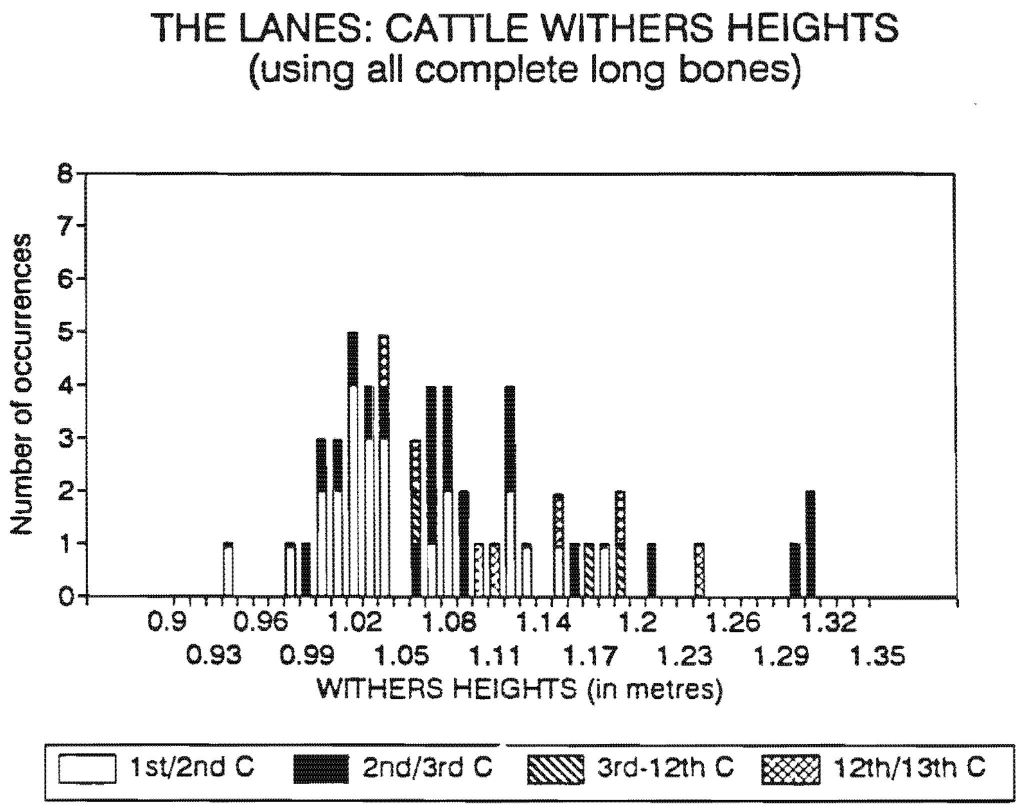


FIGURE 4: Bar graphs of cattle withers heights from the southern Lanes.

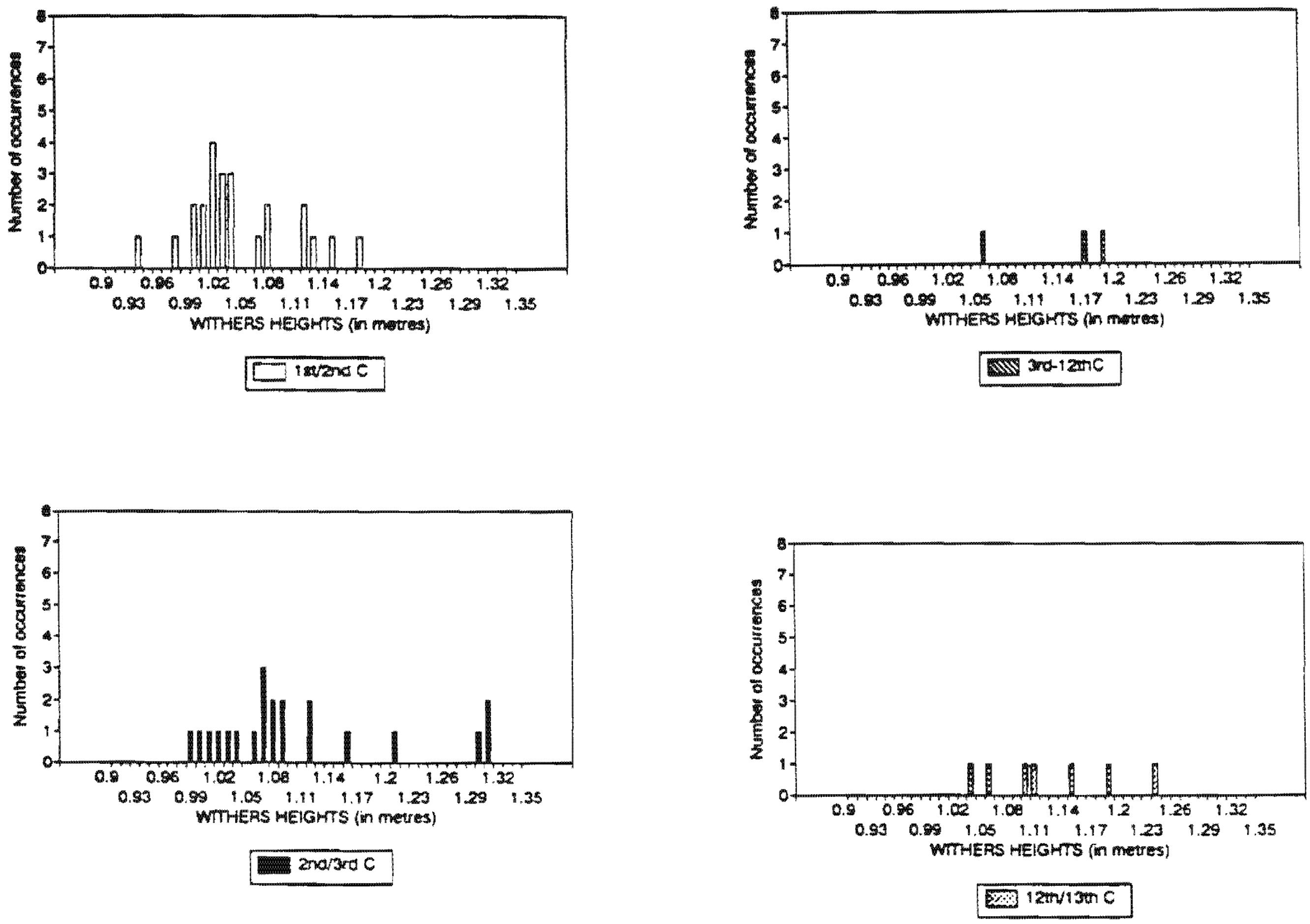


FIGURE 5: Scattergram of cattle horncore measurements: greatest and least basal diameters, from the southern Lanes.

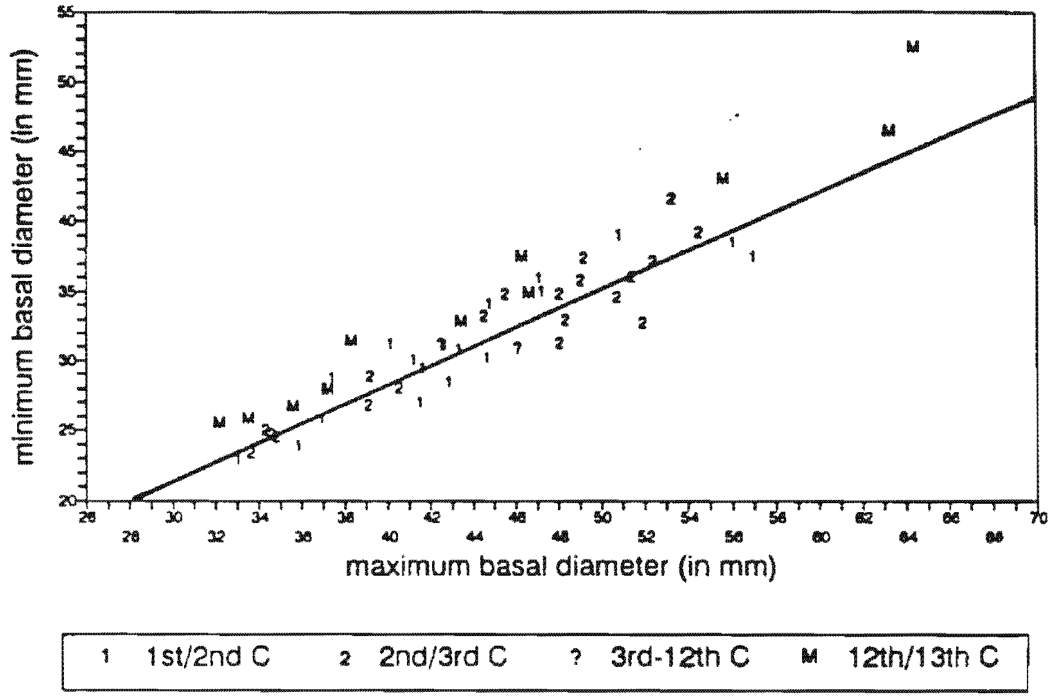


FIGURE 6: Scattergram of cattle horncore measurements: length of outer curvature against basal diameter index, from the southern Lanes.

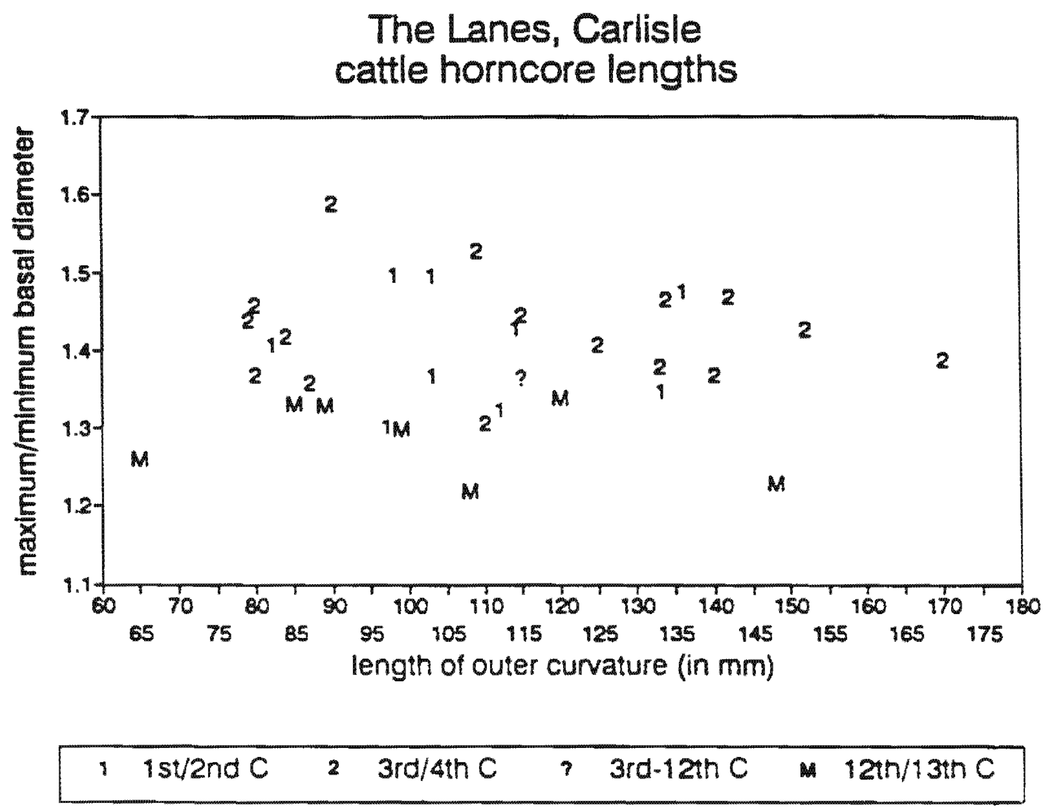


FIGURE 7: Bar graphs of cattle distal metacarpal breadths (Bd) from the southern Lanes.

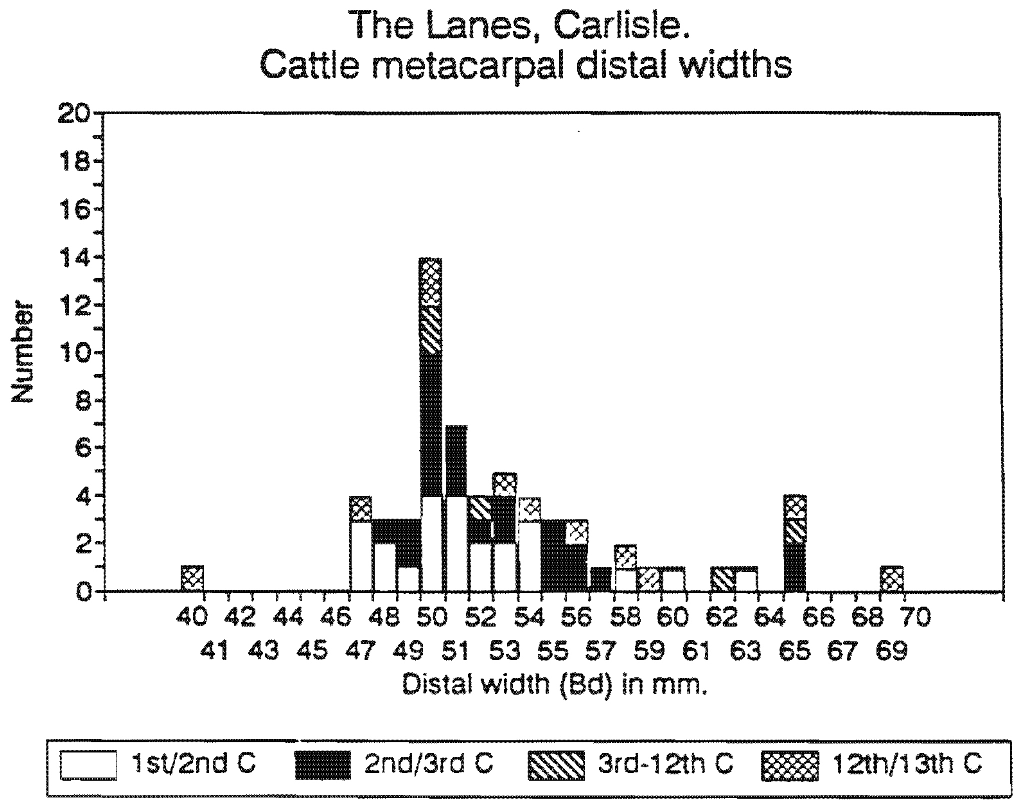


FIGURE 7: Bar graphs of cattle distal metacarpal breadths (Bd) from the southern Lanes.

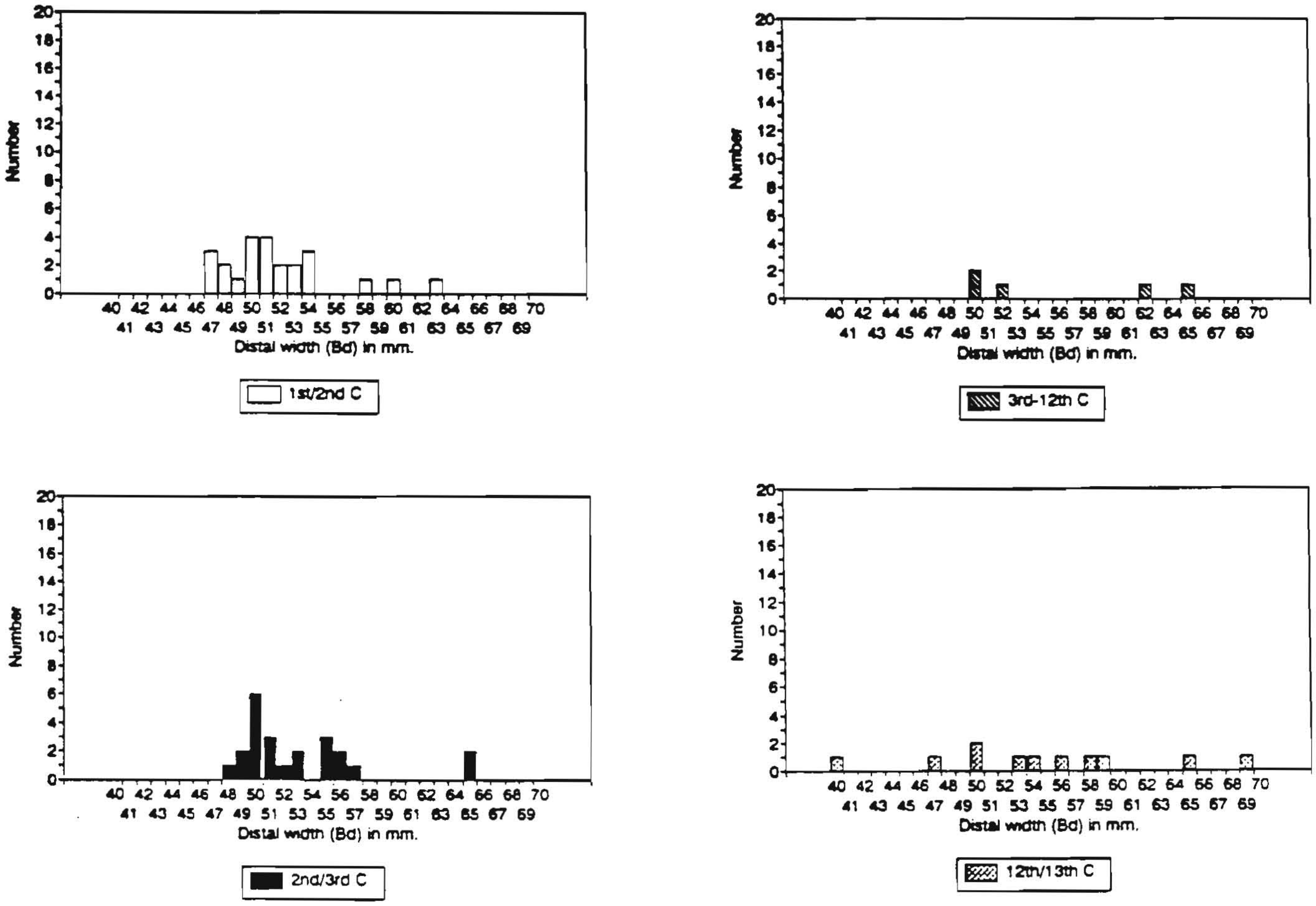


FIGURE 8a: Scattergram of cattle metacarpal distal breadth (Bd) and distal breadth at fusion point (BFd) measurements from the southern Lanes.

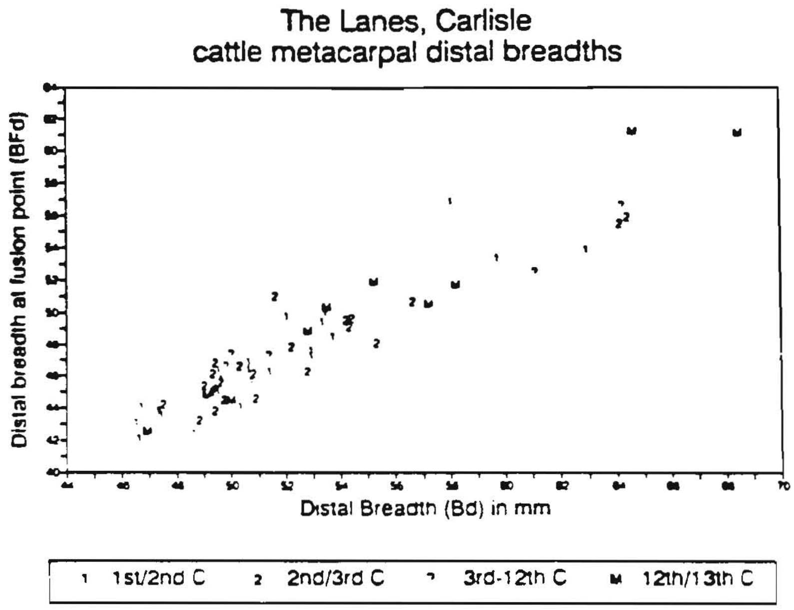


FIGURE 8b: Overlay to Figure 8a, showing sex identifications for complete metacarpals, using Howard's (1962) indices.

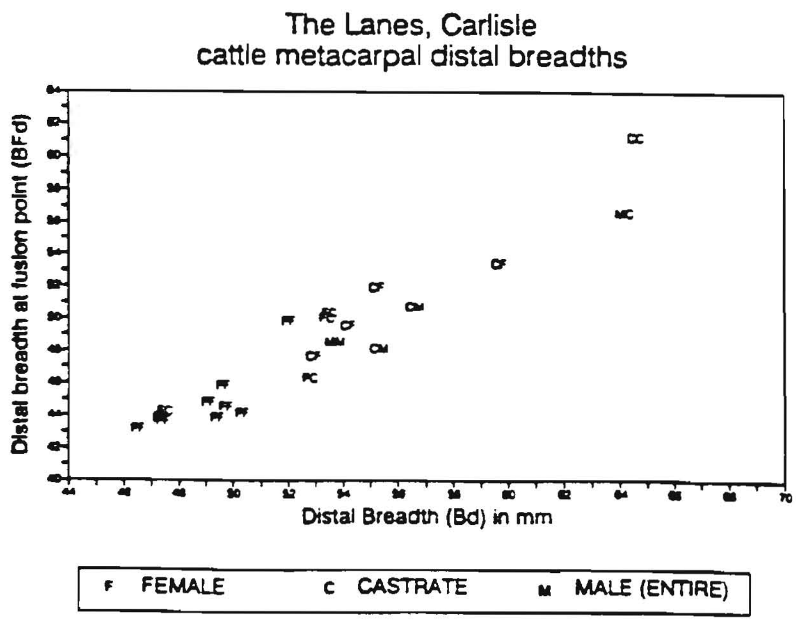


FIGURE 9a: Bar graph of cattle Mandibular Wear Scores (MWSs) for the southern Lanes.

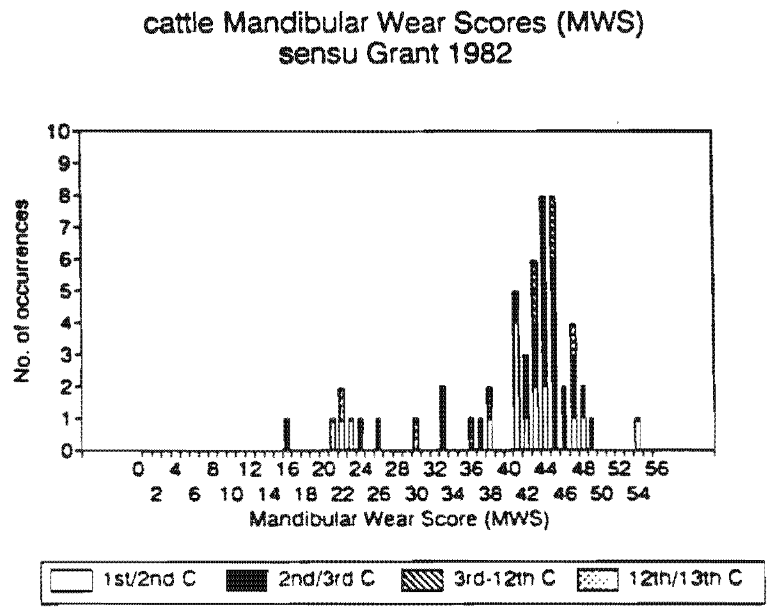


FIGURE 9b: Bar graph of cattle Mandibular Wear Scores (MWS) for Roman deposits only, including estimated scores.

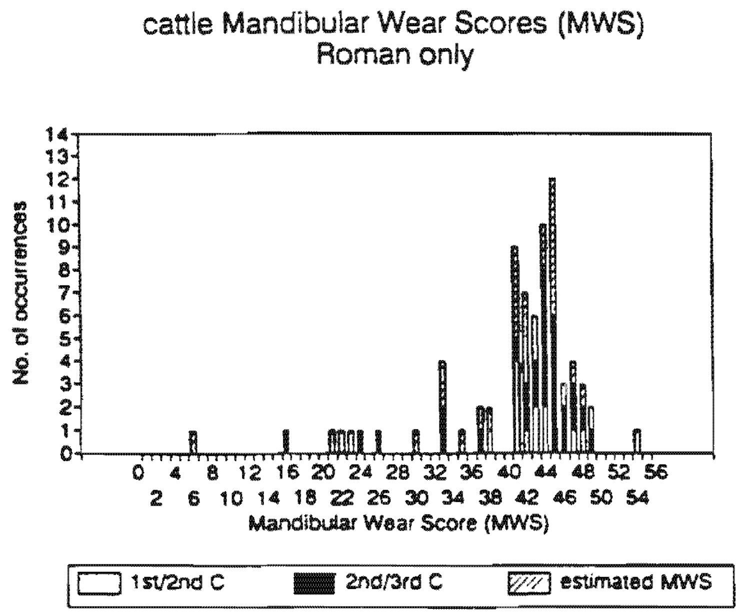


FIGURE 10: Percentage survival curves for cattle, sheep and pigs, based on epiphyseal fusion data for the three major periods from the southern Lanes.

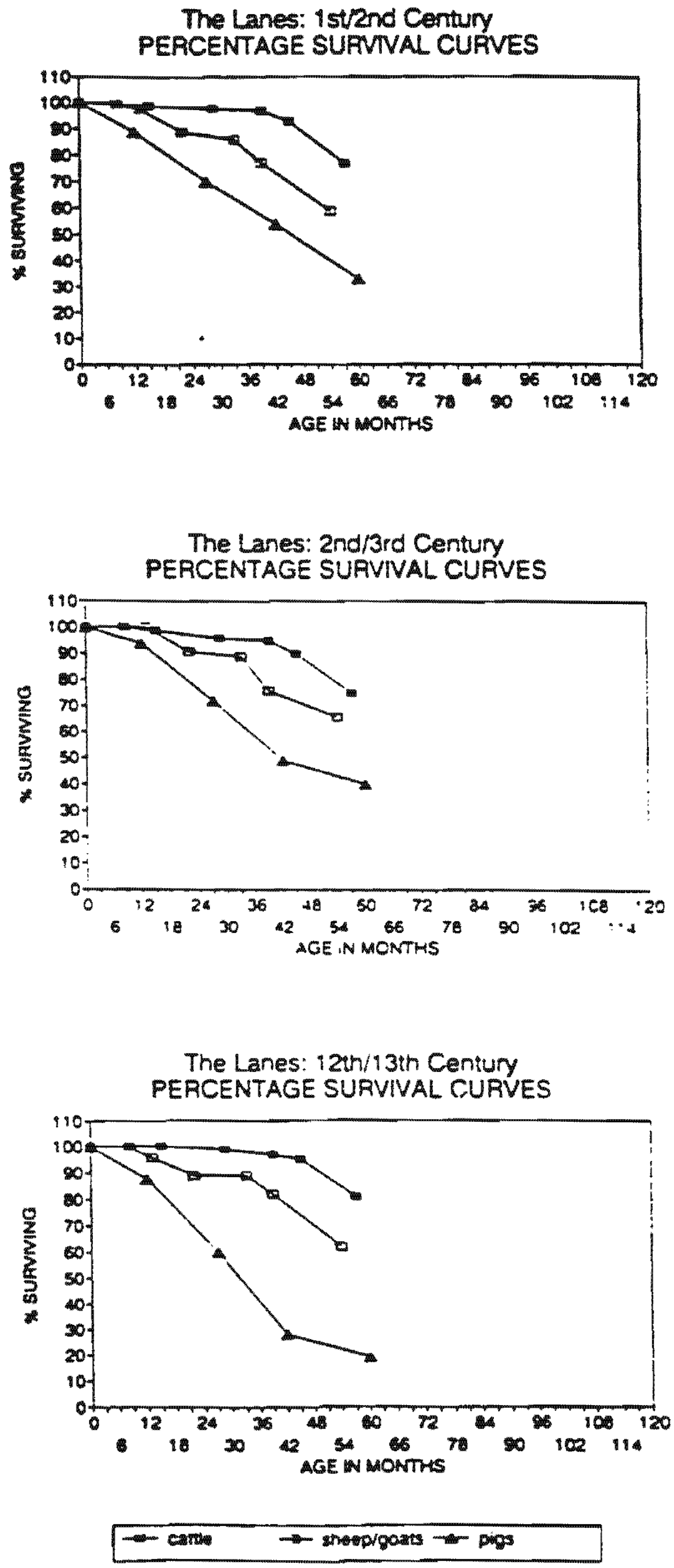


FIGURE 11: Percentage representation of skeletal elements of cattle by major period from the southern Lanes.

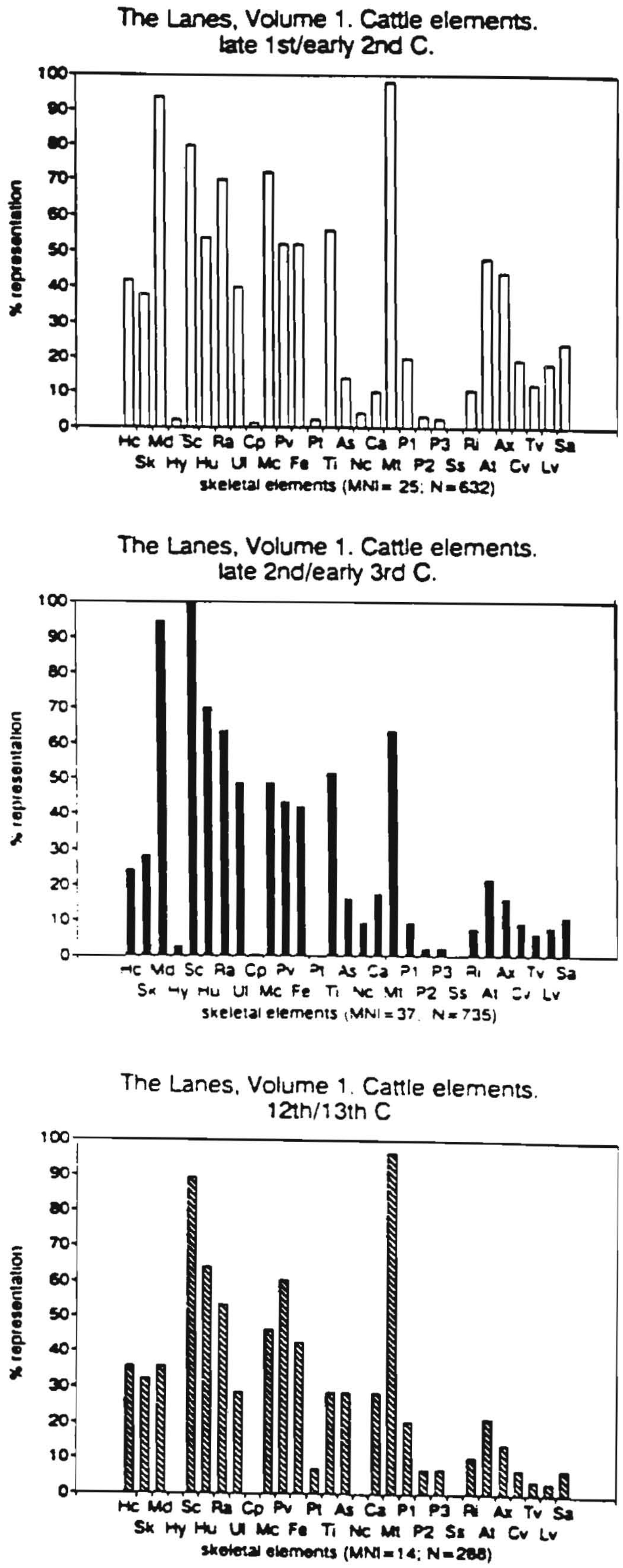


FIGURE 12: Bar graphs of sheep withers heights from the southern Lanes.

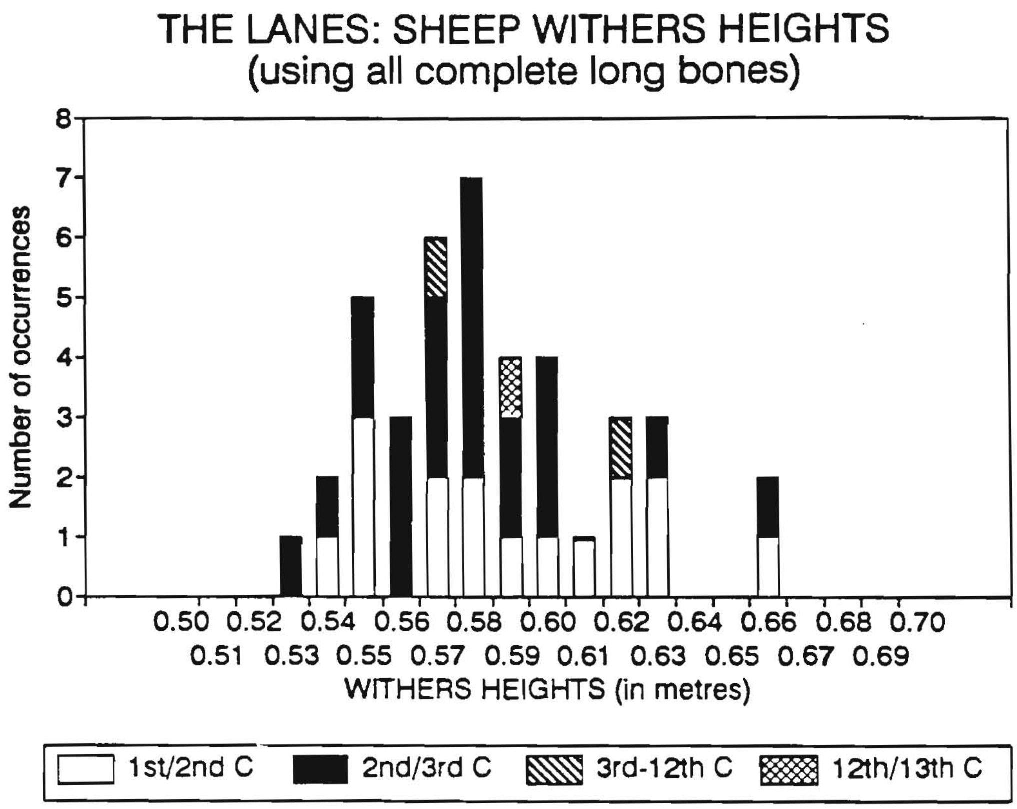


FIGURE 12: Bar graphs of sheep withers heights from the southern Lanes.

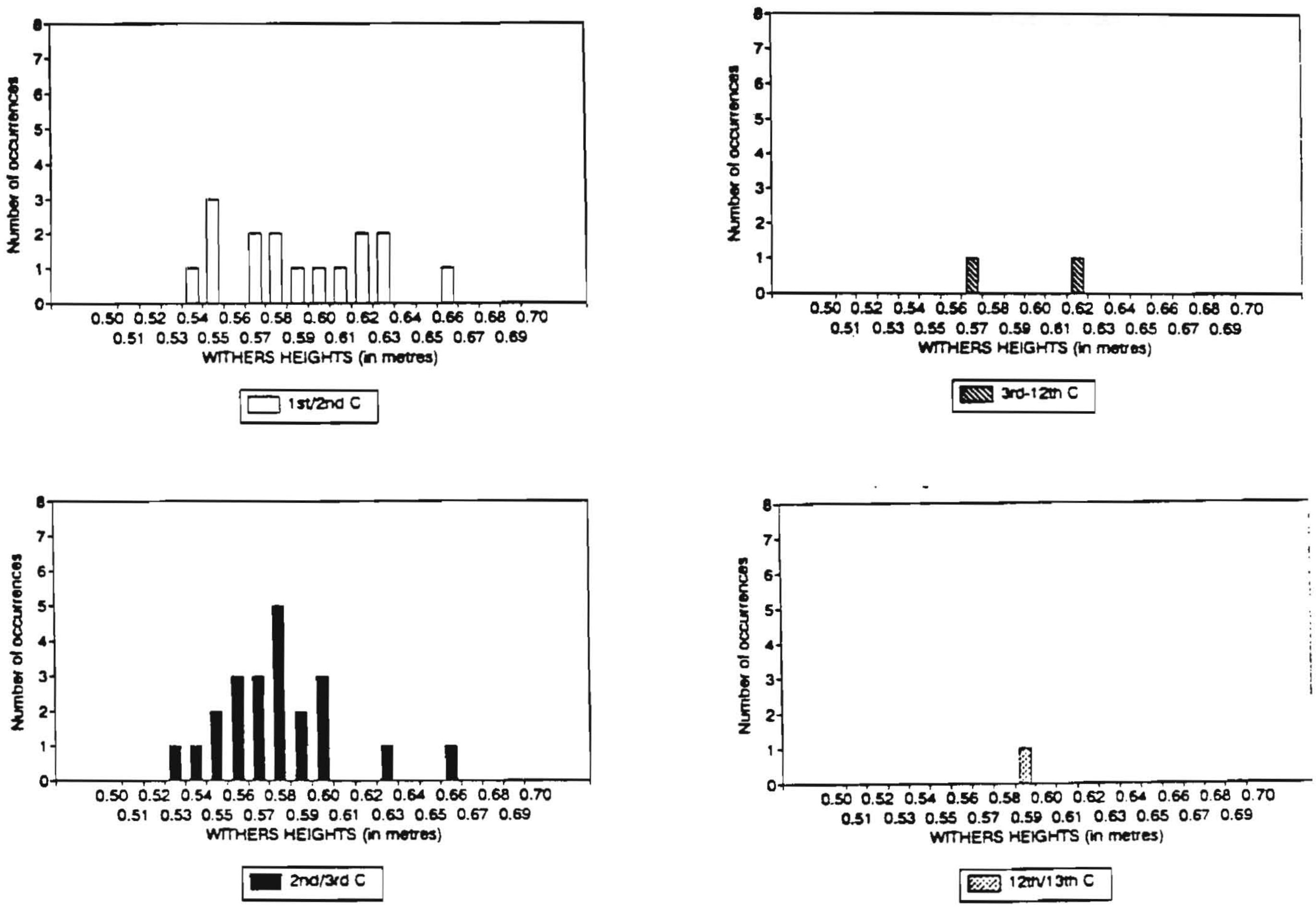


FIGURE 13a: Scattergram of sheep metacarpal proximal breadth (Bp) and proximal depth (Dp) measurements from the southern Lanes.

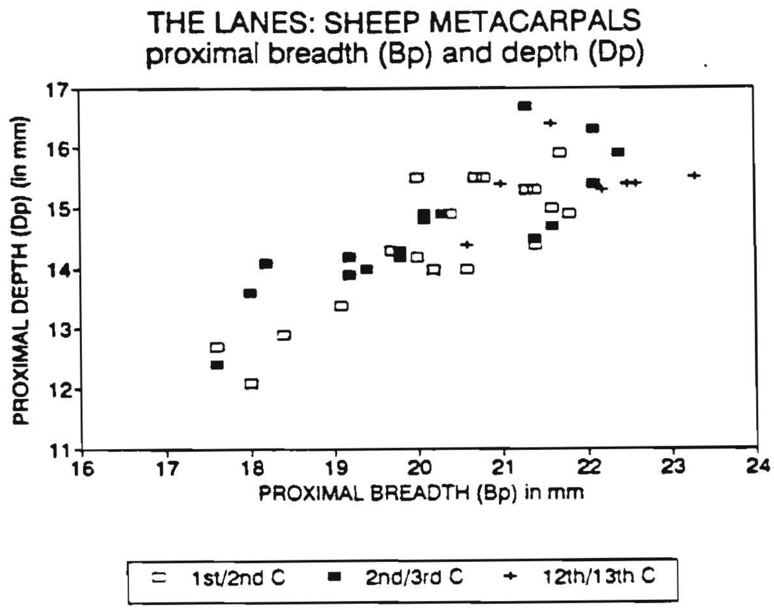


FIGURE 13b: Overlay to Figure 13a, showing distal fusion condition for all complete metacarpals.

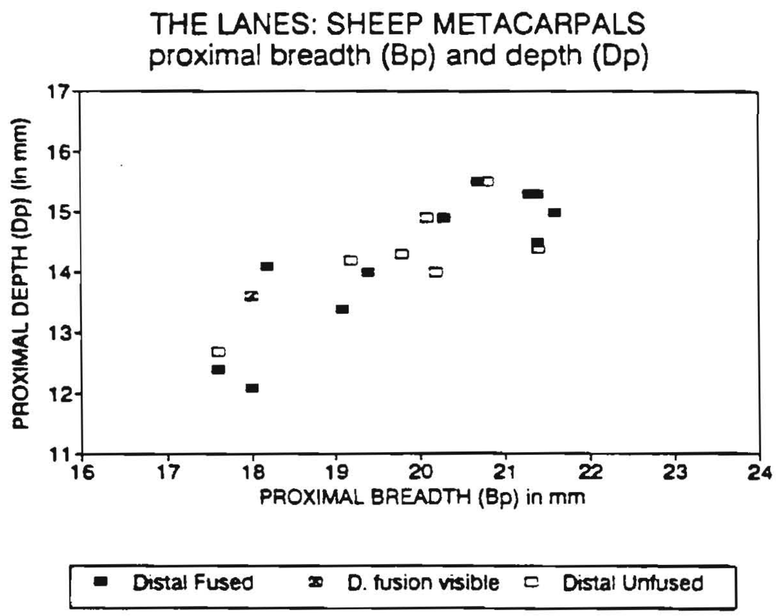


FIGURE 14a: Scattergram of sheep tibia distal breadth (Bd) and depth (Dd) measurements from the southern Lanes.

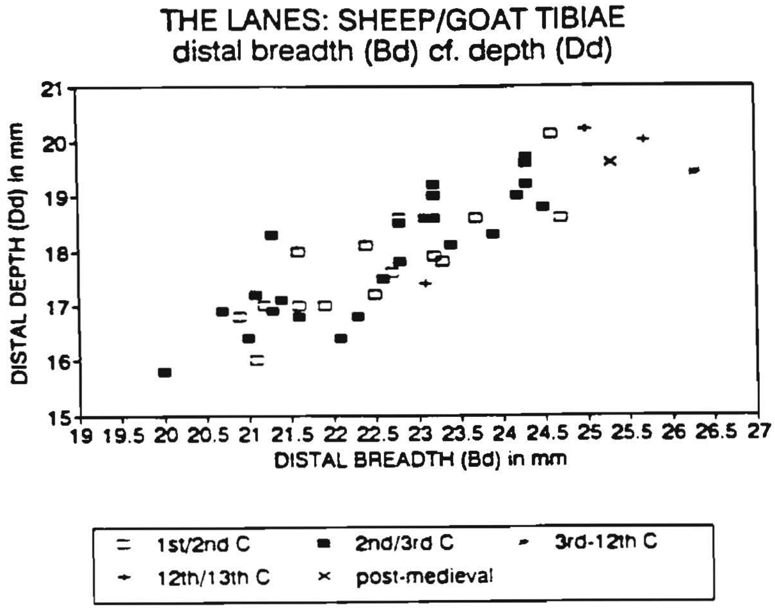


FIGURE 14b: Overlay to Figure 14a, showing distal fusion condition.

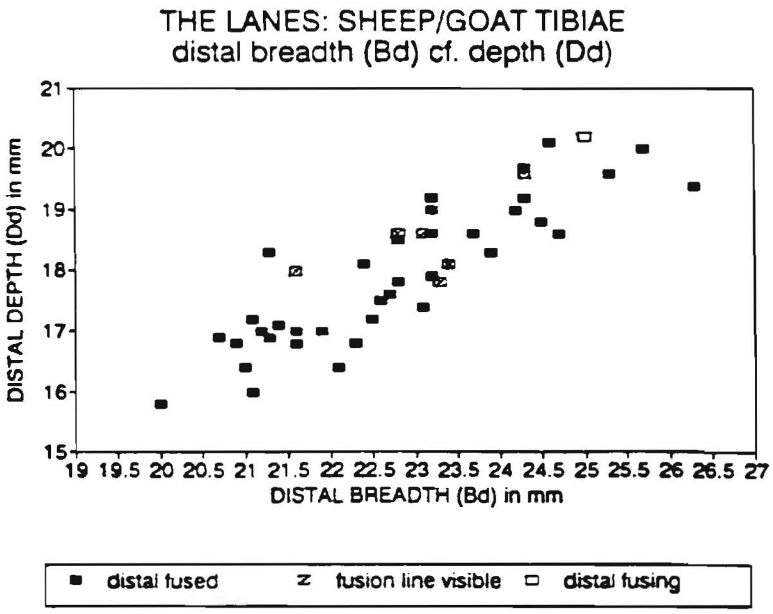


FIGURE 15a: Bar graph of sheep Mandibular Wear Scores (MWS) for the southern Lanes.

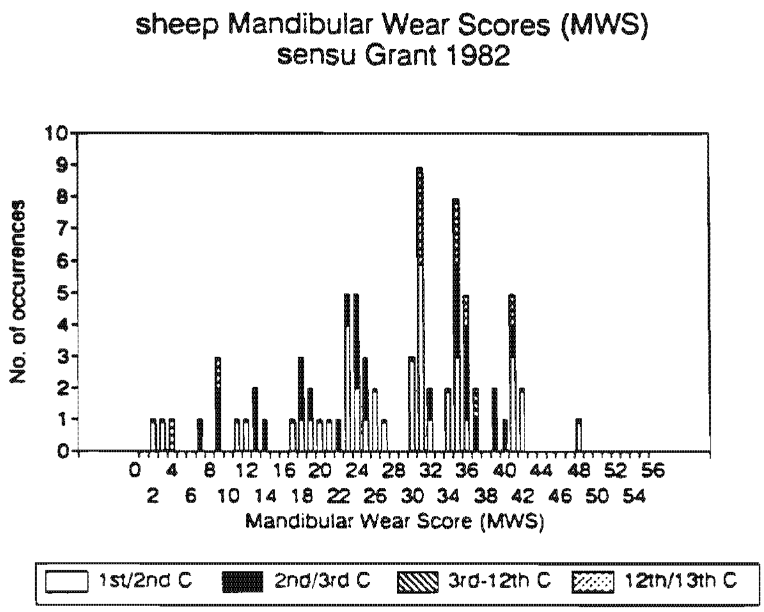


FIGURE 15b: Bar graph of sheep Mandibular Wear Scores (MWS) for Roman deposits only, including estimated scores.

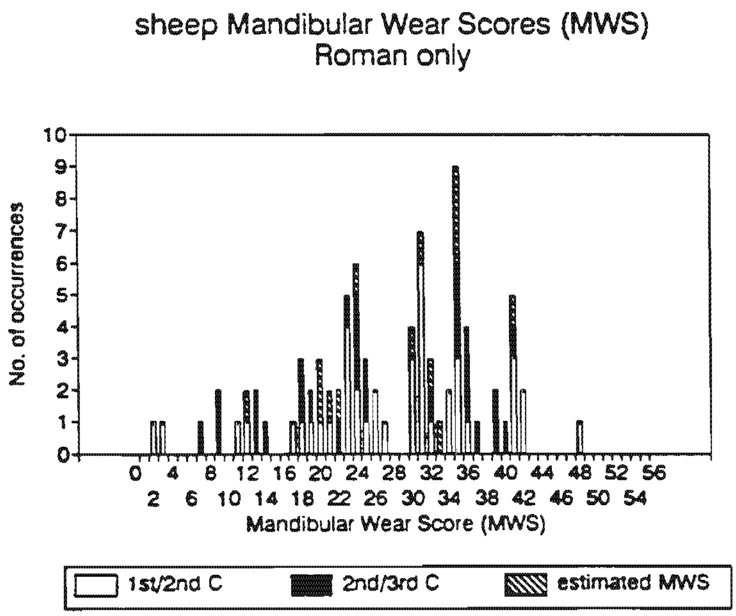


FIGURE 16: Percentage representation of skeletal elements of sheep by major period from the southern Lanes.

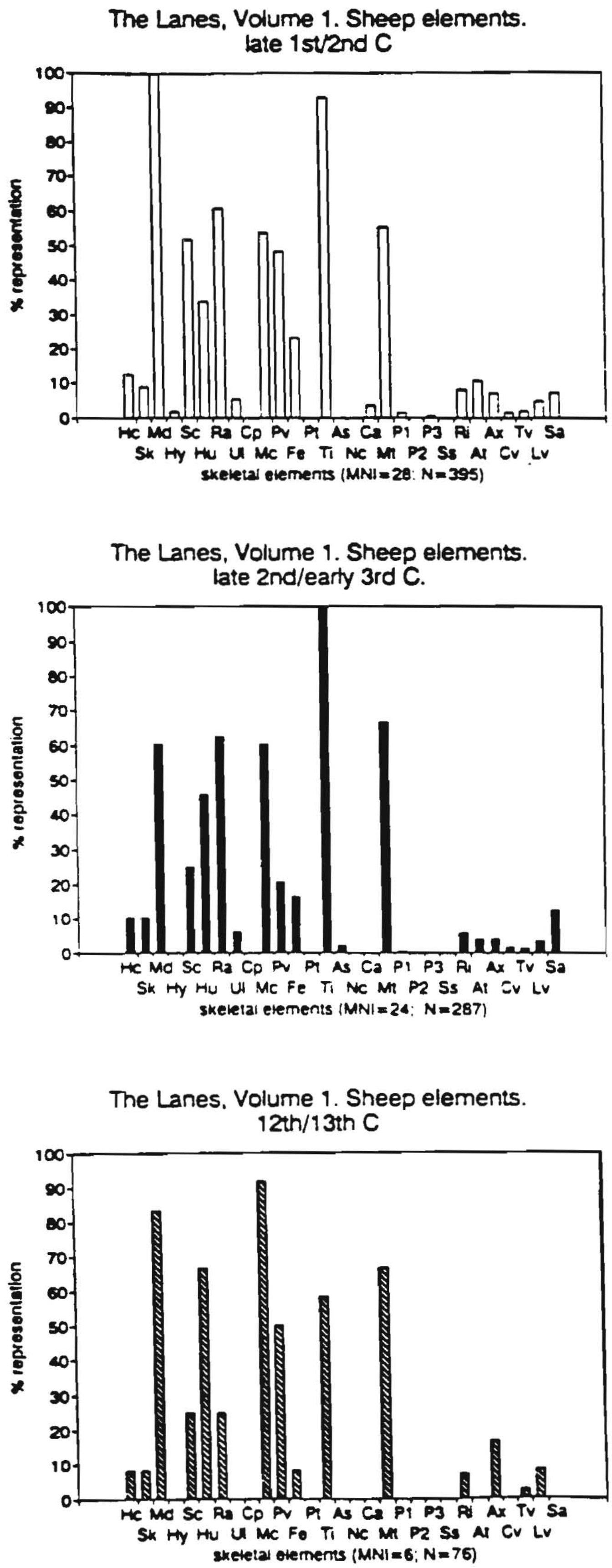
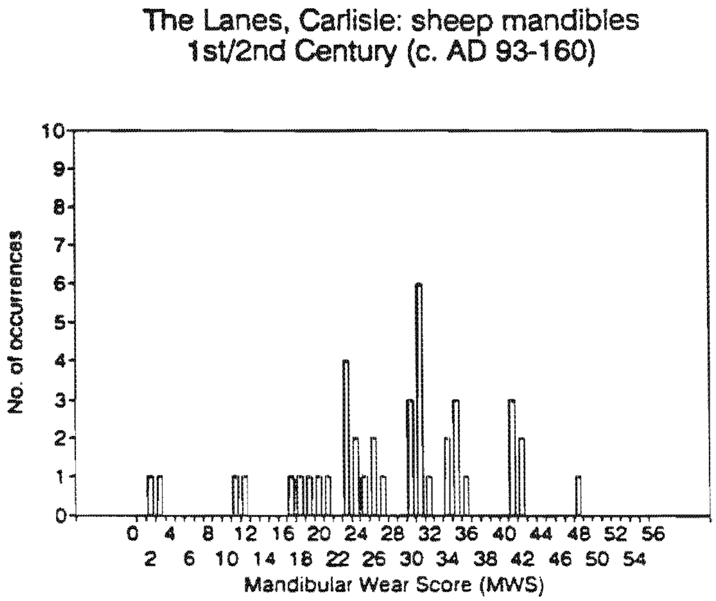


FIGURE 17: Bar graphs of Mandibular Wear Scores (MWS) for sheep from the military fort at Annetwell Street (AD 74 - 105) and the civilian settlement in the southern Lanes (AD 93 - 160).



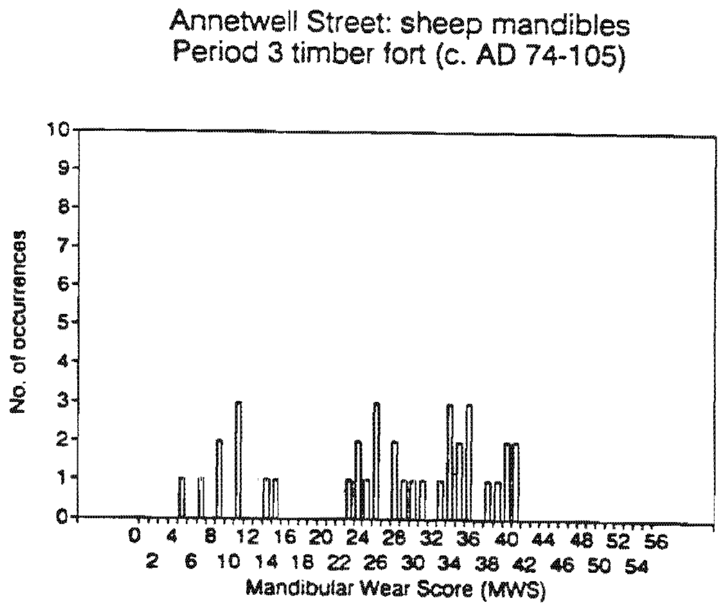


FIGURE 18a: Bar graph of Mandibular Wear Scores ~~(MWS) of pigs~~ from the southern Lanes.

pig Mandibular Wear Scores (MWS)
sensu Grant 1982

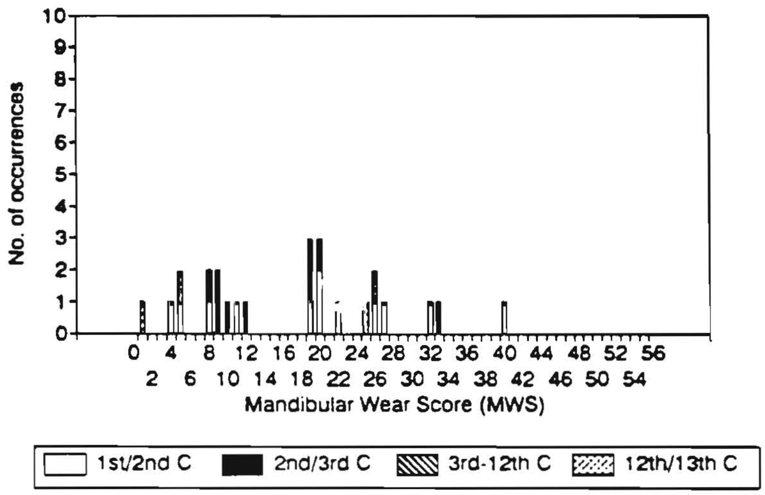


FIGURE 18b: Bar graph of pig Mandibular Wear Scores (MWS) for Roman deposits only, including estimated scores.

pig Mandibular Wear Scores (MWS)
Roman only

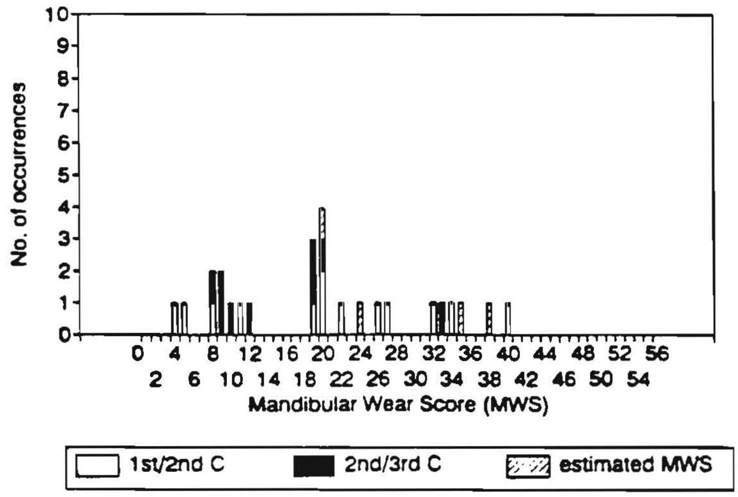
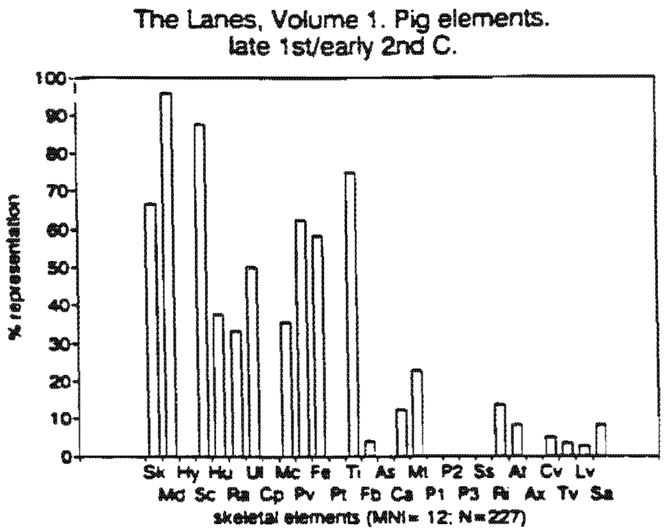
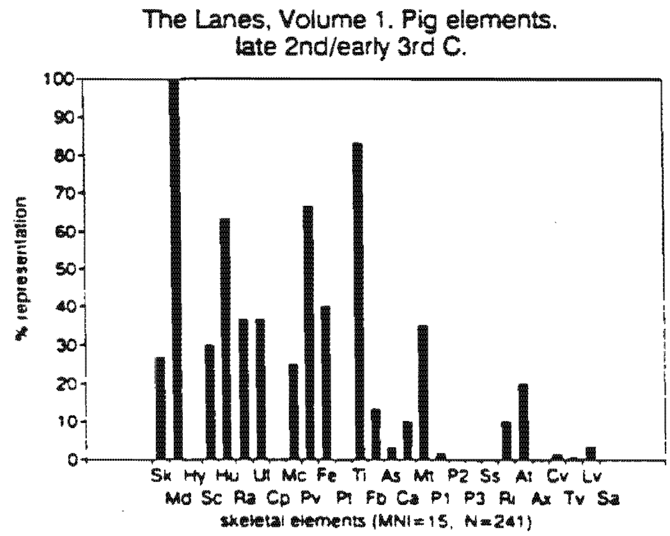


FIGURE 19: Percentage representation of skeletal elements of pigs by major period from the southern Lanes.





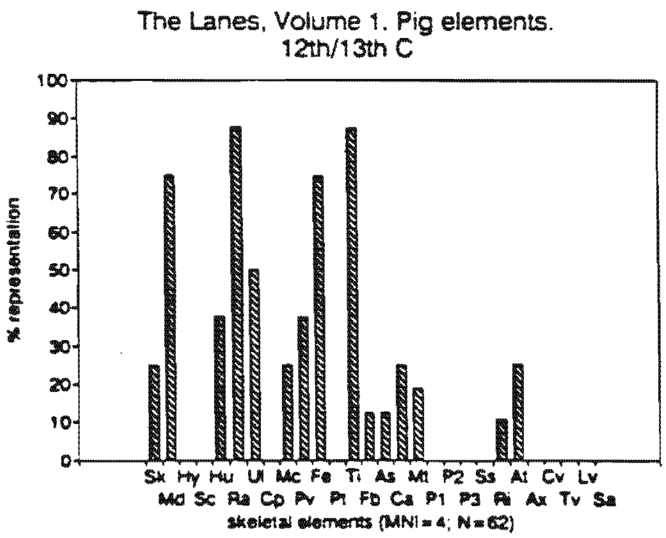


FIGURE 20: Percentage representation of skeletal elements of cattle from 1st/2nd C sieved samples from the southern Lanes.

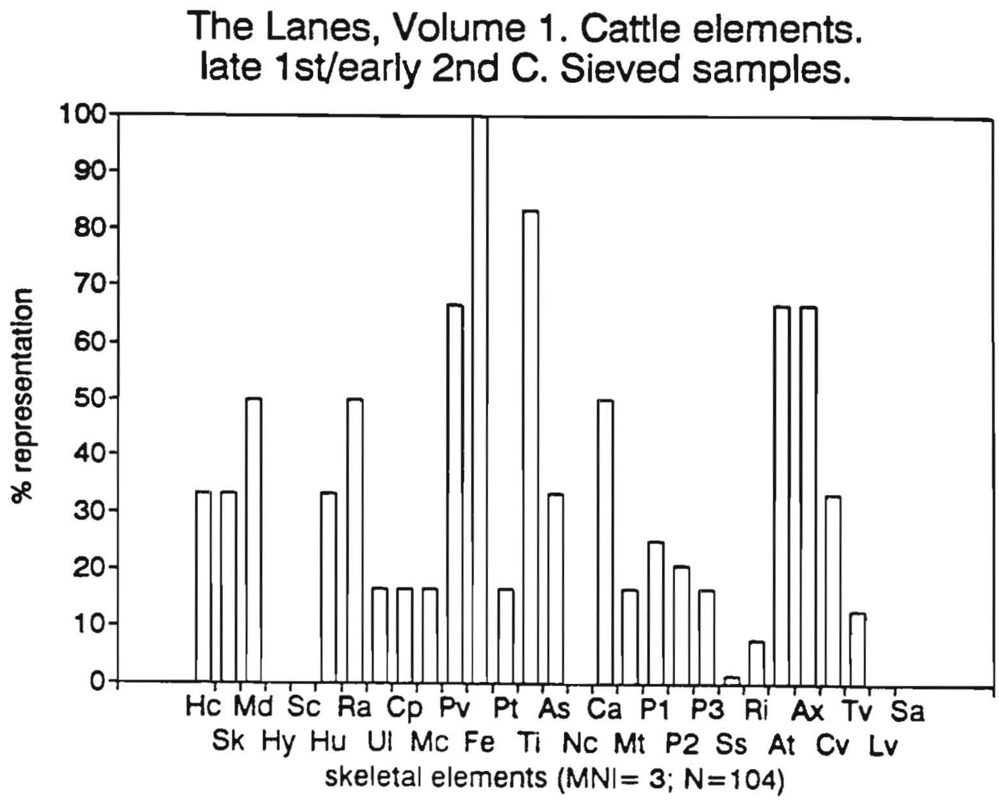


FIGURE 21: Percentage representation of skeletal elements of sheep from 1st/2nd C sieved samples from the southern Lanes.

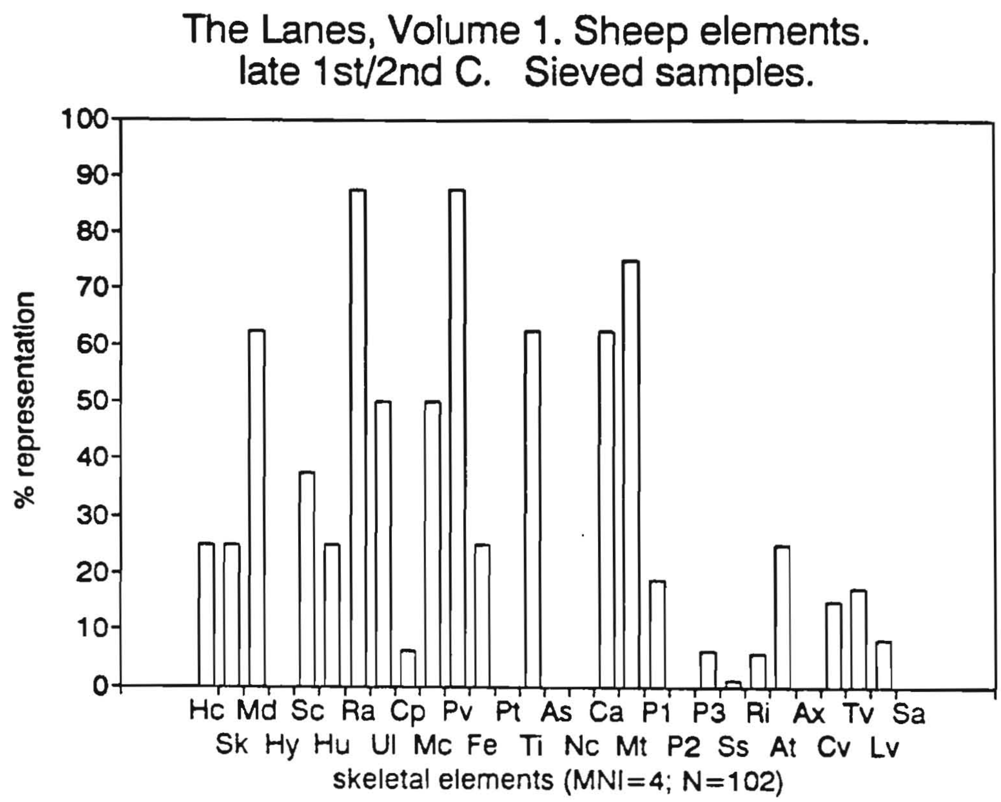
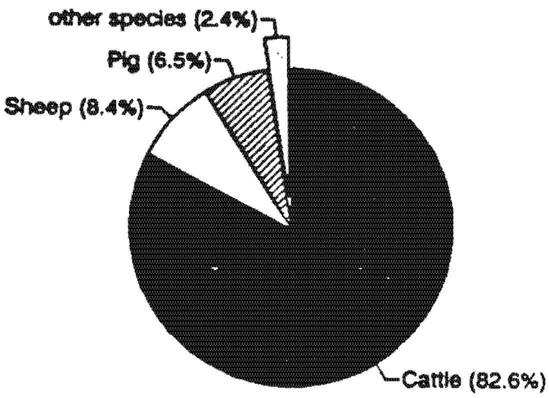
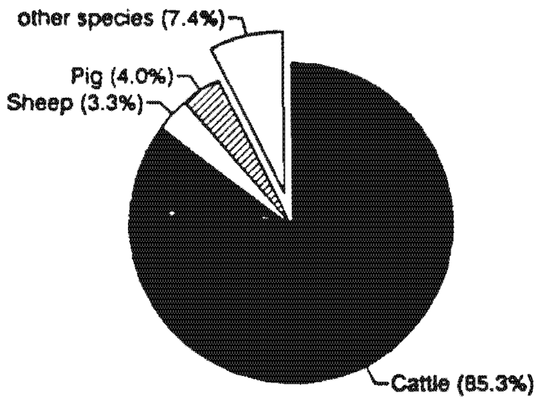


FIGURE 22: Relative contributions of different taxa to the meat diet in the three main periods at the southern Lanes

The Lanes, Carlisle. 1st/2nd Century AD
crude estimates of meat weights



The Lanes, Carlisle. 12/13th Century AD
crude estimates of meat weights



The Lanes, Carlisle. 2nd/3rd Century AD
crude estimates of meat weights

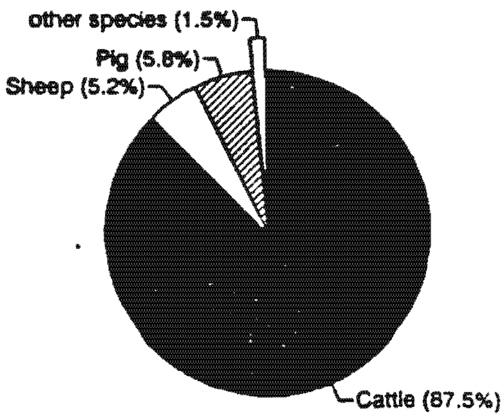
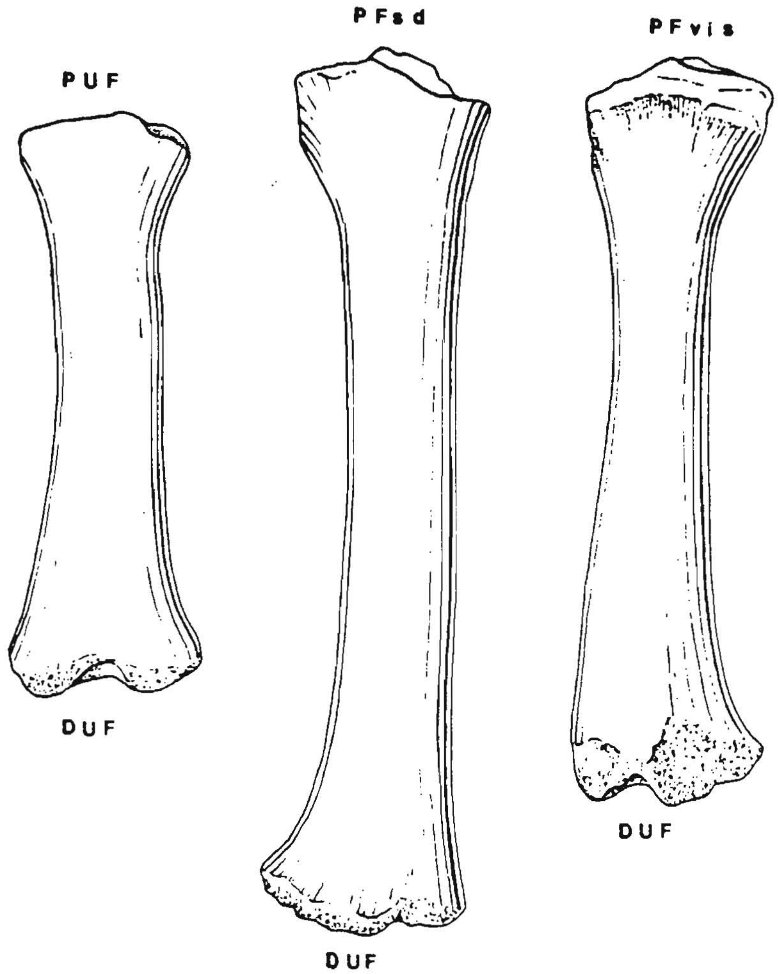


FIGURE 23: Pig radii from the southern Lanes



P	Proximal epiphysis
D	Distal epiphysis
UF	Unfused
Fsd	Fused
Fvis	Fusion line still visible

APPENDIX 1: 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.

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)

2. vertebrae are recorded in the same way

3. the proximal articulation of each rib is recorded similarly.

4. any fragments of carpals, tarsals, the patella, sesamoids and phalanges are recorded once, regardless of whether or not they are complete. In effect, they are always either complete or substantially so (ie: >50% is present).

5. loose teeth are recorded if more than 50% is present (loose pieces of enamel are not recorded)

6. for the humerus, the presence of the deltoid muscle attachment is recorded (since proximal epiphyses survive so rarely)

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 condyle forms one zone, the angle another, the tooth row a third, the diastema a fourth and the symphysis a fifth.

11. for the skull, the basioccipital, zygomatic arch and maxilla (M1) each forms a separate zone.

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 1 (continued)

List of abbreviations used in figures for anatomical elements.

Hc	Horncore
Sk	Skull
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
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 2: Minimum Numbers of Individuals (MNIs) used for calculations of meatweights for the three major periods at the southern Lanes.

Species	Minimum Number of Individuals 1st/2nd C	2nd/3rd C	12th/13th C
Cattle	25	37	14
Sheep[1]	28	24	6
Pig	12	15	4
Horse[2]	1	1	2
Red deer	1	1	2
Roe deer	1	1	1
Hare	1	1	-
Badger	1	-	-
House mouse	1	-	-
Woodmouse	1	-	-
Vole species	1	1	-
Pygmy shrew	1	-	-
Toad &/or frog	1	-	-
Fowl (domestic)	2	3	3
Duck *cf* mallard	1	1	-
Goose species	2	1	3
Swan species	-	-	1
Rook/crow	1	-	-
Thrush species	1	-	-
thrush-sized bird	1	-	-
sparrow-sized bird	1	-	-
Salmon	4	1	
Salmonids (?trout)	2	-	-
Pike (& ?pike)	1	1	1
Eel	6	1	-
Shad	1	-	-
Cod	1	-	1
Cod/saithe	-	-	1
Haddock	1	-	-
Bass	-	-	1
Mackerel	1	-	-
Herring	-	-	1
Plaice	1	-	-
Flatfish species	6	1	1
large Elasmobranch	-	-	1

[1] 'Sheep' includes sheep and/or goat
[2] Horse has been included in this table for information, but is not included in the pie charts in Figure 22 because of doubts concerning whether or not it was eaten, together with the fact that the bones are so sparse that it is extremely unlikely that whole carcases are represented.

Minimum Numbers of Individuals have not been calculated for dogs, cats or the bear, because of the lack of evidence for their use as meat animals at this site.