Heslerton Parish Project
Faunal Remains

Assessment of Potential for Analysis

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West Yorkshire
Archaeology Service

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1 Introduction

Analysis of the large quantity of animal bone being recovered from excavations at the West Heslerton Anglo-Saxon settlement was considered and agreed during the excavation phase of the project and, consequently, recording was begun by Trevor Ashwin at the project headquarters in June 1987 and continued until his departure in the Spring of 1989. At this time the West Yorkshire Archaeology Service was invited to prepare an assessment of the animal bone and a project design for the completion of an analysis, which was submitted in May 1989, and subsequently took over the identification and recording in February 1990. What follows is an update of the quantity of animal bone recovered and a re-evaluation and reiteration of the potential for analysis.

2 The Assemblage

2.1 Quantity of bone

Between February 1990 and February 1993 work has taken place recording animal bone recovered from the 1987 and 1988 seasons (previously recorded by Trevor Ashwin), the backlog material from the Summer of 1989 and material recovered from the excavation seasons 1990, 1991 and 1992.

The number of animal bones for each area of sites 2 and 11 is shown in Table 1. A total of 236,873 fragments has been recorded on computer databases with an additional 18,924 measurements and 4,395 records of mandibles or single teeth attributable to an age stage. A further 9,800 individual measurements on paper records remain to be added to the computer metrical database.

The methodology adopted for recording animal bone has divided the assemblage into element zones and non-zones (see 2.5). The element zone archive is complete, except for a small but unknown quantity of material still on-site (see 3.4.2). However, the larger part of the non-zone

assemblage remains to be added to the computer database. This is estimated to be 258,000 fragments (see 3.4.3).

Each bone fragment - with the exception of bones lifted at context level only - has been allocated a three dimensional tag number and, after washing, was bagged individually and boxed by area code. This has been a disadvantage in that most bones could only be assessed as individual fragments and not as context groups. The number of tagged fragments comprises 78% of recorded element zones.

2.2 Provenance of bone

Animal bone was recovered from all seven areas of Site 2 and all thirteen areas of Site 11 (Table 1, Figures 1 and 2). From the data currently available 31.2% of the 52,831 mammal zones can be assigned to a period, of which 92% is Saxon; the majority Early Saxon (Table 2). It is assumed that a large proportion of the contexts still to be phased will be of Middle Saxon date.

Sixty seven percent of mammal zones derived from contexts for which feature information is available (Table 3). Within this group the majority of bone comes from four feature types: grubenhaus fills (32.4%), spits (28.7%), layers (14.3%) and pit fills (7.4%) but these figures are likely to change when final period information allows the exclusion of bone from contexts that pre or post-date the Anglo-Saxon settlement phase.

Further information is required before the amount of bone contained in contaminated contexts can be quantified. Some deposits do contain intrusive material, i.e. bones of rabbit and brown rat, and some exceptionally large cattle and sheep bones have been measured that may be Anglo-Saxon but post-medieval or prehistoric dates cannot be discounted at this stage.

2.3 Composition of bone

All the main domestic species are represented in the assemblage including cattle, sheep, horse, pig, goat, dog and cat. These species form the vast majority of the assemblage with comparatively few wild species that

include: ?wild pig, red deer, roe deer, fox, badger, hare, rabbit, black rat, brown rat, house mouse, wood mouse, water vole, field vole, mole, hedgehog, stoat, weasel and whale. In addition, many wild/domesfic bird bones and a small number of fish bones were recovered.

The bulk of the bone sample was retrieved by hand-trowelling and recovery appears to have been excellent compared to many hand-picked bone assemblages; this may be due to the practice of three dimensionally recording all artefacts and ecofacts. An analysis was conducted, at an earlier stage of the recording, on the size distribution of fragments recovered by hand. A random 10% sample of non-zone fragments, totalling 16,027 bones, revealed the following statistics:

<20mm	14.0%
20-39mm	43.0%
40-79mm	35.0%
=>80mm	8.0%

Despite good recovery of small bone fragments by hand-trowelling it is inevitable that some very small fragments, such as ovicaprid incisors, small bird and fish bones, will have been missed. This can be tested, to a degree, on the bones recovered from the programme of wet sieving and flotation conducted on site. Animal bone has been collected from a large number of bulk soil samples floated for botanical remains. Also, the contents or part contents of several grubenhäuser were dry sieved for small bone through a 5mm mesh or wet sieved and floated.

Flot samples from a few selected areas have been examined and compared to hand recovered bones. The recovery of two small elements, ovicaprid third phalanges and lower third molar teeth (LM_3s), were compared. The results are reproduced in Table 4. Combined data from the six areas examined show 10.8% of all phalanges were recovered from flots and 1.3% of all LM_3s, although the figures show a marked degree of variation, for example, in area 2DC 27.9% of third phalanges were recovered in flots but none of the 15 molar teeth.

An accurate measure of recovery bias is complicated by the differential disposal of species and elements. Areas 2CA, 2CB and 2DC have relatively high percentages of ovicaprid third phalanges, 1.7-4% of the zones for that species, but the lowest percentages of bird bones, whereas areas 11BA and 11BD, which produced the highest frequency of bird bones (see 3.1.3), have less than 0.5% ovicaprid third phalanges.

2.4 Condition of bone

The site consists of chalk gravels and mixed sand and gravel deposits. Bone from surface layers, in particular, shows a great variety of preservation from good to heavily eroded and weathered. The poorest preservation occurs on areas 2DA-2DD and parts of 2CA and 11CE. The bone from areas 11AB, 11BD and 11CD display the best preservation. Very little bone was recovered from the large area 11BB due to severe plough damage. The stripping of topsoil has resulted in many freshly broken fragments, ranging across the site from 30.1% to 59.5% of identified element zones (Figure 2).

Preservation conditions have biased the assemblage in favour of the more robust and solid parts of the skeleton. In Figure 3 the frequency of over 22,000 cattle zones is plotted against relative bulk density for each element. The bulk density figures were compiled by Lyman (1982) from the bones of deer, *Odocoileus hemionus*, and are related to the potential of a bone to survive taphonomic destruction. Whilst there are obvious problems comparing these figures to the skeleton of domestic *Bos*, the scatterplot clearly demonstrates the greater survival of denser bones and indicates the parts of the skeleton likely to be underrepresented.

In addition to below ground taphonomic destruction the gnawing and chewing of bones by animals such as pigs, dogs, cats and rodents have also biased the survival and condition of certain elements. Figure 4 plots the percentage of cattle and ovicaprid bone gnawed and chewed for each area. Cattle bones always show a higher percentage of damage, possibly because they survive total destruction better than ovicaprid bones. It is interesting that the greatest degree of gnawing and chewing occurs in areas 2CB and 2CC - the 'housing' area of the site.

At this stage of the analysis of such a large assemblage of bone it is difficult to quantify the true extent of information loss due to differential preservation or recovery biases or to distinguish either effect from differential deposition, which, from the patterns of spatial distribution of elements, was clearly taking place. Taphonomic biases may be better understood as bone from individual contexts and features are analysed in more detail. Nevertheless, condition is good for the majority of material that has survived: bone is solid and retains details of even the finest butchery knife marks.

2.5 Methodology

The bone assemblage recovered during excavations has been sampled to reduce the time required for analysis and therefore the costs to the project. The sample for detailed analysis is acquired by selecting a predetermined range of skeletal element zones. This will reduce the quantity of bones recorded in depth from almost half a million to *c.* 53,000.

The zones chosen for analysis are those that hold the maximum amount of information on species, age, size, sex, pathology, butchery, etc. The number of non-zones, such as fragments of skull, limb bone splinters and unidentified pieces, are stored on a computer database with attributes such as context, tag number, fragment size, butchery, carnivore damage, etc.

It is considered that very little significant information, for the aims of reconstructing the site economy, has been missed as a result of this sub-sampling. For example, the contents of a Saxon pit 2DB 008 produced 1,205 zones and 7,510 non-zones. The number of fragments with butchery evidence in the assemblage of zones amounted to 28.4%. The butchered bones in the non-zone assemblage totalled only 0.7%.

3 Statement of potential

The importance of the West Heslerton bone assemblage has been discussed in the Project Design of May 1989 and in the Interim Report of March 1991. The assemblage offers an extremely rare opportunity to study a large deposit from a rural settlement of the Anglo-Saxon period,

unequalled in this region of England. Large, well-preserved bone assemblages of Early Saxon date are very scarce and consequently little data is available on the transition from late Roman to Early Saxon rural settlement and economy. The potential for intra-site spatial analysis within one of the most completely excavated and recorded Anglo-Saxon rural settlements in England is, perhaps, unique.

3.1 Analysis priorities

The West Heslerton bone assemblage has the potential to provide the maximum level of information for an interpretative faunal report because:

a) it is generally well preserved

b) it is large, and therefore has a high degree of statistical validity

c) it is well stratified, the vast majority of bone belonging to the Early and Middle Saxon periods

d) it includes many primary, undisturbed deposits

The following are the main subject areas to be investigated.

3.1.1 Site economy

A reconstruction of the type and level of animal husbandry practised on the settlement from an analysis of each domestic species based on: their relative proportions, slaughter patterns, sex distributions, size, patterns of butchery and carcass division and evidence for disease and injury. Some of the questions the analysis will answer include:

- were sheep important as providers of prime meat or wool?

- were cattle kept as part of a dairy economy, as traction animals or primarily as providers of prime meat?

- Horse bones outnumber those of pig and a large proportion are butchered in a similar fashion to cattle bones. Was horse tlesh a regular part of the diet?

- Are wild resources of minor importance in the rural economy, as is suggested by their relatively low numbers on many sites of this

period.

- What was the role of ducks and goats? - two species that are rare on many Anglo-Saxon sites.

- Is there evidence for trade in livestock, i.e. an absence of selected age groups?

- Is there evidence that animals were slaughtered for reasons other than economic - religious or ritual?

3.1.2 Temporal variation

It is suggested that during the Middle Saxon occupation the settlement contracted to the southern part of the site. If the bone assemblages from both phases of Saxon occupation can be confidently separated a priority would be the examination of changes or continuities in the site economy. For example, pig bones do not form a significant part of the total assemblage, yet they are widely held to have been of significant importance in the Anglo-Saxon economy. Does their role change between the Early and Middle Saxon periods?

3.1.3 Intra-site variation

Intra-site variation in the bone assemblage is a particularly important part of the analysis and should concentrate on assisting in the interpretation of site function, i.e. areas of housing, industrial/craft activity, agricultural processing and slaughter or meat processing. Patterns of bone discard, specifically from negative features containing primary dumps such as the grubenhäuser, may suggest divisions in activity or status.

Only superficial analysis of spatial variation, based on the arbitrary area site divisions, has been completed, but already crude patterns have been observed. The results indicate that cattle form over 50% and horse over 5% of identified zones in the north west of the site; Site 2 areas DA, DB, DC and CA (Fig.1). Sheep zones outnumber those of cattle only in the south west and southern parts of the site; areas 11AA, 11AB, 11AE, 11BA, 11BB, 11BD, 11CE and 11CD. The central eastern areas, 11BB

and 11BC, produced over 10% pig zones, whilst only in the north east section, areas 2CB and 2CC, do dog and cat zones represent more than 5% of the major species assemblage.

Variations in assemblage composition across the site can also be seen in the distribution of bird and small mammal bones, which show no correlation (Fig.5). Areas 11BA, 11BD and 11CD have the highest number of bird bones, ranging between 12-18% of all bird bones, but have low numbers of small mammal bones, 4-8% of all small mammal bones. The areas of highest small mammal retrieval, between 17-19%, are areas 11AB, 2CA and 2CB - whose juxtaposition to the relict stream channel may have some significance - but produced relatively low numbers of bird remains, 3-4%.

3.1.4 Interdisciplinary co-operation

It is important that any interpretations of the bone assemblage are not made in isolation of other specialist's results and full co-operation and exchange of data and interpretations should be encouraged. The use of a tag system should be invaluable for the plotting and analysis of bone data with other finds and environmental data.

3.2 Wider research questions

It has been emphasised in interim reports by the project director that the project has been funded as a rescue excavation and not as a research project. The faunal assemblage has enormous scope for research, not only into aspects of Anglo-Saxon economy but also as a pure biological data bank. Many subjects will be outside the scope of the archive and publication reports and must be left to future grant-aided research students. Nevertheless, it is hoped that time will be available to study some aspects of greater relevance to the Heslerton report.

3.2.1 The ability to plot graphically in three dimensions the spatial distribution of animal bone, with all other finds, is extremely rare. The facility to plot bone by species, element type, age group, etc. may have distinct advantages in understanding site formation processes, domestic activities or new aspects of animal husbandry. The tagging system requires

thorough consideration and evaluation which, in turn, will require a degree of exploratory research on the GIS software and data.

3.2.2 A total of 124 partial or complete articulated skeletons and limbs have been identified in the assemblage. Some of these remains will offer the opportunity for research, for example, to compare in the same individual patterns of dental attrition with epiphyseal fusion evidence, esdmates of stature from different limb bone measurements and the type and spread of pathologies

3.2.3 Differences in butchery techniques have been identified between urban and rural settlements during the Romano-British period in southern Britain (Maltby 1989). Are Anglo-Saxon butchery techniques the same as those used by the Romans? Do differences in methods of butchery exist between Anglo-Saxon rural and urban settlements?

3.2.4 The large proportion of mature sheep at sites such as Portchester (Grant 1976), Hamwic (Bourdillon and Coy 1980) and North Elmham Park (Noddle 1980) suggests that wool production was more important towards the latter part of the Anglo-Saxon period. But the data from West Stow (Crabtree 1989) suggests a higher proportion of juvenile sheep at this site. Is there evidence at West Heslerton to support an increasing importance on wool production from the Early to Middle Saxon period? Is there evidence at West Heslerton to suggest that the West Stow results may be a function of intra-site spatial variation rather than reflecting regional variation?

3.2.5 The large number of bone measurements will significanfly expand the existing data on Early and Middle Saxon domestic animals. Trends that can be tested include the progression of size increase from Roman to the Early and Middle Saxon periods, the continued variation in the size of domestic dogs as seen in the Roman period, and the introduction of different breeds comparable with continental data.

3.3 Inter-site comparisons

The evidence from West Heslerton should not be looked at in isolation

but should be compared and contrasted with other data from rural and urban sites. The rarity of large rural Saxon faunal assemblages means that data from a variety of site types and geographical locations must be used. Comparisons with earlier, contemporary and later sites are all valid, especially late Roman data to throw light on the continuation of agrarian economy, i.e. Saxon evolution or revolution? (Fineberg 1972)

Bone data from the following sites will be used as a starting point: West Stow, Suffolk (Crabtree 1982, 1985, 1989); North Elmham Park, Norfolk (Noddle 1980); Hamwic, Southampton (Bourdillon 1986a, 1986b, 1987; Bourdillon and Coy 1980); Portchester Castle (Grant 1976) and Garton and Wetwang Slacks (Noddle 1981). Urban assemblages from the York sites of Coppergate and Fishergate will also be used and it is hoped that access will be available to material that is unpublished or currently under analysis such as Flixborough, Humberside and Wharram Percy and Thwing, North Yorkshire.

3.4 Future work

3.4.1 Metrical database

All bone measurements have been taken and approximately 9,800 measurements on paper records remain to be computerized. This is estimated to take eight to ten working days.

3.4.2 Completion of zones

It is estimated that about six boxes of animal bone remain to be transferred from site. The sorting, identification and recording should be no more than one weeks work.

3.4.3 Recording of remaining non-zones

This part of the assemblage has had an agreed low priority and has been quantified on computer by an assistant as time allowed. At present 184,042 non-zone fragments contained in 82 boxes have been recorded. A further 115 boxes remain to be computerized, estimated to contain in the region of 258,000 fragments. This clearly represents the bulk of further archive work and will take in the region of 28 weeks for an assistant.

3.4.4 Control sampling

The number of zones recorded amounts to an average of 13% of the total bone in any context. This may seem low but is comparable to the results of many large bone analyses in publication (see interim report March 1991 for more detailed discussion). However, limiting identification to selected element zones is an aspect of the methodology that may be open to criticism and therefore it might be useful to establish the type and degree of information lost by this method.

It is suggested that a few contexts should be identified and recorded comprehensively as a control to predict statistically the loss of information across the whole site. One such context is a Saxon pit from area 2DB context 0008. A total of 1,205 zones has been recorded and 7,510 non-zones have been quantified. Combined, the pit accounts for 16.6% of the bone from area 2DB. It is recommended that the 7,510 non-zones be re-examined and identified to species and element. At least one other context should be treated similarly, preferably from a different part of the site and after consultation with the project director. This task, including sorting the bone, identification, the recording of measurements, butchery, computerisation and assessment of the results is estimated to take a faunal analyst six weeks.

3.4.5 Software training and application

Training in the use of Dominic Powlesland's Geographic Information System software will be necessary to explore bone distribution patterns and fully exploit and evaluate the three dimensional tagging of bone fragments.

3.4.6 Analysis and publication report

The data analysis, GIS spatial analysis, archive and publication report will require six months further work, however, it would not be economical to begin work on this stage until the following have been completed:

1) the recording of any outstanding bone material remaining on site

2) the translation of the bone, measurement and dentition database tag

numbers into 3D coordinates for use by the GIS software

3) updating of all bone, measurement and dentition databases with context details including relevant data on residuality or contamination, stratigraphic relationships, grubenhaus and structure master numbers and final period and feature type information

4) allocation of computer generated tag numbers to zones collected by context number only.

5) software training (3.4.5)

4 Storage and curation

All bone fragments are contained in their original bags retaining context and tag number information. A total of 522 boxes is known at present requiring a storage area of 19.8 m^3. No discard policy has been discussed with the project director or recipient museum. A case could be made for the discard of post-medieval, modern and contaminated material but this is likely to form only a minor part of the total bone volume.

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Table 1. **Recorded Animal Bone**

Area	Mammal Fragments	Small Mammal Fragments	Bird Fragments	Total Zones	% of total Zones	Nonzone Fragments	Total Fragments	% Zones of Total Fragments	Metrical records	Dentition records
11AA	550	21	52	623	1.2	0	623	-	284	46
11AB	2,584	101	200	2,885	5.5	0	2,885	-	1,533	277
11AC	79	2	5	86	0.2	0	86	-	37	15
11AD	3,984	2	198	4,184	7.9	0	4,184	-	33	367
11AE	1,369	8	116	1,493	2.8	0	1,493	-	793	129
11BA	3,412	59	357	3,828	7.2	0	3,828	-	38	490
11BB	48	1	3	52	0.1	0	52	-	4	11
11BC	1,890	28	77	1,995	3.8	0	1,995	-	1,273	93
11BD	5,602	78	497	6,177	11.7	21,391	27,568	22.4	1,570	463
11BE	885	4	41	930	1.8	0	930	-	566	73
11BF	240	2	7	249	0.5	0	249	-	153	28
11CD	4,525	25	457	5,007	9.5	0	5,007	-	5	322
11CE	1,785	21	169	1,975	3.7	0	1,975	-	1,070	134
2CA	4,427	139	103	4,669	8.8	39,337	44,006	10.6	2,140	314
2CB	2,145	131	71	2,347	4.4	21,626	23,973	9.8	1,241	245
2CC	914	35	38	987	1.9	10,861	11,848	8.3	468	105
2DA	5,412	33	179	5,624	10.6	29,273	34,897	16.1	2,413	513
2DB	6,885	26	142	7,053	13.4	45,363	52,416	13.5	3,938	549
2DC	1,558	14	52	1,624	3.1	10,068	11,692	13.9	877	144
2DD	1,016	0	27	1,043	2.0	6,123	7,166	14.6	488	77
Total Fragments	49,310	730	2,791	52,831	100.0	184,042	236,873	22.3	18,924	4,395
Total Records	47,847	526	2,749	51,122		85,153	136,275	37.5	18,924	4,395

= further records to be transfered to database

Table 2. Total mammal zones by period and area

	AA	AB	AC	AD	AE	BA	BB	BC	BD	BE	BF
Geological								4			
Prehistoric		4	3		5						
Neolithic	1				1						
L. Neo/EBA		1									
Iron Age	9	1									
Roman	3	2							1		
Early Saxon	417										
Middle Saxon	8										
Saxon	10	2			111	7		1,507	6		
8th C						1					
Medieval			1					2	6		
Post Medieval			1						3		
Modern		20									
"No Entry"	53	575	28	3,401	531	12		347	1,875	375	
Blank	49	1,979	46	583	721	3,392	48	30	3,711	510	240
Total	550	2,584	79	3,984	1,369	3,412	48	1,890	5,602	885	240

	CA	CB	CC	CD	CE	DA	DB	DC	DD	Total	%
Geological										4	0.01
Prehistoric	8	2				22	53	34		131	0.27
Neolithic			3			9				14	0.03
L. Neo/EBA		2	1							4	0.01
Iron Age										10	0.02
Roman		74	36							116	0.24
Early Saxon	1,390	1,173	730			3,283	2,791	695	36	10,515	21.32
Middle Saxon										8	0.02
Saxon	93	126				143	1,383		247	3,635	7.37
8th C										1	0.00
Medieval	16					33	119	4		181	0.37
Post Medieval	23						11	7		45	0.09
Modern						442	233	29		724	1.47
"No Entry"	628	42	48			1,465	2,211	766	699	13,056	26.48
Blank	2,269	726	96	4,525	1,785	15	84	23	34	20,866	42.32
Total	4,427	2,145	914	4,525	1,785	5,412	6,885	1,558	1,016	49,310	100.00

Table 3. Total mammal zones by feature type and period for all areas

PERIOD / FEATURE	Geol	Preh	Neo	LN/ EBA	IA	Roman	Early Saxon	Middle Saxon	Saxon	8thC	Med	PMed	Mod	"No Entry"	Blank	TOTAL	%
ARTIFACT/S							100								13	113	0.23
BURIED SOIL														60	5	65	0.13
COBBLE LAYER										1						1	0.00
CREMATION		3													7	10	0.02
DITCH CUT						14			1					18	22	55	0.11
DITCH CUT SEG.		1									3			24		28	0.06
DITCH FILL						65		7	4			3		627	410	1,116	2.26
DITCH FILL SEG.		3			1				1		28	10		546	8	597	1.21
DRAIN FILL													3			3	0.01
GRAVE FILL							32									32	0.06
GRAVEL LAYER														1	1	2	0.00
GRIDDED SPIT															29	29	0.06
GRUB CUT							39		28						2	69	0.14
GRUB FILL							7,640		2,228					294	538	10,700	21.70
GULLY CUT														1	2	3	0.01
GULLY CUT SEG.														231		231	0.47
GULLY FILL							10					1		57	8	76	0.15
GULLY FILL SEG.							2					8		108	2	120	0.24
LAYER		30					225				101		703	3,569	109	4,737	9.61
PIT CUT		6	1				8		2					11	10	38	0.08
PIT FILL		76	12	4		2	328		1,234					500	280	2,436	4.94
PLOUGH MK. CUT											7		1			8	0.02
PLOUGH MK. FILL											8			1	1	10	0.02
POST HOLE CUT					1		29		9					23	20	82	0.17
POST HOLE FILL		1	1		8		123		30					283	54	500	1.01
POST PIPE CUT							2									2	0.00
POST PIPE FILL							9							13		22	0.04
SKELETON		1					23		24			23		59	40	170	0.34
SLOT CUT														5	2	7	0.01
SLOT FILL							23	1	1					89	20	134	0.27
SOIL HEARTH														3		3	0.01
SPFT							374						17	5,306	3,782	9,479	19.22
STAKEHOLE FILL							1									1	0.00
STREAM CUT															1	1	0.00
STREAM CUT SEG.		1									1				1	3	0.01
STREAM FILL														37	3	40	0.08
STREAM FILL SEG.		5									17			27	173	222	0.45
STRUCTURE							1,143		51					3		1,197	2.43
TRACK CUT														2		2	0.00
UNDEF CUT							1				2			14	12	29	0.06
UNDEF FILL		4					201				12			352	75	644	1.31
VOID														4		4	0.01
WHEEL RUT FILL															2	2	0.00
?NAT CUT	1													2	4	7	0.01
?NAT FILL	3													7	9	19	0.04
"No. Entry"						29	202		22		2			12	16	283	0.57
Blank						6								767	15,205	15,978	32.40
TOTAL	4	131	14	4	10	116	10,515	8	3,635	1	181	45	724	13,056	20,866	49,310	

Table 4. Sample elements recovered by hand and in flots

	Total Ovicaprid phalanges	Recovered from floatation		Total Ovicaprid LM3s	Recovered from floatation	
11BA	121	0	0.0%	104	0	0.0%
2CA	67	1	1.5%	47	1	2.1%
2CB	54	7	13.0%	29	2	6.9%
2DA	93	11	11.8%	59	1	1.7%
2DB	79	14	17.7%	122	1	0.8%
2DC	68	19	27.9%	15	0	0.0%
TOTAL	482	52	10.8%	376	5	1.3%

LM3 = lower third molar tooth

Figure 1. Plan of excavation areas

GraSys Plot View Plan Scale= 1:1000 Grid = 10000 m. Origin 9804/33007

Figure 2. Element zones (%) by area

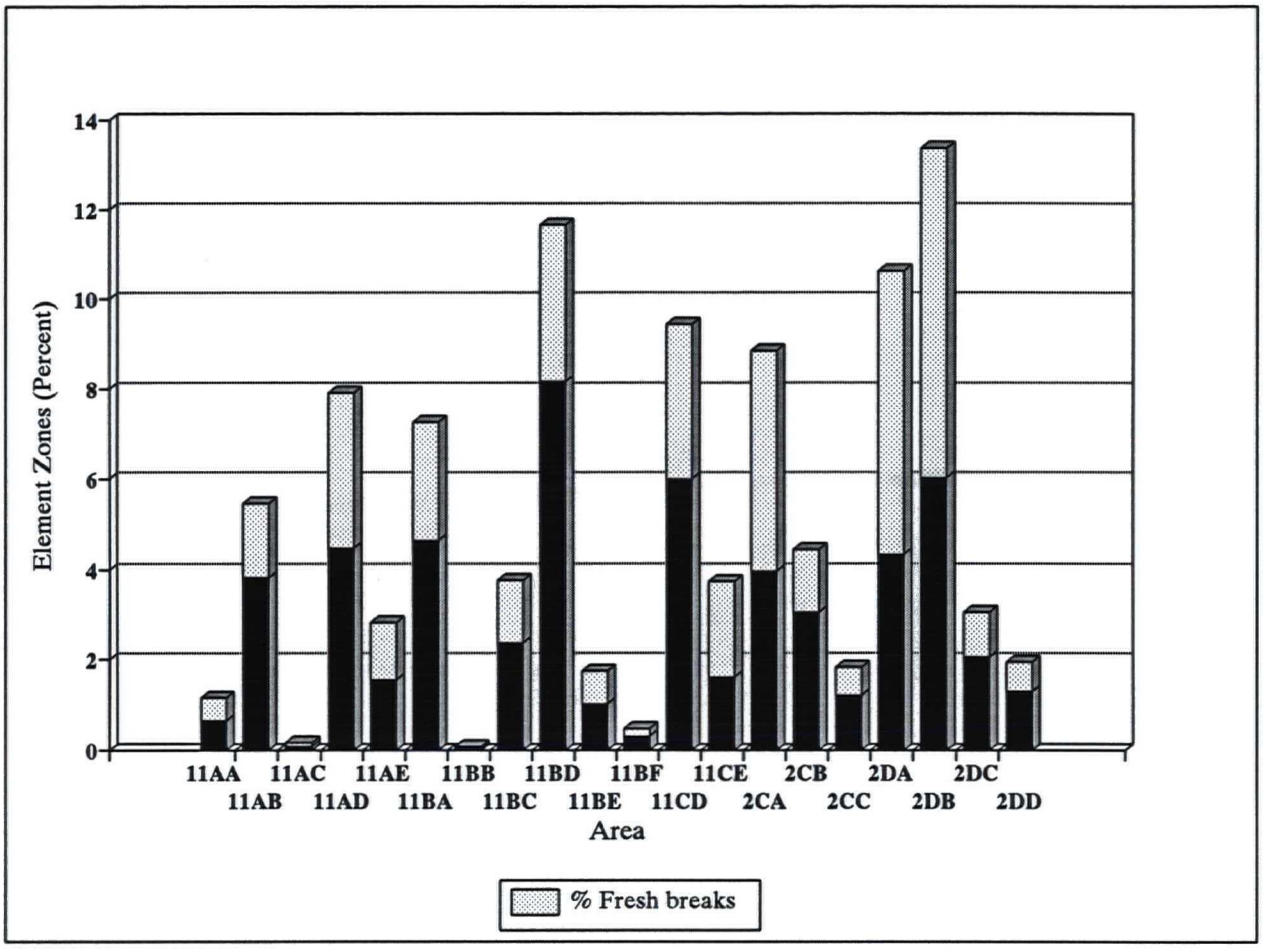
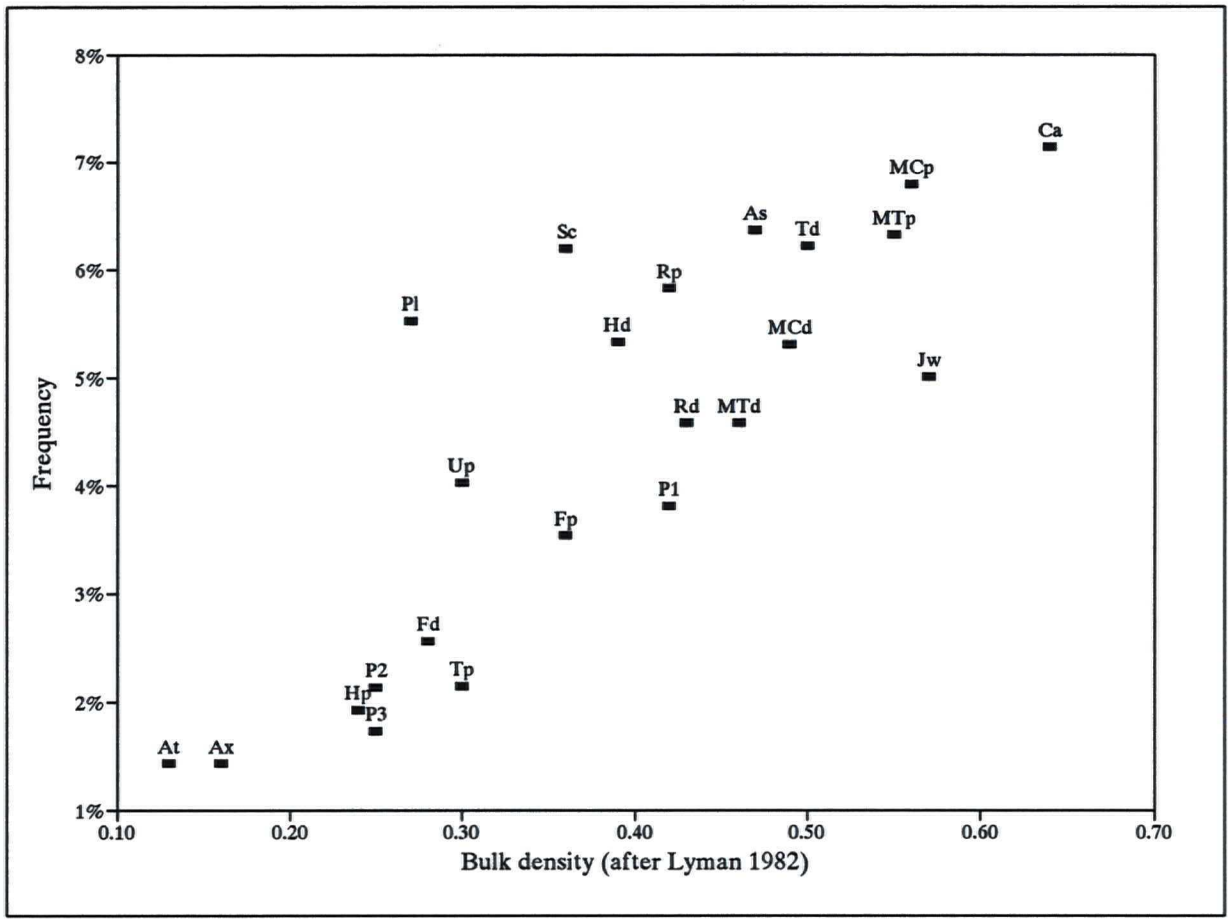


Figure 3. Scatterplot of cattle element zone frequency plotted against Lyman's (1982) bulk density values



Sample size: 22,572 element zones

Key:

As	Astragalus	MTp	Metatarsal proximal
At	Atlas	P1	Phalange I
Ax	Axis	P2	Phalange II
Ca	Calcaneum	P3	Phalange III
Fd	Femur distal	Pl	Pelvis
Fp	Femur proximal	Rd	Radius distal
Hd	Humerus distal	Rp	Radius proximal
Hp	Humerus proximal	Sc	Scapula
Jw	Mandible	Td	Tibia distal
MCd	Metacarpal distal	Tp	Tibia proximal
MCp	Metacarpal proximal	Up	Ulna proximal
MTd	Metatarsal distal		

Figure 4. Percentage of cattle and ovicaprid bone gnawed/chewed

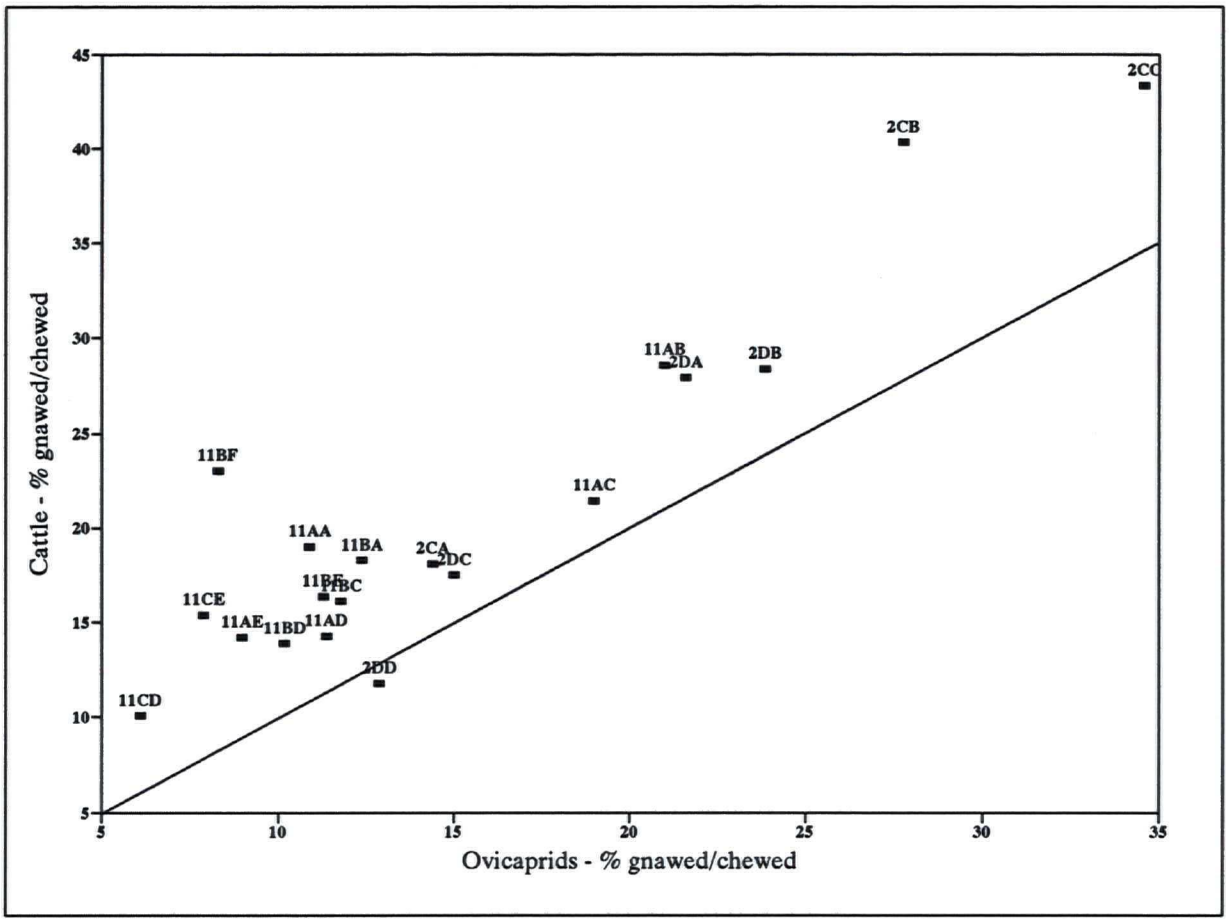


Figure 5. Frequency of bird and small mammal bones by area