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Ancient Monuments Laboratory
Report 224/87

BONE ANALYSIS AND URBAN ECONOMY:
EXAMPLES OF SELECTIVITY AND A CASE
FOR COMPARISON.

Bruce Levitan

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Summary

Reports from three recent sites in Exeter are used to illustrate the facility of a selective approach in bone analysis. In each case, the highlights of the analyses are considered, showing that the selective approach can bring out the important aspects of the bones from the site, and indicating that routine, standardised forms of analysis would be inappropriate. The sites of Exe Bridge, St. Katherine's Priory and St. Nicholas Priory are considered. At Exe Bridge, a series of river reclamation deposits are made up of the waste from the horn working industry. St. Katherine's Priory is used as an example of the importance of studying intra-site lateral variation in terms of bone distributions, whilst a related study at St. Nicholas Priory illustrates a detailed intra-site comparison of a single-group of deposits with very good temporal resolution. The paper concludes with a discussion of the usefulness of inter-site comparisons from single towns.

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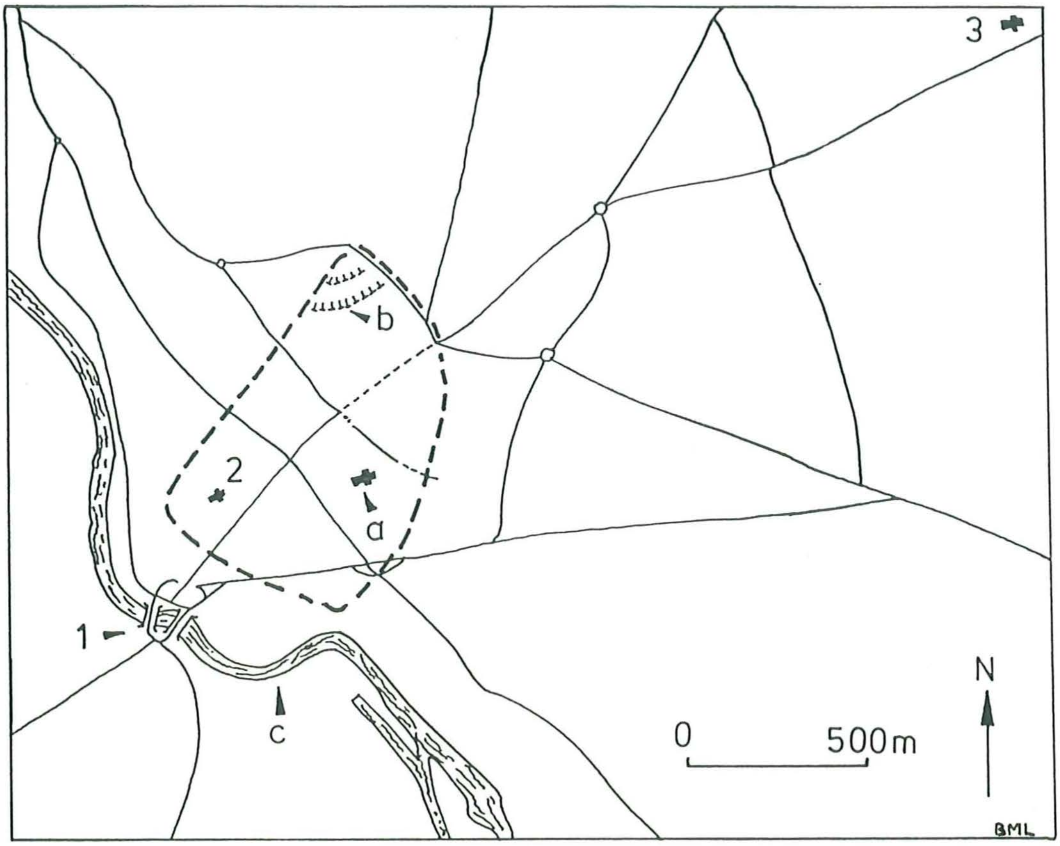
INTRODUCTION

Bone analysis from urban sites has, in recent years, become increasingly more common, mainly as a result of the "Rescue boom" of the early 1970s. Some idea of the scale of this can be deduced from the various contributions to the two recent volumes produced by DoE/HBMC on the subject of environmental archaeology, *eg* Armitage *et al* (1987), Bell (1984), Coy and Maltby (1987) and Kenward *et al* (1984).

One result of this has been the publication of major studies of bone assemblages from urban sites, *eg* Maltby (1979) for Exeter, Noddle (1985) for Hereford, and O'Connor (1982) for Lincoln. Such studies have taken bone analysis beyond the stage of analysis by rote, and as well as including much research and original thought, have become advocates of increasing selectivity. This is partly because the assemblages dealt with have been very large, *eg* 75,000, 14,000 and 60,000 respectively for the sites quoted above. Dealing with such large quantities of bone has led to the recognition that certain patternings within the evidence are repeated on different sites, and mere replication of information is of little use or sense. Furthermore, when the total number of bones from many sites from one town is considered, the size of the problem of analysis can be staggering: O'Connor (1984, 3) estimates more than three million bones for York.

It is with these points in mind that this paper is written. The aim is to show that a selective approach to bone analysis may not only reduce the work load, but can zero-in on specific problems in an analysis that is uncluttered by other, more routine aspects. Three sites from one town are chosen to exemplify this approach. In each case a different aspect of the bone assemblage is considered, the intention being to show that the essential characteristics of the sites can be thus highlighted. In addition, the aim is to show that the analysis should be integrated with the archaeology of the site, and that the bone report should be more than a mere appendix of the site report.

The comparative approach is dealt with only briefly because three sites are not a good enough basis for a case study of inter-site comparison. It is a corollary, however, of the selective approach, since it represents the next stage of analysis beyond the site report: that of inter-site comparisons from one town. It seems superfluous to have to suggest that this is a necessary next step, yet the approach to excavation and analysis from urabn sites is often too limited in scope, almost as if there is a "dig it because it's there" reasoning, rather than part of a problem-orientated strategy for the town as a whole, and there is an obvoius knock-on effect for bone analysis. That bone analysis has suffered from this situation is evidenced by



a - Cathedral   b - Castle   c - River Exe

1 - Exe Bridge   2 - St. Nicholas Priory

3 - St. Katherine's Priory   Town wall

Fig.1: Exeter - site locations

the recent review of evidence from medieval sites in South West England by the author. Despite the existence of over 40 bone reports from towns in the region, it was impossible, except in the case of Exeter, to make any useful generalisations about the information produced (Levitan, in press).

EXE BRIDGE: BODY PART REPRESENTATION AND SITE FUNCTION

The excavations at Exe Bridge, Exeter, (1975-1976) were directed by Stuart Brown for the Exeter Museums Archaeological Field Unit. It was sited on the north bank of the River Exe, to the west of the bridge and St. Edmund's Church (Figure 1). The Exe Bridge was constructed *c* 1200 AD, and replaced a timber bridge which dated from the nineth century (Henderson, 1985, 6). The excavations included parts of St. Edmund's Church which was at the northern end of the bridge, but the bones were mainly recovered from three tenement plots adjacent to the church and bridge.

A total of 12163 bones were examined, and most of them (6439) come from one phase dated to the thirteenth century. Other phases total between 695 and 2080 bones. The major group of animals represented is the mammals, with 9510 bones, and over 90% of the bones identified to species level comprise cattle and sheep/goat. This is an unusually high percentage, though cattle and sheep/-goat are generally the most important animals represented at other sites from Exeter (Maltby, 1979).

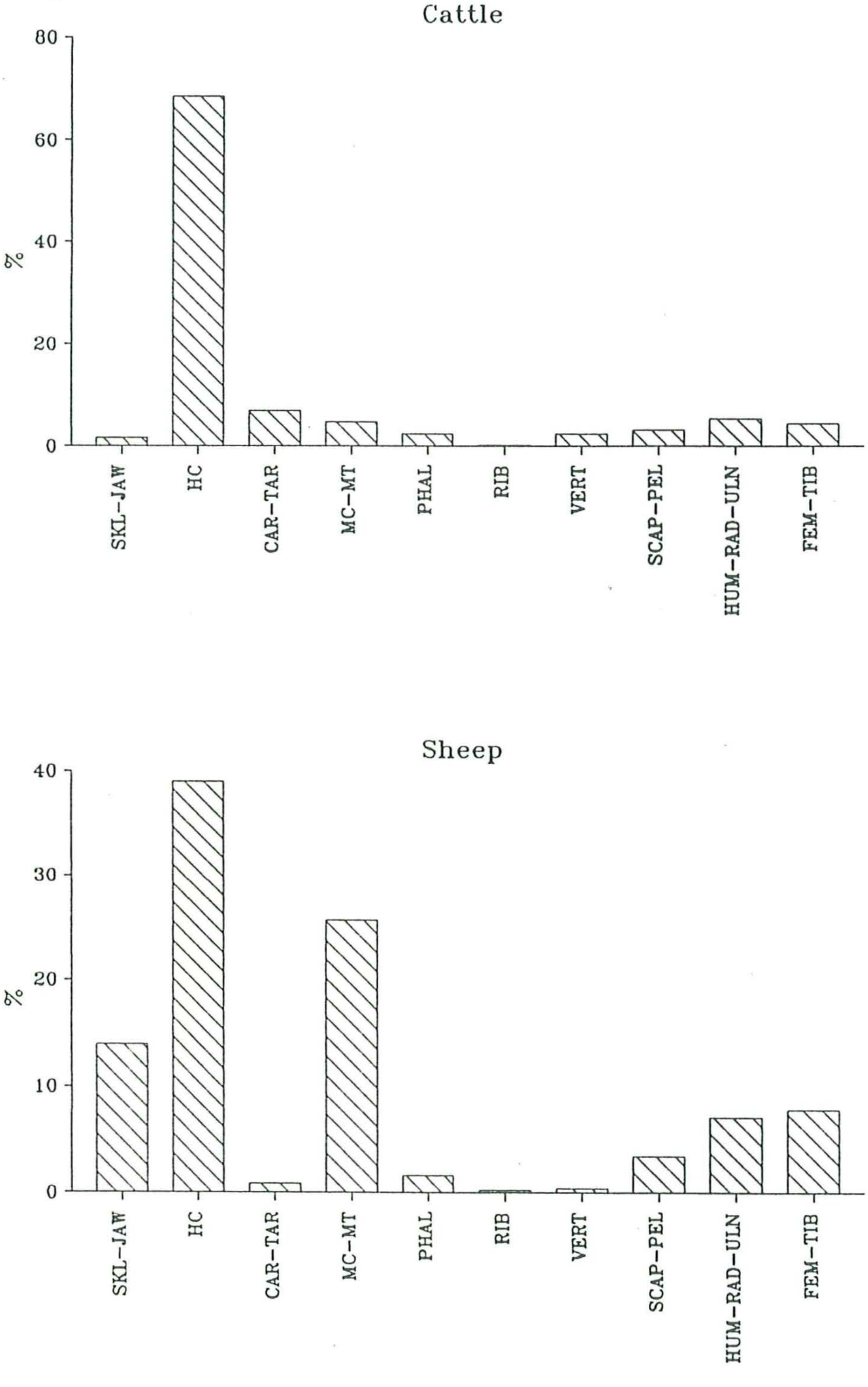
The best evidence for site function here, however, comes from an analysis of body-part representation, and not from species representation. Before presenting the results of body-part representation, a brief discussion of the methods of analysis is necessary. The use of simple fragment counts is not the most appropriate method for this analysis for three reasons. Firstly, the skeletons of different animals have different numbers of certain elements. For example cattle, sheep and goats have eight first phalanges (upper finger bones), but pigs have twice this number, whilst horses have only four. Thus a simple total of phalanges for each species would give a biased picture of frequency. Secondly, and related to the first point, different elements within a single skeleton occur in different numbers. For instance, there are eight first phalanges, seven cervical vertebrae (neck back bones), two scapulae (shoulder blades), and one skull in cattle. Thus, in a fragment count, the relative frequency of the elements may be biased. The third factor is fragmentation. The bones will be fragmented to varying degrees, and this may depend upon a number of factors which can act separately or in combination, for example butchery, cooking, scavenging, trampling. It follows that more fragile bones (*eg* skull) may be more greatly fragmented than stronger bones (*eg* phalanges), and some bones may be more heavily fragmented due to butchery (*eg* upper leg bones which might have been smashed open for marrow extraction) than others (*eg* vertebrae which may only have been chopped in half when dividing the carcase). It should be clear from this that these three biases make it impossible to assess the evidence of anatomical represen-

Table 1. Cattle anatomical counts, Exe Bridge, Exeter

		13th century		14th century		15th century		Post-medieval	
ELEMENT	EF	N	N/EF	N	N/EF	N	N/EF	N	N/EF
horncore	2	450	225.0	24	12.0	19	9.5	42	21.0
upper teeth	12	10	.8	5	.4	8	.7	9	.8
lower teeth	18	16	.9	5	.3	4	.2	4	.2
mandible	2	3	1.5	6	3.0	2	1.0	2	1.0
cervical	7	29	4.1	9	1.3	7	1.0	19	2.7
thoracic	12	10	.8	3	.3	11	.9	7	.6
lumbar	7	14	2.0	5	.7	3	.4	7	1.0
caudal	16	39	2.4	4	.3	4	.3	0	.0
ribs	24	70	2.9	16	.7	17	.7	16	.7
scapula	2	12	6.0	2	1.0	1	.5	1	.5
humerus	6	11	1.8	8	1.3	4	.7	11	1.8
radius	6	13	2.2	2	.3	5	.8	6	1.0
ulna	2	14	7.0	6	3.0	6	3.0	6	3.0
carpals	12	3	.3	1	.1	12	1.0	1	.1
metacarpal	6	15	2.5	10	1.7	9	1.5	10	1.7
pelvis	6	2	.3	2	.3	0	.0	4	.7
femur	6	14	2.3	4	.7	3	.5	4	.7
patella	2	2	1.0	0	.0	3	1.5	1	.5
tibia	6	12	2.0	13	2.2	13	2.2	7	1.2
astragalus	2	14	7.0	2	1.0	5	2.5	13	6.5
calcaneum	2	26	13.0	4	2.0	5	2.5	6	3.0
tarsals	6	3	.5	1	.2	3	.5	0	.0
metatarsal	6	15	2.5	11	1.8	4	.7	11	1.8
phalanges	24	58	2.4	10	.4	7	.3	26	1.1
TOTAL		855		153		155		213	

EF = expected frequency in skeleton except long bones (2 proximal ends + 2 diaphyses + 2 distal); ulna (proximal only); pelvis (2 ilium + 2 ischium + 2 pubis); ribs (heads).
N = fragment counts exclude those less than 25% complete (except epiphyses).

Fig.2: Exe Bridge: anatomical groups



For key to anatomical groups see Table 8 tation from fragment counts alone.

There are several ways of combating these biases (*eg* Grant, 1975; Watson, 1979; Levitan, forthcoming a), and the method employed here is to standardise for expected anatomical frequency, and to discount very small fragments (*ie* those less than a quarter complete).

The results for cattle and sheep/goat are given in Tables 1 and 2. The column headed N gives the results of the bone counts with fragments less than a quarter complete excluded. The N/EF column gives the results when N is standardised for skeletal frequency. What is immediately evident from the tables is that horncores dominate the deposits. For the thirteenth century, in the case of cattle, 450 out of a total of 759 bones are horncores, and for sheep/goat there are 467 horncores out of a total of 1332 bones. This pattern is repeated in the later periods, though to a lesser extreme, and it should be noted that the sample size also decreases in later periods.

In the thirteenth century, goats account for 422 (94%) of the sheep/goat horncores, yet, on the basis of the other parts of anatomy, sheep outnumber goats by 2:1 (184 bones identified as sheep and 95 as goat).

Figure 2 illustrates the anatomical representation of cattle and sheep/goat (labelled sheep in the figure) for the thirteenth century. Besides the emphasis on horncores, a secondary emphasis on metapodials (lower limb longbones) is evident for sheep/goat. Note that here sheep are dominant with 106 metapodials compared with 40 of goat (a further 220 could not be assigned to species).

Clearly, this deposit, comprising such high percentages of horncores, represents some specialised process. In fact, two activities appear to be represented. Interpretation of one is partly based upon the evidence for temporal differences in quantity of bones. The clear concentration of bones in the thirteenth century represents a peak of bone deposition at this time, and this fits in well with the rest of the archaeological evidence which indicates reclamation of the river bank by dumping of large quantities of bones and other material. This phase of reclamation ceased in later periods, and two tenement properties were extended onto the new ground. Such deposits, where river bank reclamation comprises the dumping of bones and other rubbish, have many parallels in other cities, *eg* London, Bristol and Ipswich.

The fact that the deposits comprise mainly horncores is not relevant in terms of bones chosen for reclamation, but it is important in that the bones were presumably gathered from close by. The postulated proximity of the activities which generated the deposits is further attested by the fact that horncores remain an important component in later periods. These deposits probably relate to hornworking, bone working and/or tanning.

The last of these would be characterised by high proportions

Table 2. Sheep anatomical counts, Exe Bridge, Exeter

ELEMENT	EF	13th century N	13th century N/EF	14th century N	14th century N/EF	15th century N	15th century N/EF	Post-medieval N	Post-medieval N/EF
horncore	2	467	233.5	43	21.5	14	7.0	25	12.5
upper teeth	12	66	5.5	15	1.3	10	.8	5	.4
lower teeth	18	42	2.3	4	.2	8	.4	8	.4
mandible	2	149	74.5	20	10.0	13	6.5	19	9.5
cervical	7	4	.6	0	.0	21	3.0	13	1.9
thoracic	12	1	.1	0	.0	2	.2	15	1.3
lumbar	7	5	.7	1	.1	13	1.9	6	.9
caudal	16	3	.2	1	.1	2	.1	3	.2
ribs	24	58	2.4	21	.9	24	1.0	41	1.7
scapula	2	26	13.0	3	1.5	7	3.5	8	4.0
humerus	6	25	4.2	11	1.8	14	2.3	13	2.2
radius	6	68	11.3	15	2.5	18	3.0	12	2.0
ulna	2	9	4.5	5	2.5	3	1.5	6	3.0
carpals	12	0	.0	0	.0	0	.0	0	.0
metacarpal	6	160	26.7	22	3.7	38	6.3	31	5.2
pelvis	6	27	4.5	1	.2	6	1.0	18	3.0
femur	6	31	5.2	12	2.0	14	2.3	15	2.5
patella	2	0	.0	0	.0	0	.0	0	.0
tibia	6	75	12.5	18	3.0	30	5.0	18	3.0
astragalus	2	4	2.0	0	.0	1	.5	1	.5
calcaneum	2	5	2.5	0	.0	2	1.0	1	.5
tarsals	6	0	.0	0	.0	0	.0	0	.0
metatarsal	6	206	34.3	33	5.5	31	5.2	27	4.5
phalanges	24	67	2.8	14	.6	9	.4	16	.7
TOTAL		1498		239		280		301	

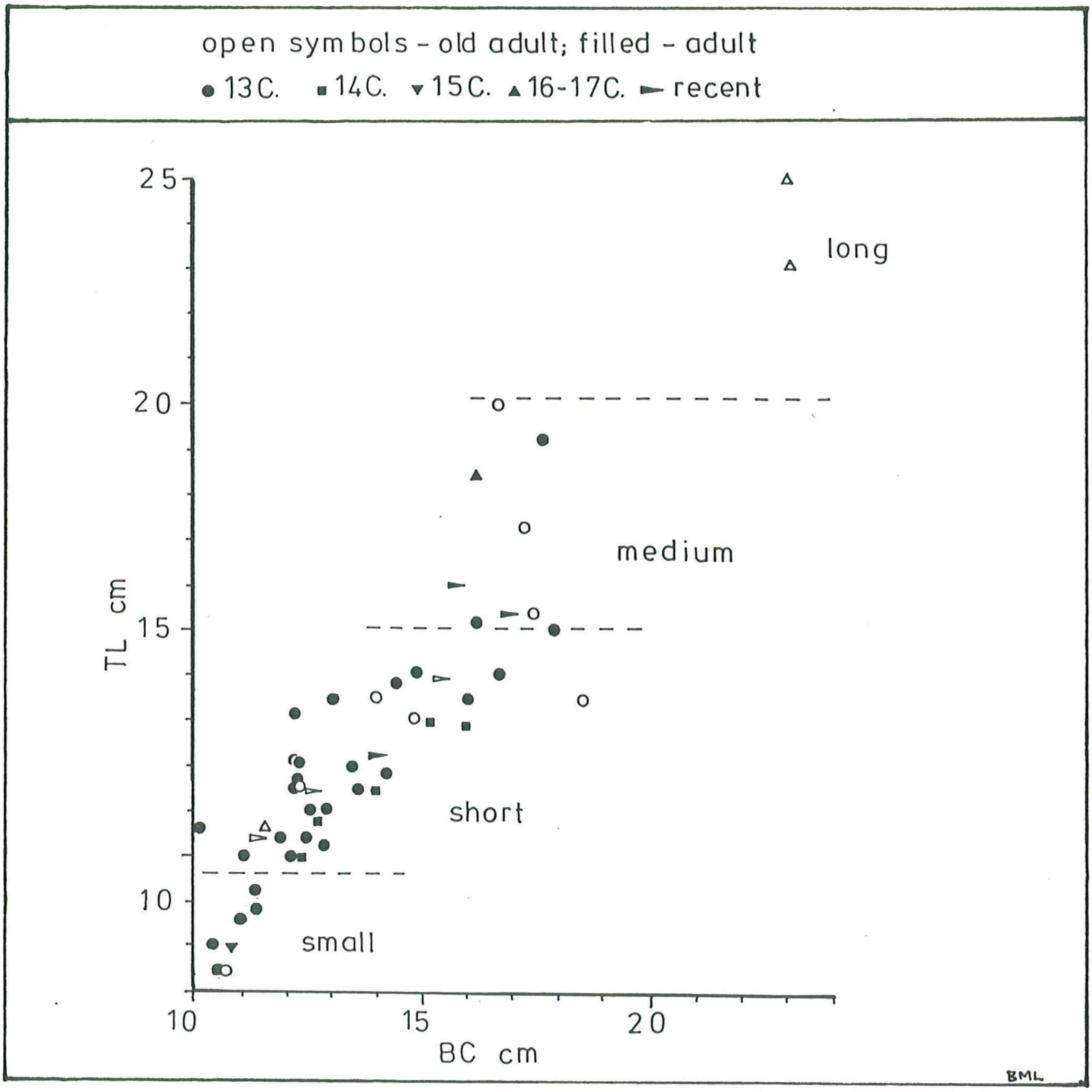
Key: see Table 1

Table 3. Cattle horncore ageing results, Exe Bridge, Exeter

AGE CLASS	AGE RANGE	13th century N	13th century %	14th century N	14th century %	15th century N	15th century %	Post-medieval N	Post-medieval %
infant	0>1yr	6	1.8	0	.0	0	.0	1	3.6
juvenile	1>2yr	87	26.4	4	25.0	1	5.9	3	10.7
sub-adult	2>3yr	34	10.3	1	6.3	1	5.9	2	7.1
young adult	3>7yr	127	38.5	6	37.5	5	29.4	10	35.7
adult	7>10yr	58	17.6	2	12.5	7	41.2	5	17.9
old adult	>10yr	18	5.5	3	18.8	3	17.6	7	25.0
TOTAL		330		16		17		28	

Age classes and ranges from Armitage (1982b, 42)

Fig.3: Cattle horncore plots, Exe Bridge



of horncores and limb extremity bones since these were generally detached with the hides. Tables 1 and 2 and Figure 2 do show relatively high proportions of limb extremities (metapodials and phalanges). The presence of metapodials might also argue for bone working since this element was often used. The lack of butchery evidence on the metapodials, however, argues against this, since metapodials used for bone working commonly consist of proximal and distal ends only, the shafts having been used for bone working (Armitage, 1982a, 104; MacGregor, 1985, 47).

Hornworking is the activity that best fits the evidence, and similar patterns have been interpreted as hornworking waste at other sites, *eg* Augst, Switzerland (Schmid, 1968), Angel Court, Aldate and Cutler Street, London (Armitage, 1982a). Other sites are quoted by MacGregor (1985, 51-53). It is ironic that Maltby (1979, 86) suggested that under-representation of horncores from second and fourth century deposits in Exeter implied reservation of horncores elsewhere in the city. MacGregor (1985, 51-53) notes the characteristic butchery whereby cores are hacked and broken from the skull for hornworking or tanning, and similar patterns of butchery were recorded here. A recent find of horncore deposits from Exeter that possibly relate to tanning rather than hornworking was reported by Levitan (1985).

Further insights into this material can be gained by comparing age profiles of the cattle based on the horncores (Armitage, 1982b) and from other bones. The 330 aged horncores are summarised in Table 3 which shows a range of ages from less than a year to over ten years old. The majority are from animals aged three to seven years old, so presumably older animals were preferred (with better developed horns). The evidence from fusion of the bones (Table 4) implies that the majority of cattle were killed at around three years old. Market forces would undoubtedly have favoured younger cattle since meat would have been the most important product from cattle sold in Exeter, so the hornworkers' raw material would be limited by this. The relatively high proportions of young adult horncores reflects this effect.

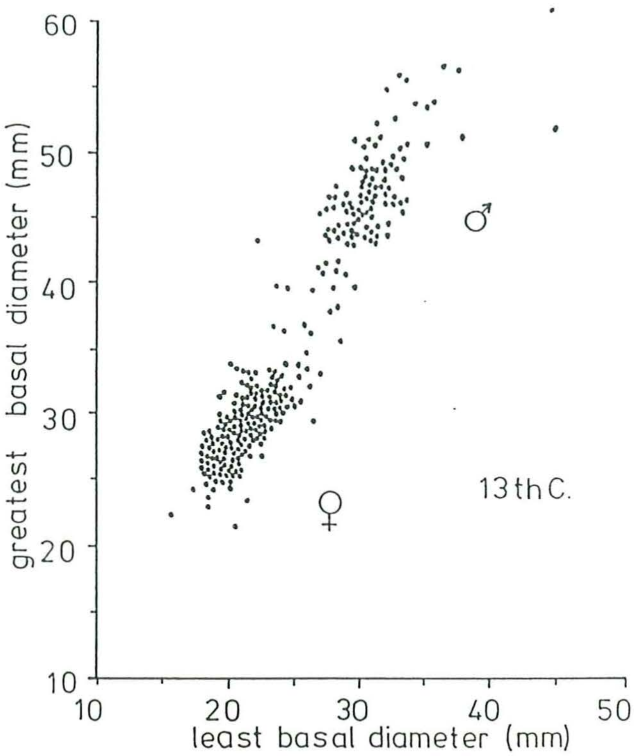
Sex determination can sometimes be carried out using metrical evidence.In the case of horncores (where there are large samples of measured bones) this is less useful in the case of the cattle, where there is a lot of non-sex based variation, (Figure 3) than for the goats (Figure 4). The cattle evidence is complicated by the presence of different size classes, and these are defined by Armitage and Clutton-Brock (1976) and Armitage (1982b). Although these results may not be informative in terms of sex separation, they do show that the short horned variety of cattle was the commonest, providing useful information about the main type of cattle that was exploited. In the case of goat horncores there is a good correlation between basal dimensions and greatest length (Levitan, forthcoming b), and whilst the latter give better sex separation results, the former have been employed here due to larger sample size (Figure 4). The larger horcores, in the top right part of the scatter plots, are probably males. Males are slightly less common than females, but the difference is not

Table 4. Cattle epiphysial fusion results, Exe Bridge, Exeter

	13th century		14th century		15th century		Post-medieval	
	F	NF	F	NF	F	NF	F	NF
7-18 months								
scapula D	6	0	3	0	1	1	0	0
humerus D	2	4	13	0	3	1	2	5
radius P	11	1	21	0	5	5	4	3
phalanx 1 P	13	0	26	0	5	0	15	0
phalanx 2 P	2	0	9	0	2	0	4	2
% not fused		16		0		30		29
24-36 months								
metacarpal D	4	6	14	3	3	6	2	4
tibia D	3	2	11	6	8	4	0	4
metatarsal D	2	12	6	2	1	8	0	7
calcaneum P	4	3	12	4	3	4	2	4
% not fused		64		26		60		83
42-48 months								
humerus P	2	6	3	3	2	3	6	6
radius D	4	0	10	1	1	6	3	4
ulna P	0	3	1	1	1	2	1	2
femur P	3	7	8	4	4	2	1	4
femur D	1	6	7	1	3	1	2	4
tibia P	1	4	6	7	1	7	5	7
% not fused		70		33		60		60

F = fused. NF = not fused. P = proximal. D = distal.
Fusion ages from Grigson (1982, 22)

Fig.4: Goat horncore plots, Exe Bridge



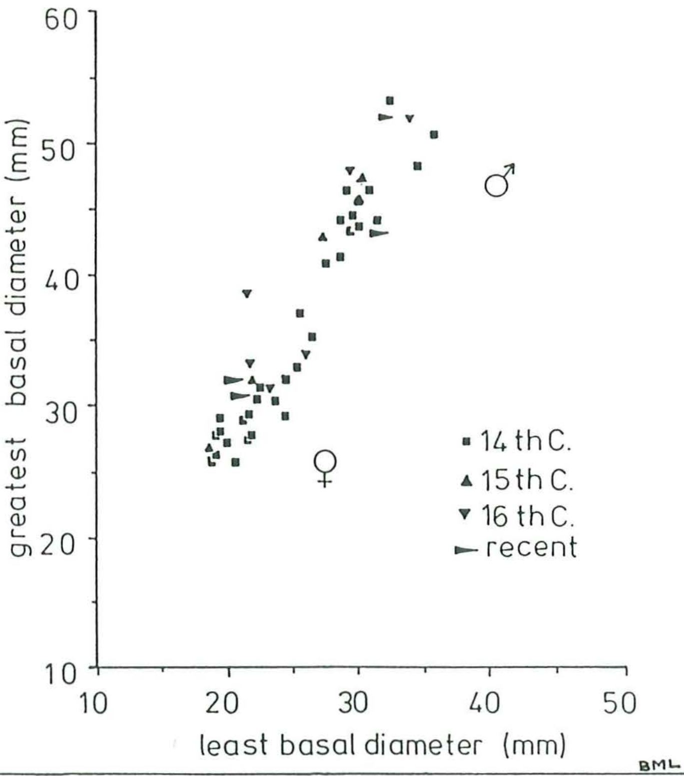
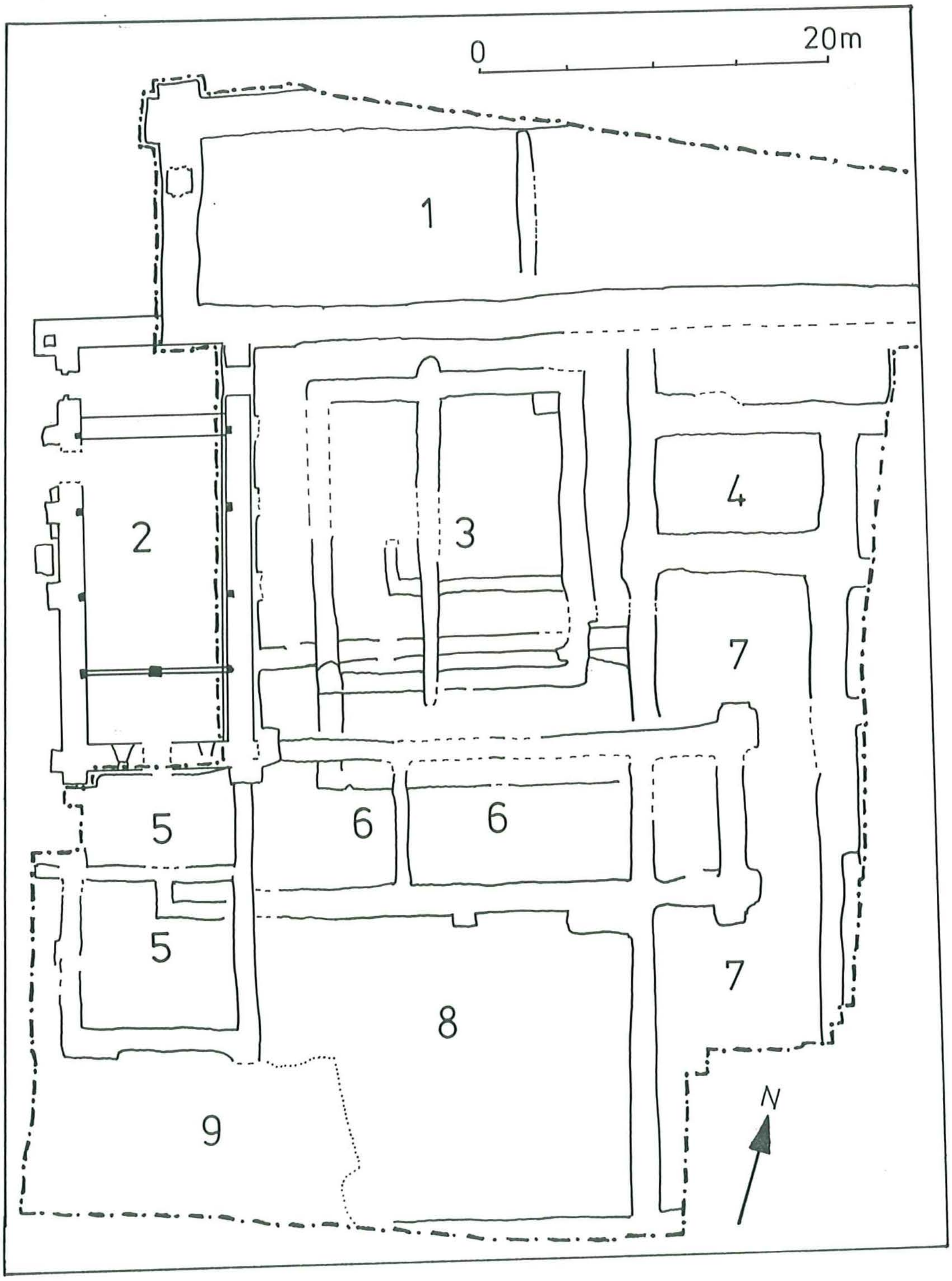


Fig.5: Plan of St. Katherine's Priory, Exeter

Key:- 1-Church; 2-West Range; 3-Cloisters (room A); 4-Chapter House; 5-Kitchens; 6-Refectory; 7-Dorter; 8-Garden; 9-Kitch. exterior.



great. The implication, for goats at least, is that there was no great preference in terms of sex, for horn raw material.

ST. KATHERINE'S PRIORY: A STUDY OF LATERAL VARIATION

St. Katherine's Priory (Figure 1), a Benedictine nunnery dating from 1160 AD to about 1600 AD, was excavated between 1976 and 1978 under the direction of John Allan. The excavations were mainly concerned with the cloisters and associated buildings to the south of the church, though parts of the church were also uncovered in the north part of the site (Figure 5). The main bone deposits relate to the sixteenth century, 7065 out of 10197 bones, with bones from other periods totalling 314 to 957. The majority of the bones are from the southern part of the site, and these could be divided up according to location, thus allowing a study and comparison of the lateral variation within these deposits. The analysis of lateral variation here is a useful tool in helping to provide information about the activities in the different locations, and similar studies have been used to good effect on different types and periods of site by Wilson (1978; 1985).

One way of looking at the lateral variation is in terms of species representation plotted as time series charts (Figure 6). It is very clear from this figure that each location gives a different view of the relative abundance of the species through time. The kitchen areas (interior and exterior) indicate an increase in the importance of cattle, set against a decrease in sheep/goat. In the dorter, sheep/goat are much more numerous in all periods, and there are decreases in sheep/goat and cattle through time. In room A, sheep are dominant, but an overall fall in percentages is set against a rise in cattle percentages. The garden deposit shows a very variable picture in the relative proportions of sheep and cattle through time. These results are important in two senses. Firstly, they indicate that the bone deposits are not uniform, so that a simple combination of all the deposits might not give a representative view of the exploitation patterns. Secondly, they show that the different deposits change through time, so they cannot necessarily be seen as temporally consistent.

Another way in which the lateral variation can be investigated is in terms of distribution plots. Wilson (1985; Wilson and Levitan, forthcoming) has recently shown that Iron Age sites may display variation in deposits in terms of size of bones. He did this by plots of bones from smaller animals (sheep, goat and pig) expressed as a proportion of all bones (*ie* small and large bones; the latter being represented by cattle and horse). The variation here may be investigated by similar means. It must be admitted that this is a crude estimate since the cattle and horse will comprise some small fragments, and the sheep, goat and pig may have some complete large bones. Without the help of a computer, however (this site was done manually), a plot which takes fragmentation into account as well would be very difficult to do with a large sample. The biases of including some bones in the

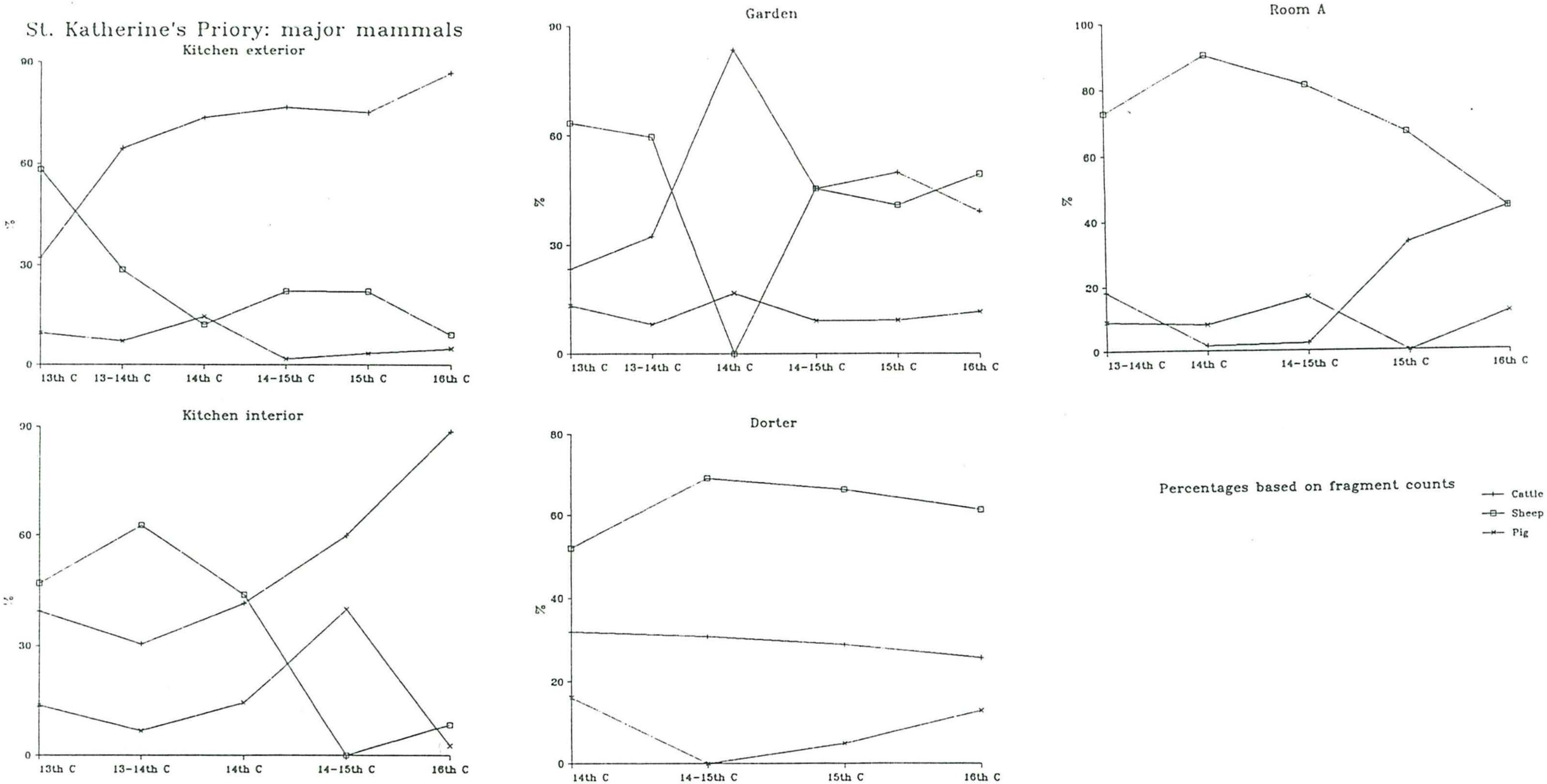

St. Katherine's Priory: major mammals
Kitchen exterior
Garden
Room A
Kitchen interior
Dorter
%
0
30
60
90
20
40
80
100
13th C
13-14th C
14th C
14-15th C
15th C
16th C
Percentages based on fragment counts
Cattle
Sheep
Pig

Fig. 6

A-13th C. B-13-14th C. C-14th C. D-14-15th C. E-15th C. F-16th C.

Key to locations: Fig. 5

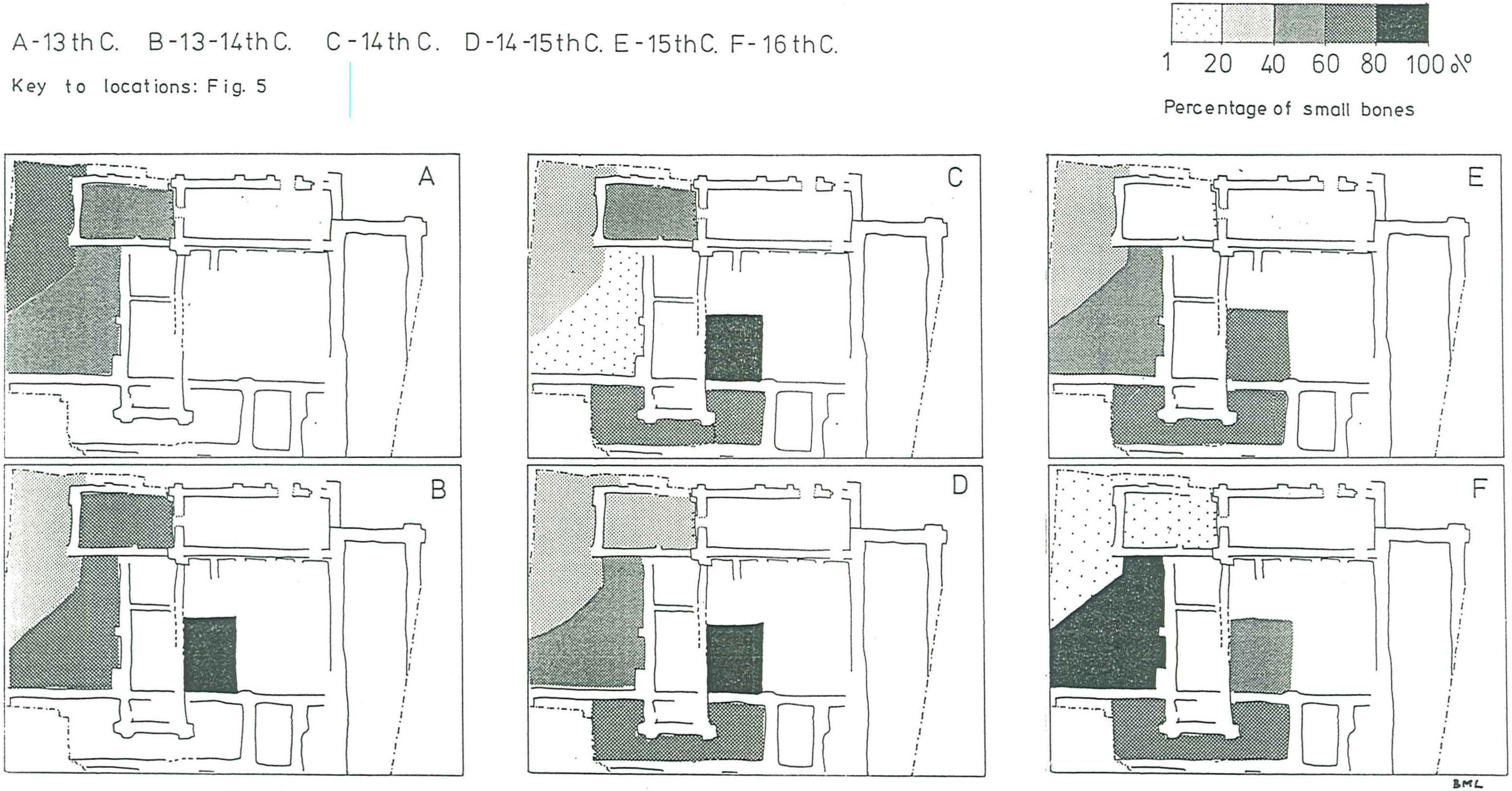


Fig.7: Distribution plots of small bone percentages, St. Katherine's Priory

wrong categories are not thought to be too great, so the results should still be reasonably informative.

The main pattern that emerges is that the smallest proportions of small bones occur in the kitchens exterior (in all periods except fourteenth century, where the proportions are the second smallest). This indicates that the largest bones were consistently deposited in the kitchens exterior area. The greatest accumulations of small bones occur within the dorter and room A, and also occasionally in the garden (thirteenth-fourteenth centuries and sixteenth century). The kitchens are the most variable, with mainly small bones in some periods (especially thirteenth-fourteenth centuries) and mainly large bones in other periods (*eg* sixteenth century).

These results show that a reasonably clear pattern occurs in all periods, though it is best exemplified in the fifteenth and sixteenth centuries. The large bones represent waste from secondary butchery (and possibly even primary butchery for pigs) in kitchen preparation. This would involve complete or half carcases which are cut into joints and boned out in the case of cattle in particular, with the bones being waste at this stage. These bones, then, were dumped in deposits near the kitchen, in ditches which may have been put aside specially for this purpose. The small bones, which represent table waste, are in deposits closer to the eating/living areas, and were perhaps disposed of more haphazardly (which may account for the variation in deposits in the kitchen and garden, for example).

It would appear, therefore, that the priory was buying in carcases whole and/or halved, and a lot of secondary butchery occurred on site. This is supported by the anatomical representation (Tables 5 and 6) which includes typical butchery waste such as limb extremities and skulls, and, in the case of cattle, some long bones as well.

ST. NICHOLAS PRIORY: TEMPORAL PRECISION

This Benedictine priory (Figure 1) was founded during the reign of William I and dissolved in 1536. It was the richest of Exeter's monasteries, and after the dissolution became a grand town house, but the fourteenth century tower that was pulled down in 1536 was succeeded by seventeenth century cottages (Allan and Henderson, 1984).

Occasionally bones may be recovered from very closely dated contexts of a short time span, and, if luck prevails, the bone groups may be large enough for a fairly detailed analysis. The 1983-84 excavation at St. Nicholas Priory, directed by John Allan, provided such an assemblage, with three groups of bone from back-filled robbing trenches of the church and tower which date to 1540-1550 AD, and a fourth group dating perhaps twenty or so years later. These yielded a sample of 4939 bones of which 3870 were identified (Table 7). This provides an opportunity to look at a series of rubbish dumps in detail; from which informat-

Table 5. Cattle anatomical counts, St. Katherine's Priory, Exeter

		13th century		13-14 century		14th century		14-15 century		15th century		16th century	
ELEMENT	EF	N	N/EF	N	N/EF	N	N/EF	N	N/EF	N	N/EF	N	N/EF
teeth	30	4	.1	1	.0	9	.3	7	.2	15	.5	166	5.5
mandible	2	3	1.5	0	.0	1	.5	1	.5	0	.0	62	31.0
vertebrae	42	2	.0	1	.0	9	.2	2	.0	8	.2	169	4.0
ribs	24	6	.3	3	.1	5	.2	1	.0	7	.3	73	3.0
scapula	2	2	1.0	0	.0	4	2.0	3	1.5	0	.0	13	6.5
humerus	6	5	.8	1	.2	3	.5	2	.3	1	.2	47	7.8
radius	6	3	.5	1	.2	1	.2	7	1.2	2	.3	47	7.8
ulna	2	1	.5	0	.0	0	.0	4	2.0	1	.5	26	13.0
carpals	12	2	.2	0	.0	1	.1	0	.0	0	.0	21	1.8
metacarpal	6	5	.8	0	.0	1	.2	2	.3	1	.2	71	11.8
pelvis	6	4	.7	1	.2	2	.3	0	.0	0	.0	23	3.8
femur	6	6	1.0	2	.3	5	.8	2	.3	2	.3	19	3.2
tibia	6	2	.3	2	.3	2	.3	1	.2	0	.0	69	11.5
tarsal	10	5	.5	2	.2	4	.4	2	.2	6	.6	77	7.7
metatarsal	6	2	.3	0	.0	2	.3	2	.3	0	.0	70	11.7
phalanges	24	7	.3	3	.1	4	.2	4	.2	12	.5	59	2.5
TOTAL		59		17		53		40		55		1012	

Key: see Table 1

Table 6. Sheep anatomical counts, St. Katherine's Priory, Exeter

ELEMENT	EF	13th century N	13th century N/EF	13-14 century N	13-14 century N/EF	14th century N	14th century N/EF	14-15 century N	14-15 century N/EF	15th century N	15th century N/EF	16th century N	16th century N/EF
horncore	2	0	.0	0	.0	0	.0	0	.0	1	.5	7	3.5
teeth	30	2	.1	0	.0	0	.0	2	.1	4	.1	27	.9
mandible	2	4	2.0	2	1.0	3	1.5	1	.5	4	2.0	57	28.5
vertebrae	42	10	.2	3	.1	10	.2	8	.2	10	.2	82	2.0
ribs	24	28	1.2	5	.2	13	.5	10	.4	18	.8	93	3.9
scapula	2	9	4.5	5	2.5	4	2.0	1	.5	4	2.0	22	11.0
humerus	6	23	3.8	10	1.7	5	.8	2	.3	14	2.3	87	14.5
radius	6	31	5.2	24	4.0	9	1.5	3	.5	18	3.0	78	13.0
ulna	2	1	.5	0	.0	1	.5	2	1.0	2	1.0	17	8.5
carpals	12	0	.0	0	.0	0	.0	0	.0	0	.0	0	.0
metacarpal	6	4	.7	0	.0	0	.0	0	.0	8	1.3	6	1.0
pelvis	6	8	1.3	8	1.3	3	.5	0	.0	9	1.5	36	6.0
femur	6	16	2.7	6	1.0	8	1.3	2	.3	4	.7	22	3.7
tibia	6	32	5.3	16	2.7	24	4.0	10	1.7	26	4.3	86	14.3
tarsal	10	2	.2	2	.2	4	.4	1	.1	3	.3	21	2.1
metatarsal	6	1	.2	1	.2	1	.2	0	.0	5	.8	2	.3
phalanges	24	1	.0	0	.0	1	.0	1	.0	0	.0	7	.3
TOTAL		172		82		86		43		130		650	

Key: see Table 1

Table 7. Summary of species present 1540-c. 1570
St. Nicholas Priory, Exeter

SPECIES	N	%
cattle	2256	60.2
sheep/goat	1182	31.5
pig	163	4.3
dog	84	2.2
rabbit	24	.6
horse	17	.5
red deer	10	.3
fallow deer	7	.2
roe deer	3	.1
cat	2	**
brown rat	2	**
TOTAL	3750	75.9
domestic fowl	71	71.0
goose	17	17.0
little gull	3	3.0
herring gull	3	3.0
duck	2	2.0
woodcock	1	1.0
lesser black-back gull	1	1.0
starling	1	1.0
rook	1	1.0
TOTAL	100	2.0
cod	6	35.3
ling	5	29.4
conger eel	3	17.6
hake	1	5.9
haddock	1	5.9
bass	1	5.9
TOTAL	17	.3
indet. mammal	995	93.1
indet. bird	16	1.5
indet. fish	58	5.4
TOTAL	1069	21.6
human	3	**
TOTAL	4939	

** = less than 0.1%

ion might be elucidated about the make-up of the dumps (are they specific types of rubbish, *eg* primary butchery, domestic?, *etc*). The only major problem in dealing with this group is the lack of the sieved bones, so small bones, especially those of fish, will be under-represented (bulk samples were taken for sieving, but this had not been completed at the time of the analysis).

Table 7 summarises the animals represented, and the first thing to note is that three species account for about 90% of the identified bones: cattle and sheep/goat. Only five out of 282 sheep/goat bones identified to species level are goat (the rest being sheep), so it is fairly safe to assume that cattle and sheep were the main species. The second point is that there is a range of mammal, bird and fish species represented: twelve species of mammal, at least nine of bird and a minimum of six species of fish. It is worth reiterating the under-representation of small bones (birds and fish), and the number of fish species could probably be more than doubled if the bones from bulk sieving had been included.

One obvious question that arises from this assemblage is: is it possible to calculate how many animals were consumed, and how important are the various species in dietary terms? Finding the answer is extremely difficult. Even supposing that accurate numbers of animals can be calculated (one possible way being the minimum number of individuals (MNI) method), it is much too simplistic to extrapolate from such a result. This is because it is very unlikely that whole animals were consumed in single units. It is much more likely that they were consumed as prepared joints, so the various parts of single individuals might become widely dispersed. For example, some parts of the body may be detached and disposed of as waste at the primary butchery butchery stage (parts of the skull, *etc*). some other bones extracted during primary butchery may be sold off for bone working or be incorporated with hides that are sold for tanning and horn working. A second group of waste bones may result from secondary butchery (*ie* preparing the meat for retail). Finally, joints of meat will be sold, some with bones in the joint, and these will become part of domestic rubbish dumps. The larger the animal, the more complicated the stages of butchery and bone removal, so cattle will be subjected to more butchery than pigs and sheep, and small mammals, birds and fish may be sold as complete carcases.

What can be attempted is to identify specific types of rubbish deposit in terms of different cuts of meat consumed for the major meat producing animals: cattle, sheep and pig. Simple fragment counts cannot suffice because, as explained above, different bones and different species will be biased in different ways. One way of avoiding this is to transform the counts for each skeletal part into an index which standardises for different parts of the skeleton and for different degrees of fragmentation. This makes each index directly comparable with any other from any part of the body and from any species. The method is fully described in Levitan (forthcoming a). The index provides only a crude estimate

Table 8. St. Nicholas Priory: anatomical groups

	All contexts				Context 16				Context 17				Context 17-7				Context 17-8		
	N	AI	<25%	R	N	AI	<25%	%	N	AI	<25%	%	N	AI	<25%	%	N	AI	<25%
Cattle																			
SKL-JAW	430	1.94	98	16	18	.06	88	.9	94	.00	100	.0	55	.32	95	2.5	23	.92	65
HC	9	.50	89	25	0	.00	0	.0	6	.00	100	.0	0	.00	0	.0	1	.00	100
CAR-TAR	92	11.30	13	4	11	1.23	9	18.1	23	3.12	17	28.1	19	2.21	26	17.4	8	.99	0
MC-MT	126	17.54	32	2	15	1.57	13	23.2	19	3.54	16	31.9	25	3.93	28	31.0	7	.48	14
PHAL	62	7.53	2	8	15	1.76	7	26.0	12	1.50	0	13.5	13	1.63	0	12.9	10	1.26	0
RIB	378	.36	92	26	45	.04	91	.6	63	.12	87	1.1	89	.00	100	.0	69	.14	80
VERT	432	2.54	62	13	73	.34	68	5.0	48	.14	87	1.3	99	.56	69	4.4	56	.40	59
SCAP-PEL	190	1.86	89	17	19	.29	5	4.3	22	.09	95	.8	52	.19	94	1.5	28	.46	79
HUM-RAD-ULN	239	7.91	62	7	29	.65	69	9.6	31	1.51	52	13.6	67	1.89	69	14.9	36	1.07	67
FEM-TIB	263	5.89	81	10	43	.84	81	12.4	29	1.08	83	9.7	73	1.94	77	15.3	32	.75	78
						6.78				11.10				12.67				6.47	
Sheep																			
SKL-JAW	135	2.85	86	11	15	.21	87	1.6	13	.00	100	.0	45	.00	100	.0	8	.42	63
HC	8	1.63	50	18	0	.00	0	.0	3	.00	100	.0	3	.13	0	.8	0	.00	0
CAR-TAR	31	6.30	0	9	9	1.87	0	14.3	5	1.03	0	11.9	4	.85	0	5.4	6	1.34	0
MC-MT	48	8.60	13	6	17	2.80	12	21.4	2	.50	0	5.8	7	1.15	14	7.3	6	1.25	17
PHAL	20	2.51	0	14	9	1.13	0	8.6	2	.26	0	3.0	2	.25	0	1.6	0	.00	0
RIB	225	1.17	61	21	39	.18	72	1.4	33	.09	82	1.0	42	.12	83	.8	28	.12	64
VERT	162	2.36	28	12	36	.57	22	4.4	32	.46	34	5.3	17	.41	12	2.6	18	.26	33
SCAP-PEL	155	9.40	45	5	26	1.61	42	12.3	30	1.02	57	11.7	37	2.85	43	18.2	23	.92	57
HUM-RAD-ULN	203	21.86	17	1	25	2.91	8	22.2	27	2.02	37	23.2	57	6.44	16	41.0	17	1.80	24
FEM-TIB	193	15.25	40	3	27	1.81	41	13.8	36	3.31	33	38.1	53	3.50	66	22.3	19	2.25	16
						13.09				8.69				15.70				8.36	
Pig																			
SKL	26	.19	92	27	2	.00	100	.0	0	.00	0	.0	8	.32	75	12.6	3	.00	100
CAR-TAR	6	1.21	17	20	3	.32	0	15.5	2	.04	50	10.3	1	.25	0	9.9	0	.00	0
MC-MT	7	.71	0	24	3	.19	0	9.2	1	.07	0	17.9	2	.10	0	4.0	0	.00	0
PHAL	7	.88	0	23	2	.26	0	12.6	0	.00	0	.0	1	.13	0	5.1	0	.00	0
RIB	18	.02	89	29	7	.01	14	.5	0	.00	0	.0	1	.00	100	.0	1	.00	100
VERT	20	.15	45	28	5	.03	60	1.5	0	.00	0	.0	5	.04	40	1.6	1	.02	0
SCAP-PEL	23	1.50	35	19	3	.32	33	15.5	0	.00	0	.0	5	.65	20	25.7	6	.34	33
HUM-RAD-ULN	25	2.15	20	15	6	.62	17	30.1	4	.22	50	56.4	10	.83	20	32.8	2	.25	0
FEM-TIB-FIB	21	.43	43	22	9	.31	45	15.0	1	.06	0	15.4	4	.21	50	8.3	0	.00	0
						2.06				.39				2.53				.61	

N - number of identified fragments AI - anatomical index <25% - proprotion of identified fragments less than quarter complete R - rank

SKL - skull; JAW - mandible; HC - horncore; CAR - carpals; TAR - tarsals; MC - metacarpal; MT - metatarsal; PHAL - phalanges; VERT - vertebrae;
SCAP - scapula; PEL - pelvis; HUM - humerus; RAD - radius; ULN - ulna; FEM - femur; TIB - tibia; FIB - fibula.

of frequency since the AI (see Table 8) ignores fragments less than 25% complete, and such fragments frequently make up the bulk of the identified assemblage. The <25% column in Table 8 shows the proportion of these fragments out of the totals for each anatomy, and there is clearly a lot of variation, with the more fragmented bones being highlighted by high percentages in this column.

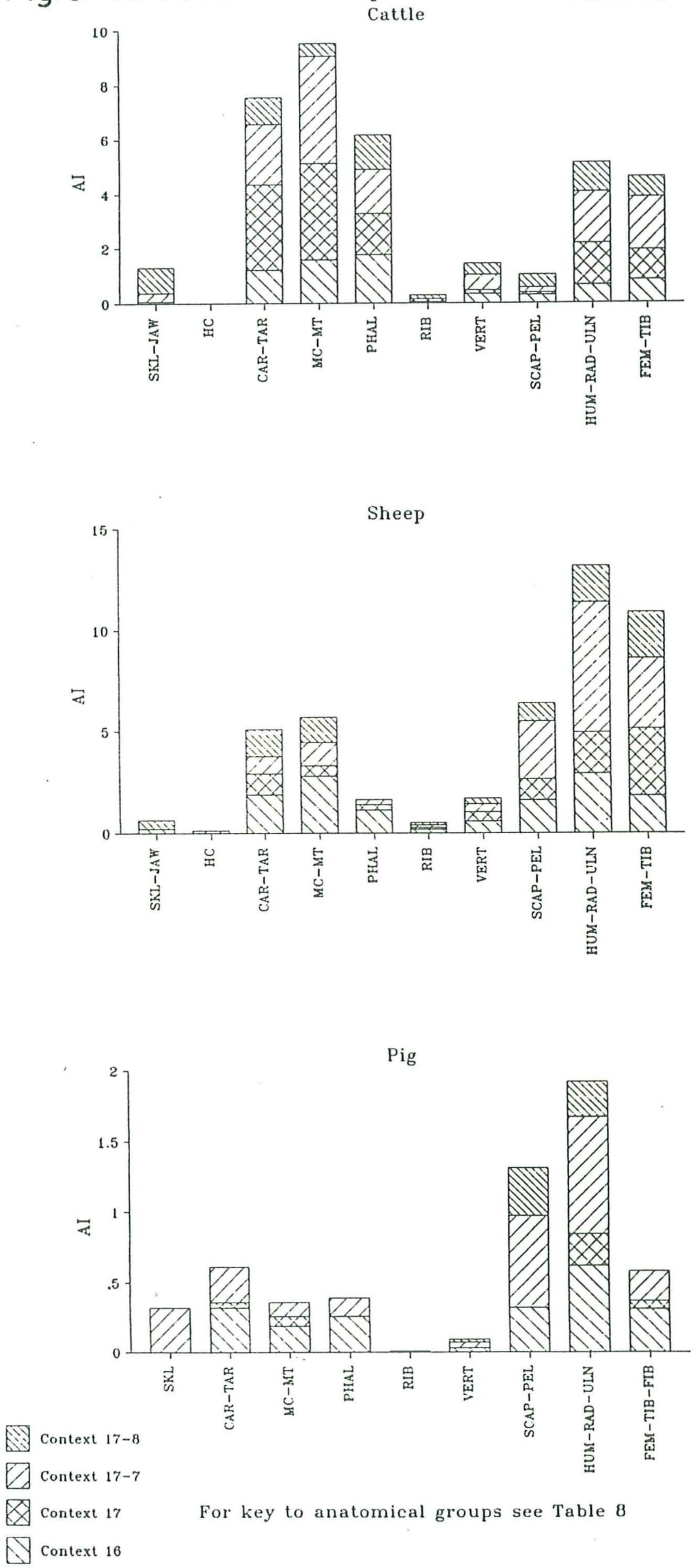
Table 8 also lists the ranks of the 29 anatomy groups. Interestingly the prime meat producing bones from sheep/goat occupy three of the top five ranks. This could imply that the rubbish consists of domestic waste since the relative paucity of the same anatomies for cattle may result from boning out at an earlier stage in the butchery process, and there would be little domestic bone waste from cattle. It is surprising, therefore, to find that the best represented cattle bones are carpals, tarsals and metapodials (from the lower part of the limb). This, however, may be another reflection of greater fragmentation of meat bearing bones of cattle compared with those of sheep due to butchery. The table shows that between 62% and 89% of the cattle bones are in the <25% category, compared with values of 17%-45% for sheep and 20%-43% for pig. This still does not fully account for the fact that cattle metapodials are so well represented (second in rank of all the anatomies, Table 8). A secondary component of the rubbish, therefore, might be waste from secondary butchery of cattle.

The table, which shows the relative frequency of the different anatomical groups, indicates that there is a mixture of deposits by highlighting the high incidence of meat-joint bones of sheep (which are the most frequent) and the butchery-waste component of cattle. One of the advantages, described above, of analysing a deposit such as this, is that one can look at variations within the deposit. Might it be that the two components described above (*ie* domestic waste and secondary butchery waste) can be recognised in different parts of the deposit?

Four main sub-groups within the deposit are summarised in the table, and these are represented graphically in Figures 8 and 9. These sub-groups have been selected on the basis of sample size, the other sub-groups being too small for anatomical analysis.

Figure 8 (top) shows the results for cattle bones, in terms of AI counts, and clearly there are differences for some of the anatomy groups. The main differences are for the carpals/tarsals, metacarpal/metatarsal, humerus/radius/ulna and femur/tibia (*ie* the limb bones). Context 17-7 is characterised by particularly high proportions of upper limb bones, and also by high proportions of the lower limb bones. Context 17 is similar in the latter respect, but has much lower proportions of upper limb bones. Contexts 16 and 17-8 are similar, with lower proportions of limb bones than the other contexts. Context 17-7, therefore, appears to represent the greatest concentration of butchery waste, with upper limb bones being those which were removed from joints before retail, and lower limb bones representing secondary

Fig.8: St. Nicholas Priory: anatomical groups



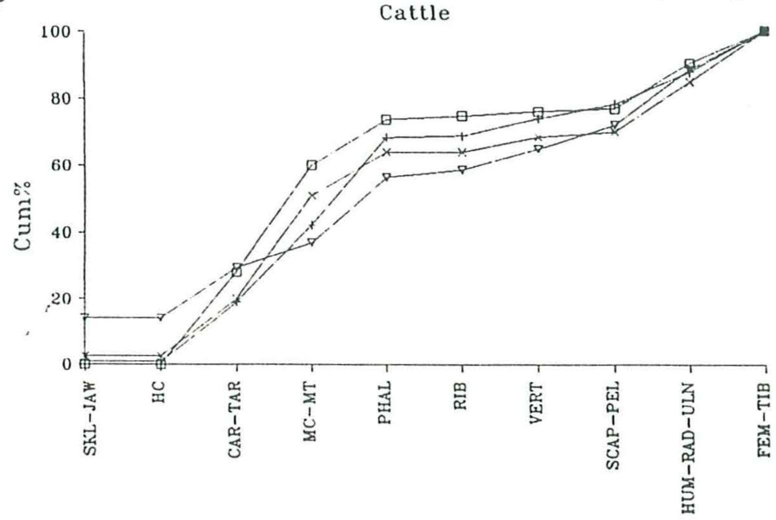
butchery waste. The relatively small proportions (in all the contexts) of skull, horncore, mandible and phalanges implies that primary butchery waste is not present. Ribs and vertebrae, which might have been part of domestic waste to a greater extent than the limb bones, are also poorly represented, so this indication is of retail butchery waste. Context 17 also equates with this pattern, though the emphasis on lower limb bones indicates a greater amount of pre-retail butchery waste. The other contexts, with much lower frequencies of bones, are more likely to be domestic waste.

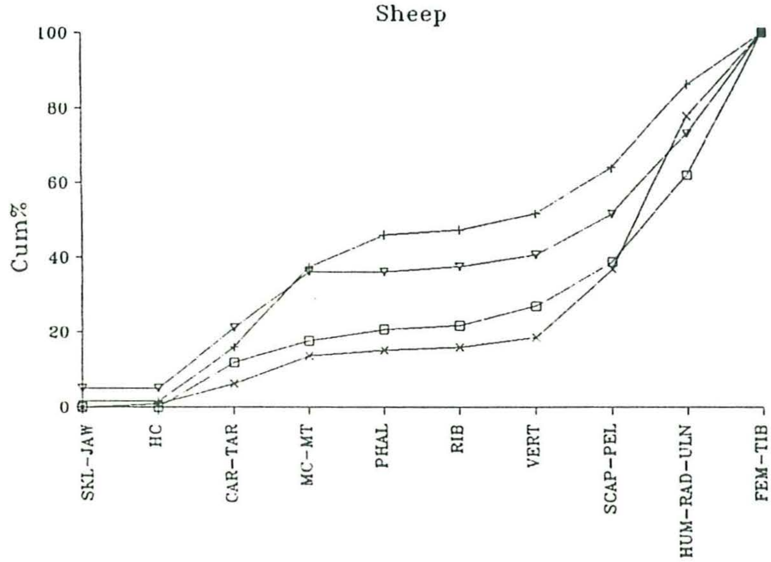
Figure 8 (middle) illustrates the results for sheep. Here there is a very obvious difference from the cattle results, with relatively lower frequencies of lower limb bones, and higher frequencies of upper limb bones. Context 16 bears the closest resemblance to the cattle results, with parallels in the same context. In this respect it is unlike the other contexts for sheep, with higher frequencies of lower limb bones and equal frequencies of upper limb bones. But for the almost complete absence of cranial elements in this context, the pattern resembles one where all parts of the butchery process are represented. Table 8 reveals that 87% of the cranial material is less than a quarter complete, so it might well be that all of the butchery processes are represented (note also the high percentage of ribs less than a quarter complete which may compensate for the low frequencies in the figure). The other three contexts are all alike in terms of lower limbs, but context 17-7 has very high frequencies of upper limb compared with the other contexts (particularly of upper fore-limb). Note, however, that 66% of upper hind limb are less than a quarter complete, the highest for the contexts, so there are also high frequencies of these elements. In this respect, the context 17-7 results may indicate kitchen waste, though a more detailed analysis (not possible here due to the method of recording) would have to be undertaken to check this. For example, one would expect to find lower frequencies of distal radius since this part of the bone may have been removed by the butcher. A complicating factor is the fact that the figure shows apparently few cranial remains (a few horncores only), but Table 8 shows that all such remains (excluding horncores) are less than a quarter complete. Thus possibly the deposit is more of a mixture than the figure implies. The other two contexts are essentially similar, and indicate a similar kind of deposit to context 17-7, though less extreme in the representation of upper limbs.

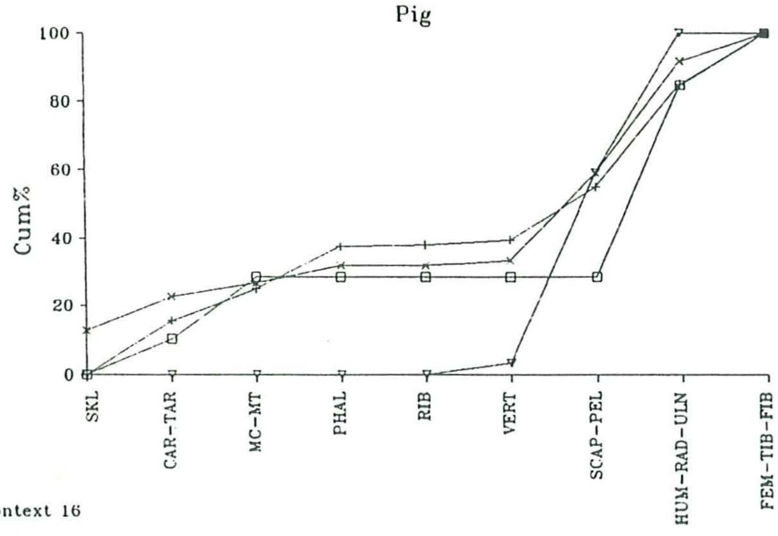
The pig results are illustrated in Figure 8 (bottom) for completeness, though the very small samples (Table 8) render these results rather unreliable. In very general terms, contexts 17 and 17-8 form a similar pair, and 16 and 17-7 a second pair. Upper limbs are better represented than the other body parts.

The AI results, illustrated in Figure 8, are shown as cumulative percentages in Figure 9. This method of illustrating the results shows differences in representation by changes in the slope of the curve. For example, for sheep (Figure 9 middle), it

Fig.9: St. Nicholas Priory: anatomical groups







Context 16
Context 17
Context 17-7
Context 17-8

For key to anatomical groups see Table 8 is evident that the steep lines for girdles and upper limbs are different to the gently sloped lines for axial bones and lower limbs. This implies that the girdles/upper limbs are much better represented, and the results for context 17-7, described above, are exemplified here by the steepest line. All the deposits are poor in phalanges, ribs and vertebrae, and the contrast between context 17-7 and the others is also well illustrated. Similarly, context 17-8 follows a rather different curve for cattle to the other contexts (Figure 9, top).

The attempt to locate different types of rubbish with the deposits has met with limited success. The cattle bones appear to fall into at least two discernable deposits, exemplified by contexts 17 and 17-7 (primary butchery waste?) and contexts 16 and 17-8 (retail waste?). The sheep bones also appear to form two groups, typified by context 16 (mixed material: all levels of watse?) and the other three contexts (retail waste?). It has been possible to show, however, that different types of deposit are present, and this means that discrete dumps of rubbish are discernable.

CONCLUSIONS: SELECTIVITY AND COMPARISON

The three sites discussed above exemplify the selective approach to bone analysis from urban sites. They have been chosen to illustrate that this approach is a useful tool for both bringing out important aspects of the assemblages and for avoiding the spending of time on repetitious information.

Examples of sites like Exe Bridge are useful in pinpointing information about specialist activities. Such activities, like the one represented at Exe Bridge, are sometimes peripheral to the main meat-based economics of bringing food animals to the city. Comparisons between such sites and sites which are more directly involved with the food-production economy will serve to show how the various animal products activities related in time and space. The Exe Bridge example showed that cattle and sheep horns were being utilised at or near the site, and hinted at a relationship between the preferred age at death for horn raw material and the market forces which prevailed: horns from mature individuals were preferred, but the market economy, which dictated for younger individuals, limited this supply.

In the second example, the results indicated how analysis of lateral variation can give clues about processes and activities within a site. To some extent it is a microcosm of the town, and the comparison of the different deposits within St. Katherine's Priory, both spatially and temporally, could be echoed on the larger, city-wide scale. In another example of this kind of approach, O'Connor illustrated that special deposits within a site can be identified. His analysis of the bones from Caerleon (O'Connor, 1983; 1986) highlighted the "snack-bar" economy of the Roman baths. Further examples of specialisation in Roman marketing activities come from Maltby's report on Exeter (1979, 82-94).

The third example was, perhaps, the least successful, but if nothing else, it helped to highlight the fact that simple questions about site function are often the most difficult to answer. Advances in the methodology of bone analysis are bringing us closer to the means of answering such questions (*eg* O'Connor, this volume), but there is still a long way to go (Bailey and Grigson, 1987). Deposits like the one at St. Nicholas Priory provide us with an opportunity to investigate such questions with problems about archaeological and temporal precision removed. In the relatively superficial analysis employed it was possible to point to discrete rubbish dumps within the main ditch deposit analysed.

It is only at the final, and as yet unexplored, stage of analysis that a good idea of the animal based economy of a town may be gained. This is at the level of inter-site comparison, touched upon above. Not only do we need to compare many such sites as those outlined above from a single town, but sites from the hinterland of the town must also be considered (Levitan, in press). Consider the complex inter-relationships that exist between town and country (*eg* O'Connor 1984) and one becomes aware of the futility of pursuing non-question orientated site analysis. Decisions about whether bones from a particular site should be analysed should be based upon how useful the potential information will be. Where there are gaps in our understanding, sites with the relevant assemblages should be sought, and such strategies should be built into the general excavation policy for a town or region. Information about what kind of sites should be sought may come not only from bone analysis, but also from sources such as historical documents (Gerrard, in press). The comparative study by Maltby for Exeter was published nearly a decade ago, yet there are few other reports of its kind. Clearly the lesson is still to be learnt. In an environment where resources are so limited, it seems logical to seek to tailor the strategies so that they fit the problems to be tackled. If this includes abandoning some bone assemblages, and selecting only proportions of others for analysis, such steps must be taken. If it requires that certain sites should be excavated for their bone analysis portential, there should be a willingness to do so. Bone analysis is part of archaeology, and excavators must be encouraged to build bone analysis into their excavation strategies with just as much enthusiasm as they would pottery or other artefacts.

ACKNOWLEDGEMENTS

The bone analyses of three sites discussed above were all funded by the Department of the Environment/HBMC as part of the South West England Faunal Remains Project based at Bristol City Museum and Art Gallery (1981-1986). I am grateful to the excavators, Stuart Brown and John Allan, and to Chris Henderson, Director of the Exeter Archaeological Field Unit, for their help with the selection of the samples and comments on the reports.

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