TUDOR STREET, EXETER: ANIMAL BONE.

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Introduction

A small assemblage of animal bone was recovered from the site during the normal course of hand-excavation; in total 905 fragments (or 5.4kg) of bone were recovered. The assemblage is quantified in Table 1 by broad chronological period. Approximately 35% of fragments are identifiable to species; the post-medieval assemblage is the largest stratified group from the site and is described and discussed in the following sections.

Methods

All skeletal elements were identified to species were possible to produce a basic fragmentation count of the number of identified specimens (or NISP). Mandibles and post-cranial bones were recorded using the zonal method developed by Serjeantson (1996, 195-200) to allow the calculation of the minimum number of elements (or MNE) and minimum number of individuals (or MNI). The calculation of MNI is based on the most numerous zone of a single element taking into account side. Ribs, vertebrae and un-diagnostic fragments of long bone shaft were assigned to size categories. Small splinters of bone were assigned to general taxonomic categories, for example mammal, bird, fish.

Caprine (sheep and goat) bones and teeth were distinguished using the criteria of Boessneck (1969) and Payne (1985). Of the small number of caprine bones that could be identified to species, only sheep were positively identified and it is therefore assumed that most caprine bones also belong to sheep, therefore the term “sheep” will be used throughout this report to refer to all undifferentiated caprine bones.

The ageing data of Silver (1969) was used to assess epiphyseal fusion of the post-cranial skeleton and fusion categories follow O’Connor (1989). Sheep tooth eruption/wear and mandible wear stages were recorded following Payne (1973 and 1987), whilst cattle tooth eruption/wear was recorded following Grant (1982).

In general measurements follow Von den Driesch (1976) with the following exceptions: measurements taken on the humerus and cattle and caprine metapodia follow Davis (1992) and measurements on cattle horn cores follow Sykes and Symmonds (2007). Individual measurements are presented in the appendix to this report. Withers height calculations follow the conversion factors of Kiesewalter for horse and Teichert for sheep (see Von den Driesch and Boessneck 1974).

Pathological conditions were categorised were possible and detailed descriptions made as to form and location after Vann and Thomas (2006). The following non-metric traits were also recorded where possible: reduction/absence hypoconulid; presence/absence of p2; presence of premolar foramina and characteristics of the mental foramina. Butchery data was recorded using the coded system devised by Lauwerier (1988, 181-212) with later additions by Sykes (2007) and Higbee (unpub.a).

Results

Preservation condition

Bone preservation is variable; differences were noted between fragments from single contexts and between fragments from different types of deposits. For example, poorly preserved bones were more common in layers than from cut features and this suggests that bones within layers deteriorated due to surface exposure, whilst bones deposited in cut features were rapidly buried.

Species represented

Only domestic species are represented in the assemblage (Table 1). Sheep is the most common species, followed by cattle, horse and then pig. A small number of un-diagnostic bird and fish bone fragments were also recovered.

Distribution and general character

A large proportion (*c.*72%) of the post-medieval assemblage is from pit 520. The bone group from this feature includes a large number of sheep bones, mostly loose teeth, mandibles, metapodia and phalanges, as well as several cattle horn cores and metapodia (Table 2). The selective nature of this group suggests that it represents waste material from the light tanning industry. Tawyers or leatherdressers process mainly sheep, goat, pig and calf- skins, which they treat with oil or alum to produce light coloured (or white) leather (Yeomans 2007, 99). The process is technically different from the heavy tanning industry, which involves soaking skins in vats containing oak bark (i.e. tannin) to produce dark coloured leather. Historical and archaeological evidence indicates that skins were usually supplied to the tanner or tawyer with the horns and/or the foot bones still attached (Serjeantson 1989, 136), usually after initial processing by a fellmonger who would soak the skins in pits of slaked lime in order to remove the hair or wool. The horn cores would have allowed the purchaser to determine the age of the animal/skin, whilst the metapodia would have been used to hang and stretch the skins during the tanning process (Yeomans 2007, 111). The presence of large numbers of teeth and mandibles in the assemblage from pit 520 is unusual and most collections of tawing waste do not include these elements (see for example Baxter 1998; Albarella *et al* 1997, 36-7; Higbee unpub.d). However, only one sheep horn core was identified from the group and this suggests that most sheep were naturally polled (i.e. hornless); therefore by leaving the mandibles attached to the skins the age of the animal could still be assessed by the purchaser.

One unstratified cattle horn core was recorded with a circular hole at is base. The hole was probably caused by the insertion of a nail that was used to secure the horn sheath to the core. Similar evidence has been noted from other sites (Ervynck *et al* 2002, Noddle 1977) and it has been suggested that this is an indication that skins have been traded over long distances (Albarella 2003).

The remaining post-medieval animal bones were recovered from well 540 and various deposits including garden soils, levelling layers and a metalled surface. The bone group from well 540 includes several horse bones. The bones all from the right ankle and foot of one individual and were probably deposited as one articulated unit. The animal has an estimated withers height of 13.2 hands and would be classified as a pony by modern standards. A large area of irregular new bone was noted on the posterior mid-shaft of the central (II) and medial (IV) metatarsi, fusing the two bones together (Plate 1). Bone remodelling of this type is usually caused by either trauma or infection. Although there are no obvious signs that the carcass of this animal was utilised (i.e. there are no skinning marks on the bones), it is worth mentioning that the carcasses of old and injured horses were occasionally exploited by the light tanning industry (Yeomans 2005, 75).

The animal bone recovered from the various deposits appears to be a mixture of domestic and tawyers waste. The domestic waste includes joints of beef from the chuck and blade, shin, silverside/topside and thick flank, and joints of mutton from the shoulder and leg. The small quantity of sheep metapodia from layers indicates that any surface accumulations of waste from the light tanning industry were dispersed across the site.

Age at slaughter

The epiphyseal fusion data for cattle and sheep post-cranial bones is presented in Table 3. No firm conclusions can be drawn from this data due to the small size of the samples and the obvious bias in skeletal elements. However, it is worth mentioning that the cattle metapodia from pit 520 are from a calf, and that the majority of sheep metapodia are from adult animals.

Recent advances in the analysis of cattle horn cores suggests that longitudinal grooving on the ventral surface of cores appear after about three years of age and gradually become deeper and more defined (Sykes and Symmonds 2007, 517, 519). Using this criterion as a rough indication of age, it was possible to determine that 67% of the horn cores from pit 520 are from cattle less than three years old, a further 20% are from 3-5 year old animals and the remainder are from animals over 5 years.

Only three cattle teeth were recovered they include two third molars, one from a 30-36 month old animal and the other from a young adult, and one deciduous fourth premolar from a 1-8 month old calf. A relatively large number of sheep teeth and mandibles were recovered and the eruption and wear data for individual teeth and mandibular wear stages for teeth retained within mandibles is presented in Tables 4 and 5. This data suggests that the majority (41%) of sheep were slaughtered between the ages of 3-5 years and a further 29% at between 6-10 years (Table 6). The mortality pattern suggests that the sheep were culled from a wool flock. This trend towards the culling of older sheep has been consistently recorded for many post-medieval assemblages (Albarella *et al* 1997, 33; Dobney *et al* 1996, 40; Gidney 1992; Luff 1993, 72; Maltby 1979, 45) and indicates that wool production continued to be an important economic trade well into the 18^{th} century (Bond and O'Connor 1999, 388).

Sex, size and conformation

Cattle horn cores are sexually dimorphic; males generally have larger horn cores than females. Scatter plots (Figure 1) of metric data taken on the basal part of the adult cattle horn cores from pit 520 suggests that both sexes are represented in the assemblage. Two loose clusters are apparent in the plots; the data points above the solid line are probably males whilst those below the line are probably females. The plot of minimum (BB) and maximum (BA) diameters suggests that there are more male horn cores than female horn cores. Whilst the plot of maximum diameter (BA) and basal circumference (BC) suggests that there are slightly more female horn cores. This discrepancy between the two plots is unsurprising since there is bound to be some size overlap between small male horn cores and large female horn cores. Taking the limited age information into account, it would seem that the majority of cattle were culled at the optimum age for prime beef, usually around 36 months, and these animals are more likely to be males.

Outer curve measurements taken on two of the horn cores from pit 520 indicate that small horned cattle are represented. This type of cattle were common in Exeter during the medieval period (Maltby 1979, 38), however improvements in husbandry during the post-medieval period saw the introduction of medium and long horned cattle. The latter were recorded by Levitan (1985) in a group of early 18th century horn-workers waste from Shooting Marsh Stile in Exeter. Large horns would have been more valuable to the horn-worker than small horns and were probably selectively procured.

The basal circumference measurements (or BC) taken on the Tudor Street horn cores were compared to assemblages of post-medieval horn-workers waste from Shooting Marsh Stile and Magdalene Street in Taunton (Higbee unpub.b). The Tudor Street horn cores are all towards the lower end of the size range recorded for the other two sites (Figure 2). Some of this size variation might be due to sexual dimorphism, however the main differences probably reflect the fact that the other sites include horn cores from different types of cattle. Long horned cattle were identified from Shooting Marsh Stile, whilst the group from Magdalene Street includes medium horned cattle. As indicated above, larger horns were preferred by horn-workers and these were probably procured from the local tanner or tawyer (Yeomans 2005, 81).

Summary descriptive statistics for all of the basal horn core measurements from Tudor Street are presented in Table 7 together with similar data from three contemporary sites in the region. The sites compared include Magdalene Street (*ibid*) and Benham's Garage (Levitan 1984) in Taunton, and Victoria Works in Dursley, Gloucestershire (Higbee unpub.c). The Tudor Street mean values for basal diameter measurements BA and BB are small in comparison to the other sites and all of the measurements (i.e. BA, BB and BC), including those for the other sites, show a high degree of variance (or CV). Sample variance indicates that the measurements were taken from heterogeneous populations. In other words the populations include both sexes and/or different types cattle.

Summary descriptive statistics for the greatest length (GL) and distal breadth (BatF and BFd) of sheep metapodia from pit 520 are presented in Table 8 together with similar data from three contemporary sites in the region. The sites compared include Shepherds Wharf in Plymouth (Higbee unpub. d), Launceston Castle in Cornwall (Albarella and Davis 1996) and other post-medieval sites in Exeter (Maltby 1979). The mean values are small in comparison to the other sites and this suggests that the Tudor Street sheep were generally shorter with more slender limbs. The mean withers (or shoulder) height of the Tudor Street sheep is only 53.8cm with a range of 47.5cm-59.0cm, this small in comparison to the sheep from Shepherds Wharf, which have a mean withers height of 62.3cm. The metapodia distal breadth measurements were also compared using the log ratio technique (Figure 3). The majority of measurements are smaller than the standard (i.e. the zero value) indicating that on the whole the Tudor Street sheep have metapodia with a different conformation to those from other sites. One possible reason for this difference is that the Tudor Street assemblage might includes a greater number of bones from ewes, whilst the other sites might include more rams and wethers (castrated rams). Castration delays the fusion of long bone epiphyses and allows them to continue growing (Yeomans 2007, 109); therefore wethers are generally taller and more robust than ewes and rams.

Conclusions

The assemblage is small and dominated by a distinct group of waste from the light tanning industry. Analysis has shown that both sheep and cattle skins were processed at the site. Many of the sheepskins were from old adult animals that had primarily been managed for wool and the metrical data suggests that most were ewes. Most of the cattle horn cores are from animals under three years of age and these were animals slaughtered at the optimum age from prime beef.

The tawing waste was compared to similar deposits of industrial waste from other sites in the region. This suggests that other industries that also rely on carcass by-products, such as horn-working, were able to selectively procure raw materials, including waste products from the tanning industry. These types of industries generally cluster together in urban areas in order to take full advantage of the trade networks that supplied them (Yeomans 2005, 81).

Tawyers were often known as ‘whyttawers’ or ‘whittawers’, a name that refers to the fine white leather they produced which was commonly marketed as gloving leather. Sheepskins were mainly processed for this purpose and would have been readily available due to the economic importance of sheep husbandry for wool production at the time. Indeed many tawyers also traded the wool they collected from the initial stage of preparing the skins or had direct connections to the woollen industry. For example, the woollen mill owner, William Shepherd, whose family was responsible for greatly extended the woollen industry in Plymouth, employed *c*.70 men to make sheepskins into glove leather and shipped the finished product up to London together with the cloth he produced (Higbee unpub.d).

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Table 1. Number of specimens identified to species (or NISP) by broad chronological period. indet. = indeterminate.

Species		**late medieval**	**post-medieval**	**post-medieval/modern**	**unstratified**	**Total**
Bos f. domestic	cattle		37		6	43
Caprovid	sheep/goat	1	209	1	17	228
Ovis f. domestic	sheep	2	31		5	38
Sus f. domestic	pig		4			4
Equus f. domestic	horse		6			6
Total identified		**3**	**287**	**1**	**28**	**319**
large mammal			241		11	252
medium mammal			101		5	106
mammal			215		1	216
bird indet.			3			3
fish indet.			9			9
Total unidentified		**0**	**569**	**0**	**17**	**586**
Grand total		**3**	**977**	**1**	**45**	**905**

Table 2. Type and number of skeletal elements by NISP, minimum number of elements (or MNE) and minimum number of individuals (or MNI) of livestock species and horse in the post-medieval assemblage from Tudor Street, Exeter. p = proximal half, d = distal half and c = complete element.

	Pit 520			**other features & deposits**				
Element	**cattle**	**sheep**	**pig**	**cattle**	**sheep**	**pig**	**horse**	**Total**
zygomatic (skull)		8			1			9
horn core	13	1			1			15
loose upper tooth		33			2		1	36
loose lower tooth	1	34		2	2			39
mandible		21		1	2			24
scapula				1	1			2
humerus p					1			1
humerus d		3	1		3			7
radius p						1		1
radius d		1		1		1		3
ulna p	1				1			2
pelvis		2		1	3			6
femur p				1				1
femur d				1	1			2
tibia d		1	1		1			3
metacarpal p	2	15			6			23
metacarpal d		18		1				19
metacarpal c		3			3			6
metatarsal p	2	21			3			26
metatarsal d	2	13		1	1			17
metatarsal c		2					3	5
metapodia		1						1
tarsal							1	1
astragalus							1	1
calcaneus	1				1			2
phalanx 1		25		3				28
phalanx 2	1	4						5
phalanx 3		1		1				2
Total NISP	**23**	**207**	**2**	**14**	**33**	**2**	**6**	**287**
MNE	**22**	**179**	**2**	**13**	**31**	**1**	**6**	**254**
MNI	**7**	**11**	**1**	**1**	**3**	**1**	**1**	**25**

Table 3. Number and percentage of fused epiphyses for cattle and sheep in the post-medieval assemblage from Tudor Street, Exeter. Fusion categories after O'Connor (1989). Fused and fusing epiphyses are amalgamated. Only unfused diaphyses, not epiphyses are counted. % = percentage of fused/ing epiphyses out of the total number of fused/ing epiphyses and unfused diaphyses.

Species	**Fusion category**	**fused**	**unfused**	**% fused**
cattle	early	5		100
	intermediate	2	2	50
	late	1	1	50
	final	1	1	50
sheep	early	7		100
	intermediate I	40	4	91
	intermediate II	19	1	95
	late	3	1	75
	final			

Table 4. Wear stages of individual sheep teeth (following Payne 1973 and 1987) in the post-medieval assemblage from Tudor Street, Exeter. Both teeth in mandibles and isolated teeth are included. Unworn isolated teeth that could have been in one of the eruption stages (C, V, E, H) are coded as "0". * = unassigned.

tooth	**C**	**V**	**E**	**H**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	*****
dp4																					1		1						
P4	1									1	1	1		3			1		1										
M1														4		1	1			1									1
M1/2													1	7															3
M2									2	1	1	2	2	5															6
M3	3						1	1		1	3		2	1		5													4

Table 5. Mandibular tooth wear data for sheep in the post-medieval assemblage from Tudor Street, Exeter. N = number.

Age Category	Suggested Age	N	%	Cumulative %
A	0-2 months			100
B	2-6 months			100
C	6-12 months			100
D	1-2 years	4	31	69
E	2-3 years	2	15	54
F	3-4 years	3	23	31
G	4-6 years	4	31	0
H	6-8 years			
I	8-10 years			
Total		**13**	**100**	

Table 6. Kill-off pattern for post-medieval sheep from Tudor Street, Exeter based upon single teeth (dp4/p4 and m3) and teeth (dp4/p4 and m3) in mandibles (following Payne 1973 and 1988).

Age range	**Tooth**	**Wear stage**	**% killed within age range**	**cumulative % killed**	**Age**
0-2 years	2 dp4		18	18	c. 2 years
>2 years	9 p4		82		
2-3 years	2 m3	2-4	12	30	c. 3 years
3-5 years	7 m3	5-10	41	71	c. 5 years
6-10 years	5 m3	11G	29	100	c. 10 years
>10 years	m3	>11G			

Table 7. Summary descriptive statistics for post-medieval cattle horn cores from Tudor Street, Exeter compared to similar data from contemporary sites. N = number, SD = standard deviation and CV coefficient of variance.

Site	Measurement	N	Min	Max	Mean	SD	CV
Tudor Street, Exeter	BA	15	31.7	47.9	37.8	4.9	12.9
Magdalene Street, Taunton	BA	63	38	71	51.1	8.3	16.2
Victoria Works, Dursley	BA	36	27.9	52	41.4	4.5	10.8
Tudor Street, Exeter	BB	15	35.5	52.7	44.4	4.8	10.8
Magdalene Street, Taunton	BB	63	43.5	86.5	60.2	9	14.9
Victoria Works, Dursley	BB	36	38.4	61.1	51.6	5.4	10.4
Tudor Street, Exeter	BC	15	111	165	138.5	16.5	11.9
Benham's Garage, Taunton	BC	17	90	155	115.7	16.1	13.9
Magdalene Street, Taunton	BC	63	127	258	182.2	26.7	14.6

Table 8. Summary descriptive statistics for post-medieval sheep metapodia from Tudor Street, Exeter compared to similar data from contemporary sites. N = number, SD = standard deviation and CV coefficient of variance.

Site	**Element**	**Measurement**	**N**	**Min**	**Max**	**Mean**	**SD**	**CV**
Tudor St, Exeter	metacarpal	BatF	18	20.9	27.2	23.7	2	8.4
Exeter	metacarpal	BatF	21	20.6	28.5	25.1	2	7.9
Tudor St, Exeter	metacarpal	BFd	18	22.1	26.5	23.9	1.3	5.4
Shepherds Wharf, Plymouth	metacarpal	BFd	93	22.8	31.7	26.4	1.9	7.1
Launceston Castle, Cornwall	metacarpal	BFd	30	22	30.7	26.1	2.3	8.8
Tudor St, Exeter	metacarpal	GL	5	109.8	120.8	114.2	4.3	3.7
Shepherds Wharf, Plymouth	metacarpal	GL	75	106.1	153.2	127.5	9.6	7.5
Exeter	metacarpal	GL	19	102	128	118.7	7.5	6.3
Launceston Castle, Cornwall	metacarpal	GL	20	110	150.3	127	9.1	7.1
Tudor St, Exeter	metatarsal	BatF	11	21	23.3	21.7	0.6	2.7
Exeter	metatarsal	BatF	7	22	24.7	23.1	0.93	4
Tudor St, Exeter	metatarsal	BFd	11	21.2	24	22.2	0.8	3.6
Shepherds Wharf, Plymouth	metatarsal	BFd	57	14.8	29.2	24.9	2.3	9.2
Launceston Castle, Cornwall	metatarsal	BFd	30	21.6	28	24.3	1.8	7.4

Figure 1. Size variation of post-medieval cattle horn cores from Tudor Street, Exeter based on a) their minimum (BB) and maximum (BA) basal diameter measurements and b) their basal circumference (BC) and maximum (BA) basal diameter measurements. The solid line shows the possible division between male and female horn cores.

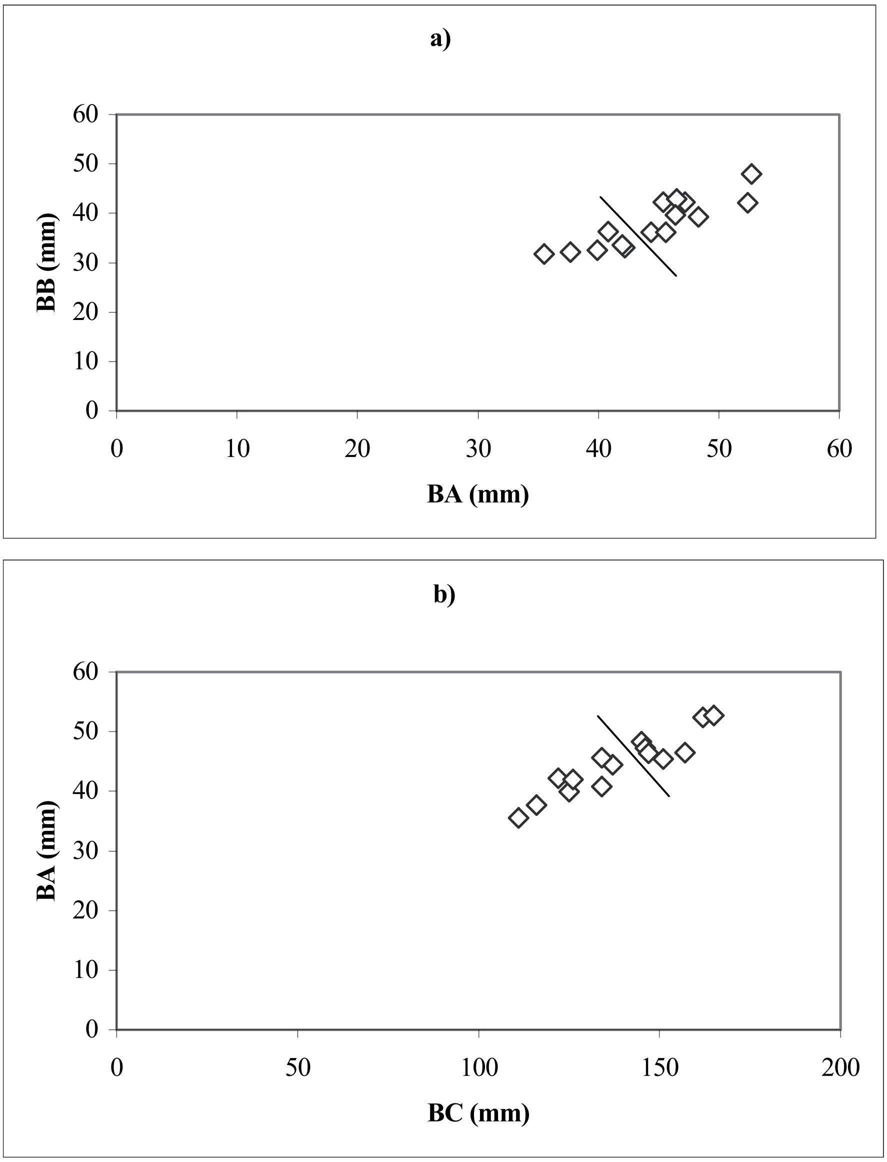

Figure 2. Size variation of post-medieval cattle horn cores from Tudor Street, Exeter based on their basal circumference (BC) measurements compared to a early 18th century sample from Shooting Marsh Stile, Exeter (Levitan 1985) and a 17th century sample from Magdalene Street, Taunton (Higbee unpub.b).

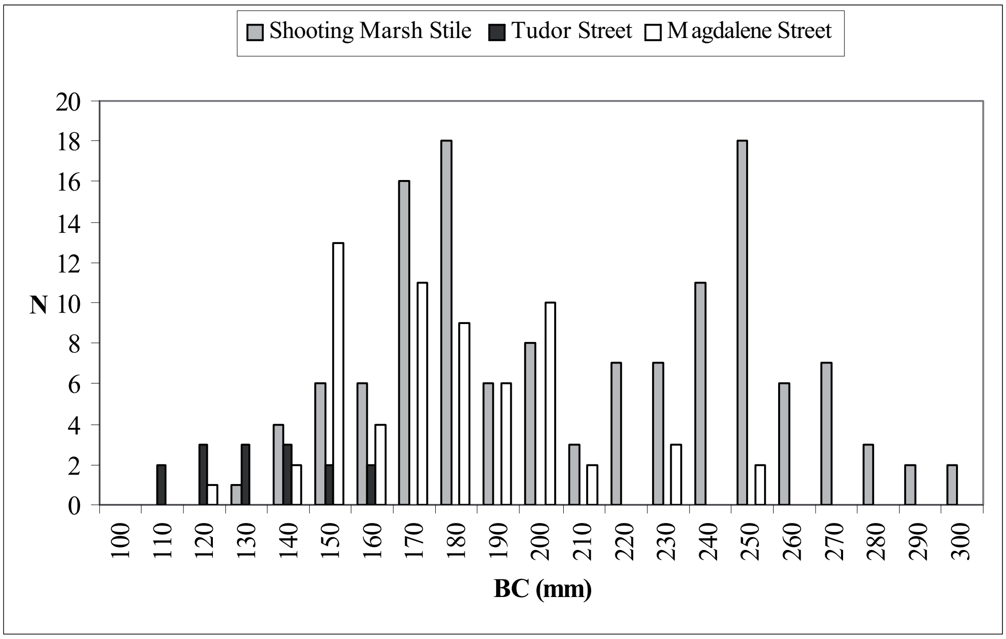

Figure 3. Breadth log ratio values for sheep metapodia from Tudor Street, Exeter calculated using standard values for sheep metapodia from other post-medieval sites a) Exeter (Maltby 1979), b) Shepherds Wharf, Plymouth (Higbee unpub.d) and c) Launceston Castle, Cornwall (Albarella and Davis 1996). Only measurements BatF and BFd (Von den Driesch 1976; Davis 1992) were included in the analysis.

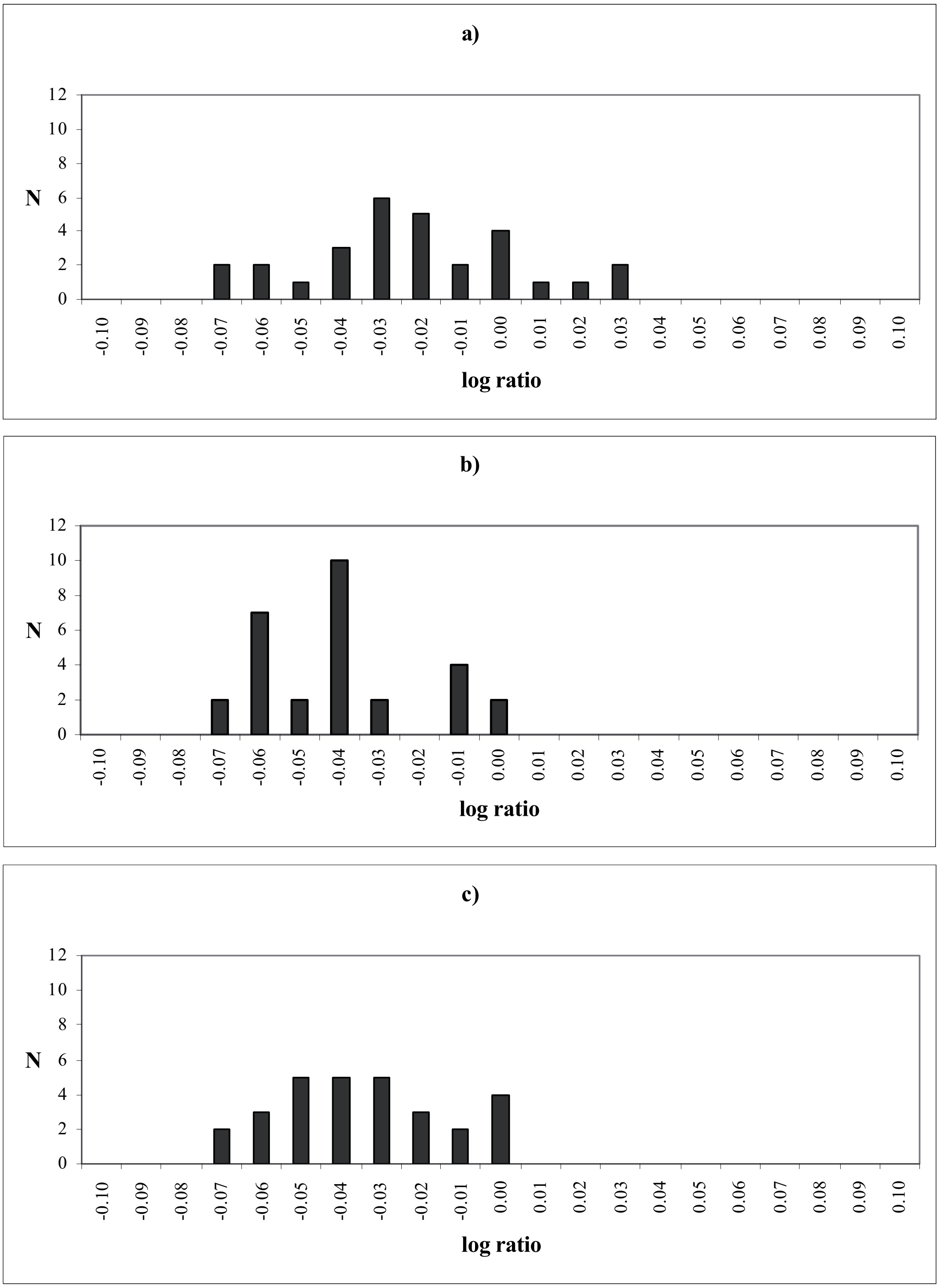

Plate 1. Pathology on horse metatarsal from pit 520.