The Animal Remains from Excavations at Burdale 2006 and 2007

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Introduction

Animal bones from the BUR06 and BUR07 excavations have been examined and hereafter are treated as a single assemblage, albeit divided by phase. The faunal assemblage dates predominantly from the Anglo-Saxon (*c*. 700-early 900 AD) period, although a minority of Iron Age/Romano-British material is also assessed. The bone assemblage associated with Anglo-Saxon occupation is compared to material of similar date from West Heslerton (Richardson 2001), Wharram Percy (Pinter-Bellows 2000), Caythorpe (Stallibrass 1996), Cottam (Dobney *et al*. 1999) and Cowlam (Richardson 2009) in particular. All are sites that occupied the Wolds or Wold edge. Bones associated with later (medieval-modern) activity are quantified here but are not considered further, while bones from topsoil deposits were scanned for atypical treatment and/or identifications but were not entered into the Access database of recorded bone zones.

Methodology

Excluding topsoil deposits, 43,660 bone fragments were recovered, 20,285 from the 2006 excavations (of which 3,577 were recovered from sieved deposits) and 23,375 from the 2007 excavations (of which 2,994 were recovered from sieved deposits). Of these, 20% and 24% respectively were identified to taxa or a lower-order group and entered into an Access database. The low proportion of identified bones is a reflection of the fragmented nature of the assemblage and the inclusion of numerous small undiagnostic fragments from sieved soil samples.

Bones were identified to taxa wherever possible, although lower-order categories were also used (e.g. sheep/goat, cattle-sized). The separation of sheep and goat bones was routinely attempted, using the criteria of Boessneck (1969) and Payne (1969, 1985), but as goat bones were limited to two horncores, sheep/goat bones are assumed to be of sheep. It is also difficult to separate the bones of the closely related domestic fowl (*Gallus gallus*) and pheasant (*Phasianus colchicus*) and they tended to be separated (subjectively) on size. This suggested that domestic fowl was exclusive and, reassuringly, this was confirmed by the absence of any air-sac foramen on proximal femurs. The few fish bones recovered are the subject of a separate report (p.00).

Recording was limited to diagnostic element zones, which by definition are easily identifiable and non-reproducible. This eliminated the possibility of recording an anatomical zone more than once. Only zones exceeding 50% were normally recorded, although exceptional cases (butchered, pathological and foetal/neonatal fragments) were included (as less than 50% complete). Definitions of the zones used, as well as details of the Access database that was created to facilitate analysis, are held with the site archive.

For age-at-death data, epiphyseal fusion (after Silver 1969) and the eruption and wear of deciduous and permanent check teeth were considered. Dental eruption and wear for cattle, sheep and pig were recorded using the letter codes of Grant (1982) and age stages were calculated using Halstead (1985) for cattle, Payne (1973) for sheep and a similar wear progression was assumed for pig. The eruption and wear of horse incisors were also noted (after Silver 1969), although as the incisors were so often loose, broad age categories were used. The sexing of the cattle and sheep populations was achieved with reference to the sexually dimorphic distinctions of the pelvis (after Prummel and Frisch 1986, 575), while the sexually dimorphic tusks of pigs were noted.

Bone condition, erosion and fragment size were recorded in order to assess bone preservation, while gnawing, burning and butchery marks were noted to determine bone treatment. Butchery was routinely differentiated into chop and cut (knife) marks and the position and direction of these marks were recorded using Binford-type codes (Binford 1981).

Finally pathological bones were described and biometrical data were recorded following the standards given by von den Driesch (1976) and Kieswalter (1888 cited in von den Driesch and Boessneck 1974). Only summaries of these data are produced here, but the complete data sets are stored with the archive.

Taphonomic bias

Relevant taphonomic processes, such as bone recovery, condition and gnawing, will influence the usefulness of a bone assemblage for reconstructing animal husbandry practices. Bone preservation and treatment, therefore, have been considered by phase and by enclosure (Table 1). Regardless of phase, bone condition is excellent with no evidence of cracking, porosity or flaking. In addition, very few eroded bone surfaces are present. In contrast, fragmentation (see size index) is consistently high and such levels will have impacted on bone survival. Fragmentation rates are lowest from Enclosure 5 and this is reflected in the relatively low proportion of loose teeth.

Butchered bones are relatively rare, but chop marks in order to split long bones along their length (commonly cattle and sheep metapodials) were noted from Anglo-Saxon deposits. Most probably for the extraction of marrow, such butchery will have led to a reduction in the number of recordable bone zones. Gnaw marks are also quite rare and suggest that bones were not commonly accessible to dogs or rodents. Again Enclosure 5 is atypical, displaying much lower levels of gnawing than the other enclosures (Table 1). The combination of relatively few gnawed bones and an absence of weathered/eroded bones indicates that bones were buried rapidly. This hypothesis is supported by the presence of articulated body parts: the hind limb of a dog from inside Enclosure 4 (1016), a partial pig skeleton from fill 1014 of ditch 1038, and three cattle skulls, three articulated cattle vertebrae, a cattle hind limb and two horse fore limbs from the secondary fill (1217) of an early pit (1299). Burning, another process that may have influenced bone survival, is scarce from all phases and enclosures, although a higher proportion of burnt bone was recorded from Enclosure 6.

In summary, bone survival is likely to have been affected most severely by the high levels of fragmentation, and to a lesser extent by butchery practices, although potentially the most destruction method of longitudinal splitting tended to be limited to particular taxa (cattle and sheep) and bones (metapodials). In contrast, bone condition and preservation are excellent, and in conjunction with the presence of articulated body parts, are likely to indicate rapid burial. The effects of burning and gnawing are likely to have had limited impact on bone survival.

Finally, it is worth noting that the biases inherent in hand excavation (the larger the bone fragment, the more likely it is to be retrieved), will have been offset to some degree by the routine collection and processing of bulk soil samples.

Animal husbandry

Animal husbandry practices have been investigated using the proportions of animals present, age, sex, metrical and pathological data in order to assess breeding programmes, movement/trade of livestock and the exploitation of secondary products such as milk and fleeces. The range of animals consumed (species, age and body part) has also been used to assess dietary preferences.

Animal proportions

The proportion of sheep and cattle implies that these two animals would have outstripped the other taxa in terms of their economic importance (Table 2). In comparing the relative proportions of these animals from Iron Age/Roman and Anglo-Saxon deposits, it is clear that sheep (with sheep/goat) predominated, with an apparent increase in the proportion of this animal over time (Table 3). This increase appeared to have been at the expense of cattle, although there was also a notable decline in horse bones from Anglo-Saxon contexts. Pig bones fluctuated very little, while chicken and geese were farmed along side the domestic mammals, albeit in small numbers.

As expected, domestic animals predominated, while wild mammals and birds were scarce (Table 3). Badger, fox and hare are represented by only a few stray bones and the bones of mice, shrews and voles were rarely encountered. Frog and toad bones were present in greater numbers, but a high proportion of these represent individuals that fell into features and were unable to escape. The number of herring gull-sized bones is interesting as this type of bird was not identified from the much larger assemblage from Anglo-Saxon Wharram Percy and only in small numbers from Anglo-Saxon West Heslerton. From the extensive excavations at Flixborough, only 8km south the Humber estuary, gull (Laridae) bones were an infrequent find (Dobney *et al*. 2007a, table 4.1) This coastal bird is common inland, particularly during the winter months, although the presence of its bones in deposits dominated by food preparation and consumption waste is harder to explain. Post-medieval folklore, however, does indicate various uses of gull parts to treat epilepsy, disorders of the sight and weak stomachs (Buczacki 2002, 286).

Comparing the relative proportions of the main domestic animals to other Wolds sites reveals some minor fluctuations (Fig. 1), but none so great as to discount the dominance of sheep farming on the Wolds during the Anglo-Saxon period. A mixed farming economy, with sheep dominating livestock numbers, had served the Wolds' inhabitants since Roman times (Richardson 2004, 262). Explaining the greater proportion of cattle from Caythorpe, Wharram Percy and West Heslerton compared to higher proportions of sheep from Burdale, Cowlam and Cottam 93, however, is difficult. It is tempting to associate cattle with their high-water requirements with spring-fed Wharram Percy and sites on the Wolds edge such as West Heslerton and Caythorpe, but Burdale was also served by a spring and both Cottam and Cowlam, by wells. Perhaps the difference, therefore, was more to do with water accessibility (compare the easy access of livestock to springs, ponds and rivers to drawing water from wells) rather than availability.

Age and sex data for cattle, sheep, pigs and horses

Animal husbandry regimes, the targeting of secondary products such as milk and wool and the production of meat, have been analysed by using age and sex data. Slaughter patterns based on fusion data (Tables 4-7) and dental eruption and wear data (Tables 8-11) have been assessed for cattle, sheep, pigs and horses. These age data have been considered by phase and compared with other Wold assemblages where appropriate.

Fusion data for cattle by phase indicate that a higher proportion of sub-adult animals were slaughtered during the Anglo-Saxon period when compared to the Iron Age/Roman period (Table 4). Regardless of period, however, around 50% of the population survived beyond their third year. Many of these older animals will have been kept as breeding stock, but also for their milk or traction capabilities. The presence of a breeding population is supported by the identification of a few neonatal bones (0.6% of the Iron Age/Roman cattle assemblage and 0.9% from Anglo-Saxon deposits). Although dental data were relatively scarce (Table 8), they do support the notion of sub-adult (but little juvenile) slaughter for meat and the maintenance of some animals to maturity for breeding and presumably for secondary products. Comparing the dental data with that from West Heslerton indicates a similar kill-off pattern, although slaughter at Burdale was marginally, but consistently, later (Fig. 2). Unfortunately the dental data from nearby Saxon Wharram Percy (Pinter-Bellows 2000, table 30) was not presented in a format that allowed for ready comparison, although at Wharram Percy the maintenance of a higher proportion of mature animals is evident.

The fusion data for sheep by phase contrasted with cattle in that a higher proportion of sub-adult animals were slaughtered during the Iron Age/Roman period when compared to the Anglo-Saxon period (Table 5). Perhaps this indicates a dietary preference for prime lamb in the Iron Age/Roman period compared to preference for prime beef in the Anglo-Saxon period. By the time the sheep had reached (osteological) maturity only around 30% of the Iron Age/Roman population survived compared to around 50% of the Anglo-Saxon population. Nevertheless, older animals representing a breeding flock are indicated from both phases, and confirmed by the presence of 0.4% of the Iron Age/Roman sheep assemblage and 1.1% of the Anglo-Saxon assemblage coming from neonatal animals. Sex ratios of 1 male to 3 females and 22 males to 42 females from Iron Age/Roman and Anglo-Saxon deposits respectively do not discount breeding populations.

Dental data confirm a sub-adult slaughter with a high proportion of sheep killed between six and twelve months from both phases (Table 9). This highlights a ready availability of lamb, and is likely to include animals surplus to breeding requirements that were slaughtered before their first winter. The slaughter is too late, however, to be an indicator of intensive milk production, but did occur before the animal could contribute any fleeces. Presumably these sheep were fattened over the summer to provide some return in terms of meat but were not of sufficient value to consider over-wintering. A proportion of animals continued to be slaughtered for their meat from subsequent age brackets, when little return in terms of fleeces would have been realised. Older animals (four years plus) would have been selected for their breeding potential, fleeces and perhaps milk production. Comparing the kill-off curves for sheep with data from West Heslerton and Wharram Percy indicates that patterns of slaughter from Anglo-Saxon Burdale and West Heslerton were quite similar (Fig. 3). At Wharram Percy, however, sheep tended to be maintained to a greater age before slaughter. At Stage E (*c*. 2-3 years) for example, over 80% of the sheep population from Wharram Percy was still alive compared to *c*. 60% from Anglo-Saxon Burdale and *c*. 50% from West Heslerton. Either prime meat was targeted more readily at Burdale and West Heslerton or mature animals, presumably for their wool, were sought after at Wharram Percy.

Pigs are ideally suited to turning food waste and arable by-products into meat, and as such it would have made economic sense to kill them when they have gained the optimum amount of weight in relation to the quantity of food they had consumed. This is likely to have occurred early in the animal's second or third winter, making it an important seasonal resource as lean months approached (Dobney *et al*. 2007a, 132) Although some variation between fusion data by phase was indicated (Table 6), most animals were killed between 12 and 30 months: 78% from Iron Age/Roman deposits and 74% from Anglo-Saxon deposits. Mature breeding animals are indicated by the dental data from both phases (Table 10) and supported by the presence of neonatal bones from Anglo-Saxon contexts (2.8% of this porcine population). The relatively high proportion of males, however, does not represent the ideal breeding population (1 male to 1 female and 10 males to 4 females from Iron Age/Roman and Anglo-Saxon deposits respectively), and with the absence of neonatal pig bones from Iron Age/Roman deposits, local pig-rearing at this earlier settlement remains unconfirmed.

No teeth indicative of donkeys or mules were noted and as such, the equid bones are 'horse', from pony-sized animals (see below). As horses would have been rarely, if ever, eaten (prohibitions against their consumption existed in both the Roman and Anglo-Saxon eras - Toynbee 1973, 185; Rau 1968 cited in Grant 1988, 174), it is unsurprising that adult animals predominated (Table 7). Young, unbroken animals, however, were also present and suggest that horses were reared here. In the absence of neonatal bones, though, this could not be confirmed. Old horses used for traction and/or riding are also indicated (Table 11), supported by the identification of age and/or work-related traumas (see below).

Metrical data

Metrical data are relatively scarce due to the high levels of fragmentation. As a result, only some sheep, cattle and horse bones have provided sufficient data for inter-site comparisons. The metrical data have been used to assess sexual polymorphism in cattle and sheep, to compare height and breadth variation in these animals and to assess the presence of horses or ponies.

Using metacarpal measurements to plot size variation for cattle indicates a dominance of shorter, slighter animals, most likely cows (Fig. 4). Presumably those bones that are longer but still relatively slight represent steers, while shorter, stockier examples are from bulls. Quite where the lines of division fall is not known, however, but the wide distribution of the metacarpals from Burdale would suggest the presence of cows, bulls and steers. Comparing size variation (based on the range and mean of cattle metatarsals) between a number of different sites indicates that while the Burdale cattle typically fall within the size range of cattle metatarsals from similarly dated sites, they are of below average height (Fig. 5). Using the breadth of the distal tibia as an indicator of robusticity, however, suggests that the Burdale cattle were of comparable size to the livestock at other Saxon settlements (Fig. 6).

Plotting the same size data for sheep metacarpals indicates that ewes, rams and wethers (castrated males that provided larger fleeces) are present in the Burdale assemblage (Fig. 7), although based on Davis' data, a relatively high proportion of the flock appears to have been entire males. These data contrast with the sex ratio calculated from pelves of 22 males to 42 females, although only a slight shift would be required in Davis' division for a number of the 'entire males' to be reclassified as female. What is clear, is the scarcity of wethers that otherwise might have indicated flocks run for their fleeces. Instead fleeces are likely to have been a valuable by-product of a sustainable, breeding population, rather than the product of a specialised wethers flock. Comparing size variation (based on the range and mean of sheep metatarsals) by site indicates that the Burdale sheep were on average shorter (Fig. 8), although all fell within the range of the much larger assemblage from Early Saxon West

Heslerton. Using the breadth of the distal tibia as a measure of robusticity, however, shows little variation by site (Fig. 9).

Finally, it is worth noting that the 'horses' of Anglo-Saxon Burdale were in fact ponies. The distribution of withers' heights, based on the lateral length of a metacarpal and metatarsal after Kieswalter (1888 cited in von den Driesch and Boessneck 1974, 334), indicate that the three measureable animals from Burdale stood at 12 hands 2 inches, 13.2 hands and just over 13.2 hands. Compared to the much larger data sets from West Heslerton, these ponies were of below average height (Fig. 10). From West Heslerton, in contrast, ten Early Saxon and two Middle Saxon animals were classified as horses (using 14 hands 2 inches/1474mm as the minimum height for a horse).

Pathological data

The incidence of pathological bones has been used as an indicator of the general health/condition of the livestock. Congenital abnormalities of the teeth, perhaps as an indicator of inbreeding, have also been noted (see Andrews and Noddle 1975).

Congenital abnormalities involving cattle dentition include six third molars displaying the absence or reduction of the third cusp of the third molar (17.6% of Anglo-Saxon mandibles; no Iron Age/Roman examples) and five cases of mandibles displaying absent second premolars (20% of Iron Age/Roman mandibles and 9.7% of Anglo-Saxon mandibles). This compares to 10.9% of mandibles with absent second premolars from Anglian Hamwic (Bourdillon and Coy 1980, 91), 6.8% from Anglo-Scandinavian Coppergate (O'Connor 1989, 164), 3.6% and 4.1% respectively from Roman and Early Saxon West Heslerton (Richardson 2001) and 2.8% from Anglo-Saxon Flixborough (Dobney *et al*. 2007a, 181-2). Absence or reduction of the third cusp of the third molar from West Heslerton stands at 5.5% of Roman mandibles compared to 2.2% of Early Saxon mandibles. The incidence of these non-metric traits within Burdale's cattle population, therefore, may indicate greater inbreeding when compared to West Heslerton (cf. Brothwell 1995, 207). This is in marked contrast to data from sheep mandibles where only 1.7% of the population from Anglo-Saxon contexts (five examples) were missing their second premolars. A similar pattern at West Heslerton led to the hypothesis that there was less inbreeding in the local sheep population when compared to cattle (Richardson 2001).

Conversely the incidence of dental pathology was much higher in sheep than in cattle. This was almost exclusively the result of periodontal disease (pitting of the bone surface, recession of the jaw and root thickening), often accompanied by calculus deposits. From Iron Age/Roman Burdale, 11.5% of sheep suffered from periodontal disease compared to 17.4% from the Anglo-Saxon settlement, while only a single Iron Age/Roman cattle jaw showed signs of this disease. This may reflect the different grazing habits of sheep and cattle, as with adequate grazing, cattle will remove the tips of grass blades, while sheep crop much closer to the ground. As such, sheep may take in a higher proportion of abrasive soil particles.

Incidences of joint disease in cattle and horses may reflect work-related stresses, although age may also have been a factor. Two cases of spavin, a proliferation of new bone on the carpals/tarsals and proximal metapodials associated with traction and hard work (Baker and Brothwell 1980, 117-118), were noted on horse bones: a fused metacarpal and carpal from an Iron Age/Roman deposit and two fused tarsals from an Anglo-Saxon deposit. Possible bony changes related to traction in cattle were three first phalanges with osteophytes to articular surfaces from Iron Age/Roman contexts (16.7%) and similar changes to four first phalanges

(3.6%) and two second phalanges (2.4%) associated with Anglo-Saxon activity. Anglo-Saxon deposits also included two cattle tarsals and a patella with osteophytes. Excluding the patella, the damage to joints appears to be confined to the lower limbs of both cattle and horses and it is tempting to link this to concussion damage due to the foot striking the ground. Hip damage seen in cattle from West Heslerton, however, was not seen at Burdale.

Joint disease in sheep was most commonly recorded in the elbow, with an estimated 12% of the Iron Age/Roman population and 7% of the Anglo-Saxon population affected by exostoses on the lateral aspect of the proximal radius, ulna or distal humerus. These changes probably indicate an ossification of the ligaments following the subluxation of the joint (O'Connor 1984, 24) and is commonly referred to as 'penning elbow' (Baker and Brothwell 1980, 127). The suggestion is that damage to this relatively exposed joint is more likely to occur when animals are closely corralled. Lower proportions of sheep were affected from Roman and Anglo-Saxon West Heslerton, while a peak in the frequency of penning elbow at Flixborough during the 9th century (at 10%) has been linked to a shift in sheep husbandry associated with fine textile working (Dobney *et al*. 2007a, 185-7).

Another group of abnormal bones are seventeen deformed sheep horncores (50% of the Iron Age/Roman and 27.3% of the Anglo-Saxon population), all of which display 'thumbprint' depressions. Albarella (1995, 704) suggests that these marks indicate the resorption of calcium rather than localised disease or trauma. This may be related to malnutrition, repeated pregnancies and lactations and/or intensive milking, although the age data here gave no clear indication of intensive milking. The incidence of deformed sheep horncores from Anglo-Saxon Burdale is much higher than the 4.3% and 5.8% from Early Saxon and Middle Saxon West Heslerton.

Pathological pig bones were limited to the larger Anglo-Saxon assemblage where trauma (fractures) were noted to a calcaneus and scapula, plus a soft tisuue injury to a tibia shaft. Given the absence of similar traumas to cattle or sheep, such damage to pigs may reflect their closer association with humans. Perhaps pigs were raised within the settlement where they were used to turn household waste into useable meat, rather than out in the fields and woods where (mis)handling by people was infrequent.

Carcass processing

Butchery marks made by knives, saws and/or cleavers were noted on a range of animals and with the exception of goat (cut marks to horncores) and possibly horse, many represent meat preparation and consumption (Table 12). These indicate that a meat diet rich in beef, lamb/mutton and pork was supplemented by meat from domestic fowl and goose. In addition to primary butchery (e.g. the removal of low-value parts such as the heads and feet) and secondary butchery (the division of the carcass into joints), cut/chop marks to the mandibles of Iron Age/Roman and Anglo-Saxon cattle, sheep and pigs may represent the removal of cheek meat (Rixson 1989, 56), while cuts to the hyoids of Anglo-Saxon cattle and sheep indicate the removal of the tongue. The marks indicative of meat removal, however, were noted most frequently on the ribs.

In addition to meat, animal carcasses may also have been processed for their skins/feathers, marrow, horns and bones. Certainly, the use of cattle skins by Anglo-Saxon settlers is likely as three metatarsals displayed cut marks indicative of skinning, while cut marks to a horse first phalanx from an Iron Age/Roman deposit probably indicates the same. The working of horncores is likely, although some of the butchery may be related to the removal of hides rather than the horn sheaths. Both goat horncores were cut (Table 12), but in addition, 25% of cattle and 45% of sheep horncores from Iron Age/Roman deposits and 42% of cattle and 32% sheep horncores from Anglo-Saxon deposits were marked by cut or saw marks to the base of the core.

A number of sheep metapodials, both metacarpals and metatarsals, from Iron Age/Roman and Anglo-Saxon deposits had a hole cut through the proximal articular surface. Nine metacarpals and five metatarsals (including one each from Iron Age/Roman deposits) were thus affected. One metacarpal also had a hole drilled through the posterior side of the distal shaft and a sheep tibia had a hole drilled/cut through the distal articular surface. From each, marrow would have been extracted, perhaps poured or sucked from the bone after gentle heating. This method of marrow extraction commonly recorded in the Shetlands, Faroe Islands and Iceland and seen as a later medieval, North Atlantic development (Edvardsson *et al*. 2004, 26), clearly has much earlier origins. An alternative method of extracting marrow, the longitudinal splitting of long bones (here cattle and sheep metapodials and a cattle humerus), was certainly undertaken, although this technique ran the risk of introducing splinters of bone to the valuable marrow. It is possible that the marrow of the metapodials was targeted. Certainly marrow was a highly valued source of calories (Outram 2001, 401), but a particular use for treating skins, waterproofing, as an adhesive or lubricant, as fuel for lighting or in cosmetics or medicines is also possible (Outram and Mulville 2005, 2).

Finally the relative proportions of body parts have also been considered to assess the pattern of element distribution. Clearly the presence of all parts of the skeleton (cranial fragments, long bones and limb extremities) would indicate home butchery of livestock. As expected for a rural site of Iron Age/Roman and early medieval date, all body parts are represented for the three main 'meat' animals, cattle, sheep and pigs.

Minor species

The minor species include birds and animals that were 'farmed' such as goat, goose and chicken. Some would have added variety to the diet, as indicated by the slaughter of sub-adult chickens from both phases, although the dominance of adult birds (88% from Iron Age/Roman deposits and 86% from Anglo-Saxon deposits) suggest that eggs were targeted. No sub-adult geese were noted, but eggs, feathers and meat would have been utilised. Goat was only represented by two horncores. The other domestic animals, cats and dogs, may have been pets, working animals or poorly tolerated pests. No pathological bones indicative of poor treatment were noted, however, and in the absence of any butchery marks, there is no evidence that their pelts were utilised. Both juvenile and adult dogs and cats were noted from Anglo-Saxon contexts. The remaining bones represent game in the form of hare; animals that benefited from the presence of people and/or their buildings such as house mouse; and those representative of the wider environment such as badger, fox, wood mouse, shrew and crow/rook (Table 2). The presence of frogs, water vole and moorhen are indicators of watery places, while the number of herring gull-sized bones has already been seen as noteworthy (above).

Use of Enclosures

Anglo-Saxon activity at Burdale is defined to a large extent by the creation and use of a number of enclosures. Assessing the bone assemblages associated with these enclosures in use may indicate different functions, although any perceived differences may also be temporal in nature as not all enclosures were contemporary. With this in mind, however, the following are compared:

- Enclosure 1 (Group 2)
- Enclosure 2 (Groups 3-5)
- Enclosure 3 (Group 6)
- Enclosure 4 (Groups 11 and 13)
- Enclosure 5 (Groups 28-31)
- Enclosure 6 (Groups 32-40)
- Enclosure 7 (Groups 41-43)

Bones from features such as the rubbish pits (Group 7) and an area of possible industrial activity (Group 8) are not considered as they contain too few bones to be statistically viable.

Comparing the proportion of domestic animal bones recovered from the seven enclosures indicates some variation but in each, sheep bones predominated with cattle bones second (Table 13). Plotting the proportion of the cattle, sheep and pigs indicated that the greatest difference was between Enclosure 1 where the proportion of cattle was greatest and Enclosure 5 where the proportion of sheep was greatest (Fig. 11). These data, however, do not suggest that any one enclosure was used predominantly for the slaughter of any one animal. This appears to be confirmed by an assessment of the butchery data (Table 14) and primary butchery waste (Table 15) by enclosure. Although variation between areas is indicated, no one enclosure was used exclusively for the disposal of butchered bone, or primary butchery waste.

To test if any one enclosure was used to pen animals during parturition, the proportion of neonatal bones has also been considered (Table 16). Certainly cattle and sheep neonates are more commonly recorded from Enclosure 4, while breeding sows may have been corralled in Enclosures 5, 6 and 7. Given the relatively small numbers involved, however, these observations are tentative, as a single animal could account for all the neonatal bones recovered from a single enclosure. Plotting cattle neonatal bones from West Heslerton did identify a number of enclosures that were probably used for monitoring cows as they calved (Richardson 2001, figure 11).

Discussion

The inhabitants at Iron Age/Roman and Anglo-Saxon Burdale were livestock farmers, raising sheep, cattle and probably pigs (although no Iron Age/Roman neonatal pigs were identified). Meat from young sheep and cattle that were selected for slaughter, most likely following a summer's grazing, was available. Proportionally more lamb was eaten during the Iron Age/Roman period compared to higher veal/beef consumption during the Anglo-Saxon era. This may reflect changes in dietary preferences or the maintenance of a greater proportion of sheep into adulthood during the Anglo-Saxon period to maximise fleece production (with a concomitant rise in veal consumption). As wethers were not predominant, however, wool production is unlikely to have been intensive. Pigs were valued for turning domestic waste into meat, but living so close to their owners and/or being tightly penned, led to occasional trauma. This meat diet was supplemented by chicken and goose and also by their eggs. Geese were not seen in the numbers recorded for West Heslerton where higher levels of goose from all periods was linked to the ready availability of low-lying, wetlands in the Vale of Pickering (Richardson 2001). Much higher proportions of geese, and also pigs, at Flixborough have been linked to the high status of this settlement (Dobney *et al*. 2007a, 118; 2007b, 90). At Burdale, wild resources, including fish, were not targeted from either period.

In addition to livestock for meat, the presence of young, unbroken horses at both Iron Age/Roman and Anglo-Saxon Burdale (and again at Wharram Percy and West Heslerton) suggest that this animal may have been raised locally, although in the absence of neonatal bones from Burdale and Wharram Percy (a handful was recovered from West Heslerton), this cannot be stated categorically. Selected animals may then have been broken to the saddle, cart or plough, with the remainder sent to market or to the local demesne. Necessary traction power, however, probably came from a combination of both oxen and horses. Horses were more versatile (they were better able to pull a cart and could be ridden) and more maneuverable, but it was not until the invention of a harness with a rigid collar around the 12th century that the true pulling power of the horse was realised (Langdon 1986, 9-10). In contrast, oxen were stronger and as such were better suited to hilly ground and heavier soils. They were also cheaper to keep and ultimately could be consumed. Nevertheless, pathological data (joint disease/trauma identified on the bones of both animals) endorse the hypothesis that both oxen and horses were worked at Burdale, and the presence of oxen, typically castrated males, was supported by the metrical data (Fig. 4).

The higher proportion of cattle from West Heslerton and Caythorpe when compared to the other Wolds' sites (Fig. 1) may reflect topographical differences. Both sites occupy the Wolds' edge where rich, lowland pasture and reliable water sources were readily available. On the higher and drier land of the Wolds, sheep-rearing was ideally suited, although reliable water sources (e.g. springs at both Wharram Percy and Burdale) ensured that cattle husbandry remained practicable. The high proportion of cattle bones from Wharram Percy, which was comparable to Caythorpe, however, may have been influenced by recovery biases. As sieving was rarely undertaken at Wharram Percy, this will have served to increase the proportion of bones from the larger animals (e.g. cattle) at the expense of smaller animals such as sheep.

Despite the perceived differences in the proportions of the domestic livestock from the six Wolds' sites compared here (Fig. 1), all the assemblages, including Iron Age/Roman precursors, are likely to reflect rural settlements that produced livestock for food, fleeces, milk, traction, eggs, hides, marrow, horns and manure for local use. Significantly, the production of a surplus is also likely, whether for export to a market or for payment as tax/tribute to a 'lord'. Identifying this surplus is most commonly based on the assumption that market-age livestock (animals in their prime) will have been exported on the hoof to a larger consumer site (Crabtree 1994, 45; O'Connor 1991, 277), perhaps even a 'royal' estate (Loveluck 1996). Previous comparisons of age (dental) data have indicated that cattle slaughtered between a year and a half and three years, and sheep between one to three years, were more frequently recovered from urban Fishergate (O'Connor 1991, table 67) when compared to rural Wharram Percy (Pinter-Bellows 2000, tables 30 and 32) and West Heslerton (Richardson 2001, figure 35). The data from the Anglo-Saxon sheep of Burdale are similar to these other rural sites with an apparent dip in slaughter between stages D-E (Table 9), but the dip in the slaughter of cattle appears to be later (Stage E) and perhaps of shorter duration (Table 8). The alternative explanation that the dip in slaughter presents the preservation of the most productive livestock following earlier selection procedures may also be valid. Further, it is worth noting that surplus livestock from Burdale, and indeed Wharram Percy, is unlikely to have fed urban York directly when much closer markets existed at Malton and Driffield. Nevertheless the potential for the Anglo-Saxon settlement at Burdale to produce a livestock surplus remains likely, despite the dearth of comparative faunal data from likely recipients.

Another potential surplus that was targeted, although not to the exclusion of a viable breeding population, was wool. Based on the metrical data, in conjunction with data from known males, females and castrates (Davis 2000, figure 8), wethers were identified from all the sites considered (Fig. 7). Early Saxon West Heslerton appeared to have the highest proportion of wethers at 29% of the population compared to 18% from Anglo-Saxon Burdale and only 8% at Middle Saxon Wharram Percy. Such values suggest that maintaining viable breeding populations was clearly the priority, although the mere presence of castrated animals indicates that a proportion of each flock may have been run for its wool. In contrast, milk production is likely to have been for domestic consumption only. In the absence of any significant neonatal slaughter from Burdale or neighbouring sites, neither cows nor ewes were reared for the purpose of intensive milk production.

One interesting pathology that was quite prevalent in the Burdale assemblage was the presence of 'thumbprint' depressions on sheep horncores. The incidence among the Anglo-Saxon population (27.3%) was around five times that at West Heslerton (4.3-5.8%). Some of the possible causes, such as repeated pregnancies and lactations and/or intensive milking, appear unlikely given the lack of evidence for intensive milk production and the relatively young age of the sheep flock. Dental data indicate that of 404 mandibles, only three came from animals of eight years plus (Table 9). On balance, a resorption of calcium due to malnutrition is the most likely cause of the horncore depressions in the Burdale sheep. This may have resulted from poor-quality grazing (unlikely given the reputation of the Wolds' pasture), inadequate grazing/ over-stocking or harsh winters. An apparent association between the thumbprint depressions and periodontal disease (Albarella 1995, 700) is also possible at Burdale where the incidence of periodontal disease was high, although the significance of this remains unclear.

Finally the identification of different activity zones at Burdale as indicated by the presence of discrete enclosures provided an opportunity to compare the faunal data by enclosure. This revealed a relative paucity of fragmentation in Enclosure 5, higher levels of burning within Enclosure 6, but no spatially distinct activities such as corralling for parturition or carcass processing. Craft activities associated with animal skins and hornworking were not isolated to a single enclosure either. Discrete atypical deposits of articulated animal bones were noted, from pit 1108 within Enclosure 4 (hind limb of a dog), from ditch 1038 (partial pig skeleton) and in particular from pit 1299 (three cattle skulls, articulated cattle vertebrae, a cattle hind limb and two horse fore limbs). While these unusual deposits indicate no spatial patterning, their presence may hint at 'structured' deposition in contrast to the presumably haphazard discard of waste products. In animal bone studies, structured deposits are often used in reference to complete skeletons, articulated parts or skulls, perhaps in conjunction with the perceived importance of context, such as wells, rivers, perimeter ditches and central pits (cf. Wait 1985, 81; Poulton and Scott 1993, 122; Hill 1995, 51). The difficulty is in determining the point at which a deposit might be viewed as ritually significant as opposed to haphazard and unstructured. Pit 1299, for example, may simply contain the disposal of butchery waste, but the discard of cattle vertebrae and a hind limb may represent the loss of a valuable asset (meat) and hence have been a symbolic gesture. Meanwhile, horses are often imbued with particular ritual significance and at West Heslerton articulated horse parts were concentrated in one particular area (Richardson 2001), while the inclusion of a horse burial in the Anglian cemetery was clearly a ritual act (Haughton and Powlesland 1999, 331).

Conclusions
Production and consumption strategies at Iron Age/Roman and Anglo-Saxon Burdale focused on sheep-rearing for meat (including meat from prime, sub-adult animals) and wool, and apparently to a lesser extent milk. Cattle herds were also maintained as a spring allowed their heavy water demands to be met, and in terms of meat weight they would have been more valuable than sheep. Oxen would have been trained for the plough (particularly useful on the slopes when compared to horses), cows were milked (if only for domestic consumption) and beef was available from surplus, sub-adult stock and from older animals that had been maintained for breeding purposes. Non-metric traits might indicate that livestock movement was more widespread in sheep than cattle where the incidence of these traits was much higher. In addition to these multi-purpose animals, pigs offered a reliable source of meat and fat over the lean months of the new year and would have been utilised for manure and skins. Geese and chickens were also kept, presumably on a household basis for eggs, feathers and meat, while ponies (presumably raised locally) were useful as pack animals and for traction.

The proportions of the domestic animals and the age data (ranging from neonatal to aged animals) indicates that Burdale was a rural site that met the majority, if not all, of its protein diet from its own livestock (consider the lack of game and few fish remains). The low levels of pigs and geese when compared to a larger, high-status estate such as Flixborough appear to confirm Burdale's producer status. Production of a surplus for sale, exchange, tax or tribute, however, is also likely. A dearth of market-age cattle and sheep might indicate that these animals were exported on the hoof, while fleeces were no doubt a valuable, and easily transportable, commodity. Horses may also have been raised for sale at market or to feed the demand of the local demesne. In comparison with other regional assemblages, Burdale conforms to the pattern of rural Anglo-Saxon, and earlier, settlements on the Wolds. From the Iron Age to Anglo-Saxon period and beyond, sheep were highly valued as the animal ideally suited to the local conditions, while cattle, horses, pigs and poultry offered flexibility in terms of an increased product range.

Fig. 1 Relative proportions of the three main 'meat' animals from Anglo-Saxon sites

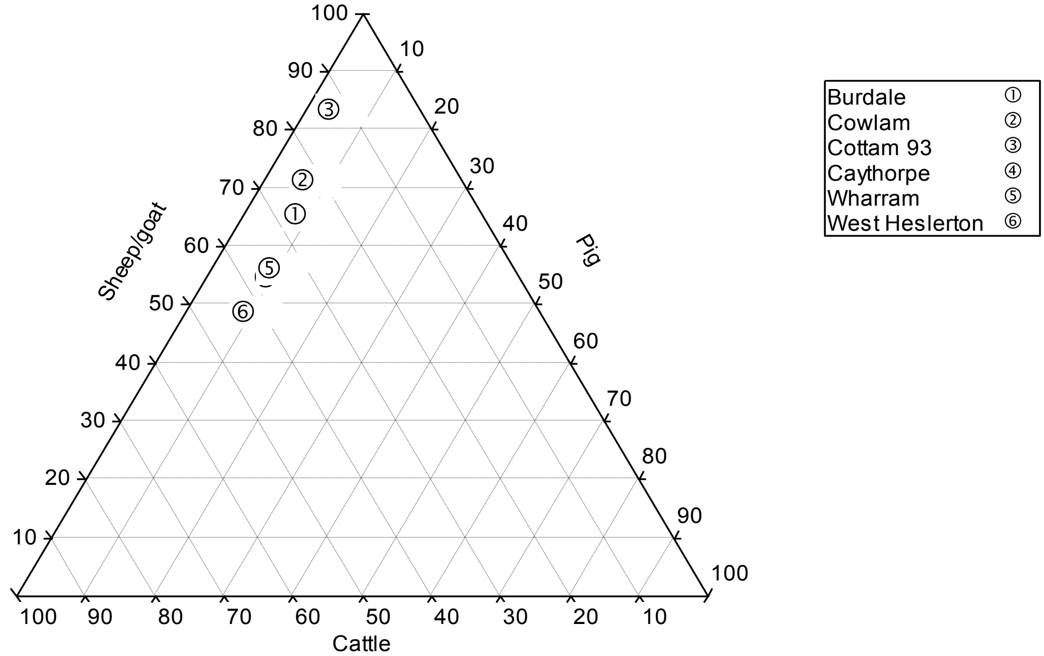

Fig. 2 Cumulative kill-off curves for cattle by phase

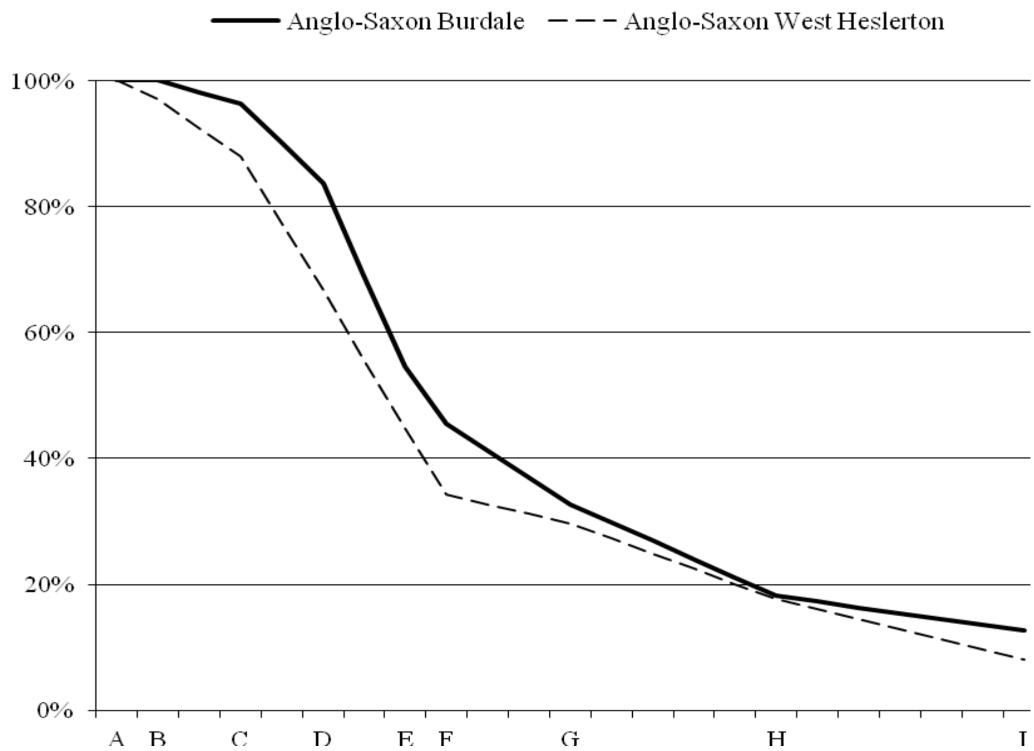

Fig. 3. Cumulative kill-off curves for sheep by phase

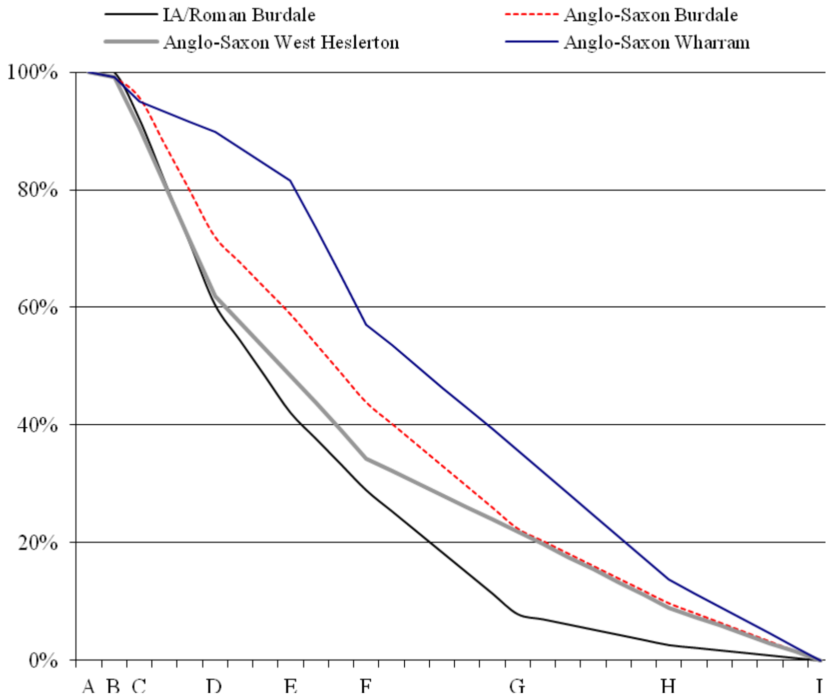

Fig. 4. Scattergram of adult cattle metacarpals showing size variation by site

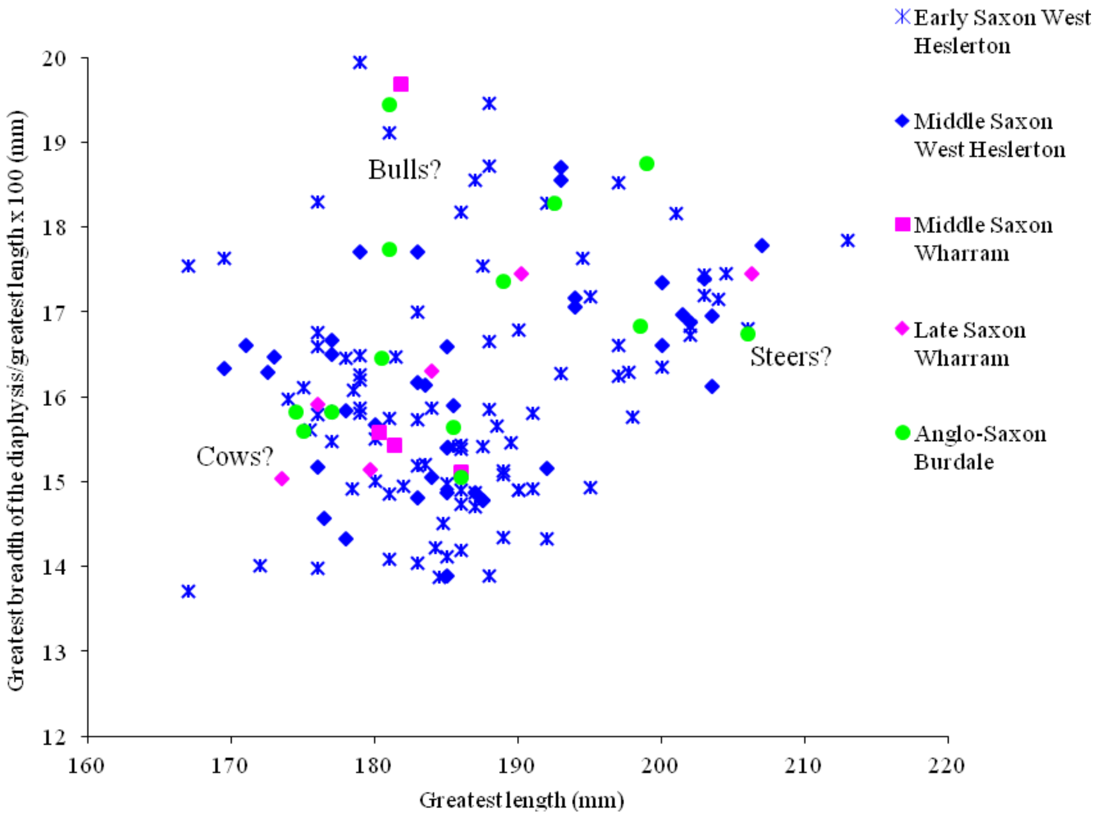

Fig. 5. Height variation (range and mean) in cattle metatarsals by site

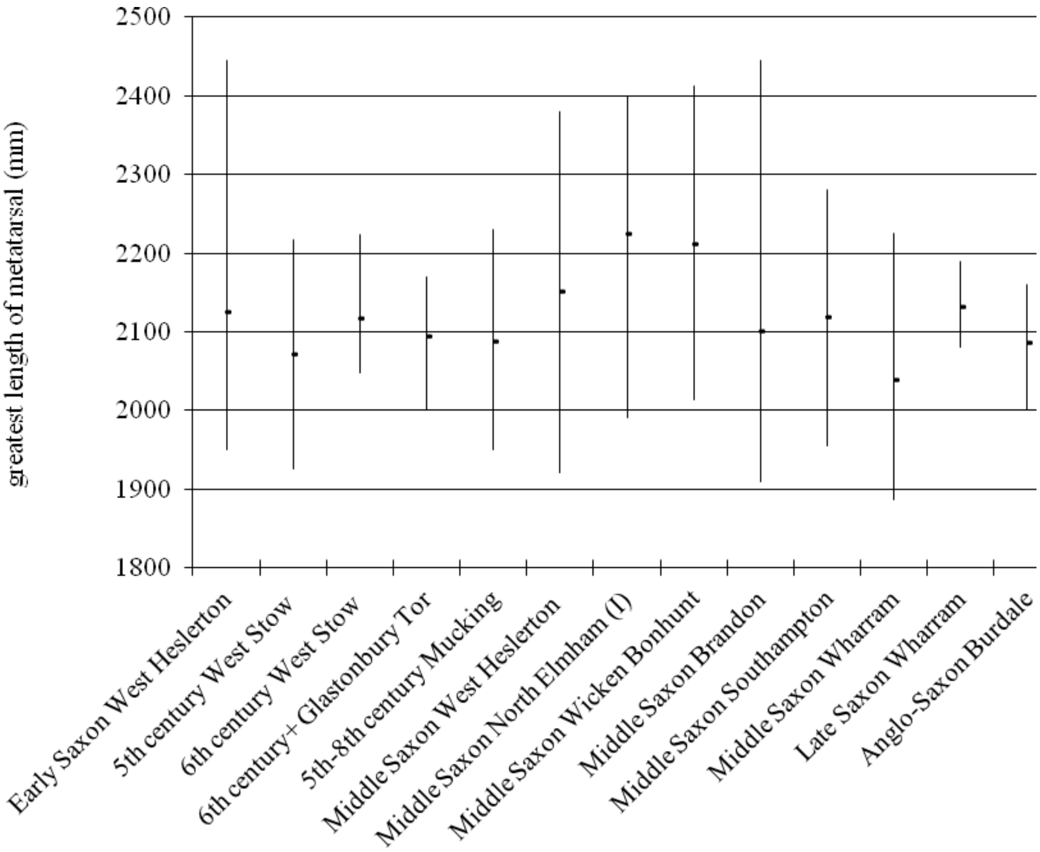

Fig. 6. Breadth variation (range and mean) in cattle tibae by site

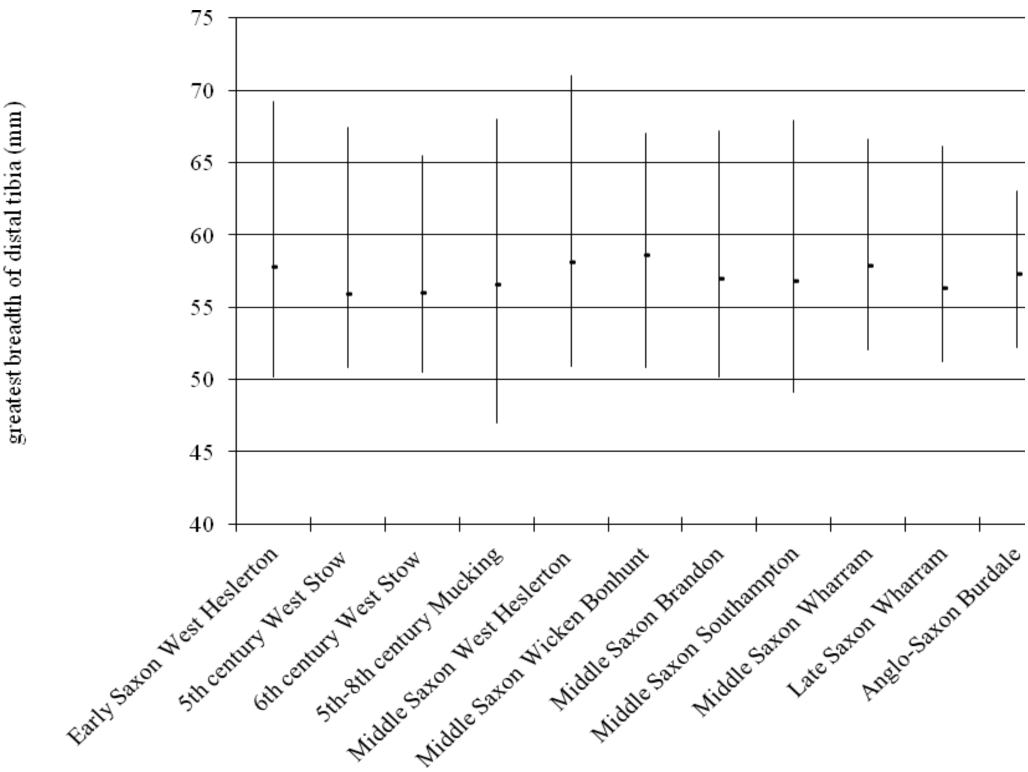

Fig. 7. Scattergram of adult sheep metacarpals showing size variation by site (divisions based loosely on data from Davis 2000, figure 8

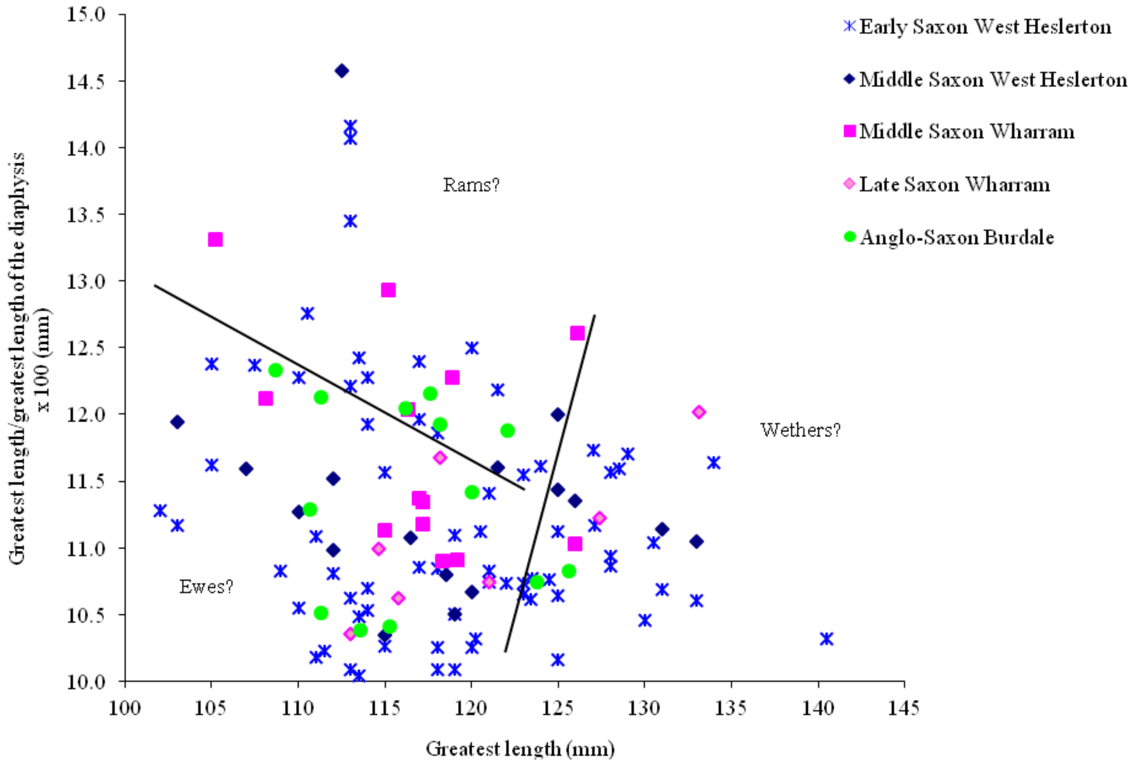

Fig. 8. Height variation (range and mean) in sheep metatarsals by site

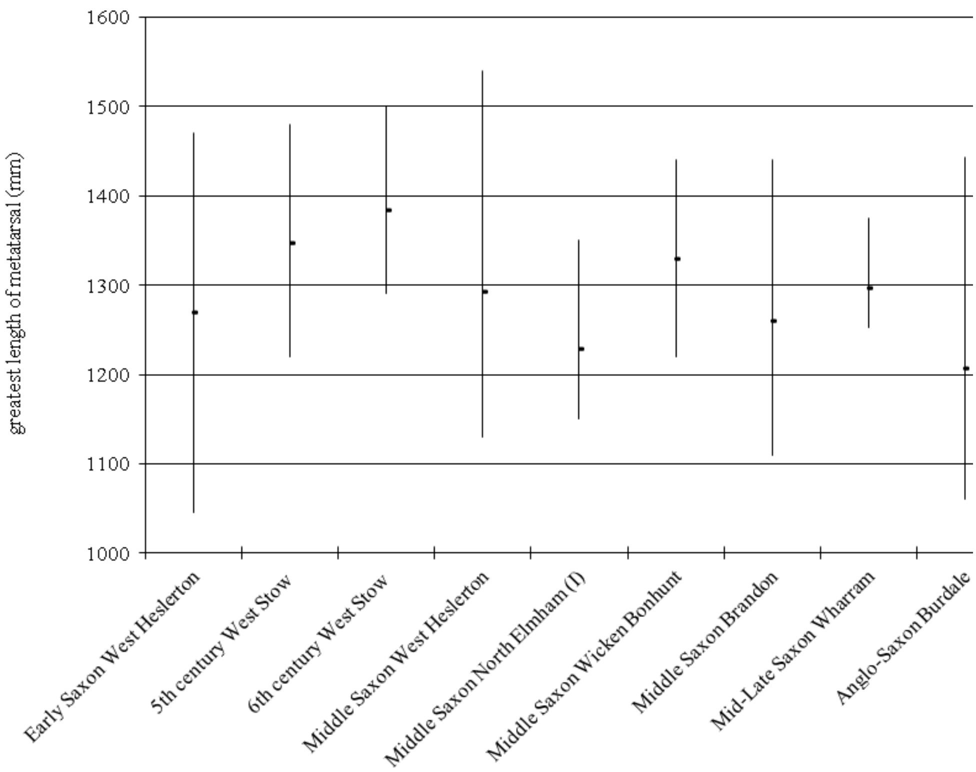

Fig. 9. Breadth variation (range and mean) in sheep tibae by site

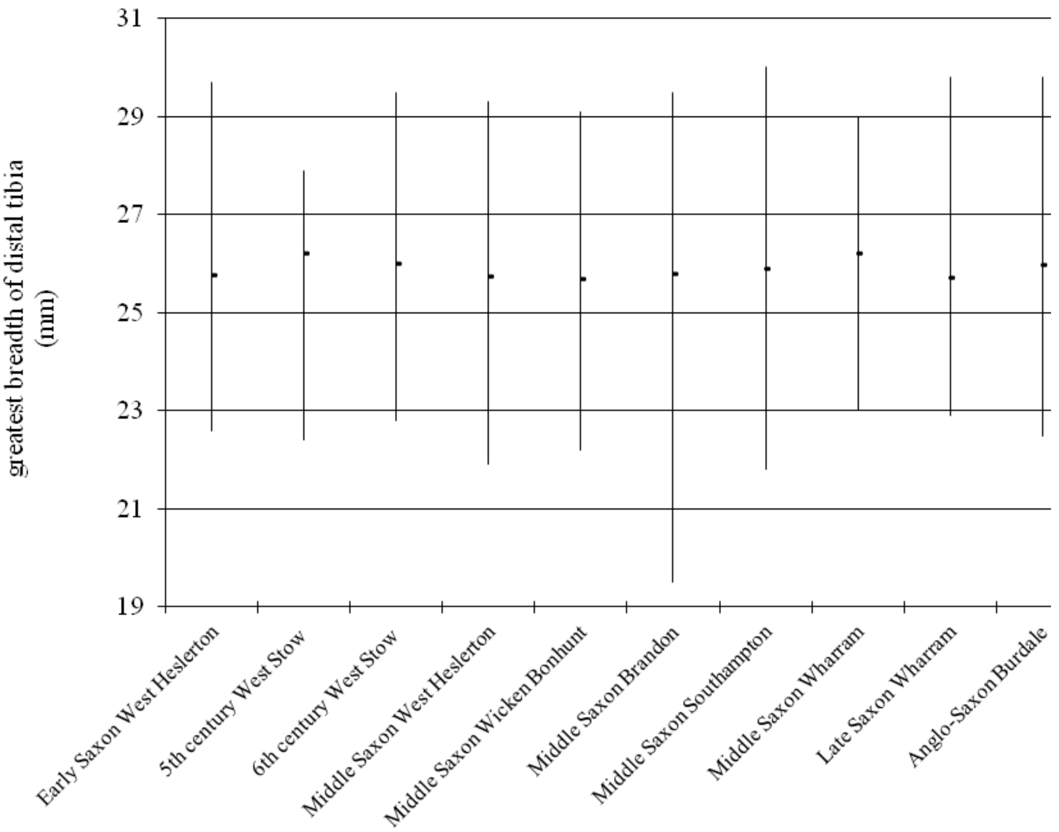

Fig. 10. The range of withers' heights based on various adult horse bones by site

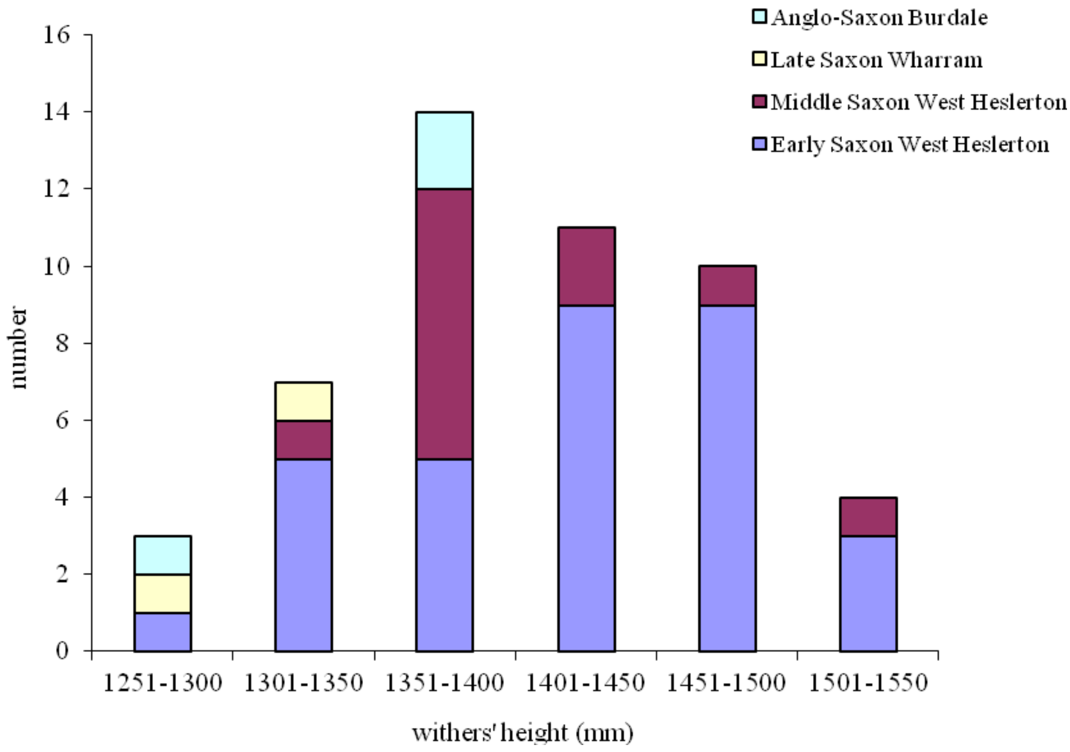

Fig. 11. Relative proportions of the three main 'meat' animals by enclosure

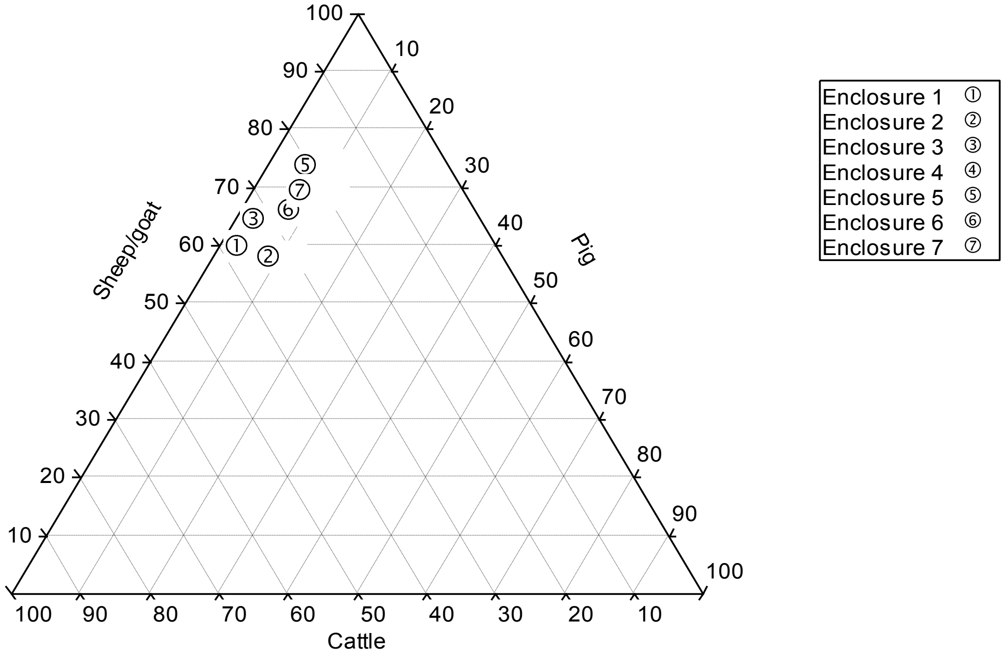

Table 1. Bone preservation and treatment by phase and enclosure

	Iron Age/Roman	Anglo-Saxon	Medieval/ modern
Size index	0.27	0.27	0.26
Condition index	1.00	1.00	1.00
Erosion index	0.99	0.99	0.99
% butchered	11.8	8.3	6.5
% gnawed	7.1	6.3	8.0
% burnt	1.5	2.4	0.6
% loose teeth	20.9	23.8	27.4

	Enclosure 1	Enclosure 2	Enclosure 3	Enclosure 4	Enclosure 5	Enclosure 6	Enclosure 7
Size index	0.26	0.28	0.26	0.25	0.30	0.26	0.26
Condition index	1.00	1.00	1.00	1.00	1.00	0.99	1.00
Erosion index	0.97	0.99	0.99	0.99	1.00	0.99	0.99
% butchered	7.1	6.3	8.2	5.4	8.6	10.8	6.2
% gnawed	7.1	7.5	9.3	7.1	1.2	5.9	6.0
% burnt	1.6	0.4	3.3	1.0	1.4	5.0	0.2
% loose teeth	22.3	20.2	26.2	31.4	18.9	22.3	27.7

For the size, condition and erosion index, values closer to 1.00 indicate more complete or better preserved bones

Table 2. Fragment count by phase

	Iron Age/Roman	Anglo-Saxon	Medieval/modern	Total
Cattle	246	1618	123	1987
Sheep	83	822	46	951
Sheep/goat	337	3312	199	3848
Goat	2			2
Pig	59	474	39	572
Dog	5	43	4	52
Horse	47	148	16	211
Cat		9	6	15
Badger		1		1
Fox		3		3
Hare	2	2		4
House mouse		1		1
Wood mouse		1		1
Common shrew		1		1
Water vole	3	1		4
Field vole		30		30
Microfauna	2	46		48
Frog		21		21
Toad		2		2
Frog/toad	2	165		167
Chicken	18	200	16	234
Goose	5	51	3	59
Crow/rook		1		1
Moorhen		1		1
Herring gull-size	3	29	1	33
Bird spp.	3	72	2	77
Cattle-size	59	422	16	497
Pig-size	5	54	4	63
Sheep-size	74	620	35	729
Total	955	8150	510	9615

Table 3. Zone count and proportions by phase

	Iron Age/Roman		Anglo-Saxon	
	Count	%	Count	%
Cattle	174	30.9	1099	24.5
Sheep +(sheep/goat)	281	49.9	2678	59.7
Goat	2	0.4		
Pig	43	7.6	320	7.1
Dog	4	0.7	37	0.8
Horse	36	6.4	93	2.1
Cat			6	0.1
Chicken	18	3.2	199	4.4
Goose	5	0.9	51	1.1
Total of domestic animals	563		4483	
Badger			1	
Fox			2	
Hare	2		2	
House mouse			1	
Wood mouse			1	
Common shrew			1	
Water vole	2			
Field vole			7	
Microfauna	2		20	
Frog	2		160	
Toad			21	
Frog/toad			2	
Crow/rook			1	
Moorhen			1	
Herring gull-size	3		29	
Bird spp.	3		69	
Cattle-size	41		316	
Pig-size	4		51	
Sheep-size	65		544	

Table 4. Fusion data for cattle by phase (zone > 0, F = fused, NF = not fused)

		7-18 months	24-36 months	36-48 months
Iron Age/Roman	Fused	41	8	10
	Not fused	1	3	9
	% fused	97.6	72.7	52.6
Anglo-Saxon	Fused	245	66	48
	Not fused	32	42	50
	% fused	88.4	61.1	49.0

7-18 months calculated from distal scapula, distal humerus, proximal radius, first phalanx, second phalanx
24-36 months calculated from distal metacarpal, distal tibia, distal metatarsal
36-48 months calculated from proximal humerus, proximal ulna, distal radius, proximal femur, distal femur, proximal tibia, calcaneus

Table 5. Fusion data for sheep by phase (zone > 0, F = fused, NF = not fused).

		6-16 months	18-28 months	30-42 months
Iron Age/Roman	Fused	32	21	12
	Not fused	8	13	26
	% fused	80.0	61.8	31.6
Anglo-Saxon	Fused	357	236	127
	Not fused	62	69	125
	% fused	85.2	77.4	50.4

6-16 months calculated from distal scapula, distal humerus, proximal radius, first phalanx, second phalanx
18-28 months calculated from distal metacarpal, distal tibia, distal metatarsal
30-42 months calculated from proximal humerus, proximal ulna, distal radius, proximal femur, distal femur, proximal tibia, calcaneus

Table 6. Fusion data for pig by phase (zone > 0, F = fused, NF = not fused).

		12 months	24-30 months	36-42 months
Iron Age/Roman	Fused	7	4	0
	Not fused	1	14	3
	% fused	87.5	22.2	0
Anglo-Saxon	Fused	26	17	4
	Not fused	10	45	23
	% fused	72.2	27.4	14.8

12 months calculated from distal scapula, distal humerus, proximal radius, second phalanx

24-30 months calculated from distal metacarpal, distal tibia, calcaneus, distal metatarsal, first phalanx

36-42 months calculated from proximal humerus, proximal ulna, distal radius, proximal femur, distal femur, proximal tibia

Table 7. Fusion data for horse by period (zone > 0, F = fused, NF = not fused).

		9-20 months	20-24 months	36-42 months
Iron Age/Roman	Fused	12	3	5
	Not fused	0	0	2
Anglo-Saxon	Fused	23	4	8
	Not fused	0	1	1

9-20 months calculated from distal humerus, proximal radius, distal metacarpal, distal metatarsal, first phalanx, second phalanx

20-24 months calculated from distal scapula, distal tibia

36-42 months calculated from proximal humerus, proximal ulna, distal radius, proximal femur, distal femur, proximal tibia, calcaneus

Table 8. Number of cattle jaws at various wear stages by period (after Halstead 1985)

	Iron Age/Roman	Anglo-Saxon
A: 0-1 mth		
B: 1-8 mths		2
C: 8-18 mths	3	7
D: 18-30 mths	7	16
E: 30-36 mths		5
F: young adult	1	7
G: adult		8
H: old adult		3
I: senile	2	7
Total	13	55

Table 9. Number of sheep jaws at various wear stages by period (after Payne 1973)

	Iron Age/Roman	Anglo-Saxon
A: 0-2 mths		4
B: 2-6 mths	3	13
C: 6-12 mths	12	95
D: 1-2 yrs	7	53
E: 2-3 yrs	5	60
F: 3-4 yrs	8	86
G: 4-6 yrs	2	51
H: 6-8 yrs	1	39
I: 8-10 yrs		3
Total	38	404

Table 10. Number of pig jaws at various wear stages by period

	Iron Age/Roman	Anglo-Saxon
A: d4 unworn		1
B: d4 in wear, M1 unworn		1
C: M1 in wear, M2 unworn		7
D: M2 in wear, M3 unworn	1	9
E: M3 in early wear	1	3
F: M3 beyond wear stage c	1	3
Total	3	24

Table 11. Number of horse incisors (mandibular and maxillary) at various wear stages by period

	Iron Age/Roman	Anglo-Saxon
A: decidous incisors present (< 2 yrs)	1	
B: incisor erupted (2.5-4.5 years)		1
C: incisor first in wear (3-6 yrs)	1	2
D: incisor with square enamel pattern (5-7 yrs)	1	1
E: infundibulum lost (7-9 yrs)		
F: incisor with circular enamel pattern (8-10 yrs)		4
G: incisor with no enamel (14 yrs +)	1	3
Total	4	11

Table 12. The proportion of butchered bones for all taxa and knife and chop marks for cattle, sheep, pig and horse

	Iron Age/Roman	Anglo-Saxon
Butchery marks %		
Cattle	10.2	9.8
Sheep	6.0	5.0
Goat	100.0	-
Pig	1.7	3.4
Horse	4.3	3.4
Domestic fowl	5.6	2.0
Domestic goose	-	2.0
Large-size mammal	52.5	34.1
Medium-size mammal	20.0	18.5
Small-size mammal	33.8	21.0
Knife marks %		
Cattle	6.1	6.4
Sheep	5.0	3.8
Pig	1.7	2.5
Horse	2.1	1.4
Chop marks %		
Cattle	4.1	3.4
Sheep	1.0	1.1
Pig	-	0.9
Horse	2.1	2.0

Bones with both cut and chop marks are counted twice

Table 13. Zone count by enclosure (main domesticates only)

	Enclosure 1		Enclosure 2		Enclosure 3		Enclosure 4		Enclosure 5		Enclosure 6		Enclosure 7	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Cattle	39	34.2	213	31.6	32	30.5	116	20.5	58	18.0	382	24.5	53	21.5
Sheep(/goat)	62	54.4	364	54.0	63	60.0	358	63.3	205	63.7	934	60.0	155	62.8
Pig	3	2.6	51	7.6	3	2.9	47	8.3	16	5.0	100	6.4	16	6.5
Dog	3	2.6	2	0.3	-		10	1.8	3	0.9	5	0.3	4	1.6
Horse	4	3.5	19	2.8	-		15	2.7	3	0.9	28	1.8	5	2.0
Chicken	3	2.6	22	3.3	6	5.7	12	2.1	32	9.9	92	5.9	9	3.6
Goose	-		3	0.4	1	1.0	8	1.4	5	1.6	16	1.0	5	2.0
Total	114		674		105		566		322		1557		247	

Table 14. Number and percentage of butchered bones by enclosure (main 'meat' animals only)

	Enclosure 1		Enclosure 2		Enclosure 3		Enclosure 4		Enclosure 5		Enclosure 6		Enclosure 7	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Cattle	3	7.7	26	12.2	4	12.5	11	9.5	9	15.5	67	17.5	9	17.0
Sheep(/goat)	5	8.1	24	6.6	6	9.5	26	7.3	18	8.8	73	7.8	10	6.5
Pig							1	2.1	2	12.5	8	8.0		
Total	8		50		10		38		29		148		19	

Table 15. Number and percentage of foot bones, as an indicator of primary butchery waste, by enclosure

	Enclosure 1		Enclosure 2		Enclosure 3		Enclosure 4		Enclosure 5		Enclosure 6		Enclosure 7	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Cattle	14	35.9	77	36.2	11	34.4	32	27.6	21	36.2	132	34.6	13	24.5
Sheep(/goat)	18	29.0	78	21.4	11	17.5	73	20.4	40	19.5	190	20.3	32	20.6
Pig			14	27.5			7	14.9	2	12.5	24	24.0	6	37.5
Total	32		169		22		112		63		346		51	

Foot bones is the total number of metapodials plus phalanges

Table 16. Number and percentage of neonates by enclosure

	Enclosure 1		Enclosure 2		Enclosure 3		Enclosure 4		Enclosure 5		Enclosure 6		Enclosure 7	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Cattle	1	2.6	2	0.9			3	2.6			2	0.5		
Sheep(/goat)			5	1.4			14	3.9	3	1.5	2	0.2	1	0.6
Pig									1	6.3	5	5.0	1	6.3
Total	1		0		0		17		4		9		2	

Cattle-sized neonates added to cattle, sheep-sized neonates added to sheep

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