Ipswich, Stoke Quay
Animal & Bird Bone: full report

By Kevin Rielly

Quality Assurance

This report is provided as a more detailed supplement to the published version of the analysis of faunal and bird remains from the Stoke Quay site presented in the site's monograph (Brown *et al.* 2020). In particular, it contains additional methodological explanation, notes on bone condition and metrical data (including tables and charts) to that presented in the monograph. The latter was subject to a more rigorous editorial process than this document and, as a result, this report should be read in conjunction with the monograph: in any instances of variation between the two reports, the published version should be relied upon as correct.

Site Summary
By Richard Brown and Elizabeth Popescu

Ipswich is one of England's oldest urban centres. It has long been recognised as an *emporium* – a specialised, managed trading place of royal power within the eastern kingdom with royal input into trade and with commercial and diplomatic relations with the Frankish empire. Its origins are linked to a royal vill/centre (at Thingstead), close to which settlement developed. Its archaeology is of international significance, but sadly remains obscured by the previous lack of publication. Understanding of the role of *emporia* has developed considerably in recent years and new evidence – such as that from Stoke Quay – is crucial to furthering such study. Fuelled by an industrious pottery industry and international trade, it rapidly emerged in the 7th and 8th centuries as one of the first post-Roman settlements which could truly be described as a town.

Excavation of a 1.2ha site at Stoke Quay, immediately south of the River Orwell and adjacent to one of the ancient arterial routes leading into the town – *Losegateweye*, later Great Whip Street – was carried out by Oxford Archaeology and Pre-Construct Archaeology, during 2012. The work was procured by Ramboll UK on behalf of ISG plc, in respect of a planning condition for development of the site by Genesis Housing Association.

An entirely unexpected discovery was the presence of a late 6th/7th- to early 8th-century barrow cemetery that stretched along a bluff facing towards the river. This burial ground suggests the presence of a community that chose to bury its dead in an open landscape on the riverside hills to the south of the river, in a manner reminiscent of prehistoric and Scandinavian influences. Other cemeteries surrounded the primary core of settlement to the north known as *Gipeswic* which lay at the junction of the Rivers Orwell and Gipping. The Stoke Quay site has considerable rarity value in that it includes distinct groups of Middle and Late Saxon burials. These have important implications for, *inter alia*, the transition to Christianity.

Investigations at Stoke Quay provide crucial new evidence about the urban fabric of Middle Saxon Ipswich, particularly since this is the first major excavation to have taken place to the south of the river. The remains demonstrate the setting out of plots, streets and buildings akin to the other *wics* (London, Southampton and York) and show strong influences from Frankia and Scandinavia. The associated pits, wells and cess pits yielded substantial finds assemblages and notable individual objects, providing some of the largest groups yet found in Ipswich. The town's industries, such as pottery production, led to substantial trade links with the continent and it produced the first kiln-fired pottery made in Britain since the Romans on a quasi-industrial scale. This pottery effectively became a social marker for East Anglian influence, with the techniques and styles employed demonstrating links with northern Frankia and suggesting that individuals were brought in to establish the industry. The discovery of an exceptionally well-preserved Ipswich ware kiln at the Stoke Quay site is of crucial importance since it indicates that production was dispersed across a wider area of the town than was previously suspected (the other known sites, including the Buttermarket, lying on the northern side of the river). This has potential implications for settlement linked to craft specialisation.

During the Late Saxon and medieval periods, the site was dominated by the church and cemetery of St Augustine's, the precise location of which had been lost for 500 years. The history of this parish and its little church have now been traced from the 10th century until their demise at the end of the 15th century (when the parish united with St Peter's). Sited in one of Ipswich's poorer areas, the population must surely have included a high proportion of 'men of the sea' as is suggested by the presence of reused boat timbers in many of the graves. Despite the poverty of its parishioners, the church developed in form (changing from an apsidal to square ended chancel), and saw the addition of a possible priest's house. Its cemetery contained over 1,100 burials spanning the Late Saxon to late medieval periods. This is the first group of burials associated with a major English port yet to have been archaeologically excavated and analysed: the findings indicate that the group is osteologically and palaeopathologically distinct from other non-port populations. Scientific investigation shows that this was a mobile and mixed population.

Once the church had fallen from use, the site and its environs saw commercial and industrial use (including a cooperage and shipyard) that reflects the development of Ipswich into its modern form.

The wide ranging results of the analysis presented in the monograph provide clear potential for further studies that lie beyond the scope of the current work, although some pointers for future research are provided throughout the volume and in the concluding chapter. Taken as a whole, the archaeological and documentary evidence across many centuries bind together the recurring themes of trade, ships and the sea.

Introduction

(Table 1)

The site provided a total of *c.*71,250 animal bones recovered by hand collection (weighing 1,240kg), of which 60,172 were recorded, with all but 700 bones taken from phased deposits (see Table 1). This assemblage included material from dry sieving that was undertaken on site, with pit fills being sieved through a maximum mesh size of 10mm: this resulted in a more representative sample in the hand collected material than would normally be the case. Animal bones were found throughout the site sequence, with the majority of the assemblage deriving from the Middle Saxon levels. Fish bones are described in a separate report (see Nicholson, monograph Chapter 7.II). Recording was undertaken using a system in which the majority of the assemblage (53,159 bones) was fully recorded, while the remainder (7,012 bones) was described using a detailed scanning method. In each method, the unidentifiable portion (divided into cattle- and sheep-size components) were simply counted, with the exception of a proportion of the cattle-size vertebrae (see below). The major domesticate collections (cattle, sheep/goat and pig) were also weighed, amounting to 690.06kg. Analysis of wet sieved (flotation) material from bulk samples was limited to the identifiable portion only, this amounting to 715 bones (excluding fish) taken from 60 samples, the great majority from the Middle Saxon (Phase 3) pit fills.

A substantial proportion of the early post-medieval (Phase 7) collection was interpreted as craft waste, comprising large concentrations of sheep/goat foot bones from three pits. These collections are generally excluded from the comparative analyses.

Methodology

The bone was recorded to species/taxonomic category where possible and to size class in the case of unidentifiable bones such as ribs, fragments of longbone shaft and the majority of vertebra fragments (excluding the atlas, axis and sacrum). Recording (depending on the method employed, see below), follows the established techniques whereby details of the element, species, bone portion, state of fusion, wear of the dentition, anatomical measurements and taphonomic (including natural and anthropogenic) modifications to the bone are registered. Age determination is based on the dental eruption and epiphyses fusion sequences described in Schmid (1972, 75 and 77), with expansion of the tooth age sequence to include wear (Grant 1982). Measurements essentially follow the information detailed in von den Driesch (1976), while shoulder heights were calculated on the basis of multiplication factors given in Boessneck and von den Driesch (1974).

The full record approach noted above was applied on a bone by bone basis, including a full set of modification analyses such as condition (preservation), butchery, gnawing, burning and pathology. The approach included the recording of non-metrical traits together with, for example, the presence/absence of certain teeth. The scanning method involved the recording of assemblages by context rather than, in the most part, by bone, essentially limited to species range, age and size data:

- the former enabled a count of the number of bones per species in each context as well as a count of skull parts, including the maxilla, the latter providing information for the weighted quantitative method (see below);

- the age data incorporated a full record of each mandible including some part of the cheek toothrow as well as the number of fused and unfused limb bone articular ends, although by fusion group (foetal/neonate, Early, Intermediate and Late, see below) rather than by bone, with a count of bones from particularly young individuals irrespective of the presence of an articular end;
- examination of size entailed a full record of all measurable bones incorporating element and bone part.

Recording of cattle-size vertebrae was undertaken to provide information on age and butchery. This included their state of fusion and butchery marks (the position, type (utensil used) and direction of cut).

Other points of interest recorded included the presence of concentrations of particular bones or body parts, as well as the incidence of notable pathological traits. Finally, identifiable material from the wet sieved collections was examined using a limited recording method (no attempt was made to record the various modifications or to take any measurements).

Quantification analyses were principally based on total fragment counts, although the weighing of the individual collections of cattle, sheep/goat and pig bones from each context assemblage allowed for a comparative analysis of major domesticate abundance by weight. Either of these methods will tend to be biased towards the larger species (cattle) due to various factors, the size and robustness of cattle bones allowing for greater survivability, leading to a greater level of recovery and identification compared to sheep/goat and, in particular, pig bones, the latter inevitably derived from relatively young individuals. In an attempt to counteract such factors, this report employs the Epiphysis Only method, after Grant (1975 and 1984), which – by limiting counts to limb bone articular ends and otherwise providing a quantification based on the best represented part of other elements (hence the count of skull parts described above in the scanned method) – aims to reduce the fragmentation and recovery biases. When comparing the calculated totals, certain parts were excluded, such as the phalanges (which would undoubtedly add to the larger mammal bias), while the counts of others were recalculated based on their expected frequency (taking account, for example, of the greater proportion of metapodials in a pig skeleton compared to that of a sheep or cow).

Age categories are employed to facilitate the interpretation of this data, specifically in connection with the major domesticates – cattle, sheep/goat and pig. These follow an age sequence incorporating a particular time of eruption (mandibular teeth) or fusion (limb bone articular ends). The mandibular teeth analysis uses two methods, following the general sequence (eruption of deciduous fourth premolar to third adult molar and the subsequent wear patterns) as well as a more detailed method devised by O'Connor (1991, 250), thus allowing for a comparison of age data from a number of other Middle Saxon sites (and see O'Connor 2001). The age sequence referring to the fusion of the limb bones comprises four main age groups based on the fusion of the following skeletal parts (using P for proximal and D for distal), thus: Foetal/Neonate – P metacarpal and metatarsal; Early – P scapula, D humerus, P radius, pelvis acetabulum and P first phalange; Intermediate – D tibia, metacarpal and metatarsal; and Late – P humerus and ulna, D radius, P and D femur, P tibia and P calcaneus. These groups approximately coincide with the first, second and third (and later) years respectively. Ages mentioned in the text are taken from Schmid (1972). When comparing the two ageing methods it is useful to provide corresponding age categories, as follows:

- Foetal/Neonate and/or Infant, based on bone size and porosity (see Amorosi 1989) and unworn deciduous fourth premolar;
- Juvenile, as Infant with the addition of unfused early epiphyses and unworn first adult molar;
- Sub-adult, unfused Intermediate epiphyses and unworn third adult molar;
- and adult, fused Intermediate and Late epiphyses, as well as worn third adult molar, further divided into young and old adult based on toothwear (after Grant 1982) the latter marked by full wear of the third adult molar (wear stage 'g').

It should of course be noted that there will be an overlap between the juvenile and sub-adult age groups, the latter probably incorporating bones from the former.

The production of distinct age groups, with no obvious overlap, as is the case with the mandibular evidence is clearly beneficial in terms of the interpretation of this data, although the quantity of data may be limited when reliant solely on a single skeletal part. In an attempt to increase the dataset, the juvenile and younger mandibular data (as well as that from the adult mandibles) has been combined with the corresponding information from the epiphysis fusion evidence, essentially adding the unfused Early and fused Late age group data respectively. In addition, the earlier group will also include those bones which are demonstrably young by their appearance as well as their tooth eruption and fusion attributes. However, it should be noted that, unlike the mandibular data, this will offer a more limited age comparison and any interpretation should be moderated accordingly.

Sexing the domesticate bones is generally limited to the pelves in cattle and sheep/goat (following Grigson 1976 and Prummel and Frisch 1986) and the canines in pigs (after Schmid 1972). In addition, an attempt was also made to sex the cattle, sheep and goat horncores, the former with information taken from Armitage and Clutton-Brock (1976) and the latter two species using Schmid (1972). In addition, a metrical method applicable to cattle distal metacarpals (Thomas 1986) was also used.

The butchery evidence is described in terms of the general progression from slaughter through to skinning, dressing, halving/jointing, defleshing and finally marrow extraction and/or the production of stew bones. This evidence is described in some detail regarding the large Middle Saxon collection. Given that rather similar butchery patterns were observed amongst the better represented later phase assemblages, it was considered appropriate to limit any further descriptions to evidence which is demonstrably different.

Turning to the analysis of the other species recovered, the age of equid cheek teeth was demonstrated using the crown height data described in Levine 1982, the sexing of chickens (and other birds) was achieved by noting the presence of medullary bone (after Driver 1982), while dog shoulder heights were calculated using the factors displayed in Harcourt (1974). The identification of the various bird species was achieved through consultation of the PCA faunal reference collections as well as to those at the Natural History Museum in Tring. The small rodents were identified according to the methods of Lawrence and Brown (1973).

Condition
(Tables 2 and 3)

This section describes the preservation state of the bones, referring to abrasion/erosion and their degree of fragmentation (with results of separate analyses shown in Table 2). The recording of the former essentially involved four levels: no abrasion, slight damage (<25% of the bone surface), moderate (up to 50%) and poor (>50%). The majority of the bones had suffered some level of surface damage, whereas only a minor proportion demonstrated the higher levels. The results include data taken from the entire phase collections and also from the major domesticate and equid assemblages. Notably, while there is a greater level of moderate and poor preservation amongst the major domestic bones, there is an approximately similar relative pattern amongst the phase assemblages.

Material from Phases 2 to 4 appears to be the least well preserved, with that from Phase 7 demonstrating the least damage. The latter result is clearly related to the presence of sheep/goat craft waste, these collections tending towards little to no surface erosion. Certain collections were taken in part from the (Early) Middle Saxon barrow cemetery (Phase 2) and from the Late Saxon phase of the cemetery of St Augustine in the northern part of the site (from Phase 4.2). Clearly, the heightened potential for redeposition within these areas may have had an effect on the level(s) of preservation. This is certainly the case in Phases 2 and 6, the majority of the least well preserved bones arising from grave fills. Notably, there is no other type of deposit or indeed area of the site within each of the phase collections showing a greater or lesser degree of damage. This would indicate that, with the exception of a selection of grave fills, there was a generally constant level of preservation across the site dependant on phase rather than area. In addition, the higher levels of moderate to poorly preserved bones in the Middle and Late Saxon deposits could perhaps suggest either a relatively greater degree of redeposition and/or a greater tendancy towards poor or no burial of faunal detritus, thus allowing bones to be weathered/eroded.

The relative degree of fragmentation can be tested by comparing quantity (total fragment count) and weight. This information is available for the major domesticate collections, the comparative values calculated by dividing the number of bones by their weight and multiplying by 100. Thus it can be seen that rather similar levels of fragmentation are demonstrated by each phase collection. The breakage pattern across the occupation phases was also shown by comparing the proportion of major domesticate limb bones in each collection which were less than 25% and approximately 25% complete. Again there is a rather similar set of results, suggestive of a moderate level of fragmentation throughout. It is of interest that the results for Phase 7 are quite different if the sheep/goat craft waste collections are included, the two percentages decreasing to 13.5% and 9.6% respectively (N=1502).

It is of course possible that a large proportion of the noted fragmentation can be linked to butchery (see relevant sections in phase descriptions below) as well as the attention of scavengers. Indeed, dog gnawing was observed throughout these collections (see Table 3). For clarity, the incidence of gnawing has again been shown both in terms of the entire phase assemblages and when limited to the major domesticate and equid components. These tend to show a relatively minor proportion of dog gnawed bones in each phase, although such material is somewhat better represented in the latest two collections. A notable proportion of dog gnawed bones would suggest that these bones were freely available, either due to poor burial or disturbance a short period after their burial. The lack of correlation between those phases with a poorer level of preservation and a higher incidence of dog gnawing is perhaps surprising as each would be reliant on a lack of cover, open to weathering and scavengers respectively. However, it can be proposed that the poorer preservation shown by the earlier collections may relate more to exposure following redeposition, this occurring some time after burial, perhaps beyond the period when such bones are attractive to scavengers.

The Faunal Assemblage by Phase

(Tables 4-11)

Prehistoric to Romano-British (Phase 1)

Deposits assigned to this phase of activity yielded 90 bones, of which 41 were identifiable (Table 4). The features containing faunal remains (detailed in Appendix 2 of the monograph) included a small gully (10981) to the north-west, an Iron Age to Romano-British ditch (4007) traversing the south-eastern part of the site and a pit (10805). Just two bones were recovered from the ditch while the gully and pit provided 29 and 59 fragments respectively. The identifiable bones comprise small quantities of cattle, sheep/goat and pig (see Table 5), these thinly spread amongst the relevant features, alongside the partial remains of an adult cat. This animal, found in pit 10805, is represented by most parts of the skeleton although excluding the greater part of the vertebral column, the ribcage and both pelves. This same pit also provided a single goose bone.

(Early) Middle Saxon Barrow Cemetery ((late 6th/)7th to early 8th centuries: Phase 2)

Distribution

During the early part of the Middle Saxon period, the site was occupied by a barrow cemetery. The graves and related barrow ditches produced an assemblage of 139 animal bones, of which 60 were identifiable to species. Some 66 of the bones from this phase were recovered from eight graves, in particular from burials 8342 (Grave Group 1) and 20809 (Barrow 5) with 16 and 24 bones respectively: some of these had clearly been deliberately placed within the graves. The remainder of the assemblage came from the barrow ditches, with 57 fragments from ditch 9732 associated with Barrow 6, perhaps as a deliberate dump of material which was limited to the lower fills of the northern part of the ditch, adjacent to its terminus.

Description

The faunal material from deposits assigned to Phase 2 is almost entirely composed of the major domesticates with the inclusion of a single chicken bone from a ditch fill (Barrow 6). Cattle remains are dominant and perhaps in consequence, they also tend to be the most widely distributed bones of the three domesticates. Notably, both sheep/goat and pig bones were largely restricted to ditch 9732 (Barrow 6) and grave 7991 (Grave Group 1), although some pig bones were also found in ditch 9726 and both species occurred in one of the barrow burials. All three species feature a wide distribution of skeletal parts which, taken at face value, is suggestive of general food and processing waste. However, the archaeological evidence detailed in monograph Chapter 3.II demonstrates that some material had been deliberately placed within graves. Perhaps the earliest example of such placement was the burial within Barrow 5 (sk 20808 within grave 20809) which was recorded as having an offering of meat (20806) placed above a wooden board within the grave (monograph Fig. 3.6). This consisted of indeterminate cattle and cattle-sized bones (15 fragments), sheep/goat and sheep-/goat-sized bones (4 fragments) and a single pig bone (a few further bones came from the grave fill). Two of the non-barrow burials, both assigned to Grave Group 1, produced similar evidence. Grave 8342 was associated with the burial of an adult male (sk 8343) and provided 11 cattle bones which had been placed near the right shoulder (monograph Fig. 3.11). These include five skull fragments which may be part of the same subadult individual as well as three humerii, a pelvis, astragaus and a first phalange, all less than 25% complete and probably originating from at least three individuals. Burial 22031 of a young adult female (sk 22032) contained a cattle mandible which had been placed next to the skull, beneath a coffin board (monograph Fig. 3.13). Further comments on the possible significance of these assemblages are given in monograph Chapter 8.II.

(Later) Middle Saxon Settlement (early 8th to mid 9th century: Phase 3)

Distribution

(Figs 1 and 2)

A total of 30,756 animal bones were recovered from the Middle Saxon settlement which overlay the barrow cemetery, of which 13,397 were identifiable to species. This phase was characterised by a wealth of cut features, principally pits, which were spread across the site although with a notably greater density to the north. The vast majority of these features provided some bones, predominantly taken from pits, although notable amounts were recovered from the few wells scattered across the site and from the contents of a possible sunken-featured structure/pit (7019; see Table 4). Regarding the density of this widespread distribution, it is notable that only about one third of these features produced more than a moderately sized collection (greater than 100 bones) and there are very few substantial collections (greater than 1,000 bones). Most of this assemblage derived from the concentration of features to the north (in Areas A and B). However, in terms of the better represented groups (moderate or greater), there would appear to be two distinct depositional zones – the first within the northern assemblage, essentially adjacent to the probable fence line (4005) that divided Areas A and B, and the second amongst the southernmost features. The more substantial collections were also found within these two 'zones', comprising pits 5431 and 6830 as well as the possible structure/storage pit (7019), these with 1,354, 2,808 and 1,360 fragments respectively. To the south, in Area C, well 1132 produced 1,438 fragments. This deposition pattern reflects the settlement density that is evident from the distribution of features.

Major Domesticates

Species Representation
(Figs 3-5)

Major domesticates dominate the Middle Saxon animal bone assemblage with a notable dominance of cattle bones (see Table 5). The greater presence of this species can also be inferred by the relative proportion of cattle- as against sheep-sized fragments, with the former essentially comprising cattle and the occasional equid fragment (comparing the quantities of cattle and equid bones), and the latter a mixture of sheep and pig bones. Cattle is followed by sheep/goat and then pig in order of numerical importance, although the prevalence is apparently inversed when considering the wet sieved as opposed to the hand recovered data (see Table 6). However, the wet sieved collections were notable for the representation of loose teeth and foot bones, principally belonging to pig, these biasing the results in favour of this species. Contributory factors include the far greater number of foot bones in a pig compared to a cattle or sheep/goat skeleton, alongside the well known capacity for pig bones to suffer a greater level of fragmentation (see Grant 1975 and 1984), most probably related to their younger age of slaughter (see below). There is also the rather small number of wet sieved bones to be considered, with just 434 major domesticate bones recovered compared to 12,198 from hand retrieval and dry sieving. It can be suggested that pig and indeed sheep/goat are likely to be underrepresented in the hand collected assemblage relative to cattle, albeit not to the extent indicated by these results. An attempt was made to alleviate some of the problems associated with the recovery method, thus incorporating a 'weighted' quantitative method (using Epiphysis Only), as originally described by Grant (1975). Biases inherent in fragmentation and identification, both favouring cattle compared to sheep/goat and pig, are lessened by a simple count of articular ends accompanied by minimum number counts of skull and mandible; the inevitably greater abundance of smaller parts in the cattle assemblage, most notably phalanges, is dealt with by excluding them from the analysis; while minimum number counts are also applied to pig metapodials, limiting their quantification to the best represented part (thus reducing the foot bone bias; see Methodology). The application of this method had the effect of increasing the relative abundance of both sheep/goat and pig at the expense of cattle, although without affecting the order of importance with cattle still followed by sheep/goat and then pig (see Tables 8 and 9; Figs 3 and 4). The major domesticate bones were also weighed and it can perhaps be assumed that this method offers the more objective approach, except that the undue biases towards cattle in terms of differential identification and survival will still apply. However, weighing does allow a clearer understanding of meat contributions and it can be assumed that any changes made to these results taking account of the former biases would make little impression on the gross predominance of beef compared to mutton and pork (Table 10 and Fig. 5).

It should be noted that most of the sheep/goat bones actually belong to sheep. Various parts of the skeleton offer a better case for identification, most notably the horncore, distal humerus, proximal radius and distal metapodials. Restricting the analysis to these parts, it was found that goat horncores, while less abundant, are nevertheless well represented (140 sheep and 57 goats, see Table 14). This contrasts with the nominated postcranial parts, where for example there are 143 sheep proximal radii compared to just nine identified as goat, and just two goat distal metapodials compared to 148 sheep. One of these metapodials can be identified using the method devised by Payne (1969) to distinguish sheep from goat metacarpals. Based on the width of the lateral distal condyle (Bl) it was noted that this single specimen had a value close to 15mm while the remainder were between values of 10 and 13mm. While this evidence is perhaps less than succinct, a far more focused result is apparent comparing similar results from the Phase 7 and 9 metacarpals (these providing a relatively compact group), all of which can be identified as sheep and all with Bl values of 13.5mm and smaller (Fig. 34). It should also be mentioned that there was no evidence for goat mandibles, at least within the pre-adult collections, with no instance of a mandibular deciduous fourth premolar with a caprine pillar (after Payne 1985). The heavy bias towards goat horncores undoubtedly relates to their import for craft activities (see below), while the poor representation of other parts of the skeleton would strongly suggest that this species provided a rather minor portion of the ovicaprid contribution to the meat diet.

While there is a broadly similar trend in terms of major domesticate abundance across the site (with cattle predominant, followed by sheep/goat and then pig) there is considerable variety of results within this general pattern, as shown in Table 11 and Fig. 2. This table uses the results from 41 features, limited to those with a sum total of 70 or greater cattle, sheep/goat and pig bones, allotting the respective abundances into eight categories (types). Notably the standard pattern (Type 1) was present within just 23 of these collections, while amongst a somewhat variable array of results, cattle is dominant within a further 11 features (Types 2 and 3), sheep in two (Type 5 and 7) and pig in one (Type 8). Further variation within these types includes cattle dominance greater than 60% in eight features with sheep/goat greater than 40% in another four collections. Unfortunately, there do not appear to be any obvious spatial associations shown by these various ‘types’ or indeed by those collections with notably dominant or well represented individual species. There is certainly no discernible pattern in relation to the concentrations in terms of the northern and southern deposition groups. Variations between collections could result at least in part from the diverse quantities of bones found in individual features, although it can be shown that each ‘type’ does include quantities in excess of 100 fragments. Thus without any obvious patterning it can perhaps be assumed that deposition was largely related to the meats available to particular households at particular times. In addition, these variable results would suggest that a better appreciation of domesticate meat usage is best suited to a more general analysis.

Skeletal Representation
(Tables 12-14; Fig. 6)

There is a lack of any obvious and distinctive spatial variations in terms of the skeletal representation of individual domesticates. Such analysis requires at least several hundred bones per domesticate and the few suitably sized assemblages from the site all provided similar results. These essentially show a rather mixed distribution of parts, closely following the pattern indicated by the combined data (Table 12 and Fig. 6, which show the combined data and that from two of the larger collections). There are notable differences between the species collections, which are probably relate to the recovery and identification biases noted above. This is shown by the better representation of skull fragments as well as the various smaller bones within the cattle assemblages, the latter including carpals, tarsals, phalanges and, for pig, the metapodials (bearing in mind that there are 16 bones compared to just four in the cattle and sheep/goat skeletons). An attempt was made to take these biases into account through further usage of the Epiphysis Only method with the results for the combined data shown in Table 13. The information displayed in this table confirms the generally wide distribution of skeletal parts. However, various elements of the smaller species do seem to be underrepresented but these can again be interpreted as post-depositional issues. These include the continuing low counts of pig metapodials and the poor abundance of later fusing epiphyses (such as the proximal femur). The younger age of slaughter of these species and pig in particular (see below) provided a greater proportion of unfused articular ends which would have been more susceptible to damage. It is of interest that one of these later fusing ends, the proximal ulna, is also poorly represented in the cattle assemblage. In this case, damage was undoubtedly caused by the action of canids, with this part providing one of the more common articular ends with signs of dog gnawing.

This part of the analysis seeks to determine whether there is evidence for carcass redistribution, essentially following a path from abattoirs/butchers to consumers and/or craft establishments. In simple terms, the removal of the head and feet, thus producing a dressed carcass, allows for the recognition of ‘butchers waste’ (skull, mandible, metapodials and phalanges). However, the absence of such collections, as here, does not suggest the absence of butchers or indeed that this basic division of the carcass did not take place (this is clearly not the case, as shown by the butchery evidence detailed below). Rather, this data may be indicative of a lack of centralised activity, thus reducing the accumulation of recognisable butcher’s waste collections. A similar conclusion can be reached in relation to potential craft waste represented by the goat horncores already noted. These are clearly biased towards male cores (see Table 14 and Fig. 15), thus highlighting their identification as craft waste – presumably following a selection procedure for larger cores. Notably, as with the general skeletal evidence, there are no obvious concentrations of goat horncores, again suggesting perhaps a lack of a centralised concern, in this case one or more workshops specialising in this activity. These points are considered further in the discussion section below.

Butchery
(Tables 15-17)

Cut marks were observed on a large number of domesticate bones and, while amounting to a notable quantity (particularly amongst the cattle component), cut bones form a rather small proportion of the individual species collections (see Tables 15 and 16). This may relate in part to the stated levels of preservation and fragmentation, which perhaps reduced the proportion of surviving cut marks. As an indication of the latter limitation, the proportion of cattle bones with butchery increases from 8.8% to 10.5% if only the post cranial elements are considered. It should be noted that these proportions are based on the total numbers of fully recorded bones, excluding the scanned collections (see Methodology). The survival of cut marks will depend to a great extent on the tools employed, with an obious bias towards cleaver or chop marks compared to knife cuts. Notably, the latter were observed on just less than 6% of the total number of butchered specimens. It can therefore be suggested that knife butchery was uncommon or more likely that the surviving marks are strongly biased towards cleaver butchery. Interpretation of the butchery marks in this (and subsequent) section(s) is based on a generally understood progression, starting at slaughter and then leading through skinning, dressing, jointing, defleshing and finally marrow extraction. The various processes along this progression are used merely as a means of comparison, noting the possibility that other interpretations may equally apply.

Turning first to cattle, most aspects of the butchery process are represented (see Table 17), with the notable exception of slaughter. Unfortunately, there were no sufficiently complete skulls to suggest whether or not poleaxing was employed (its use being indicated by indentations/perforations respectively in the mid frontal area). A single hyoid was found with knife cuts, which could conceivably represent an alternative method; however, such cuts may also occur when removing the tongue. Cuts related to the removal of the skin were seen on a few skull fragments and also at the limb bone extremities. The horn is an obvious encumbrance when separating the skin from the skull. There is evidence for at least two methods (the HC data in Table 17), chopping through the base of the horn from a dorsal direction (six cases) and an oblique lateral cut through the skull just below the horn (four cases), thus removing the obstacle directly or using a method by which the skin can be removed with the horn respectively. A grazing cleaver cut just anterior to the horncore in another specimen (SK) represents a rather heavy handed separation of the skin from this part of the skull. The same process at the limb bone extremities was shown by cut marks on a few distal metapodials and first phalanges, a combination of knife and cleaver cuts separating these bones (three cases) and one metatarsus with the distal end completely removed. This part of the cattle skeleton provided the smallest proportion of butchered specimens, the first phalange with just 1% butchered and the distal metapodial with 1.1%. It can certainly be proposed that the knife was preferentially used when skinning this part of the carcass. A similar tool bias could also explain the minimal evidence for dressing butchery at the carpal and tarsal joints, particularly at the former where no cases were observed. There were just two examples at the proximal metatarsus, both comprising knife cuts (adjacent to the anterior proximal end), these observed on just 0.5% of the total number of proximal metapodials. The various cuts (knife and cleaver marks) to the astragalus and calcaneus were similarly interpreted, as indeed was the butchery viewed at the distal tibia, comprising four examples, all showing grazing cuts through part of the distal end (these cases representing 2.6%, 1.1% and 2.7% of their respective parts respectively). Removal of the head, the other component in the creation of the dressed carcass, is indicated by the few atlases with chops at the anterior margin.

Division of the carcass into useable parts (jointing), for cooking purposes or simply to facilitate the removal of the muscle tissue, can follow a variety of stages. An initial component of this process can be the ‘halving’ of the carcass, involving chopping axially through the vertebral column. As noted above, a proportion of the cattle-size vertebrae were recorded and these, in sharp contrast to most other skeletal parts, demonstrate a high proportion of butchered specimens (46.8% or 155 out of 331vertebral fragments). The best represented other parts include the metapodials at 19.4% and then the humerus at 14.6%. Some 67.7% (108 cases) of the butchered vertebrae demonstrated an axial cut, invariably shown by chop marks to the lateral part of the neural arch and/or centrum, often chopped along both sides. There were just three vertebrae with a central axial split. In addition, some 27% of these bones had been chopped through transversely, often close to or through the anterior or posterior articulation. This combination of cuts could be indicative of a halving followed by a sectioning of the carcass along the vertebral column. Otherwise, sectioning may well have preceded halving, as suggested by axial chops from both the anterior and posterior directions. Although not apparent at this site, variations in the direction of axial cuts were observed within other Middle Saxon collections (PCA Archives, largely based on the evidence from *Lundenwic*). The widespread use of the double axial cut could then relate to the removal of the vertebrae following sectioning and halving. However, another possible interpretation is that these cuts demonstrate the initial separation of the entire vertebral column, the noted transverse cuts then representing divisons to this column (providing soup/broth bones) rather than carcass sectioning (Audoin-Rouzeau 1987, 36).

The division of the limb bones from the rest of the carcass – and indeed subdivisons between the various parts – can be divided into either cuts at the joints (through or adjacent to the articular surfaces) or through the shafts of the limb bones, referred to in the following text as J and JS respectively (as shown in Table 17). The application of both methods at each of the dressed carcass limb joints/skeletal parts may be indicative of a non-uniform approach to butchering, however, there is also the possibility that the shaft cuts may represent the next stage in the sequence, breaking up the bones for marrow extraction or stewing purposes. The articular end cuts are notably more frequent compared to those through the shaft with the notable exceptions of the scapula and pelvis. In the former case, the JS cuts are often through the midshaft, almost certainly referring to breakage following jointing, while in the pelvis chops, the concentration of cuts through the ilial blade (14 cases) and perhaps through the ilial shaft (eight cases), both anterior to the pelvic joint, can be equated with the sectioning of the vertebral column (chopping through the sacrum). The large quantity of joint cuts are mainly composed of transverse cuts separating the ilial (anterior) and ischial (posterior) parts of the pelvic joint. However, there were also a few grazing/superficial chops (three cases) which probably relate to butchery seen at the proximal femur, removing the caput or head. Similar grazing chops removing part of an articular end were also observed in the shoulder, elbow and knee joints, accompanied by heavier butchery removing the humerus distal condyle, the entire proximal end of the femur and the distal condyles of this same skeletal part. The ulna was generally chopped through the base of the articulation with the distal humerus. It would appear that the heavier method, removing all or a major part of the articular end, was less frequently utilised compared to the lighter method, with the possible exception of the ulna and the pelvis (referring to the sectioning chop through the joint). This is perhaps shown by the low proportion of pelves with an intact joint surface (at least the ilial and ischial parts).

The skull and mandibles were undoubtedly an important source of ‘lesser’ meats and the utilisation of these is shown by a variety of cuts. The most frequent are ‘halving’ or splitting chops through the skull (probably intended to facilitate removal of the brain) and cuts intended to separate the mandible (J – grazing through the condyler process or JS – removing both the condyler and coracoid processes). Otherwise there are a number of sectioning cuts both through the skull and the mandible (HVS), these most probably representing the production of soup/stew bones.

It is of interest to consider whether these subdivisions of the carcass were undertaken after defleshing or whether these parts were cooked with the meat still attached. Relatively few defleshing marks were observed, either to the skull/mandibles or any other part. However, this does not necessarily suggest that meat was preferentially eaten on the bone as this type of butchery, particularly made using a knife, would undoubtedly be under represented. Notably six out of the 38 recognised defleshing cuts were made with a knife, whereas the use of this instrument was observed in eight out of the 86 cases with jointing cuts. While not conclusive, this may suggest that knife butchery was more frequently used for defleshing purposes and therefore that defleshing cuts may be less well represented. A similar argument could be used for dressing with knife cuts observed in five out of the 18 cases. Returning to the question of use of meat on or off the bone, it was found that a large proportion of the limb bones were split, such cuts in fact accounting for a large part of the observed butchery (SP in Table 17). It can be proposed that this butchery was undertaken when the limb bone was intact or nearly so, this necessarily following the removal of the meat. The butchery evidence undoubtedly shows a degree of variation, several transverse cuts demonstrating either the cooking of meat on the bone or alternatively meat removal with cooking accompanied by stew/broth bones; however, the wealth of split bones clearly shows that a large proportion of the cattle limb bones were defleshed followed by splitting, facilitating removal of the marrow.

Cleaver marks are again much in evidence amongst the sheep/goat and pig butchered bones, despite the probable preferential usage of the knife in relation to such smaller domesticates compared to cattle. The latter utensil was observed in just 14 sheep/goat and two pig bones, *i.e.* 6.2% and 4.1% of their respective totals with butchery marks. Most of the butchery stages are represented within the sheep/goat collections although some are clearly more frequent than others, such as skinning (49 cases), jointing (66 cases), brain removal (31cases) and marrow extraction/splitting (62 cases). The first essentially refers to horn removal following the same premise described for cattle. Apart from a single sheep skull with a knife mark adjacent to the horncore, the observed cuts include chops through the base of the horncore (comprising three sheep/goat, 23 sheep and 13 goat skulls), these produced from a variety of directions; and oblique lateral chops, often through or just posterior to the orbit, intended to remove both horns (four sheep and six goat skulls). It would appear that the former method was preferentially employed with both sheep and goat skulls, this perhaps being confirmed amongst the relevant skull pieces (containing part or all of the horncore), a large proportion of which consist of horncores broken through at the base. Notably, cut marks were observed amongst 21.4% and 33.3% of such sheep and goat skulls respectively. It was mentioned above that the plethora of goat horncores may indicate the transference of various parts for craft purposes. This could include their horns and skins, the former still attached to the latter. The butchery evidence referring to the removal of both horns would tend to confirm such combined imports, although taking the more common cut into account, it would appear that horns may well have generally arrived without the skins.

Sheep/goat jointing cuts were principally type J (45 cases) and were observed in most of the joints, although in particular the pelvic (11 pelvis and one femur) and elbow joints (six humerii and three radiuses). The former examples included nine cases chopped through the acetabulum and two with nearby superficial chop marks, while the femur was chopped through, removing the proximal end. Cuts of type JS are also well represented, with all but one of the 21 cases observed being on pelvis fragments. As with cattle, these cuts were mainly through the ilial blade and shaft. This butchery phase was probably followed by defleshing and again (with comparison to cattle) the principal implement used may well have been the knife. There were 11 cases of sheep/goat defleshing, six with knife cuts, compared to just three which can be interpreted as jointing butchery. Finally, there is the wealth of bones which have been split, including several skull pieces (sheep and goat) and a wide variety of limb bones. Most of these are metapodials (52 cases), comparable to the evidence for cattle butchery, although here there appears to be a particular pattern of fragmentation. These bones tend to be split through the distal articulation with breakage through the shaft close to the proximal end, thus essentially showing a diagonal rather than an axial split. This butchery, as with the other limb bones, would presumably facilitate removal of the marrow. In terms of the notable quantity of split metapodials, the quantity of marrow extracted would justify the means for the larger cattle bones, although perhaps not for the equivalent smaller sheep and/or goat bones.

The pig butchery evidence also covers most of the stages although largely restricted to jointing (16J and 2JS) and splitting. The former includes most joints (although notably with five pelves chopped through the acetabulum) and the latter is essentially axial, the 15 cases comprising four skulls, five mandibles, an axis and a sacrum, and four pelves. In addition, there are four dressing cuts (decapitation with chop marks to the occipital condyles of one skull fragment and top of the anterior articulation of three atlases) and just five defleshing marks (including both bones with knife cuts).

Age and Sex
(Tables 18-24; Figs 7-16)

The age of the major domesticates has been calculated using the mandibular and epiphysis fusion evidence. Notably, the descriptions of the teeth follow Grant (1982) with reference to Tooth Wear States (TWS) and Mandible Wear Stages (MWS). In addition, the data from both methods has been combined, alongside other evidence relating to the identification of bones from younger individuals (see Methodology), in order to assess the relative proportion of this age group. While the mandibular evidence undoubtedly offers a more complete and objective view of age diversity, this combination of methods includes evidence from all parts of the body, thus allowing for any possible biases resulting from differential fragmentation and survival to be accounted for. An approximate quantification of such youngsters is provided by a comparison with the number of identifiable adult bones within these collections.

Turning first to the cattle mandibular data, the evidence shown in Table 18 and Fig. 7 clearly demonstrates a rather mixed mortality distribution with approximately equal proportions of pre-adults (Age Groups (AG) 1 to 4) and adults (AG5 to 7). There are peaks at AG3 and AG4, approximately later first and second year animals (after Schmidt 1972, 7) and broadly similar proportions amongst the adult age groups although with a notable peak in AG7. This data is compared to the somewhat more detailed method used by O'Connor (1991, 250), as shown in Table 19 (and see Table 20). The Immature (I) and the subadult (SA) groups are similar to AG3 and AG4, resulting in a corresponding AG3 and I peak. Notably, however, the division of the AG4 into SA1 and SA2 suggests that the second pre-adult peak is largely composed of animals closer to 16 than 24 months (*i.e.* following the eruption of the third adult molar). There is a notable overlap between the adult age groups in each method with the exception of AG7 which is essentially O'Connor's Elderly (E) group. However, most of the adult mandibles provided third molars in moderate or greater wear (TWS 'e' and greater), corresponding to O'Connor's groups A3 and E. The approximate age of the mandibles amongst these age groups can be gauged with reference to the work of Jones and Sadler (2012), thus A3 can be related to mandibles older than 3 years, while those in AG6 (TWS of 'g' or greater) are at least 3.5 years old (*ibid*, 16). Mandible wear stages could be calculated for 30 out of the 32 mandibles in AG7, with the majority between MWS 44 and 50, alongside two older examples with an MWS of 50 to 52 and the oldest with an MWS of 54. Most of these animals were probably in excess of 6 to 7 years old while the latter example may well be in excess of 15 years of age (*ibid*, 18).

There is a rather broad agreement between the cattle mandibular and epiphyses data (see Table 21 and Fig. 8), at least in relation to the major proportion of second year animals (the difference between the fused early and unfused Intermediate epiphyses compared to the AG4 mandibles) and older adults (fused Late epiphyses and probably the AG6 as well as the AG7 mandibles). The notably poor representation of first year animals (unfused Early epiphyses) compared to the mandibular evidence is difficult to explain, unless this data highlights a difference in terms of the butchery and/or deposition of these younger individuals. However, this age group is certainly better represented in the combined data (Table 22), taking account of obviously juvenile or younger bones amongst the Intermediate and Late fusing epiphyses as well as those in the Early group. Juvenile is used here with reference to the latter age group, noting unfused limb bones of a similar size, as well as mandibles in AG2 and 3. Clearly this group includes both the 'Juvenile' and 'Immature' mandibles described in the O'Connor method. The presence of very young calves is also demonstrated, indicating animals no more than a few days up to a few weeks old. Notably, none of these bones had cut marks and it could be assumed that most, and especially the foetal/neonates, represent the remains of infant mortalities. This eventuality could almost certainly account for the concentration of neonate bones found in the fill of the sunken-featured structure/pit (7019; a single bone from hand collection and a further 15 including skull, humerii, vertebrae and ribs from the sample), undoubtedly representing the remains of a single individual.

This data shows that the cattle provided to this settlement included a large proportion of animals which had been bred for their meat (the pre-adults) which were culled at specific ages; this occurred alongside a similar or possibly slightly larger proportion of older individuals including prime beef stock (third and fourth year cattle) but principally surplus dairy and/or work animals. The sex evidence would appear to indicate a variety of sources, with the pelvis data suggesting somewhat more males than females (Table 23), contrasting with a greater proportion of females compared to males using various metacarpal measurements (see Figs 9 and 10). Relatively distinct groupings are apparent in each of these figures and it can be assumed that the larger sized bones forming the group at the top right of these charts can be interpreted as male with female at the bottom left. Owing to the age of fusion of these respective parts, the pelves data clearly represent second year and older cattle while all the metacarpals are from animals at least three years of age. Thus the pelves will include sub-adult as well as adult cattle and the mandibles exclusively adults. This may explain the greater proportion of males amongst the pelves where it can be expected that more males than females would have been culled for their meat in their second year. It can also be supposed that most of these males would have been castrates, as demonstrated by a rather small proportion of identifiable bull horncores (see below).

The sheep/goat mandibular data also demonstrates a diverse pattern, again with a somewhat better representation of pre-adults compared to adults (see Table 18 and Fig. 11). However, most of the mandibles relate to animals in AG3, AG4 and AG5, the former two groups signifying individuals in their late first and second year (after Schmidt 1972, 77). AG5 can be interpreted as young adult and corresponds to Stages E and F in Payne (1973, 293) which would suggest they represent animals aged in their third and fourth years of life. There is a relatively large quantity of older mandibles, specifically in AG6 (Payne Stage G – 4 to 6 years) but clearly without the older mortality peak observed in the cattle mandibular age pattern. The greater detail available in the O'Connor (1991) method and also in the plotting of the distribution of Mandible Wear Stages (Table 19 and Fig. 12) clearly show that the majority of the pre-adults belong in the Immature and the first sub-adult groups, representing MWS peaks at 9 and 22 respectively. These peaks suggest a cull at closer to 6 months of age and (as with cattle) another in the first half of their second year. In terms of the adult distribution, the O'Connor method appears to show a greater proportion of older adults compared to the AG5 and AG6 pattern (comparing Tables 18 and 7.19). However, this is clearly related to the make-up of the defining attributes of these respective groups causing a confusing overlap. The Mandible Wear Stage results show that most of the adult examples are within AG5 (MWS29-36), which overlaps with the tail end of A2 (MWS31-33) and in particular with the beginning of A3 (MWS33 to 42). The MWS peak at about 33/34 is within the Payne Stage F suggestive of an age between 3 and 4 years, while the extension through to MWS42 is almost exclusively within Stage G or 4 to 6 years. Finally, the oldest specimen (at MWS49) is clearly within Payne Stage I (8 to 10 years).

A similar age pattern is demonstrated by the epiphysis evidence (Table 21 and Fig. 13), with comparable proportions of unfused Early epiphyses (fusing at about 2 months) and mandibles in the AG2 and J age groups (8% and 6% respectively); likewise, the proportion culled following the fusion of these epiphyses and before the fusion of the Intermediate epiphyses (at about 2 years) – the former equalling 38% and the latter about 47%. The adult groups featuring young adults (prior to fusion of the Late epiphyses) amount to 21.1% compared to 34% after fusion (Late fusion at 3.5 to 4 years). These proportions clearly do not accord with those provided by AG5 and AG6, but closely follow those produced by A1/A2 and A3 (18.8% and 27.5%), perhaps suggesting that the latter group is mainly composed of mandibles from animals of at least 3.5 to 4 years of age. This would certainly correspond to the age pattern described above (referring to Payne's Stages F and G).

The juvenile age group used in Table 22 again refers to first year animals and thus includes the AG2 and AG3 mandibles as well as the limb bones with unfused Early epiphyses or those of an equivalent size amongst other unfused epiphyseal ends. This group undoubtedly provides a major proportion of the Phase 3 sheep/goats represented at this site. The youngest age groups (foetal/neonate and infant) are clearly present in rather small numbers, the latter group probably including the youngest of the AG2 mandibles. There is again a possibility that these represent infant mortalities, although with this species, there are no obvious articulations and at least one of the infant bones, a femur from pit 6142 (Area B) is clearly food waste, as demonstrated by a knife mark to the midshaft.

In comparison to the cattle data, the sheep/goat age evidence also demonstrates the relative importance of the selection/import of animals bred for their meat as well as those initially utilised for some secondary product, in this case either milk and/or wool. There are similar age distributions amongst the pre-adults (specifically Immature and Subadult 1) suggestive of common husbandry practices, while those used for purposes other than meat production tended to be culled before reaching the advanced age of a sheep/goat equivalent of a working cow, oxen or bull. The sex evidence, using the pelves (see Table 23) shows a substantial majority of males, presumably castrates (wethers). As previously stated, the age of fusion of the acetabulum (one of the Early fusing epiphyses) allows this data to include younger as well as older animals and thus a proportion of the pelves may represent the cull of first and second year males, perhaps fattened for the table. However, in relation to adult individuals, this evidence suggests the import of surplus wool producers, perhaps taken from a wether flock. The horncore data (see Table 14) may confirm this assumption, with the great majority of these clearly representing adult individuals. However, while it is certainly possible to identify ram horncores, it is far more difficult to separate wethers from ewes. This basic separation is clearly visible in Figs 14 and 16, with rams (originally identified on morphological grounds) at top right and wethers/ewes at bottom left. It is worth noting that there do seem to be rather more ram horncores present in this collection than would be expected, reflecting albeit to a lesser extent, the preponderance of male as against female goat horncores (see Table 13 and Fig. 15). The latter distribution pattern undoubtedly suggests the import of raw material for hornworking purposes and it can perhaps be suggested that these same workshops were instrumental in the notable overrepresentation of ram horncores.

The pig mandibular data clearly shows the dominance of pre-adults, encompassing about 70% of the AG1 to AG4 and J to SA2 age groups (Tables 18 and 19, and Fig. 18). Most of these were culled following the eruption and wear of the first adult molar, at about 6 months of age, with the O’Connor method illustrating two major peaks at I2 and SA2, possibly conforming to late first and later second/early third year animals. The adult individuals were mainly culled as younger adults when the third molar was still in relatively early wear, within groups A1 and A2, although in particular within the latter age group within an age range of about 2 to 2.5 years (after O’Connor 1991, 249). This corresponds (using the Grant method) to a peak at about MWS35, the adults extending, albeit rather sparingly, to a maximum of MWS49. The epiphysis data indicates a very similar adult survival, as demonstrated by the Intermediate age group, but appears to suggest a markedly greater proportion of second year animals, contrasting with the somewhat better representation of first compared to second year mandibles. However, this may relate more to the overlapping age ranges of these age groups rather than any suggestion of differential usage. A notable comparison can be made with the proportion of older mandibles in AG6-7 (9%), with the proportion of fused Late epiphyses (13.1%). Apart from indicating a reasonable survival of animals aged at least 4 years old, this also shows that most of the adults in these groups were culled in their third and fourth years. While the combined data demonstrates a major proportion of juveniles, it should be noted that this age group may well be underrepresented due to the evident disparity between the mandibular and epiphysis results. This again illustrates a small proportion of very young individuals although without any obvious foetal/neonates. Some of the infant bones may well represent partial articulations, as shown by three similarly aged bones each from well 1132 (Area C) and pit 6341 (Area B). None of the infant bones had been butchered.

Pigs are essentially utilised for their post-mortem products and this is undoubtedly shown by the wealth of first and second year animals. The inclusion of a good proportion of older individuals, probably including those in their fourth as well as their third year, suggests the production of animals with more mature meat, while the few older animals probably represent surplus breeding stock. It is proposed that the mandibular peaks within age groups I2, SA2 and A2 represent seasonal culls, perhaps coinciding with the late autumn into early winter availability of pannage enabling their fattening prior to slaughter (Albarella 2006, 84). The sexing evidence (Table 23) based on the mandibular canines, shows a generally better representation of males compared to females, essentially following expectations, where a greater proportion of sows would be kept for breeding purposes compared to boars. Examining this collection in more detail, based on the wear of the canines and any associated teeth it was found that while males clearly outnumber females amongst the first year animals, there is a much closer match of sexes in the older age groups (see Table 24). In terms of the more complete mandibles, the ratio of males to females was as follows: AG3 12:1, AG4 8:9, AG5 4:8 and AG6 2:5. There would appear to be progressively more females slaughtered moving into the second and third years, perhaps culminating with the anticipated result – a heavy female bias – amongst the older pigs.

Animal Size
(Tables 25-31; Figs 20-26)

The size of the major domesticates in terms of shoulder heights and summary statistics for the better represented measurable parts is shown in Tables 25 to 31 and accompanying Figs 20 to 26. Of interest here is the remarkably similar size and shape of each domesticate throughout the Anglo-Saxon and subsequent phases. A major aspect of any such study is to determine whether the stock was either locally reared or whether animals had been driven some distance to the town. It can be supposed that a wider range of sizes (perhaps 'types') might be expected with the latter scenario, although any such study will inevitably run into the problems of sexual dimorphism as well as the unknown degree of variation within herds/flocks prior to the more stringent breed specifications of the late 18th into the 19th century. The similarity noticed amongst the domesticates from this site suggests no more than local variation, although there are some subtle differences which are referred to in later sections. An estimation of 'type' is essentially limited here to the convenient division of cattle horncores according to their length as described by Armitage and Clutton-Brock (1976) and the quantification of certain non-metric traits. The horncore data shown in Table 27 highlights the predominance of the Short and Medium horned 'types', these congregating in the right hand half of Fig. 22 (plotting length against maximum basal breadth), with a possible group division at Loc = 150mm and Bmax = 53mm. A large proportion of the horncores were incomplete. However, it was possible to estimate the length category for these bones by comparison to the more complete specimens, as well as to the large quantity of Late Saxon and medieval horncores found at Castle Mall in Norwich (Albarella *et al.* 2009, 46). Thus it can be suggested that the majority of the horncores were contained within the same two size categories. The representation of smaller and larger cores is demonstrated in Fig. 23, using the two basal dimensions, where it can be supposed that those cores with a Bmax less than 40mm are either Small or Short Horned, while similar basal breadth measurements beyond 65mm could represent Long Horned individuals.

Non-Metric Traits
(Table 32)

Non-metric traits (various congenital skeletal features) can potentially provide information about the genetic make-up of local populations insofar as a particular trait may be under or over represented depending on the level of isolation of the herds/flocks supplying the Anglo-Saxon settlement (following Johnstone and Albarella 2002, 22). The various traits were recorded as either present or absent and include, for cattle and sheep/goat, skulls without horncores (polled), the absence of the lower second premolar as well as the absence or reduction of the hypoconulid (third cusp) of the lower third molar; and for pigs, the absence of the lower first premolar and of the *supra-trochlear foramen* in the distal humerus. The quantification of these various traits is shown in Table 32 which shows that those attributed to cattle and sheep/goat are rather infrequent, contrasting with the abundance of the pig non-metrical traits. Indeed, the cattle premolar and molar anomalies account for 2.5% and 2% of the Phase 3 mandibles while the second premolar was absent in only 1% of the sheep/goat mandibles. In addition, the two polled examples must be compared to the 109 horned sheep skulls (*i.e.* 1.8%). The significance of these results must be gauged against the records of similar anomalies recovered from contemporary site assemblages and preferably from those in the general locality. Unfortunately, this information is generally unforthcoming in the majority of animal bone reports and, when it is available, is almost universally limited to dental anomalies. This information tends to be available from sites with notably large assemblages, with those most relevant to the Phase 3 collections at Stoke Quay being Middle and Late Saxon/Viking Flixborough, Lincoln, Coppergate and *Hamwic* (information from Dobney *et al.* 2007, 181-2); medieval West Cotton (Albarella and Davis 1994, 12); and closer to Ipswich, the early medieval assemblage from Castle Mall, Norwich (Albarella *et al.* 2009, 44). The results in relation to the dental traits from these sites are somewhat variable, with each anomaly tending to be present in less than 3% of cases, although with absent cattle second premolars accounting for 6.8% of the mandibles from Anglo-Scandinavian Coppergate and 10.9% of those from *Hamwic*. The West Cotton cattle mandibles dating to the early medieval period feature five out of 58 (9%) with reduced or absent third molar hypocondulids. Data concerning the pig traits is available from a number of Saxon and medieval London sites as well as medieval Oxford, specifically referring to the Royal Opera House and No. 1 Poultry in London and the Clarendon Centre in Oxford (data taken from MoL and PCA archives). All of these demonstrate similar results, essentially following the information from the subject site, with approximately 45-50% of the mandibles and 25% of the humerii with absent first premolars and without the *supra-trochleare foramen* respectively. The similarity in the proportions of these various traits may suggest, particularly in terms of the pig anomalies, that such analyses provide little information of value. However, the variation within the dental results offers some indication that this data could supply information relevant to population studies. Clearly, a greater body of data is required to elucidate the potential value of non-metric traits.

Pathologies

(Table 33; Figs 27 and 28)

There are a number of bones within the domesticate collections which show pathological conditions (Table 33). Most of these cases can be described as displaying a variety of oral conditions, some form of joint disease or the effects of a traumatic event. None of these conditions was particularly common but some are clearly more frequently encountered than others. Amongst the oral conditions there are a number of maloccluded sheep/goat and pig tooth rows, usually mandibular, and generally involving the abutting of the fourth adult premolar into the first adult molar. However, there are also a number of rotated adult premolars with two and four cases amongst the sheep/goat and pig collections respectively. It can perhaps be assumed that these are more likely to be related to congenital defects rather than the result of some pathological condition. The same may be conjectured for those teeth showing exaggerated crown heights (apparent on three cattle mandibles - the anterior part of a second adult premolar and the posterior cusp of two adult third molars), in the sense that the opposing tooth may have been absent rather than lost. Notably, all three domesticates suffered ante-mortem tooth loss. This particular pathology was most probably related to the culminating effects of periodontal (gum) disease, this clearly being shown by those cases with alveolar depression. While typically mandibular, this condition was also shown by a sheep/goat maxilla, no doubt exacerbated by the marked tipping and rotation of the third and fourth premolars respectively (see Fig. 27). A gross infection is evident on a pig mandible with a large abscess situated directly beneath the first adult molar.

Most of the bones described here as showing joint disease essentially exhibit some level of osteophytic lipping at or adjacent to the margins of the articular surface. In cattle these include four tarsals, three proximal metatarsals and a phalange, the last with particularly severe exotoses at the peripheral and axial distal margins. In addition three of the tarsals, all navicular cuboids, are pitted on the distal/anterior surface, perhaps suggestive of the formative stages of osteoarthritis. In sheep, this condition is limited to the elbow joint, entirely on the lateral extremity of six distal humerii and two proximal radiuses with two and one case respectively showing rather large bony growths. These conform to the classic description of 'penning elbow', suggested as occurring due to injuries sustained when animals were put through races or pens. However, this interpretation may be subject to review, with recent research indicating a series of causative agents beyond husbandry practises, including the environment, joint morphology and age (Clark 2009, 162). There is also a sheep metatarsus with a swollen proximal end perhaps related to some non-specific infection. The potential cases of osteoarthritis noted above are accompanied by a number of certain examples of this disease, each displaying at least three of the requisite features (see Baker and Brothwell 1980, 115) – osteophytic lipping as described above but often accompanied by the remodelling/extension of the affected joint, as well as polishing (eburnation) and in one case, grooving, of the articular surface. It is perhaps significant that the osteoarthritic cattle bones were all from the posterior half of the skeleton, a sacrum, two pelves, two proximal femurs and two metatarsals (a proximal and a distal).

Traumatic injuries were seen on bones belonging to a variety of species and skeletal parts. In the Middle Saxon phase, the major domesticate examples are mainly composed of bones with partial fractures although there is also a single cattle metatarsus with a slight haematoma on the lateral surface of the shaft, resulting from the impact of some blunt instrument (?a kick or perhaps being pushed against a fence pole). Otherwise the cattle bones include breaks to the mandibular condylar process and to the distal part of a metatarsus (this same bone also showing an advanced case of osteoarthritis), as well as a longitudinal break to a calcaneus which may be related to a muscle tear. Injuries in pig are represented by two damaged scapulae, one with a similar break to the cattle calcaneus (?muscle tear) and the other with a broken spine. There is a single sheep metatarsus with a notably large callus close to the proximal end but without any deformation of the shaft. The few bones with ossified soft tissue could be included in this category.

Developmental and possibly stress-related disorders are indicated by small collections of sheep horncores and cattle foot bones respectively. The first includes two sheep horncores, each with 'thumbprint' depressions on the medial surface. While originally attributed to castration, the major causative agent for these indentations would appear to be related more to malnutrition (Clark 2009, 163). The second group of bones all demonstrate profound asymmetry, shown by a metacarpus with an elongated lateral distal condyle and three first phalanges with peripheral extensions, two at the proximal end and one at the distal end. While this is still a matter of some debate, it has been suggested that this condition of the foot bones may have resulted from traction stress (see Bartosiewiecz 2008, 158 and Albarella *et al.* 2009, 44).

Further congenital defects may be indicated by the fusion of two cattle tarsals, a navicular cuboid and a cuneiform; and also by a singularly unusual pig scapula where the spine appears to start at the mid part of the blade. This bone has a notably broadened posterior edge which may have formed in response to the absence of most of the spine (see Fig. 28).

Other Food Species
(Tables 34-35; Figs 29-33)

The remaining and much smaller portion of the meat diet (see Table 34) was met by a relatively broad array of food species including other domesticates (poultry) as well as various game animals and birds. Poultry are clearly numerically the most abundant, comprising notable quantities of chicken and goose with some duck (although a proportion of the goose and duck bones may be wild rather than domestic). Certainly there is no obvious difference in size between these bones and their wild progenitors, greylag goose and mallard. However, considering the rather small quantity of bone from game species in these collections the evidence base is so limited that, equally, it can be assumed that the majority (if not all) the goose and mallard sized duck bones belong to domestic types. The great majority of the chicken remains and indeed all of the goose and duck bones are from adult individuals, no doubt suggesting that these birds were principally kept for their eggs. A notable presence of juvenile chicken suggests the occasional usage of more succulent meats as well as the cull of young males. There are also a few very young birds, which may be indicative of a particular delicacy or more likely signify that a proportion of the chickens represented in this assemblage were locally produced.

There is a clear predominance of female chickens (Table 35), demonstrated by the presence/absence of spurs on the tarsometatarsus. The alternative sexing evidence, using medullary bone, an internal accumulation related to the egg laying cycle (Driver 1982), also shows a high proportion of females. This analysis was limited to the tibias and in this phase it was found that 26 out of a total of 84 adult tibias contain some medullary bone. Plotting the size of those bones with and without this accumulation (see Figs 29 and 30) appears to suggest a somewhat higher proportion of males. Each scatterplot displays two concentrations of points, those to the bottom including the examples with medullary bone. Such different results may be expected if there were significantly more tibias or tarsometatarsuses, a bias towards the latter foot bones perhaps suggestive of preparation or butcher’s waste. However, most parts of the chicken skeleton are equally well represented. Assuming that the evidence related to the foot bones is more accurate, it follows that a large proportion of the hens were culled when they were not producing eggs. This may simply be seasonal or otherwise following a decline in their egg laying abilities, no doubt related to age, referring in modern terms to ‘old boilers’. The same argument can perhaps be used to explain the total absence of medullary bone amongst the collections belonging to the other two poultry species, although this absence may also relate to the smaller quantity of bone, particularly in terms of the domestic duck.

A number of chicken bones display visible signs of trauma and disease. The former include a probable broken sternum (the anterior keel is skewed slightly), a small haematoma on the anterior surface of a tibia and three tarsometatarsal breaks (all from female birds), one at the midshaft and two adjacent to the distal end, one of which has healed with a profound bend of the distal end to the posterior (Fig. 31). Another tarsometatarsus, from a male bird, has ossified soft tissue adjacent to the spur, perhaps related to a possible fracture or to undue stress at this part of the foot (a suggestion of fighting stress, either domestic or possibly through organised cock-fighting). In addition, there are two cases of joint disease, both tibias, one with slight epiphytic lipping at the proximal end and the other with a notable exotoses at the lateral surface of the distal end. Also of interest in the assemblage of chicken bones is a tarsometatarsus, from an adult hen, with a pronounced ulcer-like lesion adjacent to the proximal end on the medial surface (see Fig. 32). This was one of a pair, with a lesion only seen on the left foot bone. A goose humerus displays a particularly gross pathology, having undergone the successful, although overlapping and skewed, reformation of a compound fracture (Fig. 33).

There is a notably diverse range of game animals and birds within a rather small number of bones. A large proportion of this collection clearly represents working debris rather than food waste. Subtracting antler fragments, the deer collection reduces to just three red and four roe deer fragments. It can also be supposed that the three cetacean bones are working waste, possibly representing the mid parts of large bones (perhaps scapulas) taken from one of the smaller cetaceans, perhaps a small whale rather than a porpoise or dolphin. Another portion of this potential game collection is probably redeposited (*i.e.* the rabbit bones), with six fragments, all part of a right forefoot, from the sieved contents of the sunken-featured structure/pit (7019, Area A) and a single bone from pit 6142 (Area B). Both deposits appear to be securely dated to the Middle Saxon period. However, it is generally agreed that rabbit was introduced to this country by the 12th century (Sykes and Curl 2010, 122), this date conforming to its first appearance on archaeological sites (Sykes 2006a, 166-7). While rabbits have been found on Anglo-Saxon sites, it would appear, following re-analysis, that these tend to be either misidentified and//or residual (Sykes 2007 in Sykes and Curl 2010, 121). There is nevertheless the possibility of individual imports, perhaps highlighted by the dating evidence; however, the weight of evidence would suggest that the few rabbit bones from this site are very likely to be intrusive. Excluding these items, game food waste appears to be limited to features in the northern part of the site. There was, for example, red deer, roe deer and swan from pit 6830 (Area B), and heron from the nearby pit 5702 (Area A), both adjacent to fence line 4005, as well as a collection of wing bones (radii, ulnii and carpometacarpals) from at least three middle-sized ducks from pit 9813 (Area B). In addition, a particularly large pig astragalus (length of 59.2mm, see Table 30) – a possible wild boar – was found in pit 11792, also in the northern area (Area A). This distribution may conceivably relate to the status of the households responsible for the deposition of waste in these respective areas. There was undoubtedly an association between game (especially deer) and status during this period, with both the time required as well as the requirements of the chase tending to preclude all but the more affluent members of Middle Saxon society (Hagen 1995, 132-40). This is confirmed by the archaeological evidence, where in a review of bone collections dated to this period, it was found that the greater proportion of wild animals tended to be recovered from high status sites (Sykes 2006a, 162-4). The poor representation of game at the Stoke Quay site clearly suggests the rare usage of such comestibles, possibly restricted to special occasions and then perhaps, based on the perceived distribution pattern, only used by a select number of households.

Non-Food Species

As well as the food species, this collection also features a relatively substantial quantity of equid, dog and cat bones. The first two species mainly derived from just two features, with 60 equid and 45 dog bones each representing single adult individuals from wells 1031 and 10572 respectively, both in Area C. The former skeleton, possibly a mare considering the shape of the pubis, is largely composed of the axial parts (vertebrae and ribs) although both femurs are present as well as much of the remainder of the right hindleg. Several of the thoracic vertebrae display slight exotoses at the anterior margins of the dorsal articulations. This may be indicative of a type of joint disease, perhaps in response to the stress of work and/or the age of the animal. It was not possible to ascertain an age for this animal due to the absence of suitable teeth, however, the vertebrae are semi-fused, suggesting an age of no more than 4 to 5 years. The remainder of the equid assemblage is very thinly distributed amongst a further 25 features. In the absence of butchery marks, it can be suggested that this level of disarticulation is probably related to redeposition and/or the action of scavengers, with whole carcasses dumped or perhaps partially buried in this area at some time prior to the onset of dense pitting. The partial skeleton found in well 1031 may be a later addition to this collection. However, the partial usage of such carcasses cannot be discounted – perhaps these animals were flayed, this aiding the disarticulation process. A number of complete bones from well 1031 were measurable, providing an average shoulder height of 1322.6mm. Another two shoulder heights could be calculated from the bones found in the other features, both larger than the equid from well 1031 – at 1453.8mm and 1390.5mm.

There was a similarly poor distribution of the remaining dog bones, with 14 fragments scattered across another nine features. These represent at least another two individuals although, incorporating the age evidence, this extends to at least three with a juvenile (early epiphyses unfused, following the fusion sequence of the major domesticates), a sub-adult (intermediate epiphyses unfused) and an adult. The adult skeleton from well 10572 features a general mix of parts but with no head. This individual had clearly suffered one or possibly two traumatic events, as shown by bone formation (calluses) on the proximal half of one rib and on the distal half of another rib. Both breaks are well healed suggesting that these events were not related to the cause of death. There are several limb bones which provide an average shoulder height of 617.8mm. Unfortunately, the other dog remains are rather more fragmented and there are no further complete limb bones. However, a number of these bones could be measured, demonstrating at least one dog of a similar size to that from the well and one somewhat larger.

The cat bones were divided amongst 16 features, most providing no more than one or two bones. Several features produced at least five bones, while two groups, from a pit 7156 (Area B) and a ditch 9182 (Area D) had ten and 11 bones respectively. Taking skeletal part and age into account, this collection represents at least nine individuals, comprising one very young kitten, one juvenile, one sub-adult and six adults. One of the smaller partial skeletons, an adult comprising five bones from pit 11060 (Area D), features an ulna with a mid-shaft fracture. While totally healed at the junction of the break, the shaft distal to the mend is bent laterally through about 45 degrees to the longitudinal axis of the bone. It can be supposed that the adjacent radius may well have been similarly fractured and malformed.

Finally, the Phase 3 non-food waste also includes three corvid bones, two wing bones (a humerus and coracoids) from an adult raven taken from the fill of pit 6341 and another coracoid from a carrion crow or a rook which was recovered from pit 1093: both these pits lay in Area B. In addition, a radius (wing bone) from a large gull, probably a herring gull, was found in pit 5702 (Area A).

Late Saxon (mid 9th to late 11th centuries: Phases 4, 4.1 and 4.2)

Distribution

An assemblage of 8,358 bones (of which 3,722 were identifiable to species) came from features and deposits assigned to Phase 4, with an additional 1,782 bones (836 identifiable to species) from Phase 4.1 in Area A. This notable concentration of pits and other features were followed by numerous graves (Phase 4.2) associated with the cemetery of St Augustine. A few other pits lay to the south, concentrated adjacent to the eastern part of a fence line (4013). Most of the faunal assemblage came from the northern part of the site (about 90%), largely deriving from pit fills (see Table 4), although a notable quantity was retrieved from a well in Area B (fill 6143, well 6142). The grave fills produced 383 animal bones from 35 graves: this redeposited material had undoubtedly been disturbed from earlier phases during grave digging. Only 11 features yielded moderately sized collections (greater than 100 bones), including ten pits and the well, with all but one (pit 9188, Area C) located in the northern part of the site.

Major Domesticates

Species Representation

The Late Saxon bones were divided according to those pre-dating the burials (Phase 4.1, essentially taken from pit fills in the northern part of the site, Area A), those from features to the south of this cemetery and a lesser quantity from the grave fills. As noted above, the latter two groups were assigned to Phases 4 and 4.2 respectively, but are considered here collectively as Phase 4 (see Table 4 and Table 7 which details the bones from the Phase 4.2 grave fills). Both collections provide similar proportions of cattle, sheep/goat and pig bones, in terms of total fragment and Epiphyses Only counts as well as by weight (Tables 8-10). The results closely follow the domesticate pattern described from the previous phase. This similarity also extends to the individual feature collections, where the Type 1 abundance pattern (C>S>P) was found in five out of the 11 suitably sized collections, followed by three Type 2 (C>P>S), two Type 3 (C>S=P) and one Type 5 (S>C>P). Two of these collections were from the pre-cemetery pits, displaying one each of Types 1 and 3, the former type also exhibited by the contents of the overlying grave fills (Table 7). The distribution of these various abundance types, as with Phase 3, does not appear to be related to the location or the quantity of bones.

Skeletal Representation
(Tables 36-38)

As was the case in the preceding period, there is a rather homogenous spread of cattle, sheep/goat and pig skeletal parts, a pattern observed within some of the larger feature collections as well as within the combined Phase 4 and Phase 4.1-4.2 assemblages. The distribution of parts from Phase 4 (including its subsidiary phases) is shown according to the total number of bones in Tables 36 and 37, and then using the previously described Epiphyses Only method, in Table 38. While not visible previously, the latter method appears to show a notably greater abundance of sheep/goat horncores and mandibles relative to the other parts. This is explicable to a certain extent by the relative representation of sheep and goat. The high proportion of goat horncores seen in Phase 3 continues into this phase, as does the rather low proportion of other parts of the goat skeleton. There are, for example, just four goat compared to 37 sheep proximal radii. In addition, just one out of the 45 mandibular fourth deciduous molars displays goat-like characteristics. Subtracting the goat horncores from the total in Table 36 clearly removes the apparent overrepresentation of this part. Again it can be assumed that the goat formed only a minor proportion of the ovicaprid meat intake and that the principal usage of this species on this site was for craft purposes. This is also shown by the wealth of male goat horncores, clearly displayed in Fig. 15.

Age and Sex

There is a somewhat smaller quantity of age evidence from this period compared to Phase 3, although certain broad similarities and differences can nevertheless be observed. Both the cattle and sheep/goat mandibles are represented by a greater proportion of adults (AG5 to 7 in Table 18) with figures of 45 to 48% compared to just over 60%. This is related in particular to a decline in the use of juveniles. Otherwise, using the O’Connor method, there would appear to be similar subadult (SA1) and adult (A3 and E in cattle and A2 and A3 in sheep/goat) peaks, although without the wealth of older cattle. In addition, the mandibles in age group E are all close to MWS45 rather than the MWS range of 46 to 54 seen in Phase 3. The epiphyses fusion evidence, in contrast, displays a very similar Phase 3 and 4 cattle age sequence (Table 21 and Fig. 8) apart from a somewhat diminished proportion of juveniles (the percentage of fused Early epiphyses). Notably, the combined age data also shows less juveniles, down to about 13.7% compared to 18.7% from Phase 3 (see Table 22). However, the sheep/goat epiphysis data does follow the mandibular evidence with a notable proportional increase in both the Intermediate and Late age groups as well as a significant decrease in juveniles (Tables 21 and 22; Fig. 13).

The increase in adults in Phase 4 is marked by a corresponding rise in cows compared to oxen or bulls, as demonstrated by the pelvis data (Table 23), females now providing about 50% of the collection compared to 43.5% in Phase 3. As previously stated, this data will include second year and older cattle, however, there does appear to be a similar female increase in the metacarpal data (Figs 9 and 10), representing animals in their third year or older. The greater provision of adults (featuring more cows) would suggest a probable expansion in dairy production amongst those outlets providing the Late Saxon settlement with beef. The sheep/goat sex evidence, in contrast, demonstrates a very similar proportion of males, again based on the pelvis evidence, with 85% males in Phase 3 and 84.2% in Phase 4. There is a lesser occurrence of ram horncores (14.6% compared to 22.4%) but this may have a greater bearing on craft usage rather than the exploitation of these animals for their meat and secondary products. It can be conjectured that the age and pelvic sex evidence indicates the continued and possibly greater importance of wool production, again with the preferential use of wether flocks.

There would also appear to be an increase in adult pigs, although not to the same extent – the mandibular evidence confirming proportions of 29.8% and 37.9% for Phases 3 and 4 respectively (see Table 19). This again appears to be related to a decrease in juveniles, as shown by the mandibles (Fig. 18) but not by the epiphysis data (Fig. 19) and to a limited extent only by the combined data (Table 22). In addition, while there is a corresponding SA2 peak (Table 19), there is a clear shift towards younger adults (A1 and A2) compared to the A2 peak demonstrated by the Phase 3 data. A close comparison can be made with the epiphyseal data which clearly shows a better representation of adults as well as a diminished proportion of fused Late epiphyses (Table 21). There is, however, an approximately similar sex ratio between these two phases, with somewhat more males overall and parity between the sexes in the sub-adult and adult groups (Table 24). It can be supposed that males as well as females were fattened for the table with, at least in this phase, a preference for late second/third (SA2) and third year (A1 and A2) animals.

Animal Size and 'Type'

There is a slight difference in animal size between the Phase 4 and Phase 3 cattle and sheep/goat assemblages, as indicated by a minor decrease in the mean as well as the upper values of the shoulder heights (Tables 25 and 28). Similar differences can also be seen in the data displayed in the majority of the measurements (Tables 26 and 29). While such differences may simply relate to the much larger collection of data from Phase 3, the apparent change in both the cattle and sheep/goat collections may well signify an actual diminishment in size. Notably, there is no apparent difference between the Phase 3 and Phase 4 pigs, despite a similar disparity in terms of the respective size of the collections. As any change is likely to relate to the management of the stock supplying the settlement with its meat, it follows that the perceived size decrease suggests a corresponding change in the structure or management of the respective herds and flocks. While animal imports may affect their general size structure, a change will also be instigated by a modification in the manner of their use. As previously stated, the cattle bones suggest an intensification of milk production demonstrated by an increase in the proportion of cows. While there is undoubtedly a major overlap in size, cow bones will tend to be smaller than those of oxen and bulls (see Fig. 9). It can then be indicated that the perceived decrease in cattle size may relate to this conjectured modification in supply and herd structure.

The 'type' data again relies on cattle horncores and the information that can be gleaned from non-metrical traits. Neither set of data offers any obvious change(s) to that manifested in the previous phase: the horncores are evenly distributed amongst the Short and Medium Horned categories with a possibility of some larger cores (see Figs 22 and 23; Table 27). In addition, there are similar proportions of the various oral and postcranial anomalies (Table 32), perhaps suggesting similar herd structures or simply 'background' data offering too little information to be of use archaeologically.

Pathologies

(Tables 41-42; Fig. 34)

A number of pathological specific specimens are present. Although they are not frequent, they show a similarly diverse range of anomalies (Table 41 and 42). Oral pathological cases are the most numerous, mainly relating to malocclusion and invariably at the junction of the adult premolars and molars. There is another pig mandible with a gross infection (abscess), again located beneath the second adult molar accompanied by a large draining hole on the lateral side. The same mandible displayed the resorption of the site once occupied by the first adult molar with a notably loose second molar. Bones with joint disease form a major part of the remaining cases, with further examples of sheep 'penning elbow' (one humerus and two radii) and one certain (cattle pelvis) and two probable (sheep/goat distal tibia and proximal metatarsus) occurrences of osteoarthritis, the latter two demonstrating exotoses as well as surface pitting but no eburnation. The bones showing signs of trauma include a pig radius with a distinct haematoma close to the distal end on the medial side. A large and uneven bony growth was noticed on a sheep/goat metatarsus at the anterior/lateral part of the shaft close to the distal end. This does not appear to be a callus and indeed there is no obvious sign of a fracture, suggesting that it could be a haematoma or more likely ossified soft tissue. The same bone, in common with two other sheep/goat metatarsals display what appears to be swelling on the anterior part of the shaft, extending from the proximal to approximately the midshaft. This condition has been previously described from sites in Lincoln (Dobney *et al.* 1996, 42-3) and, although shown in Table 41 as representing cases of ossified soft tissue, may in fact concern elongated bony growths. It has been suggested (*ibid*) that these 'buttresses' of bone may result from physical stress, perhaps related to a change in gait as for example would be expected due to the discomfort ensuing from 'foot rot'. Alternatively, this condition may be the culmination of constant 'jarring' of the joints as would occur if the animals were confined to enclosures with hard surfaces. A notable aspect of this condition, in terms of its presence both here and in later phase collections, is that it is only seen on adult bones (*i.e.* with fused distal ends). Other possible stress-related pathologies include another example of an asymmetric cattle proximal first phalange and a sheep horncore with a recognisable 'thumbprint' depression.

Finally, a pig metapodial displays a marked oval and uneven depression within a raised border close to the proximal end on the medial/posterior face of the shaft (Fig. 34). This could represent an ulcer or some form of lesion. Ulcers form in response to major skin irritation and, considering its location, this example may have resulted from an object caught between the foot bones, which was evidently in place for some considerable period of time.

Other Species

The major domesticates are accompanied by moderate and rather small quantities of poultry and game respectively (Table 34). Subtracting antler fragments and the single cetacean (all probably working waste) from the large game reduces the wild component to one roe deer, a teal and one wader, the latter two taken from pits beneath the cemetery (Phase 4.1). The poultry are principally composed of adult chickens (Table 5 and 7.35) with a large proportion of goose (all adult). As with Phase 3, there is a very high proportion of female chickens and a notable proportion of these were culled out of lay (Figs 29 and 30). The measurements of the tibias displayed in these last two figures also suggest that the Middle and Late Saxon chickens were relatively similar in size. However, there is a rather small chicken ulna, from the fill (7308) of pit 7309 (Area B) which could be a bantam. The chicken bones provide a single pathological specimen, a male tarsometatarsus which had been fractured just above the distal end (adjacent to the spur). Notably, this injury mirrors two similar cases from Phase 3, although in this example the healing process culminated with the distal end bent medially about 25 degrees to the vertical axis.

This phase provided a small quantity of equid, dog and cat bones, which were sparsely distributed amongst a number of deposits. An indication of the size of at least one of these animals, a dog also from pit 7309, is provided by a radius with a proximal breadth of 19.7mm. This is relatively similar in size to the radius belonging to the partial dog skeleton from Phase 3 pit 10572 (Bp=21.8mm), which provides a shoulder height of 617.8mm (see above).

Early Medieval (late 11th to late 12th century: Phase 5)

Distribution

An assemblage of 9,451 animal bones was recovered from this phase, of which 4,116 were identifiable to species. The material includes 1,466 bones from graves associated with the primary stone phase of the Church of St Augustine in the northern part of the site. These came from 106 graves (three of which produced 50-60 bones and most of the remainder with less than 30 bones): again, this material is highly likely to have been redeposited from earlier phases of activity. Much of the collection recovered from ditches was taken from the western and southern boundaries of the cemetery (*i.e.* ditches 9510, 10668 and 4021) which produced 226 bones.

This phase saw a notable diminishment in pitting activity and the creation of probable animal enclosures in the central/eastern part of the site. Many of the pits were located just south of the cemetery in Area B, although there was a sparse scatter of pits across the rest of the site. Notable quantities came from a well (5754) in Area B. There are a further eight moderate to large collections (>100 bones), all from the northern part of the site, with a notable assemblage of 555 fragments from pit 8250 (Area B).

Major Domesticates

Species Representation

The domesticate abundance pattern within the Phase 5 assemblage is comparable to those of the the previous phases, although perhaps with a somewhat closer proportion of sheep/goat and pig (approximately Type 3, see Table 11). The Epiphysis Only method follows this pattern while maintaining a somewhat better representation of sheep/goat relative to pig. A large proportion of this assemblage was taken from grave fills and, by their nature, the associated animal bones are likely to be redeposited. However, excluding these collections produced very little difference regarding domesticate abundance (cattle, sheep/goat and pig percentages of 53.1, 23.6 and 23.3% respectively with N=3155 and see Table 7). Obviously, the very similar abundance patterns visible within the Phase 3 to 5 assemblages may have a bearing on this result. The individual features continue to demonstrate some variety with the large collections from pit 8250 and well 5754 providing more pig than sheep/goat (Type 2), while pit 6341 had equal quantities of all three domesticates (Type 8). Notably similar abundance types occur in quite different parts of the site. The collection with the greatest similarity to the general result was that taken from pit 5648 (Area B) (Type 3).

Skeletal Representation

In contrast, although similar to the preceding phases, there is no obvious variation amongst these larger feature collections regarding the distribution of skeletal parts, again demonstrating the general deposition of food and processing waste. The combined results, using the Epiphyses Only method (Table 38), do suggest a decrease in sheep/goat horncores compared to the previous phase. This coincides with a notably smaller proportion of goat compared to sheep horncores, as shown in Table 14, goat providing 31.7% of the total count of this skeletal part in Phase 4 down to 17.5% in Phase 5. There is a similar bias towards horncores in this species, however, as shown for example by four goat compared to 46 sheep proximal radii, *i.e.* 8%. The better representation of goat horncores relative to other parts suggests that this industry was still in operation, albeit certainly diminished.

Age and Sex

There is another change in the cattle and sheep/goat age profiles, with both similarities and differences to the evidence from the earlier phases. The mandibular data shows a return to the Phase 3 proportion of juveniles; subadults are again well represented with a bias towards age group SA1; while the proportion of adult cattle and sheep/goat is similar to that shown from Phase 4 and Phase 3 respectively. In addition, there is a further comparison with Phase 3 as shown by the distribution of adult sheep/goat and cattle mandibles, the former with a bias towards A2 and A3 and the latter towards A3 and E (see Tables 18 and 7.19 and Figs 7 and 11). The Elderly cattle group include at least six out of the 14 mandibles within an MWS range of 46 to 51. This clearly contrasts with the previous phase where there was a notable slant towards younger adults. There is some agreement with the epiphyses evidence in that both species show an increase in juveniles compared to Phase 4 (see Table 39 and Figs 8 and 13). There are clearly less sheep/goat adults and each display a greater proportion of older adults (fused Late epiphyses).

It is of interest in relation to cattle that the noted similarity to the Phase 3 adult pattern, with a greater proportion of older individuals, is accompanied by a return to the earlier sex ratio with more males than females (Table 23). However, unlike the Middle Saxon phase the adult component (as shown by the metacarpal data in Fig. 35) appears to be composed of a similar proportion of males and females. This clearly differs from the Phase 4 evidence with its slant towards females and this could perhaps suggest another change in adult husbandry practices. There is undoubtedly a continuing major import of subadult cattle and sheep, the latter providing fewer adults and possibly indicating a decline in wool production. This may contrast with the greater use of older sheep, suggesting a greater intensity of production; with each animal providing several clips of wool. Notably the sheep sex evidence is approximately similar to previous phases, again demonstrating a major bias towards males, presumably wethers, in the subadult and older age groups.

The pig mandible data also shows a return to the Phase 3 pattern although without the older adults (Fig. 18). This includes a general spread of ages with peaks at I2, SA2 and A1/A2 (see Table 18), with a greater preference for the more succulent younger animals but with a continued rearing of ‘adult baconers’. The sex evidence (Tables 23 and 24) appears to conform to the ‘expected’ result (as described in the discussion of the Phase 3 assemblage), perhaps different to previous phases, with the younger age groups providing more males and the older group including the greater proportion of females.

Animal Size

In terms of the size of the domesticates, while the datasets are again rather small (although alleviated somewhat by combining the Phase 5 and 6 measurements), it is possible to observe a continuing decrease in cattle size. The combined data displays a notably smaller mean value in relation to shoulder heights (see Table 25 and Fig. 20) – this based on the consistently smaller corresponding values amongst the various limb bone length measurements. Notably, however, there is no obvious change in the breadth of these bones (Table 26). This apparent change in size, unlike the assemblage for Phase 4, does not occur with a corresponding increase in cows. As mentioned above, there would appear to be similar proportions of males and females. It is also notable in this respect that a bimodal distribution is apparent in relation to the distal tibia (Fig. 21), whereas the earlier phases provide a single (?female) peak. The evidence would appear to suggest the presence of smaller cattle in the medieval collections, coinciding with a greater proportion of males. A size change perhaps related to the use or greater use of particular ‘types’ could be indicated by the horncore data (Table 27) although the dataset is rather small. In contrast, examination of the basal horncore measurements, irrespective of these ‘types’ and with reference to the two possible groupings in Fig. 23 (with a division at Bmax equal to 54-55mm), shows that the distribution of the Phase 3 and Phase 5 data is roughly similar (each showing a ratio of 2:1 between the smaller and larger-sized horncore groups). No obvious differences are shown by either the sheep/goat or pig size data relative to the previous phases.

Congenital Anomalies and Pathologies

The cattle and sheep/goat assemblages demonstrate the continuing low incidence of congenital anomalies, contrasting with the large proportion of such cases amongst the pig collections (Table 32). Bones displaying the effects of trauma, disease and possible developmental disorders, as well as problems potentially arising from congenital causes, were also found (Tables 41 and 7.42). The latter could explain the various mandibular and maxillary malocclusions, shown in particular by a number of pig mandibles, all indicating some degree of rotation of one or more teeth in the premolar row. A different type of oral pathology is indicated by a cattle mandible with a probable abscess adjacent to the third adult premolar showing ongoing infection and probable antemortem loss of the fourth premolar. Osteophytic lipping at limb bone articular margins was observed in all three species (including penning elbow). One cattle first phalange shows extensive bony growths, suggestive of osteoarthritis, alongside one clear case of this disease acting on the anterior articular surface of a sacrum. Another first phalange possesses a notably expanded proximal articular surface, the result perhaps (as previously mentioned) of undue physical stress. Traumatic injuries are relatively rare, being confined to two cases displaying ossified soft tissue, a cattle calcaneus with an irregular boney growth to the lateral shaft near the proximal end and a sheep/goat pelvis with a similar growth near the ilial acetabulum.

Other Species

There is a reasonable representation of poultry (as was the case in Phase 4), with a similar ratio of chicken to goose as in the Late Saxon period, contrasting with the Middle Saxon evidence, at 1.7:1. Otherwise the age and sex is comparable to the general pattern with goose strictly represented by adult birds and chicken by a large majority of adult hens (Table 34). Game again forms a very minor component of the meat diet, comprising red and roe deer and teal, the former diminishing to one and two fragments respectively following the removal of antler pieces.

Equid and cat provide the major components of this part of the collection. These groups are thinly spread across the site with the exception of minor concentrations for each species in pits 11118 (Area B; seven bones) and 10512 (Area C; eight bones) respectively. These represent individual adult skeletons, incorporating a variety of parts, the equid including a complete femur which provided a shoulder height of 1319.8mm. All of the equid bones are from adult animals. There are a further three complete limb bones in the Phase 5 collections giving an overall shoulder height range of 1306.1mm to 1453.9mm (mean value of 1371.9mm), all of which are pony-sized (*i.e.* less than 1.47m; Clarke 1995, 23).

Medieval (late 12th to late 15th centuries: Phase 6)

Distribution

Deposits assigned to this phase yielded 5,468 animal bones, of which 2,609 were identifiable to species. During this period, the northern part of the site was occupied by the church, its cemetery and the adjacent boundary ditches. As in the preceding phase, a notable element of the group derived from this part of the site, in particular from grave fills (1,588 bones) but with a moderately sized collection from the associated boundary ditches. Redeposited bones were retrieved from 116 graves, most providing rather small collections (the majority with less than 20 fragments). However, there were some larger assemblages, in particular from grave 22242 with 152 fragments.

Once again, most of the phase assemblage came from pit fills, the relevant features being scattered across the site, with a greater density between the church and the central area (Area B). There was a noticeable concentration of such features close to the site's western perimeter, possibly representing waste deposition within the yards/gardens of properties fronting onto Great Whip Street (or its predecessor). Relatively large collections were found in pits 1105 (Area C) and 6328 (Area B), with 319 and 250 bones respectively, while assemblages close to 200 fragments were recovered from pits 1014 (Area C), 10127 (not located) and 10269 (Area C).

Major Domesticates

Species Representation

While essentially following the domesticate pattern set in Phase 3, there is a notable decline in pig during this phase, with a commensurate increase in cattle and sheep/goat (Table 8), a change which is also visible using the weighted method (Table 9; Figs 3 and 4). A very similar result was observed when the grave fill data (Table 7) was excluded (cattle 54.7%, sheep/goat 27.4% and pig 17.9% with N=1685). The larger feature collections provided Type 1 abundance with the exception of pits 10269 and 11504 and grave 22242 with Types 2, 3 and 3 respectively. While there is some variation within the Type 1 collections, the combined pit, grave fill and ditch assemblages produced similar proportions akin to the general Phase 6 abundance pattern. The skeletal part distributions, either combined or within these larger collections follow the same homogenous pattern with, once again, one exception. Goat continues to provide more horncores than any other part of the skeleton, as demonstrated by the 11 horncores and two proximal radii, accounting for 42.3% and 9.5% of the total ovicaprid counts of these two skeletal parts. There is a notably better representation of goat compared to sheep horncores relative to Phase 5 which may suggest an upsurge in hornworking activity. The larger proportion of ram horncores (six out of 16 or 37.5%) may signify a similar change. However, the quantities are perhaps too small to enable any conclusive remarks.

Age

The ageing information is perhaps insufficient to warrant any close comparisons with previous phases. However, while both cattle and sheep/goat continue to be well represented by first and second year animals, there would appear to be a greater proportion of adults. This is shown in particular by the sheep/goat epiphyses fusion evidence (Table 39; Fig. 13). The cattle mandibles again show mortality peaks amongst the older individuals (Table 19) but there does now appear to be a notable increase in cows (65.2% of the pelves compared to 36.3% in Phase 5, see Table 23). Although the evidence is minimal, this pattern may be seen amongst the adult cattle (Fig. 36), perhaps indicating another change in the general exploitation of cattle either for their milk and/or as work animals. In contrast, it can be conjectured from the sheep/goat sexing data that wethers were still the major wool providers. The pig age data, although particularly slight, is represented by juveniles, subadults and adults with no clear distinction from previous phases. The mandibular evidence could suggest a possible bias towards subadults (Table 18), perhaps also demonstrated in the epiphysis data (Table 39).

Congenital Anomalies and Pathologies

This phase provided the usual congenital anomalies alongside a rather meagre proportion of pathological cases. Of particular note is a pig humerus demonstrating a marked bend at about midshaft (about 20 degrees to the vertical axis), the possible result of juvenile injury – a 'greenstick' fracture.

Other Species

There is a greater abundance of poultry in this phase, compared to Phases 4 and 5, as well as a change in species representation with a chicken to goose ratio of 3.3:1. The collections are otherwise very similar, this similarity extending to the very limited use of game, restricted to just two roe deer bones (the red deer fragment is an antler piece). A chicken tibia had clearly suffered a traumatic injury resulting in a notable lateral bend (about 20 degrees) at the midshaft, although without any sign of other redevelopment of the bone. It can be assumed that the injury took place when the bird was still juvenile.

An unusual species was recovered from one of the graves – a humerus of a red-throated diver. It can be assumed that this bone is residual (the pottery from this level is dated to the Middle Saxon period) but nonetheless it is of interest due to its rarity. Divers have been found at a small number of other archaeological sites, most famously the near complete skeleton of a great northern diver from Late Saxon Portchester (Eastham 1977). Otherwise a humerus belonging to the same species was found at Middle Saxon *Hamwic* (Yalden and Albarella 2009, 131), perhaps relevant in terms of the probable date of this Phase 6 bone. There would appear to be no red-throated divers from sites any later than the Mesolithic period in this country, however, a black-throated diver was found at late medieval Baynards Castle, London (*ibid.*, 209 and Bramwell 1975, 16). It has been catalogued here with possible food waste although, considering it is a humerus, it may simply represent a wing and therefore an item imported for its feathers.

Equid again forms a major part of the non-food species, is again widely distributed and with the exception of a single bone, a juvenile radius (proximal unfused) from ditch 9180 (Area D), is limited to the remains of adult individuals. The cat and dog bones are also liberally spread across the site and generally derive from adult animals, however, there are two bones, a humerus and a femur, from pit 5572 (Area B) which are clearly from a juvenile dog (distal humerus unfused). None of these bones are sufficiently complete to gauge the size of these animals. However, there are the remains of a moderately large dog, represented by a scapula, humerus and radius from pit 5345 with an approximate shoulder height of 575mm. The humerus in this collection displays a bony growth on the lateral side of the shaft, possibly related to an injury resulting in ossification of soft tissue.

Early Post-Medieval (late 15th to 17th centuries: Phase 7)

Distribution

An assemblage of 2,015 animal bones was recovered from features and deposits assigned to this phase, of which 1,568 were identifiable to species. During the early post-medieval period, the northern part of the site contained a series of robber trenches, following the demolition of the church. Various pits, ditches and other cut features were found to the south, generally mirroring the Phase 6 distribution pattern. Most of the animal bones came from the fills of pits and ditches. In particular, it derived from just five pits (5580, 9246, 9495, 7260 and 10001) which produced 168, 502, 258, 201 and 123 bones respectively. Pit 7260 was amongst a continuing concentration of pits located at the western perimeter, close to the Whip Street frontage, providing a total of 266 fragments.

Major Domesticates

Species Representation
(Table 44)

A major proportion of the sheep/goat bones dated to this phase can be interpreted as craft rather than food waste, essentially pertaining to the concentrations of foot bones from pits 5580, 9246 and 9495 (see below). Removing these collections to provide a more accurate demonstration of major domesticate food use provides a similar abundance pattern to that shown by the Phase 6 collection (comparing the Phase 7 and 7A[1] results shown in Tables 8 and 7.9). The largest major domesticate collection, apart from the two craft waste assemblages, was taken from the combined fills of the western pits. These provided a relatively similar Type 1 abundance pattern, although with somewhat more sheep/goat, *i.e*. 57.1%, 39.6% and 3.2% (out of 182 fragments). It should be stated, however, that this collection may also show a sheep/goat bias, relating to the 20 sheep horncores taken from pit 7260. While it is possible that this deposit is weighted towards butcher's waste, apart from the horncores there are 14 head parts and 16 metapodials and phalanges (head and feet accounting for 83.3% of the 60 sheep/goat bones), suggesting that there may also be a craft waste element. Notably the horncores include six rams and 14 ewes/wethers. The good representation of the former sex, as suggested elsewhere, may well be an indication of a selection process and hence imply hornworking waste. Of interest in relation to this craft industry is the total

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[1] Group 7A excludes the craft waste.

absence of goat horncores. This lack of usage also appears to include goat meat, with no clearly identified radii or indeed any other skeletal part with the exception of a single goat pelvis from pit 10030 near Great Whip Street.

The large collections from pits 5580, 9246 and 9495 are almost exclusively composed of sheep/goat foot bones (see Table 44), the 928 bones in this combined assemblage otherwise including just 16 cattle and eight pig bone fragments, as well as seven sheep/goat bones from another part of the carcass. Most of these foot bones are complete and there are no signs of butchery. It is also of interest that most, if not all, these bones derive from sheep rather than goat, this being emphasised by the metacarpal data (and see Phase 3 above). While these collections may represent butcher's waste, the absence of head parts favours a craft source, most probably deriving from a local tanner. This interpretation assumes that the foot bones were still attached to the skins delivered to the tanyard (see Rielly 2011, 160-1). A notable feature of the sheep horncores found in pit 7260 is that each was removed from the skull by chopping through the base. This suggests that the horns belonging to these respective carcasses were removed prior to skinning or, rather, as part of the skinning process. There is no evidence here, or indeed elsewhere in Phase 7 for the type of sheep/goat butchery that would allow the horns to be separated from the skull still attached to the skin (see Phase 3, above).

Age

This phase assemblage provides a minimal quantity of age data, with the notable exception of the sheep/goat epiphyses evidence, this principally reliant on the 'tanning waste' collections. While it can be conjectured that the skeletal component taken to the tanners originally derived from the town butchers/scalding houses and should thus comprise a representative sample, it is possible that the leather workers operated a selection procedure with choice based on size and therefore age. The Intermediate data from the Phase 7 collections, both with and without the 'craft' waste, display a similarly high proportion of fused epiphyses but a notably different proportion of fused Early epiphyses (see Table 40 and Fig. 13). While there are undoubtedly some juveniles within the other deposits, the majority were recovered from these three foot bone collections. Notably the seven juvenile bones left in this phase (see Table 22) follows the exclusion of another 67 bones, the majority taken from pits 9246 and 9495 with 34 and 26 juvenile bones respectively. It can be proposed that the skins of rather young animals were being taken to local tanners and, while their flesh was undoubtedly consumed, the majority of these lambs were eaten elsewhere. The majority of the sheep/goat adults appear to have survived beyond their fourth year as shown by the proportion of fused Late epiphyses shown in Table 40 (and note the mandibular data in Table 19). The evidence would therefore suggest the exploitation of late first/second year animals and then fourth year or older – signifying mature mutton. The cattle age structure is somewhat different, with a notable proportion of infants and juveniles (see Table 22). These apparently correspond to the 'juvenile' category using the O'Connor method (see Table 19) and are thus derived from calves aged just a few months old. None of the younger calf bones (including the infants and possibly the foetal/neonates) display butchery marks but considering the lack of articulations and the abundance of such youngsters, it can be suggested that these are also likely to represent succulent meats rather than infant mortalities. There are fewer adults (Intermediate fusion at about 50%) compared to previous phases with most of these surviving beyond their fourth year (Table 40). The pig age data is particularly slight although the majority were evidently culled as second year or older animals.

Animal Size

Any size comparisons must be limited to the sheep/goat data, essentially referring to the 'tanning' waste metapodials. Following a general similarity in sheep size from the Anglo-Saxon through the medieval phases, the Phase 7 shoulder height data suggests a slight reduction in stature, as is demonstrated in all aspects, namely lower minimum and maximum values as well as a smaller mean (Table 28 and see Fig. 24). Any change, as previously described, may relate to the ratio of males and female animals in these collections. However, there is insufficient data (see Table 23) to warrant any further comment.

Congenital Anomalies and Pathologies
(Fig. 37)

There were some congenital and pathological examples, including further instances of the elongated bony growths (noted above) observed on the anterior shaft of sheep metatarsals (described as OST in Table 41). This 'condition' was found to occur on 41 out of the 169 metatarsals (24.2%) within the 'tanning' waste collections (counting the proximal ends, see Table 44) and was entirely limited to bones with fused distal ends, *i.e.* from adult animals. The growths can be described in terms of slight (small bony ridges adjacent to the proximal end and/or small bumps extending along the shaft); moderate (more substantial bony ridges); and severe (well developed ridges often extending to the midshaft). Most of the examples are in the ‘slight’ category (27) with five ‘moderate’ and nine ‘severe’. This apparent correlation with age may conform to the previously described stress-related interpretation. However, these cases included two metatarsal pairs (both from pit 9495), the bones in each pair displaying very similar bony ridges (see Fig. 37). This raises the possibility that this condition may in fact be congenital (and see Brothwell *et al*. 2005 and Vann and Grimm 2010, 1538).

Another three sheep/goat metatarsals, from other deposits, displayed such bony ridges. In addition, there are two cases of sheep horncores with ‘thumbprint’ depressions and a sheep ulna with extensive remodelling close to the proximal end as a result of a fracture through the ‘neck’, just above (proximal to) the semi-lunar articulation.

Other Species

There is a particularly restricted representation of other food species in this phase, with the usual bird domesticates, and single examples of fallow deer and rabbit. Given that the rabbit bones attributed to Phase 3 are likely to have been intrusive, this appears to represent the earliest rabbit found at this site, an interpretation which can also apply to the single fallow deer bone. Of interest perhaps is the fact that the fallow deer was found in one of the western pits (7260), suggestive of the wherewithal of one of the households/properties situated to the west of this site to acquire a notably expensive meat joint. The remainder of the collection features a few equid, dog and cat bones. Of note is a dog fourth metacarpal with a bony growth adjacent to the proximal end on the anterior side. This could represent ossified soft tissue following a traumatic injury.

Post-Medieval to Modern (18th-19th centuries: Phases 8 and 9)

Distribution

Relatively small assemblages were recovered from contexts assigned to these two phases: 455 bones from Phase 8 (257 identifiable to species) and 958 from Phase 9 (452 identifiable to species). The demolition of the church was followed in the late 17th century by the building of the King’s Cooperage (Phase 8) in turn followed, in the 18th century, by a Shipyard (Phase 9). These building remains, all in the extreme northern part of the site, were accompanied in both phases by an array of cut features, mostly pits, which were sparsely scattered across the site. Such features account for the majority of the relevant phase assemblages, with the remainder of the earlier and later collections largely derived from robber cuts, again related to the medieval church, and various layers/dumps respectively. These layers include a possible graveyard soil as well as those described as ‘Other fill’ in Table 2, some of which represent modern scrapes through 19th-century levels. As previously, there is a high likelihood of redeposition amongst such assemblages. There was just one notable collection dating to Phase 8, from pit 9890, whereas Phase 9 provided a number of sizeable assemblages including pit 9767 with 109 bones, possible graveyard soil 5090 with 151 bones and layer 5043 with 147 fragments.

Major Domesticates

There is some variation in species abundance with an increase in cattle at the expense of sheep/goat between Phases 7 and 8, followed by a decrease in cattle and a corresponding increase in pig by Phase 9. Both phases provided relatively small collections; however, it is perhaps significant that the observed changes are visible using both the total fragment and Epiphyses Only methods. The quantities are insufficient to allow a thorough comparison between these phase collections relative to the earlier faunal material, although there is a general mix of skeletal parts for each major domesticate species. In addition, there is a clear continuation into both Phases 8 and 9 of the high proportion of juvenile cattle observed in Phase 7 (see Table 22) and there is a slight indication of the larger stock available from the latter part of the 18th century (following improvements to husbandry practices; see Rixson 2000, 215 and Davis 1987, 178). The bones of some notably large cattle and sheep were identified amongst the assemblages from both phases, as demonstrated by a single large cattle metacarpus from Phase 9 (GL of 219.6mm with a calculated shoulder height of 1350.5mm, see Table 25). This size increase is often associated with another late post-medieval trait, the use of the saw for butchery purposes, as shown at several sites dating from at least the late 18th century (PCA Archives; Albarella 2003, 74). A sawn sheep tibia was recovered from the Phase 8 fill of pit 6708, broadly dated between 1780 and 1900; while a small selection of sheep and cattle sawn bones were found in three Phase 9 deposits, all dated to the 19th century.

Both Phases 8 and 9 provided the usual array of congenital and pathological instances (Tables 41 and 7.42) with further cases of teeth malocclusion as well as joint disease and deformity. Notable examples include a Phase 8 humerus with extra bone on the distal aspect of the medial entepicondyle, probable ossification of soft tissue related to trauma and a Phase 9 cattle pelvis with polishing on the pubic part of the acetabulum, clearly indicating osteoarthritis.

Other Species

There is again a very small quantity of poultry and game of this date from this phase, the first to include turkey (Phase 9) and the latter restricted to hare and rabbit (also Phase 9). Turkey may signify a food waste item from a household of some affluence, although by the 19th century this bird had become the major celebratory food item and may have represented an occasional extravagance for all but the poorest sections of the population. Equid, dog, cat and crow make up the non-food element of the late post-medieval collections, although it is of interest that a series of butchery marks, signifying defleshing activities, were found on a near complete equid femur from one of the backfills of the Phase 8 cellar (5011) associated with Cooper's House (constructed in Phase 7). This suggests a rather different degree of affluence compared to the turkey, however, there is always the possibility that the flesh on this bone was intended for dogs rather than humans. An indication of the age of the equids is shown by a mandibular second premolar, from the Phase 9 fill of well 6336, with a crown height of 15mm signifying an age of between 14 and 15 years. Another equid bone, a complete tibia from Phase 9 layer 5043 provided a shoulder height of 1542.8mm, corresponding to an animal measuring 15.2 hands. This would equate with the lower size of modern horses suitable for riding purposes (after Clark 1995, 23). While the equid remains are sparsely spread across the site, most of the Phase 8 cat bones were derived from a partial juvenile skeleton, which was found in a fill of a robber cut (5085).

Finally, it can be assumed that the crow (probably carrion crow or rook) and the ravens represent local scavengers, suggestive of open waste dumps in the vicinity.

Discussion

Overview
(Table 45)

This section aims to describe and contrast animal usage throughout the occupation of the site, with reference to the other faunal collections excavated on sites in Ipswich and somewhat further afield as necessary. While numerous archaeological excavations have occurred in Ipswich, the available data is rather limited (with the exception of collections retrieved from the Middle Saxon levels) as a result of the infrequency of publication of the results. Most important in this respect is the work of Crabtree (2012) featuring a description of several sites excavated in the late 1970s and early to mid 1980s, with the Late Saxon (9th/10th) and early medieval (11th/12th century) portions of these site assemblages presented in Crabtree (2016). Each of these reports essentially describes the bone collections as a single unit, although there is some information on individual sites. It should also be mentioned that all of these sites are situated within the core of the Anglo-Saxon settlement to the north of the River Orwell. An earlier report by Jones and Serjeantson (1983), described the bones from another five sites from the 1970s and 1980s, mainly from north of the river but including one site to the south – Vernon Street (IPS 141/IAS 7402, monograph Fig. 1.2), which lies adjacent to Stoke Quay.

This report is largely restricted to the bones from the Middle Saxon levels, although there is again some description of the Late Saxon and early medieval collections. A further similarity is the combined nature of the account, with individual site details dependant on the temporal limits of these excavations – notably all of the early medieval part of the assemblage was taken from Elm Street. Several animal bone assemblages from more recent excavations, and from a variety of archaeological units, are available amongst a copious quantity of grey literature. However, the quantities of bones tend to be rather small and the writing is generally at the assessment level. Of importance amongst these reports is the collection from the Eastern Triangle, between Key Street and Star Lane, this providing a notable quantity of bones dating to the later medieval period (Curl 2012). Individual Ipswich sites mentioned in this section are referred to by location (street name) as well as by their individual Ipswich Archaeological Survey (IAS) number, as shown in Table 45. In addition, in order to avoid repetition, the three main Ipswich collections – Crabtree (2012 and 2016) and Jones and Serjeantson (1983), are referred to as C1, C2 and J/S respectively.

There are notable Middle Saxon comparisons further afield but in this general area they include the vast collections of animal bone from the Middle Saxon settlements at Brandon and Wicken Bonhunt (Crabtree 2012). These were located to the west of Ipswich, at the north-western border of Suffolk with Norfolk and within the north-western part of Essex respectively. The later assemblages from Stoke Quay can be profitably compared to the large bone collections from Thetford (Late Saxon and early medieval) and Norwich (Late Saxon to post-medieval) described in Albarella (2004) and Albarella *et al.* (2009).

Middle Saxon (Phase 3)

(Figs 38-40)

The large quantity of data available from other Middle Saxon sites in Ipswich forms the initial part of this comparative analysis, leading on to a more general synthesis. These descriptions essentially mirror the preceding sections with consumption followed by redistribution and then production. Most of the bones within each of these collections (generally between 90 and 95% of the food species) were identified as cattle, sheep/goat or pig, with the remainder, as at Stoke Quay, almost entirely composed of poultry (mainly chicken and goose). There is undoubtedly some variation in terms of the relative abundance of the major domesticates, although the majority of assemblages are cattle-rich, as at Stoke Quay (see Table 45, which explains the letter codes used in the following text). These sites are essentially north of the river, with just one example to the south, at Vernon Street (IAS 7402, Wade 2014o). This produced approximately 50% of the 23,064 Middle Saxon bones provided by the five sites in J/S, and it is perhaps significant that the domesticate abundance pattern is relatively similar to that observed at Stoke Quay, albeit C>S=P. A notable proportion of pig was found at several of these sites and in particular in that part of the northern town to the east of the river crossing (within three of the four sites marked as SE in Table 45). It is proposed that such differences are hardly subject to the vagaries of sample size, with wide variation noticed between some of the largest collections. Otherwise these may relate to household/area meat preferences, possible centres of production and/or temporal changes. The second explanation is probably not appropriate (see below), while the third may certainly help to explain possible differences between the Stoke Quay and northern site assemblages, with a proportion of the latter dating from the settlement’s inception in the 7th century and the former solely representative of the 8th- to 9th-century expansion. This question of possible changes/alterations in food use and supply through time cannot be taken any further here, apart from stating that the levels associated with the more expansive later settlement will most probably have provided the greater part of these site assemblages, *i.e.* in terms of the size of occupied area as well as its duration. Notably, in C1, the later sites provided a large proportion of the bones, these perhaps also including Buttermarket (IAS 3201) as the earlier levels essentially correspond to a cemetery (Wade 1993, 147). In addition, the J/S collection largely derives from a later site (Vernon Street).

At Stoke Quay (and indeed at each of the other sites mentioned in J/S and C1), the major domesticates are represented by a general mix of skeletal parts, with the notable exception of goat. This species was far less abundant compared to sheep and, rather than food waste, most of the goat bones clearly derived from craft workshops. This is demonstrated by the wealth of goat horncores, a number of which had been sawn either through the base or the shaft, making them strongly indicative of horn working waste. An alternative or possibly additional explanation for their presence is that they represent tanning waste, following the assumption that such parts would still have been attached to the skins (see Serjeantson 1989). Notably, evidence pertaining to a craft interpretation at Stoke Quay was partly based on the abundance of horncores from male goats, perhaps suggestive of a selection process. A similar, although less severe, sexual bias was seen amongst the sheep horncores at this site, indicating an import of sheep as well as goat horns. The wide and rather sparse distribution of these items tends to reflect the evidence for other crafts including bone and antler working, all of which can perhaps be conceived as cottage industry production (after Wade 1988, 95). The mix of parts with reference to the other domesticates suggests that these animals were brought to the settlement on the hoof. Without any obvious concentrations of butchery waste it is proposed that there were multiple outlets linked to the subdivision of carcasses. Individual or groups of households may have relied on itinerant butchers, resulting in a similar spread of skeletal parts from, for example, Middle Saxon levels at the Royal Opera House in London (Malcolm and Bowsher 2003, 161 based on Hagen 1992, 34). Otherwise, following a suggestion made by O’Connor (1989, 159) referring to a similar spread of body parts at Late Saxon (Scandinavian) York, the division of these animals may have been undertaken by ‘whomsoever in that particular neighbourhood had a sharp knife and a rough idea of how to use it’. This would, however, reflect an uncommon practice since butchery and those who practice it tend to be specialist and specialised professions in most societies.

There is some slight indication at Stoke Quay that a small proportion of the meat intake was based on locally reared stock. This is demonstrated by a few very young calves and lambs (foetal/neonates), which potentially represent infant mortalities. A similarly minor proportion of such youngsters was identified in the C1 collection, featuring lambs and piglets. It is possible that a greater proportion of the meat intake was delivered by home production of those species which can best tolerate an urban setting, such as pigs and chickens; however, the greater part was undoubtedly derived from a variety of exterior sources. The large proportion of adult cattle and sheep at this site, the majority in the older adult category, strongly suggests a major import of surplus animals.

These clearly comprise, according to the sex data, a general mix of draught oxen, dairy cattle and wool-producing sheep (essentially from wether flocks). The age data from the other Ipswich sites (see Figs 38 and 39) is essentially comparable. The cattle sex data from C1 also demonstrates a mix of cows and oxen/steers. Yet, there are clearly more adult cattle in the latter collection and appreciably less adult sheep from J/S. All three collections contain a substantial proportion of first and second year cattle and sheep, the latter generally prevalent in cattle with a notably similar peak of later first year sheep (AG3) at C1 and J/S. Looking more closely at the age evidence from these collections (based on tooth and mandible wear stage data; after Grant 1982), C1 follows the Stoke Quay bias towards cattle SA1 (after O'Connor 1991, 250), while this age group accounts for the major part of the second year sheep in all three collections. In addition, the cattle adult slaughter peaks coincide with O'Connor's A3/E and somewhat younger at A2 for sheep. There would certainly appear to be common practices regarding the cull of surplus adult stock, as well as those which were presumably bred for the table – the pre-adults. The consumption of good quality meats may be indicative of status, as notably shown by the J/S collection with a possible location for such good eating just south of the Orwell at Vernon Street.

This same collection also provided a rather contrasting dataset in relation to pig exploitation. Both the Stoke Quay and C1 pig age data show a 30% survival into their third year (adults) with most of these culled as young adults. J/S provided a remarkable 50% survival of adults and, while the majority of these pigs were culled in their third year, following the other two groups, there was also a substantial proportion of older adults (see Fig. 40). It is possible that pigs were being kept in this locality (again referring to Vernon Street), the older animals representing surplus breeding stock. There should also be, in this case, a number of young piglets, the inevitable infant mortalities, although their absence can be explained in terms of differential survival and recovery. The J/S age structure is clearly not entirely 'producer-like' as it follows the other collections with notable proportions of first and second year animals. Again, on closer examination, there would appear to be a general compliance with the I2, SA2 and A2 peaks found at Stoke Quay, perhaps demonstrating a seasonally based supply network. The evidence for home production is clearly of interest, with implications for the local availability of certain meats and other animal products as well as the presence of certain facilities within the settlement. The J/S age evidence could be indicative of such a facility, either as a place to house pigs temporarily or possibly even a sty or sties. This latter type of pig keeping is certainly mentioned in the historical records (Hagen 1995, 105) and there would also appear to be archaeological evidence. Concentrations of pig bones, including a proportion derived from very young individuals were recovered from deposits associated with three buildings dated to the mid 8th century at the Royal Opera House site in London. One of these buildings provided botanical evidence for fodder and bedding, which probably related to animal stalling (Malcolm and Bowsher. 2003, 65 and 103). The keeping of pigs on a small scale, perhaps even on an individual household basis, may well explain a proportion of the third year animals represented in these collections, assuming an Anglo-Saxon derivation for the noted medieval urban practice of importing youngsters which were then fattened to produce adult baconers (see Hammond 1993, 41 referring to medieval London and the keeping of pigs in medieval Norwich; in Moreno Garcia 2009, 116).

It was mentioned above that the supplementary part of the diet, excluding the major domesticates, was principally met by poultry and then in particular by chicken followed by goose. The chicken bones at C1 and Stoke Quay are predominantly adult and female, suggesting the consumption of surplus egg producers. No corresponding chicken data was supplied in J/S although a similar result can probably be assumed. The better representation of chicken may represent a dietary preference, although as part of a possible home-produced element, these birds are likely to thrive in a confined urban environment (Woodward and Luff 1983, 126).

The faunal evidence pertaining to Middle Saxon Ipswich in relation to the supply and consumption of meat may then be summarised as follows. Animal usage was essentially cattle based but with some notable variations with respect to the relative abundance of sheep and pig. Poultry formed a general although minor component of the diet while the near absence of game suggests an extremely poor exploitation of wild resources. There appear to have been no redistribution centres, on the basis of the findings of a fairly extensive series of excavations within the earlier and later spread of the Middle Saxon settlement. The age structure of the major food species is suggestive of a non-specialised approach amongst the production outlets supplying this urban centre. There is perhaps some evidence for food production within the confines of the settlement, in general pertaining to possible infant mortalities and in particular referring to the pig evidence from J/S, probably related to Vernon Street. It is perhaps remarkable considering the proximity of Vernon Street that similar evidence was not present at Stoke Quay. A distinction was made by Wade (1993, 148), describing the series of excavations to the north of the Orwell and relating to the 9th-century levels, between the close-set buildings present at sites such as the Buttermarket and the more diffuse buildings with fenced enclosures within sites at the periphery of the settlement (specifically referring to the Foundation Street excavations, IAS 4601 and IAS 4801; Wade 2014 d and e). As well as the architectural differences, he mentions the environmental evidence, with the latter sites providing evidence of agricultural activity, including the keeping of livestock and cereal cleaning. He comes to the conclusion that this settlement had a commercial centre with peripheral sites demonstrating a more agricultural function. The Vernon Street site may provide further evidence to support this supposition.

A comparison can perhaps be made with the later levels at *Lundenwic*, dating from the mid 8th century, where a number of sites at the margins of the settlement provided evidence for farming (see Rielly 2012, 149-152), although limited to livestock rather than agricultural activities (Rackham 1994, 129-130).

It can be assumed that this settlement was ultimately supplied via various farms in the surrounding area and it is unfortunate in this respect that there is an absence of rural sites with comparable faunal assemblages in the general vicinity. Wicken Bonhunt and Brandon, while clearly providing suitable bone collections, are situated at the north-western border of Suffolk with Norfolk and within the north-western part of Essex respectively. Their distance would necessarily preclude more than a cursory contribution to the Ipswich meat diet. While little can be said at this juncture about the immediate source(s) of foodstuffs brought to this Middle Saxon settlement, there is extensive information available related to the possible mechanism of supply. Ipswich and the other '*wic'* settlements are generally understood to have been under the control and patronage of the regional king or chief and as such, the supply of consumables would have been largely dependent on the redistribution of food rents (O'Connor 1991, 276 after Hodges 1989). The principal evidence for this measure of control is the rather poor diversity of food species, initially witnessed at *Hamwic*, Southampton (Bourdillon and Coy 1980 and expanded in Bourdillon 1988), and followed by the other '*wic'* sites, including Ipswich, as described in O'Connor (2001). Another aspect, following on from the last, is the minimal representation of a 'home production' element with O'Connor (1991, 278 and 2001, 55) arguing that a community provided with foodstuffs is unlikely to have either kept their own animals (shown by good proportions of pigs and poultry) or to have spent time hunting. It has been shown that a certain degree of local production did occur at these '*wic'* sites, often involving pigs, as noted from Ipswich (see above) and *Lundenwic* (Malcolm and Bowsher 2003, 65 and 103 and see Rielly 2012, 151), while both settlements may have provided a greater proportion of their consumables by the 8th/9th centuries, as suggested by the evidence for peripheral farms. Game is undoubtedly poorly represented; however, this is not particularly dissimilar to a variety of other contemporary sites, including those of high status, as for example at both Wicken Bonhunt and Brandon (Crabtree 2012, 21). Each of these two sites provided a far greater range of game species compared to Ipswich but not a greater proportion, compared to the quantity of major domesticate bones. There are exceptions, most notably Flixborough in north Lincolnshire (Dobney *et al.* 2007), but in general the low proportion of such species may simply indicate a rather restricted diet for the whole population (Holmes 2014, 103). Of greater significance is the clearly better representation of poultry on Middle Saxon high status and ecclesiastical sites compared to rural and urban settlements (*ibid*). Here it can be assumed, based on the former sites acting as redistribution centres, that there was a measure of control in terms of access to particular types of food rent.

Another factor which should be considered is the evidence at Ipswich (referring to the J/S data), York and also Dorestad for common peaks of slaughter of sheep and pigs. These could be suggestive of 'periodic extraction of resources' as would be expected in a food rent system (O'Connor 2001, 54). Such peaks were certainly present amongst the various Ipswich bone collections described in this report and were observed in the age structures of all three major domesticates. However, this age structure could also be market driven, a point continued below. In short, with the possible exception of the evidence pertaining to poultry abundance, there appears to be no compelling evidence to assert whether the redistribution model was responsible for the supply of foodstuffs to these settlements.

An alternative hypothesis put forward by Crabtree (C2) and Sykes (2006, 63-4) is that the limited range of food species viewed at these '*wic'* settlements is related more to poorly developed markets rather than the controlling mechanisms suggested by Hodges' food rent system. An explanation may be sought in the model of an infant market system supplied by a series of small production centres, of a type recognised from a number of sites in Lincolnshire (Pestell and Ulmschneider 2003 in Crabtree 2016, 24).

Late Saxon (Phase 4)

There are notable similarities between the Middle and Late Saxon collections, in particular relating to the domination and the relative proportions of the major domesticates, with cattle followed by sheep and then pig. A comparable continuation was observed within the combined results from J/S (C>S=P), essentially representing the bones from Lower Brook Street (IAS 5502), although with cattle now somewhat better represented. The early and middle Late Saxon assemblages (ELS and MLS) in C2 demonstrate more variable results (see Table 45). This variation is reduced somewhat by the exclusion of the bones from St Nicholas' Street (IAS 4201) which provided a heavily biased sheep and goat collection with a notable concentration of goat horncores in the MLS phase. It was thought that a large proportion of these bones, and certainly the horncores, were evidence of craft activities rather than food waste deposition. This allows a general C>P>S within each of these C2 Late Saxon phases, essentially following the combined abundance pattern from the corresponding Middle Saxon levels. The variation shown by the Stoke Quay, J/S and C2 data may relate to local preferences/usage in combination with temporal differences as suggested for the Middle Saxon evidence. However, unlike the previous phase, there is no general north to south divide, with most of the J/S data taken, as mentioned, from Lower Brook Street which is on the north side of the river. Of interest in terms of the time element is the greater date range applicable to the Phase 4 levels, extending to the later 11th century as against the 10th century in C2. Overall, the only point of comparison is that all of these sites demonstrate a domesticate abundance pattern dominated by cattle. In this way Ipswich clearly corresponds to the majority of Late Saxon sites in England (Sykes 2006, 58), including other East Anglian urban centres at Thetford and Norwich (see Albarella *et al.* 2004, 91 and Albarella *et al.* 2009, 22). A good representation of pig (between about 20 and 30%) is also a notable feature, signifying the continuing Saxon fondness for pork as well as the availability of suitable pannage (Albarella *et al.* 2004, 91; Albarella 2006, 74-9 and see below).

Both cattle and sheep/goat are again derived at Stoke Quay from a general spread of first year through to fully mature individuals. However, this phase clearly witnesses a greater proportion of adult cattle and sheep, corresponding to a certain extent to a severe decline in first year animals. The preponderance of older individuals within this age group, following the Phase 3 pattern, clearly shows the continuing import of animals used for secondary purposes, their greater abundance perhaps suggesting an increase in importance of such cattle and sheep products within the farming communities supplying the Late Saxon town. With sheep there would appear to be a dominance of males, perhaps again signifying the import of surplus animals from wool producing wether flocks. The cattle sex data may show a greater reliance on dairy herds but this is far from conclusive (see below). This general pattern of an increase in adults also applies to the pigs, although not to the same extent and notably with a somewhat lesser proportion of the older individuals. It is conceivable that this may be indicative of a decrease in local production, assuming that surplus animals kept for breeding purposes would be eaten locally. Yet there is again evidence for the presence of the youngest age groups as well as approximate parity of sexes as shown by the canines. Approximately equal numbers of boars and sows is generally indicative of a site where the local population were ‘keeping, as well as eating’ pigs (Albarella *et al*. 2004, 96).

Comparative age data for contemporary collections from Ipswich is unfortunately rather limited, being restricted to the cattle evidence from the C2 sites as well as some indication of sheep exploitation in Crabtree (1996, 103). The C2 cattle data also demonstrates a higher proportion of adults, now rising to 80% (mandibular evidence) in the early Late Saxon phase compared to 62.5% in the Middle Saxon phase, the Stoke Quay data starting from a lower proportion – 46.1% rising to 62.2%. Notably, there is also a majority of older adults, but again to a greater extent Stoke Quay demonstrates Middle Saxon ratios of younger and older adults at 1:3.5 and then 1:3 in the Late Saxon phase, compared to 1:4 (MS) and 1:4.6 (ELS). This pattern does not continue into the MLS phase at the C2 sites, the adult proportion dropping to 55% and with an adult ratio of 1:1.7: however, this information is based on a rather small dataset (20 mandibles). There would appear to be an intimation of a greater level of specialisation at these other Late Saxon sites, with the vast majority of cattle initially used for some secondary purpose. A close comparison can be made with the evidence from Mill Lane, Thetford, where the cattle mandibles include some 80% in the adult categories with 20% subadult (second year animals). The adults mainly fall within the older adult age groups. A similar age range was observed at Castle Mall, Norwich, as has been observed across much of Late Saxon England (Albarella *et al.* 2004, 92-3; Sykes 2006, 59 and 67). The greater proportion of the younger age groups at Stoke Quay suggests a closer comparison with the Middle Saxon evidence, although the notable increase in adults does suggest a movement towards this ‘general’ pattern. Clearly, a proportion of cattle at each of these sites (generally subadults) were bred for their meat, while the majority would have been used for traction or dairy purposes or some combination of the two. The historical evidence would certainly suggest the former usage and indeed it can be argued that cattle played a very minor part in Late Saxon dairy production, a situation which perhaps continued until the 13th century (Trow-Smith 1957, 74; Sykes 2006, 59). Thus, while undoubtedly providing some milk, the cows found at sites dating to this period would essentially have been kept for breeding purposes. There are of course exceptions, in particular North Devon where the Domesday records suggest a notably larger proportion of cows than would be required for replenishing the plough teams. In addition, there are subtle indications of such dairy farms or *vaccaria* amongst some of the entries for Norfolk and Suffolk (Trow-Smith 1957, 73). It can be supposed that a proportion of the older cattle at Stoke Quay and indeed from the other Ipswich Late Saxon sites, may have derived from such farms but the majority were a combination of surplus work and breeding animals. The greater proportion of adults and in particular old adults witnessed at these Ipswich sites may then relate to the emphasis placed on ‘agrarian output’ (following Sykes 2006, 58) which increased in importance through the Middle Saxon period up to the 11th/12th centuries. This could explain, at least in part, the dominance of cattle within the Middle Saxon levels, as well as the abundance of the oldest age group (Elderly), these perhaps significantly best represented in Phase 5 (see below).

The increase in adult sheep compared to the Middle Saxon phase is accompanied by a similar bias towards older adults and a relatively similar sex ratio, with males predominant. This would suggest that, while a greater proportion of mutton was consumed, this age group was principally derived from approximately the same source (*i.e.* wool-producing wether flocks). However, in both phases, the majority of adults tended to be culled prior to their fifth year (AG 6 in Table 18 corresponding to AG G in the system of Payne 1973), indicative of animals culled for their meat (late maturing mutton), as well as for some secondary product. There are some older individuals but these are clearly less abundant compared to the Middle Saxon phase (see Table 19). Dairy or wool producing flocks would be expected to be particularly well represented amongst such individuals and their reduction could be indicative of a decrease in the level of specialisation. A similar level of age and sex data is unavailable from the other Ipswich sites, however, the evidence does appear to suggest some increase in adults moving from the Middle Saxon to the Late Saxon periods (Crabtree 1996, 103). This follows another general pattern, as demonstrated between urban centres dated to these two periods (Sykes 2006, 67). The data from these urban sites suggests a general increase, with no obvious peak of adult slaughter, in combination with a respective decrease in younger (first and second year) individuals. Similar age ranges can also be seen at Mill Lane, Thetford and Castle Mall, Norwich, prompting an interpretation of sheep during this period as ‘multi-purpose’ animals, providing meat, milk and wool (Albarella *et al*. 2004, 95).

As already stated, the sex evidence from Stoke Quay suggests a greater provision of wool than milk amongst those flocks providing mutton to the town. This is perhaps surprising considering the historical evidence for sheep usage during this period, their principal importance being based on milk production and manuring (Trow-Smith 1957, 60), the latter no doubt following the noted emphasis on agrarian output. Wool production had not yet reached the level of national importance, which occurred from the 13th century onwards (*ibid*, 133). However, the evidence from this site may suggest a level of local importance dating back to the Middle Saxon phase. There is certainly evidence for a thriving ‘cottage’ industry relating to cloth manufacture in Ipswich during the latter period, as shown by the wealth of loom weights from several sites (Wade 1988, 95). The abundance of wethers within the Middle Saxon assemblage at this site can then be interpreted as surplus animals taken from flocks providing the raw materials for this industry.

Before proceeding further, it is worth mentioning the evidence pertaining to the exploitation of goat at this site. Looking at a readily identifiable part, the proximal radius, it was shown that the proportion of goat rose from about 6% to near 10% by the Late Saxon period, reducing slightly to 8% by Phase 5 (based on 152, 41 and 50 bones respectively). These figures clearly contrast with the equivalent 26.3%, 26.9% and 20.7% based on the horncores, with respective totals of 190, 52 and 29. Similar evidence from elsewhere including other sites in East Anglia (featuring minor postcranial collections compared to sheep and accumulations of horncores), has led to the interpretation of a general under exploitation of this species in combination with a trade in particular skeletal parts for craft purposes (see Albarella *et al.* 2004, 94 and Albarella *et al.* 2009, 50). Both aspects obviously continue into the medieval period. It has been observed that goats were essentially used for their milk and then to a limited extent for the ‘flesh of its kid and for its hide and hair’ (Trow-Smith 1957, 62). There is some evidence for the use of very young goats (a single mandible) in this phase. Otherwise, the sexing evidence, from the horncores, would suggest a much larger proportion of males compared to females. However, this is probably related more to the selection of suitable horns for craft purposes rather than a true reflection of the actual sex ratio. A final point concerns the evidence taken from Darby (1971, 142 and 199, in Albarella *et al*. 2004, 94) showing that some 7,000 goats were kept in Norfolk and Suffolk in the 11th century according to the Domesday records. This relates to about 8% of the total sheep and goat population, which is not dissimilar to the Late Saxon and indeed early medieval proportions calculated at Stoke Quay. Rather lesser quantities were noted within contemporary levels at Thetford and Norwich, amounting to less than 1% (Albarella *et al*. 2004, 94). While methods of calculation differed, this evidence may suggest a greater relative usage of goats in parts of Late Saxon/early medieval Suffolk compared to Norfolk.

The similarities between the Middle and Late Saxon collections also include a continuing absence of evidence for redistribution, with the obvious exception of the goat horncores, and a recurring somewhat narrow dietary range, again featuring some poultry and rare occurrences of game. There would appear to be a slight change in the size of cattle and sheep, both being generally smaller. An explanation for this was sought in the possibly greater occurrence of cows in the Late Saxon phase but the evidence here is rather slight. It can be shown that the size of cattle and sheep/goat within the later collection is relatively typical for the period and area, comparing range and mean values for the better represented dimensions with the data from Mill Lane and Castle Mall, Norwich (Albarella *et al.* 2004, 94 and Albarella *et al.* 2009, 43 and 59). The latter site also provided data taken from a large number of cattle horncores, the evidence indicating an almost exclusive presence of Short Horned cattle (Albarella *et al.* 2009, 43 and 46). This clearly contrasts with the mix of Short and Medium Horned animals at Stoke Quay (size categories after Armitage and Clutton-Brock 1976). It can be conjectured that a greater range of 'types' of cattle were available in the southern part of East Anglia, although substantially more data will be required to explore this subject further.

Ipswich undoubtedly underwent a change in status entering the Late Saxon period, moving from one of an exclusive company of *emporia* based on 'international trade and exchange' to a regional centre (Crabtree 2016, 35). It can be expected that a change of this magnitude would be demonstrated in the animal bone data. However, apart from the described modifications (particularly in relation to the cattle and sheep/goat age profiles), it would appear that food provisioning remained essentially the same. It should also be stated that, rather than representing a local phenomenon, the aforementioned modifications were clearly part of a more general change. These obviously occurred in response to a general concern rather than this local, albeit dramatic, change in circumstances. The evidence indicative of a rather under developed market system suggested for the Middle Saxon period is no doubt equally pertinent up to and immediately following the Conquest. A final point of similarity concerns the continuing evidence for local production, as shown by the presence into this phase of bones from very young cattle, sheep and pig. It can be supposed that domestic stock were kept within or at least at the outskirts of the Late Saxon town. This may be indicative of peripheral farms as previously mentioned or, perhaps given the more open framework of such early medieval towns, simply suggest the use of available inner urban open spaces for food production (Albarella *et al.* 2004, 98).

Medieval (Phases 5 and 6)

Cattle continues to dominate the bone collections from the medieval period. The domesticate abundance patterns are in fact rather similar between the Late Saxon and late medieval phases, apart from a subtle increase in sheep at the expense of pig within the latest levels (Phase 6). The early medieval assemblages at the other Ipswich sites (described in J/S (Elm Street) and C2) show a similar level of continuity: all are cattle-rich, but with an approximate Stoke Quay pattern at Elm Street and a notably higher proportion of sheep and pig amongst the C2 sites. The single late medieval collection, from the Eastern Triangle, appears to reflect the C2 pattern.

A preponderance of cattle is well attested at numerous medieval urban sites, as shown locally and nationally (Albarella *et al.* 2009, 34), a preference for beef contrasting with the ready availability of mutton due to the escalating importance of the woollen industry (Grant 1988, 151; Sykes 2006, 63). However, the urban markets do eventually show some correlation with the rural situation. This is demonstrated by site collections, generally dating from the latter part of the medieval period or the early post-medieval period, moving away from C>S>P towards S=C>P or even S>C>P. Such changes tend to coincide with a diminution in pig abundance, which was perhaps related to the destruction of woodland (pannage) to make way for more arable land and pasture (Albarella *et al.* 2009, 34 and Albarella 2006, 74-9). The data from the Eastern Triangle site may be indicative of the stated change in sheep usage, although the similarity to early medieval C2 may argue otherwise. There is certainly no obvious decrease in pig and, apart from the minor domesticate alterations during Stoke Quay Phase 6, the current evidence from Ipswich appears to suggest an absence of such changes within the medieval settlement. This evidence clearly contrasts with the high sheep and low pig counts in the early post-medieval phase (see below), arguing for a fairly rapid adoption of these nationwide trends. Clearly, these are general patterns and not all sites conform to these changes (Albarella *et al.* 2009, 28-33). However, it can be stated that the Ipswich evidence is markedly different from other urban centres in this locality. Notably, the nearby town of Bury St Edmunds has provided a number of sites with medieval collections, principally dated between the 12th and 14th centuries and inevitably showing a S>C>P domesticate pattern (Curl 2014 and Rielly 2017). In addition, the medieval collections at Castle Mall, Norwich, initially cattle-rich, changed to similar proportions of cattle and sheep/goat bones combined with a decline in pig by the 14th/15th centuries (Albarella *et al.* 2009, 22).

Data relating to the exploitation of these three species (excluding goat) provides further evidence for consistency and change. As in from Phase 4, the cattle are again largely derived from adult individuals with a notable proportion of first and second year animals, the former increasing and the latter decreasing during the medieval periods. The early medieval collections amongst the northern sites (in the C2 group) demonstrate a much larger proportion of adult cattle (about 90%, although based on just 16 mandibles) with a corresponding lesser proportion of sub-adults. While this clearly represents a marked difference to the Stoke Quay Phase 5 data, there is a similar abundance of younger (AG 5, as shown in Table 18) and older (AG6/7) adults, the latter providing a ratio of 1:5.4 compared to the northern sites – 1:6. There was undoubtedly a greater availability of older cattle in the early medieval meat markets in comparison to Phase 4 and indeed the contemporary Late Saxon data from the C2 sites. This may be related to an expansion of arable farming, as occurred elsewhere. The abundance of younger animals at medieval Stoke Quay appears to be relatively unusual for the period, closer in fact to the Late Saxon rather than the early medieval age pattern as shown by the regional data compiled from a number of Anglo-Saxon/medieval sites in Sykes (2006, 59) and also with comparison to the urban collections from Castle Mall in Norwich (Albarella *et al.* 2009, 39). It can perhaps be assumed that the sizeable demand and/or availability of better quality beef had been maintained in the Stoke Quay area from the Middle Saxon period well into the medieval period. The older cattle, according to the sex evidence, were equally proportioned between those used for traction and for their milk. This appears to change in the later medieval period (Phase 6), with more cows and therefore a greater reliance on animals from dairy herds. Looking again at the general picture, it would appear that there is a notable change from traction to dairy based usage of cattle by the 14th to 16th centuries. This suggestion is based on a number of factors including a diminishment of the workforce following the Black Death and the advancing substitution of cattle- by horse-power as the medieval period progressed (see Albarella 1997, 22 and Sykes 2006, 58-60). This is shown by the cattle age distributions compiled from a number of sites, including Stoke Quay Phase 6, with a predominance of older animals but also with a notable proportion of young calves. It would have been an obvious requirement to remove the calves to facilitate the availability of milk for human consumption, the same calves then being fattened to produce veal, a particular favourite of urban populations at this time and into the early post-medieval period (Thirsk 1967 in Albarella 1997, 22). The Phase 6 data does apparently show an increase in adults although not necessarily of older adults, while there is no obvious alteration in the relatively good proportion of juveniles observed in Phase 5. It could be supposed, given the potential evidence for an increase in dairy production, that a proportion of these calves may have been traded elsewhere. There is certainly a substantial quantity of veal-aged calf bones within the contemporary assemblage at Castle Mall, Norwich (Albarella *et al.* 2009, 39). The longevity of dairy production in this general area is suggested by the historical data, with the renowned trade in Suffolk milk and cheese dating to the 16th and 17th centuries based on the development of milking herds from at least the late medieval period (Trow-Smith 1957, 197-8 and see below).

The usage of first and second year animals is further highlighted by the clear majority of sub-adult sheep within both the early and later medieval phases. This undoubtedly is in marked contrast to the evidence from numerous other contemporary sites (see Sykes 2006, 67-8), including the data from Castle Mall, Norwich (Albarella *et al.* 2009, 56). These sites tend to provide a wide distribution of ages, as at Stoke Quay, but with a far better representation of adults, 60-70% rising to 80-90% by the late medieval period (14th to 16th century). A common attribute of these other sites is the dominance of older adults, signifying their usage principally in the woollen industry. There is certainly a peak in this older age group within the medieval Stoke Quay assemblages, each collection demonstrating a wealth of wethers and thereby illustrating the preferred type of wool. A slight increase in the number of adult sheep was observed in Phase 6, however, the notable proportion of younger individuals clearly suggests that sheep, perhaps in this regional area (*i.e.* the Ipswich hinterland), were equally or in fact mainly bred for their meat. It can perhaps be proposed that this continuing practice acted against the dietary change towards mutton, essentially corresponding to an increase in sheep imports as seen at other urban sites in this general locality. Obviously it would be beneficial to test this claim by reviewing the species representation, age and sex evidence from contemporary collections taken from the other Ipswich sites.

No obvious changes in the age data were observable amongst the medieval pig bone assemblages, apart from a rather better representation of first year animals in Phase 5. However, even with this increase it can be seen that exploitation was rather more extensive than intensive. It can again be surmised that a portion of these pigs were reared/kept within the town, as well as the possibility of some sty management. Sties became increasingly popular through the medieval period as pannage diminished and as various by-products of the brewing and, in particular, the dairy industries became more readily available (Albarella 2006, 79).

The supplementary part of the meat diet was very similar to the previous phase in terms of the poultry species represented and the minimal quantity of game. It does appear that poultry is most abundant amongst the late medieval deposits accompanied by a notable increase in the proportion of chicken. The few deer bones may again suggest a level of affluence amongst the local population, perhaps representing the very occasional purchase of an expensive food item. An approximately similar level of poultry and game usage has been observed at other early medieval sites in Ipswich, with the greatest proportion of poultry (8.1% - mainly chicken) occurring at Elm Street.

Late Medieval to Modern (Phases 7 to 9)

A far smaller quantity of bones came from deposits dating from these three phases, with a lesser proportion of sizeable assemblages (at least 100 bones), other than the notable exceptions of the craft waste collections from Phase 7. Processing and food waste continued to be deposited, most notably in the northern and western areas of the site, perhaps related to the houses fronting onto the road just beyond its western perimeter. However, it can be suggested that there was a general decline in the deposition of such waste, perhaps corresponding to the unavailability of the majority of this area for refuse disposal. This is reflected in the late 18th- and early 19th-century maps which depict the area to the south of the Shipyard as either orchards or gardens (Pennington's map of 1878 (Fig. 2.6) and Monson's map of 1848). Here, it is assumed that a similar usage may have extended back to the 16th and 17th centuries. Craft waste, consisting of sheep metapodials and phalanges, formed a major component of the Phase 7 assemblage. These bones are likely to represent tanning debris, clearly taken from yards specialising in the light leather industry. There is a very similar age distribution amongst these collections, showing the preparation of juvenile as well as older skins, the former perhaps intended for the manufacture of softer leathers as used, for example, in gloves. The similar location of the three assemblages, and their general similarity in other respects, strongly suggests that they may have derived from the same, probably local, tawyard.

The craft collections from the Stoke Quay site suggest that the light leather industry was in operation in Ipswich from the late medieval/early post-medieval period. Leather production was certainly an important component of the town's economy from the medieval period until at least the 18th century. However, this may have been related far more to the preparation of cattle (heavy leathers) than sheep skins. This is shown in the historical evidence for Ipswich relating to this industry in the 16th and 17th centuries. At this time there was clearly a specialisation towards the production and marketing of tanned hides and calfskins. These leathers were particularly valued by London shoemakers, benefiting from a substantial annual trade in leathers from East Anglian ports, including Woodbridge as well as Ipswich (Clarkson 1966, 30).

Excluding the craft waste, it is evident that major domesticate abundance continued to follow the previously stated nationwide pattern, at least into Phase 7, towards more sheep and less pig (Albarella *et al.* 2009, 34). While the quantity of bones in the Phase 8 collection is rather small, the abundance pattern does appear to follow the known historical data relating to the rapid decline of the woollen industry in this part of Suffolk during the 17th century and its cessation by the 18th century. The Phase 7 sheep, with data largely provided by the craft waste, were generally adult, no doubt signifying their derivation from wool producing flocks. These appear to be somewhat larger than the sheep from the previous medieval phases, reflecting a similar change observed at Castle Mall in Norwich between the 12th to 16th century and 16th to 18th centuries. The early post-medieval period witnessed a change in sheep husbandry with the requirement to provide stock of greater body mass to cater efficiently for the twin demands for wool and mutton (Albarella *et al.* 2009, 34). While the Phase 7 sheep do appear to be larger, there is no obvious reduction in age, as perhaps might be expected given the mutton requirement. It could be suggested that the data from this site corresponds to the transitional period between medieval and post-medieval husbandry practises and meat demands. There is a similar wealth of older sheep, however, within the 16th- to 18th-century levels at Castle Mall, perhaps suggestive of a rather slow acceptance of changes in urban meat demands in this general area.

It was intimated from the Phase 6 evidence that a large proportion of the cattle was derived from dairy herds. However, this did not appear to coincide with a greater consumption of veal, taking into account the obvious connection between milk production and surplus calves (see above). While the sexing and age evidence was rather poor in Phase 7, it can be seen that young calves were well represented. Veal was undoubtedly imported to urban centres and its presence in some quantity may not have a bearing on cattle husbandry in their hinterlands (see Albarella *et al.* 2009, 40). However, the historical evidence for Suffolk during the 16th and 17th centuries strongly suggests the importance of the dairy industry. Farms with particularly large dairy herds were undoubtedly present in this county in the early 17th century (Robert Reyce writing in 1618 from Hervey 1902, 38 in Trow-Smith 1957, 196) and by this time and dating from at least the end of the 16th century, it would appear that most 'of the butter and cheese arriving in London by coastal shipping came from Suffolk' (Fisher 1935, 46 in Trow Smith 1957, 197). This milk, or probably a large part of it, was produced by a Suffolk 'type', bred specifically for milk production, which perhaps dated back to the later medieval period and was produced from local stock crossed with milch cattle from the Low Countries (Trow-Smith 1957, 197-8). This animal was almost certainly polled (hornless) – although it can be assumed that a proportion of these animals are represented in the Phase 7 or later collections, no polled skulls were observed.

Bibliography

Albarella, U., 1997, 'Size, power, wool and veal: zooarchaeological evidence for late medieval innovations', in G, De Boe and F, Verhaeghe (eds), *Environment and Subsistence in Medieval Europe, Papers of the 'Medieval Europe Brugge 1997' Conference, Volume 9*, 19-30

Albarella, U., 2003, ‘Tawyers, tanners, horn trade and the mystery of the missing goat’, in P. Murphy and E.J. Wiltshire, *The Environmental Archaeology of Industry,* Symposia of the Association for Environmental Archaeology No. 20, Oxbow Books, 71-86

Albarella, U., 2004, ‘Mammal and bird bones’, in H. Wallis (ed.), *Excavations at Mill Lane, Thetford, 1995*, E. Anglian Archaeol. 108, 88-99

Albarella U., 2006, ‘Pig Husbandry and Pork Consumption in Medieval England’, in C.M. Woolgar, D. Serjeantson and T. Waldron (eds), *Food in Medieval England, Diet and Nutrition,* 72-87

Albarella, U., Beech, M., and Mulville, J., 2009, ‘Chapter 3. Mammal and Bird Bones from Castle Mall (Site 777N), excluding the Barbican Well’, in U. Albarella, M. Beech, J. Curl, A. Locker, M. Morena Garcia, and J. Mulville, *Norwich Castle: Excavations and Historical Survey, 1987-98, Part III: A Zooarchaeological Study*, E. Anglian Archaeol. Occas. Pap. 22 (NAU Archaeology and Historic Environment: Norfolk Museums and Archaeology Service), 14-93

Albarella U., and Davis, S.J.M., 1994, *The Saxon and medieval animal bones excavated 1985-1989 from West Cotton, Northamptonshire,* Unpub AML Report 17/94

Amorosi, T., 1989, *A postcranial guide to domestic neo-natal and juvenile mammals,* BAR Int Ser 533, Oxford

Armitage, P.L., and Clutton-Brock, J., 1976, ‘A system for the classification and description of the horn cores of cattle from archaeological sites’, *J. Archaeol. Sci.* 3, 329-48

Audoin-Rouzeau, F., 1987, Medieval and early modern butchery: Evidence from the monastery of la charite-sur-loire (nievre), *Food and Foodways: Explorations in the History and Culture of Human Nourishment*, *2:1*, 31-48

Baker, J., and Brothwell, D., 1980, *Animal Diseases in Archaeology,* London.

Bartosiewiecz, L., 2008, ‘Bone structure and function in draft cattle’, in G. Grupe, G. McGlynn and J. Peters (eds), *Limping together through the ages: Joint afflictions and bone infections*, Documenta Archaeobiologiae 6, Rahden, 153-164

Boessneck, J., and von den Driesch, A., 1974, Kritische anmerkungen zur widderristhöhenberechnung aus Längenmassen vor und frühgeschichtlicher tierknochen, Saugetierkdl Mitt 22 (4), 325-48

Bourdillon, J., 1988, ‘Countryside and Town: The animal resources of Saxon Southampton’, in D. Hooke (ed.) *Anglo-Saxon settlements* (Blackwell: London), 177-195

Bourdillon, J., and Coy, J.P., 1980, ‘The animal bones’, in P. Holdsworth (ed.), *Excavations at Melbourne Street, Southampton, 1971-76,* Counc. Brit. Archaeol. Res. Rep. 33, 79-121

Bramwell, D., 1975, ‘Bird remains from medieval London’, *London Naturalist 54*, 15-20

Brothwell, D, R., Dobney, K., and Jacques, D., 2005, ‘Abnormal sheep metatarsals: problem in aetiology and historical geography’, in J, Davis, M, Fabiš, I, Mainland, M, Richards and R, Thomas (eds.), *Diet and health in past animal populations, 9th ICAZ Conference, Durham 2002,* 75-79.

Brown, R., Teague, S., Loe, L., Sudds, B., and Popescu, E., 2020, *Excavations at Stoke Quay, Ipswich: Southern* Gipeswic *and the parish of St Augustine*, East Anglian Archaeology 172

Clark, J., (ed) 1995, *The Medieval Horse and its Equipment c 1150-c.1450:* Medieval Finds from Excavations in London: 5, Museum of London

Clark, K.M., 2009, ‘Pathologies of the sheep’, in D. Serjeantson and H. Rees, *Food, craft and status in medieval Winchester: The plant and animal remains from the suburbs and city defences*, (Winchester Museums & English Heritage), 158-165

Clarkson, L.A., 1967, ‘The Leather Crafts in Tudor and Stuart England’, *Agricultural History Review,* 15, 25-46

Crabtree, P, J., 1996, ‘Production and consumption in an early complex society: animal use in Middle Saxon East Anglia’, *World Archaeol* 28, 58-75

Crabtree, P.J., 2012, *Middle Saxon Animal Husbandry in East Anglia*, E. Anglian Archaeol. 143

Crabtree, P.J., 2016, ‘Zooarchaeology at Medieval Ipswich: from ‘wic’ to regional market town’, in B. Jervis, L. Broderick, and I. Grau-Sologestoa, *Objects, Environment and Everyday Life in Medieval Europe*, (Turnhout, Belgium: Brepols), 19-39

Curl, J., 2012, ‘Animal Bone’, in K Heard, *Eastern Triangle (land between Key Street and Star Lane), Ipswich, IPS 605 (IAS 5903): Archaeological Post-excavation Assessment and Updated Project Design*, SCCAS Report No. 2012/063, (Ipswich: Suffolk County Council Archaeological Service unpublished report), 63-8

Curl, J.A., 2014, ‘The faunal remains’, in Tester, A., *St Peters House, Risbygate St, Bury St Edmunds BSE367,* SCCAS Report No 2014/037.

Darby, H.,1971, *The Domesday Geography of Eastern England* (Cambridge University Press).

Davis, S.J.M., 1987, *The archaeology of animals* (London)

Dobney, K.M., Jaques, S.D., and Irving, B.G., 1996, *Of butchers and breeds: Report on vertebrate remains from various sites in the city of Lincoln,* Lincoln Archaeol. Ser. 5, (Lincoln)

Dobney, K., Jaques, D., Barrett, J., and Johnstone, C., 2007, *Farmers, Monks and Aristocrats: The environmental archaeology of Anglo-Saxon Flixborough,* Excavations at Flixborough Volume 3, (Oxbow Books)

Driesch, A, von den, 1976 *A guide to the measurement of animal bones from archaeological sites*, Peabody Mus Bull 1, Cambridge, Massachusetts

Driver, J., C., 1982, ‘Medullary bone as an indicator of sex in bird remains from archaeological sites’, in B., Wilson, C., Grigson and S., Payne (eds.), *Ageing and sexing animal bones from archaeological sites*, BAR Brit Ser 109, 251-254

Eastham, A., 1977, ‘Birds’, in B, Cunliffe, *Excavations at Portchester castle, vol III: Medieval, the Outer Bailey*, London, 233-7

Fisher, F.J., 1935, ‘The development of the London food market, 1540-1640’, *Economic History Review*, 5 (2), 46-64

Grant, A., 1975, ‘The animal bones’, in B, Cunliffe, *Excavations at Portchester Castle Volume I: Roman,* Reports of the Research Committee of the Society of Antiquaries of London No. **XXXII**, 378-408

Grant, A., 1982, ‘The use of toothwear as a guide to the age of domestic ungulates’, in B., Wilson, C., Grigson and S., Payne (eds.), *Ageing and sexing animal bones from archaeological sites*, BAR Brit Ser 109, 91-108, Oxford

Grant, A., 1984, ‘The animal remains’, in B, Cunliffe, Danebury: an Iron Age hillfort in Hampshire, Vol. 2, The excavations 1969-1978: the finds, *CBA Res.Rep.52*. (London). 496-526

Grant, A., 1988, ‘Animal Resources’, in G, Astill and A, Grant (eds.), *The Countryside of Medieval England*, 149-87, Oxford

Grigson, C., 1976, ‘The craniology and relationships of four species of *Bos*. 3. Basic craniology: *Bos taurus* L. Sagittal profiles and other non-measurable characters’, *J Arch Sci 3*, 115-136

Hagen, A., 1992, *A handbook of Anglo-Saxon food: Processing and consumption* (Anglo-Saxon books, Norfolk)

Hagen, A., 1995, *A second handbook of Anglo-Saxon food and drink: Production and Distribution* (Anglo-Saxon Books: Norfolk)

Hammond, P, W., 1993, *Food and feast in Medieval England*, Gloucestershire

Harcourt, R, A., 1974, ‘The dog in prehistoric and early historic Britain’, *J Archaeol Science* 1, 151-75

Hervey, Lord F., (ed.), 1902, *Suffolk in the Seventeenth Century, a Breviary of Suffolk by Richard Reyce, 1618,* (London)

Hodges, R., 1989, *Dark age economics: The origins of towns and trade AD600–1000,* (New York)

Holmes, M., 2014, *Animals in Saxon and Scandinavian England: Backbones of Economy and Society* (Sidestone Press)

Johnstone, C., and Albarella, U., 2002, *The Late Iron Age and Romano-British Mammal and Bird Bone Assemblage from Elms Farm, Heybridge, Essex (Site Code: Hyef93-95),* Centre for Archaeology Report 45/2002

Jones, G. G., and Sadler, P., 2012, ‘Age at death in cattle: methods, older cattle and known-age reference material’, *Environmental Archaeol.* 17(1), 11-28

Jones, R.T., and Serjeantson, D., 1983, *The animal bones from 5 sites at Ipswich,* Ancient Monuments Laboratory Report 13/83 (London: English Heritage)

Lawrence, M J & Brown, R W, 1973 (1967) *Mammals of Britain: their tracks, trails and signs.* Blandford Press. London

Levine, M., 1982, ‘The use of crown height measurements and eruption-wear sequences to age horse teeth’, in B, Wilson, C, Grigson and S, Payne (eds.) *Ageing and sexing animal bones from archaeological sites*, BAR Brit Ser 109, 223-250, Oxford

Malcolm, G., and Bowsher, D., 2003, *Middle Saxon London. Excavations at the Royal Opera House 1989-99.* MoLAS Monograph 15, Museum of London Archaeology Service

Moreno Garcia, M., 2009, ‘Chapter 4. Mammal and Bird Bone from the Barbican Well (mid/late 15th to early 16th centuries) (Site 777N)’, in U. Albarella, M. Beech, J. Curl, A. Locker, M. Morena Garcia and J. Mulville, *Norwich Castle: Excavations and Historical Survey, 1987-98, Part III: A Zooarchaeological Study*, E. Anglian Archaeol. Occas. Pap. 22 (NAU Archaeology, and Historic Environment, Norfolk Museums and Archaeology Service), 95-130

O’Connor, T.P., 1989, *Bones from the Anglo-Scandinavian levels at 16-22 Coppergate,* The Archaeology of York, The animal bones, 15(3), (York Archaeological Trust)

O’Connor, T.P., 1991, *Bones from 46-54 Fishergate,* The Archaeology of York, The animal bones, 15(4), (York Archaeological Trust)

O’Connor, T.P., 2001, ‘On the interpretation of animal bone assemblages from Wics’, in D, Hill, and R, Cowie, *The early medieval trading centres of Northern Europe,* (Sheffield Academic Press), 54-60

Payne, S., 1969, ‘A metrical distinction between sheep and goat metacarpals’, in P. J, Ucko and G.W, Dimbleby (eds), *The Domestication and Exploitation of Plants and Animals.* Aldine Publishing, Chicago, 295-306

Payne, S., 1973 ‘Kill-off patterns in sheep and goats: the mandibles from Asvan Kale’, *Anatolian Studies* 23, 281-303

Payne, S., 1985, ‘Morphological distinctions between the mandibular teeth of young sheep, *Ovis,* and goats, *Capra’, J. Archaeol. Sci.,* 12, 139-147

Pestell, T., and Umschneider, K., 2001, *Markets in Early Medieval Europe: Trading and ‘Productive’ Sites, 650-850,* Macclesfield: Windgather Press

Prummel, W., and Frisch, H. J., 1986, ‘A guide for the distinction of species, sex and body side in bones of sheep and goat’, *Journal of Archaeological Science, 13,* 567-77

Rackham, D.J., 1994, ‘Economy and environment in Saxon London’, in J. Rackham (ed.), *Environment and Economy in Anglo-Saxon England*, Counc. Brit. Archaeol. Res. Rep. 89, 126-135

Rielly, K., 2011, ‘The leather-production industry in Bermondsey - the archaeological evidence’, in R, Thomson and Q, Mould (eds.), *Leather Tanneries - the archaeological evidence*, Exeter: Archetype Publications Ltd in association with the Archaeological Leather Group, 157-186.

Rielly, K., 2012, ‘Meat’, in R. Cowie and L. Blackmore, *Lundenwic: excavations in Middle Saxon London, 1987-2000*, Museum of London Archaeology Monogr. Ser. 63, 146-152

Rielly, K., 2017, *Assessment of the animal bones from Westgate House, Westgate Street, Bury St Edmunds, Suffolk (BSE498)*, Unpublished PCA report

Rixson, D., 2000, *The History of Meat Trading* (Nottingham University Press)

Schmid, E., 1972, *Atlas of animal bones for prehistorians, archaeologists and Quaternary geologists* (Elsevier: London)

Serjeantson, D., 1989, ‘Animal remains and the tanning trade’, in D., Serjeantson and T., Waldron (eds), *Diet and Craft in Towns, B.A.R. British series 199,* Oxford, 129-146

Sykes, N., 2006a, ‘The impact of the Normans on hunting practices in England’, in C. M, Woolgar, D. Serjeantson and T. Waldron (eds.), *Food in Medieval England, Diet and Nutrition*, 162-175

Sykes, N., 2006b, ‘From *Cu* and *Sceap* to *Beffe* and *Motton*’, in C.M. Woolgar, D. Serjeantson and T. Waldron (eds), *Food in Medieval England, Diet and Nutrition*, 56-71

Sykes, N. J., 2007, *The Norman Conquest: A Zooarchaeological Perspective*, BAR International Series **1656** (Oxford, British Archaeological Reports)

Sykes, N., and Curl, J., 2010, ‘The Rabbit’, in N, Sykes and T, P, O’Connor (eds.), *Extinctions and Invasions: A social history of British fauna*, Exeter: Windgather Press for Oxbow Books, 116-126

Thirsk, J., 1967, ‘Farming techniques’, in J., Thirsk (ed.), The agrarian history of England and Wales, Volume IV, 1500-1641, Cambridge University Press, 161-199

Thomas, R N W., 1988, ‘A statistical evaluation of criteria used in sexing cattle metapodials’, *Archaezoologia* 2, 1.2, 83-92

Trow-Smith, R., 1957, *A history of British livestock husbandry to 1700.* London: Routledge and Kegan Paul.

Vann, S, and Grimm, J, 2010, ‘Post-medieval sheep (Ovis aries) metapodia from southern Britain’, *Journal of Archaeological Science 37*, 1532–1542

Wade, K., 1988, ‘Ipswich’, in R. Hodges, and B. Hobley (eds), The Rebirth of Towns in the West, AD 700-1050, Counc. Brit. Archaeol. Res. Rep. 68, 93-100

Wade, K., 1993 ‘The Urbanisation of East Anglia: the Ipswich Perspective’, in Julie Gardner (ed), Flatlands & Wetlands: Current Themes in East Anglian Archaeology, E. Anglian Archaeol., 50, 144-151

Woodward, J., and Luff, P., 1983, *The field guide. A farming companion,* Blandford Press: Poole, Dorset

Yalden, D., and Albarella, U., 2009, *The History of British Birds,* London.

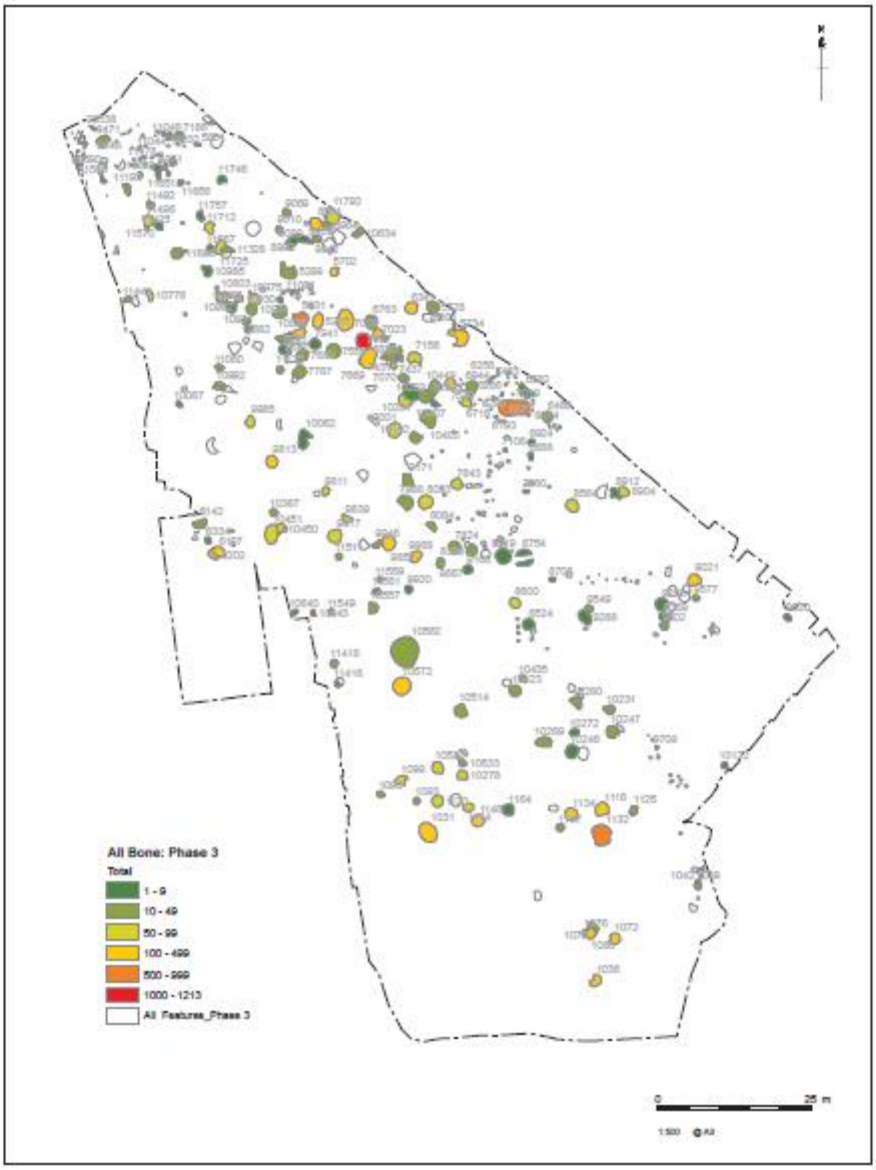

Figure 1. The distribution of animal bones in Phase 3 using Total fragment counts

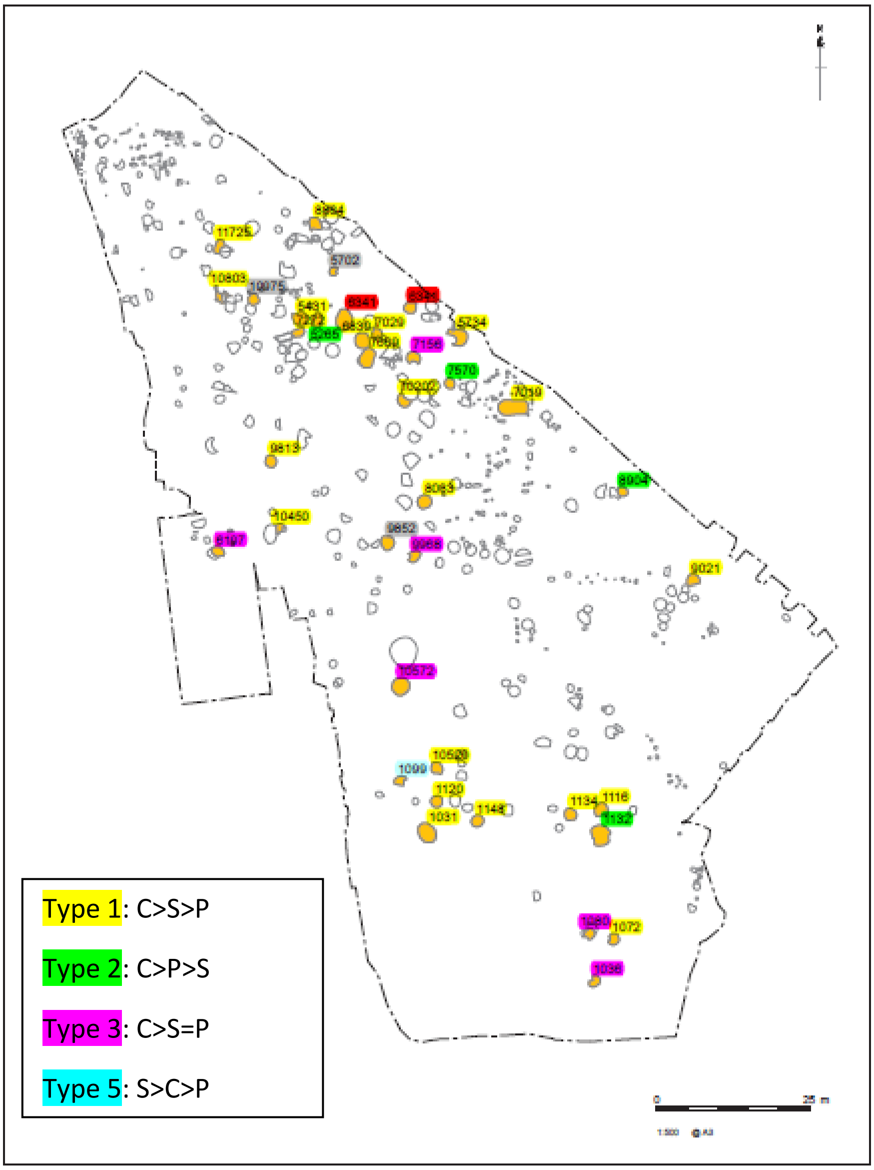

Figure 2. The percentage distribution of cattle (C), sheep/goat (S) and pig (P) amongst a selection of Phase 3 features (major domesticate assemblages greater than 70 bones highlighted in orange) divided as follows: Type 1 - C>S>P; Type 2 – C>P>S; Type 3 – C>S=P; Type 4 – P>S>C; Type 5 – S>C>P; Type 6 – C=S>P; Type 7 – S>P>C; Type 8 – C=S=P; where > is greater than, = is equals (within 2%)

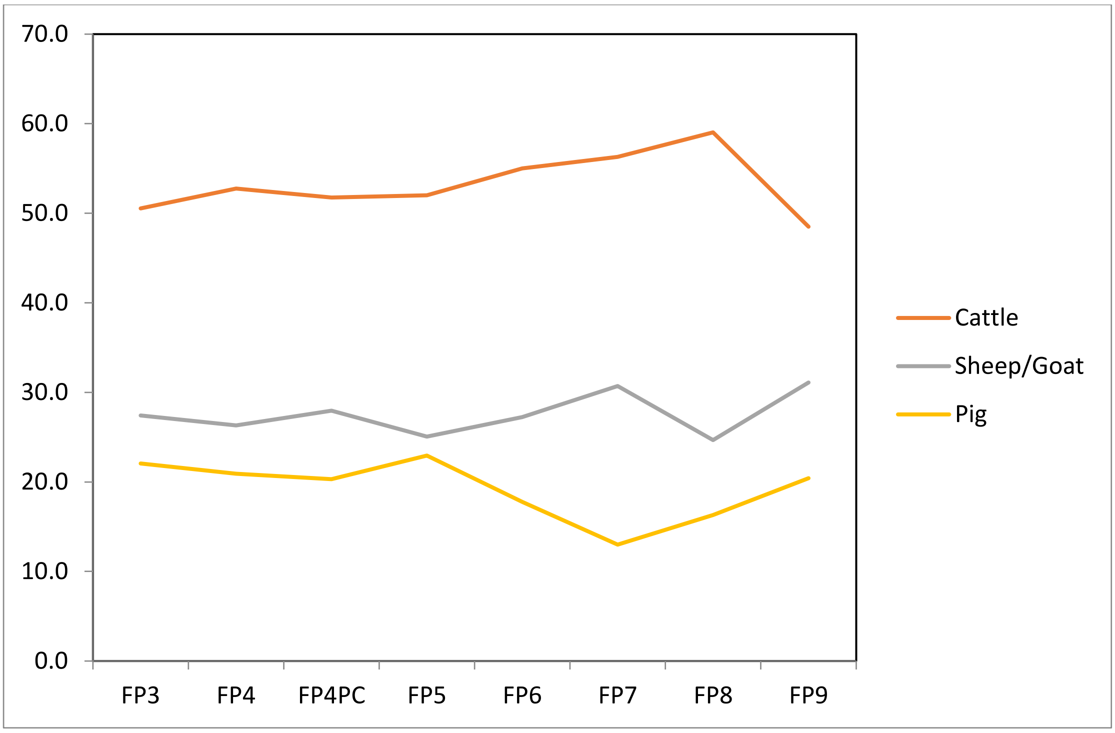

Figure 3. Percentage abundance of cattle, sheep/goat and pig per phase using Total fragment counts excluding the sheep/goat contents of the Phase 7 pits 5580, 9246 and 9495

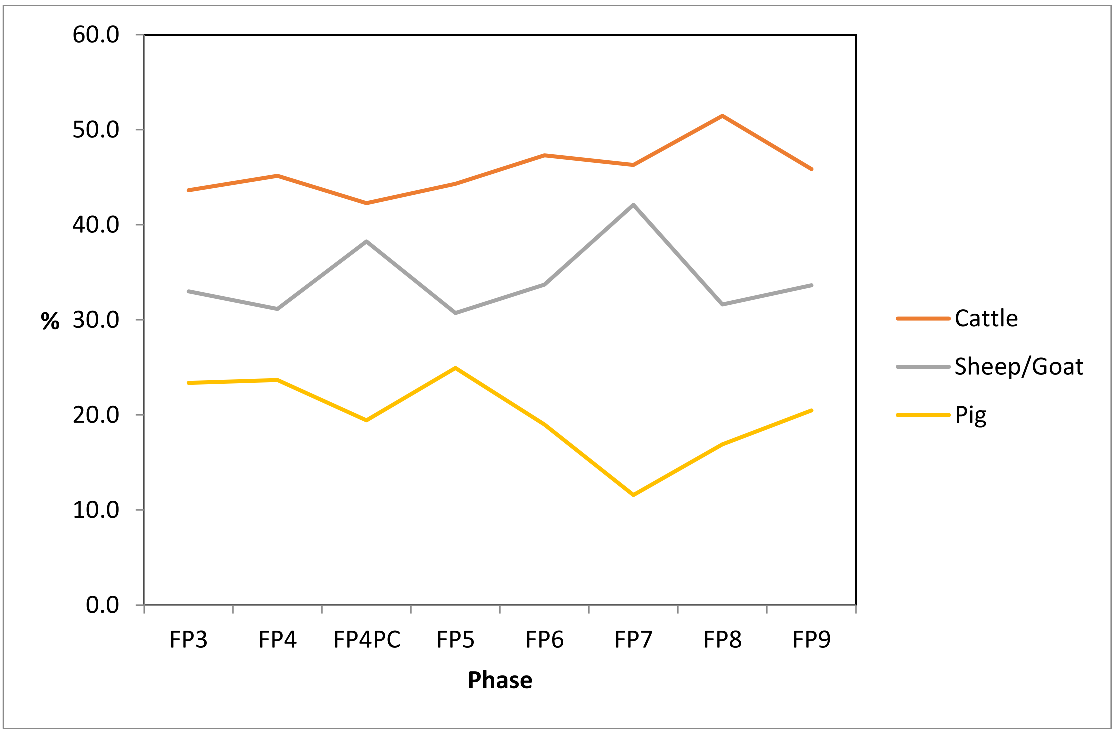

Figure 4. Percentage abundance of cattle, sheep/goat and pig per phase using Epiphyses Only counts excluding the sheep/goat contents of the Phase 7 pits 5580, 9246 and 9495

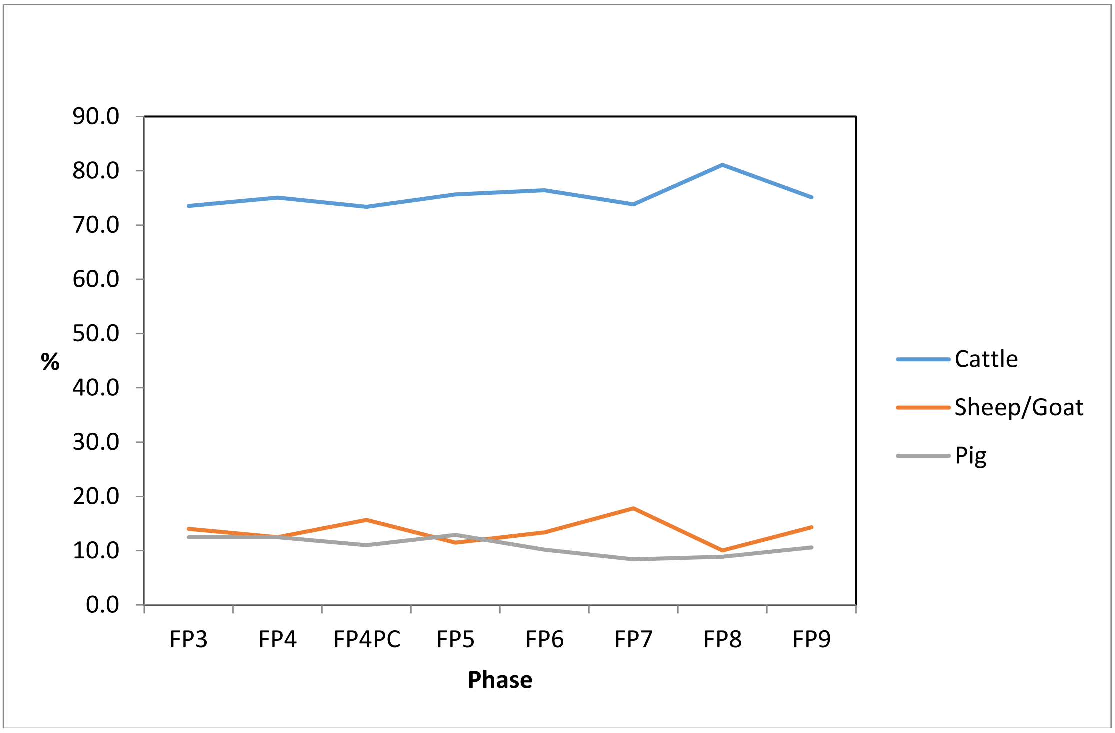

Figure 5. Percentage abundance of cattle, sheep/goat and pig per phase using weight of bones, excluding the Phase 7 sheep/goat craft waste (see Table 7.41)

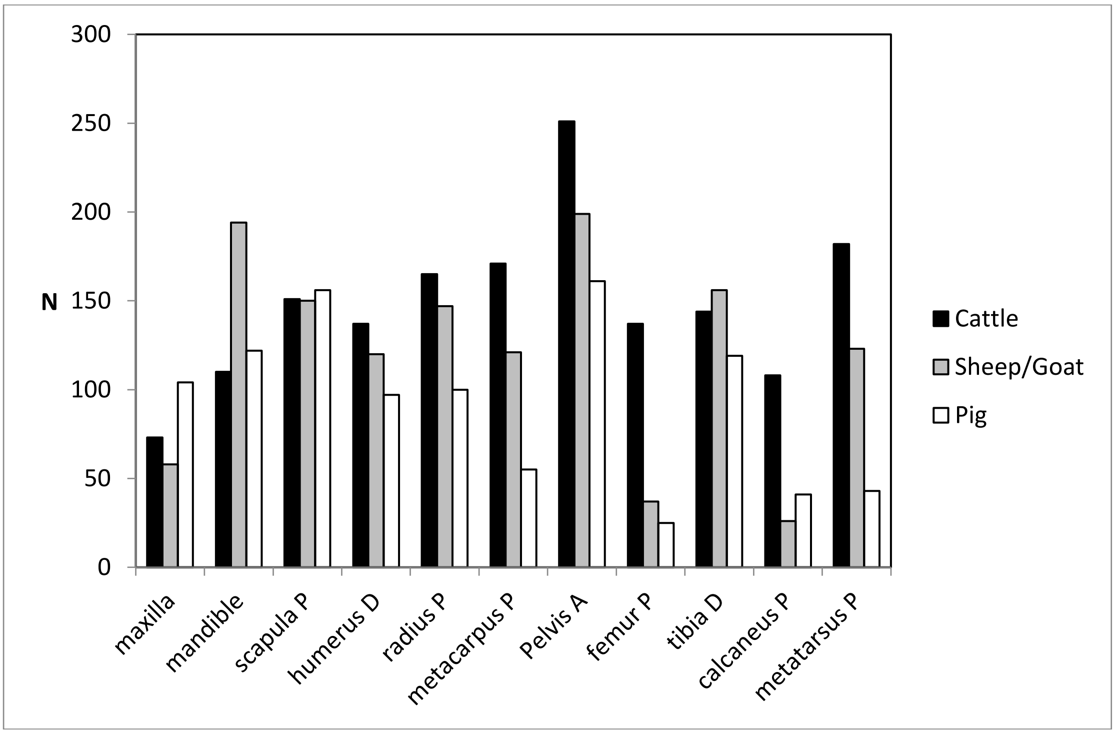

Figure 6. Cattle, Sheep/Goat and Pig selected skeletal part abundance based on minimum counts of certain teeth (maxilla and mandibles) and particular articular ends (the limb bones), where N refers to the number of parts, P is proximal and D is distal

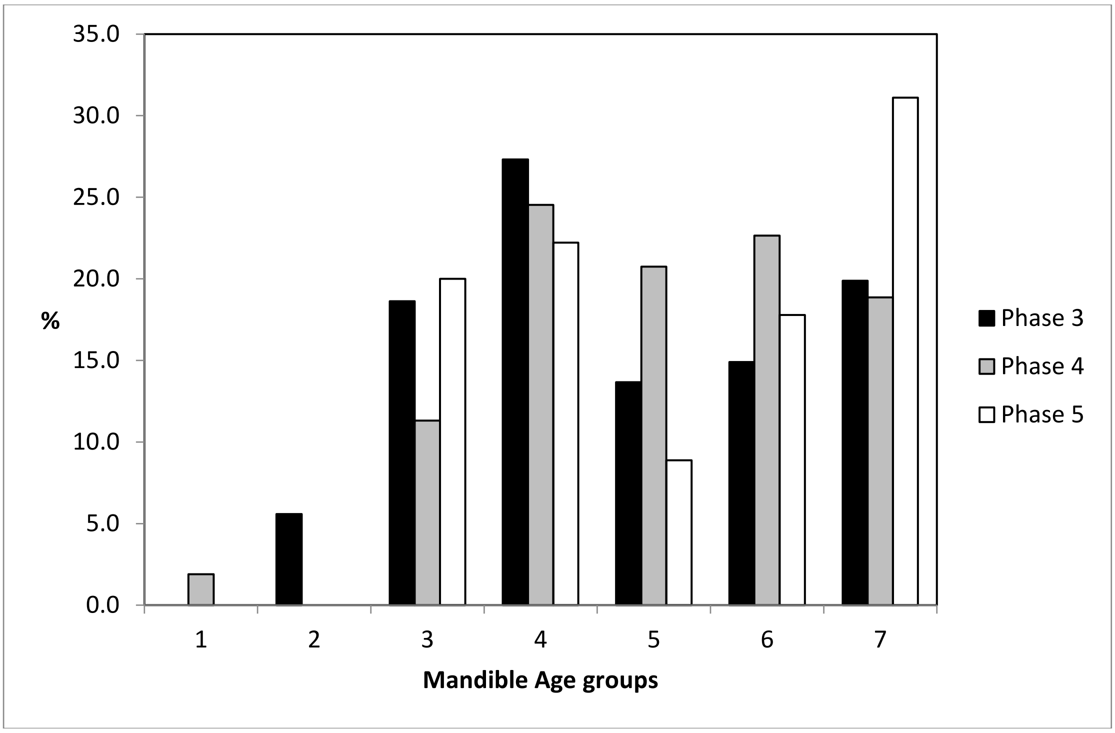

Figure 7.Cattle mandibles age: the percentage distribution of age groups from Phases 3, 4 and 5 (based on data given in Table 7.15)

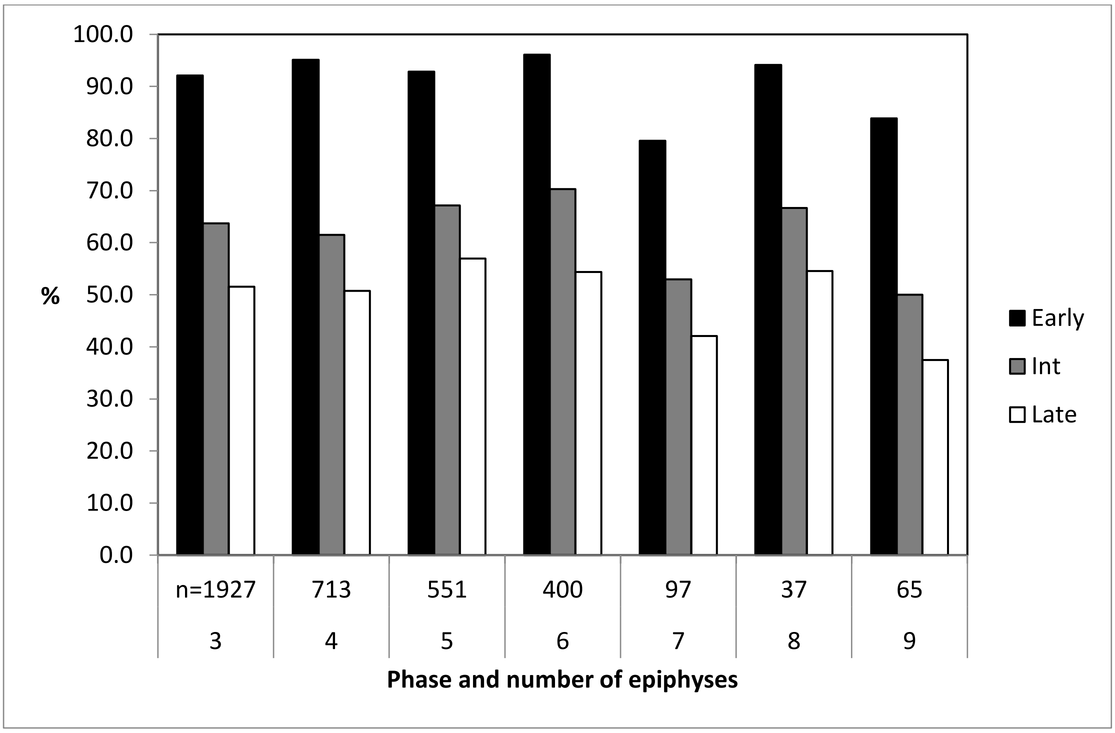

Figure 8. Cattle epiphysis fusion data (see Table 7.9 for description of age groups)

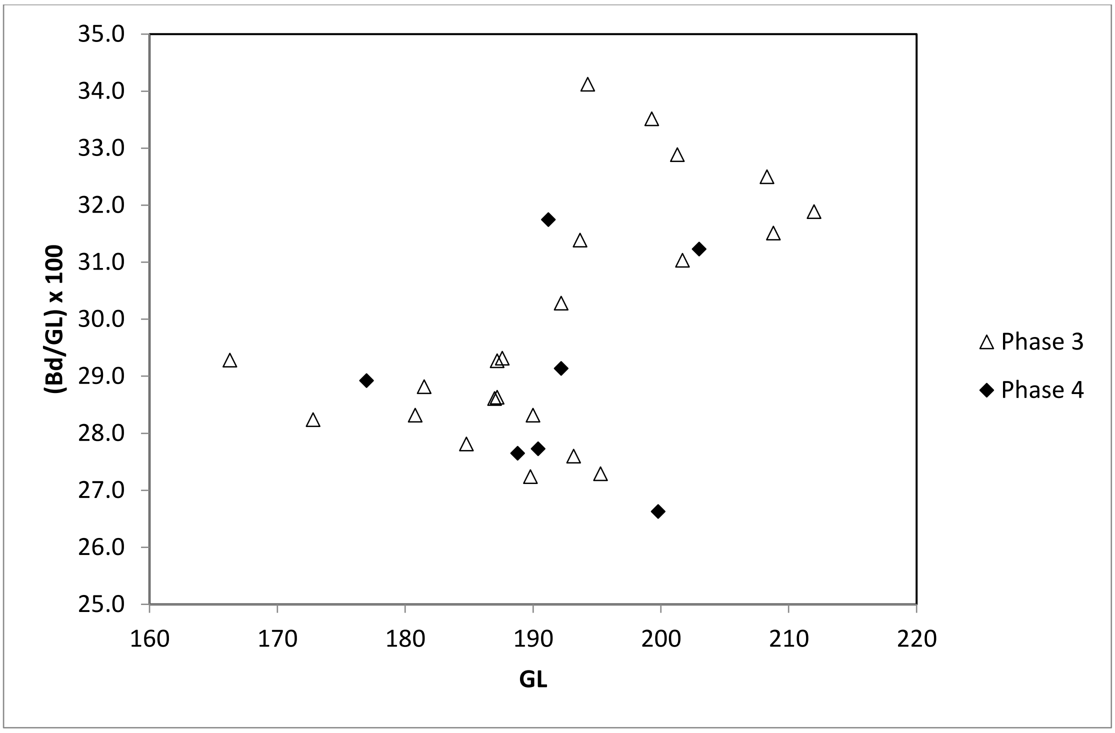

Figure 9. Cattle sex and size data in Phases 3 and 4 using metacarpal distal breadth (Bd) divided by greatest length x 100 against greatest length

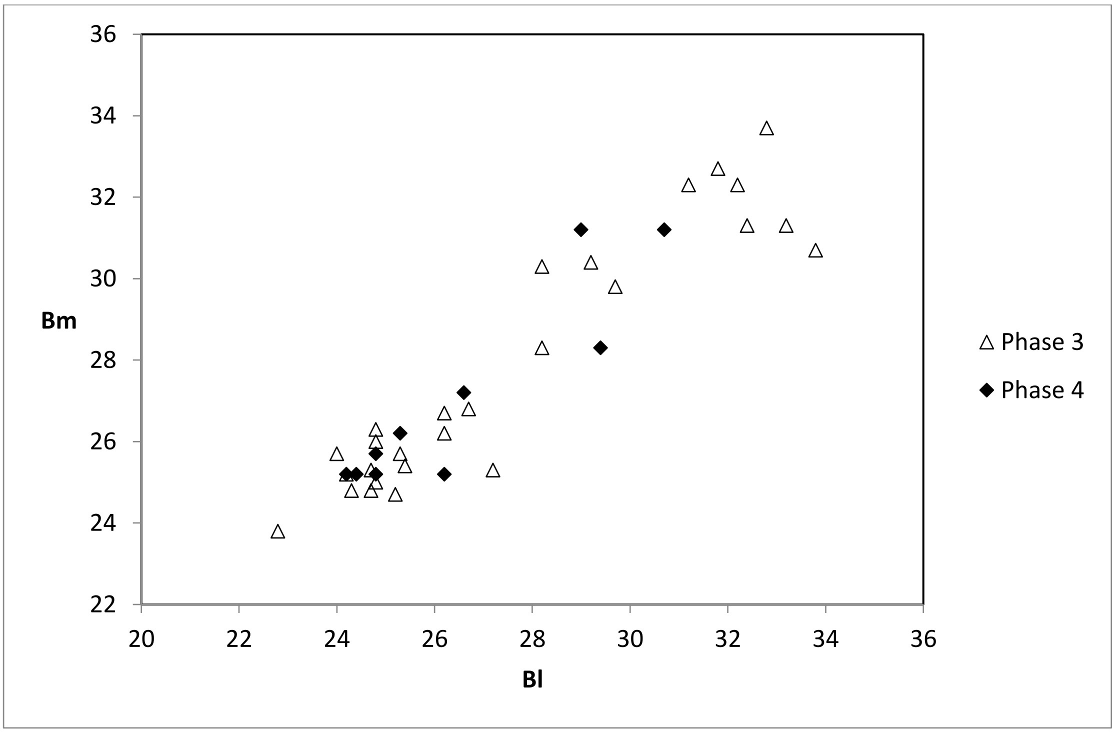

Figure 10. Cattle sex and size data in Phases 3 and 4 using metacarpal breadth of medial (Bm) and lateral (Bm) distal condyle (after Thomas 1988)

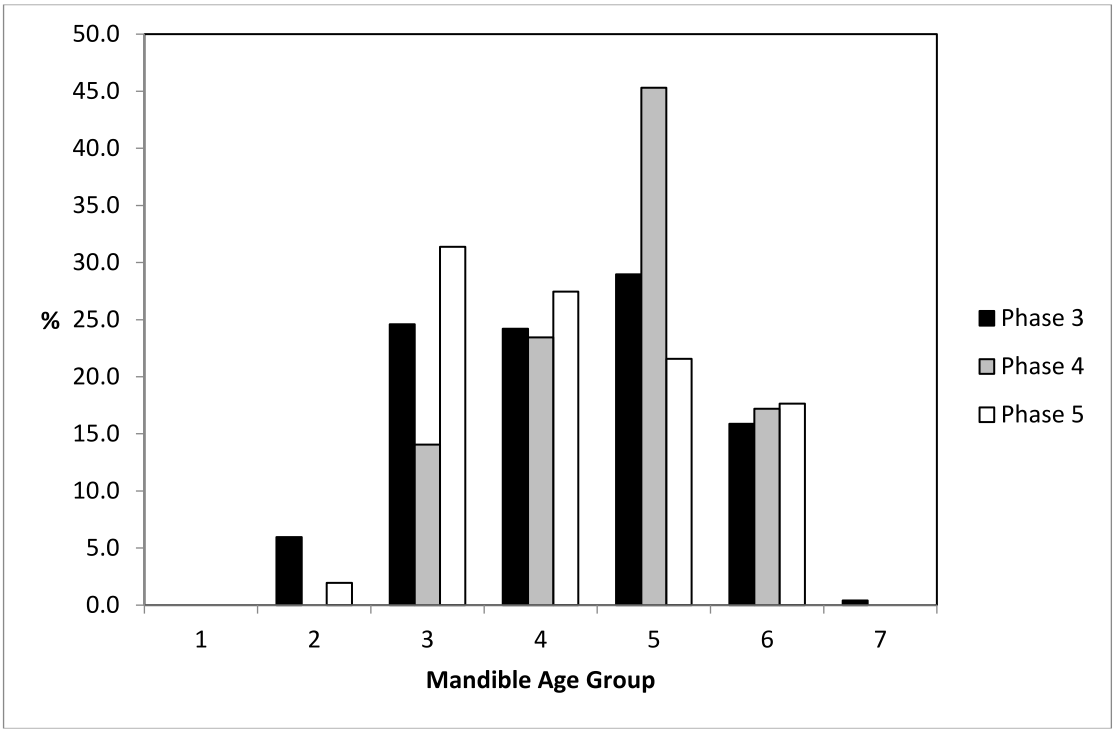

Figure 11. Sheep/Goat mandibles: the percentage distribution of age groups from Phases 3, 4 and 5 (based on data given in Table 7.15)

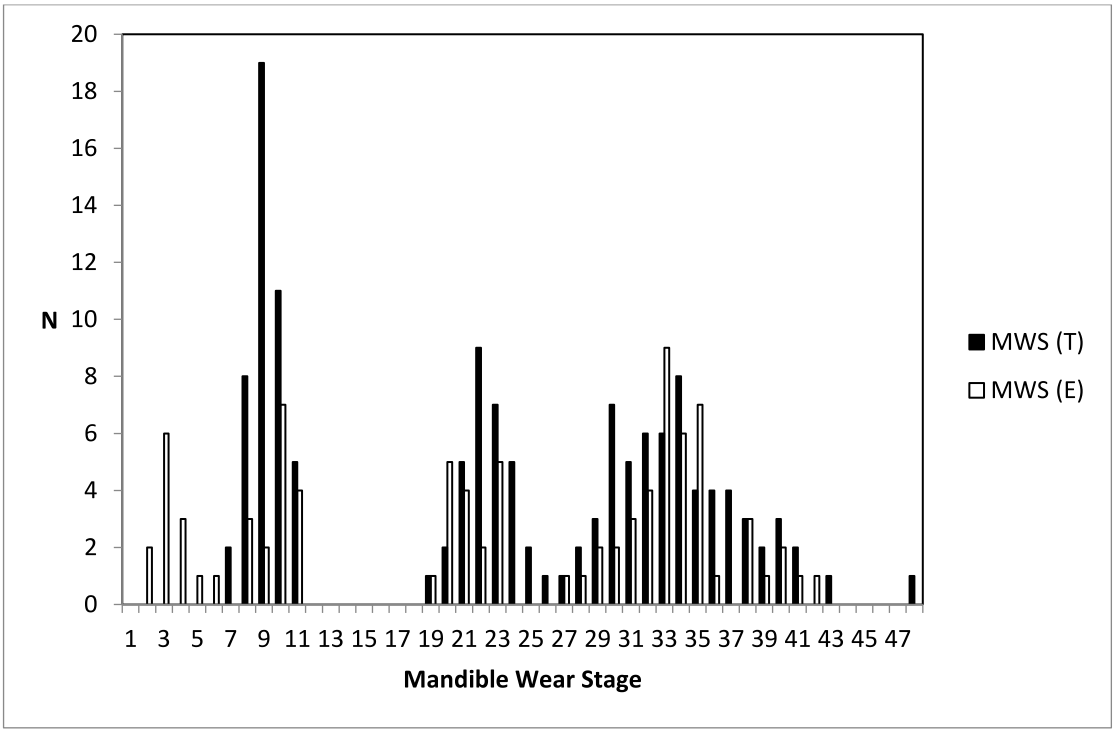

Figure 12. The distribution of Mandible Wear Stages (MWS) for sheep/goat mandibles from Phase 3 (after Grant 1982), where N is the number of mandibles, T is true (all three adult molars) and E is estimate (missing one or more adult molars depending on age but with deciduous or adult fourth premolar)

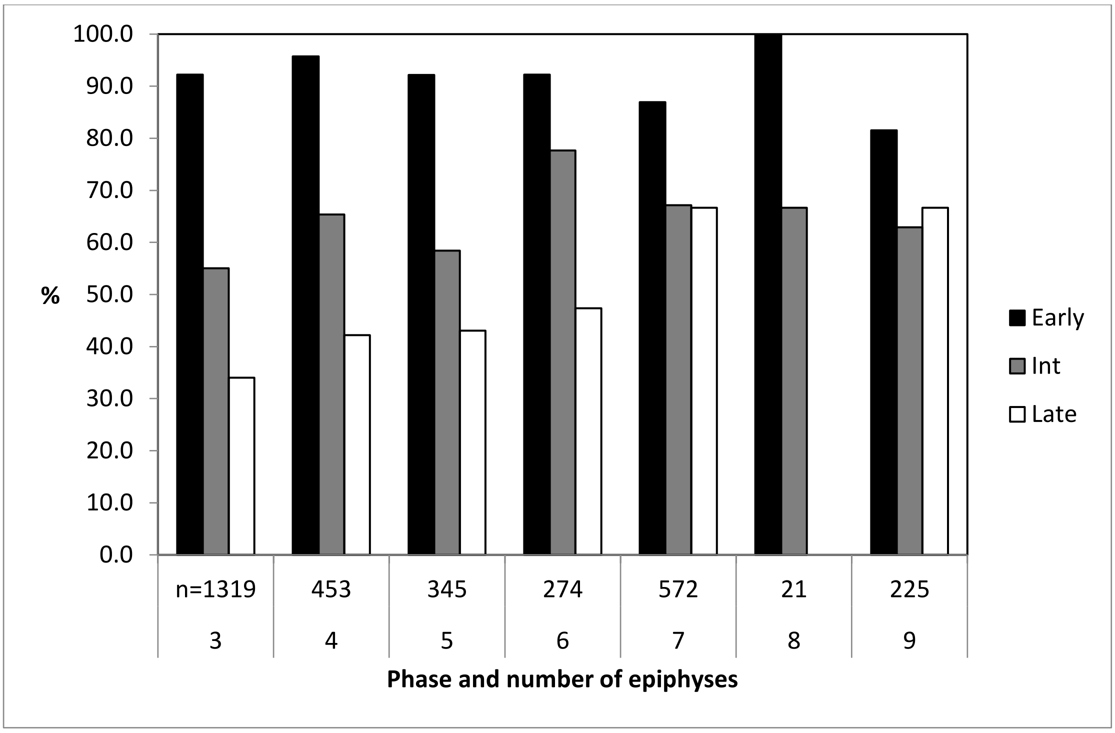

Figure 13. Sheep/Goat epiphysis fusion data (see Table 7.9 for description of age groups)

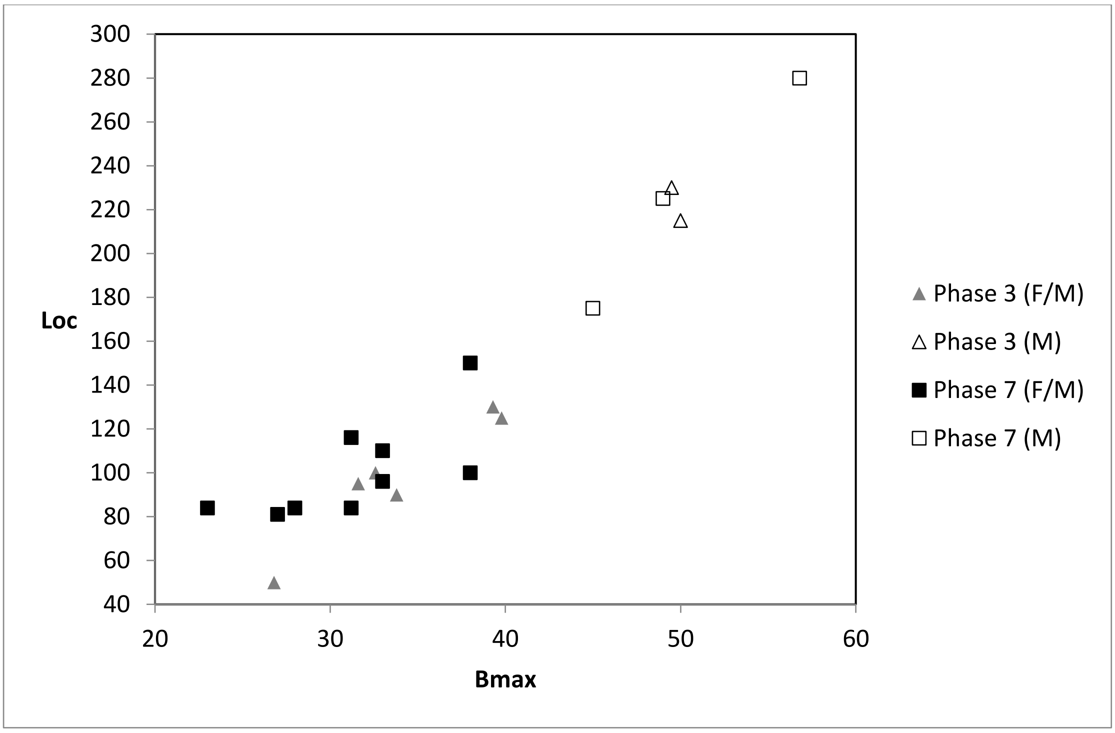

Figure 14. Size of sheep horncores comparing Length of outer curvature (Loc) and Greatest breadth (anterio-posterior) at the base (Bmax) with measurements in millimetres. Each of the cores have been identified, according to their appearance as M male (ram) or F/M female/male (ewe/wether)

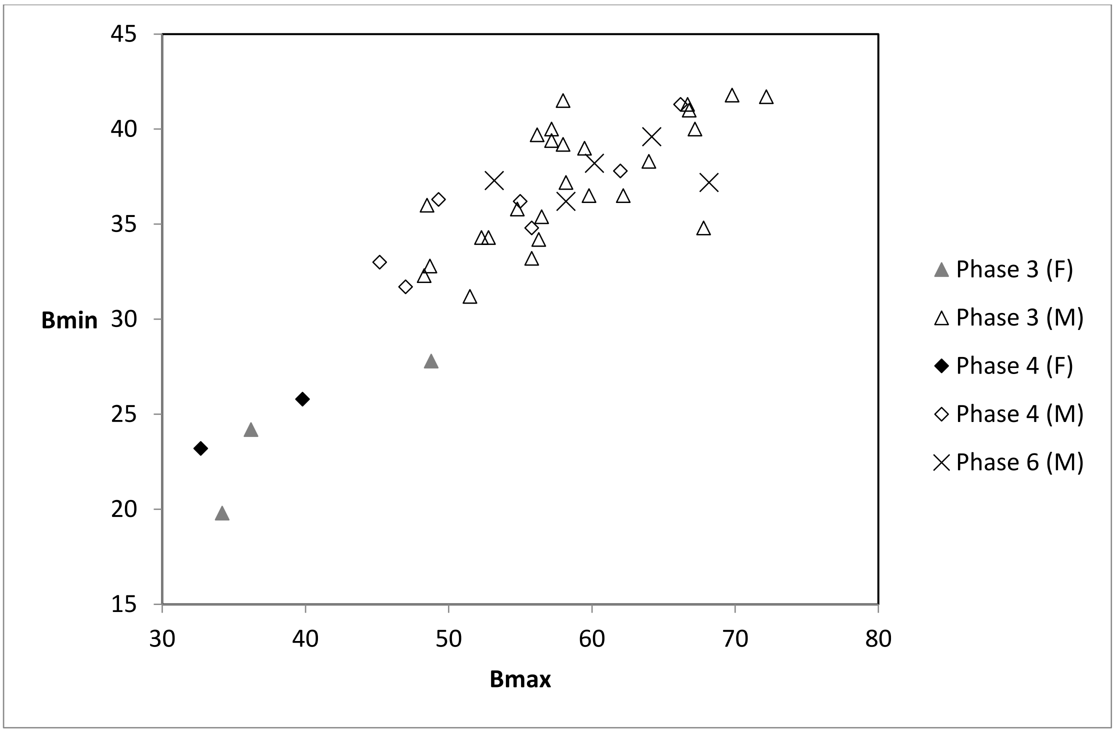

Figure 15. Size of goat horncores comparing maximum and minimum basal breadths: anterio-posterior (Bmax) and lateral-medial (Bmin) with measurements in millimetres. Each of the cores have been identified, according to their appearance as M male (billy) or F female (nanny)

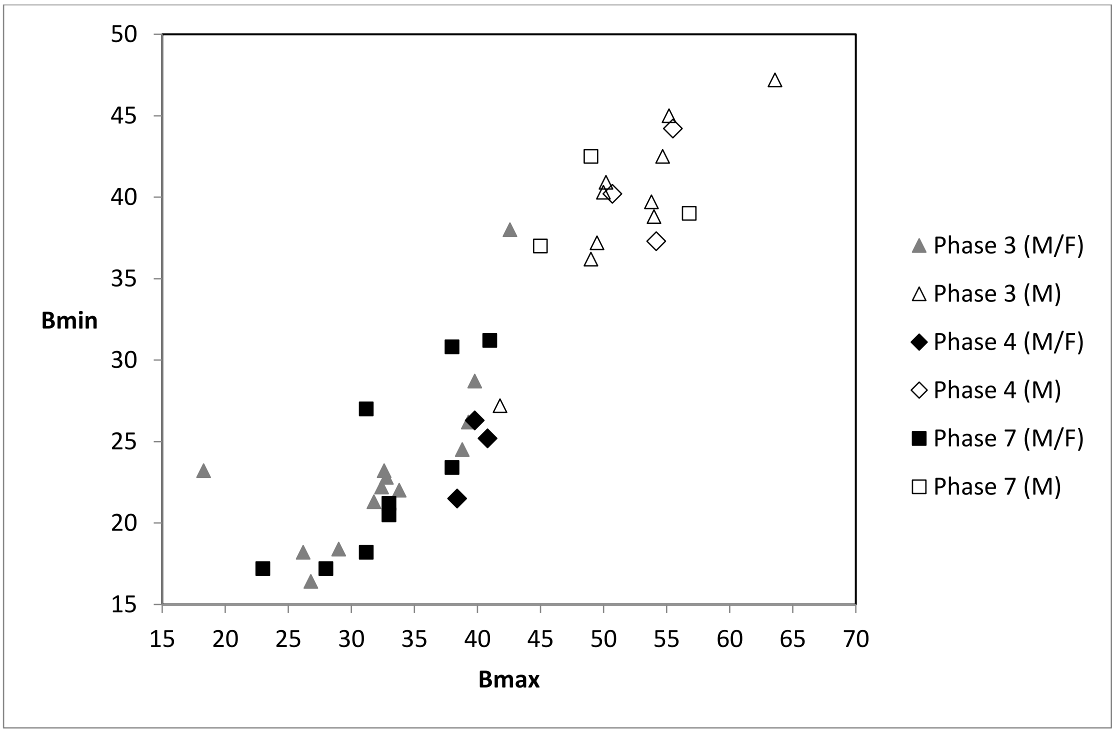

Figure 16. Size of sheep horncores comparing maximum and minimum basal breadths: anterio-posterior (Bmax) and lateral-medial (Bmin) with measurements in millimetres. Each of the cores have been identified, according to their appearance as M male (ram) or F/M female/male (ewe/wether)

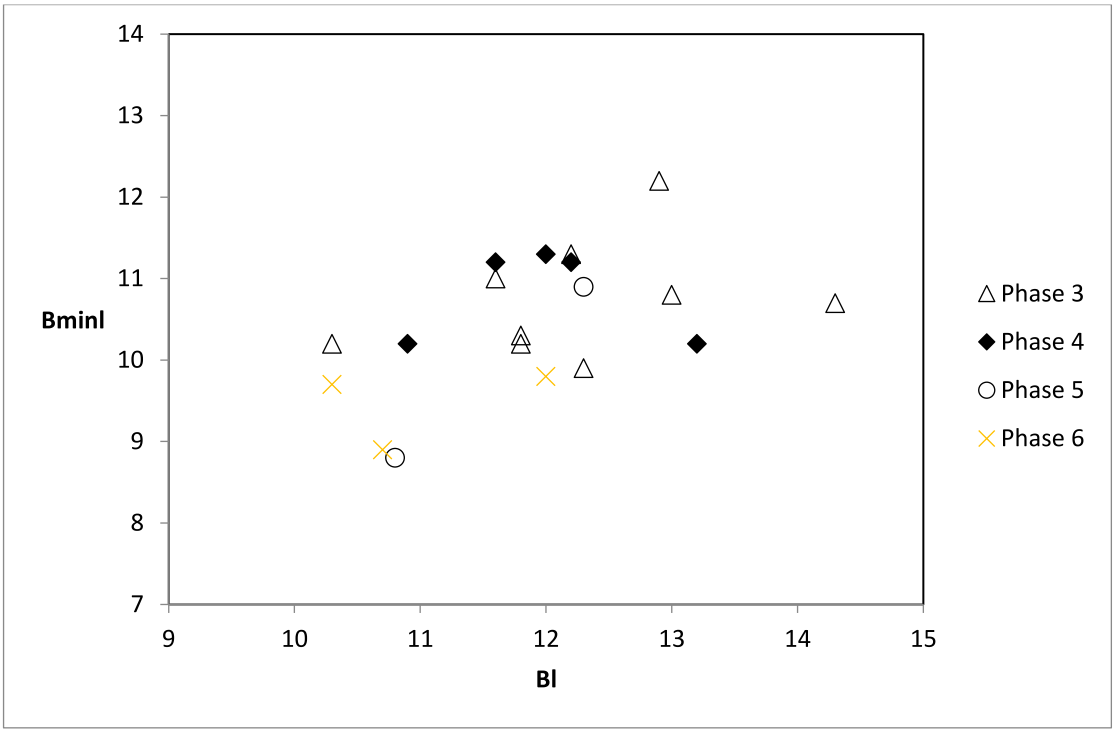

Figure 17.Scatterplot comparing two dimensions of the external or lateral distal condyle of the sheep/goat metacarpus (in millimetres): breadth (Bl) and the minimum depth (Dminl), after Payne (1969, 296 referring to w.cond and w.troch respectively)

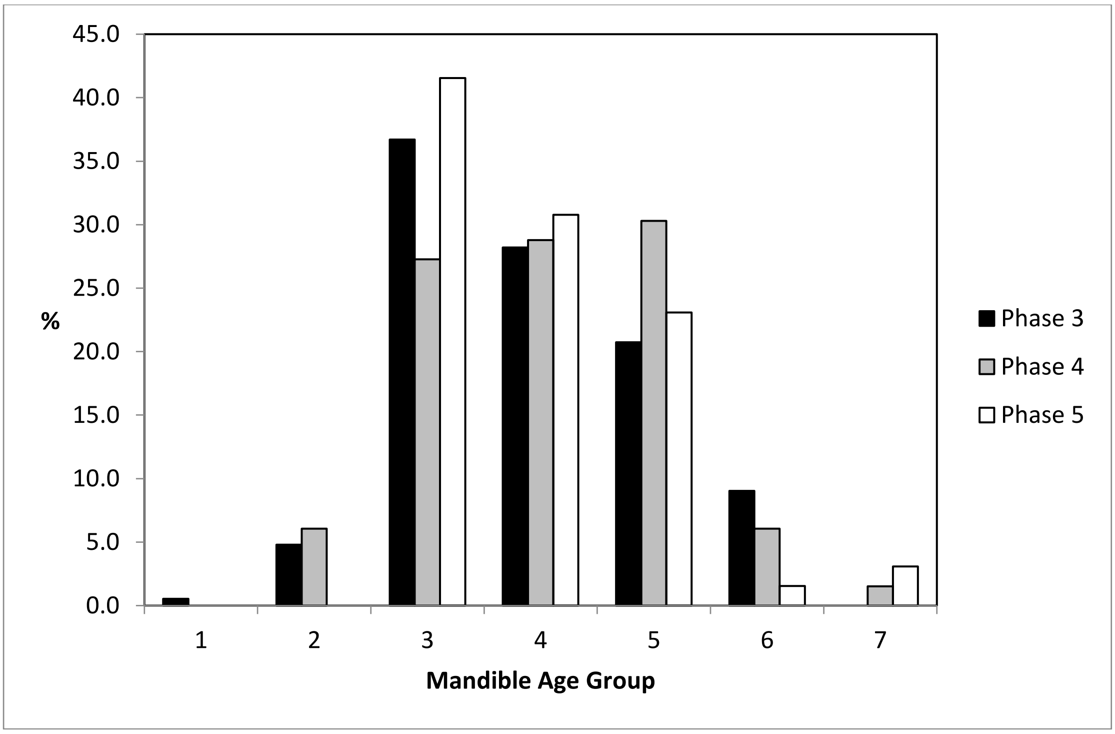

Figure 18. Pig mandibles: the percentage distribution of age groups from Phases 3, 4 and 5 (based on data given in Table 7.15)

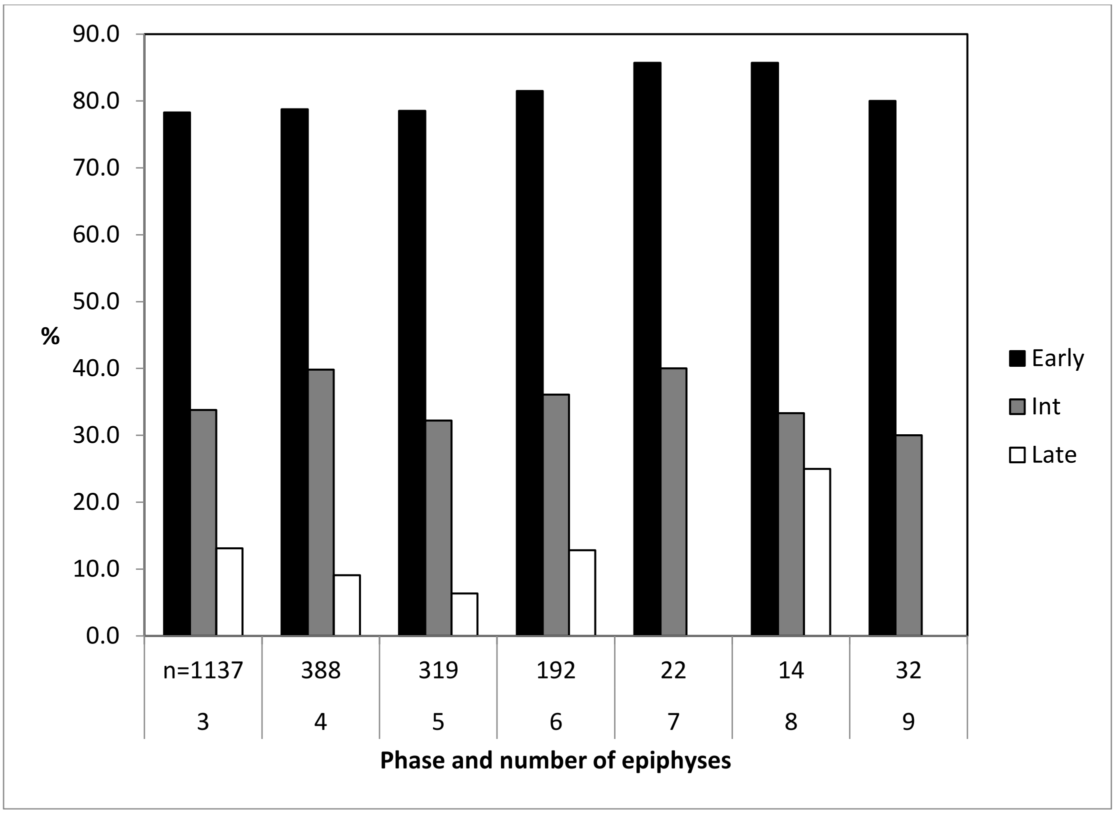

Figure 19. Pig epiphysis fusion data (see Table 7.9 for description of age groups)

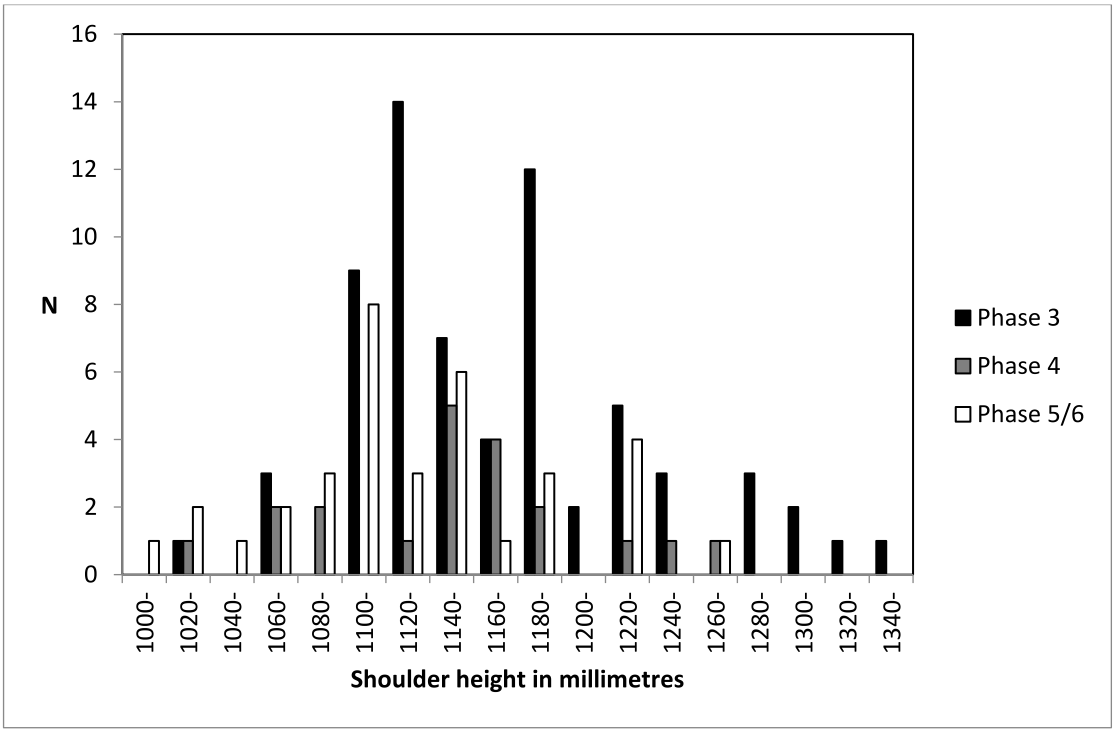

Figure 20. Distribution of cattle shoulder heights in Phases 3, 4 and 5/6 calculated after Boessneck and von den Driesch (1974), where N is the number of bones

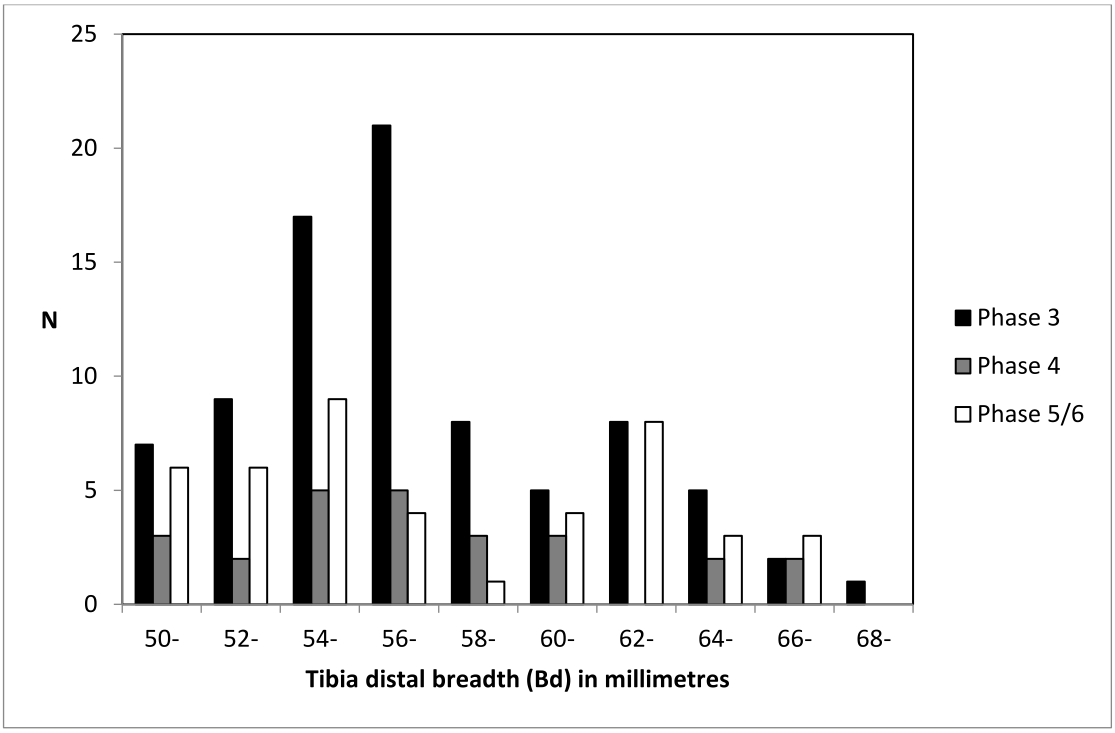

Figure 21. Size of cattle tibias: distribution of distal breadth (Bd) measurements from Phases 3, 4 and 5/6

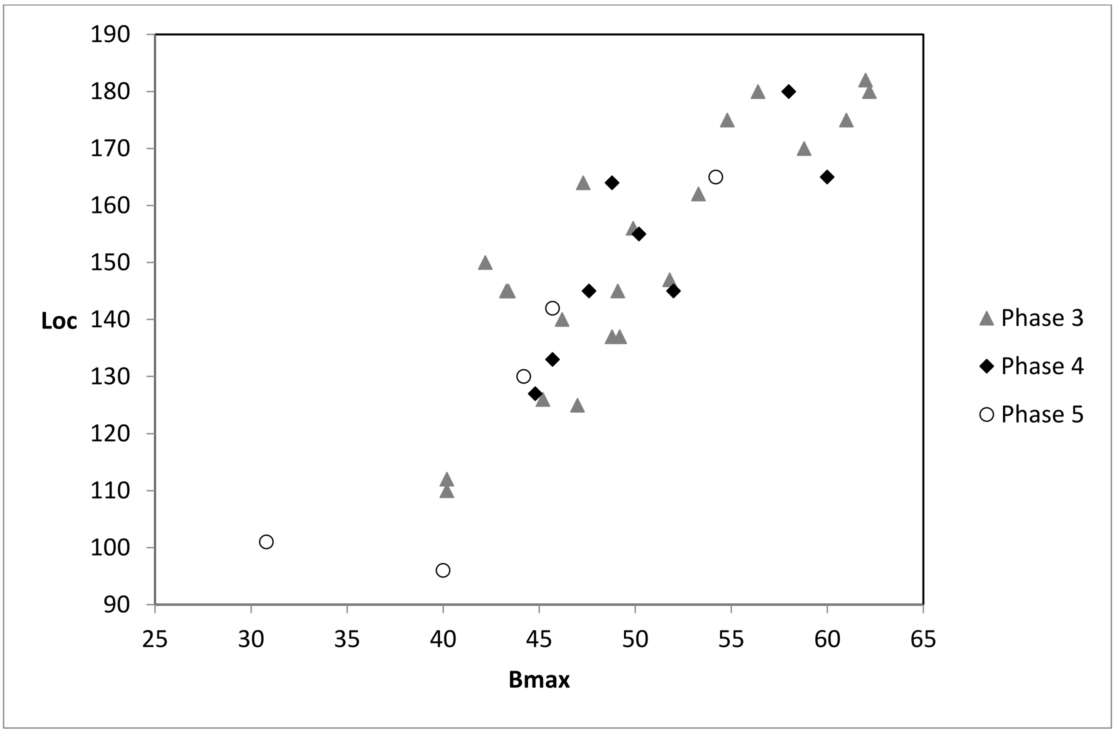

Figure 22. Size of cattle horncores: length of outer curvature (Loc) and anterio-posterior basal breadth (Bmax) with measurements in millimetres

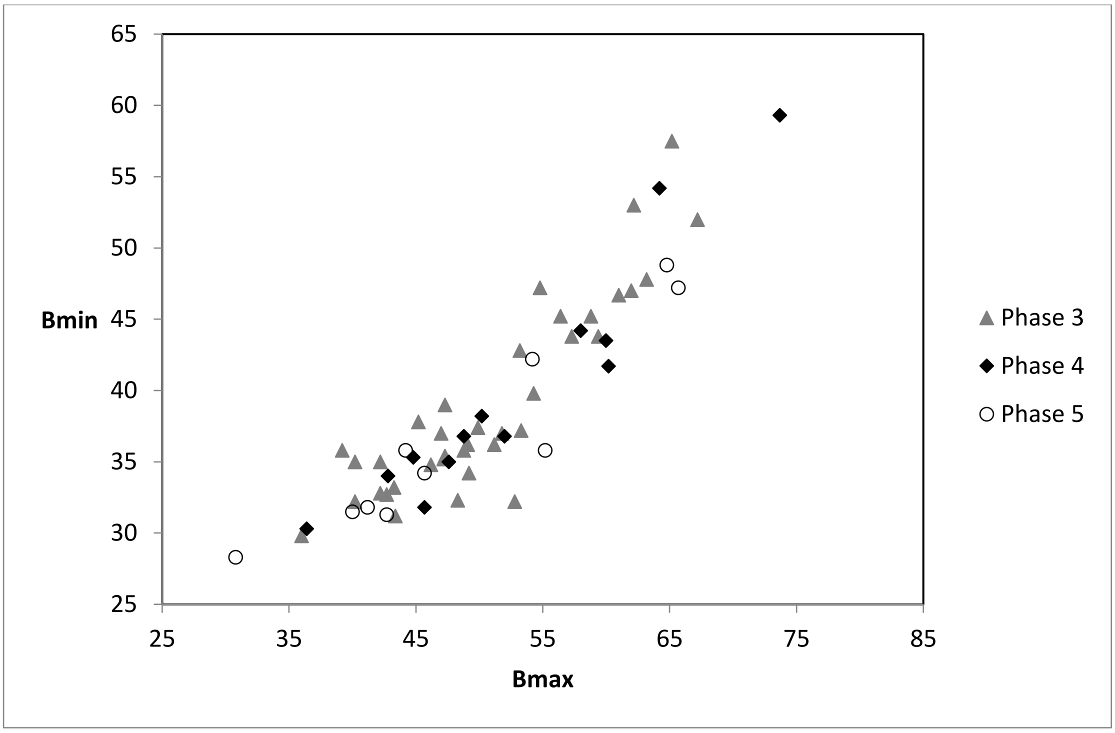

Figure 23. Size of cattle horncores: maximum and minimum basal breadths - anterio-posterior (Bmax) and lateral-medial (Bmin) with measurements in millimetres

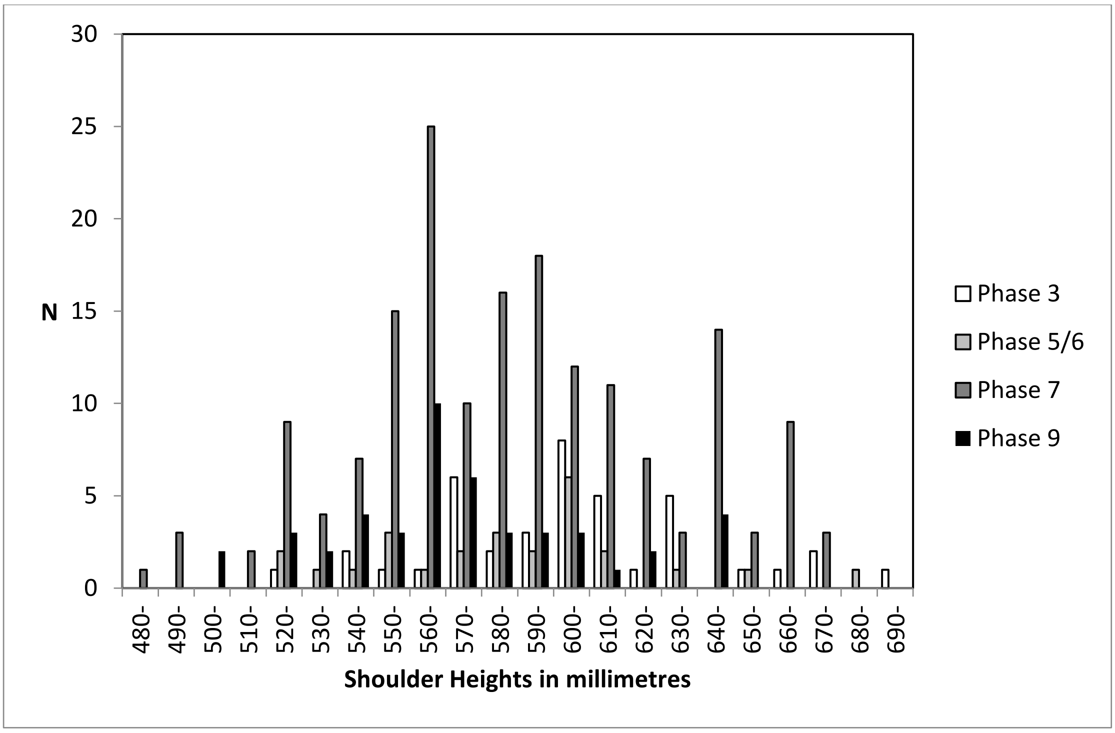

Figure 24. Distribution of sheep/goat shoulder heights in Phases 3, 5/6, 7 and 9 calculated after Boessneck and von den Driesch (1974), where N is the number of bones

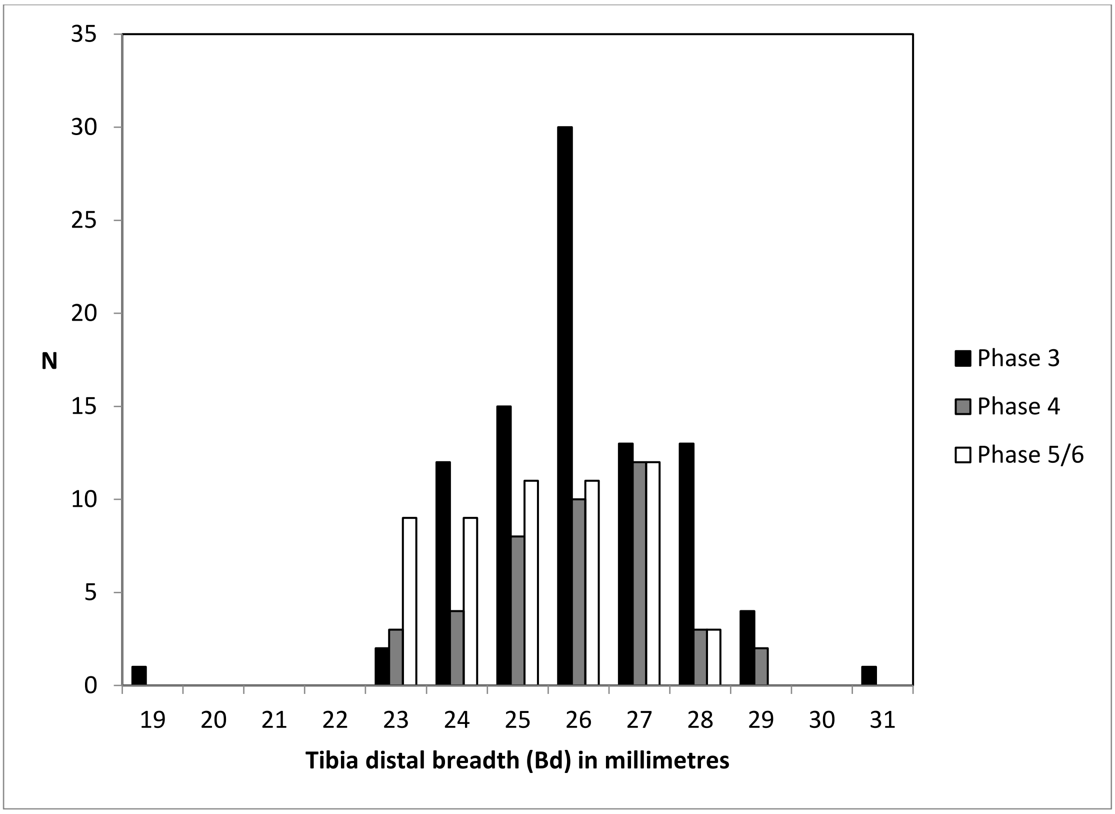

Figure 25. Size of sheep/goat tibias: distribution of distal breadth (Bd) measurements from Phases 3, 4 and 5/6

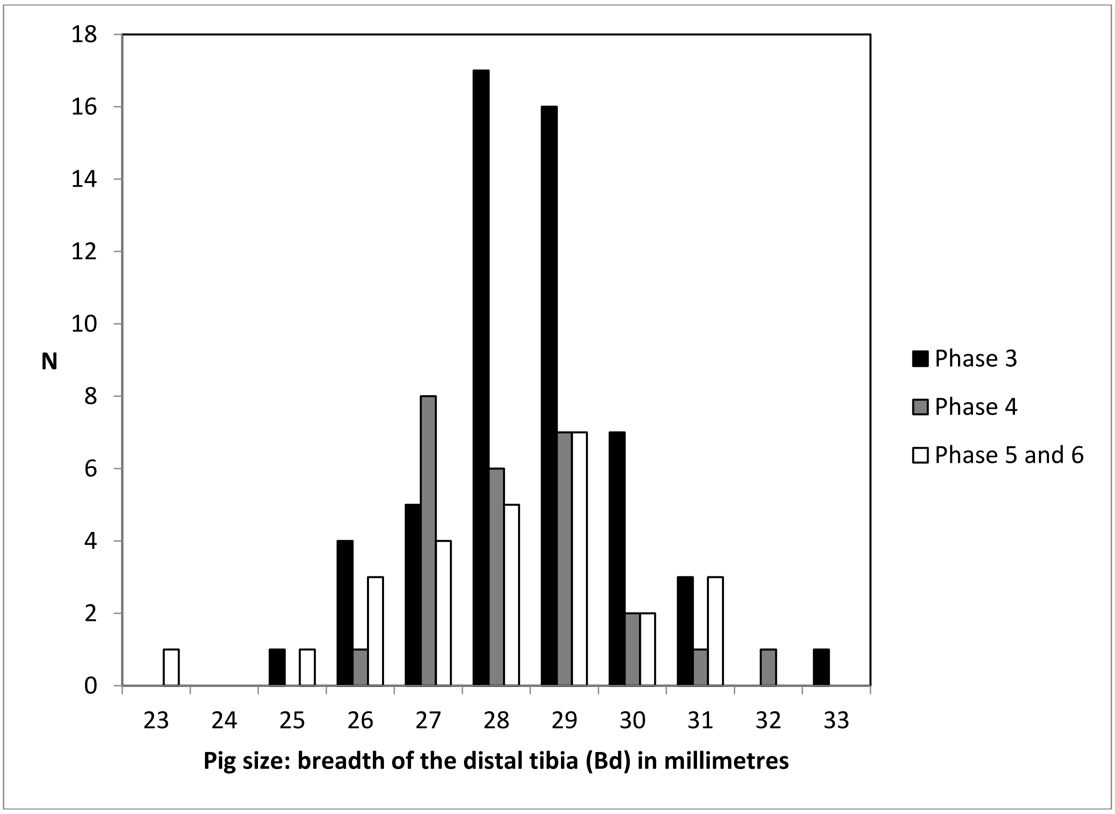

Figure 26. Size of pig tibias: distribution of distal breadth (Bd) measurements from Phases 3, 4 and 5/6

Figure 27.Sheep/goat maxilla from the Phase 3 fill (10542) of pit 10533 (Area C) with severe malocclusion (tipped third and rotated fourth adult premolars) and associated alveolar depression (A. Lateral and B. Occlusal view)

Figure 28. A pig scapula from the fill (11059) of pit 11060 (Area B, Phase 3) demonstrating a rather unusual congenital and/or pathological condition (A. Lateral and B. Posterior view)

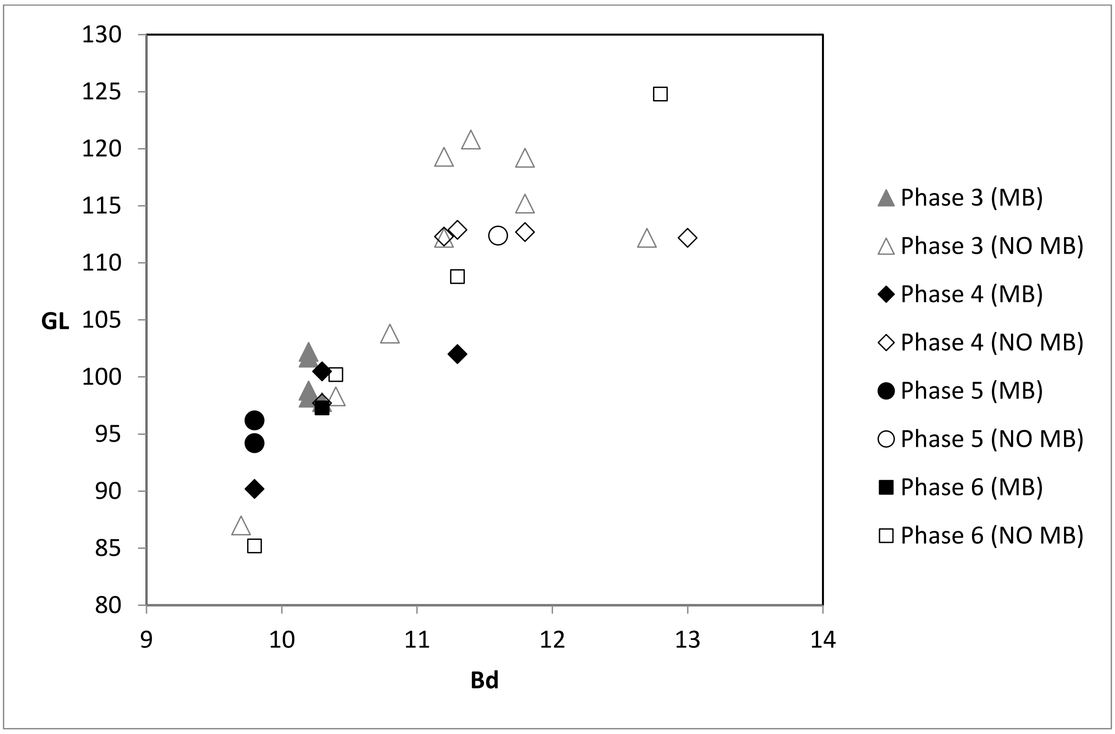

Figure 29. Size and sex of chicken tibias: Greatest length (GL) against greatest distal breadth (Bd) in millimetres, where MB refers to medullary bone

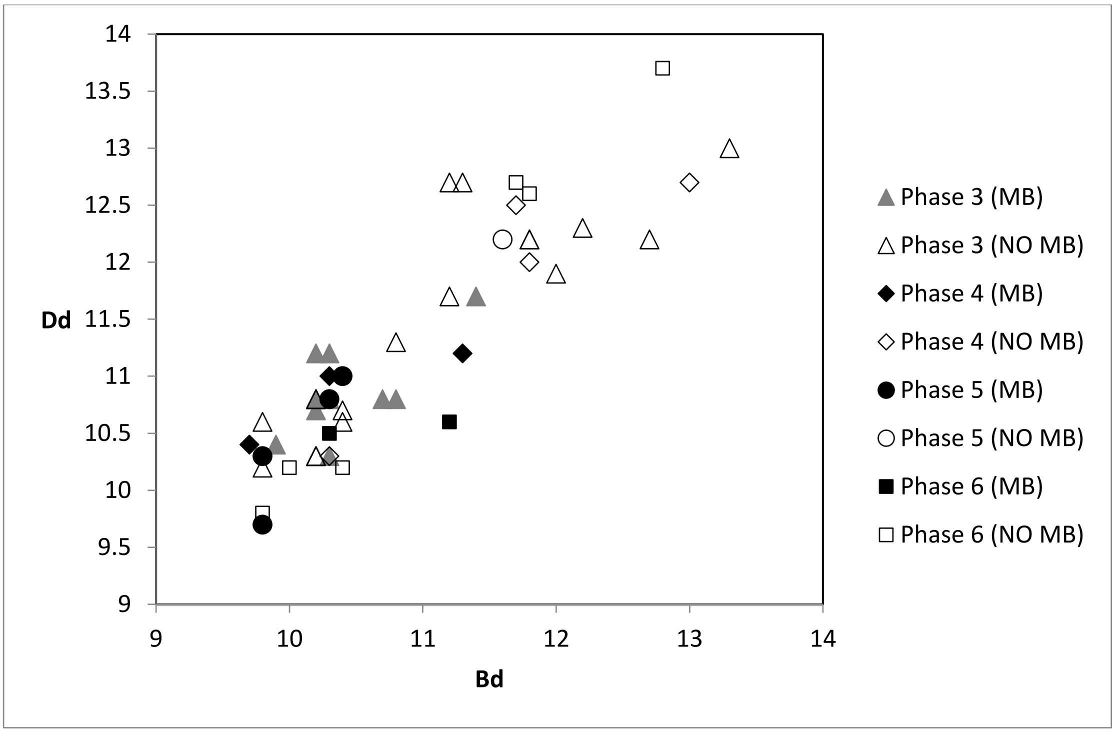

Figure 30. Size and sex of chicken tibias using two distal measurements – greatest breadth (Bd) and greatest depth (Dd) in millimetres, where MB refers to medullary bone

Figure 31. Chicken tarsometatarsus from the Phase 3 fill (9812) of pit 9811 displaying a marked posterior displacement of the distal articulation in response to an adjacent fracture (medial view)

Figure 32. Chicken metatarsus from the fill (1013) of pit 1014 (Area C, Phase 3) showing a probable ulcer (A – anterior and B - medial view).

Figure 33. Goose humerus from the fill (667) of pit 6672 (Phase 3) showing extensive redevelopment following a compound fracture (Medial view)

Figure 34. Pig metapodial (probably metatarsal 3 or 4) from the fill (8893) of pit 8892 (Phase 4) showing a probable ulcer (Medial/Posterior view)

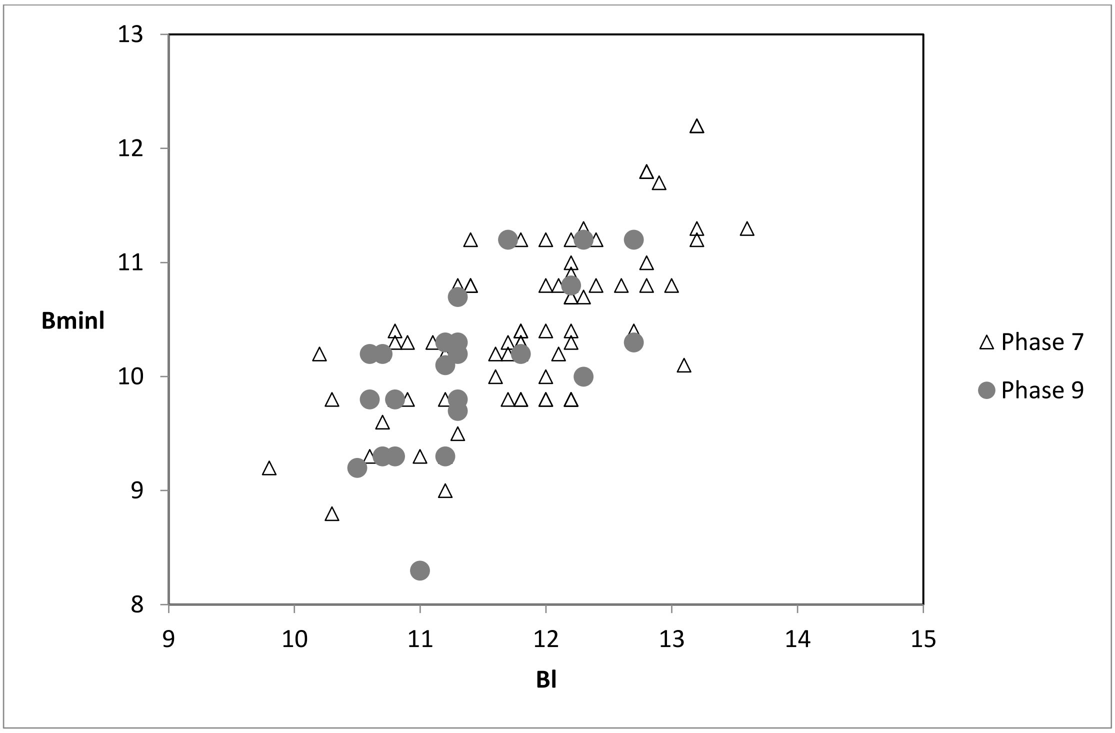

Figure 35. Scatterplot comparing two dimensions of the external or lateral distal condyle of the sheep/goat metacarpus (in millimetres): breadth (Bl) and the minimum depth (Dminl), after Payne (1969, 296 referring to w.cond and w.troch respectively)

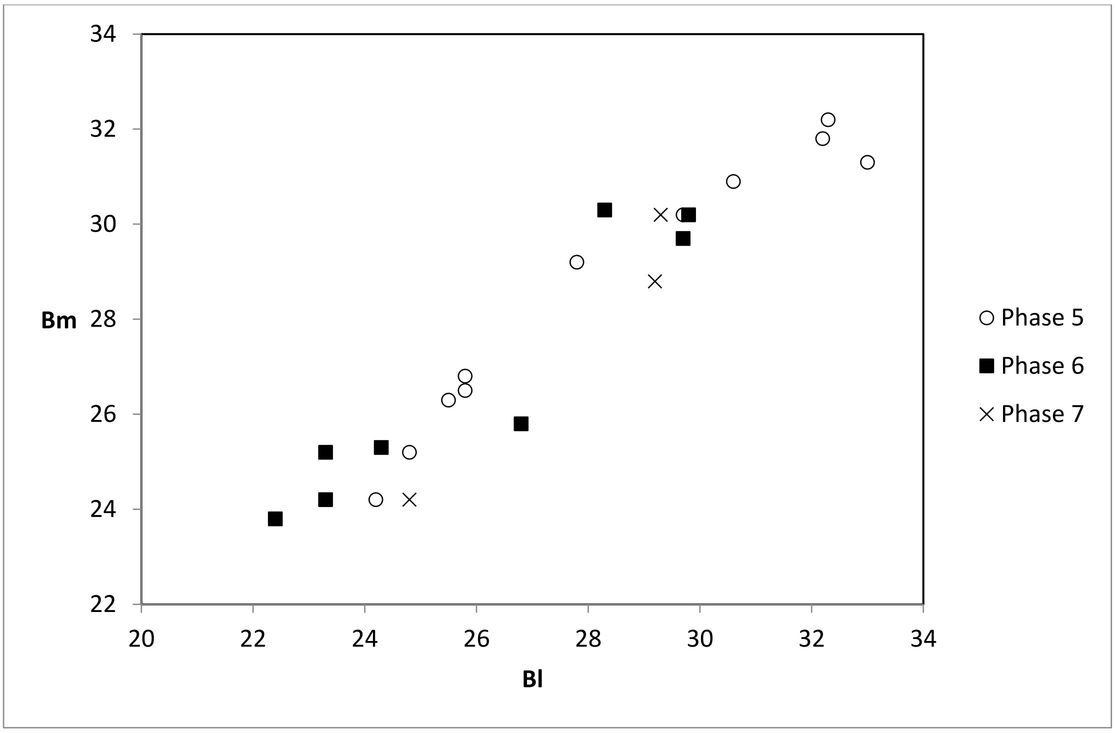

Figure 36. Cattle sex and size data in Phases 5, 6 and 7 using metacarpal breadth of medial (Bm) and lateral (Bm) distal condyle (after Thomas 1988)

Figure 37. Sheep metatarsals (represented by two pairs, A and B) with distinctive bony ridges on the anterior surface recovered from the Phase 7 pit 9495, showing the size range of this anomaly from ‘slight’ (A) to ‘severe’ (B), both pairs of bones viewed from the anterior direction while B is also shown laterally

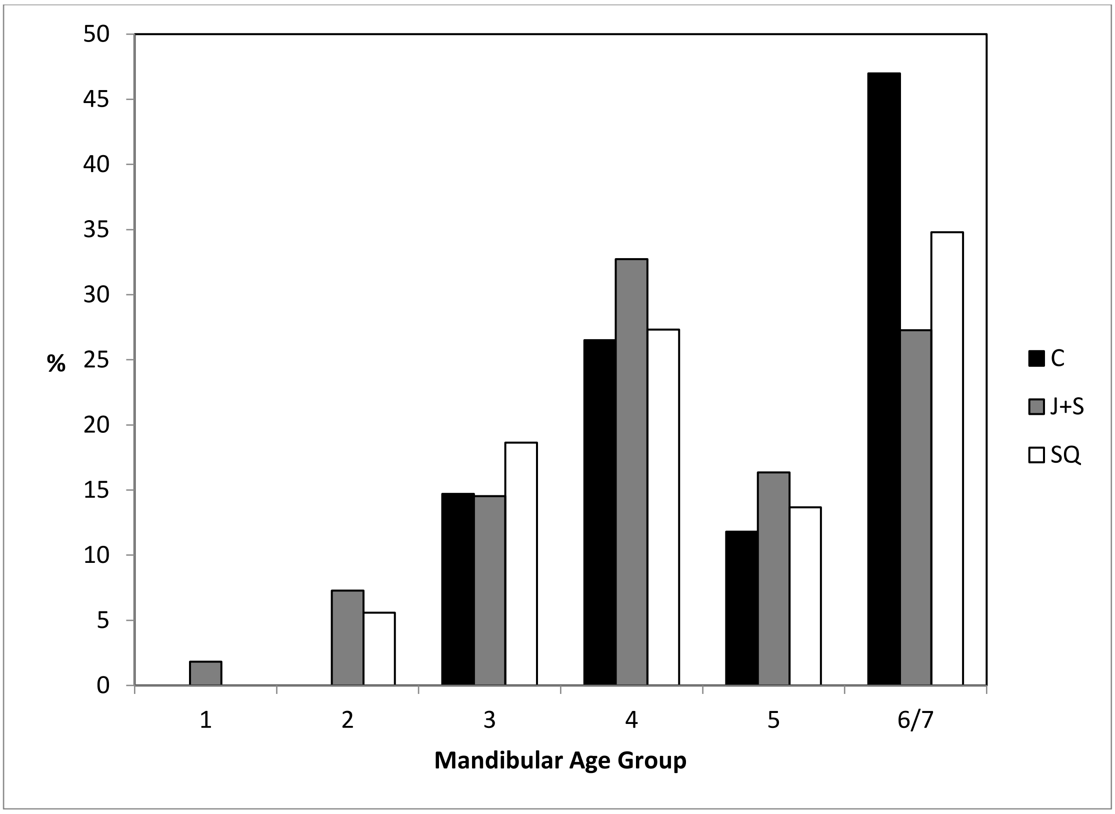

Figure 38. Cattle mandibles: the percentage distribution of age groups from Middle Saxon levels from Ipswich using data from C – Crabtree (2012), J+S – Jones and Serjeantson (1983) and SQ - Stoke Quay (Phase 3) with totals of 34, 55 and 161 mandibles respectively. See Table 7.15 for a description of the Age Groups

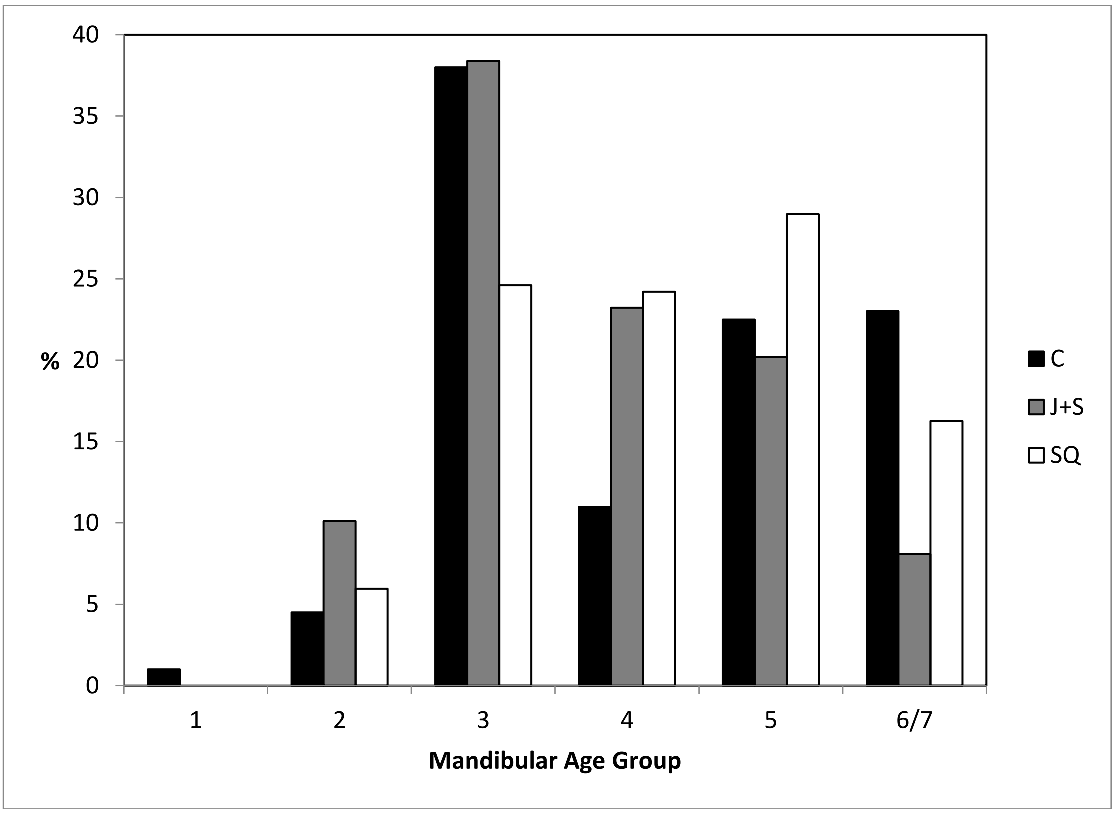

Figure 39. Sheep/Goat mandibles: the percentage distribution of age groups from Middle Saxon levels from Ipswich using data from C – Crabtree (2012), J+S – Jones and Serjeantson (1983) and SQ - Stoke Quay (Phase 3) with totals of 111, 99 and 252 mandibles respectively. See Table 7.15 for a description of the Age Groups

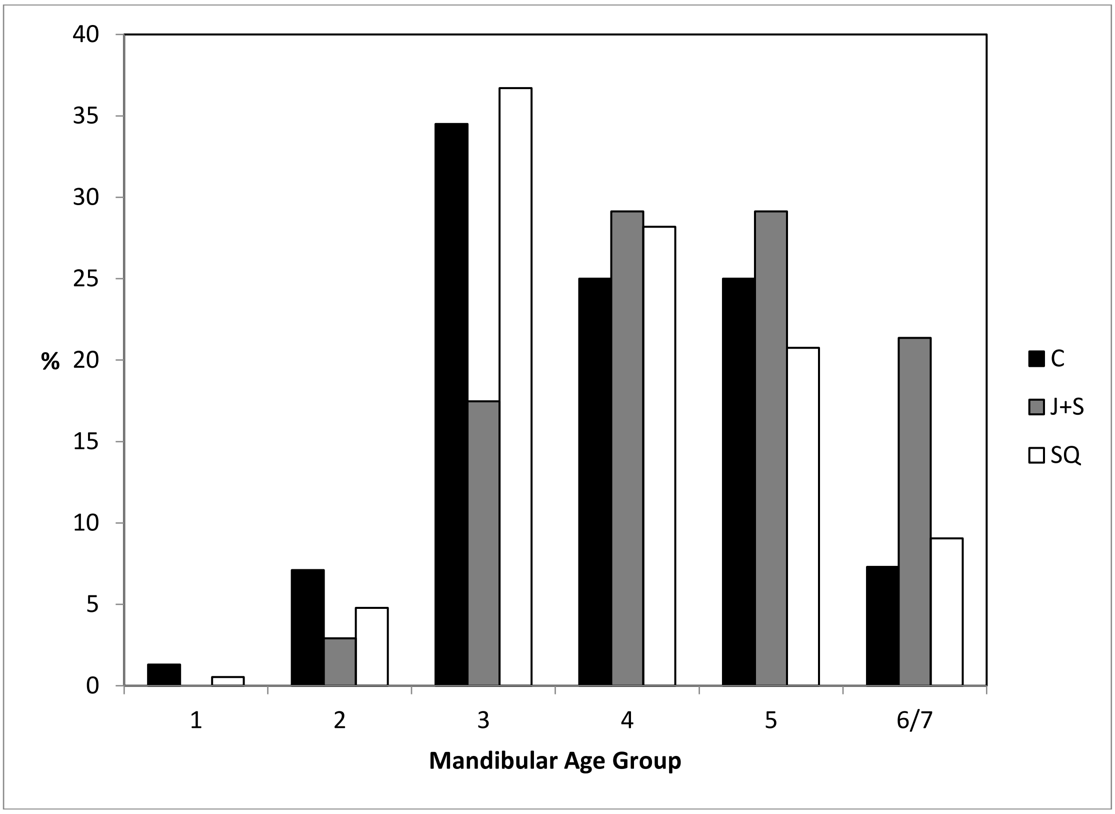

Figure 40. Pig mandibles: the percentage distribution of age groups from Middle Saxon levels from Ipswich using data from C – Crabtree (2012), J+S – Jones and Serjeantson (1983) and SQ - Stoke Quay (Phase 3) with totals of 84, 103 and 188 mandibles respectively. See Table 7.15 for a description of the Age Groups

Tables

Phase	**No. bones**	**No. iden.**	**% iden.**
1: Prehistoric to Roman	90	41	45.6
2: (Early) Middle Saxon	139	60	43.2
3: (Later) Middle Saxon	30756	13397	43.6
4: Late Saxon (Areas B-D) and 4.2, cemetery of St Augustine (Area A)	8358	3722	44.5
4.1: Late Saxon, pre-cemetery (Area A)	1782	836	46.9
5: Early medieval	9451	4116	43.6
6: Medieval	5468	2609	47.7
7: Late medieval to post-medieval	2015	1568	77.8
8: Post-medieval to early modern	455	257	56.5
9: Victorian to modern	958	452	47.1
Unphased	700	332	47.5
Total	**60172**	**27390**	**45.5**

Table 1. Distribution of hand collected bones showing the proportion identifiable to species within each phase

Phase:	**2**	**3**	**4 & 4.2**	**4.1**	**5**	**6**	**7**	**8**	**9**
P/F Method									
P: All bones	101	28831	7416	555	8210	4084	1955	455	852
% mod to poor	**21.8**	**9.0**	**8.9**	**2.7**	**4.5**	**3.9**	**2.3**	**3.7**	**2.2**
P: MDom+Eq	45	11475	3104	212	3297	1796	1512	232	395
%mod to poor	**15.6**	**10.2**	**13.7**	**6.6**	**8.0**	**7.7**	**1.9**	**7.3**	**4.8**
F: MDom	45	11348	3090	212	3274	1772	100	225	390
%<25%	**40.0**	**37.2**	**37.8**	**30.2**	**37.3**	**36.8**	**32.4**	**34.7**	**36.7**
%a25%	**6.7**	**22.5**	**23.2**	**21.2**	**21.4**	**23.6**	**20.8**	**22.2**	**23.1**
F: N MDom	46	12349	3529	798	3892	2433	618	227	431
F: Wt MDom	1044.5	356960	93532	28139	94774.7	70777	18581	7963	9706
Bones per gm*100	**4.4**	**3.5**	**3.7**	**2.8**	**4.1**	**3.4**	**3.3**	**2.9**	**4.4**

Table 2. Data presenting the levels of preservation (P) and fragmentation (F) within the phased hand collected assemblages

The former is shown by the proportion of bones (excluding the scanned collections) with moderate (mod) to poor surface erosion looking first at all bones and then limited to those identified as cattle, sheep/goat, pig (=MDom) and equid (Eq); the latter shown by the proportion of cattle, sheep/goat and pig bones which were less than (<) and approximately (a) 25% complete (again excluding the scanned collections) and also by calculating the number of bones per gram using the total weight of cattle, sheep/goat and pig bones (N) where the values illustrated equal N divided by the combined weight of these species x 100. Note that the data and values shown for Phase 7 exclude the bones from pits 5580, 9246 and 9495; see text (Introduction and Methodology) for an explanation of terms and methods used

Phase:	**2**	**3**	**4 & 4.2**	**4.1**	**5**	**6**	**7**	**8**	**9**
Method									
All bones	101	28831	7416	555	8210	4084	1955	455	852
% gnawed	**2.0**	**3.4**	**3.8**	**2.2**	**3.5**	**4.5**	**2.4**	**5.7**	**4.9**
Mdom+Eq	45	11475	3104	212	3297	1796	1512	232	395
% gnawed	**4.4**	**8.5**	**9.0**	**5.7**	**8.6**	**10.1**	**3.0**	**11.2**	**10.6**

Table 3. The relative representation of gnawed bones (all with dog bite marks) within the hand collected phased assemblages (excluding the scanned collections)

MDom = cattle, sheep/goat and pig, and Eq = equid

Phase	**1**	**2**	**3**	**4 & 4.2**	**4.1**	**5**	**6**	**7**	**8**	**9**
Type										
Pit	29	0	26290	7270	1766	5845	3242	1788	354	237
Ditch	2	73	158	31		373	285	126	4	26
Posthole			259	31	5	8	2	7	4	70
Well			2359	384		1410		4	9	7
Robber trench								13	77	3
Construction			1360	4		17	10			9
Kiln			55							
Cellar									6	7
Other fill	59		102	32	11	11	13	45	1	301
Dump			91			288	35	30		
Make up							74			
Surface			8			27	23			
Other layer			8	99	0	6	195	2	0	147
Grave		66	0	383	0	1466	1589	0	0	0
Graveyard soil										151
Other			66	29						
Total	90	139	30756	8358	1782	9451	5468	2015	455	958

Table 4. Distribution of hand collected and dry sieved bones by phase and feature type

Phase	**1**	**2**	**3**	**4 & 4.2**	**4.1**	**5**	**6**	**7**	**8**	**9**
Cattle	4	36	6240	1862	413	2024	1338	364	134	200
Equid			109	10	2	20	21	7	5	4
Cattle-size	26	67	11253	3204	593	3621	1866	306	118	295
Cattle/Sheep size			11	99		155	44	14		79
Sheep/Goat	6	9	3163	858	215	942	633	1055	54	120
Sheep		1	141	26	5	24	14	23	2	4
Goat			80	45	3	9	16	1		5
Pig	5	13	2725	738	162	893	432	88	37	83
Sheep-size	23	12	6095	1333	353	1559	949	127	80	132
Red deer			18	5		5	1		1	1
Fallow deer								1		
Roe deer			5	1		2	2			
Deer sp			1							
Dog			59	4	1	5	5	2	2	1
Cat	25		62	6		27	6	1	7	1
Hare			2							1
Rabbit			1					1		1
Small mammal			3				3			1
Cetacean			3	1						
Chicken		1	482	100	19	94	90	18	5	13
Chicken-size			27	1		5	5			3
Turkey										1
Goose	1		214	54	11	55	27	4	6	10
Goose-size			15	2		2	1	1		
Mallard			23	9	2	6	10	1		
Med-size duck (*e.g.* widgeon)			14							
Teal			1		1	2		1		
Swan			2							
Heron			1							
Herring gull			1							
Curlew			1							
Wader					1					
Dove			1							
Crow			1						2	
Raven			2				1		2	3
Amphibian			1		1	1	4			

Total	90	139	30756	8358	1782	9451	5468	2015	455	958

Table 5. Hand collected and dry sieved species abundance per phase using total fragment counts

Phase	**3**	**4 & 4.2**	**4.1**	**5**	**6**	**7**
Cattle	123	3	3	21	1	
Sheep/Goat	141	7	3	34	1	
Sheep	1					
Goat	1	1				
Pig	168	9	2	21	6	
Rabbit	6					
Small mammal	1					
Field Vole	2					
Small rodent	11			1		3
Chicken	27	1		10	1	
Chicken-size	27	2	1	4		
Goose	10	1				
Goose-size	4					
Mallard	1			1	1	
Teal	2					
Thrush	1					
Toad	1					
Amphibian	36			6		3
Total	563	24	9	98	10	6
No. samples	39	5	4	9	2	1

Table 6. Species abundance per phase from sieved (flotation) samples using total fragment counts

Phase	**2**	**4.2**	**5**	**6**	**9**
Cattle	23	101	348	415	45
Equid		1	1	6	1
Cattle-size	31	134	381	530	42
Sheep/Goat	4	50	230	201	21
Pig	2	53	159	132	10
Sheep-size	6	41	241	254	28
Red deer			2		
Roe deer				1	
Cat		1	4	3	1
Small mammal				2	
Chicken			16	11	
Chicken-size			2		
Goose		2	9	8	3
Mallard			3		
Teal			1		
Red throated diver				1	
Raven				1	
Total	66	383	1466	1588	151

Table 7. Species abundance from the grave fills and grave yard soil deposits (all redeposited, other than elements of the Phase 2 material)

Species:	**Cattle**	**Sheep/Goat**	**Pig**	**No.**
Phase	**%**	**%**	**%**	
3	50.5	27.4	22.1	12349
4	52.8	26.3	20.9	3529
4.1	51.8	27.9	20.3	798
5	52.0	25.1	22.9	3892
6	54.9	27.3	17.8	2433
7	23.8	70.5	5.7	1531
7A	56.3	30.7	13	618
8	59	24.7	16.3	227
9	48.5	31.1	20.4	431

Table 8. Percentage abundance of major domesticates (total fragment counts)

No. is the sum of cattle, sheep/goat and pig bones from that phase and % equals sum of individual species/No. x 100. The results for Phase 7A exclude the sheep/goat contents of pits 5580, 9246~~,~~ and 9495 (*i.e.* the craft waste described in Table 43)

Species:	**Cattle**	**Sheep/Goat**	**Pig**	**No.**
Phase	**%**	**%**	**%**	
3	44.7	32.3	23	6213
4 & 4.2	46.6	30.3	23.1	1711
4.1	42.2	37.1	20.7	483
5	45.5	30.2	24.3	1700
6	47.9	33.3	18.8	1233
7	46.3	42.1	11.6	380
8	53.7	29.8	16.5	121
9	45.9	33.7	20.5	205

Table 9. Percentage abundance of major domesticates (Epiphysis Only counts)

No. is the sum of cattle, sheep/goat and pig bones from that phase and % equals sum of individual species/No. x 100. The results for Phase 7 exclude the sheep/goat 9495 craft waste (see Table 43).

Species	**Cattle**	**Sheep/Goat**	**Pig**	**Total wt (g)**
Phase	**%**	**%**	**%**	
3	73.5	14	12.5	356960
4 & 4.2	75.1	12.5	12.5	95352
4.1	73.4	15.6	11	28139
5	75.6	11.5	12.9	94775
6	76.4	13.4	10.2	70777
7	55.6	37.7	6.7	25872
7A	73.8	17.8	8.4	18581
8	81.1	10	8.9	7963
9	75.1	14.3	10.6	9706

Table 10. Percentage abundance of major domesticates by weight

% equals sum of individual species/total weight x 100. The data for Phase 7A excludes the sheep/goat craft waste (see Table 43)

Type	Desc	No. features	No. bones
1	C>S>P	23	73 to 1213
2	C>P>S	4	95 to 633
3	C>S=P	7	84 to 164
4	P>S>C	1	159
5	S>C>P	1	150
6	C=S>P	3	98 to 172
7	S>P>C	1	132
8	C=S=P	1	318
Total		41	

Table 11. Distribution of major domesticate abundance (Total fragment counts) amongst 41 features dated to Phase 3

C is cattle, S is sheep/goat and P is pig; > is greater than, = is equals (within 2%); and where No. bones gives the smallest and largest assemblage denoted to each type

Species	**Cattle**			**Sheep/Goat**			**Pig**		
Feature/combined	**6830**	**7019**	**All**	**6830**	**7019**	**All**	**6830**	**7019**	**All**
Skeletal part									
Skull	111	24	648	29	3	197	34	15	283
Horncore	8	6	132	18	12	154			
Maxilla	8	3	93	6	1	71	19	6	135
Mandible	66	33	544	29	13	325	33	19	319
Loose teeth	30	20	217	9	17	176	4	6	84
Hyoid	1		16			7			23
Atlas/axis	18	9	147	10	3	76	6		11
Scapula	48	30	491	29	14	284	28	19	269
Humerus	29	29	363	25	11	209	18	9	190
Radius	21	19	314	34	22	303	12	4	126
Ulna	17	12	164	9		70	11	3	146
Carpals	2	1	23				1		2
Metacarpals	24	23	263	16	8	190	21	5	118
Sacrum	7	2	40			3			4
Pelvis	46	42	479	41	10	258	31	9	207
Femur	40	28	404	12	1	134	10	2	103
Patella		1	6						
Tibia	26	29	378	35	33	406	18	13	205
Fibula							10		69
Calcaneus	14	15	171	6	1	26	8	4	51
Astragalus	8	16	114		1	8			7
Other tarsals	5		45			1			1
Metatarsals	27	13	327	22	8	215	18	2	109
Metapodials	2	9	34			9			11
Phalange 1	20	15	198	2		25	2		9
Phalange 2	9	1	60			2			4
Phalange 3	9	5	61						
Lateral phalange									1

Table 12. Cattle (C), sheep/goat (S/G) and pig skeletal part representation in Phase 3 comparing the combined assemblage with the collections from pit 6830 and the cellared structure/storage pit (7019) using total fragment counts

Species	**Cattle**	**Sheep/ Goat**	**Pig**
Skeletal part			
Horncore	111	197	
Maxilla	74	61	105
Mandible	113	196	124
Scapula P	154	153	156
Humerus D	139	122	97
Radius P	168	154	101
Ulna P	10	30	35
Metacarpus P	174	126	55
Pelvis A	260	205	165
Femur P	143	37	25
Tibia D	146	157	119
Calcaneus P	110	26	43
Metatarsus P	190	124	43

Table 13. Cattle, sheep/goat and pig skeletal representation in Phase 3

Using counts of best represented parts, taking the minimum number of horncores, maxillae and mandibles (the first counting the number of bases and latter two the most abundant tooth) and a selection of the most numerous epiphyseal ends, (P)roximal or (D)istal, amongst the fore and hindlimb bones. The pig metapodial data uses the best represented metacarpal (2 to 5) and metatarsal (2 to 5)

Species	**No. bases/ Sex**	**Phase**				
		3	**4***	**5**	**6**	**7**
Sheep	No. bases	140	38	23	14	21
Goat	No. bases	57	12	6	8	
Sheep	M	32	8	4	4	7
	M/F	108	30	23	10	18
Goat	M	46	12	5	8	
	F	4	2	1		

Table 14. Abundance and sex of sheep and goat horncores based on the number of bases

M = male; F = female; M/F = undistinguished male sheep castrates (wethers) and females (ewes). * Includes all subsidiary parts of Phase 4, here and in subsequent tables

Phase	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Species								
Cattle		499	158	104	89	58	14	17
Equid		1					1	
Sheep/Goat		155	58	35	24	10	2	6
Sheep		46	5	5	2	18		2
Goat		25	4		4			
Pig	1	48	18	12	8	3	1	4
Red deer		1						
Chicken		5		1				
Goose		3	1					

Table 15. The number of bones with butchery marks divided by phase and specie

Note that no butchery cuts were observed on the sheep/goat bones comprising the Phase 7 sheep/goat craft waste (see Table 43)

Phase	**1**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Species								
Cattle		8.8	9.2	6.3	9.3	17.3	10.4	9.9
Equid		1.0					20.0	
Sheep/Goat		5.4	7.4	4.7	5.2	6.0	3.7	5.0
Sheep		33.6	17.2	21.7	14.3	78.3		50.0
Goat		32.9	8.7		25.0			
Pig	20.0	2.0	2.7	1.6	2.5	3.8	2.7	5.6
Red deer		6.3						
Chicken		1.1		1.3				
Goose		1.5	2.0					

Table 16. The percentage of bones with butchery cuts amongst the fully recorded collections (see Methodology) divided by phase and species, excluding the Phase 7 sheep/goat craft waste

Butchery	**SK**	**Dr**	**H**	**HC**	**HVS**	**J**	**JS**	**DF**	**SP**	**SM**	**Total**
Skeletal part											
Horncore	1			6	6						13
Skull				4	8			2	14		25
Mandible					4	9	4	6	4		27
Hyoid		1									1
Atlas		4	6		4						14
Axis			11		22						31
Scapula						6	12	3	15		35
Humerus						11	1	5	38		53
Radius						13	3	5	19		38
Ulna						11			1		11
Metacarpus	2							2	68		70
Sacrum					4				12		16
Pelvis						20	30	5	5		59
Femur						11		3	10		22
Tibia		4				5	3	4	5	1	22
Astragalus		3									3
Calcaneus		2									2
Tarsal		2									2
Metatarsus	1	2						2	47		51
1st phalange	2							1	1		3
Total	73	18	17	10	48	86	53	38	239	1	499

Table 17. Distribution of cattle butchery types in Phase 3

SK = skinning cuts, Dr = dressing, H = halving , HC = chops removing the horncore, HVS = sectioning cuts through the skull/mandible and vertebral column, J = jointing, JS = transverse cuts through limb bone midshaft, DF = defleshing, SP = splitting and SM = smashing through limb bones. Note that the number of bones with butchery cuts (Total) may not necessarily be a sum of the adjacent row as some bones demonstrated more than one butchery type

Age Group:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**No.**
Species/Phase								
Cattle								
3		9	30	44	22	24	32	161
4	1		6	13	11	12	10	53
5			9	10	4	8	14	45
6		1	2	7	2	11	8	31
7	3	9		2		1	1	16
Sheep/Goat								
3		15	62	61	73	40	1	252
4			9	15	29	11		64
5		1	16	14	11	9		51
6	1	1	7	9	11	4		33
Pig								
3	1	9	69	53	39	17		188
4		4	18	19	20	4	1	66
5			27	20	15	1	2	65
6			5	12	5	1		23

Table 18. Age distribution of cattle, sheep/goat and pig mandibles by phase and Age Group

Age Groups as follows: 1 - Deciduous fourth premolar (DPM4) unworn, 2 - DPM4 worn, adult first molar (M1) unworn, 3 – M1 worn, adult second molar (M2) unworn, 4 – M2 worn, adult third molar (M3) unworn, 5 – M3 in early wear (Cattle and Sheep/Goat Grant stages ‘a’ to ‘f’; Pig ‘a’ to ‘b’), 6 - M3 full wear (C and S/G ‘g’ and ‘h’; P ‘c’ to ‘f’) and 7 - M3 advanced wear (C and S/G greater than ‘h’ and P equal or greater than ‘g’)

AG:	**N**	**J**	**I**	**I1**	**I2**	**SA1**	**SA2**	**A1**	**A2**	**A3**	**E**	**No.**
BOS												
3		9	30			28	6	7	4	25	30	139
4 (All)	1		6			8	1	5	2	14	10	47
5			9			6	2	1	1	9	14	42
6		1	2			3				11	8	25
7	3	9				1				1	1	15
OVCA												
3		15	60			43	12	11	35	67	1	244
4 (All)			7			11	4	5	16	18		61
5		1	16			6	4	2	7	11		47
6	1	1	6			6	2		5	9		30
7		1	1			2			1	6		11
SUS												
3	1	9	1	16	34	10	24	11	22	9		137
4 (All)		4		7	7	3	9	6	7	5		48
5				6	11	5	7	5	7	1	2	44
6					3	2	3	2	3			13

Table 19. Age distribution of cattle, sheep/goat and pig mandibles by phase following the method described in O’Connor (1991, 250)

AG = age group (see Table 20 for descriptions)

Age group	**Tooth wear stage**	
	Cattle and Sheep/Goat	**Pig**
N. Neonate	dpm4 unw	as Cattle
J. Juvenile	dpmw w, M1 unw	as Cattle
I. Immature	M1 w, M2 unw	As Cattle
I1. Immature 1		M2 (C and V)
I2. Immature 2		M2 (E to U)
SA. Subadult	M2 w, M3 unw	as Cattle
SA1. Subadult 1	M3 (C to E)	M3 (C to V)
SA2. Subadult 2	M3 (1/2 to U)	M3 (E to U)
A. Adult	M3 in wear	as Cattle
A1. Adult 1	M3 (a to c)	M3 (a)
A2. Adult 2	M3 (c to d)	M3 (b to d)
A3. Adult 3	M3 (e to h)	M3 (e to g)
E. Elderly	M3 heavy wear (equal or greater than stage j)	M3 heavy wear (equal or greater than stage j)

Table 20. Age groups based on O'Connor (1989, 161 and 1991, 250)

Tooth wear stages are divided into: unw = unworn (C to U) and w = worn (a to j), all taken from Grant (1975 and 1982). The teeth represented include: dpm = deciduous premolar (milk tooth) and M= adult molar

Species	**AG**	**Age (yrs)**	**Phase**					
			3		**4 & 4.2**		**4.1**	
			N	%F	N	%F	N	%F
Cattle	E	0.5-1.5	967	92.1	286	94.8	63	96.8
	Int	2-2.5	438	63.7	133	63.2	28	53.6
	L	3.5-4	522	51.5	162	50.6	41	51.2
Sheep/Goat	E	0.25-0.75	695	92.2	168	94.0	65	100.0
	Int	1.25-2	336	55.1	99	61.6	31	77.4
	L	3-3.5	288	34.0	63	38.1	27	51.9
Pig	E	1-1.5	571	78.3	172	79.1	26	76.9
	Int	2	352	33.8	92	41.3	21	33.3
	L	3-3.5	214	13.1	58	8.6	19	10.5

Table 21. Age of major domesticates based on epiphysis fusion evidence within the Middle and Late Saxon phases (Phases 3 and 4)

The noted age groups (AG) are divided into Early (E), Intermediate (Int) and Late (L) as shown in the text (see Methodology) with age of fusion after Schmid (1972, 75). %F(used) equals the number of fused epiphyses/Total no. of epiphyses (N) from that phase and age group x 100

Species	**Age**	**Phase**						
Cattle		3	4(All)	5	6	7	8	9
	Foetal/Neonate	5	2	2	1	3		
	Infant	24	2	2	1	16	1	
	Juvenile	312	69	87	53	44	8	9
	Adult	1361	433	440	287	86	29	42
	%Juvenile	18.3	13.6	16.4	15.5	29.5	21.1	17.6
Sheep/Goat								
	Foetal/Neonate	1						
	Infant	12	4	5	6	1		1
	Juvenile	279	45	65	32	7	1	5
	Adult	788	305	205	163	18	19	32
	%Juvenile	25.8	12.7	23.6	15.9	26.9	5.0	13.1
Pig								
	Foetal/Neonate			1	2			
	Infant	14	3	2				
	Juvenile	295	74	80	24	9	5	7
	Adult	381	126	144	72	10	5	12
	%Juvenile	42.8	36.5	35.2	24.5	47.4	50.0	36.8

Table 22. The estimated age of cattle, sheep/goat and pig bones, comparing the number of bones from the younger and older age groups based on teeth data, epiphysis fusion and size/porosity, excluding the Phase 7 sheep/goat craft waste (see Table 43)

Species	**Bone**	**Sex**	**Phase**				
			3	**4**	**5**	**6**	**7**
Cattle	pelvis	M	96	30	22	16	3
		F	74	33	12	30	5
Sheep/Goat	pelvis	M	131	32	22	14	8
		F	23	6	10	7	3
Pig	canine	M	58	18	24	9	4
		F	44	15	16	9	2

Table 23. The distribution of sexed cattle, sheep/goat and pig bones (mandibular canines) within Phases 3 to 7

Age	**Phase/Sex**					
	3		**4**		**5**	
	M	**F**	**M**	**F**	**M**	**F**
Juvenile	12	1	1		7	1
Sub-adult	14	11	6	4	7	3
Adult	21	25	8	9	8	6

Table 24. Sex data for pig mandibles from Phases 3 to 5

The broad age categories approximately follow the mandibular age groups AG3 (Juvenile), AG4 (Sub-adult) and AG5/6 (Adult)

Phase	**Range**	**Mean**	**No. bones**
2	1273.7	1273.7	1
3	1022.7 – 1342.3	1172.8	65
4	1029.5 – 1268.5	1150.6	20
5	1016.6 – 1279.1	1139.0	22
6	1033.2 – 1234.9	1122.2	13
7	1066.4 – 1314.9	1169.1	6
8	1078.0	1078.0	1
9	1173.4 – 1350.5	1261.9	2

Table 25. Cattle shoulder heights (after Boessneck and von den Driesch 1974)

Bone and dimension	**Phase**	**Range (mm)**	**Mean**	**No.**
Astragalus GL	3	54.2 – 72.2	63.0	60
	4	57.2 – 63.2	60.6	26
	5/6	56.0 – 70.7	62.8	32
Calcaneus GL	3	104.0 – 147.2	126.0	34
	4	113.8 – 143.2	125.5	19
	5/6	109.8 - 149.5	126.2	15
Metacarpal GL	3	166.3 – 212.0	190.9	34
	4	185.3 – 203.0	189.1	10
	5/6	165.3 – 200.8	184.0	22
	7	173.4 – 213.8	188.8	4
Tibia Bd	3	50.5 – 68.8	57.4	83
	4	50.3 – 66.3	57.9	22
	5	50.0 – 67.7	57.0	25
	6	50.5 – 67.2	58.8	19
	5/6	50.0 - 67.7	57.8	44
Metatarsal GL	3	195.4 – 246.3	216.0	28
	4	188.9 - 216.8	206.2	9
	5/6	190.2 – 234.7	208.2	13
Metatarsal Bd	3	45.8 – 63.6	52.7	34
	4	45.5 – 60.3	49.5	16
	5/6	44.8 – 63.6	50.9	17

Table 26. Cattle size: the distribution of a selection of measurements

GL = greatest length and Bd = distal breadth

Type	Length	Phase			
		3	4	5	7
		N1(N1+N2)	N1(N1+N2)	N1(N1+N2)	N1(N1+N2)
Small Horned	<96	1			
Short Horned	96-150	10(18)	4(6)	4(6)	2
Medium Horned	150-200	10(18)	4(6)	1(3)	
Long Horned	>200	(2)	(1)	(1)	
Total		20(40)	8(13)	5(10)	2

Table 27. Distribution of cattle horncore size categories after Armitage and Clutton-Brock 1976, with length equal to length of outer curvature (in millimetres), using N1 complete cores and N2 incomplete cores

The N2 values are based on a comparison of measurements from the complete cores as well as evidence from Saxon sites in London (PCA Archives)

Phase	Range	Mean	No. bones
3	523.4 – 691.9	605.5	38
4	531.1 – 644.5	596.0	19
5	557.5 – 682.5	606.4	8
6	526.6 – 652.8	580.4	18
5/6	526.6 – 682.5	606.8	26
7	487.6 – 676.3	585.1	217
8	602.4 – 666.0	634.2	2
9	566.0 – 576.5	571.2	2

Table 28. Sheep/Goat shoulder heights (after Boessneck and von den Driesch 1974)

Bone and dimension	**Phase**	**Range (mm)**	**Mean**	**No.**
Calcaneus GL	3	50.2 – 68.8	56.3	15
	4	54.2 – 65.8	59.3	8
	5/6	52.8 – 58.6	55.8	9
Metacarpal GL	3	117.2 – 141.5	130.2	12
	4	109.8 – 131.8	121.4	5
	5/6	108.2 – 126.5	118.0	11
	7	101.2 - 138.3	119.8	109
Tibia Bd	3	19.2 – 31.0	26.4	91
	4	23.0 – 28.2	26.3	43
	5	23.2 - 28.2	25.5	25
	6	23.2 – 28.3	25.8	30
	7	23.2 – 30.2	25.5	7
Metatarsal GL	3	115.3 – 140.2	131.1	12
	4	117.0 – 138.2	131.4	9
	6	116.0 – 143.8	128.6	5
	7	107.4 - 148.4	129.2	102
Metatarsal Bd	3	21.2 – 26.2	24.2	14
	4	23.2 – 25.2	23.7	9
	7	20.8 - 27.2	23.8	104

Table 29. Sheep/Goat size: the distribution of a selection of measurements

GL = greatest length and Bd = distal breadth

Phase	**Range**	**Mean**	**No. bones**
3	637.9 – 1059.7	723.1	14
3A	637.9 – 747.2	697.2	13
4	751.8	751.8	1
5	661.2	661.2	1
8	665.0	665.0	1

Table 30. Pig shoulder heights (after Boessneck and von den Driesch 1974)

Phase 3A equals Phase 3 data excluding the largest shoulder height

Bone and dimension	Phase	Range (mm)	Mean	No.
Mandibular M3 L	3	28.3 – 35.8	31.9	24
	5/6	27.8 – 33.2	30.6	9
Humerus Bd	3	25.8 – 45.0	38.2	45
	4	34.2 – 40.4	36.9	8
	5	36.7 – 40.9	38.0	13
Tibia Bd	3	25.0 – 33.0	28.9	55
	4	26.2 - 32.3	28.7	26
	5/6	23.8 – 31.7	28.5	26
Astragalus GL	3	38.3 – 59.2	44.0	4
	3A	38.3 – 39.4	39.0	3
Calcaneus GL	3	68.3 – 79.8	74.1	7

Table 31. Pig size: the distribution of a selection of measurements

GL = greatest length and Bd = distal breadth

Species	Bone	Anomaly	Phase			
			3	**4**	**5**	**6**
Cattle	Mandible	P2 absent	4	2	1	1
		M3 2 cusps	4	1		
Sheep/Goat	Mandible	P2 absent	2			
Sheep	Skull	polled	2	2		
Pig	Mandible	with P1	42	12	12	7
		without P1	34	9	9	6
		% without	44.7	42.9	42.9	46.2
	Humerus	with FS	86	32	29	13
		without FS	25	11	12	6
		% without	22.5	25.6	29.2	31.6

Table 32. Congenital defects amongst the cattle, sheep/goat and pig assemblages from Phases 3 to 6

P1, P2 and M3 are the adult first and second premolars and the adult third molar respectively; and FS refers to the Foramen supratrochleare

Species:	**C**	**S/G**	**P**	**D**	**Cat**	**Ch**	**Go**
Condition							
Oral: malocclusion		17	11				
: alveolar depression	1	3					
: am tooth loss	1	1	2				
: exag. crown height	3						
: abscess			1				
Congenital	1		1				
Developmental		2					
Trauma	4	1	2	2	1	5	1
Stress	4						
Joint disease: undefined	8	1	1			1	
: Penning elbow		8					
: Osteoarthritis	7						
Ossified soft tissue	2	1				1	

Table 33. Description and quantification of pathological specimens in Phase 3

C = cattle, S/G= sheep/goat, P = pig, D = dog, Ch = chicken and Go = goose

Phase/Site:	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Food group							
Major domesticates	93.86	95.46	95.79	94.71	95.96	94.98	93.21
Poultry	5.78	4.37	3.99	5.18	3.59	4.60	6.11
Game animals - large	0.18	0.13	0.17	0.12	0.15	0.42	0.23
Game animals - small	0.02				0.15		0.45
Game birds	0.15	0.04	0.05		0.15		
Total number of bones	**13157**	**4533**	**4063**	**2569**	**669**	**239**	**442**

Table 34. The percentage distribution of the major food groups within the hand collected phased assemblages excluding the Phase 7 sheep/goat craft waste (see Table 43)

Age/Sex:	**I**	**J**	**A**	**%A**	**F**	**M**	**%F**
Phase							
3	10	30	385	90.6	62	13	82.7
4		7	89	92.7	23	4	85.1
5	1	5	64	91.4	25	4	86.2
6	4	8	69	85.2	8	3	72.7
7	1		15	93.7	4	1	80

Table 35. Chicken age and sex: based on the number of unfused (I infant and J juvenile) and fused limb bones (A adult), and the quantity of spurred and unspurred tarsometatarsii - male (M) and female (F), with percentages referring to the proportion of the combined counts of each age group and both sexes, so %F = F/F+M x100

Species:	**Cattle**				**Sheep/Goat**				
Phase:	**4**	**5**	**6**	**7**	**4**	**5**	**6**	**7**	**9**
Skeletal part									
Skull	138	198	61	43	48	38	16	12	4
Horncore	35	48	8	3	56	30	23	22	4
Maxilla	18	22	15	8	14	18	6	5	1
Mandible	149	173	101	38	96	77	52	10	11
Loose teeth	96	96	42	15	47	59	17	5	7
Hyoid	4	7		2	1				
Atlas/axis	31	31	23	14	25	17	8	3	1
Scapula	133	123	110	34	69	61	35	7	7
Humerus	109	113	50	19	57	56	33	14	6
Radius	108	96	72	15	87	96	64	13	21
Ulna	56	44	39	8	22	13	11	4	
Carpals	10	9		2				~~4~~	
Metacarpals	85	74	59	20	58	52	37	20	9
Sacrum	9	11	7	4			1		
Pelvis	170	114	81	30	57	57	24	17	10
Femur	124	93	53	9	38	36	20	8	5
Patella	2	2							
Tibia	153	136	75	34	123	95	82	23	24
Calcaneus	65	55	26	5	7	18	6	2	
Astragalus	33	42	17	6		3	2		
Other tarsals	8	13	4	4		1		~~1~~	~~2~~
Metatarsals	101	87	66	21	69	62	42	20	10
Metapodials	10	10	4	2	3	2	1		
Phalange 1	52	66	35	9	7	9	8	232	1
Phalange 2	17	23	13	5		2	1	~~78~~	~~30~~
Phalange 3	27	25	9	3			1	~~40~~	~~7~~

Table 36. Cattle and sheep/goat skeletal part representation within Phases 4 to 9 using total fragment counts and excluding the Phase 7 sheep/goat craft waste (see Table 43)

Phase	**4**	**5**	**6**
Skeletal part			
Skull	53	84	34
Maxilla	23	53	13
Mandible	84	96	31
Loose teeth	44	70	27
Atlas/axis	13	12	6
Scapula	74	55	19
Humerus	73	57	28
Radius	28	30	19
Ulna	35	43	22
Metacarpals	20	34	17
Sacrum		1	
Pelvis	67	41	21
Femur	36	32	24
Tibia	67	59	28
Fibula	13	8	9
Calcaneus	15	19	1
Astragalus		4	1
Other tarsals		1	
Metatarsals	28	49	16
Metapodials	4	4	2
Phalange 1	5	9	
Phalange 2	1		
Phalange 3	2		
Lateral phalange		2	

Table 37. Pig skeletal part representation within Phases 4, 5 and 6 using total fragment counts

Species:	**Cattle**			**Sheep/Goat**			**Pig**		
Phase:	**4**	**5**	**6**	**4**	**5**	**6**	**4**	**5**	**6**
Skeletal part									
Horncore	28	28	7	60	38	26			
Maxilla	25	23	12	11	19	8	14	38	10
Mandible	59	59	39	71	54	45	73	67	25
Scapula P	44	32	26	34	32	14	49	34	10
Humerus D	29	38	11	39	36	27	38	34	15
Radius P	54	51	36	49	46	32	21	27	18
Metacarpus P	49	50	34	45	34	30	12	16	5
Pelvis A	95	64	44	44	41	22	49	24	16
Femur P	51	28	23	12	9	8	7	5	4
Tibia D	53	48	27	46	41	30	46	35	18
Calcaneus P	38	30	15	7	15	5	13	18	1
Metatarsus P	53	46	38	40	37	33	14	15	10

Table 38. Cattle, sheep/goat and pig skeletal representation within Phases 4, 5 and 6 using counts of best represented parts, taking the minimum number of horncores, maxillae and mandibles (the first counting the number of bases and latter two the most abundant tooth) and a selection of the most numerous epiphyseal ends, (P)roximal or (D)istal, amongst the fore and hindlimb bones. The pig metapodial data uses the best represented metacarpal (2 to 5) and metatarsal (2 to 5)

Species	**Age**	**Age (yrs)**	**Phase**			
			5		**6**	
			No.	**%F**	**No.**	**%F**
Cattle	E	0.5-1.5	280	92.9	207	96.1
	Int	2-2.5	134	67.2	101	70.3
	L	3.5-4	137	56.9	92	54.3
S/G	E	0.25-0.75	191	92.1	141	92.2
	Int	1.25-2	89	58.4	76	77.6
	L	3-3.5	65	43.1	57	47.4
Pig	E	1-1.5	135	78.5	81	81.5
	Int	2	121	32.2	72	36.1
	L	3-3.5	63	6.3	39	12.8

Table 39. Age of major domesticates based on epiphysis fusion evidence within medieval Phases 5 and 6

The noted age groups (AG) are divided into Early (E), Intermediate (Int) and Late (L) as shown in the text (see Methodology) with age of fusion after Schmid (1972, 75). %F(used) equals the number of fused epiphyses/Total number of epiphyses (No.) from that phase and age group x 100

Species	**AG**	**Age (yrs)**	**Phase**					
			7		**8**		**9**	
			No.	**%F**	**No.**	**%F**	**No.**	**%F**
Cattle	E	0.5-1.5	44	79.5	17	94.1	31	83.9
	Int	2-2.5	34	52.9	9	66.7	18	50.0
	L	3.5-4	19	42.1	11	54.5	16	37.5
Sheep/Goat	E	0.25-0.75	373(65)	86.9(100.0)	9	100.0	25	96.1
	Int	1.25-2	368(34)	65.7(67.6)	9	66.7	9	77.8
	L	3-3.5	15	66.7	3	0.0	6	66.7
Pig	E	1-1.5	14	85.7	7	85.7	15	80.0
	Int	2	5	40.0	3	33.3	10	30.0
	L	3-3.5	3	0.0	4	25.0	7	0.0

Table 40. Age of major domesticates based on epiphysis fusion evidence within the late medieval to modern Phases 7, 8 and 9

The noted age groups (AG) divide into Early (E), Intermediate (Int) and Late (L) as shown in the text (see Methodology) with age of fusion after Schmid (1972, 75). %F(used) equals the number of fused epiphyses/Total number of epiphyses (No.) from that phase and age group x 100. Sheep/Goat data in Phase 7 includes total quantity with and, in brackets, without the craft waste (foot bones) from pits 5580, 9246 and 9495 (see Table 43)

Phase:	**4**			**5**			**6**			**7**		**8**	**9**	
Species:	**C**	**S**	**P**	**C**	**S**	**P**	**C**	**S**	**P**	**C**	**S**	**C**	**C**	**S**
Condition														
Developmental		1									2			
Trauma		1	1						1		1			
Stress	1			1			1					1		
Joint disease:														
UD	1			6	1	1				2			1	2
PE		3			2			2						1
Osteo	1	3											1	
OST		2		1	1		1				44	1		~~12~~
Ulcer/lesion			1											

Table 41. Description and quantification of major domesticate pathological specimens (excluding oral) in Phases 4 to 9

C = cattle, S/G = sheep/goat, P = pig; and the conditions are, in Joint disease – UD undefined, PE penning elbow and Osteo osteoarthritis, and OST is ossified soft tissue

Phase:	**4**		**5**			**6**			**7**	**8**	
Species:	**S**	**P**	**C**	**S**	**P**	**C**	**S**	**P**	**S**	**C**	**S**
Condition											
Malocclusion	9	2		3	5		1	4	4		1
Ante-mortem tooth loss		1				1					
Exaggerated crown height										1	
Abscess		1	1								

Table 42. Description and quantification of oral pathological specimens in Phases 4 to 8

C = cattle, S/G = sheep/goat and P = pig

Phase:	**4**	**5**	**6**		**7**	
Species:	**Ch**	**E**	**D**	**Ch**	**D**	**Ch**
Condition						
Trauma	1					
Ankylosis		1				
Joint disease:						
Undefined				2		1
Malformed				1		
Ossified soft tissue			1		1	1
Ulcer/lesion				2		

Table 43. Description and quantification of equid (E), dog (D) and chicken (Ch) pathological specimens in Phases 4 to 7

Pit:	**5580**		**9246**		**9495**	
	No. bones	**P,D,%F P/D**	**No. bones**	**P,D,%F P/D**	**No. bones**	**P,D,%F P/D**
Skeletal part						
Metacarpals	60	53,48,60.4	81	81,76,66.7	50	46,40,65.0
Metatarsals	65	53,51,64.7	83	77,80,71.2	41	39,39,56.4
1st phalange	33	33,84.8	198	196,84.7	106	105,78.1
2nd phalange	6		72		30	
3rd phalange	1		39		7	
Other bones	1		6		7	
Total	166		479		241	

Table 44. A description of the sheep/goat craft waste collections retrieved from three pits dated to Phase 7 (5580, 9246 and 9495)

P, D,%F P/D refers to, for the metapodials, the quantity of proximal and distal ends followed by the percentage of fused distal ends; and for 1st phalanges, the number of proximal ends and the percentage of fused proximal epiphyses

Site	IAS	Date	Location	Cattle	Sheep	Pig	No.	Ref
All (C1)		MS	NO	44.5	22.9	32.6	9618	1
Bridge St	6202	MS	7/BH	60.9	21.3	17.8	1476	1
St Peter's St	5202	MS	7/BH	47.3	24.4	28.2	131	1
St Peter's St	5203	MS	7/BH	50.6	20.7	28.7	3640	1
Shire Hall Yard	6904	MS	9/SE	39.3	14.9	45.8	450	1
Foundation St	4801	MS	9/SE	46.7	27.7	25.5	873	1
Foundation St	5801	MS	9/SE	25.8	36.5	37.7	379	1
Wingfield St	4601	MS	9/SE	29.7	22.9	47.5	2006	1
Buttermarket	3104	MS	7-9/C	31.3	28.4	40.3	521	1
All (J+S)		MS		47.4	25.2	27.4	7190	2
All (C2)		ELS	NO	34.5	34	31.5	NG	3
All (C2)		ELS*	NO	39.5	24	35.5	NG	3
All (C2)		MLS	NO	42	27.5	30.5	NG	3
All (J+S)		LS		63.1	18.1	18.9	631	2
Elm St	3902	EM	NW	53.8	22.1	24.1	548	2
All (C2)		EM	NO	43	28	29	NG	3
Eastern Triangle	5903	LM	SE	37.1	32.9	30	307	4

Table 45. Percentage abundance of cattle, sheep/goat and pig bones from sites in Ipswich

Using data from combined site assemblages (C1, C2 and J+S, see references below) as well as from individual sites; where IAS is the site number assigned by the Ipswich Archaeological Survey; Date includes MS (Middle Saxon), LS (Late Saxon), ELS (Early Late Saxon), MLS (Middle Late Saxon), EM (Early medieval), LM (Late medieval). * refers to ELS excluding site 22, see text; Location refers to sites north of the Orwell (NO) within the old town limits, with Bridgehead (BH), south-east (SE), central (C) and north-west (NW). 7/ and 9/ refer to 7th-century settlement and 8th-/9th-century expansion respectively; No. refers to the number of cattle, sheep/goat and pig bones with percentages calculated by number for each species/No. x 100, NG = quantities not given, percentage values estimated from fig. 4 in Crabtree in press (C2); References: 1 = Crabtree (2012), 2 = Jones and Serjeantson (1983), 3 = Crabtree (in press) and 4 = Curl (2012)